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Edited by

Ali Bahadır Yavuz - Burak Yolaçan - Matthias Bruno

DOKUZ EYLÜL UNIVERSITY - İZMİR / TÜRKİYE

Dedicated to the dear memory of

Moshe Fischer

ASSOCIATION FOR THE STUDY OF MARBLE & OTHER STONES IN ANTIQUITY

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Preface

This proceeding book includes the papers presented at the Conference of the XII. Association for the study of Marble and other stone in Antiquity (ASMOSIA XII). The conference was organized by Geological Engineering and Archaeological departments of Dokuz Eylül University, İzmir, Türkiye, on the 8th to the 14th of October. Like in the previous congresses, ASMOSIA XII was highly international and interdisciplinary. During the conference more than 100 oral and poster presentations were submitted by the partecipants, archaeologists, geologists, art historians, conservators, historians of Classical antiquity, architectural historians, chemists and physicist from at least 15 different nationalities.

The papers presented in this book can be grouped under 4 main headings like applications to specific archaeological questions – use of marble; provenance identification marble and other stones; advances in provenance techniques, methodologies and databases; quarries and geology: quarrying techniques, organisation, transport of stones, new quarries, stone carving and dressing, hazards and preservation of quarries; stone properties, weathering effects and restoration, as related to diagnosis problems, matching of stone fragments and authenticity and pigments and painting on marble.

In this symposium, which lasted 7 days, including five days of presentations and 2 days of field trips, important scientific discussions were made on the above-mentioned issues by the attendees from various disciplines. We believe that the proceeding book of ASMOSIA XII including the results of the important multidisciplinary works will help the researchers who work in these fields.

We would like to thank Dokuz Eylül University for it's support during the symposium and for printing this proceeding book. We would like to express our special thanks to Dr. Akın Ersoy and to the other organization committee members of the ASMOSIA XII conferences. Additionally, we also would like to thank the reviewers who gave important support during the reviewing processes of this book.

Finally, we want to dedicate this volume of the XII Asmosia Izmir Proceedings to the dear memory of Moshe Fischer. Esteemed colleague, one of the greatest scholar about roman architectural decoration in the Levant and in larger part of the Mediterranean, Moshe was fellow of Asmosia since the first Workshop held at Il Ciocco (Lucca, Italy) in 1988 and finally member of the executive Committee of Asmosia since 2015. We will never forget his friendliness and kindness, his archaeological expertise, his deep voice and his mustache.

Ali Bahadır Yavuz
Burak Yolaçan
Matthias Bruno

APPLICATIONS TO SPECIFIC ARCHAEOLOGICAL QUESTIONS – USE OF MARBLE

NEW RESEARCH ON IASIAN MARBLE

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Abstract

The research carried by the Italian Archaeological Mission in Iasos, or by the Italian Mission in the *chora*, often investigated the *marmor iassense*, particularly its presence within the city (in terms of forms and dating) or within quarries[1]. The place where the red cipollino marble blocks were sawn[2] was a particularly important discovery. This area used the vicinity of the eastern harbour to move the blocks and the water power of the nearby aqueduct to cut the slabs.

The huge number of waste blocks found (102, many with traces of cuts) - on a thick layer of sand - on two sides of the quadriporticus of a former tomb located against the aqueduct is evidence of significant activity. This can be dated to the 6th century, when the slabs were highly valued for their chromatism. However, the chronological data are still uncertain as well as the technical aspects and the duration of the workshop. The sand used as an abrasive, very rich in quartz and of paleo-fluvial origin[3], may originate from one of the two rivers that flowed into the "small sea", in an environment very different from today's geography[4].

Keywords: Iasos marbles, sawing technology, use of by-products.

The *marmor iassense* and sculpture

The two main lithotypes were red cipollino and brecciated; from these were obtained different manufacts: columns, pillars, cornices, mortars, tables, weights, fusaroles and more were usually made from brecciated, while flooring and sheathing slabs used cipollino[5].

The manufacture of brecciated in the round was rare: an example is the *trapeza* that belonged to the furnishing of Ephesian Hanghaus 2: its elegant carved foot ends in a lion protome[6].

Another type of iasian marble may have been used for in the round carving and also in architectural elements. It was quite rare[7], with pink-violet nuances, speckles and occasional thin streaks; the excavations evidenced this type of marble in:

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[1] Reports on iasian marble starting from Berti 1997; Andreoli *et al*. 2002; Lazzarini *et al.* 2005, for subsequent publications see *infra*.
[2] Bruno 2012, 706-714.
[3] This is the result of the analysis by Lorenzo Lazzarini, to whom we are sincerely grateful.
[4] Berti, Peirano 2016; Peirano 2018, 104.
[5] Berti, Peirano 2014. Columns made of red cipollino are also evident. See: Berti, Peirano 2016, 187, fig. 18 and example nr. inv. 6691.
[6] Quatember 2010: B-MI 5, 649-650 and 653, tfl. 248 and 276-7. See also the walled brecciated slab: tfl. 403,5 (= SR22/23) and 407. On the chronology *ante* the 262 B.C. earthquake see Parrish 1997, 600. A brecciated *labrum* foot is evident in Thasos: Ambrogi 2005 (88; type IV b; photo not provided).
[7] The lithotype should be added to the three types recorded by Lazzarini *et al.* 2005, 327, fig. 5: the veined, the brecciated and one named "Marmo Iassense Rosso Uniforme […] dal colore omogeneo […], la più rara, […] utilizzata principalmente per statuaria di piccole dimensioni, probabilmente come sostituto del 'Marmor Taenarium' (Rosso Antico), più raramente per mattonelle di 'sectilia' parietali e pavimentali […] (obtained) da livelli relativamente sottili di un uniforme colore rosso".

- the rear side (h 15 cm) of a bearded head with feral ear. On the temple, hairs were twisted around a headband (Fig. 1). It dates to the imperial age; the type (a Pan's head or a Dionysus' entourage character) suggests it was an herm[8];
- a small bent arm also of the imperial age (Fig. 2). Vertically broken along the stone fracture plane, it seems to be part of a high-relief;

Figure 1: Iasos, the rear side of an herm's bearded head (Photo: M. Molinari).

Figure 2: Iasos, a bent arm once part of a high-relief (Photo: M. Molinari).

- a round *trapeza* (Fig. 3). On the lower side - carved with different tools[9]- a central cylindrical hole and three recesses were used to insert the feet; on the upper side, incisions draw geometric shapes[10];
- an attic base type (Fig. 4) with plinth[11].

Figure 3: Iasos, the low side of a round *trapeza* (Photo: Archive Scuola Archeologica Italiana di Atene).

Figure 4: Iasos, an attic base type with plinth (Photo: M. Molinari).

Busts of a very high quality found - according to a tradition not unanimously accepted - in Hadrian's villa in Tivoli during the time of Pirro Ligorio can be added to the prestigious

[8] Nr. inv. 2641. See Angiolillo 2018, 194, fig.7: from the Agora North stoa.

[9] Among them, recognizable traces of a bush hammer and of point and toothed chisels.

[10] Nr. inv. 1898; diam. m 0.44 (now preserved in the Archaeological Museum of Izmir): See Perna 2019, 11. The slab was found in 1969 during the excavations of the so-called Artemis Astias stoa with materials dating to 150 B.C.

[11] A number of "supporti di sedili con fronte a zampa leonina" should be added to the column (Tomasello 1991, 116, tav. XVIII A-B) made of cipollino.

Ephesos *trapeza* and the modest sculptures retrieved from the Iasos excavations. The Isiac priest's bust (Fig. 5) was given as a gift by Giovanni Grimani to the Republic of Venice[12]. Other busts are the Antinous of the Capitoline Museums in Rome[13], the Louvre Antinous (a false one) and a figure with armour as part of a private collection[14]. While the former two and better-known examples are certainly original, the provenance of the latter, its authenticity and its meaning are *vexatae quaestiones*[15]. Lorenzo Lazzarini has recognized in this sculpture the *marmor iassense*[16], and this would anticipate its exportation. However, veins that are qualitatively comparable to those from which this magnificent stone was extracted emerge from none of the hinterland quarries. The in the round pieces in iasian marble now include the lion head located in the Archaeological Museum of Bodrum, at the centre of the garden's fountain (Fig. 6). It is a moulded parallelepiped block, ending with an animal's head.

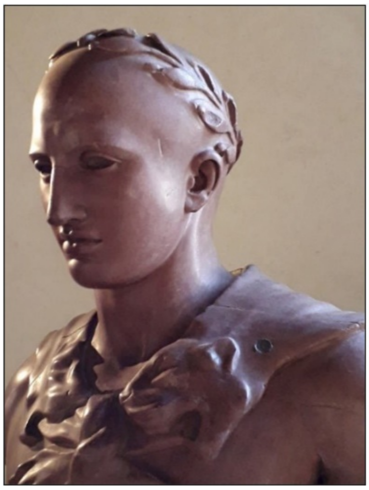

Figure 5: Isis priest bust in Palazzo Grimani in Venice (Photo: L. Innocente).

Figure 6: Lion head on display in the Archaeological Museum of Bodrum (Photo: D. Baldoni).

The flow of water was continuous and a pipeline was introduced into the rear of the head which exited from the jaws, descended along the front longitudinal groove and collected below in a basin[17]. The block - with traces of reworking - leant against a wall. The lion's head (the ears were of different material) was probably surmounted by a further element; the base is not visible as it is immersed in water. There are no comparisons with this kind of fountain.

[12] Traversari 1968, nr. inv. 117 (the author follows Forlati Tamaro's negative opinion regarding the bust's antiquity; the latter recognizes "soltanto un valore accademico puramente retrospettivo; scultore del '500?"). According to Bodon the busts were reworked and probably are parts of full-length statues; these could be "un ciclo che celebrava, nelle vesti di sacerdote isiaco, il giovane bitino" (Antinous). Some clues (the two figures' shaved heads crowned with olive branches and the leontè of the venetian bust), together with other arguments, lead the author to identify the figure with Milon). See: Bodon 1997; Venetucci 1997, 5-24.

[13] This bust too seems the result of reworking and restorations. It represents a priest of Isis: Ensoli 1997. The author believes that it originates from the time of Pirro Ligorio and from the Villa Hadriana *palaestra*: the Louvre and Venetian busts also originate from here. The branches on the head are, according to the author, laurel and not olive. The recognizing of the Antinous as "[…] sacerdote di Iside rappresenta un unicum […] ma è sostenuta da […] motivazioni storiche e religiose". However, the Louvre bust is considered a 19^{th}-20^{th} century imitation: see following note.

[14] Lavagne 2004; 2005; 2006.

[15] See: notes 12-14.

[16] Lazzarini 2004, 583-604, especially 595.

[17] Bodrum Museum, inv. 6922; m 0.79 x 0.39.

The protome finds some similarity in examples of the 5th-6th centuries[18], conversely, the muzzle's rendering recalls the zoomorphic gutters of the middle Byzantine and Seljuk ages[19], therefore the block can not be easily dated.

The time-frame could probably be reduced with further information on the place of discovery[20], in fact, the lithotype, the same as the above-mentioned fragments, by itself does not exclude the fact that it is a late work.

Other notes

Due to it being a material that was often moved or reused, it is difficult to establish a reliable chronology for the use of the different lithotypes.

In the North Adriatic, in Classe, the harbour of Ravenna, where the importation of microasiatic marbles reached high percentages, 4.7% was assignable as *marmor iassense*[21]. Here, in the Arian baptistery, part of the Theodoric's complex and less lavish with respect to the orthodox monuments of the recent past, the intrados frescos of a window (Fig. 7) imitate the veins of red cipollino[22].

Figure 7: Intrados' frescos of a window in the Arian baptistery of Ravenna (Photo: M. Molinari).

With respect to reuse, brecciated slabs from S. Apollinare in Classe, were immured in Rimini's Tempio Malatestiano (from 1447)[23]. In Constantinople during the mid-Byzantine period, red cipollino fragments were used in the marble *omphalos* of Hagia Sophia[24]; close to Iasos, the marble continues to embellish Mylasa's Firuz Bey Cami[25]. In this edifice, built in 1394, the red marble appears both in the exterior and inside: in the porch, the marble appears as a step block and in the door lintel, as tiles in the same entrance, in window cornices and flanking the mihrab, where the stone also appears in two colonnettes.

F. B.

[18] Firatli 1990, 350- 359, especially 351, tab. 20, figs. 50a, b, tab. 21, figs. 5a,b; here the author presented a series of "gargouilles et bouches de fontaines".
[19] Niewöhner 2018.
[20] The marble piece originates from Muğla. The fountain is a product of a refined milieu, whose members were educated and wealthy.
[21] Tumova *et al*. 2016.
[22] Gerola 1923, 113-114.
[23] Novara 2007, 128; Grillini 2007, 140 and 142. About Ravenna and Venice see also: Berti, Peirano 2014, 46.
[24] Pedone 2012, 751-765.
[25] Akarca, Akarca 1954, 99-102.

The aesthetics of iasian marble

Iasian uniformly-coloured marble was generally appreciated for its vividity while red cipollino was popular due to the contrast between the vivid background and the white or pale grey wavy veins. The latter was used in parietal contexts mainly as a decorative apparatus, while other qualities were utilized in pavings. In relation to these considerations, our research unit is investigating the different uses of *marmor iassense* and its various associations with other stones[26], mainly at the time of its *floruit*, the 6th century. With respect to the maps or lists of findings it should be noted how in many places these uses and associations are not verifiable, as the evidence is erratic or involves reuse.

In Macedonia iasian marble is widely attested[27], it is even sometimes difficult to reconstruct its patterns of use. An example is Amphipolis' Basilica A[28]: here scattered thin slabs made of cipollino demonstrate its use as wall cladding, while other wall fragments attest reuse. Again related to reuse is the presence of brecciated red marble, together with cipollino, in *scutulatum* paving in the room facing the narthex, from the south. Here the red marble appears with white and grey marble together with a few pieces of green cipollino.

In Philippi's Basilica A[29], iasian marble appears in two annexes in the north side of the church, again in *scutulati*. Here, more than before, the polychromy provided by the red marble[30], the green breccia and the alabaster emphasises these secondary spaces. The material colours, sometimes strong, sometimes delicate, together with the texture's proliferation, probably enhanced the perceived luminosity of rooms mainly lit by lamps.

Again, in Philippi, Iasos marble is used in *sectilia* in the stoa preceding the octagon complex[31]. Here the red marble alternates with other dark stones to frame a brighter panel or in some circles located at the corners of a net motif[32]. A large cipollino scattered slab may attest to the presence of floorings also made with this material, also seen in a colonnette fragment showing both the veins and the clasts of breccia[33]; however, these are not attributable with certainty to any part of the building.

In Thessaloniki, in the church of Hagios Demetrios[34], iasian marble is widely evident. In the walls flanking the *tribelion* large cipolllino slabs are preserved, arranged in a mirror-like configuration. These were divided into white and coloured marbles with patterns pronounced by means of denticulated frames. On the same walls, toward the nave, the design becomes more complex: in the arched lintels, red cipollino appears in scalar triangles, a motif in which it is alternated with grey veined marble. In the central sector of the same wall iasian marble recedes as the dark background of a sophisticated curtain-like motif, where the drapes are made of grey marble (Fig. 8). This ingenious design is framed by a parastas made of Thessalian breccia. Only two of the six curtain-like slabs still visible before the fire of 1917 remain (Fig. 9)[35]. The slab toward the north aisle appears remarkable, where the marble texture, made of almost vertical veins, seem to suggest the folds of a curtain. iasian marble re-appears in the north wall of the west end of the nave, here in a large rectangular slab framed by a bright veined grey marble.

---

[26] On the aesthetics of marble in byzantine times see Kiilerich 2012, 9-28.

[27] The diffusion map of iasian marble draws two somewhat concentric circles, one corresponding to the Aegean Sea and one to the eastern Mediterranean.

[28] On the building: Taddei 2008, 269-279 and the related bibliography.

[29] On the building: Lemerle 1945, 283-412; Gournaris, Gounari, 2004, 39-44.

[30] These are used both in the brecciated and in the cipollino varieties.

[31] On the building: Pelekanidis 1980, 149-158.

[32] Additionally, an *opus sectile* with an intersecting circles motif includes pieces of iasian monochrome.

[33] On these particular pieces: Baldoni 2005, 112.

[34] On the building: Brenk 1994, 27-38.

[35] See the figs. 8-9.

Finally, we find red cipollino in the arched lintels. Here two types of arches contrast with each other: in one the grey marble alternates with the green breccia, in the other with the red cipollino.

Figure 8: Thessaloniki, Hagios Demetrios: the iasian marble used as a dark background of a curtain-like motif (Photo: D. Peirano).

In Asia Minor, in the presbytery enclosure of the St. John Basilica in Ephesos, iasian cipollino was used both in the stylobate and in the bases that supported the columns[36]. While the stylobate blocks were arranged to exhibit the wavy veins toward the presbytery, the bases' marble textures were visible from the nave, using them, at the same time, in a more practical manner from a static point of view.

Figure 9: Thessaloniki, Hagios Demetrios: a watercolor showing the west end aisles before the 1917 fire (Drawing: Walter Sykes Georges, British School of Athens).

The presence of unworked blocks unearthed during excavations seems to testify to the manufacture of stylobate on the building site. It is difficult here to understand how the red marble was associated: in fact, the lintel that crowns the enclosure and the capitals below are evidently late byzantine works, but the supports may be earlier: a column made of green breccia stands out among others made of light grey marble[37].

It should be noted how in St. John red cipollino is used to frame the most sacred part of the building. In the Basilica of Mitropolis in Gortyna, rather than delimiting, the red marble

[36] Deichman 1976, 216; Berti, Peirano 2016, 184.

[37] Here is also preserved a small fragment of column, and a large plate flanks the access steps to the baptismal pool, but the latter seems a later repair.

seems to have marked a path: in fact, here the stone appears in the floor of the path crossing the *solea* from north to south[38]. In any case, the cipollino was used to frame the *naos* of Nea Anchialos' Basilica C[39]: here large slabs, embedded within others made of light grey veined marble, enclosed *opus sectile* carpets. These show a design where from hexagons of red monochrome starts a radial design made of grey and white marble. In the *synthronon* cladding there reappears the alternation between red and white marbles, both now veined; in the baptistery's floors, the carpets' designs appear to be more conventional[40].

Iasos marble is also evident in Church A[41]: as in Basilica C, large veined tiles sheath the vertical sides of the *synthronon* seats, where they alternate with white slabs. Large tesserae appear in the aisles and in secondary spaces in somewhat raw geometric mosaics, which alternate with dark and light grey pieces.

Figure 10: Istanbul, Hagia Sophia: the intrados of a windows galleries arc alternating red cipollino and *pavonazzetto* (Photo: D. Peirano).

Iasian marble appears in front of and in the sides of presbytery[42]; in the latter carpet rectangular tiles frame the central areas made of white veined marble; here the monochrome is sometimes replaced by pavonazzetto, to visually create a unique dark cornice. In general, Iasos and phrygian marble seem to establish different relationships according to the various proportions of purple background in the latter. Where purple prevailed the two marbles seem to have been considered interchangeable, while when white or yellowish clasts predominate, they were placed in contrast. The exchange between iasian and phrygian marbles already ascertained in Thessaloniki is also evident in Constantinopolitan Hagia Sofia, where the two stones were alternated in a number of arches of the gallery windows[43] or are used with the same purposes in wall revetments (Fig. 10)[44].

D. P.

[38] On the use of these paths see Majeska 1978, 299-308; Farioli Campanati, Bourboudakis 2005, 167; Berti Peirano 2016, 184.
[39] On the building: Karagiorgou 2001, 189-192 and the related bibliography.
[40] It includes monochrome and veined marbles. However, the date proposed by excavators (4th century) seems too early.
[41] A summary of excavations can be found in: Karagiorgou 2001, 189, note 34 and related bibliography.
[42] However, in the front of the presbytery these carpets are difficult to understand.
[43] Barsanti 2004, 68; Russo 2011, 105.
[44] Schibille 2014, 120, pls. 6-7.

To conclude, it seems that the Iasos red marble was popular from the imperial age until the 7th century and that Thessaloniki's Saint Demetrios, built between 629–634, seems to be one of the latest examples of its primary use. During this time the marble underwent three periods of re-appraisal: in the Hadrianic age its brecciated quality was used for sculptures, while between the tetrarchic and the Constantinian age veined columns, slabs and tiles decorated some of the most prestigious public buildings of the time. But it was during the Justinianic era that *marmor iassense* experienced the height of its glory, and its columns, sheathings and pavings were used in many edifices built by the emperors or their entourages. This is confirmed by the fact that almost all of the churches here presented belong in this period. During it, the red marble revetments were also placed in contrast with light or green marbles through textures. In some instances, red marble establishes special relationships - of contrast or exchange - with phrygian. When cipollino with dark red veins was maximally used to clad the walls of prestigious buildings, iasian breccia was also used for columns[45], and columns were obtained locally from its pink variant.

While the surveys related to the uses of iasian marble within the city and the exploitation of quarries are almost complete, the research lines presented here are currently ongoing and the results should be considered preliminary, such as the map of findings that is subject to periodic updates.

[45] See in Ravenna the two columns from Sant'Andrea Maggiore reused in the cathedral: Berti, Peirano 2014, 47. Theophanes mentions 7 and 5 columns of iasian marble once admirable (with other polychrome marbles) within a number of pavilions of an imperial palace in Constantinople: these were probably of brecciated marble. Theophanes Continuatus in Featherstone 2018, 180 ff.

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LEPCIS MAGNA AND THE LESBOS MARBLE

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Abstract

The marmorization of Lepcis Magna started in the first half of the 2nd century AD with the Hadrian's Bath and reached its top with the great Severan Complex. During this marmorization process apparently only two main white marble qualities were used, Proconnesian and Pentelic marbles. However, a systematic large-scale research program reveals that another unexpected quality was largely diffused and never recorded before. This quality identified macroscopically as glassy and brilliant, white to grayish in color and characterized by an indefinable grain size is largely attested and was used for column bases and Corinthian capitals of medium size and is largely attested in all the monuments of Lepcis Magna, except the Severan Complex. This marble has similarities with the gray shell rich marble from Lesbos quarried in the district of Moria. For this reason, a large sampling was undertaken at Lepcis Magna and the samples were submitted to archaeometrical analyses (stable isotopes, EPR, MGS, thin section) to be compared with the new database from the Lesbos quarries. The results show that this marble can be identified with a Lesbos variety quarried mainly in the district of Karyni, central Lesbos, even if other ones could be recognized as the darker quality coming from the Moria quarries.

Keywords: Lepcis Magna, Corinthian capitals, white marbles.

Introduction

Recent work carried out systematically on the architectural marbles used at Lepcis Magna and based mostly on accurate macroscopic inspection of the artifacts strongly suggests that besides proconnesos and pentelic marbles at least another marble variety was extensively used in the city as testified by hundreds of medium size column bases and Corinthian capitals, of which approximately 130 were sampled for the present research. The "unknown Lepcis marble" can be easily distinguished from most other varieties because it lacks the typical saccharoidal structure that is characteristic of most crystalline marbles and suggests a possible provenance from Lesbos Island where recrystallized limestones and/or low metamorphic marbles have similar features. Freshly broken surfaces generally exhibit an almost "glassy" appearance where the presence of calcite microcrystals is difficult to recognize. The color generally ranges from almost white or light gray to dark gray. The properties strongly suggest that the unknown marble used at Lepcis Magna might be, in fact, a lighter colored variety of the bigio antico that was quarried in the quarry district of Moria on the Greek island of Lesbos. Despite this, the close petrographic similarity often existing between the unknown Lepcis Magna and Moria bigio antico still supports the Lesbian provenance of this marble and suggests that other quarries on the island, different from Moria, might have been the source of the marble used at Lepcis. Following this assumption, a new survey of Lesbos Island was carried out and several quarries (Fig. 1), that have been recently reported[1], but never studied archaeometrically, were sampled in order to obtain a final reference database.

[1] Varti-Matarangas, Matarangas 2015; Leka, Zachos 2015.

The Lepcis Magna archaeological artifacts have been submitted to a full analytical characterization and the results were compared with the new quarry data for which generally only isotopic results are available and other data, such as MGS, EPR or trace analyses, were measured only for some groups of samples and are, therefore, of limited use. As already stated, macroscopic inspection and petrography allows in most cases to exclude provenance from Proconnesos or other sites producing crystalline marbles and indicates Lesbos as the most likely marble source for the majority of the Lepcis Magna samples. The results demonstrate that most samples come, in fact, from Lesbos quarries in the area of Karyni, whereas a few other belong to the already known quarries of Moria.

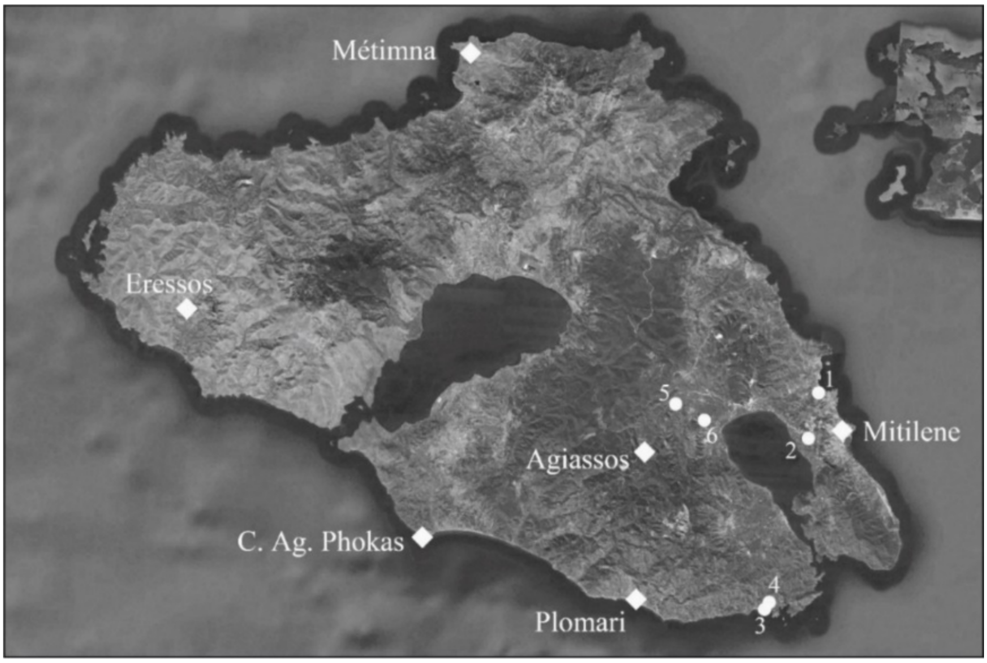

Figure 1: Location of considered Lesbos marble quarries: **1**. Moria; **2**. Alyfantas; **3**. Tarti; **4**. Tsaf Agia Paraskevi; **5**. Karyni; **6**. Ippio – Dipi (Photo: Google Earth modıfied by M. Bruno).

The Lepcis Magna monuments

Corinthian capitals and Attic column bases in Lesbos marble were recognized mostly in all Lepcis Magna buildings, except the large Severan Complex, testifying the widespread marmorization's process of the city during the 2nd century. The Hadrian's Baths, the Theatre, the Basilica and the Oriental Temple of the *Forum Vetus*, the *Macellum*, the *Serapeum* and the Temple on the *Decumanus* are the considered contexts, in which the architectural elements were sampled and have been analysed also stylistically to better define the chronology of the production of the items in this new litotype.

Baths of Hadrian

The Baths of Hadrian are the starting point of the marmorization process of Lepcis Magna. They are placed along wadi Lebda and they were excavated by Pietro Romanelli and Renato Bartoccini in the 1920s. The thermal complex was inaugurated during the *proconsulate* of Publius Valerius Priscus between February AD 137. and February AD 138. The *caldarium* was totally remodelled under Marcus Aurelius, while the whole reconstruction of the *frigidarium* and its *crypta* were supported by Q. Marcius Candidus Rusonianus *duovir quinquennalis*, *augur* and *flamen* under Emperor Commodus. Partially restored in the 4th century the Baths were abandoned just in part around the middle of the 5th century due to flooding of the nearby wadi[2]. Six Attic column bases (TA1-TA6) and one Corinthian capital (TA7), all in Lesbos marble and placed in the northern-western apsed hall of the *gymnasion*, have been sampled. Attic column bases (Fig. 2) have uniform shape but different dimensions[3]. The firm and compact profile allows to date them from the second half of the 2nd century onwards[4].

The Corinthian capital TA7 (Fig. 3) has acanthus leaves cut-out on the surface of the *kalathos*, to which they perfectly adhere. This type of working allows to date it to the late Antonine period as many other capitals used for the restyling of the Baths gymnasium[5].

Figure 2: Lepcis Magna, Hadrian's Baths, gymnasium, northern-western apsed hall. Attic column base TA3 of dark grey Moria marble (Photo: F. Bıanchi).

Figure 3: Lepcis Magna, Hadrian's Baths, gymnasium, northern-western apsed hall. Corinthian capital TA7 of dark grey Lesbos Moria (Photo: F. Bıanchi).

Oriental Temple at the *Forum Vetus*

The Oriental Temple at the *Forum Vetus* is a cult building with three rooms distyle *in antis* preceded by a central porticoed courtyard on three sides, which was built by Calpurnia Honesta in AD 153[6]. The columns of the porticoes of the courtyard and of the rooms have Attic column bases, shafts of cipollino marble and Corinthian capitals. 14 column bases (AP1-AP 5; AP7-AP9; AP12-AP17) and 9 capitals (AP6; AP10-AP11; AP19-AP24) have been sampled, all of Lesbos marble. Column bases[7] so well shaped are widespread in the whole Antonine period side by side other ones which have a generally more compact profile in the Commodus age[8].

[2] Bartoccini 1929; Pentiricci 2010, 143-145; Bianchi, Bruno 2018; Bruno *et al*. 2020, 64.

[3] The bases TA1- TA3 and TA 6 have a maximum visible height of 21 cm and a diameter of 56 cm, the bases TA4 and TA5, located in the centre of the northern side of the hall in correspondence of the apse, have a maximum visible height of 27.0 cm and a diameter of 66 cm.

[4] In this regard see the comparisons with the bases of the Eastern Gymnasion of Ephesos, whose construction, based on the analysis of the architectural decoration, follows that of the Gymnasion of Vedius, Plattner 2008, 278.

[5] Bianchi 2009, 53-54; Bianchi, Bruno 2018, 129-130; Bruno *et al*. 2020, 64.

[6] IRT 370 and 371. Pentiricci 2010, 131-132, n. 215; Bruno *et al*. 2020, 65.

[7] The Attic column bases with plinth of the central room (AP8 – AP9) are about 30 cm high, the top diameter is 69-70 cm; the other column bases of the portico of the courtyard and of the lateral rooms are about 28 cm high, the top diameter is 57-58 cm, Bruno *et al*. 2020, 65.

[8] About the variety of the bases shape from the Hadrianic to the late Antonine period see the column bases of the Southern Baths and of the inner courtyard remodelled by Plancia Magna in Perge, Boatwright 1993; Caceres-Cerda 2018, those of the stoas of the Agora of Iasos, of the Gymnasium of Vedio in Ephesos, Plattner 2008, 275, of the Agora of Smyrna and of the Nymphaeion of the Upper Agora of Sagalassos, Vandeput 1997, 212-213. The Attic column bases of the Oriental Temple at the *Forum Vetus* can be considered a fix chronological

The sampled Corinthian capitals AP6 (Fig. 4), AP10, AP11 (Fig. 5), AP19, AP20, AP21, AP22, AP23, AP24 are pertinent to the porticoes of the inner courtyard and to the smaller rooms[9]. They are a typical example of standardized production of the mid 2nd century based on Hadrianic patterns[10]. Proconnesian capitals of the same period at Caesarea and Beth Shean in Israel testify the trade of so shaped artefacts all around the Mediterranean Sea[11].

Figure 4: Lepcis Magna, *Forum Vetus*, Oriental Temple. Corinthian capital AP6 of light grey Karyni marble (Photo: F. Bianchi).

Figure 5: Lepcis Magna, *Forum Vetus*, Oriental Temple. Corinthian capital AP11 of light grey Karyni marble (Photo: F. Bianchi).

Basilica of *Forum Vetus*

Placed on the south-east side of the Forum's square, the Basilica must be identified with the so-called *tripertita porticus* built and embellished with the Troas granite by Laenatius Romulus, *praeses* of Tripolitania province in 324-326 A.D. in only one year[12]. The late antique Basilica is an opened space facing the square and surrounded by a Troas granite colonnade on three sides; rooms are placed on the short south-western side.

11 Attic column bases (B3, B6-B8, B11, B13, B15) and 8 Corinthian capitals (B1, B2, B9, B10, B12, B14, B16, B17) have been sampled. The column bases all of Lesbos marble and uniform in dimensions are of the type widespread in the 2nd century: with the exception of the Attic column bases B 8 and B 15 very similar to that AP7 of the so-called Oriental Temple, the other ones are more comparable to those previously analysed of the Hadrian's Baths[13]. With the exception of the Corinthian capital B1 in Prokonnesos marble, the other ones are of Lesbos marbles but all metrologically uniform[14]. The acanthus leaves are much more adherent to the *kalathos*; the drill runs on the surface of the leaves creating deep channels so to emphasize the chiaroscuro. All the decorative elements like elices, volutes,

point very important in the studies of this class of items because they are pertinent to a building well dated by inscriptions, Bruno *et al*. 2020, 65-66.

[9] The Corinthian capitals are 59 cm high and the lower diameter is 44 cm.

[10] In this regard see the capitals of series 2 of the Hadrian's Baths, Bianchi, Bruno 2018, 129; Bruno *et al*. 2020, 66. About the use of more linear vegetal elements decorating the upper part of the *kalathos* of capitals, like elices hook-shaped and the V ornament behind the top of the leaves of the upper acanthus row, see the capitals of the Temple of Zeus-Esculapius and of latrine of the Asklepeion at Pergamon dated to Hadrianic-early Antonine period, Rohmann 1998, 80-81, cat. C30-C32 p. 133.

[11] Fischer 1990, 41-44, groups II, IIIA e IIIDb.

[12] IRT 467; Pentiricci 2010, 134-140; Bruno *et al*. 2020, 66.

[13] The Attic column bases are 32 cm high and the top diameter is 68 cm, Bruno *et al.* 2020, 67.

[14] The capitals are 66-68 cm high and the lower diameter is around 48-50 cm, Bruno *et al*. 2020, 67.

calices are quickly worked. Therefore, also these capitals are a standardized product of the fully 2nd century: in particular, the working's type suggests to date them to the late Antonine period, chronology confirmed by the comparison with other Corinthian capitals of Palestine, which are so identical to those of Lepcis Magna confirming the existence of this massive standardized production[15].

Theatre

The huge Theatre built by the notable Annobal Tapapius Rufus at the beginning of the 1st century was totally embellished in Antonine period replacing the original architectural settings in local stone with new ones of coloured and white imported marbles. The restyling involved the stage building, the porticos *post scaenam* with the Temple dedicated to *dii Augusti* and the *porticus in summa cavea* with the Ceres Augusta Temple[16]. Have been sampled 6 column bases (T1-T3; T5-T7) and 1 Corinthian capital (T4) of the Augusta Temple, 9 Attic column bases (T8-T16) and 1 Corinthian capital (T17) of the Temple of *dii Augusti*, 8 Attic column bases (T18-T20; T22, T23, T28, T29, T32) and 6 Corinthian capitals (T21, T24, T25, T27, T30, T31) of the *porticus post scaenam*.

The column bases (T1-T3; T5-T7) in Lesbos marble of the Temple of Ceres Augusta are of Ephesos type[17], whose first examples are dated back to the 6th century B.C. In the imperial period bases of this type continued to be used side by side other ones in a same building, as for example in the temple of Apollo at Didyma[18] and in the temple of Zeus at Aizanoi[19]. The column bases of Ceres Augusta Temple can be compared with those of the latter one[20] and with those of the Oriental temple[21], whose Corinthian capitals are very similar to the capital T4 in Lesbos marble of the Temple in *summa cavea*[22]. The sampled column bases of Lesbos marble T8-T16 are pertinent to the façade (T8-T13) and to the cella (T14-T16) of the Temple of *dii Augusti*[23]. Quite all the column bases have a compact profile with the exception of those T11 and T13 whose profile is more shapely thanks to a more enlarged lower torus and a flared scotia. But, as it has been already pointed out, column bases so shaped can be used in a same period, the Antonine age. The Corinthian capital T17, the only one to be sampled, can be dated specifically to the mid Antonine period[24]. The 8 column bases (T18-T20; T22, T23, T28, T29, T32)[25] and the 6 Corinthian capitals (T21, T24, T25, T27, T30, T31)[26] of the porticos behind the stage building of the Theatre are not formally a homogenous group but on the base of the comparisons with other items already analysed can be dated from the mid to the late Antonine period (Fig. 6). The heterogeneity of shapes and chronology of these architectural elements allows to hypotize also in this case the use of artefacts ready to be employed coming from stockpiles.

[15] Fischer 1990, 44-45, group IIIDc; Bruno *et al*. 2020, 67-68.
[16] Pentiricci 2010, 115-118, Bruno *et al*. 2020, 69.
[17] The column bases are 34 cm high and the upper diameter is 66,5 cm, Bianchi 2009, 60, fig. 31; Bruno *et al.* 2020, 69.
[18] Pülz 1989, 17-46.
[19] Naumann 1979, 17-20; recently a new chronology of the temple has been proposed on the base of a new reading of the inscription, Posamentir, Wörrle 2006.
[20] Weber 1969,199, tav. 81,3; Naumann 1979, 21, tab. 20.
[21] In particular, see the shape of the upper torus.
[22] The capital is 74 cm high and the lower diameter is 58 cm, Bianchi 2009, p. 60, fig. 30; Bruno *et al*. 2020, 69.
[23] The column bases of the façade of the temple are 30 cm high and the top diameter is 58 cm; the column bases of the entrance of the cella are 27 cm high and the top diameter is 48 cm; the column bases of the inner order of the temple are 22 cm high and the top diameter is 44 cm, Bruno *et al*. 2020, 69-70.
[24] See Fischer 1990, 43, cat. 46, group IIDc; Bruno *et al*. 2020, 70.
[25] The column bases of the western *stoa* are 32 cm high and their diameter is 58 cm; the column bases of the other *stoai* are 25 cm high and the diameter is 48 cm, Bruno *et al.* 2020, 70.
[26] The capital T21 is 56 cm high, the lower diameter is 44 cm; the other capitals are 48 cm high and the lower diameter is 36-36,9 cm, Bruno *et al*. 2020, 71.

Macellum

The *Macellum* is one of the first public buildings of the city dated to the end of 1st century BC. It was quite totally marmorized in the 2nd century: the marble restyling involved the southern *tholos* with shafts of cipollino and Ionic Capitals and Attic bases in Pentelic marble and the porticoes of the courtyard with shafts of Troas granite, Attic column bases and Corinthian capitals of Prokonnesos, Pentelic and Lesbos marbles[27]. 15 Attic column bases (M44-M50; M52, M54, M56, M58, M61, M67, M69, M70) and 11 Corinthian capitals (M51, M53, M55, M57, M59, M60, M62-M 66) of the porticoes, all of Lesbos marble, have been sampled[28]. Both capitals and column bases are not shapely homogenous so that it is possible to divide them in three groups. The group 1 collects the column bases M44, M49, M52, M54, M56, M70 dated to the late Antonine period as those of group 3 (M47, M48 e M67) while the column bases of group 2 (M45, M46, M50, M58, M61, M69) are dated to the early Antonine period[29]. The Corinthian capitals (M59, M65, M66) of the group 1 (Fig. 7) are dated to the late Antonine period being very similar to those of the Basilica of *Forum Vetus*; the group 2 (Fig. 8) collects capitals (M53, M60, M62, M63, M64) datable from the late Antonine period to the Severan age[30], the group 3 is formed by capitals M51, M55 (Fig. 9), M57 datable not before the end of 2nd century[31]. Also, in this case, the chronological decalage of the artefacts is an indication of the use of stocks of materials that are used for the marmorization of the building[32].

Figure 6: Lepcis Magna, Theatre, Portico *post scaenam*. Corinthian capital T 21 of grey Karyni marble (Photo: F. Bianchi).

Figure 7: Lepcis Magna, *Macellum*. Corinthian capital M66 of grey Karyni marble (Photo: F. Bianchi).

[27] Pentiricci 2010, 120-124; Bigi 2010, 124-127.
[28] The base M 45 of the southern colonnade is 31 cm high and the top diameter is 57 cm; the other column bases are around 26 cm high and the diameter is around 50 cm; the Corinthian capitals, all pertinent to the smaller colonnades, are 46-50 high and the diameter is around 36 cm. Bruno *et al*. 2020, 72.
[29] Bianchi 2009, 56-57; Bruno *et al*. 2020, 72.
[30] Fischer 1990, 45-46, groups IIIE-Db, IIIE-Dc; Bianchi 2009, 55-56; Bruno *et al*. 2020, 72.
[31] Fischer 1990, 47, group IVCb; Bianchi 2009, 55-56; Bruno *et al*. 2020, 73-74.
[32] Bianchi 2009, 57-58.

Figure 8: Lepcis Magna, *Macellum*. Corinthian capital M60 of grey Karyni marble (Photo: F. Bianchi).

Figure 9: Lepcis Magna, *Macellum*. Corinthian capital M55 of light grey Karyni marble (Photo: F. Bianchi).

Serapeum

The *Serapeum* is placed in a courtyard with columns of Annaba marble facing a parallel street north of the so-called *Cardo Maximus*. The temple has an high podium and the façade had 4 column shafts of white Skyros marble[33]. 10 Attic column bases (TS1-TS10) and 2 Corinthian capitals (TS11-TS12) of the courtyard have been sampled. The Attic column bases (Fig. 10)[34] and the capital TS12 (Fig. 11)[35], all of Lesbos marble, can be dated between the early and the mid Antonine period[36]; the capital TS11 (Fig. 12)[37], of prokonnesian marble, is not pertinent to the colonnade of the courtyard due to its small dimensions but testifies, anyway, the changing of the shape in the production of capitals in the full 3rd century[38].

Figure 10: Lepcis Magna, *Serapeum*. Attic column base TS1 of grey Karyni marble (Photo: F. Bianchi).

[33] Pentiricci 2010, 127-128; Bruno *et al*. 2020, 74.
[34] The column bases are 27 cm high, the diameter is 52 cm.
[35] The capital TS12 is 54 cm high and the diameter is 46 cm.
[36] In particular, the capital can be compared with that T 31 of the Theatre and that AP6 of the Oriental Temple.
[37] The capital TS11 is 33 cm high and the diameter is 24,0 cm.
[38] The capital apparently recalls patterns of late Antonine age, Fischer 1990, 45-46, groups IIIDc, IAc, IIIE-Db, IIIE-Dc, but the reduction of the acanthus crowns to only one and the marked rigidity of the leaves, determined by long and oblique pointed lobes of the leaflets, allow to move on the dating of the capital without arriving to the second half of the 3rd century because the capital has still the helices, whose lack is indicated by Moshe Fischer as "*das wichtigste Merkmal*" of the capitals produced in the late 3rd century, Fischer 1990, 53.

Figure 11: Lepcis Magna, *Serapeum*. Corinthian capital TS12 of grey Karyni marble (Photo: F. Bianchi).

Figure 12: Lepcis Magna, *Serapeum*. Corinthian capital TS11 of Prokonnesos marble (Photo: F. Bianchi).

Temple on the *Decumanus*

The Temple on the *Decumanus*, is inside a courtyard whose porticoes have shafts of Troas granite[39], Attic column bases and Corinthian capitals of Lesbos marble with the exception of two items of Prokonnesos marble[40]. 7 Attic column bases (TDI1, TDI2, TDI4-TDI7, TDI10), of which TDI 10 is of Prokonnesos marble[41] and pertinent to the northern entrance of the cultic building, and 8 Corinthian capitals (TDI3, TDI8, TDI9, TDI12-TDI16) of the inner courtyard have been sampled[42].The column bases, despite some differences in their shape, are chronologically an homogenus group of fully Antonine period[43]. The Corinthian capitals in Lesbos marble (TDI3, TDI8, TDI9, TDI12-TDI14, TDI16)[44] and that TDI15 in Prokonnesos[45] testify again the commune type widespread in mid and late Antonine period[46]. The capital TDI 15, even if it has a more soft modelled acanthus, must be dated to the same period of the other ones because it is comparable with the Corinthian capitals pertinent to the rebuilding of the Agora of Izmir[47] after the earthquake in 177 and with those of the *Nymphaion* of the Upper Agora of Sagalassos[48]. Once again there is the use of artifacts from storage depots.

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[39] The granite of the shafts is wrongly identified as misian granite, Trapani 2011, 185.
[40] Buscemi 2011, 35-54.
[41] The marble is wrongly identified as Pentelic in Trapani 2011, 185, cat. 7-b/21.
[42] About the dimensions of the column bases see Trapani 2011, 184, list 1, whose correspondence is the following: TDI 1= n. 4, TDI2 = n. 6, TDI4 = n. 14, TDI5 = n. 16, TDI6 = n. 17, TDI7 = n. 18, TDI10 = n. 21; about the dimensions of the sampled capitals see TRAPANI 2011, 190, list 5, whose correspondence is the following: TDI9 = n. 1, TDI16 = n. 4, TDI15 = n. 6, TDI14 = n. 14, TDI13 = n. 17, TDI12 = n. 18, TDI3 = n. a, TDI8 = n. b.
[43] The Lesbos marble of the architectural elements has been wrongly identified as Prokonnesos or Pentelic in Trapani 2011, 183-191.
[44] The marble of these capitals is wrongly identified as Prokonnesos in Trapani 2011, 187-188, group A.
[45] The litotype of the capital TDI 15 is wrongly identified as Pentelic in Trapani 2011, 190, n. 25 –c/6 e p. 118, group B.
[46] At Lepcis Magna this type of capitals is attested in the restyling of the gymnasium of the Hadrian's Baths, Bianchi 2018, 134 (to be corrected "antoniniana" in "antonina" due to an editorial mistake); Fischer 1990, gruppo IIIDc, pp. 44-45. *Versus* Francesca Trapani who prefers to date the capitals not before the end of 2nd century, Trapani 2011, 188.
[47] Vandeput 1997, 141, tab. 120, 1-2; Ersoy *et al*. 2023.
[48] Vandeput 1997, 100–105.

Lesbos quarries

The database of Lesbos marbles includes 224 quarry samples of 6 different quarries and about 20% of the data were taken from literature. Samplings have been carried out in the Moria district and in the Karyni, Alyfantas, Tarti and Tsaf Aghia Paraskevi quarries, following indications provided by Varti Matarangas and Matarangas[49]. Not all the mentioned sites were sampled, due to their very small size, or not found, such as Thermi, where the marble seems to be very similar to the Moria bigio antico macroscopically and from the analytical point of view. According to Varti Matarangas and Matarangas, Karyni, where five different quarrying locations were sampled, is the second largest and most exploited production area after Moria and the marble is generally light gray or gray, similar in color to the marbles sampled at Lepcis Magna. The following quarries were sampled and considered in the present work[50]:

1) Moria, n. 103[51];
2) Karyni, n. 43[52];
3) Alyfantas, n. 35;
4) Tarti, n. 19;
5) Tsaf Aghia Paraskevi, n. 17;
6) Ippio - Dipi, n. 17.

Lesbos petrography

The marbles from Lesbos have been variously defined as low to very low metamorphic marbles or heavily diagenetized limestones[53]. As such they exhibit a great number of different textural and structural features and even a summary of this vast topic is beyond the limits of this work. Especially at the transition from limestone to marble (in the petrographic sense – a metamorphosed carbonatic rock) the resulting textural features may be manifold and depend on several prerequisites. The most important agent for the recrystallization of a limestone is the degree of thermal overprint the corresponding rock suffered. Usually the continuous rise in temperature results in an increasing grain-size of the carbonate crystals as can be demonstrated in areas with a steep metamorphic gradient as for example on the island of Naxos.

Investigating petrographically the marbles from the ancient quarries of the island of Lesbos multiple textural types may occur in a context of low metamorphic imprint. Thin sections may be typical of fossiliferous limestones with a moderate thermal overprint and crystallization in its initial state, but can also show the characteristic features of well crystallized fine to medium grained marbles.

Generally, however, the fully crystallized areas correspond to small patches that are only few mm wide. Correspondingly the macroscopic aspect of the stones will be glassy, crystalline or, sometimes, glassy dotted by crystalline patches. The Karyni sample KY1.14 (Fig. 13a-b) is not well recrystallized and shows in the centre relics of fossil fragments. Numerous shadowy, recrystallizing fossil fragments are present.

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[49] Varti-Matarangas, Matarangas 2015.
[50] For detailed sampling description see Bruno *et al*. 2020, 77-78.
[51] 58 samples were taken in 2008, Attanasio *et al*. 2017, 798-805, while 45 are from previous papers, Lazzarini, Pensabene, Turi 1999, 128.
[52] The Karyni district consists of five different sites: Karyni I (20 samples), Karyni II (4 samples), Karyni III (4 samples), Karyni IV (5 samples) and Karyni V (10 samples).
[53] Lazzarini, Pensabene, Turi 1999, 128; Leka, Zachos 2015, 202-203; Bruno *et al*. 2020, 79-82.

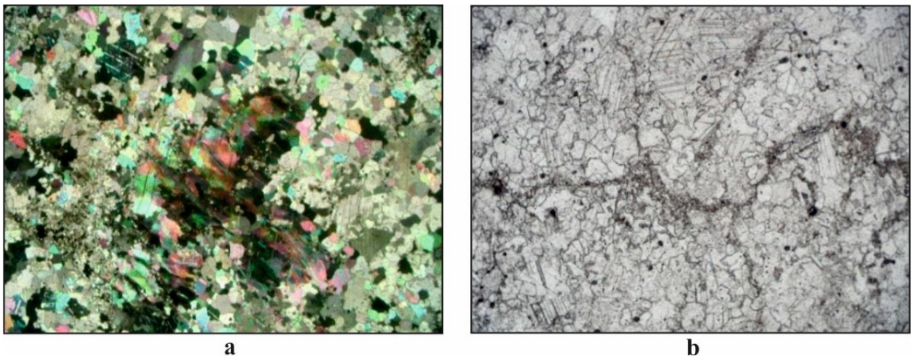


Figure 13: Thin section of Karyni I quarry sample, n. KY1.14, in polarized (**a**) and transmitted light (**b**). Again a sample not well recrystallized. Shadowy, recrystallizing fossil fragments are common. Wavy, undulatory extinction of these fragments which are situated in a matrix of small calcite grains is obvious. Image length 6 mm (Photo: W. Prochaska).

The wavy, undulatory extinction of these fragments which are found in a matrix of small calcite grains is clearly evident. In general, the less recrystallized parts of the rock exhibit all shades of greyish colours. As this rock practically lacks silicate impurities or graphitic substance this colouring is most probably due to immature organic substance (not yet mineralized because of the low overprint) distributed throughout the rock. The formation of stylolites is widespread and the insoluble organic substance is concentrated in serrated surfaces as a consequence of pressure dissolution of the carbonate material (see the transmitted light image).

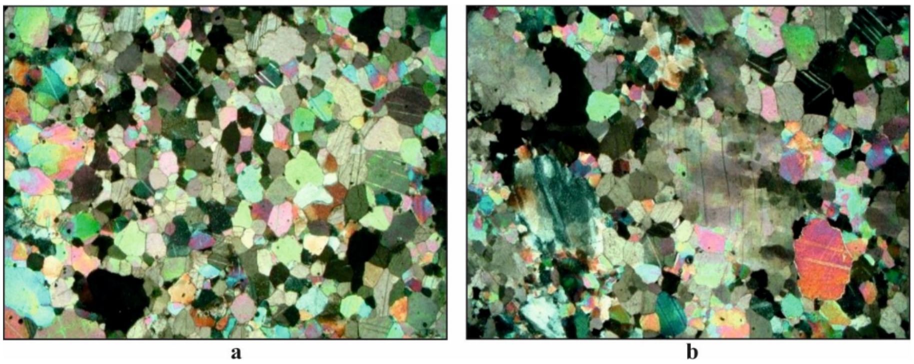


Figure 14: Microphotographs of different areas of the same thin section of Karyni I quarry sample KY1.16. Among all the Karyni samples investigated so far KY.1.16 is that exhibiting the most complete recrystallization. The image (**a**) exhibits the texture of a well crystallized fine grained marble (not unlike Carrara). Polygonal mosaic calcite crystals show a grain size of approximately mm 1 with straight grain boundaries. These well recrystallized “patches” of the thin section, however, are only a few mm in diameter. Other areas of the same section, (**b**), still show shadowy relics of the fossil fragments of the original limestone. A partly recrystallized fossil fragment (undulatory, wavy extinction) in the state of decaying into subgrains due to recrystallization is clearly visible in the centre of (**b**). Polarized light, image length 6 mm (Photo: W. Prochaska).

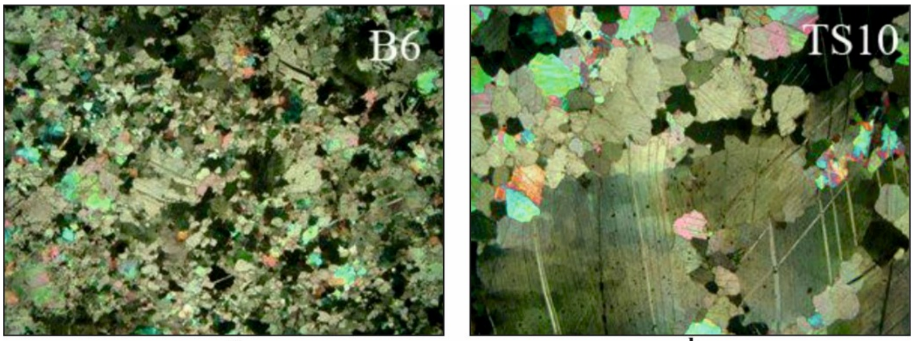
Sample KY1.16 (Fig. 14a-b) is even more interesting in that it exhibits different textures within the same thin section. The left image exhibits the texture of a well crystallized fine grained marble (not unlike Carrara). Polygonal mosaic calcite crystals show a grain size of approximately 1mm with straight grain boundaries. As already noted, however, these recrystallized “patches” are in general only a few mm wide. Other areas of the same thin section (right image) still show shadowy relics of the fossil fragments of the original limestone. A fossil fragment which is in the state of recrystallization starting to decay into a “micrograin” fabric is clearly visible at the centre. In agreement with these results sample KY1.14, observed on a macroscopic scale, exhibits a glassy aspect dotted, however, by several crystalline area of limited size.

The petrography of Lepcis Magna samples

The petrographic features shown by Lepcis Magna archaeological and Lesbos quarry samples are closely similar. In particular, the microstructures shown by the artifacts reproduce all the textural types found at Lesbos and include typical limestones as well as well crystallized heteroblastic and quasi homeoblastic marbles[54].

Seven samples, B6, B14, TA6, TA7, AP11, M66, and TS10 (Fig. 15a-b), whose thin sections are all typical of fossiliferous limestones, exhibit mortar textures with large elongated crystals of calcite deriving from the relics of shell fragments and showing undulatory extinction surrounded by fine grained recrystallized calcite crystals. Also three samples, TS2, TS4 and TS28, are evidently recrystallized limestones. In these examples, however, the degree of crystallization has appreciably progressed, relics of fossil fragments are less frequent and the size of recrystallized calcite crystals has increased. However, they represent intermediate materials along the way that leads to the two last thin sections of the samples TD1 and M44 (Fig. 16a-b). These latter exhibit completely different structures that are typical of well crystallized marbles having heteroblastic (TDI1) or quasi homeoblastic (M44) textures very similar to that of quarry sample KY1.16 of (Fig. 14a). The archaeological sample TDI1 (Fig. 16a) shows a typical heteroblastic texture similar to Prokonnesos, the grain size, however, is definitely smaller and makes Prokonnesos provenance unlikely. The sample M44 (Fig. 16c) has a highly crystalline quasi homeoblastic texture quite similar to the quarry sample KY1.16 (Fig. 14a).

In both cases the archaeological samples show petrographies that although very different from typical Lesbos limestones, are fully compatible with Lesbos quarry samples. In the case of sample TDI1 a possible Prokonnesos provenance is made unlikely by grain size results and was definitely ruled out with the help of other analytical results. On the other hand, the sample TDI15 (Fig. 16c), a well crystallized marble showing heteroblastic texture with large crystal sizes, could be identified as prokonnesian marble, as previously done on spot by macroscopic inspection.



a b

Figure 15: Thin sections of seven Lepcis samples exhibiting textures typical of fossiliferous limestones with large fragments of fossil relics, showing undulatory extinction, in a matrix of small calcite crystals: Basilica, attic base cat. B6 (**a**) and *Serapeum*, attic base cat. TS10, (**b**). Polarized light, image length 6 mm (Photo: W. Prochaska).

[54] Bruno *et al*. 2020, 82-84.

The conclusion is that the archaeological samples collected at Lepcis Magna and made of the so-called unknown marble seem to reproduce very closely the petrographic features of the Lesbos marbles also replicating the distribution of different textures that are found in the quarry samples.

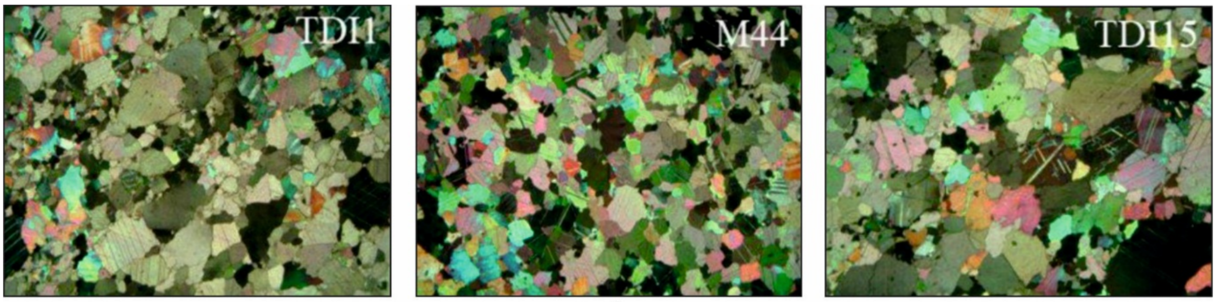


Figure 16: Sample TDI1 (**a**) showing textures typical of well crystallized marbles with heteroblastic structure and small crystal sizes ranging from mm 0.5 to 3.0 (Karyni marble) and sample M44 (**b**) with texture typical of well crystallized marbles with quasi homeoblastic structures and crystal size slightly lower than 1mm (Karyni marble). Sample TDI15 (**c**) showing textures typical of well crystallized marbles with heteroblastic structure and large crystal sizes (Prokonnesos marble). Polarized light, image length 6 mm (Photo: W. Prochaska).

Isotopic results

The isotopic plot of Lesbos marbles (Fig. 17) shows that Moria can be easily distinguished from all other Lesbian quarries, which in turn are more or less extensively superposed[55]. In particular, Moria samples are found at carbon values that are definitely lower than all other Lesbos marbles and allow reliable discrimination. As for oxygen Moria marbles are tightly grouped at heavier (less negative) values whereas other Lesbos samples are spread over a wide range of values that become comparable with Moria only for some Karyni samples. The same isotopic plot including Lepcis Magna archaeological samples (Fig. 18) indicates that only few artifacts (ca. 12) are compatible with Moria whereas most items made of the so-called unknown Lepcis Magna marble are grouped within the Karyni source field. Apparently other Lesbos quarries may reasonably be excluded (Tarti, Tsaf Agia Paraskevi) or play, in any case a very marginal role (Alyfantas, Ippio - Dipi).

A characteristic feature of the distribution is the fact that most artifacts are very tightly grouped at ca. $\delta^{18}O \sim -2.2$ and $\delta^{13}C \sim 3.3$, whereas other samples are spread out at different isotopic values, particularly in the direction of lighter oxygen compositions (more negative δ values). These results seem to suggest that most marbles used at Lepcis Magna were extracted from a single quarry in the district of Karyni. The core group of archeological samples exhibits isotopic values very similar to the few samples available for Karyni II and Karyni III. This small number of quarry samples, however, is due to the fact that both Karyni II and Karyni III are small excavation sites that certainly cannot explain the large amount of light gray bigio marbles used at Lepcis Magna. The isotopic values measured for the archaeological samples seem to rule out a possible provenance from Karyni I reporting separately and can exclude a Prokonnesos provenance, even if there is an overlapping on the base of preliminary macroscopic inspection and several thin sections.

To conclude it is worth noting that the marbles used in some buildings (notably Oriental Temple and the Temple on the *Decumanus*) are very homogeneous and are all found in the core group. The same is true for the Baths of Hadrian where, however, Moria marbles were mostly used. Finally, more heterogeneous marbles, which seem to come from different quarries, were used in other buildings especially in the Theatre and also in the *Macellum*.

[55] Bruno *et al*. 2020, 84-87.

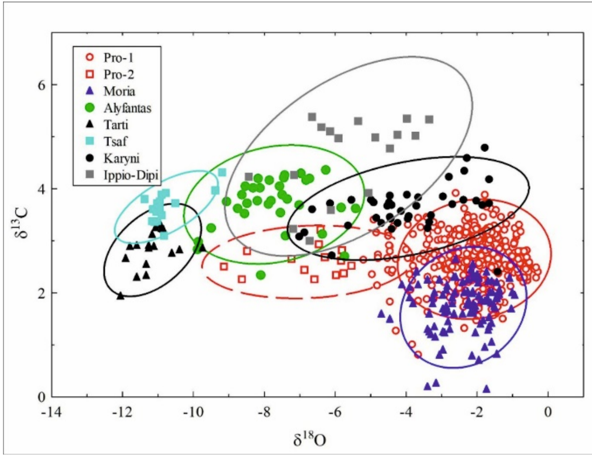


Figure 17: Isotopic diagram of the considered Lesbos marble quarries and the references isotopic clouds of Prokonnesos 1 and Prokonnesos 2 (Graph: D. Attanasıo).

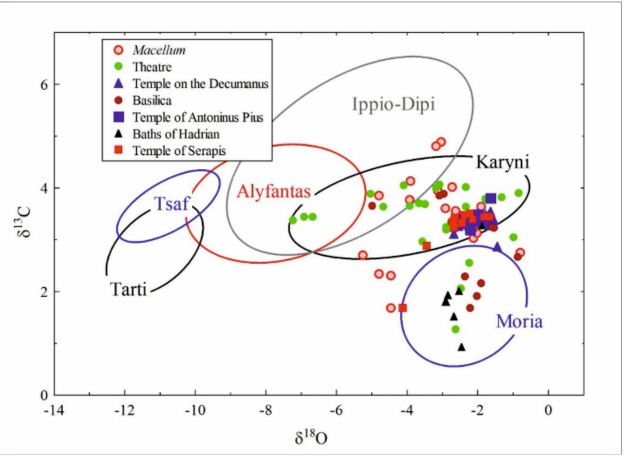


Figure 18: Isotopic diagram of the considered Lesbos marble quarries with the Lepcis Magna archaeological samples (Graph: D. Attanasıo).

Lepcis Magna archaeological samples from Lesbos Karyni

As already stated most Lepcis Magna samples (112 out of 128) are light gray marbles that upon fracture exhibit an almost glassy appearance very different from the saccharoidal texture that is typical of crystalline marbles. Upon macroscopic inspection they were assumed to be a light colored variety of the well-known bigio antico marble quarried at Lesbos and were sampled to attest that, beside Prokonnesos and Pentelic, another marble variety was widely used at Lepcis Magna for architectural purposes[56]. Preliminary analytical work demonstrates that, although the “unknown” Lepcis Magna samples are petrographically closely related to Lesbos marbles, their provenance from the quarries of Moria, that are virtually the only known source of Lesbos bigio marble, is not supported by isotopic data (Fig. 18).

The marbles used for the Oriental Temple and the Temple on the *Decumanus* are remarkably homogeneous. They seem to originate from a single quarry or perhaps even from a single stock of marble quarried purposely for these buildings. The samples from the Basilica and from the *Serapeum*, although less homogeneous than the marbles just mentioned are still relatively similar. The Basilica, however, includes two samples already discussed and assigned to Moria marbles (B11 and B14), while one was identified as prokonnesian marble (B1). Another sample shows a lighter oxygen value, similarly to several samples tested in the Theatre. A sample taken in the *Serapeum* (TS10) is very similar to four other samples from the *Macellum*. Their combination of low $\delta^{13}C$ values and moderately light (i.e. negative) $\delta^{18}O$ compositions is unique among all Lepcis Magna samples. Again a common provenance is likely, probably different from Moria and difficult to identify precisely. The samples from the *Macellum* and the Theatre exhibit a much wider variability. For the *Macellum* this is mostly due to the four low $\delta^{13}C$ samples mentioned above as well as to some $\delta^{18}O$ inhomogeneity. In the case of the Theatre the heterogeneous isotopic results are due to several samples exhibiting strongly lighter oxygen values. Sample T2 from the Temple of *Ceres Augusta*, due to its gray color, fits better with the other samples and therefore referable to Karyni, as already stated, rather than to Moria. The samples of the Temple of *dii Augusti* are again clustering into the Karyni field and T15, even if overlapping with Alyfantas can be attributed to Karyni, or Ippio - Dipi, for its gray and not dark gray color. The items from the portico *post scaenam* are mainly in the Karyni clustering area, two, samples T19 and T28 from dark gray

[56] Bruno *et al*. 2020, 87-91.

items can be attributed to Moria, one T18, again dark gray, could be assigned preferably to Alyfantas than Karyni or Ippio – Dipi, while one T20, a coarse grained marble, can be identified as prokonnesian marble. The only sample of the Hadrian's Bath, TA5, in the Karyni isotopic field, due to its dark gray color and the preliminary macroscopic Moria identification, must be considered an outlayer of Moria and attributed to the same district of all other samples from the Baths.

Conclusions

The study of the architectural marble decoration of Lepcis Magna has pointed out a new historical and archaeological data about a new white-grey marble used in architecture. The stylistic analysis of the capitals and column bases employed in the considered buildings allows to verify the use of Lesbos marble from Hadrianic period onwards. The research has very well showed that architectural elements, column bases and Corinthian capitals, of Lesbos marble and Prokonnesos one are attested in quite equal quantity unlike those of pentelic marble in this group of public building of the city from Hadrianic period onwards (Tab. 1)[57].

Karyni quarry, unlike Moria one, seems to have been the main production district of the largest quantity of analysed items, as also confirmed by samples of different buildings clustered in a same area of the quarry. The importance of this district within the quarries of the Lesbos Island is strengthen by one unfinished capitals and another one (Fig. 19) completely finished in Karyni marble in the Kastro of Mitilini. This last one, of Antonine period, is perfectly comparable with other capitals from Lepcis Magna attesting, therefore, Lesbos island as another centre of production of this class on items. The few architectural elements produced in the dark quality of Moria corroborate the previous general macroscopic identification and especially the Karyni (Lesbos) provenance. At the light of these results the Lesbos quarries began to be intensively exploited to produce architectural items, column bases and capitals of middle size since the second quarter of 2nd century. This more intensive quarrying activity is probably linked to the marmorization of the Mediterranean cities.

Buildings	Total		Lesbos marble		Prokonnesos		Pentelic	
	Bases	Capitals	Bases	Capitals	Bases	Capitals	Bases	Capitals
Basilica at *Forum Vetus*	20	20	7	10	3		-	-
Macellum, courtyard and eastern colonnade	94	94	18	11	54	52	5	1
Oriental Temple at *Forum Vetus*	20	20	15	12	-	1	-	-
Serapeum, courtyard	12	12	10	1	-	4	-	-
Serapeum, façade	4	4	-	-	1	2	-	-
Temple on the Decumanus	22	22	6	7	1	1	-	-
Theatre, Temple of *Ceres Augusta*	12	12	6	7	-	-	-	-
Theatre, Temple of *dii Augusti*	20	20	9	5	-	5	1	2
Theatre, Portico *post scaenam*	68	68	49	49	4	10	-	1
Total	272	272	120	102	63	77	6	4
TOTAL	544		222		140		10	

Table 1: Amount of column bases and Corinthian capitals in Lesbos marble, prokonnesian marble and pentelic marble preserved in the Hadrian's Baths, in the Oriental Temple and in the Basilica in the *Forum Vetus*, in the Theatre, in the *Macellum*, in the Temple on the *Decumanus*, in the *Serapeum* with respect to the expected number of artifacts. For the Temple on the *Decumanus*, the calculation of the items covers only the column bases and capitals of the l courtyard and those of the rear entrance to the building. For the *Macellum*, were considered only the architectural elements pertinent to the restyling of late Antonine period.

[57] To this first group on items of Lesbos marble it is possible to add many other ones whose marble has been identified autoptically as Lesbos marble. This second group of architectural elements are pertinent to the *Chalcidicum* (19 column bases and 17 capitals), the portico outside the Theatre (2 column bases and 11 capitals), the *Stibadium* (5 column bases and two capitals) and the unfinished Baths (17 column bases and 2 capitals).

Figure 19: Lesbos, Kastro of Mytilene, Powder-Magazine. Corinthian capital of Karyni (Photo: M. Bruno).

The district of Moria, few kilometers from Mytilene, must have pushed to search for other sources of supply to be exploited for the large-scale production of mid-size artefacts. Some quarries around the Gulf of Geras were known and used already in the Hellenistic era and among the latters the most important district was precisely that of Karyni whose marble is neither black nor dark, in grain and appearance completely different from prokonnesian but similar to Luna marble with which at the beginning of this research it was in fact confused. The Prokonnesos quarries are so large that they could produce a huge amount of items in order to answer without any problems and very quickly to the market's requests. But the Lesbos quarries, known and exploited since early Flavian age for the bigio lumachellato quality used for column shafts, in the 2nd century began to be intensively exploited to produce and export architectural items, side by side those of Prokonnesos ones. This could depend by the characteristics of the marble of Lesbos which determine the choice to start a large-scale production of bases and capitals in this litotype that circulate in parallel with those of the Prokonnesos, whose production capacity is obviously not feared. Could have pushed to search for new marbles capable of emulating the aspect of the Luna, the presence of a composite capital stored in the garden of the Archaeological Museum of Bergama[58] and of a Corinthian capital in the lapidary of the Commercial Agora of Ephesos[59], both in Luna marble, of western tradition and dated to the Flavian era, of which the Ephesian one sent from Rome as a model for the construction of Domitian's *Sebasteion*[60]? In any case, the inclusion of the quarries of Lesbos Island in this perfect mechanism of production and export of architectural elements, which seems to be represented until now only by Prokonnesos quarries, must be expression of the will of the central imperial power which wanted to start to exploit the Lesbos quarries to the production and export of architectural items on a large scale[61].

[58] Heilmeyer 1970, 87, fn 350; Plattner 2004, 27-28, fig. 7; Plattner 2009, 399-400, fig. 8. The provenance of this capital is unfortunately unknown. Analytical data have confirmed the Luna provenance of the marble which is still clearly identifiable even macroscopically. In fact, it is a fine-grained white marble, different from all other medium-grained Asian architectural marbles, such as Prokonnesos, Aphrodisias or Ephesos, the Greek insular ones, such as the two varieties of thasian or the Paros 2 marble, and also from the fine-grained Greek and Asian ones, such as the phrygian Dokimeion, the carian Göktepe and the attic Pentelic ones.

[59] Plattner 2002; Plattner 2004, 24-65, fig. 5; Plattner 2009, 399-400, fig. 9; Plattner. 2014, 59-60, fig. 8.

[60] Plattner 2004, 25.

[61] This hypothesis does not allow to exclude the involvement of an eminent patron linked to the imperial house. It would be suggestive to think of Herodes Atticus, rich Athenian notable who had economic interests in the Pentelic quarries and access to the Karystian marbles used in the monuments he financed in Athens and Rome. Philostratus (Philostr., *Vitae Sophistorum*, 2.1.8, 556) remembers that Herodes had covered totally his house with black Lesbian marble after the death of his wife as to emphasize his pain due to the mourning. This particular choice could confirm that the Moria quarries were in its availability so much that even pillar shafts

Architectural elements produced both in Prokonnesos and in Lesbos marble are contemporary exported and employed combining them indifferently with Troad marble or Misian granite shafts in a same building at Lepcis Magna as in many other cities of the Mediterranean, as well testified by the Agora of Smyrna, by the Colonnaded Street at Perge and by the Agora at Side. Lesbos items could be exported semi-finished, as testified by some column bases in the Izmir Agora and in Side or completely worked in analogy to the prokonnesian artifacts[62]. The association of column bases and capitals in Lesbos and prokonnesian marble with Troas and Misian granite shafts must be linked to export routes as well as the Pentelic-Karystian route for column bases and capitals and shafts, attested at Lepcis Magna, for example, in the portico *in summa cavea* of the Theater, in Porta Oea and in the southern *tholos* of *Macellum*, all of the Antonine period. The architectural elements analyzed are formally, metrologically and chronologically uniform and are undoubtedly an example of standardized mass production, as those of Prokonnesos marble.

Figure 20: Prokonnesos, Saraylar district. Half-finished Corinthian capital of prokonnesian marble (**a**) and details of working of the first **(b**) and second acanthus row (**c**).

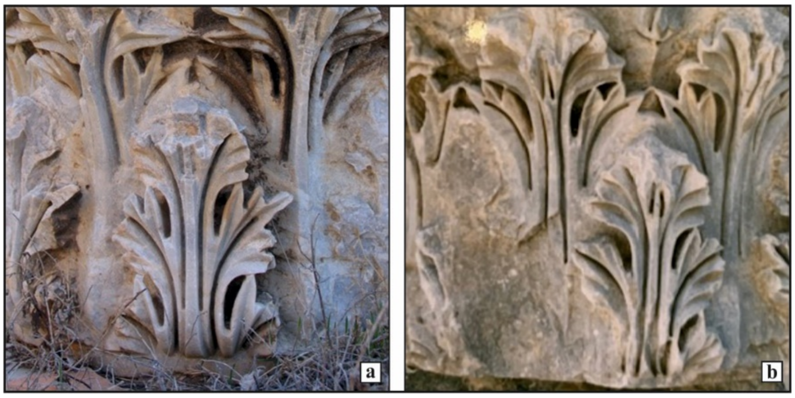


Figure 21: Detail of the acanthus leaf of the first row of the Korinthan capital AP 11 of light grey Karyni of the Orıental Temple at the *Forum Vetus* (Photo: F. Bıanchı) (**a**); detail of the acanthus leaf of the first row of the Korinthan capital (**b**) of Lesbos marble of the Archaeological Museum at Mytilene (Photo: M. Bruno).

The use of architectural items of these two marbles in a same construction phase of a building strengths the hypothesis of Ward-Perkins who supposed the existence of agencies overseas for the order and distribution of items in the Mediterranean area[63]. Without these

in the same stone are used in his villa at Loukou. This important Roman citizen could also have promoted the large-scale exploitation of other marble districts on Lesbos island considering also that the first Corinthian capitals of this marble are dated to the Hadrianic period.

[62] In this regard, see the shipwreck at Capo Granitola 2, Pensabene 2003, 534-535; *versus* Natalia Toma who considers these architectural elements as despoiling items shipped in Late Antiquity, Toma 2018, 167, fn. 30.

[63] Ward-Perkins 1980, 25.

agencies is very difficult to understand the marmorization which characterised very quickly and in the same cases on large scale the cities of the eastern and western Mediterranean in few years in the 2nd century or fast reconstructions after terrible events. Lepcis Magna and Smyrna are two clear examples about this. These agencies are a very important part of the mechanism of ordering and distribution of a bulk production which forms the stock-piling at the quarries and their ports, as those at Prokonnesos, and also the marble yards at the importing cities, as shown by the deposit of quarry blocks and architectural elements of Smyrna[64]. They both are the result of an overproduction which can explain well the use of architectural elements of middle size fashionable and not and in different white marbles in a same building. The items of Lesbos marble reached not only Asia Minor and north Africa but also Palestine and astonishingly Ostia and Rome. What unifies bases and capitals in Prokonnesos and Lesbos marble? The Asiatic marble style[65]. This is particularly evident for the capitals and opens the question of the training of the craftsmen working this class of artefacts in the two lithotypes. A semi-finished capital (Fig. 20a-c) now in the open air museum of Saraylar at Prokonnesos, a capital from the Oriental Temple at Lepcis Magna (Fig. 21a) and another one in the Archaeological Museum of Mytilene (Fig. 21b) are so identical to each other as to suggest that the craftsmen from Prokonnesos may have worked at Lesbo Karyni district in order to start a new large-scale production of column bases and capitals. In this way Lesbos marble and prokonnesian marble have circulated equally in the Mediterranean, flooding the cities with artifacts of which the capitals[66] remain the magniloquent sign of the ever prevailing and unifying Asiatic marble style.

[64] Ersoy *et al*. 2023.

[65] The Asiatic marble style is characterized by the use of particular elements such as the pointed acanthus, the anthemion with palmettes decorating the sima, a specific ornamental syntax, a style that will be spreaded in all the eastern and western provinces of the roman empire also by itinerant craftsmen. See Bianchi 2022.

[66] Bianchi, Bruno 2018, fig. 14-15.

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QUARRY ITEMS FROM A MARBLE YARD AT THE ANCIENT HARBOUR OF SMYRNA

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Abstract

During the underground Metro excavations of Izmir in 1997-2000 a huge amount of ancient items was discovered and lifted at Çankaya, location close to the harbour of ancient Smyrna. 48 elements mainly in prokonnesian marble have been identified as rough quarry export architectural elements destined probably to specific building projects, while several other unfinished column shafts in coloured marbles testify a heterogeneous "collection" of items imported probably in different periods to *Smyrna* from quarries located in Asia Minor and Greece. These rough items must represent leftovers or the few remains of a Smyrnaean marble yard of imperial age located near the docks of the ancient harbour. Even if the semi-finished items in white marble could be easily identified macroscopically as coming from Prokonnesos island, a large number of elements was sampled and submitted to stable isotope analyses in order to clearly identify their marble provenance.

Keywords: Smyrna, marble yard, quarry items.

Introduction

In the late nineties of the last century, between 1997 and 2000, works were carried out for the new city metro of Izmir and during the excavations for the construction of the tunnel at Çankaya, along the Fevzi Paşa Bulvarı, many archaeological items were found apparently piled-up in a disordered way (Figs. 1-2). This huge number of artefacts comprised both rough and finished architectural elements[1], probably recovered in the mid of the 14th century from the many abandoned monuments of the ancient city to be reused in the construction of St. Peter Castle, now demolished, which once stood on the northern mole of the ancient harbour[2] (Fig. 3).

The finished architectural elements are smooth column shafts, capitals and column bases, inscribed pedestals mainly of white-grey marbles but also, sometimes, in coloured marbles, while many huge parallelepiped blocks used for walls or substructures are in local stone.

[1] These elements are now stockpiled in the archaeological area of the Agora, while several other elements, mainly capitals, are on display in the metro station of Çankaya.

[2] Mas-Latrie 1889, 1789; Hasluck 1919/1911, 145-147; Nauman, Kantar 1950, 71. The Castle was built around 1344, The ancient harbour basin gradually silted up and in 1834 the whole area was built over but is still visible in the urban layout, while the coastline has receded by several hundred metres.

Figure 1: Izmir, Çankaya, Fevzi Paşa Bulvarı. Metro excavation 1997-2000. In the background some ancient blocks are visible.

A large number of elements, on the other hand, consist of semi-finished quarry items, among which we can note parallelepiped and stepped blocks, different architectural elements, such as friezes, frieze-architraves, capitals, column shafts and column bases, archivolts, pillars and pedestals mainly of prokonnesian marble. Above all, these quarry artefacts, which are to be considered as products destined for different construction sites in the city itself or for export to other cities of the region, testify not only to the existence of a marble yard at the ancient harbour basin of Smyrna, but also to the circulation and distribution of white and coloured quarry marbles in Asia Minor.

Figure 2: Izmir, Çankaya, Fevzi Paşa Bulvarı. Metro excavation 1997-2000. Lifting of the ancient items discovered during the excavations.

Quarry items

A total of 48 quarry artefacts was discovered (Tab. 1). The most common marble is prokonnesian, followed by single examples in coloured marble qualities from Asia Minor, such as breccia corallina from Bithynia, phrygian pavonazzetto from *Dokimeion* near Afyonkarahisar, Milas lilac and the red brecciated iasian marble from Caria; two qualities originate from Greece, the green-banded cipollino from Euboea and the grey bigio quality from the island of Lesbos. The prokonnesian marble items display the largest typological variety of rough architectural quarry elements. There are thirteen quarry blocks, almost all parallelepiped, with the exception of a stepped one (Fig. 4).

Figure 3: The ancient coastline and harbour overlaid on the modern city of Izmir (Photo: Google Earth, modified by M. Bruno).

Items	Prokonnesos	Breccia corallina	Pavonazzetto	Iasos	Milas lilak	Cipollino	Lesbos	Total
Parallelepiped block	12	-	-	-	-	-	1	13
Parallelepiped stepped block	1	-	-	1	-	-	-	2
Architrave	2	-	-	-	-	-	-	2
Frieze	1	-	-	-	-	-	-	1
Frieze architrave (small)	4	-	-	-	-	-	-	4
Frieze architrave (large)	4	-	-	-	-	-	-	4
Column base	4	-	-	-	-	-	1	5
Archivolt	1	-	-	-	-	-	-	1
Corinthian pilaster capital	1	-	-	-	-	-	-	1
Pilaster	1	-	-	-	-	-	-	1
Double column pilaster	1	-	-	-	-	-	-	1
Pedestal	6	-	-	-	-	-	-	6
Column shaft	2	1	1	-	1	2	-	7
Total	40	1	1	1	1	2	2	48

Table 1: Summary table of the quarry marbles discovered at Çankaya.

Eleven are elements of entablatures and of these two conspicuous groups, respectively of four items each, are elements of medium-sized (Figs. 5-6) and large-sized frieze-architraves (Figs. 7-8). There are four column bases, two column shafts, while there are single examples comprising an element of an archivolt (Fig. 9), a Corinthian pilaster capital (Fig. 10), a rectangular pilaster (Fig. 11a) and a pilaster with double half-columns (Fig. 11b). A large group is represented by six pedestals in different working stages (Figs. 11c, d).

Figure 4: Izmir, Roman Agora, depot. Parallelepiped stepped quarry block in prokonnesian marble, cat. 21 (Photo: M. Bruno).

Coloured marbles of Asia Minor, breccia corallina from *Bithynia* (Fig. 12), pavonazzetto from *Dokimeion* (Fig. 13) and Milas lilac from near Muğla in ancient Caria are attested by medium-sized column shafts, while the brecciated iasian marble, coming from the environs of the ancient city of Iasos, on the Gulf of Mandalya, in Caria, is represented by a single parallelepiped stepped block (Fig. 14).

Figure 5: Izmir, Roman Agora, depot. Small rough frieze architrave block in prokonnesian marble, cat. 13 (Photo: M. Bruno).

Figure 6: Izmir, Roman Agora, depot. Small rough frieze architrave block in prokonnesian marble, cat. 16 (Photo: M. Bruno).

Figure 7: Izmir, Roman Agora, depot. Large rough frieze architrave block in prokonnesian marble, cat. 33 (Photo: M. Bruno).

Figure 8: Izmir, Roman Agora, depot. Large rough frieze architrave block in prokonnesian marble, cat. 34 (Photo: M. Bruno).

Figure 9: Izmir, Roman Agora, depot. Rough archivolt element in prokonnesian marble, cat. 27 (Photo: M. Bruno).

Figure 10: Izmir, Roman Agora, depot. Rough pilaster Corinthian capital in prokonnesian marble, cat. 28 (Photo: M. Bruno).

Greek marbles, on the other hand, are attested in lesser quantities and among these we can note above all two large shafts in Euboean cipollino (Fig. 15), while the grey Lesbos marble is attested by a single parallelepiped block and one rough column base.

The several typological groups have different peculiarities. In fact, all the architectural elements in prokonnesian marble, such as architraves, friezes, two-dimensional architrave friezes, column bases, archivolt elements, Corinthian pilaster capitals, pilasters and pilasters-with-two-half-columns, even if still roughly-worked, clearly attest the importation of semi-finished products of predetermined sizes, produced apparently on demand in the Prokonnesos marble quarries for specific building projects probably in the city of Smyrna itself.[3] The reasons for which they were never used are unknown; they are intact and have no faults, and so, probably just by chance, they increased the amount of marble items in the harbour's yard in a non-predetermined way. By contrast, the marble pedestals, an artefact mass-produced in the Prokonnessos quarries, may represent a group of items that could have been imported not by specific request, but to be destined to a city deposit in order to satisfy, over time, any requests or needs from any local clients. Quarry blocks in prokonnesian marble, to be used generically for the production of cladding slabs or, more generally, for a local production of architectural elements, can represent both a surplus of material to be used for a specific building project, but also blocks just to increase the amount and the availabilities of marble in the stockpiles of Smyrna rather than by specific request.

The coloured marbles are of both Asian and Greek provenance. They are mainly attested as column shafts with only one exception represented by the parallelepiped stepped block in red breccia from Iasos. This marble quality, whose diffusion began not earlier than the second half of the 2nd century AD, had to be subjected to sawing for the production of cladding slabs and could have been imported, like the prokonnesian marble blocks, to enlarge the marble quality availability in the yard of the city, as well as the medium-sized shafts in Milas lilac from Caria and the breccia corallina from Bithynia.

The cipollino shafts from Euboea are quite large and from a usual standard production, so could represent leftovers of particular building projects that had increased the stocks of the harbour depot. The unfinished pavonazzetto shaft from the phrygian quarries, located more than 300 km inland, arrived by land transport, as well as the others completely finished now present in the deposits of the Agora which, however, cannot be attributed to the buildings of the complex.

[3] The marble architectural elements considered cannot be related to the buildings of the Roman Agora. Hypothetically, they could also have been destined for other cities of the hinterland.

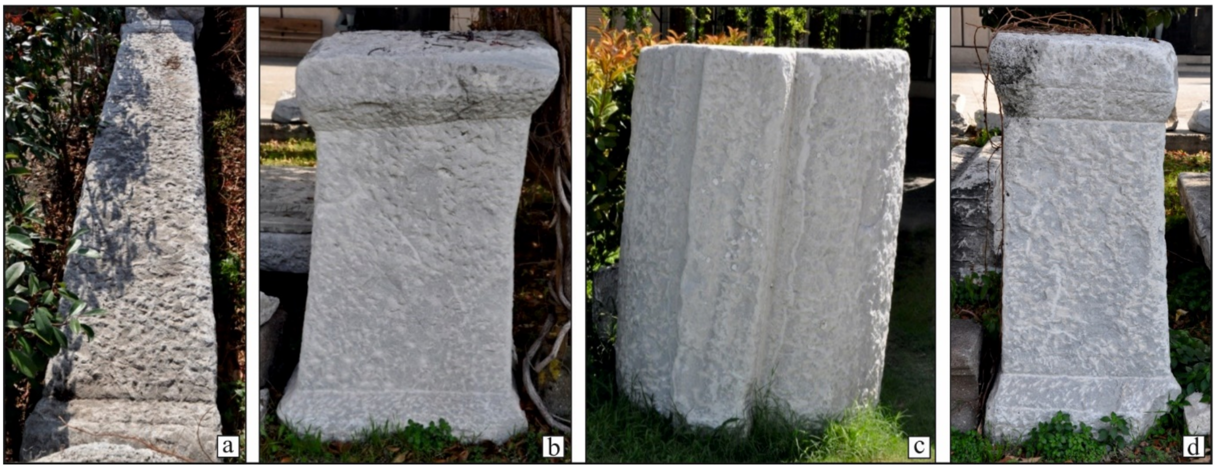

Figure 11: Izmir, Roman Agora, depot: **a**. rough pilaster in prokonnesian marble, cat. 30; **b**. rough pedestal in prokonnesian marble, cat. 38; **c**. rough double semicolumn pılaster in prokonnesian marble, cat. 35; **d**. rough pedestal in prokonnesian marble, cat. 39 (Photo: M. Bruno).

Figure 12: Izmir, Roman Agora, depot. Rough column shaft in Bilecik breccia (breccia corallina), cat. 73 (Photo: M. Bruno).

Figure 13: Izmir, Roman Agora, depot. Rough column shaft in phrygian marble (pavonazzetto), cat. 60 (Photo: M. Bruno).

Figure 14: Izmir, Roman Agora, depot. Parallelepipedal stepped block in red Iasos breccia, cat. 17 (Photo: M. Bruno).

Figure 15: Izmir, Roman Agora, depot. Rough column shaft in green karystian marble, cat. 48 (Photo: M. Bruno).

Isotopic analyses

The identification of the coloured marbles, cipollino, pavonazzetto, breccia corallina, Iasos breccia, Lesbos marble, and the white-grey marble from Marmara Island was done macroscopically. Despite this, it was considered appropriate to verify the proposed identification of the latter white-grey marble with some archaeometric analyses performed on a selection of a quarter of the prokonnesian marble artefacts. The following items were therefore submitted to isotopic analysis (Tab. 2): four large frieze architraves (IA20 - IA23); two medium-small frieze architraves (IA29 - IA30); the pilaster (IA24); the Corinthian pilaster capital (IA25); a stepped parallelepiped block (IA26); two pedestals (IA27, IA28).

The isotopic data clearly confirm the preliminary autoptic identification with prokonnesian marble. All the artefacts have been attributed to Prokonnesos 1, with only a single exception, the pilaster, sample IA24, which is instead referable to Prokonnesos 2 (Fig. 16). These isotopic results are also confirmed by some thin sections done on two samples of frieze architraves, IA20 and IA30 (Figs. 17, 18), which confirm the petrographic characteristics of the Marmara marble, crystalline, with an heteroblastic fabric and grains up to 2 or 3 mm in a groundmass of smaller crystals.

Sample	Cat. n.	Object	Marble	$\delta^{13}C$	$\delta^{18}O$
IA20	34	Large frieze architrave	Prokonnesos	3,13	-1,75
IA21	33	Large frieze architrave	Prokonnesos	3,62	-2,18
IA22	32	Large frieze architrave	Prokonnesos	3,36	-1,37
IA23	31	Large frieze architrave	Prokonnesos	2,67	-2,39
IA24	30	Pilaster	Prokonnesos	3,23	-6,39
IA25	28	Corinthian pilaster capital	Prokonnesos	2,77	-1,74
IA26	21	Parallelepiped stepped block	Prokonnesos	2,61	-2,13
IA27	38	Pedestal	Prokonnesos	3,40	-1,93
IA28	39	Pedestal	Prokonnesos	3,16	-1,97
IA29	13	Small frieze architrave	Prokonnesos	3,10	-3,06
IA30	14	Small frieze architrave	Prokonnesos	2,17	-2,44

Table 2: Isotopic data of the sampled quarry items.

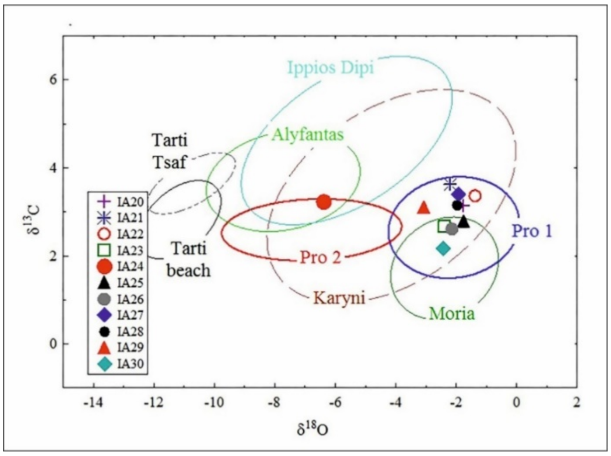

Figure 16: Isotopic graph of the sampled quarry items from Çankaya (Graph: D. Attanasio).

Looking at the isotopic data in more detail, it is possible to observe that with the exception of two samples, one of which falls in the cloud of Prokonnesos 2 (sample IA24), and the other within the values of Prokonnesos 1 (sample IA29), there are two distinct groupings in the cloud of Prokonnesos 1 which could suggest the same origin within the larger district of the Saraylar quarries.

The first group has higher carbon values and includes 5 artefacts (samples IA20, IA21, IA22, IA27, IA28), while the second one with lower carbon values is represented by 4 items (samples IA23, IA25, IA26, IA30).

In the case of the first group especially, a substantial homogeneity of analytical values corresponds also to a typological affinity, while in the second grouping there is a greater typological heterogeneity.

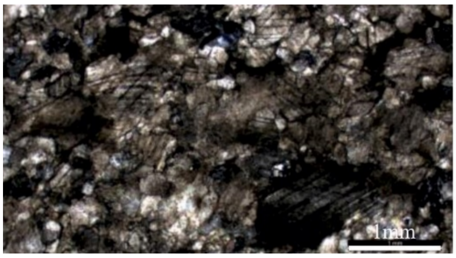

Figure 17: Thin section of sample IA30, small frieze architrave cat. 14. Crystalline marble, heteroblastic fabric, grains up to 2 or 3 mm in a groundmass of smaller crystals, prokonnesian marble (Photo: A.B. Yavuz).

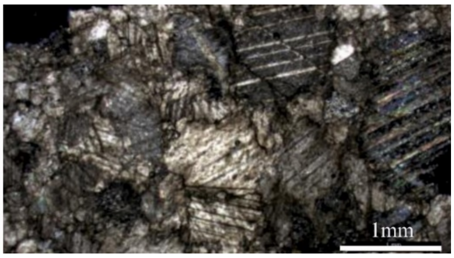

Figure 18: Thin section of sample IA20, large frieze architrave cat. 34. Crystalline marble, heteroblastic fabric, grains up to 2 or 3 mm in a groundmass of smaller crystals, prokonnesian marble (Photo: A.B. Yavuz).

Coloured and white marbles in Izmir and its hinterland

The splendor of ancient Smyrna known from ancient sources is lost today and the Roman Agora with its buildings is certainly the most important preserved complex of the imperial town[4]. The Basilica and the two stoai were built in a grandiose way using coloured marbles of different origins, besides white-grey ones from the islands of Prokonnesos and Lesbos. Different granites, from the *Troas* and *Mysia*, were used for the stoa colonnades, while different varieties of red breccias from the Karaburun peninsula and from the Manisa area were employed for the two orders of the Basilica, whose entrance was exalted by the use of the prestigious Numidian yellow imperial marble. However, other coloured marble varieties of different origin are attested by shafts discovered in the city area and are now in the depots of the Agora. Qualities of more or less local origin are the breccia of Limontepe and that of Tirazlı, the Körfez breccia corallina and the broccatellone from Gerence, both quarried in the Karaburun peninsula. Regional marbles are the Beyler breccia and some varieties of banded alabaster. Marbles imported from other Asiatic regions are the breccia corallina from Bilecik in Bithynia, the red Iasos breccia, the grey shifted marble from Euromos and the Milas lilac “pavonazzetto-like” marble, the latter all quarried in the ancient province of Caria, while the Dokimeion marble, known also as pavonazzetto, was introduced from central Anatolia (ancient Phrygia). From Greece, the bigio of Lesbos, Skyros breccia, cipollino from Karystos and verde antico or *marmor thessalicum* from Thessaly were imported, while some other qualities are still of unknown origin such as breccia bruna oolitica, breccia di Aleppo and breccia pavonazza. The panorama so far outlined in which those of Asian origin seem to prevail is further enlarged considering the literary sources about the donations of the emperor Hadrianus to the *Aleipterion* of *Smyrna*, to be identified perhaps with the “Kaisersaal” of a harbour gymnasium, to which seventy-two column shafts in phrygian Dokimeion marble, twenty in Numidian yellow marble and six in imperial red porphyry from the eastern Egyptian desert were destined[5]. This range of coloured marbles used for column shafts can be enlarged considering some other qualities discovered during the excavations undertaken along the northern external side of the Basilica and where, even if in limited quantities, fragmentary slabs in Egyptian red porphyry, grey granite from the *mons claudianus*, green Laconian porphyry stone from Sparta, the so called serpentino or *lapis lacedaemonius*, cipollino from Euboea, breccia from Skyros, pavonazzetto from Afyon, the red breccia from Teos known as africano, as well as different alabaster qualities from Asia Minor were discovered.

[4] Ersoy 2016, 1-21.
[5] Petzel 1982, 697; Barresi 2003, 445-446.

To better understand the import and distribution of coloured and white marbles through the harbour of Smyrna we can also consider some other cities of Smyrna region, ancient Lydia, such as Sardis, about 90 km to the east, and *Thyateira*, today's Akhisar, a city about 100 km to the northeast. The Bath-Gymnasium complex at Sardis, dating back to the Severan age, had a large central palaestra adorned with 100 shafts of local red breccia, probably from Manisa. The large Marble Court and the two entrance halls were decorated with at least twenty-eight column shafts in pavonazzetto marble and about thirty-six in giallo antico from Numidia, while in the deposits of the archaeological area are some fragmentary column shafts of imperial red porphyry, green Carystian cipollino, grey marble from Lesbos and others of grey mysian granite. In the excavation area of the Christian Basilica of *Thyateira*, on the other hand, it was mostly column shafts in local red breccia from Manisa that were discovered, while only a few imported marbles are attested as column shafts in Egyptian Aswan granite and Skyros breccia from Greece.

The panorama that has been outlined so far shows a prevalent use for column shafts of coloured marbles from the regional area, or, more generally, from western Asia Minor. Fewer are those imported from Greece or from Africa. Among the latter, there are a large number in giallo antico from Chemtou in Numidia. Twenty had been donated by Hadrian for the Aleipterion of Smyrna, twenty-two were employed for the propylaea of the Basilica of the Roman Agora and thirty-six were used in the large halls of the Bath-Gymnasium complex in Sardis. The imperial red porphyry from the Eastern Egyptian desert is attested sporadically in Sardis and is remembered with a limited number of only six shafts again in the hadrianic donation for the Aleipterion of Smyrna.

The phrygian pavonazzetto, another imperial marble par excellence, was put to considerable use: twenty-eight shafts must have been employed in the Bath-Gymnasium complex at Sardis, while seventy-two made up the majority of Hadrian's donation for the Aleipterion of Smyrna. However, this apparent parallelism in the use of coloured marbles in these two cities does not correspond to a chronological equivalence, since the rearrangement of the Aleipterion of Smyrna belongs to the Hadrianic period and the first phase of the Roman Agora can be related to the late-Hadrianic/early-Antonine period, while the Bath-Gymnasium complex of Sardis is well-dated, between AD 211 and 213. Therefore, the methods that determine the choice of marble to be used do not seem to change over time. Local ones prevail, such as the very colourful breccias from Karaburun and Manisa. The pavonazzetto marble, although one of the most renowned imperial marbles since the Augustan age, is widely used in both Sardis and Smyrna, perhaps because these cities were located along the transport route of the quarry marbles from *Dokimeion*, and Smyrna could have been the harbour or at least one of the main export harbours of the export products from the phrygian quarries of Iscehisar and Altintaş.

The use of the imperial pavonazzetto marble in some of the main monuments of Sardis and Smyrna may have been determined by their favourable position along the main road coming from Phrygia, the ancient *via regia*[6], which may have contained the costs of this high-ranking marble. This hypothesis could be corroborated by the far lower quantity of shafts in other imperial marbles, such as the giallo antico of Numidia and the Egyptian red porphyry which were used in these buildings in a selected and scenographic display beside other local coloured marbles.

The use of architectural white marbles was different and less articulated. In fact, if the almost exclusive use of local marble from the quarries of Mağara Deresi and Marmara Gölü seems likely in Sardis, where it has been used since older times for the construction of the great Ionic temple of Artemis, in Smyrna, as well as in *Thyateira*, the use of Prokonnesos marble prevails together with others, such as the white-grey marble from the island of Lesbos.

[6] Barresi 2012, 356.

Conclusions

The subway excavations at Çankaya brought about the discovery of a large cache of architectural items probably used for the construction of the Castle of St. Peter built on top of the northern pier of the ancient harbour of Smyrna. Among these materials, many were dismantled from abandoned monuments of the ancient Roman city, while others, the quarry pieces, had probably been there since Roman times, probably as part of the stockpiled marbles. The Çankaya area corresponds to an area close to the ancient harbour, located behind it and outside the central area of the harbour, where it would seem very likely to hypothesize the marble yard of ancient Smyrna. The few marble deposits of Roman times known to-date were almost always located in areas adjacent to and outside of harbour basins[7], in order to avoid problems for other commercial activities due to their volume and weight. This, for example, was the case of the yard at *Portus*, the imperial harbour of Rome enlarged by the emperor Trajan at the river mouth of the Tiber, which was located in an external area along the left bank of the ancient *Fossa Traiana*. The different urban marble yards, including the main one at the foot of the Aventine hill, were in neighbouring areas or in locations specifically intended for the arrival and storage of heavy monoliths from all quarries of the Roman empire. The large number of quarry artefacts discovered in Çankaya therefore seem to unequivocally attest the presence of an ancient marble yard in Smyrna, where rough and semi-finished quarried items arrived in different periods generally at the yard or at specific construction sites of the city. Specific roughly-defined architectural elements in prokonnesian marble must be leftovers of an overproduction of items to be destined for specific building projects that had increased the holdings of the marble yard, while others, more common, seem to have been imported not on demand, but rather to increase the resources, the quantities and the qualities of the deposit in favour of local customers[8]. Unfortunately, the quarry items in phrygian pavonazzetto that otherwise could have strengthened the hypothesis of Smyrna as an export harbour for quarry artefacts from Dokimeion are too few, even if historical, archaeological and geographical references, even from nearby Sardis, would seem to reinforce this suggestion.

The city of Smyrna and its harbour must have played a fundamental role not only in the marbling of the city, but also in those of the hinterland, and at the same time it could have been the export harbour of the quarry items from the Dokimeion quarries, even if the pavonazzetto quarry items discovered at Çankaya represent only a minimal evidence.

[7] Maischberger 1997.

[8] Generally speaking, against such a hypothesis of the creation of Roman marble yards, see Russell 2013, 232-239; Toma 2018, 180-181.

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GLASS IMITATIONS OF ORNAMENTAL ROCKS: SUBSTITUTES OR LUXURY ITEMS? THE CASE OF *MARMOR NUMIDICUM* AND ITS GLASS SKEUOMORPHS

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Abstract

The practice of objects made of precious metals (gold/silver), hard stones (ornamental and precious) and rock crystal being imitated using cheaper metals, ceramic or glass in the Classical period is known through written sources and archaeology. Vessels, fragments of *crustae*, and shards of bright red streaked and yellow/orange glass have been found at several ancient sites, while some examples housed in museums have also been published. The likeness of the colour of these objects to some chromatic varieties of *marmor numidicum* is unquestionable. Such a similarity may also be observed on mural paintings and on a variant of Gallic terra sigillata, known as marmorata, produced in the workshops of La Graufesenque. This paper analyses the chromatic variants and imitated shapes of these artefacts from various perspectives, with particular attention to cases from *Hispania* by setting them within the context of the imitation of ornamental rocks in the Roman period.

Keywords: Giallo antico, marbled glass, Roman *Hispania*.

Introduction

The practice of using cheaper yet uncannily similar materials to imitate products made of precious or prized materials that would be only affordable by the elite is a phenomenon found across all cultures and historical periods. It consists of a twofold process which involves, on the one hand, high-quality goods in terms of material, technique and artistic value; on the other, products using cheap metals, ceramic and glass that were inspired by, and in imitation of, objects made of precious metals, gemstones and ornamental stones, rock crystal and others.

In the Roman period, coloured *marmora* played a major role in architectural decoration, especially by being extensively used as *crustae* in extremely colourful compositions. In the private sphere, its use conveyed economic and social prestige and splendour. Furthermore, classical sources mention, and archaeology confirms, that vessels made of stone were imitated using glass.

Ornamental rocks

Marmor numidicum is a limestone of a mostly yellow background with chromatic varieties ranging from cream to red, including orange, with brown, reddish and white clasts and streaks[1]. Differences in colour and pattern may be considerable, concerning both plain varieties, which are chromatically more uniform, and brecciated varieties that are more widespread and popular. Its use was closely linked to the figure of Caesar, partly because it was extracted from quarries that became the property of the Roman people after he defeated

[1] The full range of chromatic variations may be seen in Rakob 1993, plate A-D.

the Numidians in 46 B.C. and incorporated the city of *Simitthus* into the province of Africa; partly because after Caesar's death, a monolith made of this rock was erected in the Forum and engraved with the dedication: *Parenti Patriae*. According to Suetonius (Iul. 85), sacrifices were offered there in Caesar's name, amongst other uses (Fant 1988, 149; Fant 1993, 147). Furthermore, the quarries are believed to have belonged to Agrippa, as his name is found there, (Pensabene 1998, 337) before becoming imperial property.

In the Italian Peninsula, *marmor numidicum* was used from the end of the 2nd century B.C. and in private houses from the 1st century B.C. onwards (Ardeleanu 2018, 156). The chronology provided by these contexts is in line with Pliny's testimony on the use of this stone by some notable Romans, such as Marcus Lepidus who had the floors of his house paved with this rock in 79 B.C. (Pliny, NH, XXXVI, 49), and Marcus Scaurus, who decorated the atrium of his house with it in 58 B.C. (Pliny, NH, XXXVI, 4 and 5). The link between these two characters and such a stone is hardly incidental given the connection of the *gens Aemilia,* to which they both belonged, with North Africa since the early 2nd century B.C. (Gaggiotti 1987).

The use of *marmor numidicum* reached its peak between the age of Augustus and that of the Severans. It was used in architecture mainly for paving and wall cladding, small capitals and columns, and in sculpture for herms, figures of captive barbarians and lions as well as for trapezophora, candelabra, *labra* or bathtubs (Pensabene, Bruno 1998, 13; Cioffarelli 1989, 74; Bruno 2002; Cioffarelli 2002; Filippi 2005). Furthermore, cups and plates with figurative decoration were carved from it, such as the votive plate featuring Baal-Saturn, now at the Römisch-Germanisches Museum of Cologne (Fig. 1), or the series of plates in the museums of Utica, Tipasa and Carthage that were possibly mass-produced (Gregarek 2002).

Figure 1: Votive plate in giallo antico dedicated to Baal-Saturn. Römisch-Germanisches Museum of Cologne, inv. n. KL 626. Diam. 30,5 cm. (Photo: Gregarek 2002, 371, fig. 71).

The symbolic significance of this stone is undeniable, as its display in public architecture became entwined with imperial propaganda, particularly under Augustus (Ardeleanu 2018). The popularity of giallo antico has been amply attested also for most of Roman Spain (Mayer 1996, 841-847), where recent research has linked its popularity to a certain number of "replacement rocks" (Cisneros 2010, 135-138).

Imitations

The importance of *marmor numidicum* may have prompted the representation of columns and other architectural elements made of this stone in mural paintings particularly from the Second style onwards, as shown by several fairly accurate examples that are known to us (Ardeleanu 2018, 156; Barker, Taelman 2021).

It may also have been reproduced in terra sigillata by the Gallic workshops of La Graufesenque (a satellite workshop of Le Rozier), where a type of tableware known as marmorata was produced between the pre-Claudian and the Trajanic periods with a peak during Nero's reign (Dannell, Mees 2013, 169-171, fig. 12.7 and tab. 12.1). The tableware series includes a wide range of plain and patterned vessels decorated using moulds and à la barbotine technique. The appearance of *marmor numidicum* was (Fig. 2) reproduced by mixing but not fully blending, yellow coloured and oxidised pigment slips (Genin 2008, 155-161).

Figure 2: Terra sigillata marmorata. Hofheim 8-shape bowl. Diam. 10,2 cm. AD 50-70 *circa*, British Museum (London), GR 1889.7-15.1 (Photo: M. Cisneros).

In glass, the chromatism and patterns of *marmor numidicum* were obtained by fusing a yellow/orange glass base with red thread rods. Preformed canes were later cut into sections and assembled to be heated at the appropriate temperature without fully melting so as to take the shape of the casting mould. Open vessels could be shaped from larger rods or preformed glass moulds (Wight 2011, 39-42). In some instances, opaque red segments were merged. Temperature control in order to achieve the appropriate ductility was essential in the case of glass and ceramics. The finish consisted of carving, grooving and polishing the pieces. The technology to make opaque glass was more complex than that used for translucent or transparent pieces. Specific skills were required to obtain a red colour similar to that resulting from certain metallurgical processes, as has been pointed out (Freestone *et al*. 2003, 151; Bayley 2003, 46-47).

These imitations of giallo antico served very specific functions: tableware, architectural revetments, *crustae* and *tessellae*, or inlays to decorate furniture; however, examples of containers for *medicamenta* or personal adornment have not been found. Among the tableware five types prevail: Isings 1 variant, 2, 18 variant, 18/24 and 22 (Isings 1957), some with ceramic parallels, such as Isings 2 / Dragendorff 27 and Isings 22 / Dragendorff 23. Pieces of yellow-red glass with red streaks have recently been found at the sites of *Colonia Celsa* (Velilla de Ebro, Spain), *Augusta Emerita* (Mérida, Spain) and *Asturica Augusta* (Astorga, Spain). Other examples feature among the collections of several museums, such as

The Metropolitan Museum of Art of New York[2], The British Museum or Le Musée Départamental de l'Arles Antique (Cisneros *et al.* 2013, 282; Caldera *et al.* forthcoming). Yellow monochrome varieties, some with small brown streaks, are in the Gorga glass collection at the Museo Nazionale Romano Palazzo Altemps, and in the panels of Lucius Verus' villa, now in the Museo Nazionale Romano Palazzo Massimo (Verità *et al.* 2013; Saguì 2013). This museum also houses the *opus sectile* panels from the Basilica of Junius Bassus excavated in Rome: the panel of Hylas and the Muses and the panel representing the *pompa circensis*, both dating to *circa* AD 331. The former presents a series of figures framing the mythological scene simulating the embroidered fabric decorated with Egyptianizing motifs known as *velum Alexandrinum*. Glass was used for the rendering of the clothes of the characters and of their ornaments (Fig. 4). The wall revetments from the Basilica also contain mosaic and opaque glass (red, blue, yellow and green) according to a fashion popular in the Julio-Claudian period (Guidone 2012; Gasparini 2021).

Figure 3: Glass. Isings 18/24. Platter with umbilical base. Diam. 17,3 cm. AD 50-60 *circa*. Sketch of the profile based on the find of Colonia *Celsa* (Paz 1998). The Metropolitan Museum of Art, New York, 17.194.1481. (Photo: https:// www.metmuseum. org/art/collection/ search/ 250143 Public Domain; E. Ortiz).

Figure 4: Rome, Basilica of Junius Bassus. Wall panel of Hylas with the Muses, *opus sectile* in marble and coloured glass. Detail of the *velum alexandrinum*. AD 331 c*irca*. Rome, Museo Nazionale Romano Palazzo Massimo alle Terme. (Photo: M. Cisneros).

Glass was frequently used in mosaics. Reference ought to be made here to a piece of preformed glass from *Asturica Augusta* found in a layer dating to the late 4th century which may have been used to extract *tesserae* (Fig. 5). The likeness with certain chromatic variants of *marmor numidicum* is apparent (Cisneros *et al*. 2013, 282-283, fig. 2c). Although in admittedly small quantities, this type of glass has been found, in mosaic pavements in the mid-Ebro valley.

[2] This museum houses an Isings 18/24 platter with an umbilical base (Milleker 2000, 64, ig. fig.51) (fig. 3). A similar profile has been dated to the years AD 54-60 in the case of Colonia *Celsa*, though in this case it is made of opaque black glass (Paz 1998, 513, fig. 250, 11).

Figure 5: Lump of mosaic glass probably used from which the tesserae were cut, 4th century AD? 3 x 2,1 cm and w. 11,924 gr. *Asturica Augusta* (Astorga, Spain). Museum of Roman Art of Astorga, AA.LC.20-24.92.1021. B.44 (Photo: M.T. Amaré).

Two examples are kept in the Museum of Zaragoza: the mosaic of Orpheus, dating to the period of Septimius Severus, from *Caesar Augusta* (Zaragoza, Spain) (Fig. 6.a) and the incomplete *opus tessellatum* from room 13 (probably a *tablinum*) of the villa *Fortunatus* (Fraga, Huesca), dated to AD 361-363. The large extant portion of the mosaic bears the inscription *FORTV—chrismon* with omega and alpha—*NATVS*; it seems to reproduce a painting (Fig. 6.b), as it is surrounded by a frame or passe-partout made with coloured stone and glass tesserae (Paz 2001, 68-69, figs. 76 and 79).

Figure 6: Mosaics with glass tesserae imitating *marmor numidicum*. **a**. Mosaic of Orpheus, detail of the tiger's head, tongue made of tesserae of red stones and tip of glass (6,5 x 6,5 mm), Severan period. *Caesar Augusta* (Zaragoza, Spain). Museum of Zaragoza, 07588; **b**. Mosaic of Fortunatus, detail. Duck, the top of one of its legs features a glass tessera (7,5 x 8,5 mm), the bird was made with stone and opaque glass tesserae of different colours (blue, green, yellow, red, and white). AD 361-363 *circa*. Fraga (Huesca, Spain). Museum of Zaragoza, 07622 (Photos: J. Garrido).

The chronology of these skeuomorphs is set by the Isings 2 found in Magdalensberg. The shape has been dated to the end of the Augustan period (Czurda-Ruth 2004, 264, nº 21, pl. 1, n. 21), however, its production increased under the emperors Claudius and Nero prior to AD 45-50, as confirmed by finds from Magdalensberg (Czurda-Ruth 1979, 168, n. 1355, pl. 18) as well as from Colonia *Celsa*, where the vessels Isings 1 variant (Fig. 7), 18 variant (Fig. 8) and 22 (Fig. 9) dating to the years AD 54-60 have been found (Paz 1998, 513-515, fig. 250, 10 and 11; fig. 251, 4; fig. 329, 3).

The definite chronology of the presence of this glasswork in floor and wall decoration poses the question of whether its production continued into the 3rd - 4th century AD. Although retrieved in a late 4th century layer, the shard from *Asturica Augusta* may well be a residual element from the early Empire, as is the case of similar finds, and may not necessarily be contemporary to the layer. Despite the evidence of its function being certain, it is impossible to be sure that it was manufactured in the late Empire. Consequently, it is possible that the fragments were reused over the years or that specific broken pieces were recast, according to a practice that starting from *circa* A.D. 75 continued throughout the Late Empire. From the 2nd to the 4th centuries AD, the opaque glass imitating ornamental stones were used as tableware, whereas those simulating gemstones decreased notably. The villa of *Lucius Verus* yielded a vast array of *opus sectile* (for wall and floor revetment) elements made of marble and of opaque coloured, marbled and mosaic glass (Saguì 2012).

Some small glass pieces used as personal ornaments or furniture inlays closely resemble certain kinds of jasper, which can also be very similar to *marmor numidicum* (The British Museum: nos. 1868,0501.106.3; 1868,0501.106.4 and 1886,1117.160). In this case, discerning their function is key to evaluating their quality.

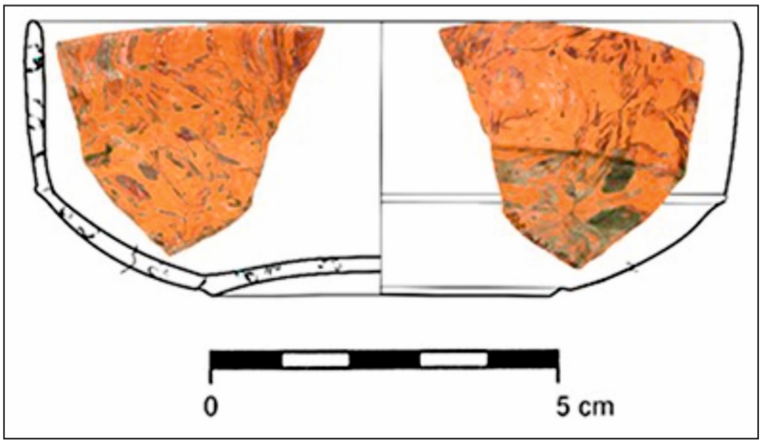

Figure 7: Glass bowl Isings 1 shape variant. *Colonia Celsa* (Velilla de Ebro, Spain). AD 54-60. Museum of Zaragoza, 47593 (Drawing: E. Ortiz; photo: J. Garrido).

Figure 8: Glass, Isings 18 variant. Dish. Diam. 14 cm. *Colonia Celsa* (Velilla de Ebro, Spain). AD 54-60. Museum of Zaragoza, 47592 (Drawing: E. Ortiz; photo: J. Garrido).

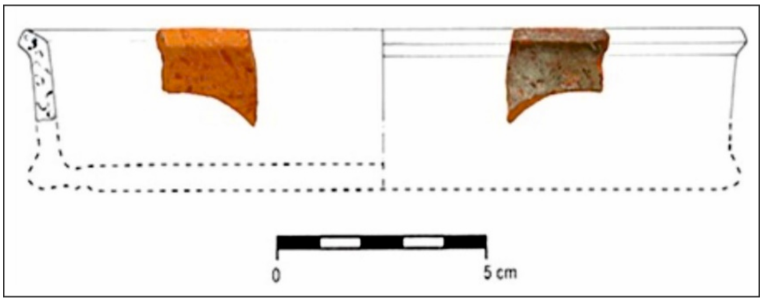

Figure 9: Glass, Dish Isings 22. Diam. 17,5 cm. *Colonia Celsa* (Velilla de Ebro, Spain). AD 54-60 Museum of Zaragoza, 47591 (Drawing E. Ortiz; photo: J. Garrido).

Discussion

This paper discusses examples of the widespread type of glass with a yellow/orange background and red streaks and how it relates to giallo antico. However, many other glass patterns exist which could be associated with other varieties of this type of marble.

The potential reasons behind these imitations may have included: the need to find cheaper alternatives to rocks, which were limited in nature and expensive to extract, though the manufacture of glass would not have been cheap either; the possibility of displaying a material that looked like gemstones and ornamental stones without the complications attached to their sourcing and procurement; the difficulty in obtaining rocks of a particular colour or changing trends and market tastes; overcoming the size limitations imposed by natural materials.

The satisfactory quality of stone imitations in glass encouraged the combined use of both materials in *opera sectilia*. The same bonding agents of organic nature, such as beeswax and pine resin, were used for glass and for marble *crustae*, as chemical analysis of these substances found in *Antinoupolis* have confirmed (Silvano 2015, 245). Therefore, it may be argued that, given the same opacity of both stone and glass, neither material required specific installation skills, because the same adhesive agent may be applied without altering their appearance. The transposition of patterns characterizing *marmora* of imperial property into different materials used for tableware shows the extent of the phenomenon known as *luxus mensae* (Tac. Ann. 3. 55) as well as the high standards reached by glass artisans involved in production.

The existence of dateable stratigraphic contexts characterized by the presence or absence of specific objects, morphotypes of ceramic vessels, South-Gallic terra sigillata (marmorata) and glass, provides us with a reliable chronological sequence. Glass imitations of *marmor numidicum* fall within the wide range of items reproducing ornamental stones that were manufactured mainly between the periods of Tiberius and Nero. If the end of the Augustan period dating suggested by the Magdalensberg stratigraphy is accepted (Czurda-Ruth 2004, 264, nº 21), the glass imitations of this marble occurred before those in terra sigillata marmorata and after those in mural paintings.

Certain glass shapes, which are very rare, have not been found in ceramic and this indicates that glass imitated exclusively stone ware, just like *tessellae* and *crustae* (for floors and walls) would be made of stone. Nonetheless, marmorata mainly reproduced terra sigillata tableware. The hypothesis that glass initially imitated marmorata must be discarded bearing in mind that the most ancient glass pieces date to the end of Augustus (Magdalensberg) whereas marmorata started to be produced in the pre-Claudian period. In addition, most glass vessels do not correspond to ceramic shapes, save for Isings 2 (Dragendorff 27) and 22 (Dragendorff 23).

The majority of terra sigillata red and marmorata were crafted by the same potters (Pérez 2004, 12). It is commonly accepted that alongside typology transfers, several composition and decorative patterns used by glassmakers were copied from pottery or simultaneously shared, setting style trends. Rims, bases, ridges, and some decorations in glass practically mirror pottery that was mass-produced throughout the 1st century A.D. and beyond (Fleming 1999, 33, 34, 172, n. 35). These data support the information provided by *Athenaeus* of *Naucratis* in "The learned banqueters", (*Deipnosophistaí*) 11.784c: "the inhabitants of Alexandria (*Athenaeus* reports) work with glass, transforming it into cups of a wide variety of shapes and imitating the look of all types of pottery imported from every corner of the world". He next reveals yet another significant detail regarding free artistic creation when adding that: "they say that the sculptor *Lysippus* did a favour for *Cassander* when *Cassander* founded *Cassandreia* and wanted to establish his reputation by inventing a distinctive pottery shape, since he was exporting *Mendaean* wine from his city on a massive scale; Lysippus got hard to work, assembled a large number of pots of various sorts, made casts of them all, and produced a distinctive form” (edited and translated by Olson 2009, 260-261).

The skill and dexterity of South-Gallic potters to combine different iron oxides was key in the rendering of *marmor numidicum* in sigillata. The production of dark red terra sigillata can be noticed in *haematinon* glass, which has been linked to several stones and minerals, especially hematite (Ignatiadou 2012: 73).

The scarce excavated finds indicate that table services must have existed. The diversification of glass tableware is characteristic of the early Empire, whereas in the Late Empire mainly drinking vessels were produced. Isings 2 bowls, as well as the Isings 18 variant, 18/24 and 22 plates and platters, were complemented with the Isings 1 variant bowl[3]. Other shapes, such as the Isings 3a porringer and the 3b bowl, are not known in mould-shaped ribbed vessels, which frequently imitate different stones, such as agate like the pieces in the J. Paul Getty Museum.

The two chronological phases, which also correspond to two functional phases for this kind of Roman glass, need archaeometrical characterization in order to spot the existence of potentially differentiating markers between vessels and *tesserae* in terms of: identification and/or composition of chromophores and opacifiers; the kind and level of damage to the glass; the morphology or the development of the design; finally, the possible technological or technical variations in each case (lower quality of Roman *tesserae*: Boschetti 2011, 90)). On the one hand, the highly homogenous composition of the glass and production techniques of the excavated examples may reveal geographical specialization, that is, production by a prime workshop; on the other, uneven features in manufacture or composition could indicate the commercialisation of preformed bars which could have been purchased by secondary workshops. The possible transfer of the colouring activity onto secondary, less specialized workshops, has been put forward as one of the reasons for the decline of red glass (Boschetti 2011, 90). This was produced by highly-qualified artisans who followed a standard procedure whose recipe originated in and evolved from the oldest documented instances, such as the tablet of Tell Umar (Iraq) with cuneiform script in the British Museum (no. 120960). Such knowhow was zealously transmitted in a hierarchical world of artisans, who preserved its secrecy. The area of production of the glass must have been in the West, most probably in Italy, given the lack of finds in the eastern Mediterranean. In conclusion, as the general topic of this paper suggests, archaeological research on material culture production and use must adopt a multidisciplinary approach and combine multiple aspects involving stones, ceramic, metal, and glass.

[3] Parallels to this shape’s profile have been found in Colonia *Celsa*, though in blown green glass dating to Nero’s reign (Paz 1998, 500, fig. 246, 5).

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LOCAL AND IMPORTED MARBLES IN REAL AND IMITATION PAINTED REVETMENT AT APHRODISIAS IN KARIA*

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Abstract

Stone revetment is abundant at Aphrodisias, some preserved in its original context and other slabs reinstalled perhaps multiple times. The revetment programs often mix imported and local stone, of which there was a good supply. A series of rooms painted with imitation marble revetment was excavated in a domestic area; the Late Antique work is interesting for the stones it represents and the way they are arranged. The imitation revetment only shows real stones also used at the site, including local ones, and does not include pan-Mediterranean marbles that were not imported to Aphrodisias; the decorative scheme matches actual marble ones. The decoration in this 6th century CE context speaks to the desire to represent imitation stones as they could have actually existed.

Keywords: Late antique, visuality, reuse, faux marble.

Introduction

Marbles and other colorful, patterned stones were highly valued in Imperial Roman times, and quarrying and long distance transportation costs could be quite high[1]. By slicing blocks of rare or expensive stone into thin slabs for use as revetment, ancient builders were able to expose and display a greater amount of the decorative surface area than was possible when using a solid mass as a column, jamb or pier. In this regard a wall covered in marble revetment made more efficient use of a stone's visual properties than did a monolithic building block that "wastes" much of the color and pattern in its interior. By using local stone, if such sources were available, builders or patrons could significantly decrease the cost of creating colorful stone revetments but retain the overall effect of marble-clad surfaces. And by using simple painted imitation of stone revetment, they could eliminate practically all cost. In this paper, I first introduce in general terms the use of imported and local marbles at Aphrodisias in Karia (Türkiye) both as large-scale blocks and as revetments and look at examples of painted imitation revetment also found there. Second, I look in detail at one example of painted imitation revetment from a 6th century CE domestic context and examine how it reflects local and metropolitan practice.

Aphrodisias

Aphrodisias is sited in a tributary valley of the Maeander, about 100 km from the Aegean coast. The city was founded in the 2nd century BCE, and its monumental development extended from the 1st century BCE through the late 2nd century CE[2]. In Late Antiquity, it was the metropolitan city of Karia. The territory of Aphrodisias is extraordinarily rich in white and colored marble resources, and the city is justly well-known for its marble sculpture and

*I thank the organizers, and R.R.R. Smith, director of the Aphrodisias Project, for the opportunity to work on this material.

[1] See Ward-Perkins 1992 and Russell 2014.

[2] Ratté 2001, 2002.

architecture. The largest and closest quarry complex, the City Quarries[3], are located just a few kilometers from the site and produced primarily a brilliant white, medium to coarse grained marble, but also a soft to darker blue-gray marble occasionally streaked with white. The Aphrodisias Regional Survey Project located eight additional marble quarries: five for white marble of differing qualities clustered together on the south side of the valley, and three that targeted specific colored marbles in the mountains to the east and southwest[4].

Of interest here are the three newly discovered quarries that extracted colored marble to be used for large blocks, revetment and decorative carving rather than for construction. One of these, in a saddle on the Baba Dağı ridge between the two peaks (Regional Survey site C084), produced a breccia with blue-gray background interspersed with large white clasts. A second, the farthest east at Çamova Tepe (site F073), produced a stone virtually indistinguishable from Dokimeian pavonazzetto[5]. The third, near the village of Yazır southwest of the city (site A082), is the largest after the City Quarries and produced a distinctive mottled blue-gray and white marble used for revetment, architectural blocks and monolithic columns up to 6.50 m high[6]. This is the colored marble used most extensively at Aphrodisias and for a significant proportion of all revetment and monolithic columns. Colored marbles distributed throughout the Mediterranean also reached the site but in relatively limited quantities, and they are most often used for revetments[7].

Imported marbles

Only a small number of large imported blocks are found at Aphrodisias; all are columns, and none is complete. The best-preserved context using marble columns originating from outside the immediate territory of the city is the Bouleuterion stage building, dating in its final monumentalization to the later 2nd/earlier 3rd century CE[8]. Among others, it included multiple spiral-fluted columns of black marble with yellow veins from Göktepe, several Dokimeian pavonazzetto colonnettes[9], and a smooth column possibly also of pavonazzetto. An alabaster colonnette may also derive from the Bouleuterion stage. A last large column fragment, formerly near the Theater, is not securely identified[10], The megalithic imports are few and regional rather than truly international with the most distant arrivals still coming by land from western Asia minor rather than from overseas. One of the more significant conclusions of the Regional Survey Project was to recognize Aphrodisias as remarkably self-sufficient in a wide variety of materials[11], including marble.

At Aphrodisias, it is much more common to find imported stone cut into slabs or pieces, whether for wall revetment or *opus sectile* floor or wall tiles. A wide compliment of international marbles has been recovered from multiple contexts; the stones represented include africano, alabastro fiorito, cipollino verde, cipollino rosso, giallo antico, pavonazzetto, portasanta, red porphyry, rosso antico, green serpentino, verde antico, fior di pesco, breccia di

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3 Rockwell 1996; Russell 2016.

4 For the Regional Survey, see Ratté and De Staebler 2012; for the quarries, see Long 2012; for the geology, see Stearns 2012. A map showing all quarries is at: https://deepblue.lib.umich.edu/handle/2027.42/93195.

5 Attanasio *et al.* 2014 they publish the 'Çamova' quarry as 'Karahisar'. It is possible that this quarry was in the territory of Herakleia Salbakes (modern Vakıf [Tavas]) and not of Aphrodisias.

6 These largest blocks were columns for the Four-Column Monument, late3rd century CE; see Ratté 2001, 123.

7 Long 2012, 189 n. 81, for citations and discussion of earlier investigation; Attanasio *et al.* 2014.

8 Bier 2008.

9 Attanasio *et al.* 2009 for Göktepe; Attanasio *et al.* 2014, for scientific identification of the pavonazzetto column and colonnettes.

10 Fior di pesco, from Euboea, has been suggested; if so, this would be the only megalith from beyond Asia Minor.

11 In general and for ceramics, see De Staebler 2012, 69; for marble, See Long 2012, 189-190.

Settebassi, breccia di Sciro, and indeterminate varieties from Bithynia[12]. Sometimes colored marbles at Aphrodisias cannot be easily identified. Colored stones, including red and dark gray limestones and pavonazzetto inset into decorative moldings in the Flavian Civil Basilica have both local and imported varieties.

Many revetment fragments of imported marbles quarried primarily during the Roman Imperial period are found in the fill of Late Antique houses, and it is unlikely that they were first brought to the city for domestic use[13]. One possible origin for much of this material could be the Hadrianic Baths. This grand complex was certainly decorated in the highest contemporary "marble style" when it was new, but over the course of five centuries of damp, steam, earthquakes and massive renovations, including at least three full campaigns of revetment and a shrunken footprint[14], the original imports could have been sold off or otherwise dispersed[15]. and essentially none remain in the building today.

Painted marbles and real revetments

Walls were also painted to imitate stone revetment, but seldom can an over-all pattern be reconstructed. The best-preserved paintings of revetment usually date to Late Antiquity, and examples have been found in the Theater stage building, Theater Baths, Hadrianic Baths, and in most Late Antique houses. In one example from the Water Channel House in the northeastern part of the city, two layers of painting were preserved, and the earlier layer depicted a series of elaborate framed panels between columns, with at least three colored stones represented in the larger panels and many more in the fictive inlay frames.

The painted schemes generally reflect what we known of real marble revetment schemes at the site. At the North Temenos House, with mural decoration dated to the 3rd to early 4th century CE, the north wall of the main apsidal hall was revetted in local marbles including white reeded pilasters with figured Corinthian capitals and mottled blue-gray, darker gray, and brown panels[16]. A similar marble revetment scheme of panels between pilasters on a dado and believed to date to the 2nd century CE was used on the back wall of the Portico of Tiberius and remained on view with minor repairs through the 7th century CE[17]. This revetment was made up, however, to a significant degree of imported marble, including portasanta pilasters and moldings, alabaster moldings and panels, and africano, pavonazzetto and local Yazır marble panels. The popularity of this general scheme was long lived and wide spread, and is also seen in painted and marble examples in the Terrace Houses at Ephesos[18] and around the Bay of Naples[19].

Painted imitation revetment in the NES excavation

My primary example of painted imitation revetment at Aphrodisias was revealed during an excavation to the northeast of the city center done in preparation for the

[12] This list combines identifications by Clayton Fant, as well as by Donato Attanasio, Matthias Bruno and Ali Bahadır Yavuz together with the author and Leah Long.

[13] De Staebler 2016, 147.

[14] Mcdavid 2016.

[15] See Barker 2011, 2012, Fant *et al.* 2013; Barker, Fant 2019 for additional discussion of reuse of existing revetment.

[16] Dillon 1997: dating at 743, reconstruction illustrated in fig. 9; 'brown' stone panels at 741.

[17] Kidd, Russel 2018; they hypothesize that the back wall of the Tiberian portico was (re) decorated when it was modified to accommodate the Hadrianic Baths.

[18] Terrace House 2 in Ephesos includes painted versions in Apt. 4, and marble ones in Apt. 2 and the Marble Hall of Apt. 6.

[19] For a marble version dating to the 1st century CE with spiral fluted Corinthian half-column pilasters at the Casa del Rilievo di Telefo, room 18, at Herculaneum, see Clarke, Barker 2019, 48, fig. 15.

construction of an addition to the Aphrodisias Museum[20]. The complex can be dated only generally to Late Antiquity, and the paintings come from four incompletely excavated rooms that were part of a domestic area. The paintings should date to its final classical phase, perhaps the 6th century CE. Where the painting is best-preserved, the scheme follows the familiar one of a pilaster order standing on a dado with framed panels in between. The plaster layer is extraordinarily thin—only 2.5 to 4 mm thick—laid down over a bedding of fine clay used to even out the surface of the mortared stone wall. This is not a technique designed to last for the ages and may suggest, at the very highest, a middling level of production[21]. The paintings under discussion were found near the center of the excavation area. Farther to the east and west, other walls were preserved in similar conditions and to the same relative height, but no trace of paintings was found.

At least four rooms were originally painted (Fig. 1). Only the southeastern part of Room 1 was excavated to floor level, and it preserved the same scheme on the east and south walls; the south wall was better preserved. Only the uppermost part of the walls was uncovered in Room 2. Since the painting schemes in Rooms 1 and 2 repeat to some extent on adjacent walls—the east and south walls in Room 1, and the south and west walls in Room 2—I treat them as two separate rooms. The rooms would both be quite narrow, each only about 2.0 m wide; it is possible that the different schemes were within one larger room, as no dividing wall was found and some representations of individual stones appear in both rooms. A modern drainage canal cut through the northern part of the excavation area The east-west dividing wall between Rooms 3 and 4 was exposed to the north of this channel. No painted plaster was preserved *in situ*, but many loose fragments were found in the fill to the north and south of the wall. Similarly, enough of the dividing wall between Rooms 2 and 3, and of the south wall of Room 3, was seen to know that these walls had also been painted, but not enough to recognize the decorative scheme.

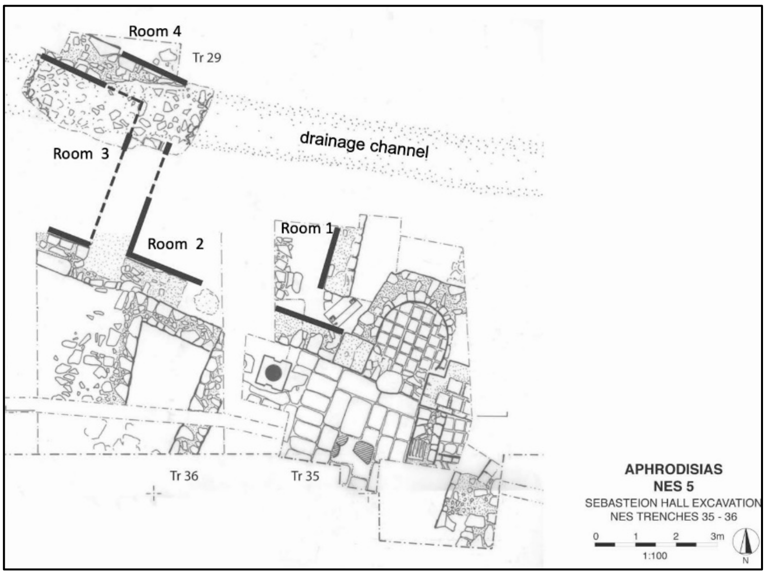

Figure 1: Plan of excavation area. The dark lines indicate where wall painting was preserved (Drawing: Aphrodisias Excavations and P.D. De Staebler).

[20] For the excavations, see De Staebler 2016, 140-50. Excavation occurred in late summer 2006, and the new museum opened in May 2008. The compressed timetable and proscribed trench dimensions dictated that only part of one room could be excavated to the floor.

[21] Wall paintings of all qualities that depict marbles-whether provincial or metropolitan, Hellenistic or Late Antique-emphasize recreating a recognizable stone; see Fant 2007, and numerous examples in the ASMOSIA and AIPMA proceedings.

The painting in Rooms 1 and 2 represent fictive marble revetment. In each room, a large panel is surrounded by a series of borders, and the paintings represent real ancient marbles. In Room 2, on the south wall, wide panels are framed by a border made up of a vertical stack of alternating white lozenges and red triangles flanked by plain white vertical bands (Fig. 2). At the lateral apices of the lozenges are small white circles, and at the inner corners of the triangles are red circles. Two sections of frame flank the same swirling central panel, which is 1.05 m wide. To the left of this framed section is a green panel; isolated elements of the swirling and green patterns are also seen on the west wall of the room.

The swirling framed panel is likely meant to represent a kind of alabaster, perhaps alabastro fiorito, from the area around Hierapolis in Phrygia, while the mottled green panel may represent verde antico, from near Larisa in central Thessaly. The white stone could be local white marble, and the red a local fine-grained limestone known from use in decorative inlays in the Flavian Civil Basilica. Other possibilities for the red could be porphyry, though in the painting it is not speckled and this extent would represent a fairy extravagant amount; alternatively, it could be rosso antico with its more consistent coloration or a dark variant of cipollino rosso from near Iasos in Karia. Also, it is possible that the mottled green could represent serpentine, however at Aphrodisias serpentine is only found in much smaller pieces, usually shaped, while verde antico slabs are more frequent, larger and thicker.

Figure 2: Detail of “alabaster” panel and borders on south wall of Room 2 (Photo: P.D. De Staebler).

The greatest surface area of painting was exposed in Room 1, and it includes a larger variety of stones (Fig. 3). As in the examples of real revetment, the painted architectonic scheme in Room 1 resolves into a series of framed panels set between pilasters on a dado. In addition, a fragment of detached plaster was identified during excavation and block-lifted from the fill of the room; it preserves an acanthus capital painted in purple, blue-green, and white (Fig. 4). The bottom of the capital is the same width as a tall vertical panel, making that panel the pilaster. The south wall was excavated to floor level, and the exposed area shows a large framed panel flanked by two pilasters.

On the south wall, the central panel in swirling green is framed first in white, then in a diagonal red-blue-white striped pattern. To either side are the vertical panels, with a background of wide blue, gray and white vertical stripes overlaid by open red circles. Continuing to the left is a yellow band, and lastly a mottled gray and white panel (Fig. 5). Below the framed central unit is a panel with blue veins on a white background, and to either side of that are panels with a mottled yellow background overlaid by open red circles; the right-hand yellow panel may have a blue-gray circle set within it (Fig. 6). Elements of this same scheme repeat on the southern end of the east wall of the room; one change there is the addition of an “alabaster” panel at the far south end of the wall, and the framed central panel may be mottled green rather than swirling green.

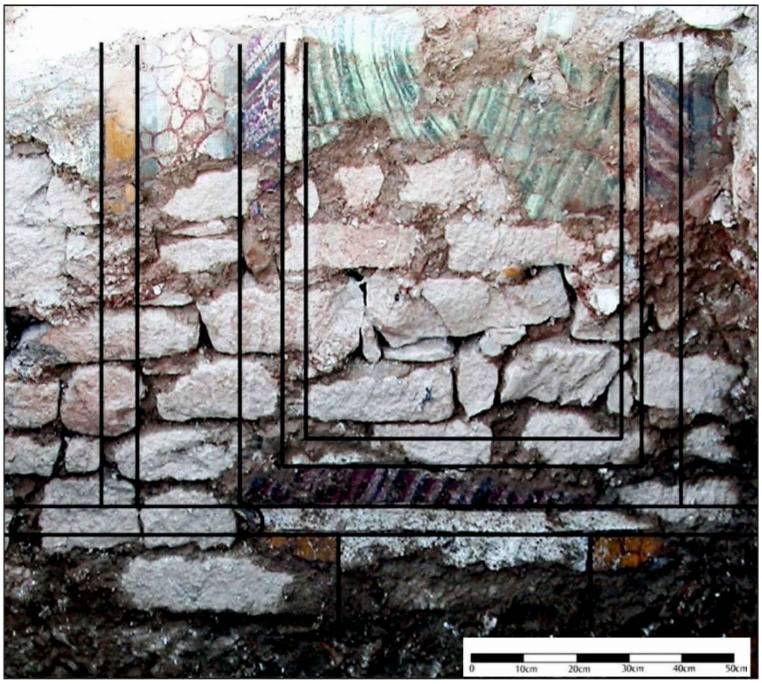

Figure 3: Decorative scheme on south wall of Room 1, with reconstruction overlay (Photo: P.D. De Staebler).

Figure 4: Painted capital from Room 1 (Photo: I. Cartwright).

The central swirling green panel certainly represents cipollino verde, quarried at Karystos on Euboea in Greece. It is likely meant to show book-matched slabs, as indicated by the vertical break through the pattern down the center of the panel[22]. The framing stone represented by the red-blue-white striped pattern could stand for the blood-red, gray-veined cipollino rosso from Iasos on the coast of Karia.

The pilaster stone with red circles over a white ground could be pavonazzetto, the dark red and creamy white marble from Phrygia or the local variant from Çamova Tepe, or alternatively portasanta, the pink and gray swirling marble from Chios. An assignment

[22] Book-matched panels is a standard way to display cipollino revetment, as seen at Ephesos in the Marble Hall of Terrace House 2, Apt. 6, and at Hagia Sophia.

depends in part on whether the lighter and darker blue-gray vertical stripes to the sides were intended as part of the background coloration of the marble or whether they indicate highlights and shading, in which case the "pilasters" might then be half-columns. The yellow band to the side could be either a local beige marble, or perhaps a plain alabaster of the kind also quarried near Hierapolis in Phrygia. The area of the threshold, at the far eastern end of the wall, is painted a mottled white and blue-gray that resembles the local Yazır marble from the territory of Aphrodisias[23].

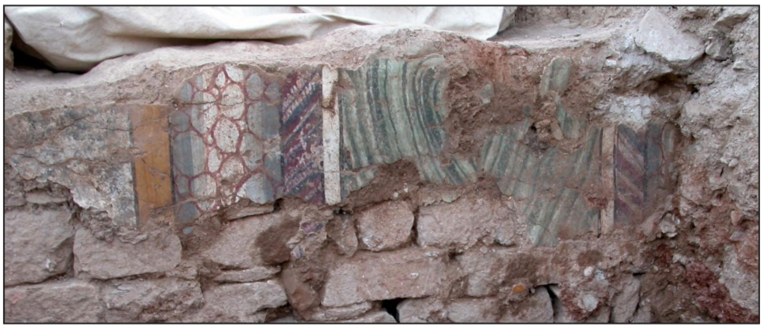

Figure 5: Detail of central framed "cipollino" panel and flanking pilasters on south wall of Room 1 (Photo: P.D. De Staebler).

Figure 6: Detail of lower borders of frame and dado on south wall of Room 1 (Photo P.D. De Staebler).

Two further distinctive stones are in the dado level below the central panel. To the sides are panels with red circles over a mottled yellow background. This could represent giallo antico from Chemtou in Tunisia, though examples found at the site tend to be creamier than this representation. Alternatively, it could represent occhio di pavone, quarried near Kutluca (Izmit) in Bithynia. The central dado panel, with brushy blue veins on a white background, is poorly preserved and not strongly individualized; it could be a veined version of one of the local marbles, or possibly proconnesian.

Together with the representations from Room 2, a total of 11 marbles are depicted: eight distinct stones with patterns, plus three solid colors. Of these, five are probably immediately local; of the remainder, three could originate from western Asia Minor, two from Greece, and only one from far overseas.

Real imitation

Interesting about this selection of painted stones is how "real" the imitations are. For the most part, they are immediately visually identifiable, and examples of the stones are found

[23] This pattern should not represent granite; to my knowledge there is no ancient granite on site, in any context, from any source, in any size.

at the site[24]. Local and import are included together on equal footing[25]. Not only that, but found in the fill of this same excavation area were revetment fragments in local white, local Yazır, giallo antico, cipollino verde, cipollino rosso, verde antico, pavonazzetto, portasanta, and alabastro fiorito marbles — all represented in the paintings — as well as breccia di Settebassi, green serpentino, and porphyry.

Painting a representation of marble revetment would seem to be an opportunity to loosen restrictions, to create fantasy-scapes or allow for an impossible collection of exotic and luxurious stones, to represent that which "does not and could never exist" (Vitruv., De Arch. 7.5.3-4). But instead, the composition seen here is deeply rooted — in materials, scale and design — with what would have been possible and most likely existed in real structures at Aphrodisias at this time.

Conclusion

Painted imitations of marble are important documents that record what ancient viewers actually saw when looking at colored stones, and how they perceived the patterns and distinguished among them. Ancient stone was usually named in two ways: either in reference to the person first associated with it, as with Lucullus (for africano) or the emperor Claudius (for Claudiano); or more often in reference to their province of origin, such as Phrygia, Numidia or Karia, or if more specificity was needed, the town, such as Karystos. These names as a group suggest that contemporary viewers were generally familiar enough with the look of each marble that they were able to recall the image of the stone, its key characteristics such as its colors or patterning, just from a word that did not immediately relate to any of those characteristics[26].

These paintings at Aphrodisias likely date to the 6th century CE, so are roughly contemporary with Paul the Silentiary's praise poem in honor of the re-built Hagia Sophia church[27]. While others in the past had referenced specific stones, often in evocative language, Paul is the first writer to consistently describe a series of marbles in a way that explicitly refers to their colors, patterns and poetical visual effects together with their traditional topographic origin names[28]. Notably, his text dates to near the end of large scale marble quarrying, when long-distance exotic marbles were fast becoming a fossil resource rather than available on command, even for the emperor on behalf of God. Perhaps by the 6th century CE, cosmopolitan urbanites of Constantinople need verbal visual cues in order to match names to the shimmering display arrayed in front of them. In keeping their "imitations" "real," the Aphrodisian patron and painter could have been participating in this same moment of joining the fictive and physical into a single visual decorative environment.

[24] Barker, Perna 2018 use the case of alabaster at Pompeii to describe the parallel introduction of real and painted versions of a stone.

[25] Kidd, Russell 2018 also note that the revetments from the back wall of the Portico of Tiberius mix local and imported stone.

[26] A notable exception is porphyry (= purple). Other ancient stone names that reference color appear together with a toponym, such as *chloeron lakaines* for green serpentine, likely to distinguish between multiple stones from the same region, the Peloponnese.

[27] Mango 1986, 80-91.

[28] Paul the Silentiary (verses 605-646) enumerates 10 marbles: cipollino, pavonazzetto, porphyry, green serpentine, cipollino rosso, breccia corallina, giallo antico, bianco e nero from Aquitiania, alabaster, and verde antico. Kiilerich 2012, 17, suggests that the stones were selected for their geographic representation and that Paul ordered his description geographically; Pentcheva 2011, 96-98, suggests that the visual patterning in the stones relates to the aural experience of song within the building.

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THE AGORA OF SMYRNA: MARBLE AND ARCHITECTURAL DECORATION

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Abstract

The Agora of Smyrna is the best-preserved monument of the ancient Roman city. The square is flanked by two *stoai* on the western and eastern sides while the Basilica closes the northern one and the southern stoa remains unexcavated. The complex of Hellenistic times was rebuilt probably in the middle of the 2nd century AD, during the Antonine period, and destroyed by a severe earthquake that occurred at Smyrna in AD 177. After this dramatic event the Agora complex was rebuilt in a few years with the help of the emperor Marcus Aurelius. Different polychrome marbles of local and foreign provenance were used for shafts and pillars, prokonnesian and a non-Asiatic greyish white marble was used for the other architectural elements such as bases, capitals and entablatures. In order to verify marble provenances, archaeometrical testing was done on a selection of white marble items.

Keywords: Smyrna Agora, marbles, architectural decoration.

Introduction

Izmir was one of the most important harbour cities on the western coast of Asia Minor, which extended from the slopes of Mount Pagos to the coast (Fig. 1). Literary sources mention important monuments, some of which were rebuilt with imperial gifts[1], but unfortunately only the buildings of the Agora attest this ancient splendour today. The western stoa and the Basilica have undergone partial anastylosis, but many other architectural elements lie in the deposits of the Agora. These items have been the subject of a systematic analysis in order to fully understand the construction phases of the buildings and their architectural and decorative style. Column bases and capitals had been produced using not only the well-known Prokonnesos marble but also another one, a white-grey marble with a glassy appearance. Additionally, local coloured breccias were extensively used along with a few imperial marbles for pillars and column shafts. In order to identify exactly the provenance of the glassy white–grey unknown marble, several architectural elements have been submitted to archaeometrical analysis.

[1] Barresi 2003, 442-450.

The Roman Agora of Smyrna and its buildings

The Agora was built on the southern slopes of Mount Pagos in a very central area of the ancient city, near the harbour of Smyrna[2] (Fig. 1). Partially excavated by Selahattin Kantar during the thirties of the last century, and later by the Archaeological Museum of Izmir, the site has been under excavation by a team from İzmir Katip Çelebi University led by Akın Ersoy since 2007[3]. It lies now in the city district of Namazgah[4]. The central open space of the Agora measures so far 129 x 89 metres, its northern side is occupied by a huge Basilica, both sides are flanked by *stoai*, 83 metres in length but of different widths (Fig. 2), while the southern one is still unexcavated.

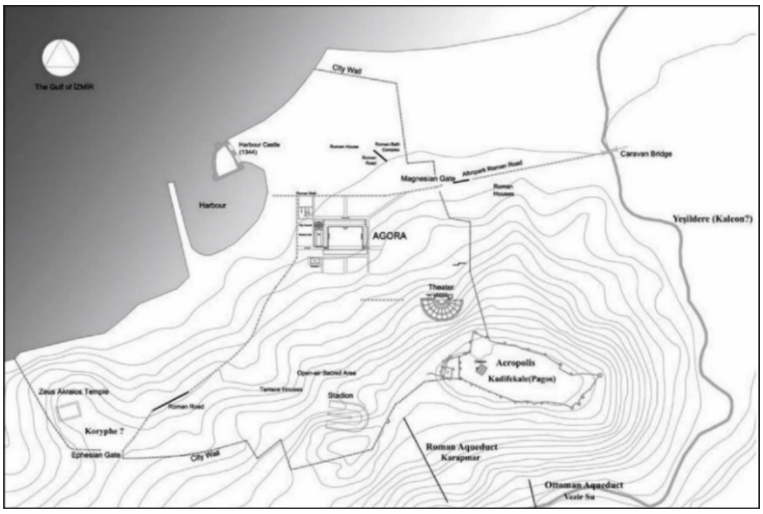

Figure 1: City plan of ancient Smyrna (Yolaçan 2016).

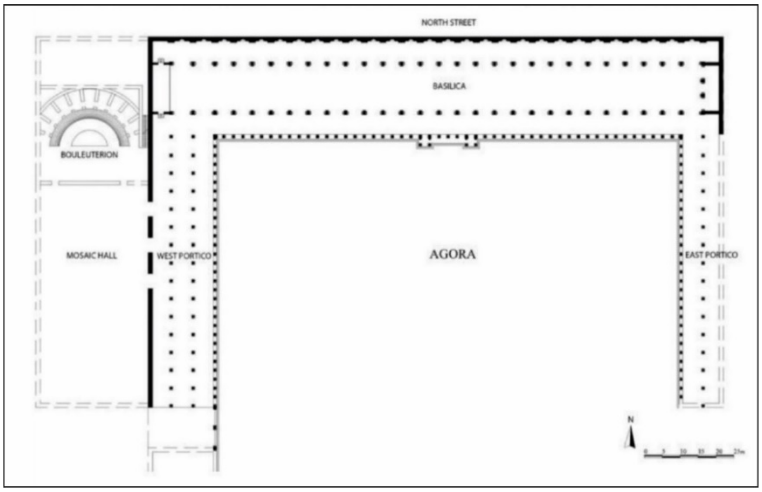

Figure 2: Plan of the Agora of Smyrna and its buildings (Yolaçan 2016).

The actual aspect of this monumental complex is due to the radical transformations that took place in Roman times in the middle of the 2nd century AD. A few years later, around AD 177, after a devastating earthquake, the huge state Agora of Smyrna was quickly rebuilt, with additional funding coming from the emperor Marcus Aurelius[5]. The huge Basilica was a

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[2] Ersoy 2015; Ersoy 2016, 2.

[3] For recent excavation reports see the annual Kazı Sonuçları Toplantısı volumes. For other research on the various aspects of the city see Ersoy, Şakar 2015; Yolaçan *et al.* 2017; Göncü *et al.* 2019.

[4] Naumann, Kantar 1950, 69-70.

[5] Nauman, Kantar 1950, 69-70; Yolaçan 2015; Yolaçan 2016.

two storeyed building with a façade of columns in red Karaburun breccia emphasized by a central *propylaeum* with column shafts in the imperial yellow marble from Numidia. Even the central nave of the building was decorated on both stories with tall pillars in red breccia probably from the Manisa region. On the other side, both the western and the eastern *stoai* had façades decorated with columns on pedestals and shafts of common greyish granites from the Troas and Kozak areas.

The architectural elements of the Roman Agora

The architectural elements lying in the four main depots of the Agora (Fig. 3) or stored in the underground structures of the Basilica and in other open areas close to the main buildings are the object of a research program undertaken by the director of the Agora of Izmir, Prof. Akin Ersoy. The aim of the project is the study of the architecture and the marble decoration of the *stoai* and of the Basilica. A systematic cataloguing of column shafts and capitals stored in the Agora is in progress in order to verify their effective pertinence to the buildings of the Agora because the square has been used as a general depot of marble items coming from other excavations made in the modern city of Izmir in the last 30 years.

Figure 3: Smyrna, Agora. Aerial view of the four main depots (Photo: H. Göncü).

In this first phase of the research, about 630 fragmentary column shafts and 120 capitals have been catalogued and studied. Grey granites, mainly from Troas but with some from Kozak, breccia corallina (red breccia) and the Numidian giallo antico marble are the coloured stones used for the shafts and pillars of the *stoai* and the Basilica. In detail, Troad granite is attested by 240 fragments, the Kozak one only by 50 and they both were employed for the colonnades of the western and eastern *stoai*. Breccia corallina and a red breccia from Manisa and the Karaburun peninsula were used for the shafts of the façade of the Basilica, while only the Manisa variety was employed for the pillars of both orders of the inner nave. The central propylaeum of the Basilica was emphasized by the use of fluted and spiral column shafts of large size of giallo antico, the yellow Numidian imperial marble (that is, from quarries owned by the imperial administration) coming from Simitthus in Tunisia, which is attested by 26 large fragments. It is evident that the use of coloured marbles in the buildings of the Roman Agora was very unusual, as out of a total of 326 shafts and pillars 94% is represented by stones of regional provenance while the only imperial marble, the *marmor numidicum,* is attested at not more than 6% of the total amount. In the first order of the *stoai* 106 granite shafts from Troad and Kozak were originally employed (Fig. 4), in the second order of the Basilica's façade presumably 42 smooth shafts in Karaburun breccia were used, while the *propyleion* was emphasised by 11 fluted and spiral shafts in Numidian yellow marble. Inside, the two orders of the central nave were marked by 60 pillars in Manisa breccia

(Fig. 5). The two orders of the facade of the Basilica employed 106 Corinthian capitals and Attic column bases, at the first inner order there were 60 Corinthianising capitals for half columns facing the inner nave and 60 Ionic capitals for pilasters along the aisles, in the western and eastern *stoai* were employed 106 items, capitals and pedestals with Attic column bases only for the first order. Among the catalogued Corinthian capitals which could belong to the façade of the Basilica only 2 in prokonnesian marble, one of Composite type[6], the other one of Corinthian type (Fig. 6)[7], can be dated to the second quarter of the 2nd century AD and they are related to the late Hadrianic - early Antonine phase of this building. Belonging to the same period is the Corinthianising capital of prokonnesian marble on top of the half column of the pilaster of the first inner order[8].

Figure 4: Smyrna, Agora, western stoa. View from southwest of the outer colonnade replaced in the fifties of the 20th century. Troad and Kozak granites are used for the shafts (Photo: M. Bruno).

Figure 5: Smyrna, Agora. Overview of the central nave of the Basilica with pillars in red breccia from Manisa (Photo: M. Bruno).

The larger number of items is pertinent to the reconstruction phase of the Basilica after the earthquake of AD 177. This group of capitals of Corinthian (Fig. 7) and Composite[9] type was employed in the two orders of the external façade and in the second inner one. These capitals are dated to the late mid-Antonine period, as clearly indicated by comparison with the capitals of the Nymphaeum of the upper Agora at Sagalassos[10] and those of the Faustina Baths at Miletos[11]. Slightly less than 50% of the 106 capitals of the western and eastern *stoai* are still preserved: a group of Corinthian capitals of the façades and few Corinthian fluted capitals with round eyelets and Corinthianising fluted ones of the two inner orders of the *stoai* (Figs. 8a-d).

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[6] The Composite capital, cat. n. 27, Cavalier 2012, 154, cat. Ch3D, fig. 2, could belong to the *propyleion* of the Basilica and it is comparable with that of the Harbour Gymnasium at Ephesos, Strocka 198, 302, tab. 45, 3. Laurence Cavalier dated to Hadrianic period also another very fragmentary Composite capital on the base of the shape of the bead-and-reel closely comparable with that of the above mentioned capital, Cavalier 2012, 154, cat. Ch3B, fig. 4.

[7] The Corinthian capital can be compared with capitals of the Traianeum at Pergamon, Rohmann 1997, 11-30.

[8] The capital is dated by Laurence Cavalier to the second half of the 2nd century A.D, Cavalier 2012, 156, fig. 10, but the acanthus leaves show the typical refined carving of Hadrianic - early Antonine period as shown by the similarities with elements from Cyzicus, Claudiopolis and Aizanoi. In particular, see the pilasters decorated with acanthus scrolls from the theatre of Claudiopolis, Firatli 1979: 112, figs. 2-6; Mellink 1973, 190-191, pl. 38, fig. 39, and the right acroterion of the Temple of Zeus at Aizanoi, Naumann 1979, 31, tab. 61, d. Recently, a new analytical study of the rivet-holes of the architrave from the east end of the temple at Aizanoi allowed to bring forward the construction date to the Domitianic age, Posamentir, Wörrle 2006.

[9] Some Composite capitals are still in the Agora and they are without tendrils, one example, now in the Archaeological Museum at the Kültürpark, has tendrils and cauliculi which are non-canonical ornament for this type of capital, Naumann, Kantar 1950, 82, tab. 24, a; Cavalier 2012, 154, cat. no. Ch3A, fig. 1.

[10] Vandeput 1997, 100, tab. 43, 3-4.

[11] Köstner 2004, tab.122, 4.

Figure 6: Smyrna, Agora. Corinthian capital cat. n. 1 (inv. KN 127), in prokonnesian marble, of the second quarter of the 2nd century AD, pertinent to the first order of the façade of the Basilica (Photo: F. Bianchi).

Figure 7: Smyrna, Agora. Corinthian capital cat. n. 68 (inv. KN 209), in prokonnesian marble of mid Antonine period, pertinent to the first order of the façade of the Basilica (Photo: F. Bianchi).

Figure 8: Smyrna, Agora. *Stoai*, outer order: **a**. Corinthian capital in prokonnesian marble, cat. n. 120 (inv. KN 229); **b**. Corinthian capital in Lesbos marble, cat. n. 35 (inv. KN 128); inner order: **c**. fluted Corinthian capital in prokonnesian marble, cat. no. 66 (inv. KN 203); **d**. fluted Corinthian capital in prokonnesian marble, cat. n. 131 now exhibited in the Archaeological Museum in Kültürpark, Izmir (Photos: F. Bianchi).

Some capitals of these types, which are of Hadrianic – early Antonine date[12] and therefore belong to the same first phase of the construction of the Basilica, were re-employed in the rebuilding after the earthquake side-by-side with the new ones[13].

Many of the Corinthian capitals of Antonine period have a "Hadrianic aspect" to the shape of the eyelets and leaves, the mid rib of the leaves of the upper row of acanthus leaves running down in many case quite to the base of the *kalathos*. But the harder and flatter carving and a clear difference in relief between the leaves of the lower row and those of the upper mark the distance from the Hadrianic model and testify to the formal evolution of the Hadrianic pattern in the standardized production of the capitals in the second half of the 2nd century AD. This "Hadrianic aspect" cannot have been deliberately created in order to harmonize the new capitals to the old ones, because a group of capitals are, on the other hand, much more fashionable. In any case, the hierarchy of buildings determines the use of items more or less "trendy". In fact, these last ones, also of medium size, seem to be employed by preference in the Basilica. The combined use of restored and new elements is also confirmed by restoration traces on shafts and pillars in breccia corallina, shafts in giallo antico and in Troad granite and by replacement letters visible not only on these shafts but also on several capitals and archivolts.

Archaeometric analyses

This systematic cataloguing work has allowed us to highlight the use of two different white-grey marbles for column bases and capitals. The first one is the well-known prokonnesian marble, coarse grained with white and grey banding; the second one is a white to greyish marble with heterogeneous grain size and a glassy aspect on the surface, well visible in fracture. These macroscopic peculiar characteristics suggest identification of this marble with that quarried from the early imperial period on the island of Lesbos (Greece), where the most famous quarry district was that at Moria. In order to verify this unexpected hypothesis a selection of 19 items has been sampled (Tab. 1): 12 Corinthian capitals (IA1 - IA5, IA9, IA10, IA12, IA14 – IA17), 2 fluted capitals (IA8, IA11), 3 fluted Corinthianising capitals (IA13, IA18, IA19) and 2 Attic column bases (IA6, IA7). The samples have been selected on the base of the above-mentioned characteristics of Prokonnesos and *marmor lesbium* and submitted only to stable isotope analysis, and the autoptic identifications have been supported by a few selected thin sections. The isotopic results have been compared with the quarry databank of the Lesbos quarry districts of Moria, Alyfanta, Tarti, Ippios Dipi and Karyni and the most important white imperial marbles of the Mediterranean basin.

The preliminary archaeometrical data allows us to confirm the previous macroscopic identification. Five samples, IA1, IA 4, IA12, IA17, IA18, have been identified with Prokonnesos marble (Fig. 9), as confirmed also by thin sections (Fig. 10).

The other samples can be identified as Lesbos marbles (Fig. 11), in particular nine from the Karyni district (samples nn. IA6, IA7, IA8, IA9, IA10, IA11, IA13, IA14, IA19) and five from the Moria quarries (samples nn. IA2, IA3, IA5, IA15, IA16), as confirmed again by thin sections (Figs. 12a-c).

The Lesbian provenance of the samples considered, split between the Karyni and Moria districts, is indirectly strengthened by the clear identification of the five Moria samples.

[12] The comparisons with the Corinthian capitals of the Harbour Gymnasium at Ephesos, Plattner 2002, 247, fig. 11, Cavalier 2012, 159, fig. 11, note 34, of the South Baths at Perge, Vandeput 1997, tab. 105,3, of Hadrian's Baths at Aphrodisias, Vandeput 1997, tab. 75,1, Öztürk 2016, 197, fig. 12.7, and with the fluted Corinthian capitals of the Nymphaion to the North of the lower Agora at Sagalassos, Vandeput 1997, 89-90, tabs 39,4 and 40,1, support the late Hadrianic-early Antonine chronology.

[13] Naumann, Kantar 1950, 108-109, tabs. 28, a-b.

Sample	Cat. no.	Object	Inv. no.	$\delta^{13}C$	$\delta^{18}O$	Marble
IA1	68	Corinthian capital	KN 209	3,12	-1,76	Prokonnesos
IA2	4	Corinthian capital	KN 126	1,31	-3,30	Lesbos
IA3	6	Corinthian capital	KN 124	2,03	-2,95	Lesbos
IA4	12	Corinthian capital	KN 122	2,60	-1,81	Prokonnesos
IA5	13	Corinthian capital	KN 120	1,52	-4,18	Lesbos
IA6	10	Column base	-	3,82	-4,11	Lesbos
IA7	14	Column base	-	3,73	-3,60	Lesbos
IA8	15	Fluted Corinthian capital	-	1,11	-4,18	Lesbos
IA9	17	Corinthian capital	KN 142	1,72	-4,40	Lesbos
IA10	18	Corinthian capital	KN 15?	3,69	-1,21	Lesbos
IA11	19	Fluted Corinthian capital	KN 173	3,55	-3,14	Lesbos
IA12	25	Corinthian capital	KN 170	2,25	-1,08	Prokonnesos
IA13	30	Fluted Corinthianising capital	KN 167	3,71	-4,55	Lesbos
IA14	29	Corinthian capital	KN 131	3,18	-2,48	Lesbos
IA15	32	Corinthian capital	KN 144	1,77	-4,14	Lesbos
IA16	35	Corinthian capital	KN 128	2,23	-2,70	Lesbos
IA17	48	Corinthian capital	KN 189	1,17	-2,40	Prokonnesos
IA18	65	Fluted Corinthianising capital	KN 202	2,54	-5,11	Prokonnesos
IA19	71	Fluted Corinthianising capital	KN 208	3,52	-5,75	Lesbos

Table 1: List of the sampled items of the Agora with isotopic results and marble provenance indication.

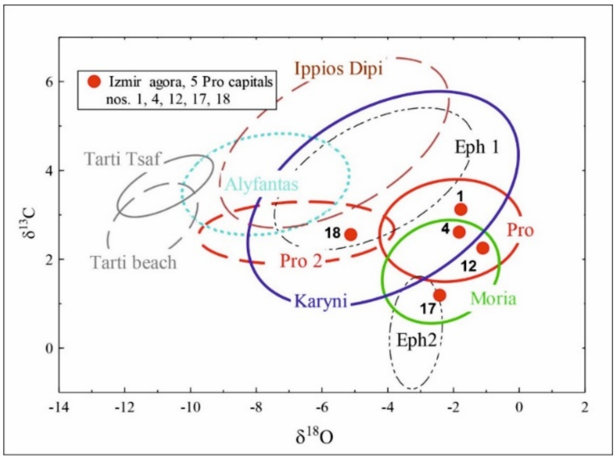
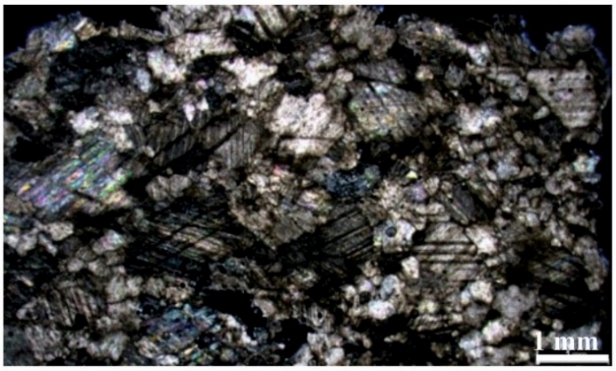


Figure 9: Isotopic diagram of the five sampled capitals in prokonnesian marble (Graph: D. Attanasio).



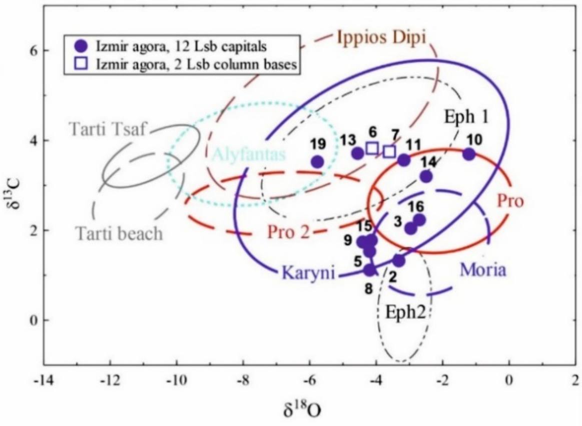


Figure 10: Thin section of sample IA1, cat. no. 68 (inv. KN 209), prokonnesian marble (Photo: A.B. Yavuz).

Figure 11: Isotopic diagram of the fourteen sampled Lesbos marble items, 12 capitals and 2 column bases (Graph: D. Attanasio).

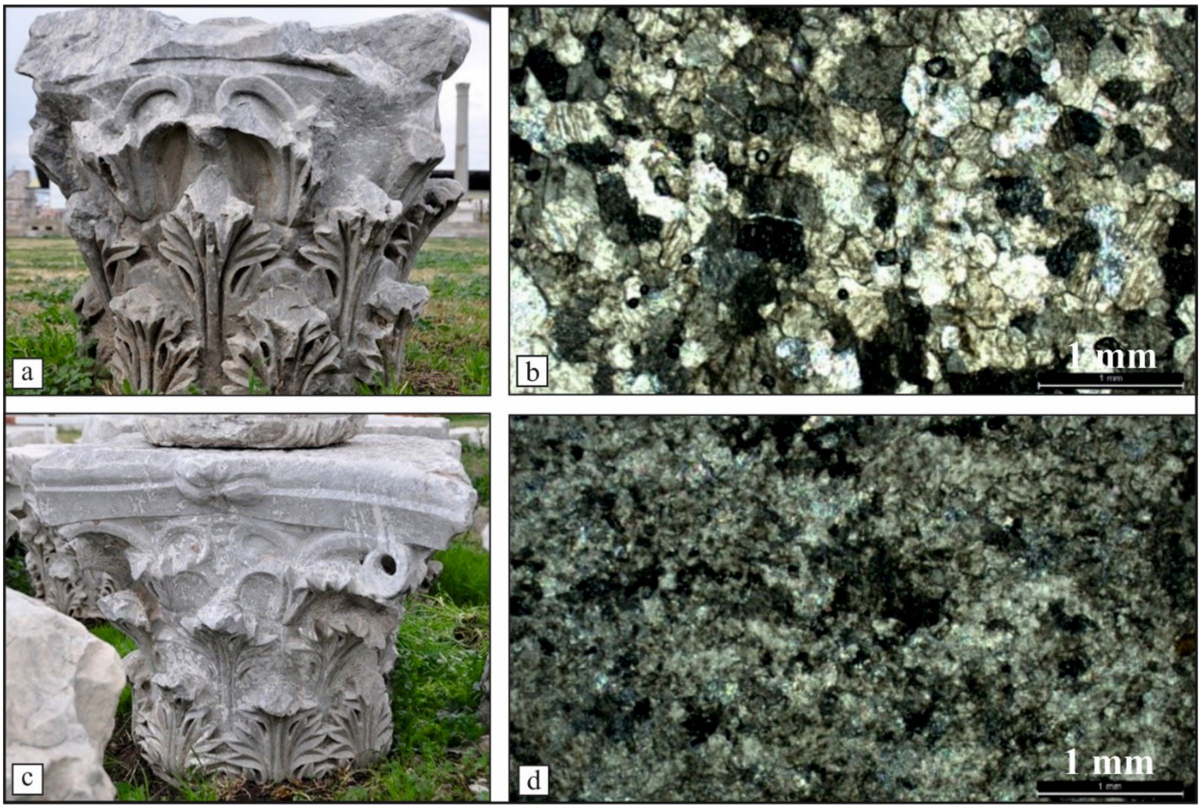


Figure 12: **a**. Smyrna, Agora. Corinthian capital cat. n. 6 (inv. KN 124), sample I3, in grey Lesbos Karyni marble of mid-Antonine period (Photo: F. Bianchi); **b**. Thin section of sample I3, cat. n. 6 (inv. KN 124), Lesbos Karyni marble (Photo: A.B. Yavuz); **c**. Smyrna, Agora. Corinthian capital cat. n. 29 (inv. KN 131), sample I14 in grey Lesbos Karyni marble (Photo: F. Bianchi); **d**. Thin section of sample I14, cat. n. 29 (inv. KN 131), Lesbos Karyni marble (Photo: A.B. Yavuz).

Conclusion

This evidence opens a new perspective on the use of white - grayish marbles in roman architecture in which the Lesbos marble varieties must now be considered. Capitals in Prokonnesos and Lesbos marble have been used side by side in the architecture of the Agora both in the second quarter of the 2nd century AD and in the rebuilding after AD 177. Considering that column bases and capitals of medium size are typical examples of the standardized mass production of the mid imperial period, how can this new data about the use of Lesbos marble be interpreted? What role did the Lesbos quarries play in the standardized productions of architectural elements in imperial period? Could the quarry districts of Lesbos island be considered competitive with those of Prokonnesos? The history of Smyrna can help to answer to these questions; Smyrna was destroyed by the terrible earthquake of AD 177 or 178. In three letters Aelius Aristides gives us plentiful information about the effects of this event on the city. In one[14] he bemoans the loss of squares, buildings, baths, gymnasia, the Theatre, and colonnaded streets which had made this city so wonderful that it outdid overcame in beauty and culture the other cities of Asia. In another letter[15] he asks Marcus Aurelius to support the reconstruction of the city which the emperor duly did, as also recorded by Cassius Dio[16]. In the third letter, a year later, Aristides celebrates this reconstruction and the support received by some Hellenic cities[17]. These literary sources have been confirmed by an inscription discovered during the excavations for the subway. This inscription,

[14] Ael. Ar. Orat. 18, 1-7.
[15] Ael. Ar. Orat. 19, 7-10.
[16] Cassio Dio 71.32.23.
[17] Ael. Ar. Orat. 20, 18.

unfortunately not yet published, records in a long list the cities which funded and helped Smyrna after the earthquake[18]. But all this aid is not sufficient to explain the rapidity of the rebuilding involving the production of a large quantity of architectural elements destined not only for the Agora but the whole city. How was it possible? The architectural elements of the Agora of Smyrna show very well which mechanism has been behind this quick reconstruction: the "agencies overseas" hypothesized by Ward-Perkins[19]. These agencies were able to supply very quickly building sites with standardized finished or unfinished architectural elements of medium size, like the architectural elements of the Agora. The agencies had connections to the depots of architectural items located at the main quarries and ports, as revealed by the discovery of a marble yard close to the harbour of Smyrna. Standardized items could arrive continuously from different quarries to the depots which had been formed by a production surplus which could be of different periods. In the light of these data, the Ward-Perkins hypothesis of "agencies overseas" acquires new strength. Although recently some scholars have tried to demolish it[20], it appears to have been a very good mechanism to ensure a quick distribution of standardized mass-produced elements and respond quickly to the market's demand. However, it remains to be clarified why the use of the lightest varieties of Lesbos marble that were destined for the massive production of medium-sized bases and capitals was intensified from the mid-imperial era. The effects of this production are clearly visible in the architectural restyling of the main cities of the eastern and western Mediterranean where prokonnesian marble is no longer the only one used in architecture. It has been supposed until now that pentelic marble was the competitor of prokonnesian in architecture until Antonine times but the systematic study of the marble elements of the Agora of Smyrna, along with the surveys in other cities around the Mediterranean such as Leptis Magna, which can be considered one of the most important examples of marmorisation of a Roman city, allows us to affirm that Lesbian marble was really that competitive with prokonnesian. What connects the Prokonnesos capitals to the Lesbian ones is a common Asiatic style, which this mechanism of distribution of architectural elements helps to spread all around the Mediterranean.

[18] About the orations of Aelius Aristides and the earthquake of Smyrna and the helping system used in antiquity and its social, economic and political value see Franco 2014, 126-132.

[19] Ward-Perkins 1980, 25.

[20] Russell 2013; Toma 2018.

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VILLA DEL CASALE (PIAZZA ARMERINA, SICILY): THE *OPERA SECTILIA* OF THE BASILICA'S FLOOR AND ITS MARBLES

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Abstract

The Villa del Casale at Piazza Armerina in the Sicilian province of Enna is world famous for its extensive and very beautiful mosaic floors, but it also preserves an important room called "The Basilica" that once had *opera sectilia* and *crustae* made of very precious marbles and stones. This paper reports the results of a detailed study of the floor, of which a survey of the marbles still *in situ* and of traces preserved in the setting mortar has been carefully conducted, together with the macroscopic identification of all stone materials and their relative quantity. This study is based on a new plotting of the floor, whose scheme has been compared with other contemporaneous Roman monuments. The marbles used were of the most common white and coloured species of Asia Minor, Greece and North Africa, to which were added some very rare types such as bianco e nero tigrato of unknown origin, and a few Sicilian limestones.

Keywords: Piazza Armerina, Villa del Casale, Basilica, *opus sectile*.

Introduction

During the first excavations made in 1812 in the area called "del Casale" near Piazza Armerina, province of Enna (Sicily), a floor of precious coloured marbles was discovered. Among the finds, the excavators noticed the large quantities of verde antico (Lazzarini 2007, 223-244) and gave as a gift to the Bourbon king Ferdinand II two slabs of this breccia measuring 180 by 150 cm and 4 cm thick. The king destined them to decorate two tables in the Royal Palace of Palermo.

These early excavations surely damaged half of what later turned out to be the apse of the so-called Basilica and other sectors of the hall of a wide and rich Late Roman villa world-famous for its magnificent mosaics. Although somewhat damaged, the same floor appeared still to be in good condition when regular and systematic excavations of the villa were begun in 1950. More than 30% of the floor slabs, in fact, are preserved (Fig. 1) and almost all the lime-mortar preparation was still *in situ*, showing the imprint of the original marble slabs (Fig. 2). The attention of scholars at the time was concentrated on some elements of the floor only, such as the great tondi (roundels) in the middle and in the apse. Kähler hypothesized to locate here some curvilinear fragments in porphyry, based on a comparison with the floor in Saint Peter's Basilica (Del Bufalo 2012). However, this idea (Gentili 1958, 400) was overcome in the scientific debate, firstly due to the abandonment of the hypothesis of "imperial" ownership of the Villa. Secondly, too few elements are preserved between the finds stored in the archaeological magazines of the site to be able to reconstruct a porphyry tondo with such a large diameter. As noted, considering that such tondi were probably not in red porphyry, and that now the prevalent opinion of scholars is that the Villa belonged to a member of the Roman senatorial elite who had properties in Sicily (Lugli 1963; Carandini *et al*. 1982; De Miro 1984), we may conclude, also on the basis of the results reported here, that the Villa was definitely not an imperial one.

The Basilica's floor and its marbles

The last restoration of the Villa, under the supervision of the Centro Regionale per il Restauro e la Conservazione (C.R.P.R.) of Palermo included a systematic analysis of the *in situ* marbles which has permitted us to look more closely at the chosen lithotypes. A comprehensive analysis and drawing of the floor, based on the plotting of the remaining slabs and the imprints in the mortar of the missing slabs, was made before and during a recent restoration (Di Gregorio *et al.* 2015). The identification of the marbles still *in situ* was done in several steps (Lazzarini 2004, 2009; Gallocchio 2014) through an inspection (Fig. 1).

This was completed by a detailed archaeometric study of the stones (and glasses) of the tesserae used in the mosaics of the villa (Lazzarini *et al.* 2004; Verità *et al.* 2019), some of which were by-products of the manufacturing of tiles for the *opera sectilia*.

The first aim of this work has been the determination of the original pattern of the floor. Both in the apse and in the rectangular sector of the hall we find one unitary scheme applied to the entire space. In fact a symmetrical design covers all the space adapting itself to the overall plan of the Basilica. It is based on the repetition of simple but varied motifs. The majority of the space in bears a grid organised in 7 parallel and 6 longitudinal bands. The longitudinal slabs are 2 feet in length and of a white/grey tonality obtained by the use of prokonnesian marble (Monna, Pensabene 1977, 147-174) greco scritto (Attanasio et al. 2012) and bardiglio from Carrara (Dolci 1980). The parallel bands consist alternatively of polychrome squares and rectangles separated by rectangular slabs of stones with a light tonality. Their dimension is between one and two Roman feet. Along the walls thin bands (1.5 feet in dize) are composed of slabs of different sizes. In the centre of the composition there is a large (8-foot-sided) quadrangular emblema, framed by cipollino verde (Lazzarini 2007, 183-203) slabs of 1 foot and a rosso antico cornice (Lazzarini 2007, 71-96). Another rosso antico listel circumscribed a lost tondo of 5 foot diameter (QD scheme with listel: Guidobaldi 1985, 183; the space in between the cornices (Fig. 3) is filled by breccia di settebasi (Lazzarini 2007, 161-181).

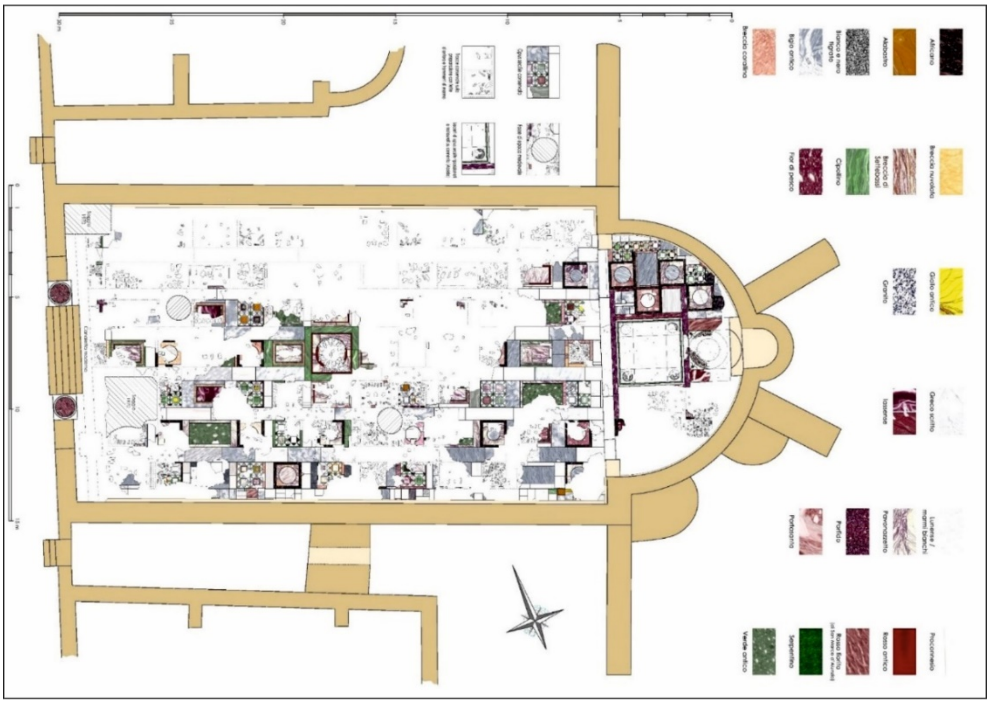


Figure 1: Drawing of the existing marbles still *in situ* in the Basilica’s floor, and their identification (Drawing: E. Gallocchio).

Figure 2: An example of a portion of the floor still retaining the potsherd amphora-fragments used to fix the various marbles in a panel, and the imprint of the latter attesting the prefabrication of the *opus sectile* elements (Photo: E. Gallocchio).

Figure 3: Detail of the floor showing the emblema in the center of the room with cornices of cipollino verde and rosso antico contouring a fragmented roundel of proconnesian marble and a breccia di settebasi infill (Photo: E. Gallocchio).

Figure 4: Detail of the apse's floor showing a large use of bardiglio and portasanta (Photo: S. Prestifilippo).

The longitudinal symmetry of the floor in the apse is simpler (Verde 2008). It is based on two main *emblemata* along the central axis. In this case, too, the central tondi are not preserved. Around the tondi the same type of panels that appear in the rectangular space were used. They are distributed in sequence following the curvilinear edge of the apse in order to fill the remaining space, together with other rectangular slabs (Fig. 4). We find the same design in the marble floors of some *orchestrae*, such as in the Theatres of Lyon, Spoleto and Nora (Sardinia), which share the same semi-circular plan of the apse considered here.

We should note that the two panels at the centre of the apse marked the focus of the floor decoration. The largest presents a 10-foot side and it was framed by two thin listels in white marble and cipollino verde. The listels border a large band (70 cm wide) that has at its sides four squares with inscribed tondi (with a 1,5 foot diameter) in bianco e nero tigrato (Sironi 1980) The two above-mentioned verde antico slabs were perhaps placed on the long sides of the panel (Fig. 5). As in the rectangular part of the hall, the central element, perhaps a 5-foot tondo, is missing.

Figure 5: One of the large verde antico rectangular slabs (Photo: E. Trumino).

Figure 6: As for fig.5, but with breccia di settebasi in the centre (Photo: E. Gallocchio).

Better-preserved is the smallest panel of 6 feet, placed immediately behind the other. The difference in their dimensions is filled by two rectangular slabs about 2 feet wide, one in cipollino rosso (Andreoli *et al.* 2002) and the other in rosso fiorito of S. Marco d'Alunzio (Bellanca 1969, 133). The central space of this panel is occupied by a series of concentric circles inscribed in the same square (Fig. 6), with the resulting spaces characterized by elegant lotus flowers in alabastro cotognino (Egyptian alabaster) (Shaw 2010) or giallo antico focato (Marchei 1989) long petals in africano and pistils in laconian Porphyry or serpentino (Fig. 7) with porphyry at the bottom, on a pavonazzetto (Pensabene 2011) background.

Figure 7: An example of the repeated modulus: roundel of white/grey marble, veined lunense, inscribed in a square formed by a breccia, two varieties of breccia di settebasi (Photo: E. Gallocchio).

It is a design that has important comparisons already in Pompeii, but also in Rome, Sagunto and Constantinople. The circles are separated by listels of pavonazzetto, with two bands of cipollino crossed by a continuous cyma with astragal and beads (two in the major and only one in the minor), in white marble. It frames a wider band in cipollino rosso, with a lesbian cyma still in contrasting white. Missing is the central space, of about 1 m diameter. All the most important qualities, including some rare ones, and several white marbles (lunense, pentelic, prokonnesian, thasian dolomitic), have been used in their holotypic varieties and autoptically identified. The percentage of use of each single lithotype with respect to the total was calculated. The result, even if based on only 30% of the total floor surface, represents a statistically valid sample as it is homogeneously distributed in space: 27 lithotypes were found, 9 of them (with presences over 3% of the total) make up more than 80% of the sample.

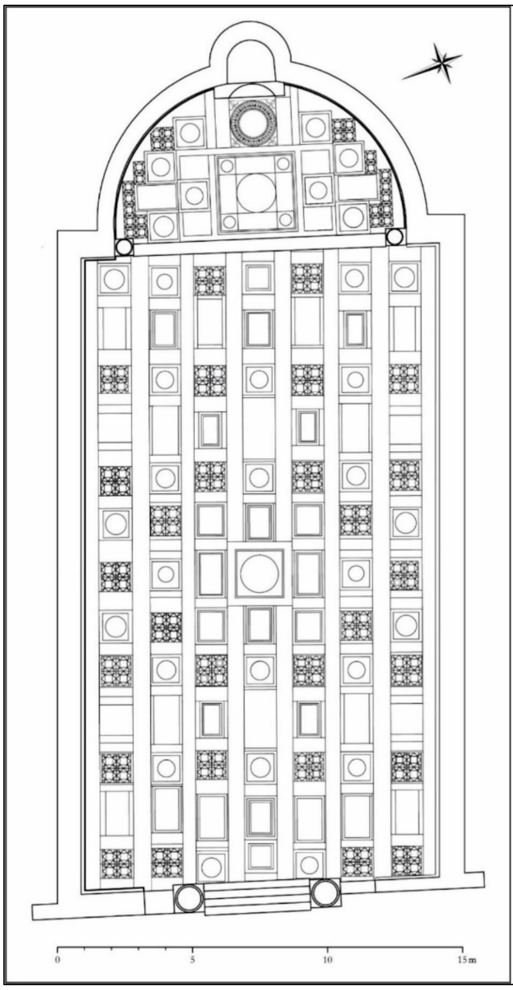
Figure 8: Two polychrome lotus flowers formed by africano and serpentino on a giallo antico / alabaster base (Photo: E. Gallocchio).

The predominance of the Proconnesian marble, almost 30%, is mainly linked to its use in the dividing large bands of 1 or 2 feet, but it is also used in the tondi. We found a similar use for the greco scritto, even if present with 15%. Large slabs of both marbles are the only ones that are still *in situ* in the wall revetments. This analysis has stressed the primary importance of verde antico within the Basilica. We observe that this marble, even if with a lower percentage (5%), is used in significant elements consisting of single slabs of greater size, such as those mentioned by antiquarian sources. The increasing role assumed in late antiquity by this marble is well known, especially in the Constantinopolitan environment, starting from the elements employed in Santa Sofia. Together with panels characterised by multiple listels and with wall paintings, verde antico probably represented a specific choice at the base of the entire composition that was not entirely dependant on its availability in the warehouses. A similar argument should be made for the breccia di settebasi, with abundant use (15%) in large slabs (Fig. 8), but also in less significant positions. In fact, it was used mainly as a filler of interconnecting spaces, as in the rounds of the squares. Roman architects employed this marble increasingly after the 2nd century AD, with the opening of new quarries, probably at Aghios Panteleimon, and later those of Treis Boukes / Koprissiès and Valaxa. We want to emphasize that the very significant presence of breccia di settebasi in the Villa is also reflected by the numerous shafts made from the same marble, used both in the peristyle and in the front of the Great Hunting Corridor. Shafts so numerous and of such considerable size are rare even in Rome.

It is important to underline how the so called Augustan coloured marbles, giallo antico, africano (Gnoli 1988, 174-178), pavonazzetto, portasanta (Lazzarini 2007, 119-136), cipollino verde have almost completely been lost (perhaps removed in the past for re-use in Sicilian Baroque monuments), with a relevant survival only of the africano, used in the frames of the tondi, and cipollino verde, in the borders of the main compositions, with unitary elements.

Finally, the use of rare marbles, such as Egyptian alabaster or bianco e nero tigrato, occurs in very small percentages and only in the main compositions. Anyway, the loss of all the central elements must be underlined, thus leaving a margin of uncertainty about the reconstruction of their use.

As a conclusion, both from the analysis of the schemes and the reconstruction of the sequence of marbles used (Figs. 9, 10), the floor of the Basilica of Piazza Armerina appears to be a product of Late Antiquity, with possible comparisons to be made with Late Antique capitals in important reception rooms such as in Galerius' Palace in Thessaloniki (Lazzarini *et al.* 2002). However, in our case the syntax moves away from the imperial models still in vogue in Rome, such as in the remaking of the floor of the Curia, or the imperial *triclinium* of the Domus Flavia. (Pensabene, Gallocchio 2006; Gallocchio 2014). The Basilica still shares with the imperial tradition the high value of the marble used and the message that the senatorial elite intended to transmit through such luxurious revetment.



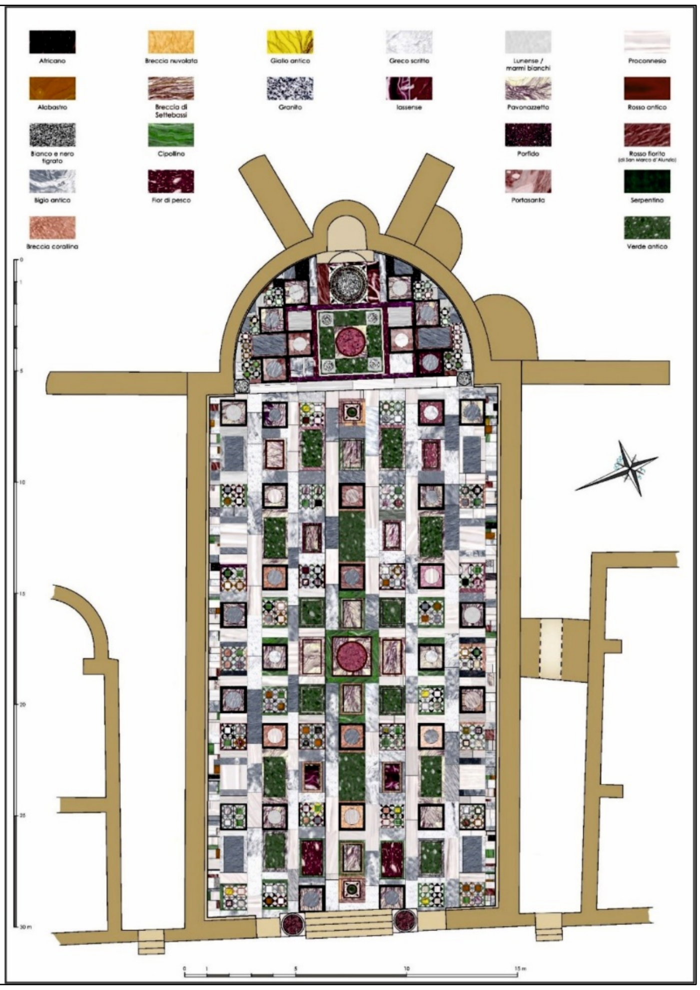


Figure 9: Hypotetical reconstruction of the geometrıcal layout of the floor's *opus sectile* (Drawing: E. Gallocchio).

Figure 10: As for Fig. 9 with the placing of the marbles (Drawing: E. Gallocchio).

Finally we would like to briefly mention the way in which the owners of the Villa acquired the marbles. The colonnades and capitals are certainly reused elements, perhaps from other Roman Sicilian monuments. By contrast, the most used marbles employed in large slabs both in the flooring and the *crustae* on the walls (Guidobaldi 2007), come from large blocks sawn on site (a marble and mosaics workshop certainly existed in the Villa, as testified by the finding in the excavations of waste material from both: Pensabene 2010). All blocks were made of marbles still quarried in Late Imperial times. Only the minor elements are certainly from *spolia*. A more specific note should be made for the quadrangular panels. They are the result of a specialized production by workshops that used small elements of precious marbles (such as the Egyptian alabaster), but perhaps even larger elements, which they kept in their stores. Therefore, we should be at production in Africa, which is well-attested and the probable location of some of the production centres were situated. Among them we can certainly mention Alexandria in Egypt but perhaps also the closer Carthage. If we consider the marble floor of the Basilica from a stylistic and compositional point of view, we can offer the hypothesis that the panels were imported from this area. We may also propose a common African origin with the workers who created the well-known mosaics of the Villa. They perhaps also undertook the entire marble paving (Gallocchio 2019).

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MT. FILFILA AND MARBLE IN RUSICADE (SKIKDA, ALGERIA) IN ROMAN TIMES

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Abstract

Rusicade, modern Skikda, lies near to the white marble quarries of Mt. Filfila, and this proximity makes it likely that the marble had a special importance in the city in ancient times. An extensive program of sampling for marble identification was undertaken in the Skikda's museums to explore the relationship between local and imported marble. Stable isotopes of carbon and oxygen were analyzed, and maximum grain size (MGS) measured. In the realm of architectural decoration, this data was often sufficient to eliminate all plausible alternatives to the Filfila quarries. In the realm of figural sculpture, however, archaeometric data could establish that some sculptures were Carrara marble, but in most cases macroscopic observation was required to determine the most probable quarry assignment among the possibilities indicated by the analytic data. Most white marble at Rusicade seems to come from Mt. Filfila, but several imported marbles could be identified. White marble was occasionally imported from nearby quarries, such as Cap de Garde and Mt. Mahouna, and was shipped from a few distant sources, such as Carrara, Italy, and probably Prokonnesos in the Sea of Marmara, and Mt. Pentelikon near Athens. In style and typology, central Italian models predominated, but eventually Asiatic models came to have importance, and it is likely that sculptors came to Rusicade from Italy and the Aegean to work the local marble. A few colored stones were imported from Algeria (onyx dorée) and the eastern Mediterranean (cipollino, breccia corallina, Aswan granite).

Keywords: Sculpture, architectural decoration, isotopic analysis.

Introduction

The large marble quarries of Mt. Filfila (Djebel Filfila) overlook the Mediterranean harbor city of Skikda (formerly Philippeville), the ancient Colonia Iulia Veneria Rusicade, in the Roman province of Numidia, now eastern Algeria. Rusicade and the quarries are only about 14 km apart, and this proximity makes the city a site of special importance for understanding this marble source. The Ministry of Culture and the Ministry of Energy and Mines in Algiers have permitted us to conduct extensive campaigns of sampling in the quarries and museums of Algeria, and we have analyzed the isotopic ratios of carbon and oxygen and measured maximum grain size (MGS) (Tab. 1). The Filfila quarries have also been analyzed by Antonelli *et al.*[1] and have proven to be variable from an archaeometric point of view; they produce isotopic values that stretch across the heart of the fields for most of the main ancient white marbles (Fig. 1). The marble has both fine and coarse grain. It is mostly calcitic, but there is a small dolomitic area. The Mn++ content is usually high, but also variable. In spite of this variability and the problematic location of the isotopic field, multi-method study, combining archaeometric analysis, macroscopic examination, and archaeological information, can establish probable and in some cases virtually certain identifications of Filfila and other marbles at Rusicade.

[1] Antonelli *et al*. 2010.

Two other quarries in Numidia also produced white marble, but they can usually be distinguished both optically and archaeometrically. Cap de Garde, near the ancient city of Hippo Regius, modern Annaba, about 90 km to the east of Skikda by sea, produced both white marble and a variety of greco scritto. Mt. Mahouna, which is a little more than 50 km to the SSE of Rusicade, produces a pink and gray onyx marble with some areas of white. The isotopic fields of these marble sources are separate from those of the main ancient white marbles (Fig. 1)[2].

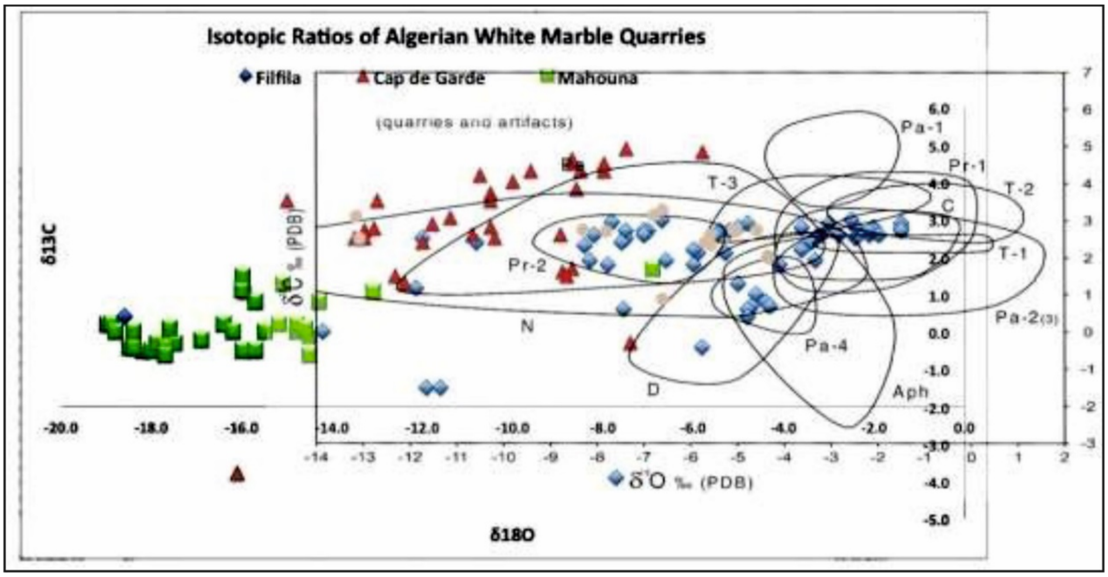

Figure 1: Isotopic rations of architectural decoration at Rusicade/Skikda, quarry samples of Djebel Filfila, and main Mediterranean marbles (Graph: Gorgoni diagram modified by H. Tykot).

The role of Filfila marble in antiquity has been somewhat contested. Geologists and archaeologists from the French period to the present believe that it was as important in antiquity as it has been in modern times[3]. Attanasio and Bruno, however, found that in the ancient capital city of the region, Caesarea Mauritaniae (Cherchell, Algeria), none of the statues they analyzed were marble from Filfila; instead, the marble came from the quarries of Greece, Türkiye, and Italy[4]. Other studies have shown that most architectural decoration in Cherchel was Carrara marble[5]. On the other hand, in the politically less important cities of Numidia, such as Djemila[6], Hippo, Thamugadi, etc.[7], architectural decoration and some fine sculpture was indeed made of Filfila marble and other Algerian marbles, as well as from traditional Classical marble sources, such as Carrara, Pentelikon, Paros, Prokonnesos, and Thasos. The contributions of the various sources, however, varied from place to place.

Architectural decoration makes the best starting point for an analysis of marble use at Rusicade. In many regions, the local marble is used for most architecture even when imported marble plays the main role in figure sculpture[8].

A large collection of architectural elements from Rusicade has been assembled in the city's Roman Theatre and in Skikda's museum[9]. We have sampled and analyzed sixteen

[2] Herrmann *et al*. 2012a; Herrmann *et al*. 2012b.
[3] Gsell 1898, 10, 71-72.
[4] Herrmann *et al*. 2012a; Herrmann *et al*. 2012b.
[5] Pensabene 1973; Herrmann *et al.* 2012b.
[6] Antonelli *et al.* 2010.
[7] Herrmann *et al.* 2012a; Herrmann *et al.* 2012b; Herrmann *et al.* 2012c; Herrmann *et al.* 2015a; Herrmann *et al.* 2015b; Herrmann *et al.* 2017.
[8] Pike *et al.* 2002, 271-273; Herrmann *et al.* 2015b, 165.
[9] Gsell illustrates 12 pieces, two of which may no longer be present: Gsell 1898, pl. 11.9,12.

architectural pieces (capitals, column shafts, and a small altar). Much of the decoration shows strong links to central Italy in typology and style. This is particularly clear in the case of the Corinthian capitals, most of which can be paralleled closely in 2nd and 3rd century Ostia[10]. The most common kind of capital at Rusicade is the schematic version of the orthodox Corinthian capital (USF 10938) (Fig. 2)[11].

Figure 2: Schematic Corinthian capital, Skikda Theater, C16, USF 10938, Filfila marble, ca. 160-220 CE (Photo: A. Van Den Hoek).

The composition is complete, but the details of foliage have not been finished. This modest capital type can be paralleled quite exactly at Ostia[12], but central Italian standards of execution were not uniformly maintained at Rusicade. Corinthian capitals tend to be less sharply defined than at Ostia, and often become sloppy and indefinite. Composite capitals in Rusicade were also inspired by Italian designs but were more variable and less bound to Italian types[13].

In Ostia and Rome, almost all architectural decoration in the central Italian style is made of Carrara marble, the local white marble of Italy[14], but the isotopic data make it clear that most of the Italianate capitals of Rusicade are made of the local marble from Mt. Filfila, or, in any case, not marble from Carrara (Fig. 1). Furthermore, most of the twelve capitals sampled have coarse grain, unlike the fine grain of Carrara. In this respect, the situation at Rusicade differs radically from the situation in Augustan times at the capital city of Caesarea Mauretaniae (modern Cherchel), where capitals followed ambitious central Italian designs and were skillfully carved of Carrara marble[15]. Sculptors may periodically have come to Rusicade from Italy, and model capitals could also have been sent, as in the case of an Istrian limestone Corinthian capital sent to Prokonnesos to be reproduced for export back to the West[16]. The isotopic ratios of marble architectural decoration at Rusicade also fall into the isotopic fields of several Greek marbles (Fig. 1), but three of these marbles, from Naxos, Dokimeion, and Aphrodisias, should be discounted since they were apparently not used for architectural decoration in the western Mediterranean. Two Aegean quarries, Prokonnesos and Mt.

[10] Gsell 1898, pl. 11.3 (C56: USF10943) is almost identical to Pensabene 1973, cat. nos. 318-319.
[11] For another example, see Gsell 1898, pl. 11.2.
[12] Pensabene 1973, cat. 422, 114, pl. 42.
[13] Herrmann 2017.
[14] Pensabene 1973.
[15] Pensabene 1973; Herrmann *et al.* 2012b.
[16] Lazzarini 1990, 259, fig 4. A capital in the Pula museum more-or-less reproduces this same design in banded prokonnesian marble (optical identification).

Pentelikon, however, were used for architectural decoration in the central Mediterranean (Tunisia and western Libya)[17] and could potentially have been used farther west at Rusicade. It is, however, unlikely that any decoration at Rusicade was actually made of pentelic marble; its typical brilliant white color and foliated texture seem to be missing, and the local quarries of Mt. Filfila seem like a much more likely option. Prokonnesian marble and Asiatic sculptors, however, evidently did have a role at Rusicade. A few Corinthian capitals of standard Asia Minor type and workmanship were carved of marble of a gray color[18]. Although not analyzed isotopically, their marble is probably from Prokonnesos or Lesbos[19], and the capitals could well have been imported in a prefabricated state. One example of Asiatic type, however, made of a fine-grained, lighter gray marble, was analyzed, and isotopically its marble seems to stem from Filfila rather than Prokonnesos (USF10940). The design of its abacus flower, moreover, is Western, as Fulvia Bianchi has pointed out[20], and it must have been made by a travelling sculptor trained in the Asiatic tradition. The imported Asiatic capitals and the presence of such migratory sculptors trained in the Asiatic tradition clearly had an important influence on capital production at Rusicade. Many Corinthian and composite capitals in Filfila marble from the late 2nd through the 4th century show the influence of Asia Minor in the design of their acanthus leaves. Some have turned up far to the south at Thamugadi (Timgad)[21], Other kinds of architectural decoration were made of Filfila marble. Many column shafts at Rusicade are a pale grayish or dingy white marble with occasional gray spots or streaks, which seems to be from Filfila (USF10950-1). Filfila column shafts with more interesting spots or markings (*reseda*) appear elsewhere in Algeria[22], Judging from its isotopic values, an altar dedicated to Mercury is also Filfila marble (USF 10928). Other North African sources of both white marble and limestone for architectural decoration were also available at Rusicade. Striated gray-and-white marble column shafts (greco scritto) came from the Cap de Garde (USF10950). It is striking that no capitals at Rusicade seem to be made of marble from Hippo/Cap de Garde or Guelma/Mt. Mahouna.

All three Numidian sites seem to have primarily used marble from their own nearby quarries for more intricate architectural carving[23]. However, an elaborate Corinthian capital, probably of Flavian or Trajanic date is made not of marble but of a yellowish, fine-grained limestone (USF10944, Fig. 3). Similar limestone capitals are found in in Carthage, Bulla Regia, and Kairouan[24], and it seems likely that the example in Rusicade was made by a sculptor from the Tunisian area, and the limestone could have come from a quarry in that area as well.

A few pieces of architectural decoration are made of colored stone. One is local, an altar was made of yellowish onyx dorée alabaster from Aïn Smara, some 90+ km to the SW of Rusicade (USF10954). The others are imported from the east. Several column shafts at Rusicade are of cipollino (Carystan marble), one is Aswan granite (optical identifications), and another is breccia corallina from an indeterminate source but probably Asia Minor (USF10948-9)[25]. Several sources of breccia corallina have recently been discovered in western Türkiye, but their isotopic signatures are not yet known[26].

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[17] Bianchi 2009.
[18] Gsell 1898, pl. 11.1.
[19] On the use of Lesbian marble for standard Asia Minor capitals, Bianchi *et al.* 2023.
[20] Personal communication: Herrmann *et al.* 2012b, 1329, tab. 3, figs. 5, 6.
[21] Herrmann 2017, 356-357, figs. 19, 22-24; Tykot *et al.* 2018, USF10863, 475-477, tab. 2, figs. 18-19.
[22] Herrmann *et al.* 2019, 473, 475-476, tab. 2, fig. 15p.
[23] Herrmann *et al.* 2012b, 1323-1330; Herrmann 2017, figs. 7-9, 14.
[24] Harrazi 1982, probably cat. no. 25, sandstone.
[25] Herrmann *et al.* 2012c; said to be Filfila marble: Gsell 1898, 72.
[26] Bruno *et al.* 2012, 568-570.

Figure 3: Corinthian capital, Skikda Theater, C66, USF10944, unknown limestone, probably Tunisian, ca. 80-120 CE (Photo: A. Van Den Hoek).

The figure sculptures of Rusicade have isotopic values that spread over more of the isotopic field for Filfila than the architectural decoration does (compare Figs. 1, 4). This may be coincidental or it may indicate that marble for figure sculpture was extracted opportunistically wherever a good block could be found. All the sarcophagi tested have fine grain, with a MGS ranging from 0.5 mm to 1.5 mm. The four decorated pieces have isotopic values that are compatible with both Filfila and prokonnesian, the most popular marble for sarcophagi at Rome at that time[27], but a source on Mt. Filfila seems more likely, since the sarcophagi have a finer grain size than usual in prokonnesian, and none of them display the parallel banding almost always seen in prokonnesian sarcophagi.

The isotopic signatures of the Rusicade sarcophagi also correspond to the fine-grained marbles Paros, Afyon, and Göktepe, but these marbles are hardly ever used for Roman sarcophagi in the West. Isotopically, three sarcophagi could be from Mt. Pentelikon, but they do not show the foliation common in that marble. In terms of iconography and style, two of the decorated sarcophagi at Rusicade are closely linked to Rome. One has a tomb door and fluting (USF 10921) and is much like pieces in Timgad[28] and Tunis[29]. All of these African examples are essentially indistinguishable from tomb-door sarcophagi in Italy[30]. Guntram Koch considers a sarcophagus with centaurs pulling chariots (USF 10919) a local imitation of Roman sarcophagi[31]. The quality of this sarcophagus has been excessively criticized[32]. The figures on the Centaur sarcophagus are slightly flattened and use of the drill is reduced, as in a garland sarcophagus in Timgad, which also has a Roman design[33]. Sculptors may have come from Italy, and cartoons on cloth or paper may have also been sent for execution in the local marble. In other markets of the Western Mediterranean, such as Sardinia, most of the marble sarcophagi were imported from Italy[34]. In Rusicade with its nearby supply of white marble, it was evidently more convenient to do the carving locally.

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[27] Van Keuren *et al.* 2010.
[28] Tykot *et al.* 2018, 466, fig. 4, in prokonnesian or perhaps Filfila marble.
[29] Teatini 2011, 213, fig. 201.
[30] Gabba *et al.* 1977, cat. nos. 225, 228; Teatini 2011, cat. nos. 43; Huskinson 2015, 81-84, fig. 5.3; Borg 2013, 128, 130, fig. 78.
[31] Koch, Sichtermann 1982, 312, fig. 337.
[32] Matz 1975, 454, 463-464, fig. 272.
[33] Tykot *et al.* 2018, 468, fig. 2.
[34] Teatini 2011, 414-417, cat. nos. 72, 77, 84.

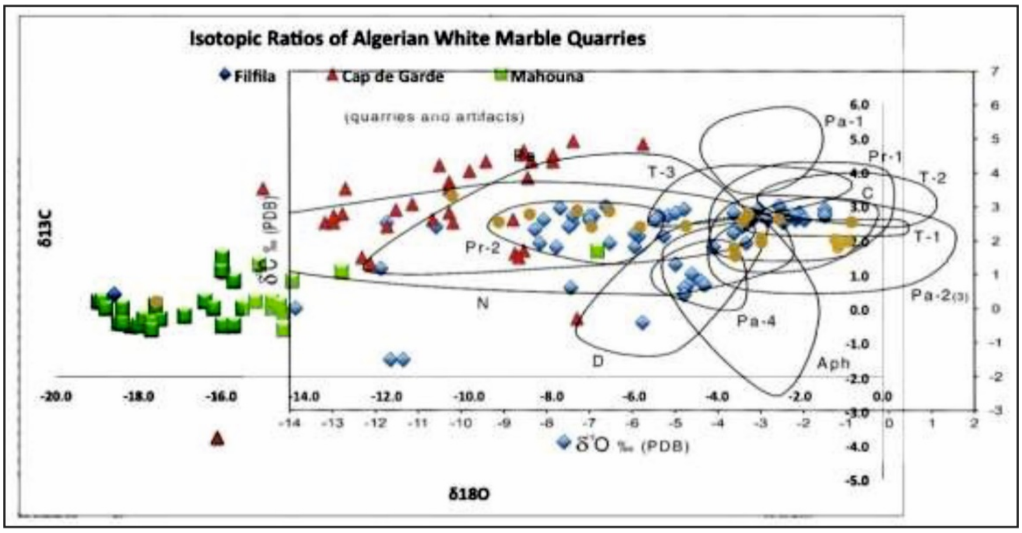

Figure 4: Isotopic rations of figural sculpture at Rusicade/Skikda, quarry samples of Djebel Filfila, and main Mediterranean marbles (Graph: Gorgoni diagram modified by H. Tykot).


Figure 5: Sarcophagus with a hunt, Skikda Museum, SARK 214, USF10922, Filfila marble, ca. 235-240 BC (Photo: A. Van Den Hoek).

A Filfila marble sarcophagus decorated with an unusual hunting scene is more creatively provincial (USF 10922) (Fig. 5)[35]. The figures are flattened, as on the back and sides of many Roman sarcophagi. The subject, a hunter pursuing a hare, is rare on sarcophagi but popular in Tunisian mosaics of the 3rd century[36]. The chase surprisingly leads beyond a tree and flocks of animals into the lair of a herdsman with a club and lionskin. The scene recalls an Early Imperial landscape relief with a Hercules-like herdsman from Italy in Munich[37]. The jutting chin of the hunter on the sarcophagus recalls the features of the Emperor Maximinus the Thracian (235-238 CE), and the sarcophagus probably dates from about that time. A Filfila marble sarcophagus with the Good Shepherd of the early 4th century (USF10920) is more schematic and more provincial in workmanship than the others. It seems to draw on the traditions of the Adriatic, where sarcophagi have widely spaced figures in archways[38].

Several splendid sculptures of the 2nd century closely follow the standards of central Italy in terms of typology and workmanship, but they too were very probably made of Filfila marble: Antoninus Pius (10933), Togatus Sk 215 (USF 10934) (Fig. 6), Togatus Sk 217 (USF

[35] Koch, Sichtermann 1982, 312, fig. 343.
[36] Dunbabin 1978, 46, 49-50, 52, pls. 22, 43-44.
[37] Adriani 1959, 8, pl. 8, no. 26, calling the herdsman "Polyphemos", Wünsche 2007, 159.
[38] Rebecchi 1978; Herrmann *et al.* 2019, 242, figs. 8, 10.

10935), and the Large Herculaneum Woman, Sta Sk 219 (USF 10936). These statues have isotopic signatures that correspond to a multitude of white sculptural marbles, but their coarse grain size reduces the options to Prokonnesos, Aphrodisias, and the Carrière Romaine at Djebel Filfila. Their isotopic signatures fall on the border of Prokonnesos 1 but are located centrally in the fields of Aphrodisias and Filfila. Since Aphrodisias is an uncommon marble in the western Mediterranean, this group is very probably made of Filfila marble. These good quality statues could have been produced by sculptors from Rome working in Rusicade. A portrait of a woman of the time of Antoninus Pius belongs to this sophisticated group (USF 10931)[39]. Although the bust's isotopic values are somewhat different and could indicate an origin on Mt. Pentelikon as well as Filfila, its coarse grain favors the local Numidian source. Local workmanship may be revealed in the bust's rather faint definition and the absence of polishing. A local sculptor could have been copying a plaster cast sent from Rome.

Figure 6: Togatus, Skikda Museum, Sk215, USF10934, Filfila marble, early 2nd century (Photo: A. Van Den Hoek).

Four sculptures in a uniform white marble could be from either Mt. Pentelikon or Filfila on the basis of their fine grain and their isotopic ratios. Only one of them, however, a worn and fragmentary portrait, seems actually to be imported marble. The marble's long parallel flaws may indicate a Pentelic origin (USF 10924) (Fig. 7). The head could well represent Vespasian; it has the proportions seen in many portraits of the emperor, including an example from Carthage in the British Museum[40]. The other three sculptures are likely to be marble from Filfila rather than Pentelikon since they lack foliation. In a portrait of Julia

[39] Gsell 1898, pl. 10.4.
[40] British Museum 1850,0304.35.

Domna (USF 10927)[41], the outline of the iris of the eyes is omitted, as in a portrait of Faustina II from Lambaesis (Lambèse, Algeria) in the Louvre (MA1175), and the head could be local work. A relief with a victory, a cuirass, and palm branches (USF 10926) has a simplified style with heavy-handed drill channels that recalls Roman sarcophagi of around 300 CE. A bust of a long-haired youth (USF 10930) (Fig. 8) is typologically similar to busts of minor Eleusinian gods, such as *Triptolemos*, produced around Athens[42], but its rough workmanship is undoubtedly local.

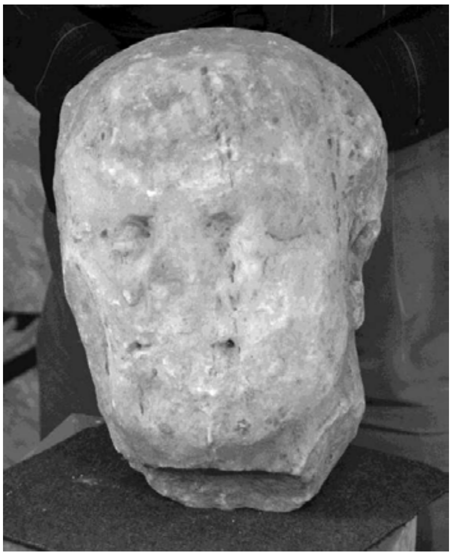

Figure 7: Flavian Portrait, possibly Vespasian, S Sk118, USF10924, probably pentelic marble, ca. 70-96 BC (Photo: A. Van Den Hoek).

Figure 8: Bust of a genius or Triptolemos, S Sk125, USF10930, probably Filfila marble, ca. 150-200 (Photo: A. Van Den Hoek).

Isotopic analysis reveals clear identifications of two figure sculptures from other Algerian quarries. A relief with small figures engaged in a sacrifice (USF10937) has fine grain, but its isotopic ratios place it solidly in the area of Cap de Garde. A statuette of the Mithraic *genius Cautopates* is onyx marble from Mt. Mahouna[43].

Archaeometric data make it clear that some marble for freestanding figure sculptures was imported from the northern shores of the Mediterranean. Four figure sculptures at Rusicade are very probably Carrara marble. They have fine grain, but isotopically they are not from Filfila. Their oxygen values are particularly positive or "heavy". They could be Paros 2, or prokonnesian as well as Carrara, but those are medium to coarse-grained marbles. A splendid statue of Kore could also be from Mt. Hymettus isotopically (USF 10929) (Fig. 9). Since Hymettan marble is rare in the West, it is more likely to be Carrara. The statue is comparable to the elaborate draped statues of Carrara marble dated to the 1st century in Leptis Magna[44]. The Kore's head and hands were made separately, possibly in an even more prized marble. A rather lackluster togatus of the later 1st century is also made of Carrara and put together from pieces (USF 10953). The marble for both statues must have been shipped from Carrara, perhaps as slabs or blocks, to Rusicade, where it would have been carved, possibly by sculptors trained in Rome. A statuette represents a *Genius* holding a cornucopia probably of the first half of the 2nd century (USF10932). Another of these fine-grained Carrara pieces

[41] Gsell 1898.
[42] Limc 8, s.v. Triptolemos (G. Schwarz), cat. 159.
[43] Clauss 2011, fig. 96.
[44] Musso *et al.* 2016.

shows Latona/Leto with Apollo and Diana/Artemis in her arms (USF10925) (Fig. 10). This is a virtually unique subject: the standing Leto of Hierapolis in Asia Minor, otherwise known only from coins of Cibyra of 161-180[45]. The isotopic signature suggests that the marble might be from Dokimeion, not far from Kibyra, but the dingy, spotted piece of stone and the rather local-looking style of carving do not suggest a work exported from Asia Minor, and isotopically Carrara is a more probable source of the material. Except for the Latona, the Carrara sculptures are relatively early, and local marble may have largely displaced imported marble in the course of the 2nd century.

Figure 9: Statue of Kore, STA Sk 116, USF10929, Carrara marble, 1st century (Photo: A. Van Den Hoek).

Figure 10: Statuette of Latona with Apollo and Diana, Sta Sk 021, USF10925, Carrara marble, ca. 170-220 (Photo: A. Van Den Hoek).

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USF Lab	δ13C	δ18O	MGS	Description	Location	Gsell 1898 p. & plate	Quarry assignment
10918	2.7	-4.3	1	Composite Capital CH.SK.051, H 33.3 cm	Museum	-	D, **F**
10919	2.5	-6.0	1	Sarcophagus with 2 centaur chariots SAR.SK.117	Museum	p. 30, pl. 2.2	**F**, Pe
10920	2.9	-6.8	.6mm	Good Shepherd sarcophagus SARK.SK.212	Museum	p. 35, pl. 3.2	**F**, Pe
10921	2.9	-3.3	.5mm	Strigillated sarcophagus with tomb door SARK.SK.213	Museum	p. 34, pl. 4.3	**F**, Pr
10922	2.7	-2.8	1.5	Sarcophagus with hunt SARK.SK.214	Museum	p. 32, pl. 2.1	**F**, Pr, crackled veins
10923	-0.2	-17.9	2	Genius with torch (Cautopates) S.Sk.001.	Museum	p. 46, pl. 6.3	**Mahouna** yellowish, translucent, layering
10924	2.9	-7.8	1.2	Flavian portrait., S Sk118	Museum	-	F, **Pe:** isotoptes, long flaws
10925	2.1	-1.7	1	Latona and twins Sta. Sk. 021 Sta.	Museum	-	dirty smudgy **C** or Pr
10926	2.7	-9.2	.6mm	Relief with Victory and a trophy S.Sk.045	Museum	p. 54	**F** or Pe
10927	2.9	-8.5	1	Julia Domna S.Sk.046	Museum	p. 62, pl. 9.2	**F** or Pe: faint gray smudges, no clear Foliation
10928	2.6	-4.8	2	Altar to Mercury St.Sk.047	Museum	-	**F**, Pr, N, coarse, gray Band
10929	2.5	-1.1	.6mm	Kore STA.SK.116	Museum	-	**C**
10930	2.8	-3.7	.6mm	Bust of Genius S.Sk.125	Museum	-	Doc, Aphr, Pa1, **F** looks like plaster
10931	2.7	-7.0	2	Bust of Antonine woman S.Sk.126	Museum	p. 65, pl. 10.4	Grayish Pr or **F**
10932	1.8	-1.6	.8 mm	Genius S.Sk.126	Museum	p. 54, pl. 7.5	**C**, gray veining
10933	1.9	-3.6	1.7	Antoninus Pius, Sta.Sk.210	Theater	p. 60, pl. 8	smudgy streak, white face Pr, Pa2, **F**
10934	2.1	-3.4	3	Togatus STA.SK.215	Museum	-	Aphr, Pa2, **F**
10935	2.3	-3.4	2.5	Togatus STA.SK.217	Museum	-	Aphr, Pa2, **F**
10936	1.6	-3.6	2	Large Herculaneum Woman STA.SK.219	Theatre	-	Aphr, Pa2, **F**
10937	3.2	-10.3	.8mm	Relief with sacrifice, H 55, W 64, D 21 cm	Theatre	p. 38, pl. 1.4	white, small brown spots, **CdG**, F
10938	2.8	-5.0	2	Schematic Corinthian capital C.16, coarse grain, H 42 cm	Theatre	-	Pe, Pr2, D, Aph, **F**
10939	2.6	-5.3	2	Schematic composite capital C.28, H 23.2 cm	Theatre	-	Pe, Pr2, D, Aph, **F**
10940	2.8	-5.0	2.5	Asiatic Corinthian pier capital C29, H 57.5 cm[451]	Theatre	-	Pe, Pr2, D, Aph, **F**
10941	3.1	-6.6	2	Schematic composite capital C.31, diagonal of abacus 50.8 cm	Theatre	-	Pe, Pr2, D, **F**
10942	2.3	-5.5	2.5	Schematic composite capital C.47, H 37.6 cm	Theatre	pl. 11.6	Pe, Pr2, D, Aph, **F**
10943	3.3	-6.5	8	Corinthian capital C56, H 45 cm	Theatre	pl. 11.3	Pe, Pr2, D, Aph, **F** fine crack
10944	2.4	-13.1	.5mm	Corinthian capital with decorated abacus C66, H 60 cm	Theatre	-	CdG, **Unknown limestone**
10944	2.4	-13.0	.5mm	Corinthian capital with decorated abacus C66, H 60 cm	Theatre	-	CdG, **Unknown limestone**
10945	2.7	-5.4	2	Schematic Corinthian capital C.73	Theatre	-	Pe, Pr2, D, Aph, **F**
10946	2.5	-8.2	1.1	Schematic Corinthian capital with rounded abacus ornament, C22, H 39 cm	Theatre	-	Pe, Pr2, D, **F**: irregular cracks
10947	0.8	-6.7	2	Composite capital with decorated abacus, limestone (?), H 38 cm	Theatre	-	N, D, **F**
10948	2.0	-9.1	4	Breccia corallina column shaft COL38	Theatre	-	**Breccia corallina**
10948	2.3	-9.2	4	Breccia corallina column shaft COL38	Theatre	-	**Breccia corallina**
10949			7	Breccia corallina column shaft COL38 (sample B)	Theatre	-	**Breccia corallina**
10950	3.3	-13.3	2	Column shaft, COL51, CdG., dm ca. 50 cm	Theatre	-	**CdG**
10951	2.8	-7.6	1.5	Giant column COL67bis	Theatre	-	Pe, Pr2, D, N, **F**
10952	2.8	-4.4	.6mm	Plain sarcophagus, SA.8	Theatre	-	Pe, Pr2, D, Aph, **F**
10953	2.1	-1.4	.8mm	Togatus, St. 02, H frag. 93 cm	Theatre	-	Pa2, **Ca**
10954	0.2	-10.4	3	Altar with pitcher and patera 50, Onyx dorée	Theatre	-	**Aïn Smara**
Aph=Aphrodisias, C=Carrara, CdG=Cap de Garde, D=Dokimeion, F=Djebel Filfila, N=Naxos, Pe=Pentelicon, Pr=Proconnesus, Preferred quarry source in **bold**							

Table 1: Marble artifacts from the Theater and the Museum at Skikda/Rusicade, analyzed at the University of South Florida (USF).

[45] Herrmann *et al*. 2012B, 1329, tab. 3, figs. 5, 6.

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THASIAN HADRIANS: PORTRAITS OF THE EMPEROR IN DOLOMITIC MARBLE FROM THASOS

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Abstract

Ten marble portraits of the emperor Hadrian have been identified optically as thasian marble, and six identifications have been confirmed with laboratory techniques. The portraits are then analyzed to identify cases where sculptors from Thasos or the north Aegean area were involved in their production. Seven, in fact, are clearly the work of northern Greek sculptors, although they differ from one another in their stylistic approach. All but one of the sculptors based themselves on three of the seven recognized types of Hadrian portrait, but in several cases they diverged from these models in various details. A workshop at Rome produced an illusionistic head of the emperor, but the provincial sculptors produced more idealized and stylized works.

Keywords: EPR, XRD, microprobe, North Aegean.

Introduction

Portraits of Hadrian made of thasian dolomitic marble make a good control group to determine what we learn in art-historical terms from identifying marble[1]. Over the past thirty years ASMOSIA has inspired me to track the use of dolomitic marble from Thasos around the Mediterranean, identifying likely candidates by eye, obtaining samples, and submitting them to scientists for laboratory analysis. In a recent catalogue of portraits of Hadrian, dating from 1994, Cécile Evers lists 149 freestanding portraits[2]. I have not examined all of them, but of those I have seen, nine appeared by eye to be thasian marble. In addition to these freestanding sculptures, one monumental relief containing a portrait of Hadrian is made of thasian dolomitic marble as part of the Antonine Monument of Ephesos, the so-called Parthian Monument (Fig. 9). All ten of these portraits probably fall into the span of 117 to ca. 150 CE Hadrian reigned from 117 to 138 CE, and the latest known dedication of a statue to him seems to be from 148 CE[3]. The Antonine Monument of Ephesos is often dated after 169 CE, but on stylistic grounds is seems much more likely to have been carved not long after the death of Faustina I (who appears as a goddess in the monument) in 141CE[4]. These sculptures then form a group of highly comparable pieces made of marble from the same quarry, representing the same subject, and produced in a single, relatively short period of time. Their ancient provenances, when they can be determined, however, are widely scattered throughout the central and eastern Mediterranean.

Thasian sculptural marble has rather distinctive characteristics optically, since it is pure white, has medium-to-coarse grain, and has crystals that frequently glitter conspicuously. Furthermore, it is relatively easy to confirm these optical identifications scientifically since marble from Cape Vathy and the Saliari Area in northeast Thasos is the only coarse-grained dolomitic marble widely used in antiquity. Six of the ten thasian-looking portraits of Hadrian

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[1] Thanks for a sample and pictures to Sven Ahrens, Oslo and for laboratory analysis by Donato Attanasio.

[2] Evers 1994.

[3] Evers 1994, 38-39, 296.

[4] Vermeule 1968, 96-97; Evers 1994, 61-62; Liverani 1999, 153-155, 168. The limited use of drillwork and the absence of incised irises in the eyes favor the early Antonine date.

have been sampled and analyzed. Making use of X-ray diffraction (XRD) and electron-beam microprobe, Richard Newman and Eric Doehne have proven that four portraits are dolomite, and their results have been published in ASMOSIA proceedings. Donato Attanasio has recently identified two portraits as dolomite with paramagnetic resonance spectroscopy (EPR). I am confident that the four unverified optical identifications are correct. The whiteness and the glittering crystals of thasian marble are very distinctive visually.

According to Cécile Evers, there are seven official types of portraits of Hadrian, which were created in the city of Rome and were replicated throughout the Empire[5]. These types were treated somewhat differently in different workshops, and Evers identifies five workshops operating in the city of Rome[6] and notes the existence of various provincial workshops[7]. The question arises what relationship, if any, does the treatment have to the marble. Is the marble purely raw material, or does it share a geographical connection with its sculptor? From time to time archaeologists have argued that it is logical and indeed likely that sculptors favored material from their places of origin and that the material used is a good indicator of the place of origin of the sculptor. This hypothesis has been advanced most recently by Attanasio, Bruno and Prochaska[8]. This paper will seek to identify stylistic traces of a possible relationship to the culture of the north Aegean area from which the thasian marble came.

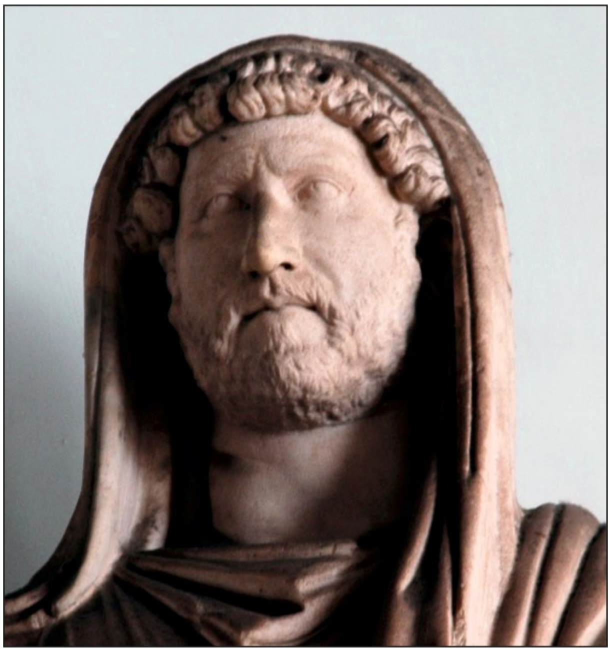

Figure 1: Hadrian, "Baiae type", part of a togate statue with veiled head, Capitoline Museum, inv. no. 54. Thasian dolomitic marble (Photo: A. Van Den Hoek).

In Rome, the Capitoline Museum has a full statue of Hadrian with his toga veiling his head (Fig. 1)[9]. Donato Attanasio has shown with EPR that the marble is dolomite and hence from Thasos[10]. In the head the curls above the forehead and the nose tip are reconstructed, but it is otherwise well preserved. It presents the "Panzer-Paludamentum type Baiae" in a way typical of normal, high-quality work in the city of Rome, and Cécile Evers regards the statue as the work of her Roman workshop D[11]. If the sculptor was from Thasos or the north

[5] Evers 1994, 215-271. See also Fittschen, Zanker 1985, 44-58, pls. 49-60, suppl pls. 22-38.
[6] Evers 1994, 295-329.
[7] Evers 1994, 297-300.
[8] Attanasio *et al.* 2019, 168, 185.
[9] Inv. MC 54: Fittschen, Zanker 1985, cat. no. 51; Evers 1994, 158-159, 245, 341, cat. no. 99, Atelier D.
[10] Herrmann *et al.* 2014, 12, CD14; Attanasio *et al.* 2019, 191-192, cat. 75.
[11] Evers 1994, 158-159; 295-341; Attanasio *et al.* 2019, 192.

Aegean, he had fully assimilated Roman practice. Evers perceived some dryness in the execution, but this could be due to the hardness of dolomitic marble. Calcite rates a 3 on the Mohs scale of hardness, while dolomite is 3.5-4. Any sculptor might have simplified and flattened forms somewhat when working in this unusually hard stone. The toga of the thasian piece is a rare, old-fashioned type, which is simplified in a heavy-handed way, but these peculiarities do not seem to have anything to do with Thasos or Greece[12]. In this case then, the Thasian marble was simply used as raw material by a central Italian sculptural workshop, which may or may not have included a thasian master and which produced a portrait consistent with the subtle, illusionistic techniques characteristic of the city of Rome.

Figure 2: Hadrian, "Rollocks type", part of an armored statue, Thasos Museum, apparently thasian marble (Photo: A. Van Den Hoek).

The Northern Aegean island of Thasos itself has a splendid statue of Hadrian in armor, with an unusually simple breastplate (Fig. 2). The statue is untested, but to observers such as Evers, as well as to us, it appears to be thasian dolomitic marble. The head belongs to the so-called Rollock type; nine broad, S-shaped curls form an arch above the forehead from ear to ear[13]. Evers and Lee Ann Riccardi describe the statue as the product of a local workshop and note its great dryness[14]. Everything is made more regular and emphatic than in central Italian Hadrian portraits. The features are bordered by sharp, graceful curving lines, and the beard is made up entirely of clearly outlined flame-like locks, unlike the sketchy, more naturalistic technique of the Capitoline portrait (Fig. 1). The pattern of undulating locks has much in common with the hair of a late Julio-Claudian portrait in the thasian tradition and also in dolomitic marble in Izmir from Miletos[15]. The sculptor on Thasos has taken liberties with the official type and made the emperor more elegant, ideal, and prettier. Here thasian marble and northern Greek workmanship go together.

There is another thasian Hadrian in the north Aegean: the armored statue excavated in the Theatre of Troia, now in Çanakkale (Fig. 3), and the marble has not been tested, but it seems very evident optically that it is dolomitic marble from Thasos. Evers ascribes the head to the type "Imperatori 32"[16]. She discerns a summary quality comparable to that of the statue on Thasos, but that is more evident in the armored body than the head. In the Trojan piece the

[12] Goette 1990, 39, 42, pl. 19,3; cat. no. B b 56.
[13] Evers 1994, 187, cat. 138. She calls the marble "local".
[14] Riccardi 2000, 121.
[15] Herrmann, Newman 1995, 83, figs. 16-17.
[16] Evers 1994, 352 cat. no. 141bis; Rose 1998, 411, fig. 3.

hair is a compact mass of locks modeled with broad grooves that are not outlined with the drill. The strands of hair in the beard are indicated with long grooves. The head is anything but idealized; in fact, it is decidedly homely. The nose is elongated, the chin shortened, the eyebrows harshly level, and the face narrow, perhaps recalling portraits of Trajan. The sculptor was careless about detail and exaggerated some of the official type's harsh individuality. Once again, a marble of the north Aegean goes with a distinctive and apparently north Aegean style, but in spite of a certain kindred simplification, the Çanakkale head represents a different northern Aegean workshop from the one that carved the Hadrian on Thasos.

Figure 3: Hadrian, "Imperatori 32 type", part of an armored statue, Troia Museum, apparently thasian marble, (Photo: J.J. Herrmann).

Figure 4: Hadrian (atypical), Ostia Museum, thasian dolomitic marble, (Photo: A. Van Den Hoek).

A portrait of Hadrian excavated in Ostia has long been a puzzle (Fig. 4). Evers called it an enigma and was unable to classify it among any of the official types[17]. Raissa Calza recognized the head as the work of a provincial Greek sculptor and compared it to the Hadrian on Thasos[18]. Since then its coarse-grained, pure white marble has been proven with XRD to be dolomite and hence thasian[19]. This extra thasian connection confirms Calza's interpretation of the portrait's peculiarities. The Çanakkale portrait from Troia (Fig. 3) makes these connections even clearer. The elongation of its face and nose and its harsh expression find a close parallel in the Ostia portrait. At the same time, the Ostian portrait is much more ornamental than the piece from Troia; not only are its surfaces polished, but the curls around the forehead are emphatically outlined, somewhat as in the Hadrian on Thasos. The beard is a mass of ringlets, much like the crests of hair in female portraits of Flavian to Hadrianic times,

[17] Inv. 32: Evers 1994, 141, cat. no. 78.
[18] Calza 1964, no. 117, pp. 73-74, pl. 68; Herrmann, 1990, 83-84, fig. 15-16.
[19] Herrmann, Newman 1995, 82.

and the detail is lightly incised into the surface of the face. The ringlets have a metallic quality similar to a contemporary portrait in thasian marble in Athens[20]. In this case, the thasian provenance of the marble is a key to the north Aegean origin of the sculptor of the Ostian Hadrian, but the sculptor once again had a very distinctive approach to his subject.

Figure 5: Hadrian, "Tarragona type"?, Glyptothek, Munich, apparently thasian marble. (Photo: A. Van Den Hoek).

A Hadrian in Munich looks as though it is made of thasian dolomitic marble, and it seems related to the Ostian portrait (Fig. 5). The elongated proportions of the face and nose are quite similar, as are the eyes and eyebrows. The curls around the forehead, however, are much smaller and less emphatic than in the Ostian Hadrian. The Munich head follows none of the official types closely, it seems most similar to the rare Tarragona type[21]. The Tarragona piece does have a bit more emphatic curling at the ends of the locks, but it has a similar type of beard, with rows of flame-like locks marching down the cheek. Like the marble, the sculptor of the Munich Hadrian seems to have come from the north Aegean, and could have been associated with the sculptor of the Ostian portrait. He may well have also traveled to Italy.

Another head of Hadrian of unknown origin is in Providence. This portrait has puzzled generations of scholars, who were perturbed by the portrait's strange marble and unusual style[22]. More recently it has been shown that the stone is dolomitic marble from Thasos, which is an uncommon material outside the north Aegean[23]. Another problematic feature has been the concavity in the back of the portrait, which has been interpreted as an arrangement to fit the head into a draped statue with the toga covering the head. It has also been considered a product of reworking in the Renaissance. However, a close parallel for the concavity has recently appeared at Sagalassos in Türkiye, where a huge portrait of Faustina the Elder, of the mid 2nd century, was hollowed out in just this way[24]. The head was part of an acrolithic statue of Faustina, whose garments were made in another material. The Hadrian is also over-life-size (the head is 30 cm. high), and probably was also from an acrolithic statue.

Unlike some of the previous thasian marble Hadrians, the head in Providence (Fig. 6) follows an official typology closely; it has been identified as the Imperatori 32 type. The carving of the beard and the curls around the face, however, is abnormal, and Evers has suggested the portrait might come from Egypt or North Africa[25]. Just these abnormalities, however, appear in portraits in thasian marble in the north Aegean. The Hadrian from Troia has his curls above his forehead modeled with broad grooves (Fig. 3).

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[20] Herrmann, Newman 2002, 216; Kosmetes 416, erroneously called Kosmetes 410.
[21] Fittschen, Zanker 1985, 57-58, pl. 60, no. 54; Evers 1994, 186, 240-245.
[22] Evers 1994, 155-156, cat. no. 94; Borromeo *et al.* 2009, 44-45.
[23] Borromeo *et al.* 2009.
[24] Mägele 2013, 54-55, fig. 8a-d.
[25] Evers 1994, 155.

The broad locks of hair split with a single furrow seen in the beard of the Providence Hadrian also appear in dolomitic marble portraits in Thessaloniki[26]. In spite of his careful reproduction of an official portrait type, the sculptor must have been from the north Aegean. Both his technique and his material betray his origins. Since his technique of hollowing out the back resembles what was seen at Sagalassos, it may be that he was working on the eastern side of the Aegean; in Thrace or the Troad. The head went through English and Italian collections before arriving in Providence probably starting in the 16th or 17th century[27]. but it seems likely that it had previously begun its travels in Türkiye.

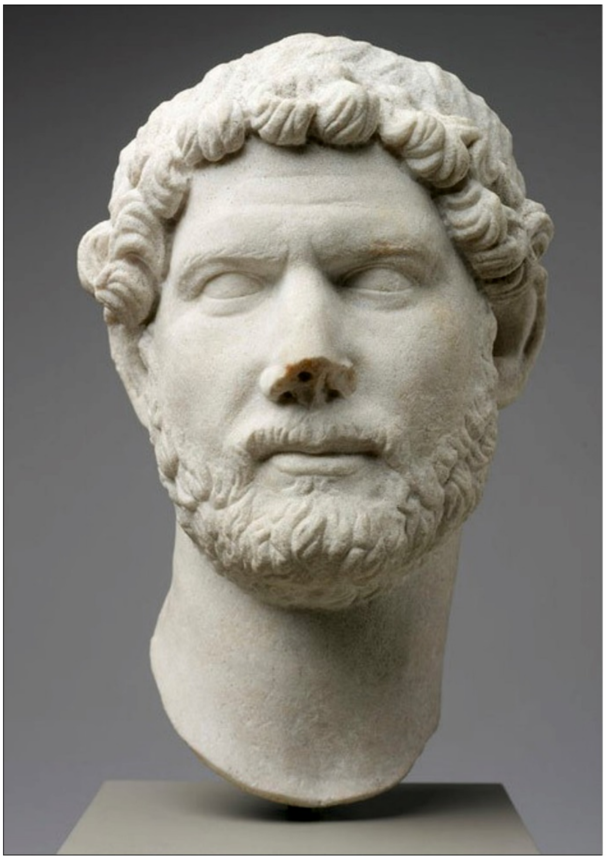

Figure 6: Hadrian, "Imperatori 32 type", part of an acrolithic statue, Rhode Island School of Design, Providence, thasian dolomitic Cape Vathy marble (Photo: Museum).

Figure 7: Hadrian, "Imperatori 32 type", part of an acrolithic statue, Freya Chocolate Factory, Oslo, thasian dolomitic marble (Photo: S. Ahrens).

Another portrait of Hadrian of uncertain origin in Oslo (Fig. 7) shows great similarities to the head in Providence. The grooving of the curls around the forehead is very similar to that of the Trojan and the Providence Hadrians (Figs. 3, 6)[28]. The carving of the locks of the beard, which emerge in three gill-like layers on the sides, is also like the Providence head. Like the Providence head, the Oslo head was an acrolith; it was cut flat in the back and is way over life-size. Both heads were probably part of cult statues in temples to the emperors. Sven Ahrens has recently obtained a sample, and Donato Attanasio has determined with EPR that its marble is pure dolomite and therefore from Thasos.

[26] Borromeo *et al.* 2009, 48-49, fig. 8 (relief tondo); Herrmann 1992, 98, fig. 17: Herrmann, Newman 1999, 81, 82, 84, fig. 24 (portrait of a man, inv. 103).
[27] Borromeo *et al.* 2009, 43-44.
[28] Borromeo *et al*. 2009, 45-46, figs. 3, 5.

Like the Providence head, the Oslo Hadrian is a fairly accurate reproduction of the "Imperatori 32 type"[29], but it is remarkable in having an open mouth. This dramatic feature, which suggests emotion or action, is at home primarily in Asia Minor. The huge acrolithic head of Domitian or Titus in Ephesos, some 30 to 40 years earlier, is an example that is also made of pure white, coarse-grained dolomitic marble from Thasos[30]. Like the Providence Hadrian, the Oslo acrolith could well be from NW Türkiye, perhaps the Troad or Thrace.

The head of Hadrian on the Antonine Monument of Ephesos is a special case: it is a relief rather than a free-standing sculpture and is heavily damaged (Fig. 8). Nevertheless enough survives for it to be classed tentatively as an example of "Imperatori 32"[31]. It is closely connected to two large-scale figural reliefs (without portraits) in Izmir (ancient Smyrna) that are also made of thasian dolomitic marble[32]. In spite of the Ephesos portrait's fragmentary condition, the technique has something in common with the portraits of Hadrian in thasian marble from NW Türkiye. The locks of hair are chiseled in a similar broad technique, and the beard, which does not follow the complicated prototype, has locks that are split with a single groove, much as in the Providence and Oslo Hadrians (Figs. 6, 7). The locks are arranged in regular superimposed rows, as in the mid 2nd century portrait of Titonius Primus in Thessaloniki[33]. Evidently the workshop that produced the huge imperial altar incorporated north Aegean sculptors accustomed to carving thasian dolomitic marble.

Richard Newman has proven that an over-life-size Hadrian in the Museum of Fine Arts, Boston is dolomite has isotopic ratios compatible with Cape Vathy, Thasos (Fig. 9)[34]. Since it is also coarse-grained and pure white, the stone must come from Thasos. In this case, the piece follows an official prototype exactly; it has the broad S-shaped curls of the so-called Rollock hairstyle[35]. In spite of this accuracy, the Boston portrait still has a provincial flavor. The back of the head is left schematic; detail in the finished part is flat and outlined with fine incised lines. The hooked nose is a unique, personal touch of the sculptor.

The Boston Hadrian is said to come from Egypt, and this seems highly probable. Another very similar but even larger Hadrian in Alexandria definitely comes from Athribis in the Egyptian delta (Fig. 10)[36]. It too appears to be made of thasian marble, but this could not be verified; a request for a sample was turned down. The head, which is also an accurate replication of the Rollock type[37], has timid, linear detail much like that of the Boston portrait, and both lack the slightest trace of the drill. The peaked eyebrows and the pronounced concavity above the upper eyelids are also common features. The beard of the head in Alexandria is a mosaic of dainty, comma-shaped locks, which recalls the beard of the Hadrian on Thasos. These Hadrians are probably the work of a local workshop; the peaked eyebrows, at least, appear in Egyptian portraits of Vespasian[38]. The thasian marble was apparently just raw material in the local sculptors' hands.

[29] Sande 1991, 60-61, pl. 47.
[30] Selçuk Museum, inv. 670: Herrmann, Newman 1995,78, 83, fig. 8.
[31] Evers 1994, 61-62. For the identification of the marble, see Herrmann, Newman 1995, 78, 83 (2 pieces in Ephesos analyzed with X-ray diffraction by Eric Doehne), fig. 9; Herrmann, Newman 1999, 302 (slab in Vienna).
[32] Relief of Poseidon and Demeter from the Agora of Smyrna, Relief of Soldiers and Captives from Smyrna, inv. 1002: Herrmann, Newman 1995, 78, 883, figs. 9-10.
[33] Bakalakis 1973, 681-682; Stefanidou-Tiberiou 2003, no. 262, figs. 781-784; Borromeo *et al.* 2009, 48, fig. 7.
[34] Mineralogy determined with Raman spectroscopy. Isotopic ratios δ 13C +3.66 / δ 18O -2.64; Harvard Laboratory number H1227: information from MFA Boston website, https://collections.mfa.org/objects/151352/hadrian?ctx=6cb65e64-a4ec-47c6-a890-027199f89a93&idx=9.
[35] 1975.292: Comstock, Vermeule 1976, cat. no. 356; Evers 1994, 94-95; van de Water 2014, statue no. 31.
[36] Graeco-Roman Museum 20855: van de Water 2014, statue no. 30.
[37] Comstock, Vermeule 1976, cat. no. 356; Evers 1994, 96-97.
[38] Van de Water 2014, nos. 27-28.

These ten portraits of Hadrian in thasian marble then show variable relationships between marble and workmanship. In three cases, the Capitoline and the two Egyptian pieces, the thasian marble was apparently imported raw material used by local sculptors or perhaps by northern Greek sculptors fully integrated into the local traditions and workshops. In seven other cases, however, identification of the thasian marble makes it possible to identify the work of northern Greek sculptors. While these seven sculptors (or

Figure 8: Hadrian, "Imperatori 32 type", part of a monumental relief, the "Antonine Monument of Ephesos", Ephesos Museum, Vienna, thasian dolomitic marble (Photo: ADOK Ephesos, TR 1112018 67).

Figure 9: Hadrian, "Rollocks type", part of an acrolithic statue from Egypt, Museum of Fine Arts, Boston, thasian dolomitic marble (Photo: Museum).

Figure 10: Hadrian, "Rollocks type", part of an acrolithic statue from Athribis, Egypt, Greco-Roman Museum, Alexandria, thasian dolomitic marble (Photo: A. Van Den Hoek).

sculptural workshops) apparently came from the same region, they did not all work in the same style. Each sculpture has to be interpreted individually. Identification of the marble can provide important clues but not instant answers to art historical questions. Art historians are still required to interpret the individual relationships between marble and workmanship.

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POLYCHROME MARBLE AT APHRODISIAS: THE INTERIOR SCHEME OF THE NORTH STOA OF THE PLACE OF PALMS

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Abstract

The use of polychrome marble within Aphrodisias' monumental landscape has received little attention in scholarship to date. Recent excavations of an urban park (formerly known as the 'South Agora') have yielded one of the city's largest assemblages of polychrome stones. Based on stratigraphic analysis and a quantitative assessment of these finds, this paper demonstrates that this assemblage of wall cladding derived from the park's North Stoa and proposes a hypothetical reconstruction of the building's interior decorative revetment scheme. We suggest that the arrangement was designed not only as a lavish second century AD embellishment but also to showcase imported materials from regional and inter-regional sources to maximum effect, with local stones used as framing materials along the top and bottom of the wall. Both the materials employed and the manner in which they are arranged provide significant information concerning the motivations for local and imported stone trade in Asia Minor during the High Imperial period.

Keywords: Asia Minor, Aphrodisias, wall revetment.

The North Stoa of the Place of Palms and the recovery of its remains

Fieldwork conducted at Aphrodisias between 2012 and 2017 as part of the Mica and Ahmet Ertegün South Agora Pool Project has shed new light on one of the city's largest civic structures, the epigraphically-attested Place of Palms[1]. This monumental space, which was previously labelled the 'South Agora', functioned as an urban park from the 1st to 7th centuries AD. It consisted of a public piazza over 200 m long, featuring a vast ornamental pool along its centre, which was enclosed by stoas to the north, west, and south and a monumental propylon to the east (Fig. 1)[2].

Figure 1: The Place of Palms, with the pool running along the centre of the open space and the North Stoa to the north of this (Photo: courtesy the New York University Excavations at Aphrodisias).

[1] The full results of the excavations will be published in Wilson, Russell *in press*.
[2] For the architecture, see Kidd 2018 and Wilson, Russell *in press.*

The stoa[3] running along the northern edge of the Place of Palms was erected by Diogenes, son of Menandros, during the reign of the emperor Tiberius in the early 1st century AD. In design, it was an Ionic colonnade, probably 74 columns long in its original form. Its back wall, constructed of grey marble ashlars along its base with small petit appareil blockwork above, was punctuated by at least two doorways, which provided access from the Place of Palms to the North Agora. However, at some point in the early 2nd century AD, the west end of the North Stoa was shortened to accommodate the construction of the Hadrianic 'Olympian' Baths and the West Stoa, which allowed access between the new baths and the Place of Palms. Holes positioned along the back wall of the West Stoa at regular intervals demark the location of revetment pins, which would have been inserted to attach marble cladding for the new decorative scheme. This pattern of revetment holes continues along the back wall of the North Stoa, suggesting that the North Stoa was updated with its own marble revetment scheme to match the ornamentation of the new West Stoa following its second century construction (Fig. 2).

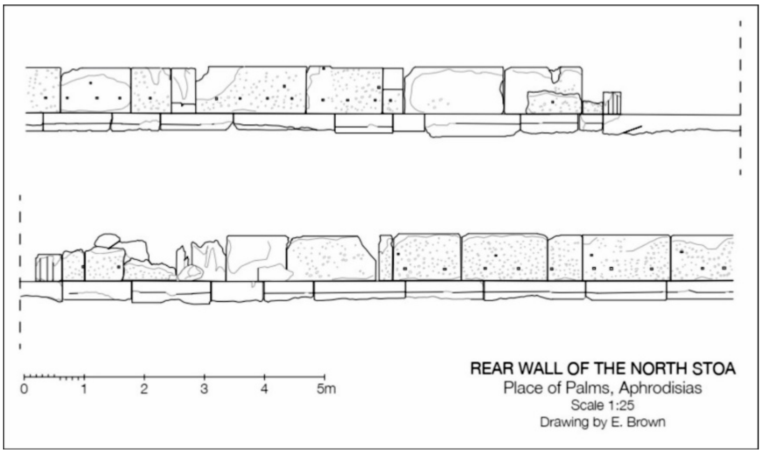

Figure 2: Holes indicating the position of revetment pins in the rear wall of the North Stoa, facing north (Drawing: E. Brown).

The recent excavation of a series of artificial deposits and accumulated fills from within the Place of Palms' pool yielded over 2 tonnes of marble revetment, one of the largest assemblages of decorative stones documented at Aphrodisias to date. These deposits consisted primarily of a wide scatter of finds lying directly on the pool floor across its central and southern sectors and a massive artificial clearance deposit situated across the entirety of the pool floor's north side[4]. This latter deposit was thickest at the north pool wall and gradually sloped southward, indicating that these materials had been thrown into the pool from its north side. Numismatic evidence gives a *terminus post quem* of AD 643/4 for the dumping of this material into the pool[5]. The composition of these deposits was largely the same, comprising marble revetment and pilaster capitals, as well as nearly five tonnes of roof tiles, wooden rafters and planks, several marble sculptural fragments, revetment pins, as well as limited numbers of fragments of Ionic capitals, columns, bases, and entablature elements[6]. These latter materials are consistent in size and type with those previously recovered from the North Stoa. Such components indicate that the deposits are associated with the clearance of debris from within the Place of Palms after a catastrophic event, or series of events in the early to mid-7th century AD. Marble from one later fill of the pool, dating to the Byzantine period,

[3] Here called the North Stoa and previously labelled the 'Portico of Tiberius'.
[4] The stratigraphic units from which this marble comes are 4328, 4448, 4466, and 4482.
[5] The 11 coins found directly on the pool floor, which range from the 540s to 643/4, gives this *terminus post quem*.
[6] Kidd, Russell, Wilson *ın press*.

was also analysed, since it closely resembled the material from the lower deposits[7]. Considering the spatial position of these deposits along the north side of the pool and their specific architectural components, it is evident that the assemblage of marble revetment recovered from within the pool once belonged to the rear wall of the North Stoa.

Whereas these deposits show that the North Stoa probably lost its roof and much of its interior decoration by the middle of the 7th century, the colonnade itself seems to have remained standing until around the 11th century[8]. It should be noted, however, that this assemblage represents only some of the material that once belonged to the North Stoa's second century decorative scheme. Excavation notebooks from 1985-1990 show that substantial quantities of marble were also recovered at the pool's east and west ends, though the varieties of stones were only recorded by Fant in 1993[9]. Although our own investigations recovered polychrome revetment also from later deposits within the pool, this appeared to be residual material that was dispersed throughout the area as the North Stoa continued to degrade[10]. What is more, repairs to the floor of the monumental pool in the 5th century made extensive use of recycled revetment matching the size and variety of that found within the clearance deposits. Such evidence suggests that the North and perhaps West Stoas were, like the pool, in a poor condition by the 5th century and necessitated repairs coinciding with an expansive Place of Palms restoration project, which we know from epigraphic sources was initiated by a local aristocrat, Ampelios, in the late 5th/early 6th century[11]. Therefore, the material discussed below is a representative sample of what remained of the North Stoa's interior decoration by the early 7th century.

Recovered lithotypes, mouldings, and quantities

The revetment can be divided into two categories: flat panels and mouldings. A total of 1524 kg of flat panel fragments and 792 kg of moulding fragments were documented from the stratigraphic units noted above. The breakdown of the lithotypes represented is plotted in Figures 3 and 4. In the case of the flat revetment, 94% of the assemblage consists of just four materials: africano from Teos and its vicinity (33%), alabastro fiorito from the region around Hierapolis and Tripolis in Phrygia (19%), a mottled grey marble (25%), and a variety of bluish pavonazzetto (17%). The latter two types are from Aphrodisian territory; the grey probably derives from the Yazır quarries (11 km west of the city) and the pavonazzetto-like marble probably from Çamova Tepe (22 km east of the city)[12]. While the africano and alabastro fiorito panel fragments were not ornamented in any way, both the mottled grey and pavonazzetto fragments belonged to large rectangular panels with scotia mouldings running

[7] This is stratigraphic unit 4442.

[8] This date is corroborated by the significant number of large architectural components found in stratigraphic layers belonging to the Late Byzantine period and continuing through to the 19th century, with limited evidence for such elements among earlier phases.

[9] Fant 1993, 154-155, n. 67. For the excavations, see relevant on-site notebooks: Nbk 269: Portico of Tiberius NE II, Book 2 (Önce 1985); Nbk 293: Portico of Tiberius W I (Tulga *et al*. 1988); Nbk 300: Portico of Tiberius NCE I (Önce 1988); Nbk 304: Portico of Tiberius W I (Page, Thode 1989); Nbk 305: Portico of Tiberius W II (Page, Thode 1989); Nbk 306: W Portico of Tiberius; SW Pool (Görkay 1989); Nbk 307: SW Portico of Tiberius (Thode 1989); Nbk 308: Portico of Tiberius SI & II (Page 1989); Nbk 309: Portico of Tiberius SIII (Pag 1989); Nbk 310: E Portico of Tiberius: Basin 89-I (Önce 1989). For 1990: Nbk 316: Portico of Tiberius: W Pool, Book I; E Pool (Tek 1990); Nbk 317: Portico of Tiberius: W Pool, Book II (Tek 1990); Nbk 318: Portico of Tiberius: E Pool (Önce 1990).

[10] See on-site notebooks: Nbk 528: SAg 12.1 (Ozdemir *et al*. 2012); Nbk 567: SAg 16.1 (Kidd *et al*. 2016); Nbk 574: SAg 17.1 (Kidd *et al*. 2017); Nbk 576: SAg 17.2 (Halcrow *et al*. 2017).

[11] Wilson, Russell *in press*.

[12] Long 2012; Attanasio *et al*. 2015, 754.

down either both or one of their long sides. Apart from these four main types, further flat panels were also found in white marble (4%, also of a local variety) as well as much smaller quantities of opus sectile fragments, comprising only 2% of the total, in a wide range of stones: cipollino (12.82 kg), verde antico (3.31 kg), serpentino (2.45 kg), nero antico (2.32 kg), porfido rosso (1.73 kg), rosso antico (1.04 kg), portasanta (0.53 kg), giallo antico (0.36 kg), cipollino rosso (0.07 kg), and granito nero e bianco (0.05 kg)[13].

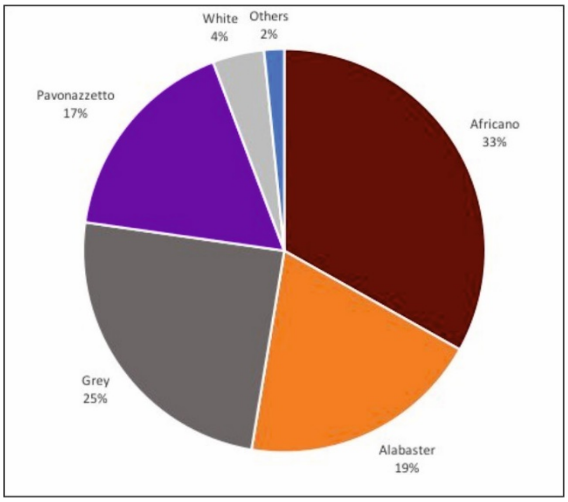

Figure 3: Flat panels sorted by lithotype by weight (n:1524 kg).

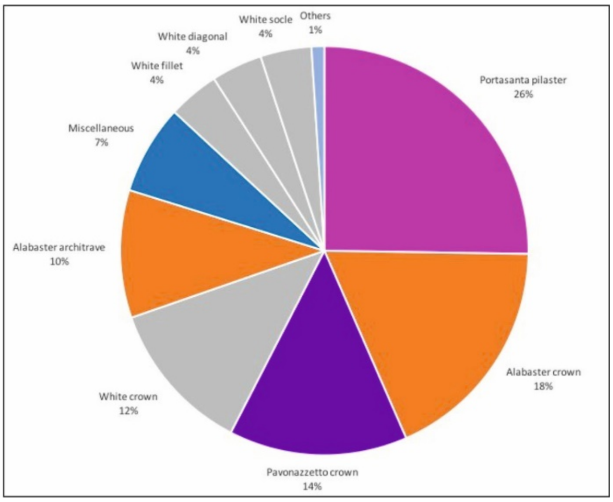

Figure 4: Moulding fragments sorted by weight (n:792 kg).

The moulding fragments from the North Stoa demonstrate some slight differences in their range of lithotypes. Only four main materials are used: local white marble (24%), Çamova Tepe pavonazzetto (14%), alabastro fiorito (28%), and portasanta from Chios (26%). These stones are used for specific elements: portasanta for fluted flat pilaster shafts and their astragal mouldings; pavonazzetto for a shallow crown moulding; alabastro fiorito for both a crown moulding and an architrave moulding; and local white marble for a crown moulding, a fillet with rounded profile, a fillet with diagonal recesses into which the aforementioned porfido rosso and serpentino stones were set, and a plain block with rectangular recess for further polychrome insets. This quantitative distribution of lithotypes, with such an abundance of africano, alabastro fiorito, and a local variant of pavonazzetto, corresponds with finds from elsewhere in Asia Minor, which demonstrate that these varieties of polychrome stones were most popular during the Hadrianic period[14]. There existed also a small number of fragments in mottled grey from Yazır comprising pilaster shafts, architrave mouldings, crown mouldings, and flat mouldings with two scotias (they are listed under 'Others' in Figure 4). Since these elements are few in number, amounting to less than 1% of the moulded fragments, but duplicate the same mouldings featured among the other lithotypes, it appears that this material was used to replace damaged elements and should probably be associated with the late fifth-/early sixth-century restorations to the Place of Palms.

[13] Most of these, along with the moulded types categorized as 'miscellaneous', probably did not belong to the North Stoa's original decorative scheme but had been deposited along with other various clearance debris into the pool in the early 7th century.

[14] Pensabene 2016, 674.

Figure 5: Figured Corinthian pilaster capitals from the North Stoa (Photo: I. Cartwright, courtesy the New York University Excavations at Aphrodisias).

Alongside the revetment panels and mouldings, more than 50 fragments of figured Corinthian pilaster capitals in local white marble were also recovered from the new excavations[15]. As discussed below, their size indicates that they belong with the aforementioned portasanta shafts. They show *Erotes* engaged in various bucolic activities; the most complete capital depicts a winged *Eros* holding a *thyrsos*, two others winged *Erotes* hunting, and the last two winged *Erotes* harvesting grapes (Fig. 5). This group can be connected to a series of four figured pilaster capitals found in the area of the Place of Palms between 1978 and 1989 and a pair of stray finds from the site, which depict matching *Erotes* as well as *Artemis*[16]. This latter group has been published by Dillon, who dates these pieces to the 2nd century AD based on their technical details, size, format, and subject matter, noting also their stylistic similarity to the 'peopled scrolls' from both the Hadrianic Baths and the Theatre Baths at Aphrodisias[17]. These examples are also similar to second century figured pilaster capitals from various structures at Laodikeia[18].

Given the evidence provided by the revetment holes made within the rear walls of the West and North Stoa, the types of stones recovered, and the style of the pilaster capitals, we may conclude that the North Stoa's interior was ornamented with elaborate marble cladding at some point during the early/mid-2nd century.

The reconstructed decorative scheme

The holes for revetment pins in the rear walls of both the North and West Stoas demonstrate that these walls were decorated with a base socle surmounted by large panels of revetment to form a dado. This part of the scheme would have comprised of base panels in white marble superimposed by larger panels in Yazır grey[19]. Since none of the walls are preserved much over a metre, the exact formulation of the decoration above this is not clear. However, the range of mouldings excavated and the quantities of different lithotypes allow a

[15] For more on these, see Wilson, Russell *in press*.
[16] Inv. Nos. 78-7, 85-124, 85-125, 89-9, and one uncatalogued find from 1988.
[17] Dillon 1997, 762-767.
[18] Şimşek 2013, 250-251 fig. 333, 452 fig. 633.
[19] A complete base panel in white marble measures 39-48 x 22 cm. A complete panel in Yazır grey measures 46.6 x 94 cm.

tentative reconstruction to be proposed (Fig. 6). Like the panels in Yazır grey, there are no corners on the scotias of the pavonazzetto panels. As such, these must run horizontally; with reasonable confidence, we propose a line of these smaller panels within the dado, topped by the white crown moulding, since it is the only element deep enough to support the bases of the pilasters above. To judge from the width and the height of the pilaster capitals (32.5 cm by 32 cm), which also matched the width of the pilaster shafts in portasanta, the height of the pilaster shafts was probably 2.8 m[20] and they were capped by an astragal moulding, also in portasanta. The distribution of figured capital fragments within the pool suggests that there existed one pilaster for every structural column within the stoa. If the pilasters were spaced like the columns, they would have had an interaxial spacing of 2.89 m. Two small fragments of base moulding survive; these might have been raised on white marble blocks with rectangular insets. The field between the portasanta shafts must have been primarily occupied by the africano panels. This is determined not only by their quantity but also by the fact that a number of these that are cut to fit around the edge of the pilaster capitals. The other elements that can be located with reasonable confidence are the alabaster mouldings: the thick architrave panels must go above the capitals and were likely topped by an equally thick crown moulding in the same stone; the white marble fillet with diagonal recesses, apparently imitating a twisted cord moulding typically found on architrave blocks between fascias or on the abacuses of capitals, should belong to this mock entablature too, perhaps beneath the architrave. The final elements belong to the field between the pilasters and below the africano panels. These include a line of the larger pavonazzetto panels, topped by a crown moulding of the same marble. Above this, we propose that the flat alabaster panels were set within the africano surround, since none of these are cut to fit around vertical elements.

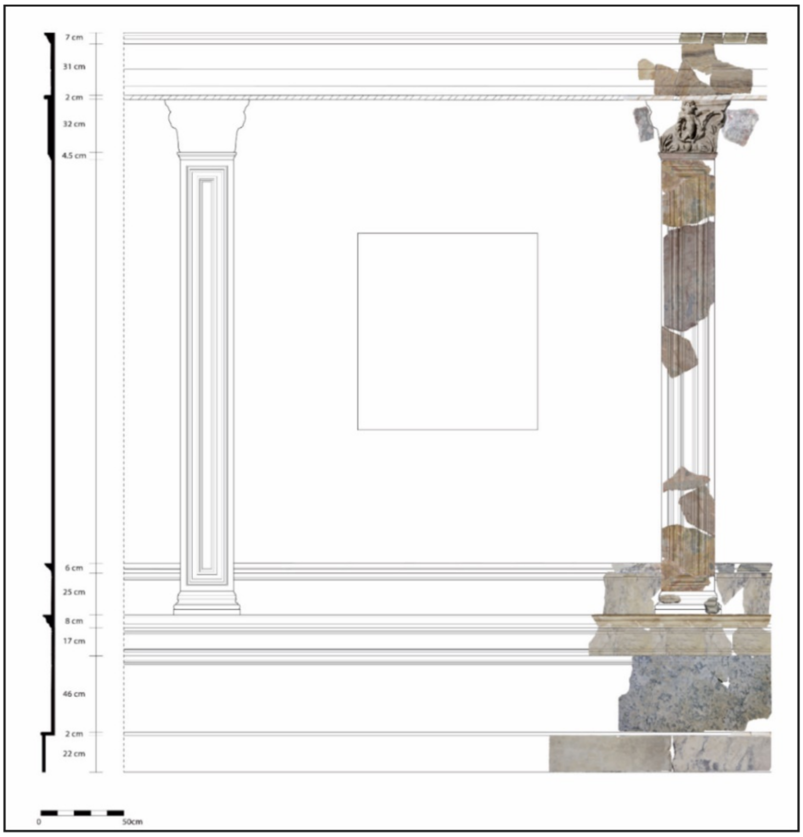

Figure 6: Reconstruction of the North Stoa interior decorative scheme (Image: A. Kidd).

[20] An estimate determined by using a ratio of height to lower width of 8:1.

Showcasing regional marbles and local pride

While the details of this scheme are conjectural, the general location of these various elements within the scheme is clear. Interestingly, the arrangement seems to have been designed to showcase imported materials to maximum effect. The bulk of the wall's central field was adorned with africano, portasanta, and alabastro fiorito, and the top of the scheme with alabastro fiorito, whereas local Aphrodisian stones (Çamova Tepe pavonazzetto, Yazır grey, and local white) were relegated to the bottom and top of the wall where they were used as framing devices. All of these stones were sourced from Asia Minor or its immediate vicinity. Most types deriving from beyond Aphrodisian territory were procured from nearby Phrygia or acquired from the coast via the Maeander valley. However, the heavy use of local Aphrodisian stones fits with what we know about the use of these materials elsewhere in the city: the Çamova Tepe pavonazzetto and Yazır grey were local alternatives to polychrome imports, widely used from the late 1st and early 2nd centuries AD respectively in buildings such as the Civil Basilica, the Bouleuterion, the Theatre Baths, the Hadrianic Baths, and the late antique domestic quarter 'NES'[21]. The only materials acquired from further afield that were employed in the North Stoa are the small, finely cut pieces of *opus sectile*, which were found in minimal quantities.

The sparing use of these more exotic imports reflects a general reticence at Aphrodisias when it comes to large-scale decorative stone importation, which corresponds to some extent with evidence documented elsewhere in Asia Minor. While decorative marble schemes in the region show a heightened propensity for polychromy during the 2nd century AD, the coloured stones that received privileged positions within these schemes were largely imported from within the region. Often the most exotic lithotypes were replaced with suitable local variants. At Nysa, the interior wall of the *scaenae frons* of the late Antonine *odeon* building, identified as the *Gerontikon*, was ornamented using revetment and smaller inlay comprising africano, alabastro fiorito, and pavonazzetto, as well as bigio antico and greco scritto from nearby Ephesos, cipollino, serpentino, rosso antico, verde antico, porfido rosso, and giallo antico[22]. Although this demonstrates a predominance of coloured marbles from within the region, the slightly higher quantity of imported Greek stones in this scheme is plausibly explained by Nysa's position closer to the coast[23]. At Hierapolis, where an even greater reliance on local rather than imported materials is documented during the 2nd century, ready access to local coloured stones such as alabastro fiorito and a variant of red breccia helped achieve the same ornamental effect in buildings such as the Stoa-Basilica and the West Stoa of the North Agora, as well as in the Theatre[24]. Even during the Severan period, when polychrome styles seems to have reached their height of popularity in Asia Minor, only 20% of the stone supplied for building projects and statue display in Hierapolis was imported, with most of it coming from the quarries of Dokimeion (13%), which were still within Phrygia[25]. Likewise at Sagalassos, where 97% of marble revetment decorating the walls of the *frigidarium II* and *apodyterium* of its Imperial Baths was imported during the Hadrianic period, this assemblage was nevertheless largely dictated by access to the quarries of Dokimeion, which supplied the city with pavonazzetto and a fine-grained white marble. In the baths, these stones were supplemented by substantial quantities of cipollino, plausibly an Imperial gift, as well as local pink limestone, and, to a much lesser degree, white marble from Aphrodisias and Thasos, greco scritto, rosso antico, verde antico, alabaster, and bianco e nero tigrato[26].

[21] Long 2012, 194-195.
[22] Kadıoğlu 2016, 718-719.
[23] Kadıoğlu 2014.
[24] D'Andria, Rossignani 2012, 143, fig. 12.
[25] Scardozzi 2016, 430.
[26] Corremans *et al.* 2002, 43-44.

These examples indicate that, unlike the coastal sites of Asia Minor such as Ephesos, or even those closer to the coast such as Nysa, sites further inland relied heavily on local stone and made sparing use of imports from beyond their region. In a majority of cases in which there existed a suitable local substitute for imported stones, local materials were utilised in polychrome decorative schemes to achieve the same effect. An analogous pattern in Aphrodisias' ceramic record has been interpreted by De Staebler as reflective of the city's "isolationist economic tendency"[27], which saw local consumption dominated by local products. Since such trends do not align with patterns of wider economic integration witnessed in port cities and cities positioned along major trade routes, they could be interpreted as a reluctance to spend money on costly transport[28]. However, it might also reflect regional, local, or civic pride. At Sagalassos, pride in local materials is expressed in a remarkable second/third-century sepulchral epitaph, the skilful carving of which is said to 'deceive' the viewer (*ψεύδεται*), making the local stone it is in resemble Dokimeion marble[29]. Similar sentiments privileging the symbolic value of local stones are found elsewhere in the Roman East. Pliny notes that the Chians were extremely proud of their polychrome city walls, built presumably in portasanta, despite Cicero's disparaging remark that the structure would have been more impressive had the stones been imported[30]. The unusual inscription on one of the Roman-era peristyle columns of the Temple of Artemis at Sardis, which seems to suggest that it comes from quarries owned by the sanctuary itself, has also been interpreted as celebrating the fact that "the source of this marble was local, and that this was a source of pride"[31]. Even in later antiquity, much the same view is evidenced in Gregory Nazianzenos' fourth century description of the ashlar blocks of a church at Nazianzus when he states that the local stone used in its construction "does not yield [in quality] to the imported"[32].

Such statements of civic and local pride coincide with broader cultural trends in Asia Minor that manifested themselves in various aspects of the architectural landscape; examples include the construction of neokorate temples or specific buildings associated with civic cult festivals and games. As cities progressively lost their political independence in other aspects of civic life, building programs became prestigious emblems of their autonomy in the face of Roman hegemony[33]. Just as privately sponsored euergetism constituted a celebration of an individual's citizenship, public construction in the service of the *polis* exemplified the civic ideal and set cities apart from each other and from those of the wider Roman world[34]. Alongside this self-assertiveness were more specific declarations of self-sufficiency, as witnessed not only in the ceramic record but also in the minting of civic coinage and, as we argue here, in the display of regional and local polychrome marbles. As demand for polychrome stones increased and more quarries came under Imperial control, it became a point of pride among cities and local regions to be able to boast of the wealth of their own resources. In the North Stoa at Aphrodisias, a city which hosted one of the most renowned sculptural workshops of Asia Minor, the locally-produced figured pilaster capitals were combined with imported stones and then vaunted in the central field of the scheme, thereby ensuring that the most markedly local components of the entire ensemble were also ostensibly exhibited as its most important ornamental features.

[27] De Staebler 2012, 69.
[28] On transport costs of stone and the resulting dynamics of its distribution, see Russell 2008; 2013, 164-166; 2018.
[29] Cig 4377; Igr III, 362.
[30] Pliny, NH, XXXVI, 46.
[31] Cahill, Lazzarini 2014, 37.
[32] Greg. Naz., Or. 18.39 (trans. Mango 1972, 27).
[33] Zuiderhoek 2013, 173.
[34] For more, see Yegül 2000.

Conclusions

The decorative scheme of the interior of the North Stoa of the Place of Palms provides us with a key insight into decorative marble use in second century Aphrodisias. Although transport costs are likely to have played a role in shaping the nature of the display, our proposed reconstruction of the scheme suggests that showcasing local and regional stones was also an imperative of the project. For inland sites rich in marble supplies like Aphrodisias, the availability of local and regional stones allowed the city's builders to meet the contemporary aesthetic demand for polychrome decorative schemes and simultaneously boast of the wealth of their own local resources while keeping the cost for the procurement of coloured stones as low as possible.

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EXPLORING THE USES OF WHITE ASIATIC MARBLES AT ROMAN ATHENS: THREE STATUETTES FROM THE ATHENIAN AGORA

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Abstract

This study presents the results of white marble provenance identification for three statuettes of Asklepios from the Athenian Agora. The scientific investigations that were conducted on the collected samples include electron paramagnetic resonance spectroscopy (EPR), isotopic ratio mass spectroscopy (IRMS), maximum grain size (MGS) and most frequent grain size (MFS) measurements, portable X-ray fluorescence (pXRF) analysis, and optical examination. The results demonstrate that one statuette (Agora S 480) was carved from marble quarried at Göktepe near Aphrodisias in Caria, and that two statuettes (Agora S 854, S 1807) very probably were carved from marble quarried near Dokimeion (Afyon) in Phrygia (Afyon). The statuettes illustrate the complex pathways through which sculptures carved from Asiatic white marbles made their way to Athens in the Roman period: as a raw material procured for carving; as a commodity imported in a finished state; or as a personal belonging carried by its owner.

Keywords: White marble provenance, Athens, Göktepe, Dokimeion, stable isotopes, EPR, pXRF, grain size.

Introduction

Ninety years of excavations in the Agora at Athens, conducted under the auspices of the American School of Classical Studies, have helped bring to light the rich sculptural legacy of the ancient city. Among the large accumulation of figured marbles from the site are hundreds of statuettes of divinities made in the Roman period for display in local houses and shrines. While white marble quarried from nearby Mount Pentelikon was the preferred stone for these little gods and goddesses, our present research has found that some were carved from marbles sourced from Asia Minor. In this study, we present the results of white marble provenance identification for three statuettes, which were selected for analysis on account of visual properties that suggested a non-Attic origin.

The figures under discussion depict the healing god Asklepios in an iconographic type known as the Giustini model (Fig. 1: a–c)[1]. Asklepios stands with the left leg engaged. His left hand, not visible, was placed behind the hip. He wears a mantle over his left shoulder, drawn under the right arm, draped below the chest, and thrown over the left elbow. The Giustini model was a popular choice for representations of Asklepios at Athens, and it was embraced widely throughout much of the Mediterranean basin. The present study follows the comprehensive publication of the statuary of Asklepios found during the Agora excavations, and it supplements the findings reported there[2].

[1] Limc II (1984), 879–882, nos. 154–233, pls. 647–649, s.v. Asklepios (B. Holtzmann), with earlier literature.
[2] See Martens 2018.

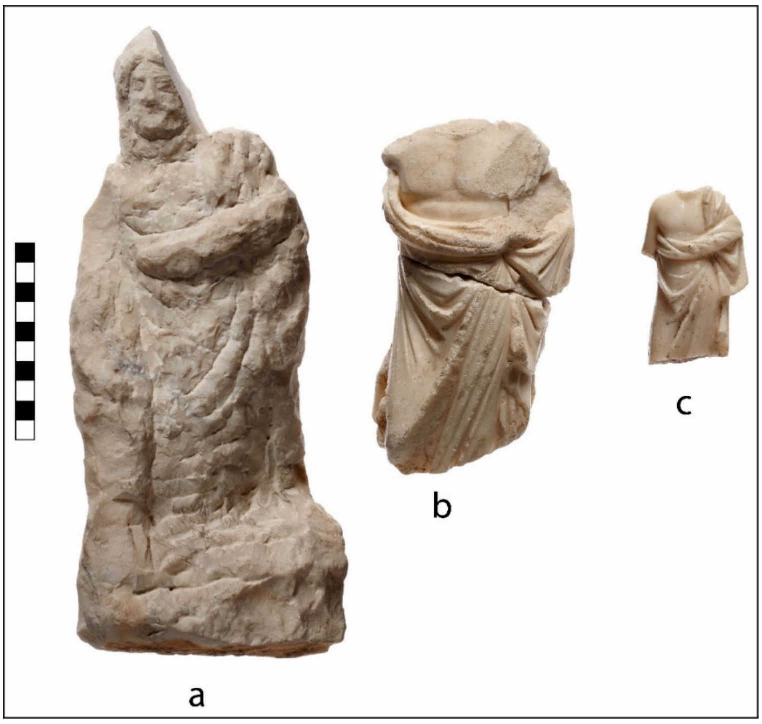

Figure 1: Statuettes of Asklepios from the Athenian Agora. **a**. Agora S 854; **b**. Agora S 1807; **c**. Agora S 480 (Photos: C. Mauzy, courtesy ASCSA Agora Excavations).

Samples and techniques

The statuettes were first examined with non-invasive optical techniques, using a constant lumen light source and digital microscopes, in order to assess the characteristics of the marble (e.g., translucency, veins, and other features) and to measure Maximum Grain Size (MGS) and Most Frequent grain Size (MFS)[3]. Additionally, the strontium (Sr) content was measured using a portable X-Ray Florescence analyzer (pXRF)[4]. Marble flakes were then collected from each statuette for laboratory analyses. The analytical techniques used in the laboratory included (1) verification measurements of MGS and MFS under a stereoscopic microscope, and qualitative examination of the crystalline features of the marbles; (2) Electron Paramagnetic Resonance spectroscopy (EPR); and (3) Isotopic Ratio Mass Spectroscopy (IRMS) for the stable isotopes of carbon and oxygen[5].

The procedure for the measurements of the samples in the laboratory first included cleaning with dilute acid and then gentle grinding in an agate mortar so that no grinding peaks were induced in the EPR spectrum[6]. The ground samples were sieved with US standard sieves and the fractions between 63 and 180 μm were used for EPR measurements. The parameters measured from the EPR spectra are described in Polikreti, Maniatis (2002), Tambakopoulos, Maniatis (2017b).

For stable isotope analysis, aliquots of the prepared EPR samples, consisting of very fine-grain fractions (<63 μm), were ground to a fine powder and submitted for isotope analysis to a mass spectrometer (IRMS). The isotopic ratio values of $^{13}C/^{12}C$ and $^{18}O/^{16}O$ — expressed as $\delta^{13}C$‰ (PDB) and $\delta^{18}O$‰ (PDB) and normalized to the international standard

[3] Tambakopoulos, Maniatis 2017a.
[4] Magrini *et al.* 2018.
[5] See Maniatis 2004, for a general account of these methods.
[6] Mandi *et al.* 1992; Maniatis, Mandi 1992.

PDB (Pee Dee Belemnite)[7] — were measured by Prof. Walter Prochaska at the Department of Applied Geosciences and Geophysics, University of Leoben, Austria.

The results of the above analyses were compared to the data for known ancient marble quarries from Greece, Türkiye, and Italy (Carrara). This dataset having been compiled over the last 30 years through the fieldwork and analyses of the Laboratory of Archaeometry, NCSR "Demokritos"[8] and through the inclusion of further data published in the scholarly literature[9]. Our EPR data was integrated and amalgamated with that from Attanasio 2003, Attanasio *et al.* 2006, by using as a theoretical standard the Mean value of Mn^{2+} of all Penteli samples from each laboratory, given the large number of analyzed samples (161 for Attanasio; 277 for Demokritos). The Sr data for Göktepe and other quarries was retrieved from Attanasio *et al.* (2015a), Bruno *et al.* (2015a).

Provenance results

The results of all measured parameters for the three statuettes are presented in Tab. 1. The MGS values and the MFS values demonstrate very fine-grained marbles. No dolomite content was detected in the EPR spectra of the samples; the marbles are purely calcitic. A high similarity is observed between all parameters of Agora S 854 and Agora S 1807, pointing to a common source, while a clear difference is attested by the parameters of Agora S 480.

Object	Marble Color	MFS (mm)	MGS (mm)	Mn^{2+} (r.u.)	Width (Gauss)	Fe^{3+} (r.u.)	Dol (%)	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	Sr (ppm)
S 854	Whitish (fine purple veins)	<0.05	0.1	264.8	2.7	11.5	n.d.	-6.06	-0.10	53
S 1807	White/Whitish	0.1-0.2	0.4	266.8	2.0	15.8	n.d.	-5.35	-0.29	65
S 480	Whitish, honey color	0.1-0.2	0.4	64.1	2.4	9.4	n.d.	-2.61	3.04	625
r.u. = relative units - n.d. = not detected										

Table 1: All measured parameters for the three statuettes from the Athenian Agora.

As a first approach, the isotopic values of our samples were compared statistically with the parameter fields of known ancient quarries with fine-grained marbles. These are deduced from the comparison of the fine-grained nature of the samples against the global database of MGS gathered at the Laboratory of Archaeometry, NCSR Demokritos, as well as those published by Attanasio *et al.* (2006). These quarries are Penteli and Hymettos in Attica, Mani in the Peloponnese, Dokimeion in Asia Minor, and the recently discovered Göktepe quarries near Aphrodisias in Asia Minor, which have MGS values as low as 0.4 mm[10] (Fig. 2). To these quarries with fine-grained marbles, we have added the Aphrodisias field, comprising a mostly medium- to coarse-grained marble, but which contains three outlying samples with MGS values below 1.0 mm, two of which exhibit values of 0.4 mm and 0.1 mm, comparable to Agora S 1807 and Agora S 854, respectively. As can be seen in Figure 2, Agora S 854 falls solely in the Afyon field. Meanwhile, Agora S 1807 falls in the Afyon field, in the lower edge of the Göktepe field, and just outside of, but close to, the Aphrodisias ellipse. All other origins are excluded for these two samples. Agora S 480 falls in a region where the isotopic fields of a wider range of possible quarries overlap.

Among the quarries in Figure 2, Pentelikon and Carrara are excluded isotopically since none of our samples fall in or close to these fields. Among the quarries that seem possible for Agora S 480, we should exclude the Paros-Lychnites field because its marble has never been recorded with MGS below 0.6 mm, and additionally, the crystallization of parian

[7] Herz 1987; Attanasio *et al.* 2006.
[8] Polikreti, Maniatis 2002; Maniatis *et al.* 2012; Tambakopoulos, Maniatis 2017b.
[9] Herz 1987; Gorgoni *et al.* 2002; Lazzarini, Antonelli 2003; Attanasio 2003; Attanasio *et al.* 2006; Lazzarini, Malacrino 2010.
[10] Attanasio *et al.* 2009a; Attanasio *et al.* 2009b; Attanasio *et al.* 2015a.

marble is very different to the marble of Agora S 480. Furthermore, the Mani quarries should also be excluded because — even though its marble reaches fine grain-sizes, which may be comparable to Agora S 480 — stone from the quarries there always contains random crystals that can be over 1.5 mm[11], not observable in Agora S 480. This allows us to narrow further the possible quarries for the Agora statuettes to Afyon, Göktepe, and Hymettos, and also to leave Aphrodisias tentatively in consideration for the reasons explained above (Fig. 3). In Figure 3, we have included the field points for a clearer view of the distributions. As seen here, Afyon remains the only option for Agora S 854, although outlier points from the Göktepe and Aphrodisias fields are scattered at some distance around it. Agora S 1807 falls within the Afyon and Göktepe fields. It plots just outside the 95% confidence ellipse of the Aphrodisias field; however, its isotopic signature is very close to two Aphrodisias field points which plot outside the ellipse as well.

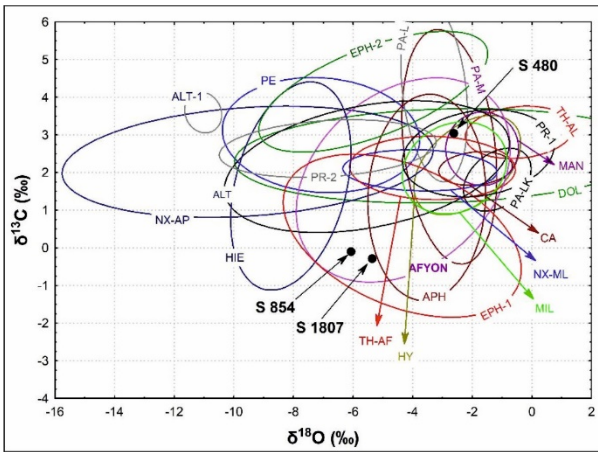

Figure 2: Isotope signatures of the three statuettes in this study against the fine-grained quarries extracted from the global isotope database containing data of the Laboratory of Archaeometry – NCSR Demokritos, Maniatis *et al.* 2012; Tambakopoulos and Maniatis 2017b, and other published data, Herz 1987; Gorgoni *et al.* 2002; Lazzarini, Antonelli 2003; Attanasio *et al.* 2006; Attanasio *et al*. 2009a, b.

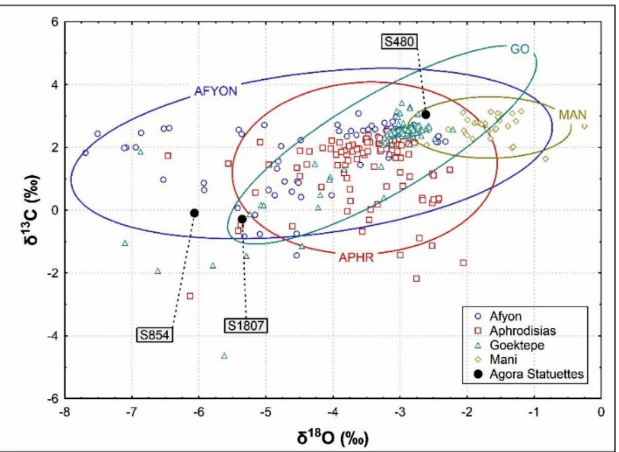

Figure 3: Isotopic signatures of the statuettes in this study against the isotopic fields of screened fine-grained quarries which are isotopically possible, see text. Data from Maniatis *et al.* 2012; Tambakopoulos, Maniatis 2017b; Herz 1987; Gorgoni *et al.* 2002; Lazzarini, Antonelli 2003; Attanasio *et al.* 2006; Attanasio *et al.* 2009a, b.

Agora S 480, on the other hand, falls in the overlap of the Göktepe, Afyon, Hymettos, and Aphrodisias fields. In examining the distribution of the actual field points, it can be seen that Agora S 480, although within the statistical ellipse of the Aphrodisias field, actually plots rather far from all of its field points, which, in combination with the different qualitative features of Aphrodisian marble, excludes Aphrodisias as the origin for this sample. The same can be said, more or less, for the field points of Afyon and Hymettos, while the sample plots in the center of the Göktepe field ellipse and adjacent to the main distribution of the field points.

Next, we compare the Sr values of the three statuettes against the Sr values of the possible quarries discussed above, regardless of the probability that each one may have (Fig. 4)[12]. As can be seen, the Göktepe quarries have Sr values reaching far above the other quarries considered here. The Sr value of Agora S 480 (625 ppm) is clearly in the Göktepe range, and all other isotopically possible quarries must be excluded. By contrast, the Göktepe origin can be excluded for Agora S 854 and Agora S 1807.

[11] Maniatis *et al.* 2021; Bruno *et al.* 2002; Cooper 1996.

[12] Attanasio *et al*. 2016; Attanasio *et al*. 2015a; Attanasio *et al*. 2009a; Attanasio *et al*. 2009b.

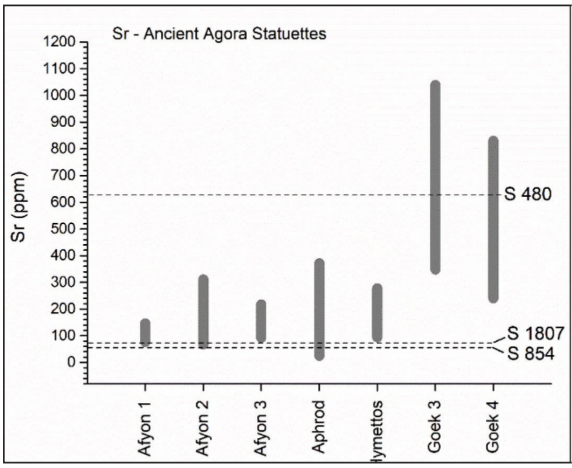

Figure 4: Sr values of the statuettes in this study against the Sr values of possible quarries as filtered from isotopes and MGS. The Sr data for the quarries are from Attanasio *et al.* 2015a; Attanasio *et al*. 2009a, b; Bruno *et al.* 2015b. Afyon 1 = Dokimeion Bacakale, Afyon 2 = Dokimeion III/V, Afyon 3 = Dokimeion II/V.

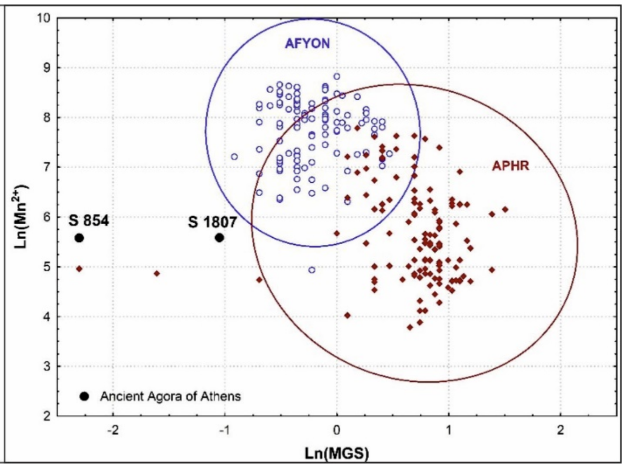

Figure 5: The Logarithm of the EPR Mn2+ intensity against the logarithm of the MGS for the two statuettes Agora S 854 and Agora S 1807 compared with the same parameters of the Afyon and Aphrodisias quarry districts. The ellipses represent 95% confidence. Data from Maniatis *et al.* 2012; Tambakopoulos, Maniatis 2017b; Attanasio *et al.* 2006.

Thus, having determined the origin of Agora S 480 as Göktepe, the question of the origins of Agora S 854 and Agora S 1807 focuses mostly on Afyon and, less likely, on Aphrodisias, which, as discussed above, could be possible on the basis of isotopes and the Sr content. Further, we introduce a new parameter in the treatment, namely the Mn^{2+} intensity as measured with EPR spectroscopy[13], in combination with MGS, and compare these two statuettes against the equivalent values of the Afyon and Aphrodisias quarries. Figure 5 shows this treatment using the logarithmic values as has been shown best representing the natural distribution[14]. As can be seen in this plot, the Ln(Mn^{2+}) value, being the same for both samples, would be compatible with both quarries, perhaps a bit on the low side of the Afyon field, but within the 95% confidence level, and more in the center of the Aphrodisias distribution. Their Ln(MGS) values, on the other hand, and particularly that of Agora S 854, are outside the range of both quarries, except the three outlying samples from Aphrodisias, mentioned above. These three outliers from Aphrodisias, reported by Attanasio *et al.* (2006), all contain a high amount of dolomite (42–62%), which is not observed in the Agora samples. Apart from these three samples, all other Aphrodisias field points measured (more than 100 samples) by us and by Attanasio *et al.* (2006) have values above 1.00 mm. This suggests that the Aphrodisian origin is quite unlikely; however, the low MGS value, particularly in the case of Agora S 854, is a point of concern for Afyon as well. The lowest MGS reported for the ancient quarries at Afyon is 0.4 mm[15] and a nearby quarry site at Alintas has similar marble[16]. That said, in a detailed geological paper on marble from the İscehisar (Afyon) quarry, Celik and Sabah (2008) state that the grain sizes of the calcite crystals in Afyon marbles range between 0.2–0.5 mm, thus bringing down the values observed previously, and in turn making the Afyon (Dokimeian) provenance more secure.

A summary of the provenance results is presented in Tab. 2. We can confirm the Göktepe origin for Agora S 480; the sample is compatible with all parameters including the

[13] Polikreti, Maniatis 2002.
[14] Polikreti, Maniatis 2002.
[15] Maniatis *et al.* 2012.
[16] Attanasio *et al*. 2006.

characteristic whitish-honey coloration. The Dokimeian provenance of Agora S 1807, can be ascertained because most of its parameters are either fully or marginally within the Afyon field. Agora S 854 has very similar parameters to Agora S 1807, so it should also be from Dokimeion, although its extremely low MGS (0.1 mm) causes some concern with respect to what has been observed thus far in the ancient quarries sampled from that region. Nevertheless, in an area like Dokimeion with very extensive ancient quarries and heavy modern quarrying activity, variations of MGS beyond what has been measured so far may be expected. Further features of Agora S 854 that point also to Dokimeion are the fine, purple veins observed at two locations on the statuette (Fig. 6a, b). These veins are characteristic of another marble varietal from Dokimeion: pavonazzetto[17]. The isotopic parameters of Dokimeian pavonezzetto are similar to the white variety as plotted in Figure 3, hence agreeing with the signature of Agora S 854 and S 1807. The minimum MGS of the Dokimeian pavonezzetto is 0.5 mm, again similar to the local white variety, so the same comments regarding the MGS as discussed above hold for the pavonazzetto as well. Pavonazzetto or pavonazzetto-like marble also exists in the Aphrodisias quarries and at locations southwest of Aphrodisias; however, the isotopic parameters and MGS do not agree with those of Agora S 854 and S 1807[18]. This reinforces the Dokimeian provenance of these two samples. Agreement with the isotopic and MGS parameters is observed with breccia-type marbles from Beyler in Türkiye and from the island of Skyros in Greece[19]; however, it is practically impossible to break out and separate the irregular, white inclusions, some being only a few cm wide, from a breccia-type stone in order to make statuettes more than 25 cm high. Thus, in summary, the quarries at Dokimeion are the most probable origin of the marble used for both Agora S 854 and S 1807, with the Aphrodisian origin being rather improbable, despite the similarity of certain parameters.

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Object	Marble Color	Provenance	Confidence Level
S 854	Whitish (fine purple veins)	Afyon	Very high
S 1807	White/Whitish	Afyon	Most certain
S 480	Whitish, honey color	Göktepe	Absolutely certain

Table 2: Provenance assignments for the marble of the three statuettes from the Athenian Agora

Figure 6: Details of statuette Agora S 854, showing purple veins in two locations. **a**. intense, parallel to the underside; **b**. fainter at the front, over the right forearm and thigh.

[17] Attanasio *et al*. 2015b.
[18] Attanasio *et al*. 2015b.
[19] Attanasio *et al*. 2015b.

Discussion

(a) A locally-made god

Agora S 854 (Fig. 1a) was excavated in 1937 from a well on the north slope of the Areopagos at Athens, together with other refuse originating from a nearby sculptor's studio[20]. The workshop material, which comprises seven additional marble sculptures, four unfinished and three finished, was gathered and discarded immediately following the sack of Athens by the Heruli in A.D. 267. Given the archaeological context, Agora S 854 dates to the years immediately preceding the invasion.

Agora S 854 is obviously unfinished. A pit at the top of the statuette marks where a chisel was driven too hard, causing the diagonal fracture across the head and neck that resulted in the abandonment of the piece. The choice of marble, very probably quarried at Dokimeion in the region of Phrygia, seems to have been rare at Athens. Our result marks the first time that a white, Asiatic marble has been documented among the corpus of unfinished Athenian statuary. Another unfinished sculpture from the workshop debris, a head of a statuette of Dionysos (Fig. 7), shares the same visual properties[21]. It is probable, therefore, that the Dionysos is a second example carved at Athens from dokimeian marble, although a sample was not collected for laboratory analysis.

Figure 7: Head of a statuette of Dionysos (Agora S 859), from the same workshop as Agora S 854 (Photo: C. Mauzy, courtesy ASCSA Agora Excavations).

The statuette of Asklepios demonstrates that sculptors based at Athens acquired marble from Dokimeion, even though there was a plentiful local supply of white marble. One reason for the choice of stone likely has to do with the cultural identity of the sculptor. Martens (2021) has recently presented the full workshop assemblage and has demonstrated — on the basis of iconographic peculiarities and associated finds, in addition to the results of the present provenance investigation — that the discarded sculptures represent the activities of a sculptor who had immigrated to Athens, probably from the region of Phrygia. The sculptor was familiar with the working properties of the stone and possessed the means to procure it.

[20] Martens 2018, 560, 567, 590, no. 9, fig. 9. H. 32.2; W. 14.0; D. 8.2 cm.
[21] Athens, Agora Excavations S 859. H. 6.4; W. 4.6; D. 5.0 cm.

An alternative explanation is that the statuette was carved from a reused block that was already present in Athens, perhaps having made its way to the city for an architectural purpose.

Agora S 854 is a reminder that sculptors conducted business under complex circumstances. The appearance of a non-local marble (i.e., not from Penteli or Hymettos) and of a non-island marble (i.e., not from Paros or Thasos) for figural carving based at Athens has not been documented previously. Future researchers of the large corpus of unfinished works found in the city should be on alert for white Asiatic marbles.

(b) A traded god

A second statuette of Asklepios (Agora S 1807), excavated in two pieces from modern contexts, is carved from an all-white marble that was also very probably quarried at Dokimeion (Fig. 1:b)[22]. Unlike the previous figure, however, this statuette was not made locally. Parallels found elsewhere in the eastern Mediterranean basin suggest that it instead traveled to Athens as a prefabricated object of trade.

Agora S 1807 recalls other figures of the god that have been found at Alexandria in Egypt and at Nea Paphos on Cyprus, albeit with substantial differences in scale[23]. The group is connected by technical, stylistic, and iconographic similarities, especially the distinctive hard treatment of the drapery, which is best observed in the deep folds that radiate from the left hip to the right ankle and that hang below the left arm.

A common workshop for the Egyptian and Cypriot examples has been proposed at Alexandria[24]. While the materials of these figures have not, to our knowledge, been subjected to laboratory analyses, it is more probable that they too were fashioned at Dokimeion where there existed a large and organized marble-carving industry. Additional statuettes belonging to the group are known; many of these have been assigned to the Asklepios Amelung type, a scholarly subcategory of the Asklepios Giustini that exhibits a harder treatment of the drapery, a curtailed S-curve, bare feet, and the frequent inclusion of narrative elements[25]. Some of these statuettes have been found in Asia Minor. The nuances detected in the Asklepios Amelung may, therefore, primarily reflect stylistic and compositional mannerisms of Asiatic workshops.

To offer a cautious conclusion, the statuettes in this group seem, provisionally, to have been made in Dokimeian workshops that catered to regional markets in Asia Minor, as well as to consumers in more distant locales such as Greece, Egypt, and Cyprus. The proposed trade networks probably reached farther west. A statuette of Asklepios carved from dokimeian marble has been documented in Gaul, for example[26]. That figure assumes a different iconographic model and cannot be linked with the present group, but it is nevertheless representative of the wide-reaching trade networks that emanated from the phrygian quarries. Wherever the members of the circle of Agora S 1807 were carved, it is certain that Athenian hands were not at work. It is hoped that future scientific analyses of other figures belonging in this group will bring clarity.

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[22] Martens 2018b, 551–552, 590, no. 8, figs. 7, 8. H. 19.1; W. 10.5; D. 5.5 cm.

[23] Paphos, Archaeological Museum FR 1/67 (H. with plinth 48 cm): Grimm 1989, 168, fig. 1. Said to be from Alexandria is Trier, Archäologische Sammlung der Universität OL 1985.158 (original H. ca. 140 cm), Grimm 1989, 168–169, fig. 4.

[24] Grimm 1989, 171. More skeptical of the workshop attribution: Sirano 1994, 216; Hannestad 2007, 287.

[25] For the most recent list of evidence, see Freyer-Schauenburg 2013, 151–157.

[26] Toulouse, Musée Saint-Raymond Ra41: Attanasio *et al.* 2016, 187.

(c) A personal god

A miniature statuette of Asklepios (Agora S 480) was removed from the wall of a modern house that had been constructed over the center of the Agora Square (Fig. 1c)[27]. In its complete state the figure would have stood around 15 cm high, and it would have weighed ca. 0.25 kg. The statuette was, then, highly portable and certainly not intended for one fixed viewing environment. Rather, its place of display changed routinely, perhaps even daily, as it was carried from place to place by its owner — a cherished personal belonging that may have possessed talismanic-like effects.

The statuette is carved from marble that was extracted from the quarries at Göktepe. Recent scholarship has demonstrated the close connections between the quarries at Göktepe and sculptors from neighboring Aphrodisias[28]. The statuette exhibits telltale signs of production in Late Antiquity, presumably during the 4th century A.D., a period of high output for Aphrodisian workshops. Indicative of the late chronology are the glossy polish, the narrow proportions, and the rubbery drapery[29]. Moreover, the statuette bears a covert three-letter inscription that points further to an Aphrodisian origin (Fig. 8). The letters, incised shallowly on the side of the right arm, could be read horizontally or vertically: ΧΜΘ̣ or Θ̣ΣΧ, though the former interpretation seems most probable[30]. The letters recall statues that bear the inscription ΧΜΓ, almost all of which come from Aphrodisias. The inscription ΧΜΓ has been interpreted as a Christian abbreviation, perhaps a statement of personal faith carved by the sculptor[31].

An Aphrodisian sculptor produced Agora S 480, probably at the Carian city itself[32]. From there, the little Asklepios likely traveled far and wide as an object of personal devotion, before being deposited at Athens. The statuette adds to the growing corpus of sculpture carved from Göktepe marble, which now must also include miniature figures in the round, in addition to larger-scale statuary and portraiture.

Figure 8: Inscription on the right arm of Agora S 480 (Drawing: A. Hooton, ASCSA Agora Excavations).

[27] Martens 2018, 551, 552, 563, 566, 584, 596–597, no. 23, figs. 6, 9, 16, 32. H. 8.9; W. 5.3; D. 2.8 cm.
[28] Attanasio *et al*. 2009b; Bruno *et al*. 2015b.
[29] On identifying Late Antique statuary, see esp. Stirling 2005, 91–137; Hannestad 2007.
[30] Martens 2018, 584.
[31] See esp. Smith 2002, 150–153, with the full range of possibilities. The usual interpretation of the letters is Χ[ριστὸν] Μ[αρία] Γ[εννᾷ] or "Mary begat Christ."
[32] Marble from Göktepe was worked elsewhere, however. Consider, for instance, unshaped blocks of the marble variety found at Rome, presumably where they awaited use for sculptural products; see Attanasio *et al.* 2016, 187. For sculpture carved in marble from Göktepe and found at Athens, most probably imported to the city as finished products: Attanasio *et al.* 2009a, 336–337; Bruno *et al*. 2015b, 463, fig. 1.

Conclusion

Archaeometric analyses of the marble of three statuettes of Asklepios from the Athenian Agora have offered an opportunity to consider some of the channels through which white Asiatic marbles entered Athens: as a raw material, as a ready-made good, or as a personal belonging. In particular, the discovery of an unfinished statuette most probably carved from Dokimeian marble is surprising, and it raises caution for determining the place of manufacture on the basis of marble provenance alone. As has become increasingly clear, workshop identification must take a multi-method approach that considers marble provenance in addition to technical, iconographic, and stylistic criteria. Moving forward, our planned future collaborations on the unfinished corpus of Athenian sculpture promises to bring into sharper focus the extent to which Asiatic white marbles were used for figural carving at Athens during the years under Rome.

Acknowledgments

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THE "CENTAURI FURIETTI" IN BIGIO MORATO MARBLE. NEW FRAGMENTS FROM THE ATRIO MISTILINEO AT HADRIAN'S VILLA

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Abstract

The so called "Centauri Furietti", preserved in the Capitoline Museums at Rome, are famous and celebrated statues, signed by the ancient authors, the sculptors Aristeas and Papias of Aphrodisias. Almost absent has been a study of the monument in which they were presumably exposed.

The recent discovery, inside the building called Atrio Mistilineo at the Accademia of Hadrian's Villa, of two small statuesque fragments in bigio morato marble confirms the certainty of the place of origin of the statues. The architectural characteristics of the building allow to offer hypotheses on the original location and on the themes expressed within the figurative programme.

The aim of this study is therefore to trace the link between the statues and the building, producing new information on the use of the precious bigio morato marble from Göktepe, the relationship existing between the quarry and sculptors working at Aphrodisias and the workshops involved in the production of the figurative programmes of Hadrian's Villa.

Keywords: Hadrian's Villa, "Centauri Furietti", Aphrodisias marbles.

Introduction

Many studies have defined and emphasised the formal and communicative characteristics of the most famous and popular pair of statues from the ancient world, the "Centauro Vecchio" and the "Centauro Giovane" (Figs. 2, 3). They were found in Hadrian's Villa in the 18th century by G. Furietti and are now in the Capitoline Museums of Rome[1].

As is well known, the statues are signed by the ancient sculptors Aristeas and Papias of Aphrodisias. However, almost no attention has been paid to the building that housed them and in which they were presumably on display[2].

We can deduce from the writings of Furietti and several Renaissance scholars that the centaurs were found in the building known as the Atrio Mistilineo in the Accademia of Hadrian's Villa (Figs. 1, 5, 6).

The recent discovery in this building of two small bigio morato marble statue fragments ─ part of a mane or tail and part of a *pedum* ─ confirms the information given by the antiquarians. This confirmation of the original placing of the statues and the architectural characteristics of the building allow us to offer hypotheses regarding the original location and the themes expressed in the figurative programme.

In fact, this was probably also the origin of two "Fauno Ebbro" sculptures, in rosso antico marbles, one almost certainly found in the Atrio Mistilineo.

The aim of this study is to trace the link between the statues and the context in the light of recent studies and discoveries and to produce new information on the use of the highly-valued bigio morato marble from Göktepe. It is of great interest to speculate on the relationship between the quarry and the sculptors working at Aphrodisias and the workshops involved in the production of the figurative programmes at Hadrian's Villa.

[1] Furietti 1752.
[2] For a wider dissertation and for bibliography see: Ottati 2017; Ottati 2018; Ottati 2021.

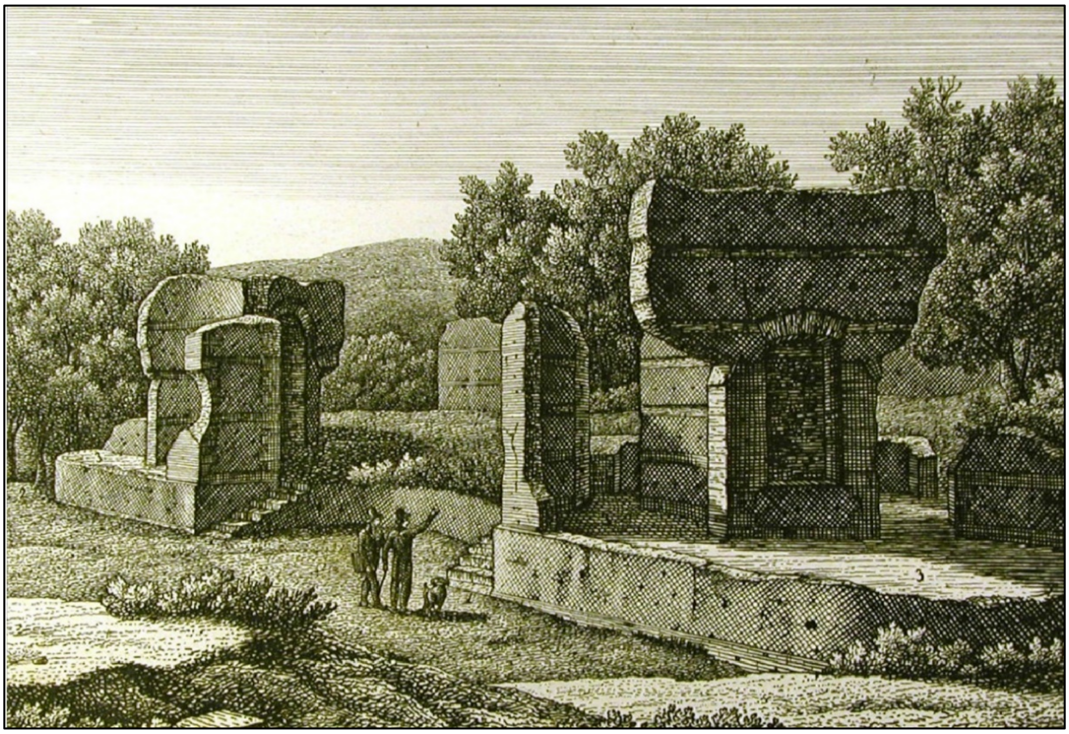

Figure 1: Hadrian's Villa, Accademia, Atrio Mistilineo by A. Penna (1826-44).

Figure 2: Rome, Capitoline Museums, “Centauro Giovane” in bigio morato marble (Photo: A. Ottati).

Figure 3: Rome, Capitoline Museums, “Centauro Vecchio” in bigio morato marble (Photo: A. Ottati).

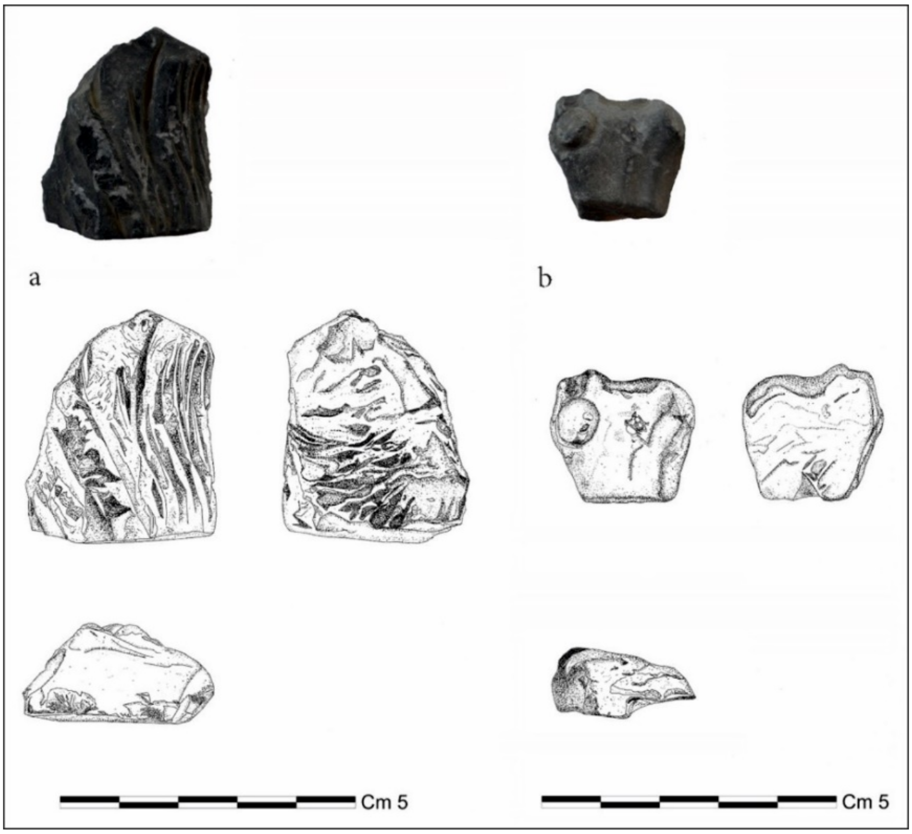

Figure 4: Bigio morato marble fragments from Atrio Mistilineo (Photo: A. Ottati).

The "Centauri Furietti" in bigio morato marble

The "Centauro Giovane" and the "Centauro Vecchio" in the Capitoline Museums are well-known statues and their anatomical and semantic characteristics have been described by many scholars[3]. It is not possible here to go into all those features or even to summarise them; however, very important observations can be made with regard to the building where the statues were discovered.

The finding of the centaurs in the Atrio Mistilineo can be deduced from the description of the person who found them, Giuseppe Furietti[4], and from the diary of Alessandro Capponi[5], who bought the "Fauno Ebbro" torso in rosso antico marble that had been found in the same area (see *infra*, Fig. 7).

The Atrio Mistilineo has been confirmed as the origin of the "Centauri Furietti" by the find during a survey - carried out by myself in 2015 - of two bigio morato marble statue fragments (Fig. 4). The first is part of a mane or tail (Fig. 4a) and the second is recognisable as part of a *pedum* (shepherd's crook), a feature of fauns and centaurs, (Fig. 4b). The two finds were made outside the building's western entrance, on a slope where a great deal of rubble had been washed down by rain (Fig. 6).

The first fragment (Fig. 4a) measures 4 x 2.2 x 1.6 cm and has tool-marks on the back. It is therefore probably part of an ancient restoration. The second fragment (Fig. 4b) is clearly part of the shepherd's crook held by the "Centauro Giovane" and measures 2.2 x 2.1 x 1 cm.

They are only statue splinters; however, in light of the information that can be deduced from the antiquarian sources, these marble fragments can be linked, without much doubt, to the Capitoline statues. These fragments are very important, as they allow us to identify with certainty the building in which the "Centauri Furietti" were found and had been displayed.

The "Fauno Ebbro" Capitolino in rosso antico marble

Regarding the "Fauno Ebbro" in the Capitoline Museum (Fig. 7)[6], provenance from a specific building is more difficult to establish. The circumstances of this statue's discovery are unclear. From the Marquis Alessandro Gregorio Capponi's reports, we can assume that the "Fauno Capitolino" torso was found during a clandestine excavation[7]. In fact, the faun torso was sold by Giovanni Migliore to Capponi on 1st December 1736 and the finder claiming to have discovered it on his own plot of land[8]. On 15th December of that same year, Capponi discovered that the small faun had actually come from the lands of Generoso Bulgarini (Accademia), where other fragments that were intended for sale to him are preserved[9]. On 3rd and 9th January 1737, the Centaurs belonging to Furietti, who in the meantime had bought the right to excavate on the Bulgarini land, arrived in Rome[10]. The discovery of the faun, therefore, took place just before, or at the same time, as Furietti's excavation when the centaurs were found. It does not seem unreasonable to assume, therefore, that the faun was found after the excavation concession had already

[3] Stuart 1912; Floriani 1943, 32-33; Della Seta 1930, 483-487; Bocconi 1938; Raeder 1983, I46-47; Zanker 1998; Morawietz 2005.
[4] He indicated the find was made "*Supra Canopum est ad austrum*": Furietti 1752.
[5] Ubaldelli 2002.
[6] Cadario 2010, 182-184 with bibliography.
[7] Barberini 1993, 23-25. Cadario 2010, 182.
[8] Capponi [c 117r (143r.], in Ubaldelli 2002.
[9] Capponi [c. 118r (145r)].
[10] Capponi [c. 119r (146r)].

been sold to Furietti[11]. It is no coincidence that the last fragments of the statue were sold by Furietti himself to Capponi in 1744. The various parts of the statue were reunited only a few years later, on the initiative of Pope Benedict XIV who had been given the Furietti fragments as a gift. He invited Capponi to restore the statues, work that was entrusted to Clemente Bianchi[12]. Finally, therefore, while the bigio morato marble fragments confirm the origin of the centaurs as the Atrio Mistilineo, the proximity of the dates the faun and the two centaurs were discovered are a probabilistic factor and further data to support the hypothesis of a provenance from the same place[13].

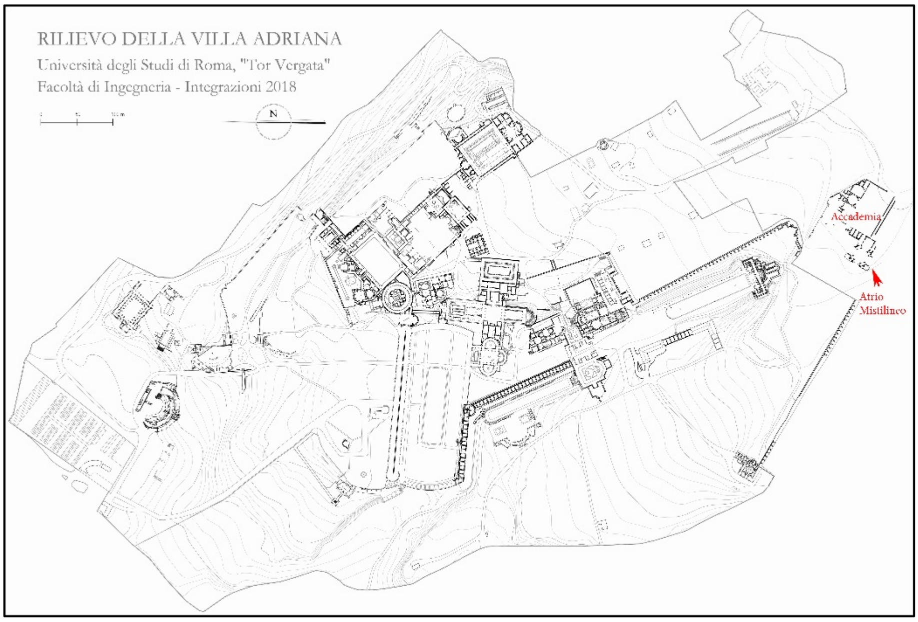

Figure 5: Hadrian's Villa, (Drawing: E. Eramo; A. Ottati).

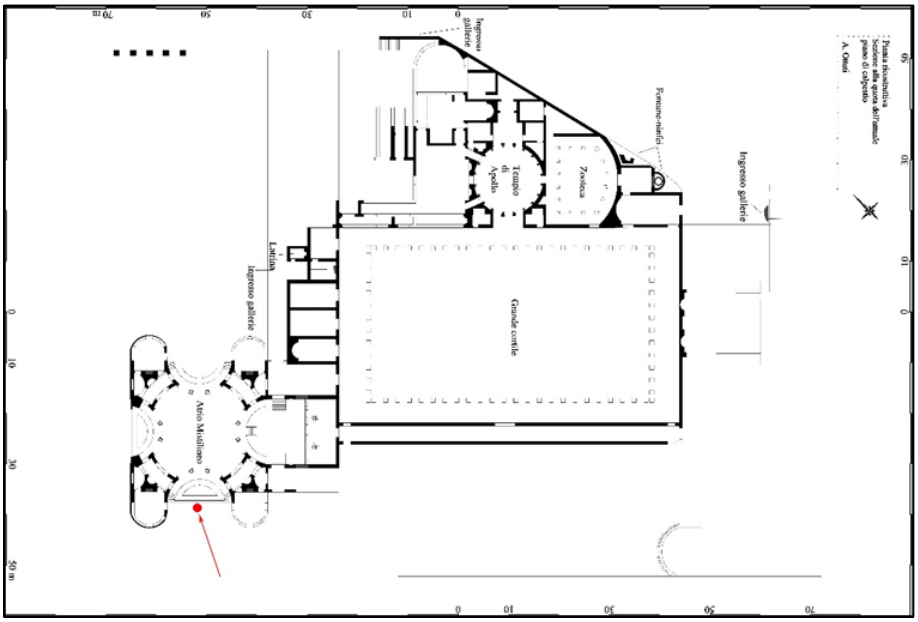

Figure 6: Hadrian's Villa, Accademia, place of discovery of bigio morato marble fragments (Drawing: A. Ottati).

[11] Also Ficoroni (1757, 128) indicate the discovery of two centaurs and the faun in the same years and attribute the find of the faun to Furietti.
[12] Cadario 2010, 182.
[13] As already highlighted by Fea 1790.

Figure 7: Rome, Capitoline Museums, “Fauno Ebbro” in rosso Antico marble (Photo: A. Ottati).

The monument and the dionysian theme

Regarding the context of discovery, thanks to a careful examination of the archaeological evidence, it was possible to reconstruct the building and comprehend the original volumes and masses (Fig. 8)[14]. The Corinthian order colonnade, consisting of giallo antico marble columns with pilasters or lateral semi-columns, can be reached by ascending two curved staircases with a semi-circular basin inside, where there was a monumental fountain. The staircases gave access to corridors that opened to the right and left, or passed through the intercolumns inside the central hall[15]. From a structural point of view, the reconstructed building represents an eccentric architecture, comparable to the western complex of the Piazza d'Oro[16] and the Temple of Venus at Baia[17], although distanced from them in both appearance and function.

The Centaurs and Fauns would have been displayed in four 4 niches on the four corners of the building.

The Atrio Mistilineo is an exceptional example of Roman architecture, the result of an architectural experiment. The statues found there also reflect the originality of the building in the decoration of the hall, where the statues were distanced from their natural setting, the garden, and brought inside[18], re-proposed and re-read in a communications laboratory (Figs. 9-10). The so-called Atrio Mistilineo was not only a hall or a place of passage, but a true stage on which depictions of the Dionysian thiasus transported the observer to a mythical ambience. The colours of the statues in the torchlight would have contributed to a particularly evocative, almost mystical setting.

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[14] Ottati 2017 with bibliography; for alternative hypothesis of reconstruction: Hansen 2000, 387-398; Hansen 2011, 83-100.

[15] Hansen 2000; Ottati 2017.

[16] Hansen 2011, 83-100 with bibliography.

[17] Rakob 1961, 114-119.

[18] Neudecker 1988, 47-54.

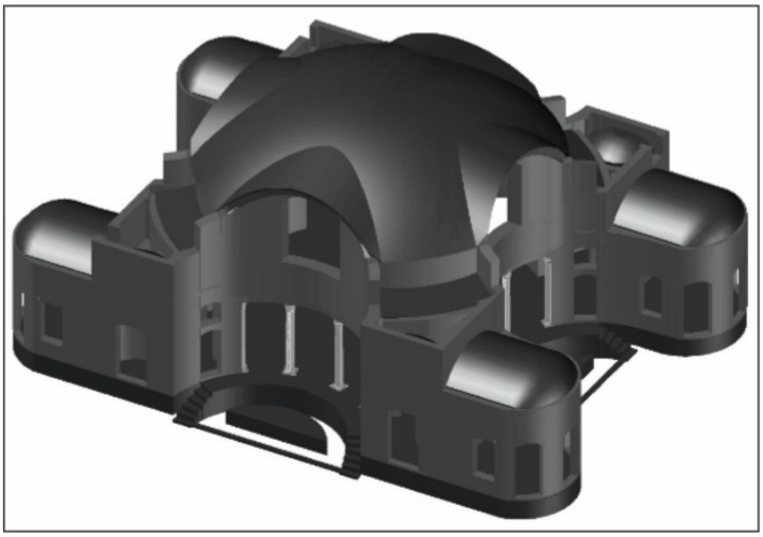

Figure 8: Hadrian's Villa, Accademia, Atrio Mistilineo, 3d reconstruction (Drawıng: A. Ottati).

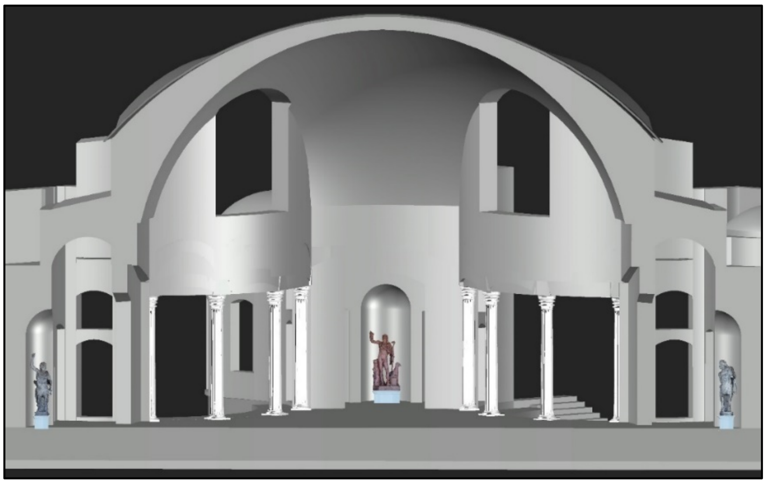

Figure 9: Atrio Mistilineo, proposal of figurative programme reconstruction (Drawing: A. Ottati).

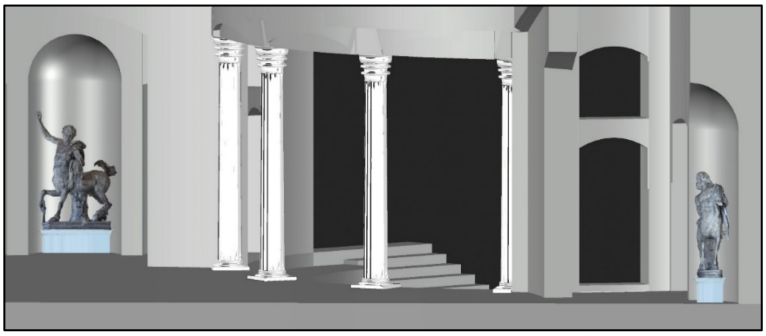

Figure 10: Atrio Mistilineo, proposed reconstruction of the figurative programme, with particular regard to the centaurs (Drawing: A. Ottati).

Marble and its importance

As is well known, the “Centauri Furietti” pedestal bears the signature of Aristeas and Papias, sculptors from Aphrodisias. The comparison between the “Centauro Giovane” and the “Fauno Ebbro”, which have an amazing resemblance, leads us to suppose that the latter is also the work of the sculptors from Aphrodisias. It has been observed how, during the imperial period, sculptors demonstrated special expertise in the reproduction of statues characterised by the adoption of a pathetic formal language and the Hellenistic tradition. This is recognisable, for example, in the two Satyrs with the small Dionysus on their shoulders, one medium-sized and the other small. They were found in a workshop behind the Odeion of Aphrodisias and, notwithstanding the different iconographies, they have shapes and styles similar to the rosso antico marble faun from Hadrian's Villa[19].

In Aphrodisias there are various replicas of Hellenistic and original classical statues that document the abilities and iconographic models available to the local workshops[20]. Equally important would have been the specialisation of the Aphrodisias workshops in working particularly hard stone, such as bigio morato marble, and the relationship between the Aphrodisian workers active in Rome or at Hadrian's Villa, and the workshops in the quarries of origin of some of these types of marble. Recent studies locate them very close to Aphrodisias, near Göktepe, 50 km from Muğla in western Türkiye. It is a black and white marble quarry where several semi-finished architectural pieces and white raw sculptural blocks were found[21].

The isotopic analyses of the marble from the new quarry and the black marble specimens from Hadrian's Villa began with the "Centauri Capitolini" and were undertaken by D. Attanasio, M. Bruno and A.B. Yavuz. They confirmed the provenance of the marble as Göktepe[22]. The use of this quality of bigio morato marble ─ a bluish crystalline limestone with whitish streaks[23] ─ in association with Dionysian subjects, such as the "Centauri Furietti", allows us to look for a key not only to connect the colour, but also the marble's provenance, Aphrodisias, from whence the sculptors Aristeas and Papias also came. This discovery adds a further element of reflection on the use of this quality stone and the relationship of the workshops of Aphrodisias (where the sculptors of the aforementioned pieces, including the well-known centaurs, worked) with the workshops active at Hadrian's Villa.

Regarding the "Fauno Ebbro", rosso antico is fine-grained marble with an intense red colour, due to a high heamatite content, and sometimes with thin white veins. It is well-known that some of the quarries where it was extracted are near the town of Agios Kyprianos, on the eastern coast of Cape Taenarum (Cape Matapan) in Greece. A very similar quality, found in Iasos, near Miletus in Asia Minor, is distinguishable by a larger grain (iassense marble)[24]. However, recent archaeometric analyses have found that the rosso antico marble from which the "Capitolino Fauno Ebbro" is made does not come from either the Taenarum or Iasos quarries[25], but from another still unknown to us. It has been hypothesised that, even in this case, the statue may have come from one of the quarries near Aphrodisias - it has been proposed that the marble of the faun comes from a quarry at Milas (Kalinağil)[26]- and would have reached Hadrian's Villa in a semi-finished state[27].

At this point the question arises of whether the black and red marble pieces, including the centaurs and the fauns, arrived semi-finished at Hadrian's Villa and were completed on the spot or whether they were completely made in the villa's own workshops. The enormous

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[19] Pensabene 2009, 400.

[20] For the identification of sculptures production from Aphrodisias see: Chaisemartin 1987; Linant de Bellefonds 1996, 180-85; Erim - Smith 1991; Smith 1996; Smith 1998; Smith 2009.

[21] Attanasio *et al*. 2009, 312-248; Attanasio *et al*. 2010a; Attanasio *et al*. 2010b, 81-90.

[22] The analysis has been conducted on many statues of the second century A.D. always demonstrating theprovenance from the Göktepe quarries, confirming the great activity that this quarry carried out and the primary role it had in the Hadrianic period: Attanasio *et al*. 2009, 97-98.

[23] Attanasio *et al*. 2009, 340, n. 116, for the analysis of the stone of centaurs from Hadrian's Villa.

[24] Gorgoni *et al*. 2002; Lazzarini 1990.

[25] Lazzarini 2007, 90, fig. 48, tab. 6.

[26] Bruno *et al*. 2012, 555-556.

[27] Pensabene 2009, 400.

amount of statuary and furnishings made with these marbles found in Hadrian's Villa suggests the presence of specialised labour on the site, linked to the quarries, and responsible for the completion of the pieces that had been semi-finished or were in different stages of working. However, the signatures affixed to the centaurs denote the work of high-calibre sculptors, who could have been responsible for all the processing phases.

There is therefore a strong possibility that there would have been statues in various stages of completion and from various origins in much larger numbers than we might think, but also statues completely made at the construction site, but maintaining the relationship between sculptor, marble used and quarry of origin. Some statues would have been finished at the villa building site, perhaps with the help of moulds. Trade in them is proven by the fact that copies with identical subjects are found elsewhere, in different parts of the empire. They are statues with the same subjects and formal characteristics that lead one to think of highly organised production centres, such as Athens, the Docimium quarries or Aphrodisias. Even in the case of the pentelic marble used at Hadrian's Villa, which denotes a very close link to the quarry of origin and Athenian workshops, we would find ourselves looking at labour skilled in the production of marble sculptures, with very close bonds to the quarry of origin of the marble used, and capable of creating sculptural works of a quality to justify their signing[28].

It has already been pointed out that at Hadrian's Villa the sculptors from Aphrodisias appear to have specialised in the sculptures of coloured marbles or the figurative architectural decorations of friezes, etc. This workshop, therefore, not only used rough blocks, but was also in contact with the period’s large manufacturers of copies and reworkings of Greek originals destined for export[29].

Conclusions

The find of two fragments certainly attributable to the two famous “Centauri Capitolini” in bigio morato marble, in one of the buildings of the “Accademia” of Hadrian's Villa, allowed the statues to be traced back to the monument of origin - the “Atrio Mistilineo” - and to allow us to hypothesize a suggested reconstruction. The proposed image allows to appreciate the ancient display system of statues in which their chromatic value and studied perspective stand out in an absolutely avant-garde architecture.

The possible origin of the marble of the Capitoline Faun and of the Vatican Faun found in Hadrian’s Villa from a quarry near Milas, not far from Aphrodisias, and the connection with the Centaurs, still in marble from Aphrodisias territory, signed by Aristeas and Papias sculptors, allows us to think that the sculptors, generally, had to have particular familiarity in working marbles from their own territory, in which they were born and grew artistically[30]. Also in recent period, the processing of certain stone determines the displacement of stonemasons, due to their expertise, to building sites far away from the quarry site. This happened for example in Italy, at the beginning of the last century, with travertines. Therefore, it seems certain that sculptors of high calibre were able to sculpt any marble. However it is equally plausible that they were called in to work materials they were more accustomed to and that probably they also were in charge of choosing the materials as also happened in the Renaissance period. For the sculptors of high calibre, therefore not mere copyists, the choice of the material had to be not secondary and it is plausible that they chose quarries of materials that they knew and with which they maintained a close relationship.

In conclusion, sculptors and especially high-quality workshops preferred to use, whenever possible, a marble they knew. Perhaps they would have been able to sculpt any marble, however they chose their own material.

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[28] Ottati 2014b, 99-128 with bibliography.

[29] Pensabene 2009, 396.

[30] For a study about the presence of skilled workers in the use of the marble of own territory of provenance see Burford 1969.

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THE USE OF GRECO SCRITTO IN ROMAN CAMPANIA: EVIDENCE FROM THE VESUVIAN AREA (MURECINE, POMPEII, HERCULANEUM) AND THE WESTERN BAY OF NAPLES (CUMA)

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Abstract

This paper discusses the presence of greco scritto marble types in early Imperial contexts in Campania drawing on new data from Cuma and Murecine (Pompeii). Long believed to come primarily, if not exclusively, from Algeria, greco scritto is now understood to have been extracted also in other parts of the Empire and an Ephesian provenance is now favoured by many scholars. In Italy, it is found in contexts dating from the late 1st to the 2nd century AD, however earlier and later uses have now been attested. Despite the considerable scientific advances, the picture of its quarrying, distribution and use remains controversial. The contextual evidence from Campania shows that greco scritto – in all probability of turkish provenance – was used in bath complexes starting from the late Julio-Claudian - early Flavian period. Moreover, epigraphic evidence points towards use by wealthy private and local benefactors.

Keywords: Ephesian marble, ancient Campania, Baths.

Introduction

Greco scritto is a type of medium-to-coarse grained white marble characterised by black lines and spots resembling scrawled writing, hence the name given by the Italian collector Francesco Belli in the nineteenth century[1]. However, other varieties with bands or veins ranging from light to dark grey-to blueish colour hues known by the same name are also found (Fig. 1)[2]. As also with other patterned stones, the diverse macroscopic faces - veined, spotted or banded patterning - can often be seen on the same artefact (Fig. 2).

Since Raniero Gnoli's discovery[3] of the greco scritto quarries in the area of Cap de Garde (ancient *Ippona*, Annaba, Algeria), the question of its primary source has become debated and attempts have been made to provide this stone with a potentially meaningful identity. Despite the considerable scientific advances made by recent analyses, the picture of its quarrying, distribution and use remains controversial. This paper addresses the presence of greco scritto marble types in early Imperial contexts in Campania in light of new data from Cuma (ancient *Cumae*) and Murecine (Pompeii). The objective is to provide further information that may prove useful in refining the chronology, selection and distribution of this stone, whose identity is still fraught with problems.

Quarries, terminology, uses and distribution in Italy and the Mediterranean

The Algerian variety from Cap de Garde was long believed to be the 'real' greco scritto[4]. However, this came to be contested in the past decade as the existence of other

[1] BorghinI 1989; Lazzarini 2004; Price 2007.
[2] Antonelli *et al*. 2009, 352.
[3] Gnoli 1988.
[4] Pensabene 1976; Mielsch 1985; Borghini 1989.

possible geographical sources yielding varieties looking like greco scritto was made apparent by intense fieldwork campaigns and laboratory analyses. The stone is now understood to have been possibly sourced not only from North African sites other than Cap de Garde, where the stone there retrieved was seemingly different from the more popular varieties[5], but also other parts of the Mediterranean, such as Türkiye. The quarries of Hasançavuşlar and Zimpara near Ephesos, first noted by Marc Waelkens 1980s, are now regarded as the main - or the only, by certain commentators[6] - source of 'typical' greco scritto. Such an Ephesian provenance has been proven by geochemical analyses for several ancient artefacts at least and is now favoured[7]. However, while it has emerged that Ephesian greco scritto is more widely found than originally thought[8], systematic archaeometric investigation and studies of its distribution in the Roman empire are yet to be undertaken. Because the presumed 'typicality' still largely relies upon the macroscopic aspect of this stone[9] as the primary discriminator in favour of or against 'typical' greco scritto, labels such as 'true or real' should be avoided as there might not exist a 'real' greco scritto[10]. With the proviso that analytical characterization remains fundamental[11], the stone discussed in this study has been identified visually based on comparisons with the varieties known from publications and quarry samples. While it is undeniable that most of our sample shows striking visual and granulometric similarities with the Ephesian greco scritto, such identification awaits confirmation and should be seen as preliminary[12].

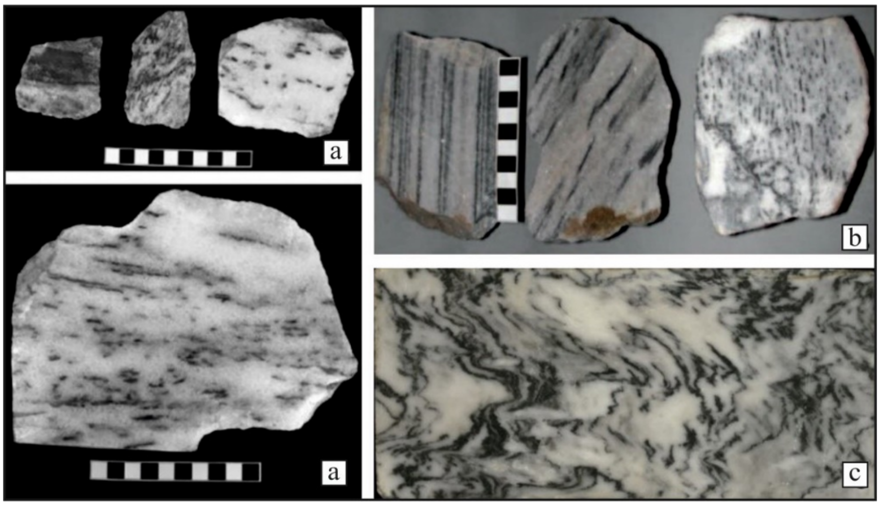

Figure 1: Overview of greco scritto 'varieties': **a**. Ephesian; **b**. North African; **c**. Cap de Garde (?) (Photo: Attanasio *et al.* 2012; Antonelli *et al.* 2009; http://www.oum.ox.ac.uk/corsi/stones/view/99).

[5] Antonelli *et al*. 2009; Hermann *et al*. 2012.
[6] Attanasio *et al*. 2012.
[7] Corremans *et al.* 2012; Russell 2013.
[8] Ephesian greco scritto has been found in Roman sites at Xanten and Sirmium, Prochaska 2012, 589-90.
[9] Equally confusing is differentiation based on the colour of the patterning, as blue, black or grey hues seem to be common to both the Turkish and North African varieties. See Russell 2013: Ephesian greco scritto with black speckles *versus* Algerian 'Marmo di Ippona' with blue and grey streaks (quarry Gazetteer).
[10] Indeed, given the existence of several varieties, which are no different macroscopically and which scholars regard as the 'real' ones, one is left to wonder what 'typical' greco scritto is supposed to look like. See Antonelli *et al*. 2009, 353, pointed out that Luna bardiglio, prokonnesian and thasian marbles may often be macroscopically very similar to greco scritto.
[11] Yavuz *et al*. 2011; Prochaska 2012.
[12] Sampling and testing of some of the stone here presented is currently being undertaken by Simona Perna in collaboration with Fabrizio Antonelli and Lorenzo Lazzarini (LAMA - IUAV, University of Venice).

Figure 2: **a**. Re-used Roman column in Salerno, Via dei Mercanti; **b**. detail of the stone pattern on the shaft (Photo: S. Perna).

Greco scritto marble was used in Roman contexts for architectural (wall revetment, floor tiles, capitals, small- to medium-size columns) decorative and ornamental purposes (fountain basins and stands). Its use is recorded in private dwellings and, in small quantities, in public buildings. Yet, greco scritto seems to have been used largely for fountains-nymphaea, public and private baths and small thermae built by private patrons in Italy[13] and in the provinces[14]. The traditionally accepted chronology for the use of this marble in Roman Italy spans from the late Flavian period (Domitian) to the end of the 1st century AD (Domus (?) on the Caelian Hill – Rome; Terme del Nuotatore – Ostia) to the fifth century AD (Villa at Cazzanello - Tarquinia), with a peak in the 2nd century AD (Hadrianic to Antonine)[15]. However, at other sites around the Mediterranean, Asia Minor and Italy itself earlier and later uses[16] are known. In Roman buildings in North Africa, for example, the use of this marble is recorded as early as the 1st century BC[17].

Greco scritto in the Vesuvian area (Pompeii, Herculaneum, Murecine)

In the Vesuvian area, particularly at Pompeii, greco scritto is found in small quantities and in some private houses, public buildings and on several bar counters. At Pompeii, small inserts in cement or *tessellatum* pavements (like in the corridor B and *vestibulum* 8 of the Suburban Baths) and *crustae* in sectile floors (like in the summer *cubiculum* in the House of Sallust, VI.2.4) are found in the same mixed varieties, speckled or striated, as the panels and inserts that clad bar counters, such as on bar VI.8.9 (Fig. 3).

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[13] Public baths: Vasto and Chieti (Abruzzo); Rome (Quintilii Villa, tepidarium), Fondi and Ostia (Latium); Pozzuoli, Baia, Pompeii and Herculaneum (Campania); private thermae at Concordia Sagittaria (Veneto) and Francolise (Campania).

[14] Sagalossos and Ephesos (Turkey); Ruspina (Tunisia).

[15] Viglietti 2010; Aoyagi, Angelelli 2005.

[16] Barker 2012, 25.

[17] Hippo Regius (Annaba) and Cuicul (Djemila), in Algeria; Volubilis, in Morocco; Cyrene, in Libya; Carthage and Utica, in Tunisia. See Antonelli *et al*. 2009; Dessandier *et al*. 2012.

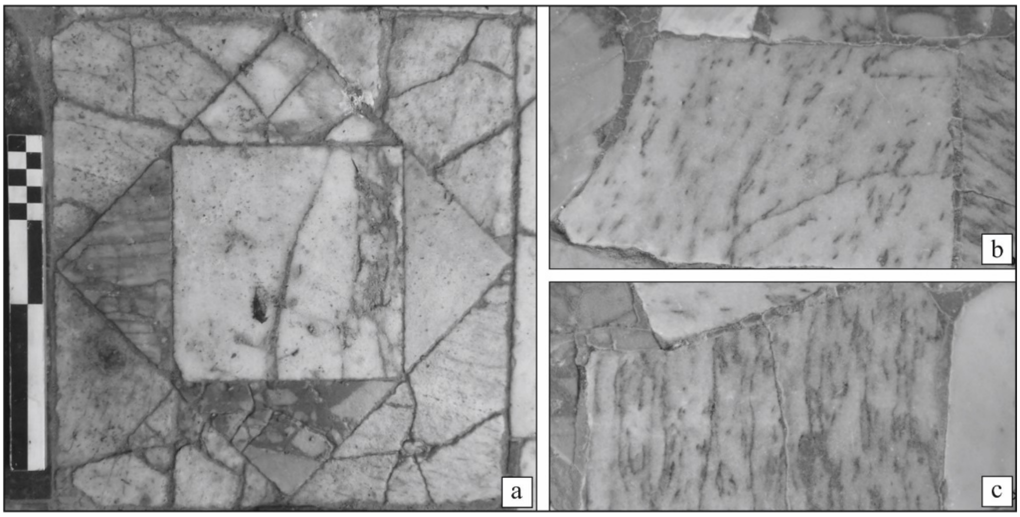

Figure 3: Greco scritto at Pompeii. **a**. Floor inserts, House of Sallust VI.2.4; **b**-**c**. inserts on bar counter VI.8.9 (Photo: S. Perna with permission of the Ministero della Cultura – Parco Archeologico di Pompei. The image may not be reproduced in any form.)

At Herculaneum greco scritto is even rarer. Small quantities in the shape of inserts (4-11 cm) are mortared into the cement floor, dating to the early Fourth Style (AD 54-68 ca), of one of the halls (M) on the south-eastern side of the Central Baths. Rectangular slabs (measuring 33 x 66 cm) of this marble, in the variant with a white groundmass and blueish swirls, alternating with bardiglio slabs, pave the pronaos of the so-called *Sacellum* B of the four Gods on the southern terrace of the town overlooking the sea (Fig. 4). The building and its twin *Sacellum* A constituted a 'double shrine' dedicated to Venus akin to those at Pyrgi, Anzio, *Minturnae* and the Forum Boarium in Rome[18]. The earliest construction phase of Temple B dates to the end of the 2nd century BC, but it underwent major restructuring in the Augustan age, when it was paired by *Sacellum* A.

The greco scritto pavement can be attributed to the last building phase of *Sacellum* B when it was rebuilt as a tetrastyle, prostyle temple by two patrons of libertine origins, *Vibidia Saturnina* and *Furio Saturnino*[19]. An inscription found in 1992 and probably belonging to the pronaos of the temple[20] mentions, alongside the names of the two benefactors, the dedication of two portrait-busts to Titus and Domitian Caesars, dating the restoration of the building to the reign of Vespasian (early 70s). This datum allows us to set a new *terminus ante quem* to AD 70 for the introduction of *greco scritto* in the Vesuvian area. Interestingly, the counter of *thermopolium* IV, 15-16 presents several inserts of the same variety as the *Sacellum* B on the counter-top (Fig. 5).

The first fragment is a slab with a white groundmass with corrugated veins broken into nine parts of which only the upper edge is preserved (c. 55 x 33.5 cm). The second fragment, broken into three parts, has a white background and parallel veins (c. 36 x 15 cm). Of the same variety, and probably part of the same slab, is the third fragment (c. 11 x 11 cm). The pattern, together with the rectangular shape and dimensions, may lead one to think that the large fragments came from the same batch of stone used for *Sacellum* B. Given the rarity of greco scritto at Herculaneum, it cannot be excluded that the slabs were originally destined for the pronaos but, having been damaged during transport or fitting, were reused on the bar counter.

[18] Guidobaldi *et al*. 2009, 39.
[19] Guidobaldi *et al*. 2009, 84-88, 104-105.
[20] Guidobaldi *et al*. 2009, 47-67.

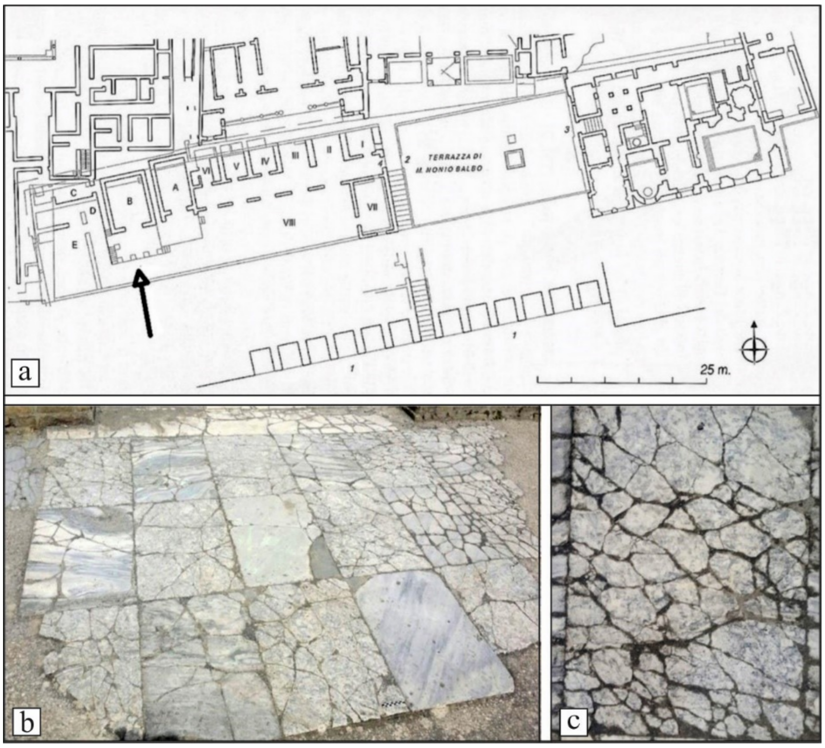

Figure 4: Greco scritto at Herculaneum. **a**. Plan of the Sacred area and *Sacellum* B; **b**. marble pavement in front of *Sacellum* B; **c**. detail of slab (Plan: Guidobaldi et al 2009; Photo: S. Perna, R. Scognamiglio with permission of the Ministero della Cultura – Parco Archeologico di Ercolano. The image may not be reproduced in any form.)

Figure 5: Greco scritto at Herculaneum. Inserts on bar counter IV.15-16 (Photo: R. Scognamiglio with permission of the Ministero della Cultura – Parco Archeologico di Ercolano. The image may not be reproduced in any form).

A large quantity of greco scritto marble - more than 150 panels – was found in the so-called Building A, *Edificio dei Triclinii* or *Hospitium* dei Sulpici in Murecine (or Moregine), about 600 m from Pompeii's Stabiae Gate[21]. The marble cache was discovered during the building's second rescue excavation campaign in the year 2000 (the first was in 1959) following the extension of the A1 Napoli-Salerno motorway[22] (Fig. 6).

[21] In antiquity corresponding to the suburban area of Pompeii on the Sarno river mouth (*the pagus maritimus*).
[22] De Simone, Nappo 2000.

Figure 6: Murecine (Pompeii). **a**. Map of the modern suburb of Pompeii and location of modern Murecine in respect to the archaeological site; **b**. plan of the excavated portion of Building A or *Hospitium Sulpicii* (Photo: De Simone, Nappo 2000 with modifications).

Since the structure had to be reburied, its painted decoration, furnishings and finds, including the marble slabs, were removed and taken elsewhere. The identity of the marble lay unquestioned[23] until the cache was 're-discovered' by the present author in the backyard of the House of the Cryptoporticus at Pompeii during the "*Mille Genera Marmoris*" Project fieldwork (2017-2018).

The marble in most cases is medium to coarse grained with a white to blueish groundmass mottled by thin black to blueish dots and veins (Fig. 7).

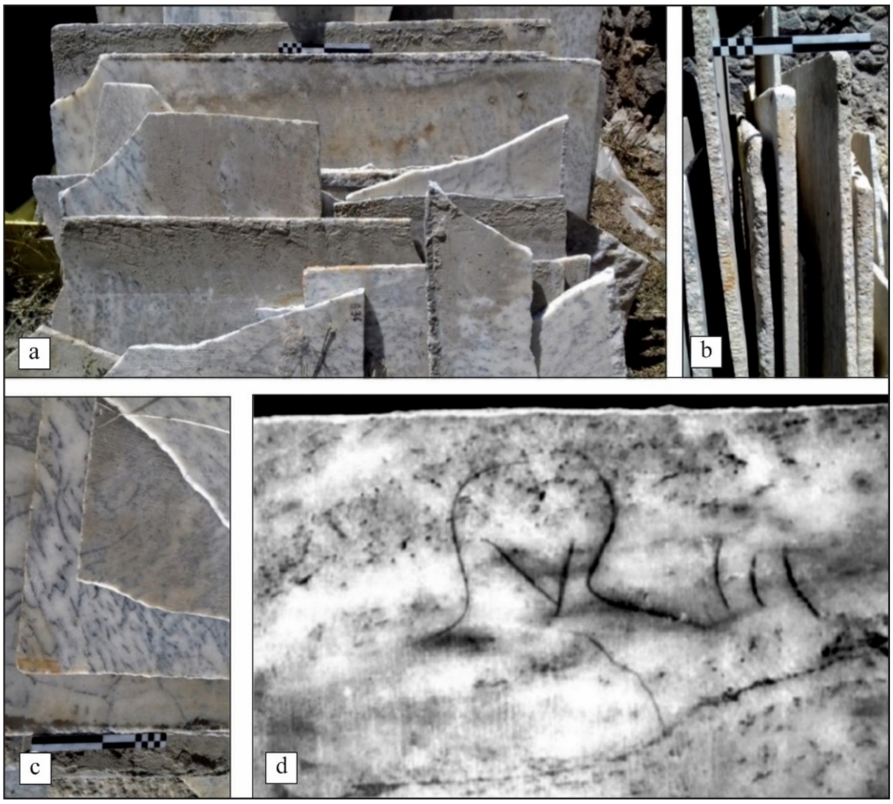

Figure 7: Greco scritto cache from Murecine. **a**-**c**. Overview of sawn panels; **d**. detail of the initials *SVL* for *Sulpicii* on one of the slabs at the time of discovery (Photo: A-C, S. Perna with permission of the Ministero della Cultura – Parco Archeologico di Pompei. The image may not be reproduced in any form; De Simone, Nappo 2000).

[23] See Russell 2013, 134, 253: 'white marble'.

Based on macroscopic comparisons with published samples from several studies as well as autoptic observation at the quarries near Ephesos, the marble can be classified as speckled or veined greco scritto, quite likely of Turkish origin and, although similarities might also be noted with the North African type, it seems unlikely that it came from more than one source. The slabs, many found broken into big fragments, are rectangular with an average height of 60 cm and length of 120 cm; the thickness, however, varies from 1 cm to 6 but most are between 1.5 and 2 cm thick. Most panels present a smooth surface, but some examples have one side left completely rough. Many slabs present saw-marks and, however, whilst no clear reuse signs have been spotted, it cannot be excluded that some pieces had been reused. What is more, some 74 slabs were marked with charcoal labels, mostly Roman numerals in 36 cases preceded by the initials *SVL* of *Sulpicii*. Scholars have dated the building (in all probability a *collegium* or *statio negotiatorum* for businessmen and traders) to the late Claudian/early Neronian period, but the conclusions are discordant[24]. Nonetheless, it is generally agreed that from at least AD 62 the Murecine building, belonged to the *Sulpicii*, bankers, money lenders and traders from *Puteoli*[25]. Archaeology revealed that the edifice was undergoing major construction and renovation work in AD 79 as suggested by the discovery of large quantities of building material. The ready-to-use greco scritto panels, found in the kitchen (F), were quite probably destined for the wall and floor revetments of the baths (9, 10, S, O, N, 3, 2) under construction on the northwest wing of the building.

If the identity of the stone were upheld (permission by the Parco Archeologico di Pompei has been granted to analyze the slabs), the AD 79 *terminus ante quem* would push its established use forward into the early (Vespasian) rather than late Flavian period. This dating accords not only with the AD 70 terminus *ante quem* of the tiles from Sacellum B at Herculaneum, but also with the Julio-Claudian date proposed for the debut of most lithotypes in the Vesuvian cities[26]. Second, the initials of the *Sulpicii* on the slabs suggest indirect trade and acquisition directly by private wealthy patrons, including those of libertine origins. The *Sulpicii* bankers of *Puteoli* (Pozzuoli) were involved in business throughout the Mediterranean and Asia Minor and may have acquired the marble directly, possibly from Ephesos,[27] or through suppliers in Campania or elsewhere.

Greco scritto in the Western bay of Naples: Cuma.

Several public buildings in the Forum of Roman *Cumae* were decorated with greco scritto. In the Sacellum, built at the end of the 1st century BC on the northern side of the Forum, such marble is used in the variant with a white background to pave the building. The rectangular slabs measure 60 x 26 cm and are 1.5 to 3.5 cm thick. The use of this marble is connected to the renovation of the building in the Domitian period, according to an inscription found at its entrance[28]. Greco scritto had also been widely employed in the Forum Baths[29] (Fig. 8).

Despite consistent spoliation of the marble decoration over time (mostly in Late Antiquity to produce lime), remnants of the wall revetment can be still seen *in situ*[30]. The Baths are located northwest of the Forum and were first built between the late Domitianic -

[24] Like the so-called House of the Triclinii at Ostia. Torelli, Marroni 2016; Perna *ın press*.
[25] An archive of 350 wax tablets recording the financial transactions of the Sulpicii was in fact found at the site in 1959, Camodeca, 2000.
[26] Fant *et al*. 2013.
[27] See Barresi 2003.
[28] Foresta 2009, 219-220.
[29] Scognamiglio 2016, 49-59.
[30] Gasparri 2008, 80- 87; Id. 2011, 23-40.

Hadrianic period in an area previously occupied by late Republican housing units[31]. Greco scritto is found in halls P, Q, E, R and room F with the apse, however, their chronology is unclear (Fig. 9).

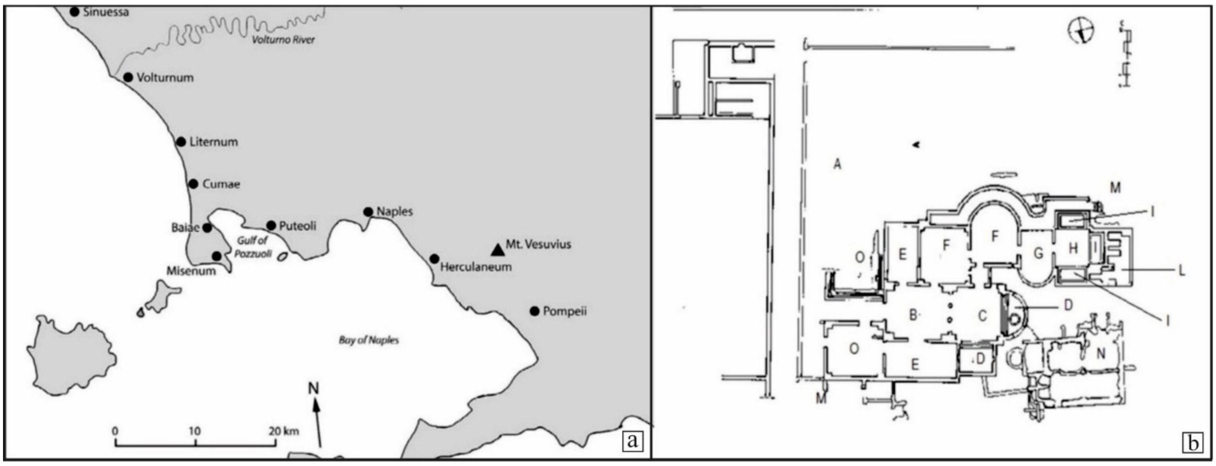

Figure 8: Greco scritto on the Western Bay of Naples. **a**. Map of the bay of Naples; **b**. Plan of the Forum Baths of Roman Cumae (Map: Popkin 2018; Plan: R. Scognamiglio).

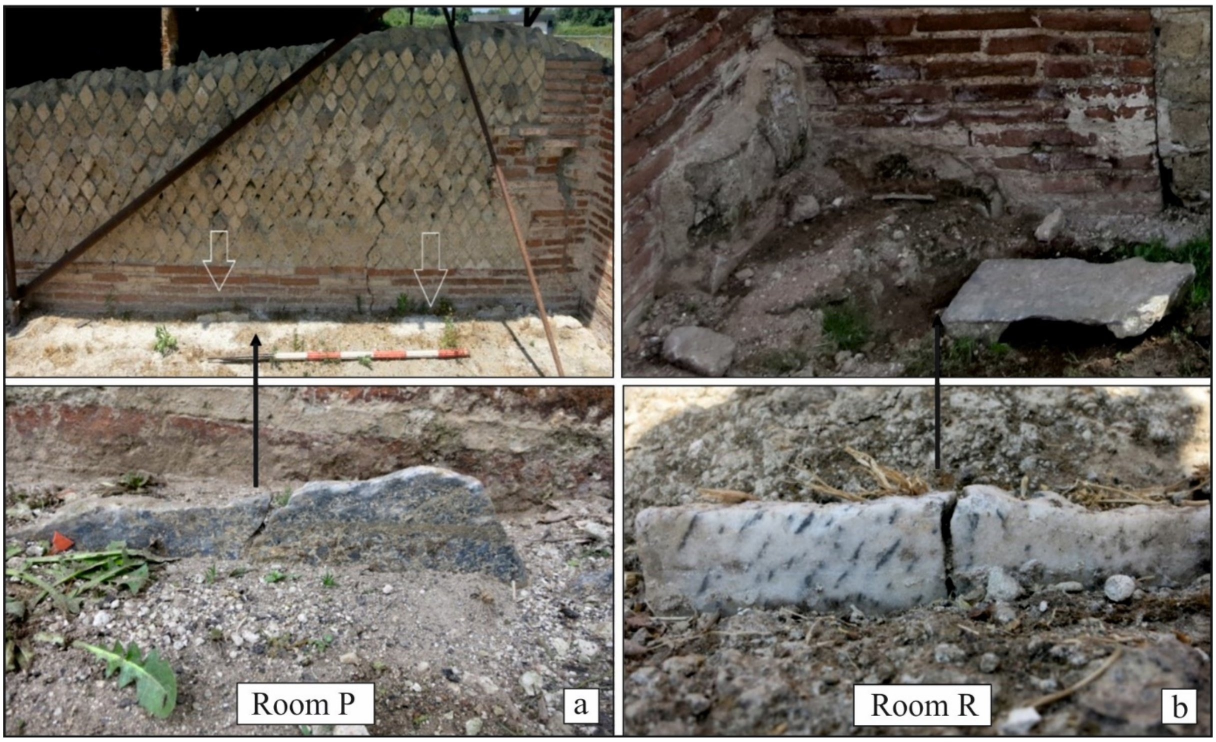

Figure 9: Greco scritto at Cumae. Details of marble remnants: **a**. room P; **b**. room R (Photo: R. Scognamiglio, 2016).

The entrance corridor Q was decorated by 1 cm thick panels of greco scritto on the north wall for a length of 4.28 m and again by 1.3 - 1.5 cm thick panels on the south wall for 1.70 metres. The area labelled P enclosed the complex and had a whole socle in greco scritto (2.50 m long; 6 cm high; 1.3- 1.5 cm thick) still visible on the western wall[32]. Corridor R linked the two tepidaria (Fb) with the frigidarium (C). A portion of such socle (13 cm long, 3 cm high and 0.50 cm thick) is preserved in the northeastern corner. Room E was the

[31] Zaccaria 1995, 203, 225-228; Morichi 1996, 141- 144; Nuzzo 2002, 344- 349; Guardascione 2006, 61.
[32] Guardascione 2006, 72.

apodyterium and also had a greco scritto socle (max height 15 cm, thickness 1 cm) on the eastern, northern and southern walls. Room F with apse, one of the two *tepidaria*, also preserves some traces of a greco scritto socle in the northwest corner (Fig. 10).

The extant fragment is 83 cm long, 9 cm high and 1 cm thick. It must be pointed out that the baths complex underwent several renovation phases, the last one taking place between the end of the 2nd and the mid-3rd century AD with the construction of rooms P and Q with their greco scritto revetment and the expansion of E and F with the possible rearrangement of the marble lining. Regrettably, there is no current evidence of the patrons that built or renovated the Baths; however, it cannot be excluded that one of the local élite families, such as the *Luccei* or the *Heii*, who are known to have funded the construction of other public buildings in the Forum, financed the Baths as well[33]. The so-called 'Byzantine Hall' is also known to have had a greco scritto socle (1-1.5 cm thick), but the building is currently unpublished.

A considerable amount of greco scritto featured amongst the marble that had been stripped, presumably from the Baths and from several other buildings, around the 5th century AD to produce lime[34]. Greco scritto is the predominant lithotype, the fragments covering a total area of 1.56 m². Amongst the most remarkable pieces, there are several panels (0.5 – 3 cm thick) and four fragments of rectilinear moulded frames that formed the wall revetment of an unknown building in the Forum[35]. The greco scritto of these fragments ranges from the white to the darker variants. In conclusion, while in the Vesuvian cities greco scritto is recorded in its light-coloured variant starting from the years around AD 70 (Sacellum B, Herculaneum), at Cuma the same variant seems to have been introduced only from the Domitian age (*Sacellum* on the north side of the Forum). Its use continued but with the addition of the darker groundmass variant in the 2nd century and 3rd century AD (Baths).

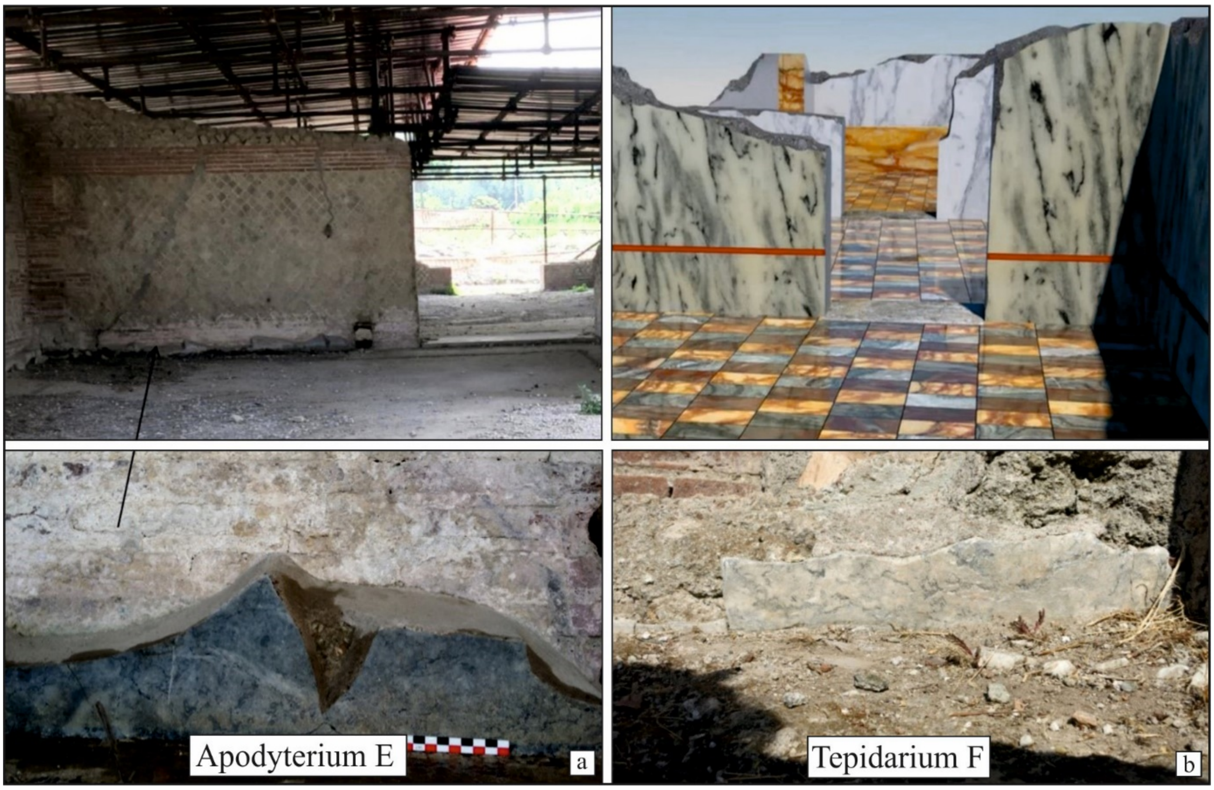

Figure 10: Greco scritto at Cumae (Cuma). Details of marble remnants: **a**. room E; **b**. room F with 3D reconstruction (Photo: R. Scognamiglio, 2016).

[33] Gasparri 2008.
[34] Nuzzo 2002, 88; Scognamiglio 2016, 18, 37-42.
[35] Coraggio 2013, 38, fig. 22.

Conclusions

The data from Campania show that greco scritto marble, in many cases presumably of Turkish origin, is found at several sites. First, all the evidence combines to suggest that in all probability the distribution of this stone, albeit on a smaller scale, started much earlier in certain parts of Italy than commonly believed. We may tentatively suggest, therefore, that it came into use as early as the Julio-Claudian - early Flavian period (mid 1st century AD). This is confirmed by some early recorded uses of this stone elsewhere in Campania (Santa Maria Capua Vetere, Caserta: Domus di via degli Orti)[36] and in Northern Italy (Gallia Cisalpina), particularly at Aquileia and in Piemonte, where greco scritto is attested as early as the Augustan period, thus earlier than in Rome[37].

The hypothesis of an earlier use of greco scritto in Campania is in line with the general patterns of imported marble trade and consumption known for this region. Campania may in fact be considered land of experimentation and innovation, when compared to Rome[38], for what concerns the import of marble and decorative stone (like cipollino, prokonnesian, Troas granite), particularly in the Vesuvian area[39] and in the Western Bay of Naples, whose commercial and cultural hub was the thriving port-town of *Puteoli*[40]. The port was indeed the core of intense trade networks both with the western and the eastern Mediterranean[41] and must have played a pivotal role in the progressive introduction of novel marble varieties in Campania as new quarries came to be exploited. Such a tendency towards innovation was also due to the euergetism of the powerful local élites, many of libertine origins, that since the Augustan period had been using the growing importance of marble as a means to promote their personal power and prestige within their communities. This can be seen at towns like Baiae, *Misenum, Cumae* and *Puteoli*[42] where public buildings were embellished or built anew using the newly discovered marble varieties, such as greco scritto. Nevertheless, this proposed chronology of the use of greco scritto marble types is problematic because it is not currently possible to tell which geographic varieties it refers to. A systematic contextual and geo-chemical study of all the varieties used in Roman contexts and their role within the Roman marble trade has yet to be undertaken. Therefore, the current picture might change as more data become available.

Second, the new data from Murecine and Cuma point to greco scritto being used especially for the wall and floor decoration of baths and *thermae*. The reasons for this might have been also aesthetic, possibly motivated by the colour and patterning of the stone. It can be argued that its shimmering white surface with speckles and waves would have been particularly apt to decorate spaces whose main element was water, as substantiated by the vast use of greco scritto for the *Hydreon* of Ephesos, a huge nymphaeum-fountain rebuilt in the Severan period. By recreating the hues of a 'marine' landscape, the stone would further enhance the character and function of bathing halls and fountains.

Third, the epigraphic and contextual evidence from both Murecine and Herculaneum seems to point to the use and direct acquisition of greco scritto by wealthy private individuals, including patrons of libertine origins, commissioning public buildings. This seems to accord with what Pensabene observed regarding a potential private ownership of the Algerian greco scritto quarries[43]. Whether we can now go further and suggest that all greco scritto quarries, whether North African, Ephesian or both, shared a similar status is very much open to question. Only a systematic study of this stone will be able confirm or disprove such a hypothesis.

[36] Colombo, Slavazzi 2001.
[37] Gomez, Rulli 2012.
[38] De Nuccio, Ungaro 2002, 127-132.
[39] Guidobaldi *et al*. 2009, 88.
[40] Demma 2007.
[41] D'Arms 2003, 61-337, in part. 103-314; Zevi *et al*. 2008.
[42] Nuzzo 2010.
[43] Pensabene 2002.

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MARBLE FRAGMENTS OF MONUMENTAL INSCRIPTIONS FROM THE TARRACO CIRCUS (HISPANIA CITERIOR)

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Abstract

Though the architectural configuration of the Roman circus of Tarraco is well known, until now there has hardly been any information about its epigraphic program. The archaeological excavations carried out recently have brought to light numerous fragments of monumental inscriptions in white marbles. They exhibit some characteristics that indicate them to be official inscriptions of monumental dimensions. No fragments fit together, but most of them present common parameters which allow them to be separated into at least two different groups. Macroscopically, differences in whiteness and in the quality of carving have been observed. To be certain of the common geological nature of marbles from the same group, they have been investigated under optical microscope and cathodoluminescence equipment. Complementary C and O stable isotopes have been analysed in order to attribute the samples to a particular ancient marble quarry. This contribution will lead us to progress further in the study of this architectural complex.

Keywords: marble provenance, Luni-Carrara, Afyon.

Introduction

The Roman circus of Tarraco (Fig. 1), built in Domitianic era as part of a huge architectural complex dedicated to imperial cult, was located in the highest part of the city. Its architectural configuration is well-known, but thus far there has been hardly any information about its epigraphic programme. However, the archaeological excavations carried out recently, have brought to light numerous fragments of monumental inscriptions in white marbles, originally located next to one of the entrances, connecting the *arena* with the *cavea*. The fragmentary words have confirmed the name of the emperor Domitian (CIL II^2/14, 900) and the participation of the provincial high priest (*flamen PHC*) (Gorostidi, Ruiz 2017a) (Fig. 2). Other minor fragments with common visual aspects but with diverse morphology and lettering seem to belong to another monumental inscription. However, the letters are incomplete and insufficient to facilitate any reading.
The aim of this contribution is to provide preliminary analytical evidence to confirm the grouping of the fragmented pieces, within which at least two different types of white marbles have been distinguished.

The archaeological context

The monumental complex of the Tarraco *acropolis* was structured around three large terraces (Mar *et al.* 2015, 67-211; Pensabene, Domingo, 2019). The upper terrace was the site of the *temenos* of the Temple of *Divus Augustus*, situated in the middle of the grand plaza, with an *aula* for worship on the northern side, aligned along the same axis as that of the temple (Pensabene, Domingo 2019, 73-86). It appears to have been completed either during the reign of Titus or that of Domitian.

The intermediate terrace corresponded to a large square Forum, in fact, the largest of its kind known in the whole Roman empire (Pensabene, Domingo 2019, 86-93). On the lower terrace there was a Circus, which was rather small in comparison to other circus buildings in *Hispania* (López (ed.), 2017).

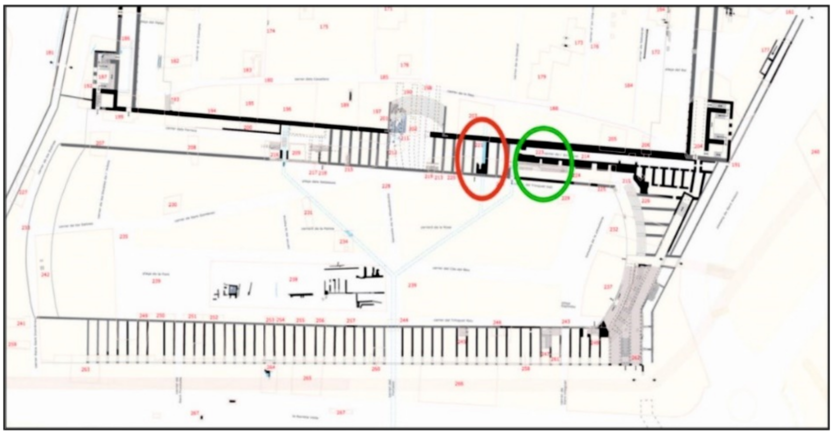

Figure 1: Roman *circus* of Tarraco (after Macias *et al.* 2007, lam. A1).

Figure 2: Proposed textual reconstruction with five fragments of group A. Monumental inscription from the Roman circus of Tarraco. Hypothetical reading of some fragmentary lines, not completed (from Gorostidi, Ruiz 2017a, fig. 2).

The fragmented pieces were discovered during two different archaeological excavations in the area where today a considerable portion of the circus remains is visible (Díaz, Teixell 2017; López (ed.) 2017, *passim*). The first, directed by Jaume Massó and Xavier Dupré in 1985, was carried out at the place currently occupied by a restaurant[1] located in carrer del Trinquet Vell 12, where numerous fragments of monumental inscriptions were recovered (CIL II^2/14, 898, 900, 1000 and 1913-1916)[2]. In 2013, a second excavation was carried out at an immediately neighbouring site, during which another set of fragments (not yet published) was brought to light.

The pieces found in the 1985 campaign are collected in the recent update of the Tarraco epigraphic corpus by Géza Alföldy, but most of them were not associated with the

[1] On this plot and its relation with the urban place of the Roman city cf. Macias *et al.* 2007, 82 no. 221 plans A and 4. In the same place were found others, whose state of conservation makes them unviable for the study: CIL II2/14, 1916 and another unpublished (ref. TTV-13-219-16).

[2] All preserved in the National Archaeological Museum of Tarragona (MNAT).

same inscription. However, those recovered during the 2013 campaign could be linked to some pieces from the previous excavation thanks to similar formal characteristics – material, support, module and palaeography – but also – and especially – the particular fact that some of them have both faces smoothed, while others have a smooth back, but with the epigraphic field worked with the gradina. This detail was also observed in some fragments of the 1985 campaign.

Once all parts were assembled, a macroscopic examination was carried out. None of the fragments fit together, but most of them have common parameters that allow them to be divided into at least two groups. The monumentality of the inscriptions to which they belonged is evident in the size and modules of the letters, with measurements ranging from 6 to 12.5 cm in height and bezels, in some cases, around 2 cm in width, along with a very thorough palaeographic execution. The presence of holes for clamping bolts, as well as the mismatch of the divisions of the plates with the incisions of the letters demonstrate their *in situ* palaeographic execution, once the monumental plaques were placed on the architectural support. The best preserved epigraphic fragments had previously allowed the first hypothetical reconstruction (Fig. 2) mentioned above (Gorostidi, Ruiz 2017a).

A total of twenty pieces were recovered during the excavation campaigns. Except for two that are made of local limestone (CIL II^2/14, 1001, 2041), they are made of white marbles and matching features, suggesting that they are likely to belong to the same inscription, which possibly consisted of several parts.

Although the pieces are extremely fragmentary, they exhibit some characteristics that show them to be official inscriptions of monumental dimensions. They are all made from fine-grained white marbles, which display certain macroscopic features that help separate them into sets. Although no fragments fit together, most of them present common carving techniques allowing them to be divided into the following two groups.

Group A

The largest group consists of epigraphic plaques fragments whose front was worked with a gradina, but their backs are smooth (Fig. 3). The type of work with the gradina allows us to assume that they might have belonged to the same monumental plaque, composed of various pieces of varying thicknesses, attached by metal studs[3]. Five of them have retained text sequences that can be plausibly reconstructed and allow a preliminary reconstruction proposal.

The characteristics of the inscription to which they belonged, and the preserved text sequences suggest its association with an emperor of the Flavian dynasty – surely Domitian – and a character linked in some way with the *concilium provinciae Hispaniae citerioris*, which is mentioned twice. The size and modules of the letters, together with the high quality of their palaeographic execution, make clear the monumentality of this official inscription. For the confirmation of their association with this same group, the presence of scarce orientated grey veins was also fundamental.

One of the fragments differs from the others in that both faces were worked with a gradina. However, a close examination shows that it is a reworked piece, since the face currently belonging to the back is deeply carved out, while the side belonging to the epigraphic field originally had a smoothed surface. Being also macroscopically and microscopically of a similar marble, this fragment has been attributed to the same group. A small sample, to be further analysed to obtain the C and O isotopes, was taken from this fragment (sample no. 1).

[3] Despite the difference in thicknesses, they could be part of the same monumental plate (see e.g. the different preserved blocks of Diocletian's Baths: CIL VI, 1130; cf. EDR-115769 (G. Crimi).

Figure 3: Group A, plaques whose front is worked with a gradina, but their backs are smooth (Photos: J.C. Ruiz).

Group B

This group (Fig. 4) comprises five plaques which differ from the previous one in their slightly palaeographic variations and, in particular, in the superficial treatment of the pieces, since they have both sides smoothed. They also display a certain homogeneity in thicknesses (between 3 and 4 cm) and a greater uniformity in the colour of the fresh surface of the marble. Moreover, a common difference is that their epigraphic fields are not worked with the gradina. Unfortunately, due to their poor state of preservation, the pieces do not contain enough information to identify their text.

Figure 4: Group B, plaques with both sides smoothed (Photos: J.C. Ruiz).

In this case, two samples were extracted (samples nos. 2 and 3) for analysis. As far as the nature of marble is concerned, the macroscopic characteristics are quite similar to those described for group A, except for the absence of grey veins. On the contrary, although the marble surface is mostly almost uniform, there are irregularly-arranged specks and small purple veins.

Methodology

Thin sections of the fragments from both groups were made. Optical microscopy was used to examine their mineralogy, fabric, texture, grain boundary shape and to determine the Maximum Grain Size (MGS). Cathodoluminescence (CL) microscopy was applied with CL8200 Mk5-1 cold equipment coupled to a NIKON Eclipse 50iPOL OM. The electron energy was 15-20 kV and the beam current was operated at 250-300 μA. The observed luminescent colours, their intensity and distribution of each sample were recorded with an automatic digital NIKON COOLPIX5400 camera. The CL images taken were automatically controlled (29 mm focal length, f/4.6 aperture, 1s exposure, ISO-200) to obtain comparative images of the CL intensity in comparison with an internal standard (Lapuente, Royo 2016). They were compared with those available from several classical quarrying areas (Barbin *et al.* 1989, 1992; Lapuente *et al.* 2012; Brilli *et al.* 2018; Blanc *et al.* 2020) and from ancient Iberian and French quarries (Lapuente *et al.* 2000, 2014, in press; Lapuente, Blanc 2002; Royo *et al.* 2018).

Oxygen and carbon isotopes were determined by isotope ratio mass spectrometry (IRMS) with Finnigan MAT 252 equipment. A Finnigan MAT Kiel II automatic preparation device was previously used (15 mg) for phosphoric acid digestion at 72ºC and CO_2 purification. The results were expressed in terms of usual delta notation ($\delta^{13}C$ and $\delta^{18}O$) in ‰ relative to the international reference standard PDB (Mccrea, 1950). Analytical precision was better than 0.1 ‰ for both isotopic determinations. In calculating the $\delta^{18}O$ values, the phosphoric acid fractionation factor of 1.01025 for calcite was used (Sharma, Clayton, 1965). The isotopic signatures of the archaeological pieces were compared with those of the main classical marbles reported elsewhere (Moens *et al.* 1992; Gorgoni *et al.* 2002; Attanasio *et al.* 2009, 2015; Antonelli, Lazzarini 2015; Brilli *et al.* 2018; Wielgosz-Rondolino *et al.* 2020). Iberian isotope databases were also used for their comparison (Lapuente, Turi 1995; Lapuente *et al.* 2000; 2014). The approach used to determine marble sources was a "step by step" multi-method (Lapuente 2014).

Results

The results of the mineralogical-petrographic examination, the main CL features and the $\delta^{18}O$ and $\delta^{13}C$ (PDB) values in the representative samples are displayed in Tab. 1.

Sample 1, as a representative from Group A, is a pure calcitic marble with very fine grain and Maximum Grain Size (MGS) of 0,9 mm. It displays granoblastic to slightly heteroblastic texture, with very small scattered opaques, presumably pyrites. Boundary Grain Shapes (GBS) are straight to curved derived from almost stable conditions reached over long metamorphic times. Cathodomicrofacies (CL) is of homogeneous medium to faint intensity (Fig. 5a). Isotopic values are 1,7 for $\delta^{13}C$ (‰) and -1,6 for $\delta^{18}O$ (‰) which confirm their provenance from Carrara (Figs. 6a and 6b) in agreement with the minero-petrographic and CL features.

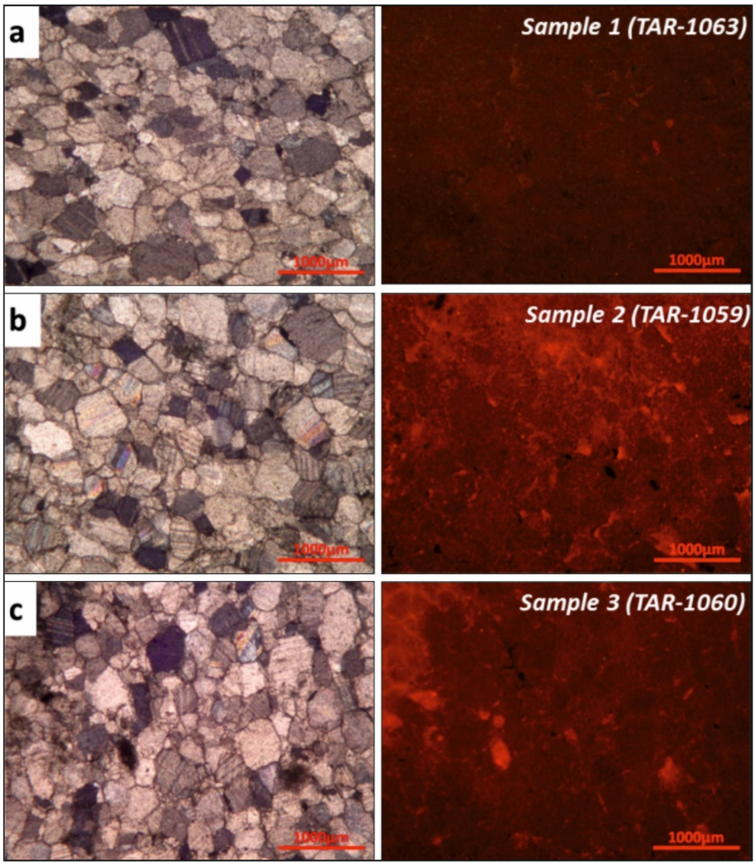

Figure 5: Selection of photomicrographs in crossed polarized light and cathodoluminescence images.

Samples 2 and 3 are both fine grained white pure calcitic marbles, with MGS of 1,2 mm. They exhibit a typical heteroblastic texture with clear evidence of stress and thick twins shown in many calcite crystals (type II after Burkhard, 1993). Boundary Grain Shapes range from mainly curved, but some rare straight ones can also be recognized, to sutured contacts. The latter, formed by intracrystalline plasticity, are typical of diffusive mass transfer mechanism. There is no evidence of accessory minerals. The patchy CL-pattern reveals different behaviour in unaffected relicts by the recrystallization processes (Fig. 5b-c). This CL heterogeneous pattern, combining areas of different intensities not related to any specific crystal, is very distinctive for *Dokimeion* marbles but not for Carrara or Göktepe (Blanc *et al*. 2020). C and O isotopic data (Figs. 6a and 6b) confirm a Turkish provenance as Afyon marbles. Worth mentioning is the isotopic data obtained, which is practically identical in both analysed pieces, with the same 1,8 value for $\delta^{13}C$ (‰) in both samples and -2,9 to -3,0 for $\delta^{18}O$ (‰), showing that they certainly belong to the same block of marble (group B of fragmented pieces).

Group	Sample	Main Mineral	Accessories	Fabric Texture	MGS (mm)	GBS	CL	$\delta^{13}C$ (‰)	$\delta^{18}O$ (‰)	Provenance
A	1 (TAR-1063)	Calcite	Opaques	Granoblastic to slightly heteroblastic	0,9	Straight (curve)	Homogeneous Medium-faint intensity	1,7	-1,6	Carrara
B	2 (TAR-1059)	Calcite	-	Slightly heteroblastic	1,1	Curve (straight, sutured)	Patchy Heterogeneous	1,8	-2,9	Afyon
	3 (TAR-1060)			Heteroblastic	1,2	Sutured (curve, straight)	High-medium intensity	1,8	-3,0	

Table 1: Analytical results and proposed marble provenance.

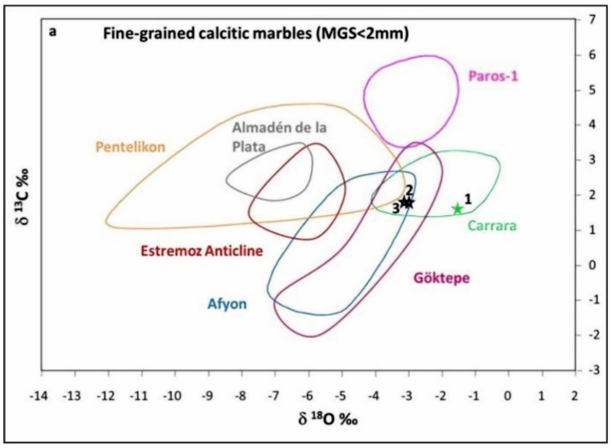

Figure 6a: Oxygen and Carbon isotopic signature of the analysed samples, compared with those of the main fine-grained Mediterranean marbles (after Gorgoni *et al.* 2002; Attanasio *et al.* 2015) as well as some fine-grained Hispanic marbles (Lapuente *et al.* 2014).

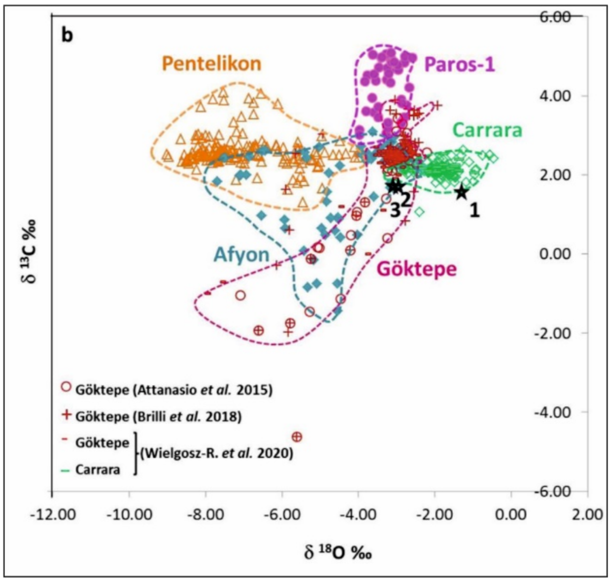

Figure 6b: Their isotopic signature plotted in the isotopic diagram based on data from Attanasio *et al.* 2006 updated with Göktepe and Carrara marbles from recent literature.

Final considerations

The multi-method analyses carried out confirm that the marbles used for the monumental epigraphy of the *circus* of Tarraco consist of at least two different fine-grained types of white marbles. Specifically, two varieties of imported marbles have been identified: Group A is made from Luni-Carrara marble, while group B corresponds to marble of *Dokimeion* (Afyon) origin. Fragments from both groups can also be clearly distinguished based on the different surface treatment: those made from Italian marble are worked with the gradina on the front, corresponding to the epigraphic field, while the backs are smoothed. On the contrary, the plates carved in Afyon marble are smoothed on both sides.

Palaeographical and formal features of all fragments are similar, although this could be motivated by the entity of the inscription, since monumental inscriptions have little variation. However, the diversity of the material used and the different carving technique might indicate that the elaboration of both plaques could be not contemporary or that they belong to different inscriptions. Taking the epigraphy into account, fragments of Group A date from the time of Domitian. For Group B samples, there is no evidence of a chronological assignment; they could also have been worked a little later.

This circumstance raises several questions, especially in the case of one of the fragments under study, whose work breaks homogeneity with the pieces included in the same group (Group A). Their correspondence with the material and palaeography, together with the treatment and shape of the support, as well as the samples of obvious reuse, allow us to propose that it is a re-use of a part of the plate for reasons that, with the available data, cannot be determined with certainty.

Both materials are visually almost identical, and similarities in palaeography are evident, mainly in size and V-shaped groove, although there are slight differences which allow one to propose a second hand in their lettering, and to conclude one similar aesthetic intention as a whole. Therefore, maybe fragments of Group B do correspond to a subsequent restoration. From a material point of view, it is plausible to think that stonecutters combined two functionally-equivalent materials: two fine-grained white marbles whose polishing was practically identical to the eye.

Concerning the provenance, Luni-Carrara marble seems to be the favourite for monumental inscriptions in Tarraco from Flavian times (Peña *et al.* 2015; Ruiz 2016; Gorostidi, Ruiz 2017b), and it was imported on a large scale for building and decorative purposes. For practical reasons, this italic marble is the most widespread in the western Mediterranean (Pensabene 2012), and is widely documented in the northeastern Iberian Peninsula (Gutiérrez Garcia, Rodà 2012), with emphasis on the provincial capital, Tarraco (Ruiz 2015, 2018). The state of the issue of *Dokimeion* marble is quite different. As far as epigraphy is concerned, only one epigraphic fragment – related to an imperial inscription from the Julio-Claudian period (CIL II^2/14, 887) – is known in Tarraco (Ruiz 2017, 47, 50, fig. 7, 2019, 314, fig. 13c). In this material, there are probably some more inscriptions which should be analysed in the near future to confirm its presence. Worthy of mention is the existence of another contemporary plaque with inscription, probably also dedicated to an emperor or other member of the Julio-Claudian dynasty (CIL II^2/14, 957), made in pavonazzetto (Ruiz 2017, 47, 50, fig. 7; Ruiz 2019, 314, fig. 13e). With respect to sculpture, up to now only one piece is known, possibly a table leg (Koppel 1985, 134-135, no. 302, pl. 94,6; Cuadra 2015, 121, no. 13; Ruiz 2020, 49, no. 21). However, numerous *crustae*, both in the white variety of Afyon and in the pavonazzetto *marmora*, have been documented in the area of the temple of Augustus, which was erected and embellished at about the same time as the circus (Àlvarez *et al.* 2012). The wide dissemination of these materials for the monumental architectural project of the city temple makes evident that this material was also used for wall revetments, probably in conjunction or as an alternative to Luni-Carrara marble, being used occasionally for epigraphic official purposes of the provincial administration.

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PROVENANCE IDENTIFICATION I:

MARBLE

PROVENANCE MATTERS: A MULTI-PROXY APPROACH FOR THE DETERMINATION OF WHITE MARBLES IN THE EASTERN RHODOPES AND THE VILLA ARMIRA, BULGARIA

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Abstract

Roman production and trading of marble is well known from areas such as Prokonnesos or Thasos and a series of other renowned production sites in antiquity. However, in the broad area of Thrace the numerous marble deposits in the interior, in particular in today's Bulgaria, have received far less attention. The marble quarries and outcrops area of South-East Bulgaria are extensively studied for the first time. Macroscopic and petrographic investigations all showed transitions from a coarse-grained, deformed texture to an extremely fine-grained, cataclastic marble. The isotopic diagram showed two different groups of marbles, one group with light and another with exceptionally heavy $\delta^{13}C$ between 5 and 6 ‰. The marble inventory of the Villa Armira was investigated with the result that all the architectural elements and decorative architecture of the villa are of local origin. The marble sources are the ancient quarries next to the villa on one hand and on the other hand the quarries near Kamilski dol some 27 km away.

Keywords: Marble quarries, Villa Armira, Eastern Rhodope.

Introduction

Within the territory of the province of Thrace some of the most prominent, renowned and studied marble sources of antiquity are located (e.g. Prokonnesos or Thasos). These marbles were widely exported throughout the empire, and the material can be traced in larger inland cities of Thrace. By contrast, the numerous marble deposits in the interior, in particular in today's Bulgaria, have received far less attention. Evidence of Roman marble production in the interior territory of Thrace is found in different areas of the Rhodope Mountains, in the Strandza Mountains and in the northwest Balkans near the town of Berkovitsa. Initial analyses indicate that these marbles were not only employed in the province itself, but also exported to a certain extent. Within the province, architecture and sculpture reveal striking connections to Asia Minor. By means of a sampling of Thracian quarries and Roman artefacts, the issues of the marble trade and cultural and technological transfer between the two provinces can be definitively pursued. The starting point of our investigations is a case study of marbles used in the Villa of Armira.

Armira (municipality of Ivaylovgrad, Bulgaria) is a luxurious villa, whose remarkable planning scheme, lavish marble decoration and floor mosaics characterize it as a unique specimen of Roman provincial art and architecture[1].

[1] Mladenova 1975.

The estate, covering an excavated area of 3,600 square metres, is situated in the eastern Rhodope in the valley of the small and unnavigable river Armira, a tributary of the greater Arda river[2]. In the case of the Villa Armira, the extensive use of white marble in the representative part of the house (pars urbana), especially in the 2nd century renovation phase, might be connected to the quarrying activity in the region. In general, it can be stated that the exploitation of marble quarries in Roman Thrace must have significantly increased in the 2nd century, as a systematic urbanisation process took place in the province and a number of new cities were founded. Marble quarries like those in the Pirin mountains, along the Struma valley and in the Montana region were usually close to rivers and major road networks. River transportation was preferred to road as it was faster and cheaper: this facilitated the construction of monumental buildings in cities like Philippopolis and Augusta Traiana, which lay along navigable rivers[3].

Despite the importance of these resources, these marbles have not yet been systematically studied. The heterogeneity of the analytical data and the large number of quarries and sources of marble production in antiquity require a combination of different methods for a sound analysis of the provenance. The results of the investigation of the Bulgarian marbles, and especially the marbles of the Eastern Rhodopes area, and the analytical data will be used in future research and expand the list of the ancient white marble quarries of antiquity.

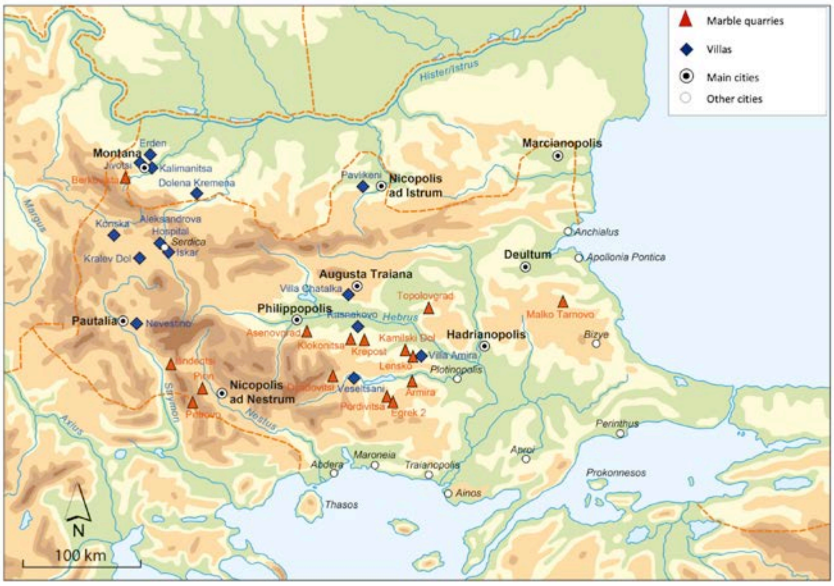

Figure 1: Map of the area of Thrace; the quarries, the major and smaller cities and villas are indicated. (Editor: N. Math, OeAI).

The area of southeastern Bulgaria

Sixteen quarries and outcrops were investigated in the surroundings of the Villa Armira. Quarries around the Villa (Armira 1, 2, 3, 4) are located at a perimeter of 3-4 kilometres. The quarries at the area of Kamilski Dol are located about 28 kilometres in the North of the Villa. Dyadovitsi is situated 142 km east from the Villa. Pordivitsa and Egrek are located about 90 km SE from the Villa. The distance between the Lensko quarry and the Villa Armira is approx. 25 to 30 km. Most of the quarries were in use until recent decades. This means that their use and production in antiquity cannot be established with certainty in several

[2] Kabakchieva 1995.
[3] Russell 2013.

cases. Due to the continuous extraction possible ancient traces of tool marks and mining activity are lost. In some cases the owners of the quarries or local guides refer to ancient semi-finished abandoned objects, which however cannot be proved. According to the archaeological evidence, in the area of Kamilski Dol 1, an abandoned object (a stela without inscription) was found and is now on display in the local museum.

Quarry	Coordinates	Description
Dyadovitsi	41.60296-025.13998	Very coarse grained white marble. Some pieces have slightly grey. Grey banding; coarse grained calcite crystals; marble with grey and pinkish banding.
Pordivitsa	41.32911-025.63926	White fine grained marble with coarse grained recrystallization, calcite.
Egrek	41.33329-025.64376	White marble, mainly coarse grained few fine grain varieties.
Lensko	41.44094-025.95058	Fine grained white to light yellow marble, pronounced banding on the weathered surfaces.
Klokonitsa	42.00066-025.52878	Dark - black limestone.
Krepost	41.99305-025.57146	White – beige limestone with red veins.
Kamilski Dol (abandoned) 1	41.60139-026.06303	coarse grain marble with different colours - all transitions from very white to greyish banded, mica and Muscovites on the schistosity
Kamilski Dol 1A	41.60712-026.05536	Coarse grained marble, with some fine grained, fractured material. Modern exploitation.
Kamilski Dol 2	41.60676-026.05612	Fine to coarse grain marble calcite.
Kamilski Dol 3	41.61557-026.05603	White to slightly grey marble. Medium grained size. Platy structure. No block extraction.
Kamilski Dol 4	41.60753-026.05882	White to slightly grey marble. Medium grain size. Platy structure.
River Armira Valley	41.51191-026.08516	Coarse grained marble, light blue grey to white colour.
Armira 1	41.50602-026.09191	Debris 1, 2, 3, 4. White slightly greyish colour, medium grained size, graphite in one of the samples. 3 km from Villa Armira. Blocks in starting phase of working.
Armira 2	41.50854-026.09143	White medium grain, similar to Armira 1. Quarried large block. No working space. Block with tool marks found next to it.
Armira 3	41.50001-026.09764	very fine white marble, irregular fractures, small quarry
Armira 4	41.51372-026.08405	Coarse to very coarse white to greyish marble with schistosity, mica on the schistosity layers. Some layers of fine grained, white colour. Platy structure on the upper part of the mountain. Modern Quarry-Abandoned. At the entrance of the quarry-used as a modern table-possible marble slab with tool marks.

Table 1: Table of the quarries sampled in the Eastern Rhodope (Editor: V. Anevlavi, OeAI).

Geological position

From a geological point of view Villa Armira is situated in the Eastern Rhodope. The mountain range was formed by the collision of the Drama continental block in the south against the Moesian platform in the North. This tectonic activity started in the Mid-Jurassic and resulted in intense thrusting and stacking of the nappes and metamorphism of the area in various degrees up to eclogite facies temperatures[4]. Exhumation extension and cooling of this crustal segment started in the Upper Cretaceous and was related to magmatic activity. Retrograde metamorphic overprint is a characterizing feature of these rocks.

The regional hostrocks are metamorphic rocks of variable degree of metamorphism. Common are gneisses, metabasic rocks and eclogites with layers of marbles of limited size. The marbles of the area are generally coarse-grained and show distinct features of the above-

[4] Burg *et al*. 1996, Ricou *et al*. 1998, Wüthrich 2009.

mentioned retrograde overprint. The investigated quarries have various characteristics. Most specifically, the Kamilski Dol is a good quality marble, with white to slightly grey colour, medium to coarse grained size. The marbles of the quarries Armira 1, 2 are white slightly greyish in colour and of medium grained size. Armira 3 is a very white and extremely fine grained marble (tectonized) while coarse to very coarse grained, white slightly greyish marbles occur in Armira 4. Large amounts of debris, most probably debitage dumps, located at short distance between them, were observed (Armira 1, debris 1-4).

Figure 2: Sampled quarries, most of the quarries are located in the area around the Villa Armira (Kamilski Dol 1, Kamilski Dol 2, Armira 1 – debris, Dyadovitsi. (Photos: V. Anevlavi, OeAI).

Experimental methods and marble database

The samples were obtained in the form of a small chip taken from a suitable place of an already existing old or new break so that there was no loss of any archaeological / art historical information or aesthetic value.

The geological samples were characterized by petrographic, isotopic, chemical analyses traces element and trace elements analyses. More specifically:

-Stable Isotope Analysis, (^{13}C /^{12}C and ^{18}O/^{16}O),

-Petrographic analysis,

-Trace element analysis (Mg, Mn, Sr, Fe, La, Ce, Cd, Ba, Y, Yb, U),

-Analysis of the fluid inclusions (Li/Na, Cl/Na, K/Na, Br/Na, I/Na),

For the statistical treatment, a large database of the most important ancient quarries was employed, in combination with an extensive collection and analysis of the new quarries of the Eastern Rhodope area. The programme packages STATISTICA and SPSS were used. These results provide additional data and complete the databases on marble provenance analysis. The collected samples were analysed at the Department of Geosciences and Geophysics at the University of Leoben Austria.

Petrography

The most characteristic feature of the investigated marbles is the retrograde overprint resulting in a highly deformed fabric of the rocks. Due to this intense tectonism all transitions from a coarse-grained, deformed texture to an extremely fine-grained, homogenous fabric can be observed. For architectural and artistic purposes, the less deformed varieties were used. The ultramylonites exhibit a conchoidal and vitreous fracture and therefore are not used for these purposes. However, mosaic stones and tesserae are made of this type of rock.

Three characteristic examples are presented in this paper which shows the prograding deformation of a coarse-grained marble to ultramylonitic deformation. The quarry sample from Kamilski Dol 1 (PM-PG-079) is coarse-grained marble with clear signs of deformation. The calcite crystals have irregular grain boundaries and deformed twin lamellae. The second quarry sample from Kamilski Dol 2 (PM-PG-095) has cataclastic texture of a strongly deformed marble. Relics of big calcite crystals are visible in a fine-grained recrystallized matrix. The extremely fine grained, deformed quarry sample is from Lensko quarry (PM-PG-196). The sample has ultramylonitic texture of a completely deformed marble without any relics of the original big calcite crystals. The photos are taken under polarized light, and the length of image is 6 mm (Fig. 3).

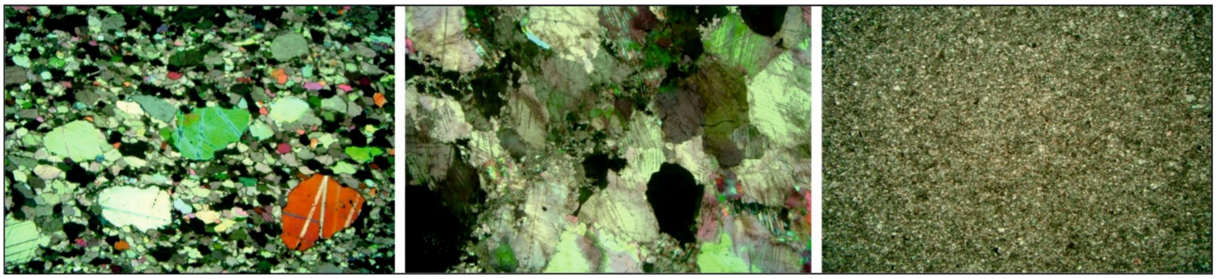

Figure 3: Petrographic analysis shows the different textures, starting from the coarse-grained marble with clear signs of deformation to ultramylonitic texture of a completely deformed marble without any relics of the original large calcite crystals (polarized light, length of images are 6 mm). (Photos: V. Anevlavi, OeAI).

Results

As can be seen in Fig. 4 two general groups of marbles in the region exist which differ basically in their isotope composition. One group (Armira 1, Kamilski Dol 1 and 3) shows exceptionally heavy $\delta^{13}C_{(PDB)}$ numbers between 5 and 6 ‰ (Fig. 4). The group with the lighter C-isotope composition shows a broad range in the O-isotope number most probably due different degrees of metamorphic overprint and recrystallization. According to these two groups we split the multivariate evaluation into these two groups for the sake of clarity (Fig. 5). The multivariate evaluation of the quarries shows a much better discrimination between the locations compared to the sole use of the stable isotopes. The upper diagram of the Fig. 5 is representing the quarries with the heavy $\delta^{13}C$ and the lower diagram shows the quarries with the marbles of the lighter $\delta^{13}C$ composition. In both diagrams there is a clear discrimination between the quarries. The variables used are: Mg, Fe, Mn, Sr, V, Y, La, Ce, Yb, U, DS, Li/Na, Cl/Na, K/Na, Br/Na, I/Na, $\delta^{18}O$ ‰, $\delta^{13}C$ ‰.

For the multivariate evaluation of the results (see below Tab. 2) we selected quarries for comparison which produce marble similar to the artefacts under investigation and did not consider those quarries, which could a priori be eliminated, for example the limestone quarries. For the sake of clarity and to avoid confusion statistical evaluation was carried out after combining nearby quarries with similar compositions (e.g. Kamilski Dol 1 and 3).

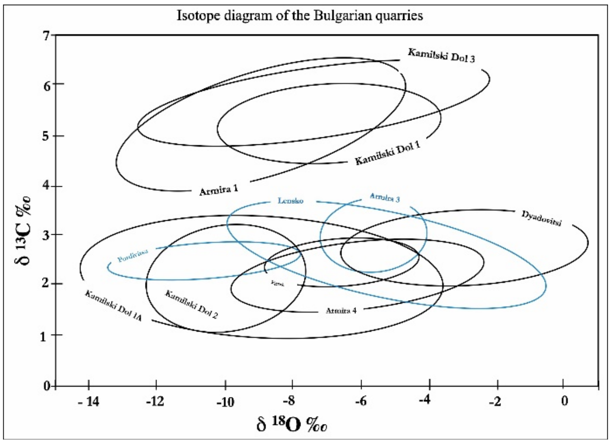

Figure 4: Isotope diagram of the quarries of the Eastern Rhodope. The locations Pordivitsa, Lensko and Armira 3 are fine grained white marble quarries. The rest of the locations are medium to coarse grained, white to greyish marble quarries. (Graphs: V. Anevlavi, OeAI).

In the Villa Armira a large number of artefacts (architectural pieces and decorative architecture) were sampled. All the decorative architecture of the villa is made of different local marbles and no imported marble was found in the architectural elements. The details of the marble decoration of the villa will be published elsewhere and only some examples of the local origin of the marble used is given in this paper.

As shown in Fig. 6 the six friezes investigated originate from two main quarries. Two of them are from Kamilski Dol 1 while the remaining four are from Armira 4. The studied hermae and balustrades can be separated into two groups. The “heavy carbon” samples are from Kamilski Dol 1/3 while the “light carbon” samples of this group are from Armira 4. The balustrade sample PM-BG-135 was too small to be analysed with the methods usually applied and therefore is not displayed in Fig.6. According to isotope and trace element analysis it also originates from the area of Armira 4.

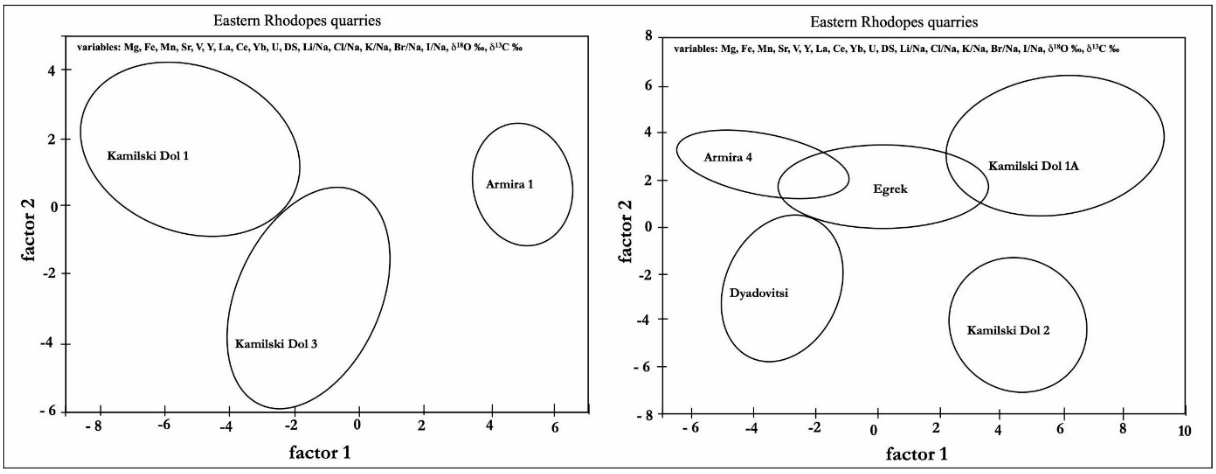

Figure 5: Multivariate diagram of the quarries of the Eastern Rhodope. The left diagram represents the quarries with the light $\delta^{13}C$. The right one shows the quarries with $\delta^{13}C$. In both diagrams there is a clear discrimination between the quarries. The variables used are: Mg, Fe, Mn, Sr, V, Y, La, Ce, Yb, U, DS, Li/Na, Cl/Na, K/Na, Br/Na, I/Na, $\delta^{18}O$ ‰, $\delta^{13}C$ ‰. (Graphs: V. Anevlavi, OeAI).

Figure 7 shows the results for the investigated pilaster capitals and one pilaster. One group of samples clearly plots in the compositional field of Armira 4 and can thus be considered to come from this quarry close to the villa. The other group falls in the overlap area of the “heavy carbon” quarries Armira 1 and Kamilski Dol 1/3 and cannot be attributed unambiguously. Further surveying of the area of the villa may reveal another location where these marbles were mined. The pilaster was also produced with marble from the area of Kamilski Dol 1.

`		∂18O	∂13C	DS	Li/Na	Cl/Na	K/Na	Br/Na	I/Na	SO_4/Na	$MgCO_3$	Mn	Fe	Sr	Cr	V	Y	Cd	Ba	La	Ce	Pr	Dy	Ho	Yb	Pb	U
Klokonitsa	ø	-5,64	1,28	6586	1,246	1744	5115	8,0	1,6	1629,6	n.a	122,98	3776,55	143,99	1,449	0,608	4,517	0,053	3,366	4,369	7,797	0,994	0,694	0,135	0,322	3,274	0,648
	σ	1,18	0,17	2315	0,770	251	3176	2,4	1,5	672,1	n.a	27,61	780,94	80,80	0,649	0,197	0,690	0,058	0,745	0,559	1,185	0,147	0,098	0,018	0,031	2,320	0,525
Kamilski dol 1	ø	-6,92	5,23	2019	1,210	1533	628	9,5	7,4	4627,7	1,69	60,00	367,41	208,76	3,629	0,736	2,799	0,231	2,417	1,363	0,786	0,229	0,224	0,049	0,116	0,643	0,182
	σ	1,33	0,32	774	0,712	376	212	10,3	3,8	2938,5	0,97	22,00	291,57	72,75	0,925	0,364	1,298	0,068	0,836	0,756	0,393	0,131	0,117	0,025	0,051	0,481	0,210
Kamilski Dol 2	ø	-10,00	2,16	709	0,303	1053	506	9,2	6,3	2258,3	1,83	73,83	218,73	184,94	1,599	0,814	1,273	0,208	2,836	0,364	0,302	0,068	0,196	0,024	0,069	2,457	0,077
	σ	0,84	0,39	127	0,131	169	107	2,7	1,6	1086,0	0,88	31,40	47,08	7,26	0,643	0,230	0,355	0,055	0,689	0,126	0,087	0,021	0,253	0,008	0,019	0,804	0,028
Kamilski Dol 1A	ø	-8,94	2,16	1244	0,349	3839	330	12,6	1,8	2377,0	0,68	63,80	247,19	234,21	1,464	0,656	1,830	0,133	2,849	1,009	0,460	0,123	0,181	0,040	0,104	1,220	0,038
	σ	1,93	0,45	263	0,248	1326	177	5,0	1,2	2104,0	0,61	40,35	147,52	95,63	0,193	0,392	0,986	0,092	1,560	0,706	0,229	0,097	0,113	0,025	0,060	0,790	0,020
Kamilski Dol 3	ø	-7,67	5,66	2426	0,571	2186	579	5,9	6,7	5714,4	1,73	27,92	372,12	164,79	2,128	0,631	2,972	0,281	2,473	1,387	0,965	0,239	0,228	0,060	0,146	0,884	0,063
	σ	1,69	0,37	773	0,296	888	374	4,1	4,2	7227,3	0,68	12,73	173,11	85,73	1,008	0,563	0,936	0,089	1,490	0,423	0,355	0,079	0,106	0,020	0,047	0,958	0,048
Kamilski Dol 4	ø	-5,70	4,67	1523	1,469	1444	496	6,0	7,3	2210,8	2,37	26,17	412,52	105,70	3,992	0,410	1,075	0,159	1,532	0,481	0,455	0,092	0,068	0,021	0,053	0,541	0,031
	σ	2,71	1,41	411	2,135	183	173	1,8	4,0	2712,6	1,14	15,08	191,29	55,52	1,502	0,209	0,607	0,108	1,129	0,277	0,235	0,049	0,036	0,011	0,030	0,593	0,028
River Armira Road Cut	ø	-6,54	1,39	3841	1,154	1267	689	6,2	5,7	665,7	1,13	41,57	682,87	437,52	1,600	0,317	1,449	0,054	4,503	0,873	1,386	0,198	0,190	0,038	0,100	2,145	0,394
	σ	1,58	1,41	2258	0,840	301	332	1,9	4,5	741,4	0,66	34,10	382,01	186,63	0,462	0,180	0,906	0,060	2,280	0,478	0,750	0,104	0,098	0,021	0,049	1,434	0,353
Dyadovitsi	ø	-2,87	1,93	1914	0,499	1548	483	8,1	11,0	1537,4	1,20	42,82	577,92	147,45	1,517	0,451	1,550	0,118	2,050	0,941	1,099	0,184	0,186	0,035	0,086	1,325	0,189
	σ	4,79	1,89	678	0,308	295	195	2,2	5,9	850,1	0,58	29,32	942,04	105,63	1,109	0,215	1,144	0,075	1,112	1,056	1,966	0,242	0,160	0,032	0,077	0,876	0,209
Pordivitsa	ø	-2,35	1,99	2357	0,117	1355	341	5,2	1,5	3097,6	1,12	36,59	366,20	150,92	1,435	0,422	1,257	0,119	2,042	0,677	0,691	0,125	0,151	0,028	0,070	1,169	0,123
	σ	5,19	1,63	996	0,077	225	173	2,4	1,2	1639,4	0,58	17,85	258,06	109,90	0,977	0,206	0,672	0,068	1,040	0,378	0,565	0,074	0,066	0,014	0,035	0,597	0,133
Egrek	ø	1,19	1,86	977	0,133	1193	293	8,9	0,2	1177,5	0,87	31,65	536,06	128,47	1,259	0,324	1,156	0,095	1,561	0,763	1,080	0,156	0,141	0,027	0,067	0,992	0,164
	σ	4,40	0,16	307	0,061	154	80	1,6	0,2	401,3	0,34	10,72	301,50	24,02	0,258	0,131	0,365	0,027	0,561	0,302	0,633	0,073	0,052	0,009	0,022	0,322	0,042
Lensko	ø	-5,21	2,64	1126	0,303	1439	550	12,5	1,7	2692,7	0,94	53,12	698,26	126,02	1,844	0,912	1,568	0,198	2,653	0,539	0,499	0,112	0,150	0,033	0,086	1,230	0,098
	σ	1,82	0,43	466	0,303	281	248	2,7	1,7	1695,9	0,50	40,23	369,82	75,37	0,169	0,380	1,119	0,076	3,458	0,471	0,507	0,108	0,112	0,025	0,065	1,418	0,079
Armira 1	ø	-8,97	5,20	4155	1,752	2327	150	4,1	1,6	2500,0	1,15	14,28	222,19	206,03	1,472	0,213	0,374	0,048	4,502	0,543	0,268	0,040	0,037	0,008	0,022	3,597	0,010
	σ	1,79	0,58	1804	2,314	370	43	1,2	0,8	565,1	0,47	17,22	218,17	76,91	0,338	0,094	0,143	0,028	2,019	0,502	0,162	0,021	0,014	0,003	0,007	2,850	0,004
Armira 2	ø	-6,54	4,84	3362	1,086	2107	125	6,7	5,3	2224,0	1,02	22,51	125,61	109,97	1,181	0,175	0,263	0,059	0,904	0,336	0,244	0,033	0,028	0,006	0,017	0,951	0,012
	σ	3,28	1,64	534	1,177	308	14	1,7	7,6	1666,6	0,37	25,12	103,41	33,69	0,160	0,128	0,096	0,032	0,383	0,052	0,118	0,015	0,008	0,002	0,004	1,296	0,003
Armira 3	ø	-5,60	2,96	1477	17,459	1555	794	4,8	8,6	2938,8	2,01	52,64	205,80	124,18	2,305	0,399	1,737	0,138	2,153	0,639	0,451	0,129	0,107	0,034	0,085	0,966	0,047
	σ	0,57	0,28	554	44,290	260	315	1,8	9,7	2099,1	1,12	72,73	107,30	30,03	0,460	0,210	0,925	0,108	0,965	0,354	0,223	0,076	0,064	0,020	0,049	0,511	0,023
Armira 4	ø	-6,04	2,21	2438	1,553	1667	418	5,5	1,3	1524,8	1,60	32,27	271,80	136,50	2,079	0,251	1,732	0,208	1,793	0,799	0,548	0,148	0,101	0,032	0,076	1,591	0,014
	σ	1,52	0,28	632	3,628	275	156	1,4	1,7	955,9	0,71	24,10	221,55	44,00	0,419	0,156	0,896	0,087	0,789	0,505	0,352	0,098	0,061	0,019	0,040	1,697	0,005
Krepost	ø	-4,40	2,42	7362	1,695	1900	579	6,3	4,8	805,0	1,89	63,71	1102,68	121,95	1,848	0,551	2,510	0,160	2,214	2,078	2,383	0,466	0,345	0,068	0,160	1,774	0,456
	σ	2,24	0,48	3080	1,809	202	490	2,0	4,2	348,7	1,48	27,55	517,27	35,85	0,093	0,269	1,950	0,096	1,354	1,250	0,810	0,304	0,238	0,048	0,101	0,679	0,201

Table 2: Analytical data (mean value and standard deviation of the 16 sample locations around the area of Villa Armira (Editor: V. Anevlavi, OeAI).

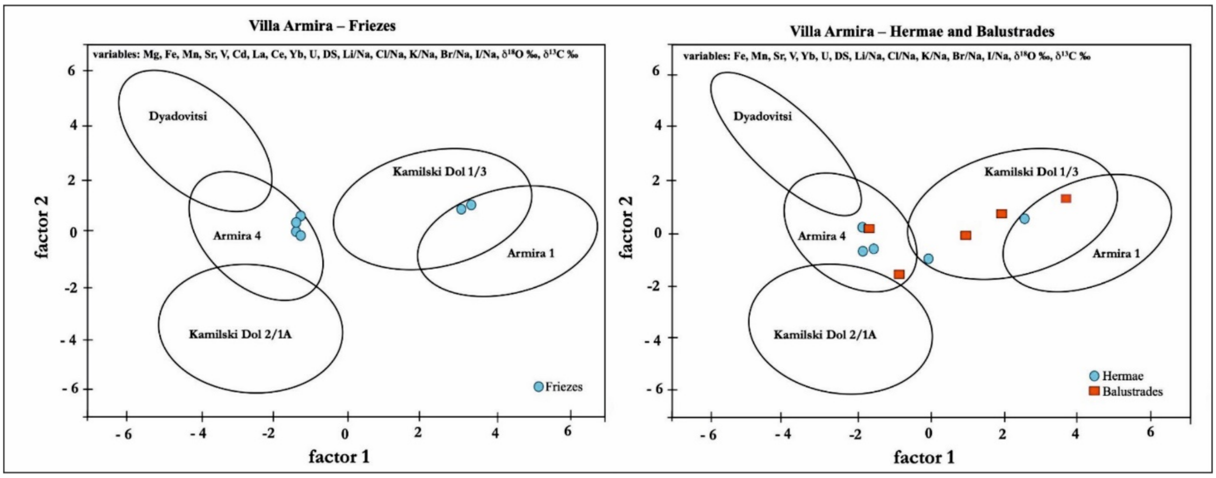

Figure 6: Multivariate diagram of the friezes, the Hermae and balustrades (Graphs: V. Anevlavi, OeAI).

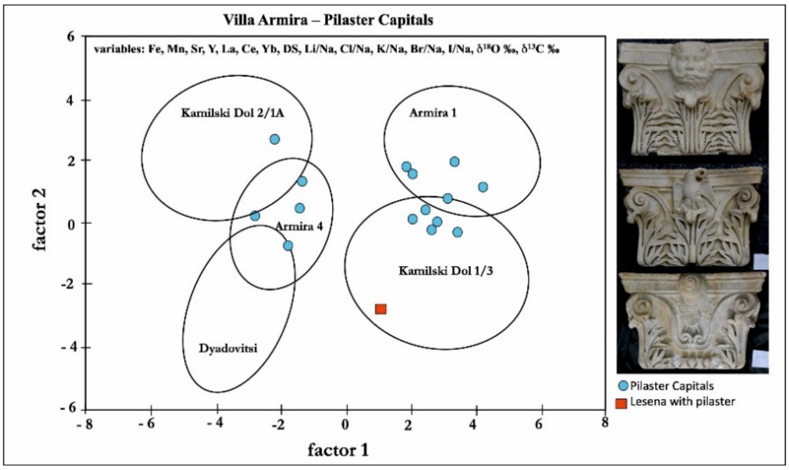

Figure 7: Multivariate diagram of the pilaster capitals (Graph and photos: V. Anevlavi, OeAI).

Conclusion

The marble inventory of the Villa Armira was investigated with the result that all the architectural elements and decorative architecture of the villa are of local origin. An Asian provenance (e.g. from the Aphrodisian quarries) can by excluded. The marble sources are the ancient quarries next to the villa on one hand and on the other the quarries near Kamilski dol some 27 km away. The archaeological record proves the latter to have been of some importance in antiquity. The local production of exquisite artefacts made from the high-quality marbles in the immediate surroundings of the Villa Armira seems to indicate the temporary activity of specialists during the construction and furnishing of the Villa by travelling masters. The concentration of several quarries of high-quality marbles at Kamilski Dol maybe indicates the existence of a permanent workshop. As Kamilski Dol lies few a kilometres north of the navigable Arda river, waterborne transport could have taken marbles from these quarries to important Thracian cities like Plotinopolis or Hadrianopolis and have contributed to the monumentalising of these centres.

Acknowledgements

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MARBLE AT *AECLANUM* (ITALY): NEW EVIDENCE FROM THREE PUBLIC BUILDINGS

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Abstract

The city of *Aeclanum* was an important regional centre in the southern Apennines from the Samnite period through to late antiquity. It developed as a Roman *municipium* in the 1st century BC before becoming a colony under Hadrian; it then continued to prosper in late antiquity as a bishopric. Excavations in the 20th century uncovered various public buildings (baths, *Macellum*, church) and a residential zone; more recent work in the early 2000s identified a further large public building, thought to be a *nymphaeum*, now shown to be the Theatre. Most of these buildings have produced reasonable quantities of marble, primarily revetment but also some column shafts. Although an inland centre, *Aeclanum* was connected by the Via Appia to both coasts of the Italian peninsula. This examination of marble revetment from three public buildings provides new insights into the extent of these connections and the architectural aspirations of the city's elites.

Keywords: Italy, *Aeclanum*, wall revetment.

Aeclanum: The Site and its History

Aeclanum lies beyond the shores of the Bay of Naples in the ancient district of *Hirpinia* (Fig. 1). The early history of the site remains poorly understood. Prior to the Roman period it was a centre of the *Hirpini*, a Samnite people, and ceramics and architectural finds suggest it had an urban character by at least the 3rd century BC[1].

The site came increasingly under Roman influence during the course of the 3rd century BC, when the Via Appia was pushed through the region and a Roman colony founded at *Beneventum* in 268 BC; the fact that the Via Appia ran through *Aeclanum* suggests it was a centre of some importance by the 290s BC, and indeed the presence of the road would continue to define the city's political and economic life for the rest of its history[2]. By the 1st century BC the city was a key player in regional politics and apparently the main urban centre of the *Hirpini*. In 89 BC Appian tells us that it resisted Sulla, despite the fact that a sizeable portion of Sulla's own army had been raised in *Hirpinia* by Minatius Magius, who was himself from *Aeclanum*[3]. The city was besieged, its walls destroyed and the settlement sacked. It was then rebuilt as a Roman *municipium* with a host of new public buildings, walls and gates, partly under the patronage of Magius' son and other supporters of Sulla, such as C. Quinctius Valgus[4].

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[1] On the Hirpini, Poccetti 2017; Colucci 2017; Isayev 2013; on the finds from the site, Sgobbo 1930; Di Giovanni 1996, 241; Frese 2012.
[2] On the road network, Lo Pilato 2013; and on the city's territory, Ditaranto 2016.
[3] App. BCiv. I 50-51; for a narrative of these events, Dart 2016 159-162.
[4] CIL IX 1140, 1141; CIL I2 3191, 3192; Avagliano 2017a, 100-101.

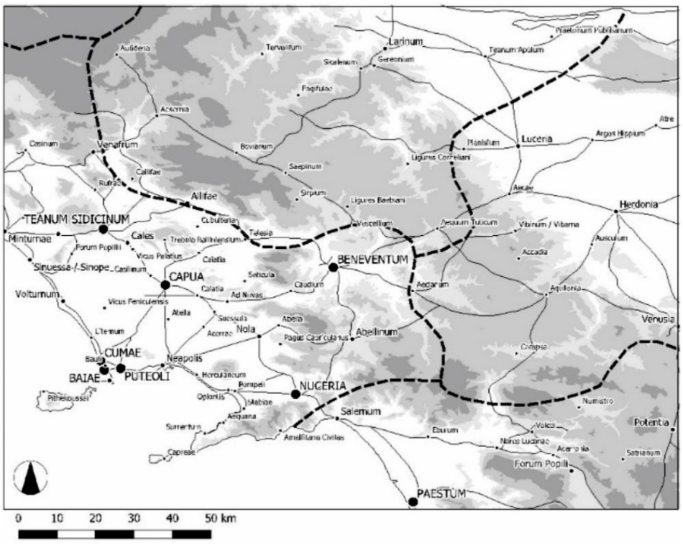

Figure 1: Inland Campania and northern Apulia, showing the location of *Aeclanum*, south-east of *Beneventum* (Map: J. Souček).

Although *Aeclanum* became a Roman city in the early 1st century BC, the majority of the remains surviving on the site date to the imperial period and late antiquity. In fact the site seems to have blossomed in the 2nd century AD, especially following its promotion to colonial status (as Aelia Augusta Aeclanum), late by Italian standards, in AD 120[5]. At this date, the major baths at the northern edge of the site seem to have been built, as does the *Macellum*, both of which are discussed below; the Forum also seems to have been paved for the first time at this point. All of this suggests that the city's strategic location on the Via Appia continued to matter even after the construction of the Via Traiana, a road with which the city maintained contact via the Via Aurelia Aeclanensis. The large number of inscriptions from the site are testimony to its continued vibrancy well into late antiquity, when it also became a bishopric[6]. Between the 4th and 5th centuries the city experienced both disaster and resurgence: it was first struck by a substantial earthquake, probably in AD 346, when much of the rest of central southern Italy was devastated[7]; then in AD 472 it was hit by the late antique eruption of Vesuvius[8]; between this pair of natural disasters, however, there are signs of investment on the part of the local elites and a renewed ecclesiastical significance for the city, which was home to the dynamic Julian of Aeclanum in the early 5th century[9]. Following the AD 472 eruption, *Aeclanum* does seem to have reduced in size as a settlement and there are few signs of continuity except in the immediate vicinity of the church[10].

Limited archaeological investigations at *Aeclanum* began in the 18th century but it was not until the 1950s that systematic excavations began in earnest, under the direction of Giovanni Onorato[11]. Later work directed by Gabriella d'Henry in the city centre, and extensive excavations in the suburban zones, extended Onorato's investigations[12]. These various phases of interventions have revealed a number of key public structures (the baths, a *Macellum*, a major early Christian Basilica), a residential sector, and extensive cemeteries. The overall topography of the site, however, remains little understood, and almost no work has been undertaken on the artefacts recovered by the excavations, especially the ceramics[13].

[5] Camodeca 2017, 103.
[6] On the epigraphy, Evangelisti 2017.
[7] On this event, Galadini, Galli 2004; on its impact at Aeclanum, De Simone, Russell 2019a.
[8] On this eruption, Rosi, Santacroce 1983; 1986; Mastrolorenzo *et al*. 2002; Rolandi *et al*. 2004; De Simone, Russell 2019a.
[9] For fourth-century investment, see CIL IX 1128 = ILS 5506; Caruso 2005; on Julian, see the papers in Nazzaro 2004.
[10] On the church, Lo Pilato 2010.
[11] Onorato 1960.
[12] Colucci, Di Giovanni 1999; Colucci 2017; Lo Pilato 2005.
[13] An important attempt to understand the site's topography, however, is Ditaranto 2013.

The marble has received more attention, especially the finds from a campaign of excavations between 2006 and 2009 close to the entrance to the Parco Archeologico, which uncovered the remains of a large public building, then thought to be a nymphaeum but now identified as the city's Theatre[14].

Started in 2017, the new research project at the site of *Aeclanum* is directed by the Apolline Project and the University of Edinburgh, in collaboration with the Soprintendenza per le province di Salerno ed Avellino, the Comune di Mirabella Eclano, the Accademia di Belle Arti di Napoli, and the British School at Rome. The project's aims have been to study the long-term urban development of the site and especially its economic connections, both regional and inter-regional[15]. Much of this work has focused on the ceramics from the site but the decorative stones provide an insight into the ancient wealth of the city as well as its regional and inter-regional connections and architectural aspirations. Strikingly, for an inland centre that was extensively spoliated in the post-antique period, *Aeclanum* has produced large quantities of marble revetment, as well as fragments of larger architectural elements in imported materials. The new excavations and survey at *Aeclanum* have concentrated on clarifying the city's topography and the chronology of a series of its most important civic spaces. Three of these structures have produced marble revetment: the large bath complex, probably built in the 2nd century AD; a Theatre (previously identified as a nymphaeum) of Julio-Claudian date; and a *Macellum*, seemingly constructed in the Hadrianic period. The new assemblages brought to light in 2017 and 2018 are here combined with the dataset collected in the previous excavations in the Theatre between 2006 and 2009.

Marble from the Theatre

The foundations of the *scaenae frons* of the Theatre and the remains of its *proscenium* were first revealed in 2006-2009; at this point they were thought to belong to a *nymphaeum* but in 2017 new excavations confirmed that they were in fact part of the Theatre of the city[16]. This structure was probably constructed in the 1st century AD: the architectural elements recovered can be dated to the Julio-Claudian period on stylistic grounds, while the ceramics from the stratigraphic units beneath the foundations date to the Augustan period and earlier. Most of what remains of the structure, however, is heavily shaped by a series of late antique developments. To judge from the recent excavations, the Theatre went out of use at some point before the 5th century AD; by the time the eruption of AD 472 struck, at least, the substructures of the *cavea* had been turned into domestic units[17]. By this point the *scaenae frons* had also fallen down or been dismantled, since some of its constituent elements were found on the ground behind the *proscenium*, beneath the ash layer associated with this eruption. Since many of the architectural elements recovered from the building were broken, it seems likely that the *scaenae frons* collapsed and the AD 346 earthquake is a reasonable candidate for the cause of this destruction. There is no evidence for continued use of the Theatre, even for domestic occupation, after AD 472 and indeed at this point the structure seems to have become an open-air quarry for building stone.

The marble recovered during the 2006-2009 excavations, therefore, was disassociated from the surfaces it originally adorned, aside from a series of moulding panels still attached to the lower surfaces of the *proscenium* façade. As well as revetments, the excavations uncovered architectural elements in Luna marble, including entablature blocks and Corinthian capitals, in the area behind the proscenium[18]. Two pieces of column shafts, one in cipollino

[14] On the marble from these excavations, Mesisca *et al*. 2013; Mesisca 2015.
[15] See De Simone, Russell 2018; 2019b; Russell, De Simone 2020; Strapazzon *et al*. 2017.
[16] Mesisca *et al*. 2013; Mesisca 2015; Lo Pilato 2010, 352; De Simone, Russell 2018.
[17] De Simone, Russell 2019a.
[18] Mesisca *et al*. 2013; Mesisca 2015.

and the other in breccia di settebasi were also found, and two further fragments of shafts, again in breccia di settebasi, are recorded by Mesisca in private collections in the vicinity of the site[19]. Part of a pilaster capital in rosso antico was also recovered from the Theatre area[20]. The size of the free-standing architectural elements suggests they originally adorned the *scaenae frons*. The most striking discovery, however, was the cuirassed torso of an over-life-size imperial statue, previously thought to be Marcus Aurelius but recently re-identified as Domitian[21]. The marble has been identified as pentelic[22]. This piece was found lying behind the *proscenium* façade with a number of fragments of column shaft and a capital, which appear to have been collected here during spoliation activities following the collapse of the *scaenae frons*; the size of the statue suggests that it once also adorned the *scaenae frons*.

In 2017-2018, a new trench was opened to the west of the *proscenium* which revealed the central section of the *orchestra* and two sections of the foundations of the *cavea*[23]. While the marble paving of the *orchestra* was almost entirely stripped off in late antiquity, two panels of africano belonging to the border remained in place.

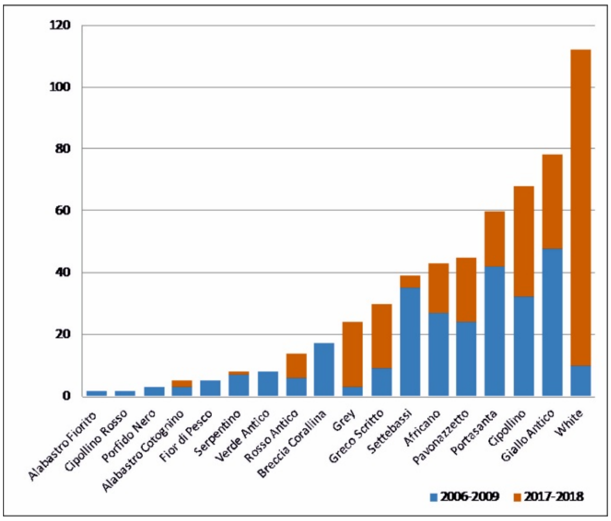

Figure 2: Lithotypes recorded from the theatre by count, excavations in 2006-2009 (n=284) and 2017-2018 (n=280), (Graph: B. Russell).

The lithotypes recorded during the 2017-2018 campaigns and their quantities (n=280) are plotted in Fig. 2 alongside the totals identified during the 2006-2009 campaigns (n=284). Aside from white marble (20%), the three most attested lithotypes are giallo antico (14%), cipollino (12%), and portasanta (11%), closely followed by similar quantities respectively of pavonazzetto (8%), africano (8%), and breccia di settebasi (7%). The different quantities of materials from the two phases of excavation may well reflect real differences in the revetment schemes in the building itself.

The material recovered during the 2006-2009 excavations most likely derive from the *proscenium* and *scaenae frons*, while those found in 2017-2018 come from the area of the *orchestra* and *cavea*. This suggests that white and assorted grey marbles, including greco scritto, were favoured in the latter areas, with some polychrome stones (like the africano still in place) used in the border of the *orchestra* floor. For the *proscenium* and *scaenae frons*, however, a wider range of polychrome stones were employed, complementing the coloured column shafts that must also have adorned this façade.

[19] Mesisca 2015, 97-9, figs. 4-5.
[20] Mesisca 2015, 96-7, fig. 3.
[21] Avagliano 2017a; De Simone, Russell 2019b.
[22] Mesisca *et al.* 2013.
[23] De Simone, Russell 2018.

Marble from the baths

The northern baths at *Aeclanum* were first identified and extensively excavated in the 1960s. They constitute the largest single building revealed to date in the city. Their masonry is typical of the early 2nd century AD and a Hadrianic date has been proposed[24]. Three heated rooms with *suspensurae*, an *apodyterium* divided by a screen of two columns, and a large *frigidarium* with marble-lined pool were uncovered in the 1960s excavation. A series of pieces of sculpture were also found here[25]. Although these pieces date to the imperial period, they were probably installed in the baths only in late antiquity[26]. Indeed there is extensive evidence for the refurbishment of the structure in this period, probably in the wake of the AD 346 earthquake. A new pool was inserted into Room 9, off the north side of the *frigidarium*, the floor levels of several rooms also north of the *frigidarium* were raised (including in Room 10), and a new mosaic added in Room 8[27]. This evidence fits with data from elsewhere in central Italy for the restoration of bath houses in the 4th and 5th centuries, often under the oversight of provincial governors[28]. Although the baths at *Aeclanum* probably reached their peak size in the 4th century, the Vesuvian eruption of AD 472 also impacted them; ash layers here suggest minimal physical disturbance but there is no evidence for continued use of the structure after this date[29].

Three distinct assemblages of marble have been recovered from this area during the recent excavations: first, a deposit of marble wall revetment and paving that had been assembled during the 1960s excavations and stacked along the southern edge of the mosaic to act as a form of retaining wall; second, the *in situ* paving of Room 10, north of the *frigidarium*, which is composed of white marble and verde antico panels, some re-used, some new (see Fig. 5 below); and finally, a substantial quantity of wall revetment found in the post-abandonment deposits excavated throughout the complex. While we cannot be sure where exactly the material belonging to the first of these assemblages came from within the baths, we can be reasonably sure that it came from the baths or the public building adjacent to the baths, identified as a possible *palaestra*. The revetment from the excavations and the 1960s deposit is graphed in Fig. 3. What this shows is the total dominance of cipollino, which accounts for 40% of all the revetment recovered. Since it is now clear that Room 10, which is only partially excavated, was also floored in verde antico, we should expect more of this material to be recovered if future excavations are undertaken in this area.

Marble from the *Macellum*

The *Macellum* at *Aeclanum* was also discovered by excavations in the 1960s. It consists of a circular open court ringed by small rooms set within a square enclosure wall. The distinctive form is paralleled in the 2nd century AD *Macella* at *Herdonia* (Puglia) and *Alba Fucens* (Abruzzo)[30]. The central court of the structure was paved in mosaic, while the flanking rooms had terracotta tiled floors. Much like the Theatre, the *Macellum* seems to have largely gone out of use as a public building in the 4th or 5th century. By the time the AD 472 eruption struck it had again been turned into a series of domestic units, with new lime-washed floors added above the earlier tiles. Only in the northeastern corner of the complex was evidence for commercial activity, and perhaps butchery, uncovered[31]. Ceramic evidence indicates that the domestic activity did in fact continue after AD 472, at least into the 6th century AD, though the commercial activity probably stopped in the 5th century.

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[24] Di Giovanni 1996; Colucci, Di Giovanni 1999.
[25] Avagliano 2017b.
[26] On this point see, De Simone, Russell 2019a.
[27] De Simone, Russell 2019a.
[28] On this phenomenon see Ward-Perkins 1984, 20-27; Christie 2006, 199; 2011, 131-132.
[29] De Simone, Russell 2019a.
[30] De Ruyt 1983.
[31] Russell, De Simone 2020.

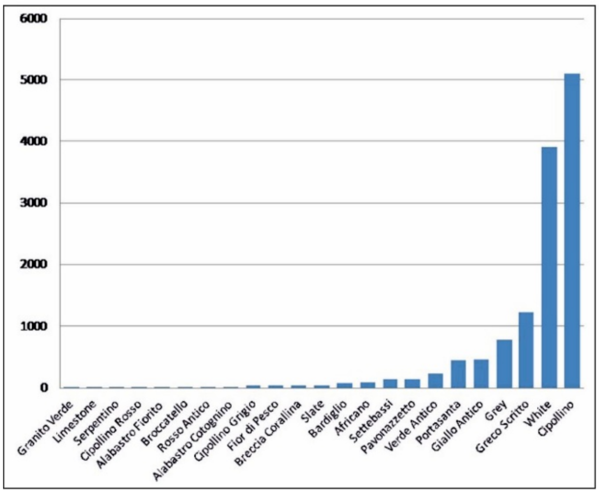

Figure 3: Lithotypes recorded from the baths by count, excavations in 2017-2018, (n = 12802), (Graph: B. Russell).

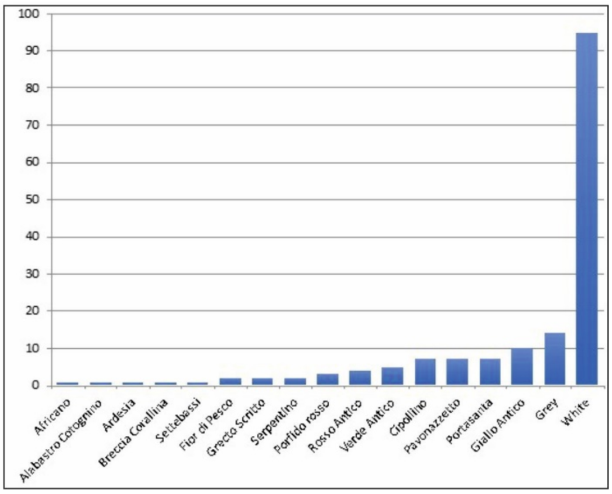

Figure 4: Lithotypes recorded from the *Macellum* by count, excavations in 2017-2018, (n = 163), (Graph: B. Russell).

While only one trench was opened in the *Macellum* during the 2017 season, the revetment recovered suggests that the walls of the original 2nd century AD structure were faced in marble. While such adornment in what is effectively a utilitarian structure might seem unusual, *Macella* of this type were often lavishly decorated: the *Macellum* at *Herdonia* had ornate wall-paintings, stucco-covered brick pilasters and half-columns, and a central mosaic similar in form to the *Aeclanum* building. Further afield, the *Macella* at Puteoli and Leptis Magna, of course, were lavishly decorated in imported marbles[32].

Compared to the Theatre and the baths the range of lithotypes from the *Macellum* is much narrower; the decorative scheme seems primarily to have been white, perhaps with small panels of other colours (Fig. 4).

Marble use at *Aeclanum*

The three public buildings introduced above show different patterns in terms of their marble use. While the largest quantity and widest range of revetment comes from the baths, the decorative scheme of this building was overwhelmingly green and white/grey – cipollino is far and away the most common material, while together cipollino, white, greco scritto, grey and verde antico account for 88% of the marble from this structure. Cipollino seems to have been favoured for walling and verde antico and white marble for flooring, as visible in those areas where *in situ* flooring has been preserved (Fig. 5). The overall 'green-ness' of the final effect is striking and while cipollino is common in bathing contexts (Fig. 6), its combination with verde antico in the flooring is more unusual. The Theatre, in contrast, contained a wider range of polychrome marbles in significant quantities, including many more examples of the marble types so common in imperially-financed projects at this time, such as giallo antico, portasanta, pavonazzetto, and africano. Of the three structures compared here, it is also the only one in which column shafts in imported marbles were found; in fact, to date, it is the only building in the city that we can be sure employed monolithic shafts in decorative stones. Finally, the *Macellum*, a more utilitarian structure, had a decorative scheme that was correspondingly restrained. The fact that it made use of marble at all, however, is indicative of the level of investment in imported stones at the site generally.

[32] On Puteoli, De Ruyt 1977; on the Lepcis Magna *Macellum* see Bruno, Bianchi 2015, 31-37.

Figure 5: Preserved section of white marble and verde antico flooring in the *frigidarium* of the baths, with Room 10 beyond (Photo: A. Kidd).

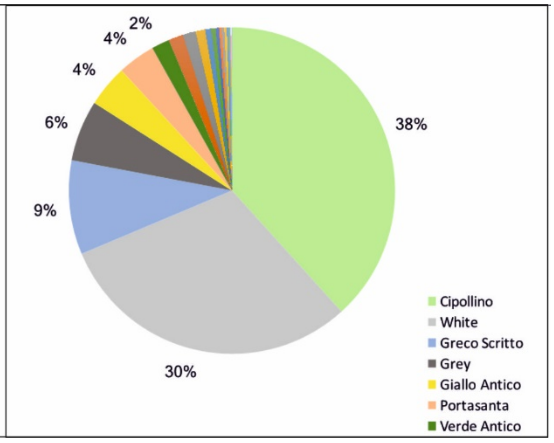

Figure 6: Total percentages of different lithotypes from the three public buildings under investigation (Graph: B. Russell).

While the baths and *Macellum* are 2^{nd} century in date, the use of various imported stones in the Julio-Claudian Theatre demonstrates that the site enjoyed good commercial connections with the coast already in the early 1st century AD. Whether these imports came from ports on the Tyrrhenian coast (i.e. the Bay of Naples) or the Adriatic is not clear but the ceramic evidence from the site strongly indicates that it enjoyed close connections to Campania, despite formally being part of *Regio II Apulia et Calabria* from Augustus onwards[33]. *Aeclanum*'s position on the Via Appia must have facilitated these connections. Indeed, almost all the imported commodities in the city are likely to have arrived by road. Although the river Calore ran through the territory of the *Aeclanum*, its closest accessible point was still 5 km. away from the city and at an elevation 250 m. below it; beyond *Beneventum* the navigability of the Calore also remains unclear. At that city, where the Calore was directly accessible and river traffic more feasible, we do find a wider range of marbles, especially in the form of column shafts: Egyptian granites, in particular, are more common than at *Aeclanum*[34]. Nevertheless, rare materials are found at *Aeclanum*: broccatello (7 pieces) from Spain; porfido nero (3) and granito verde della sedia (1) from Egypt.

In sum, the fact that architects at *Aeclanum* were prepared to import the range of materials that they did, for use both in the revetment schemes and for monolithic column shafts, is testament to the wealth of the city, its commercial connections, facilitated by the Via Appia, and also the architectural pretensions of the elites of the region who ultimately paid for all of this.

[33] A full study of the ceramics by Vincenzo Castaldo is forthcoming.
[34] Lazzarini, Mesisca 2015.

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ON THE PRESENCE OF WHITE AND BLACK GÖKTEPE QUARRY MARBLES AT ROME AND OSTIA

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Abstract

Eighteen white marble quarry blocks, twelve of which had been already published and identified as Carrara marble, have undergone new analyses. Eight of them are confirmed to be true Carrara marble whereas the remaining twelve are Göktepe marble imported from the quarries not far from Aphrodisias in Caria. These results confirm the Carrara/Göktepe confusion that was common in the past and demonstrate, as expected, that the white marble of Göktepe was regularly imported to Rome to supply high quality urban sculptural production. This result and previous archaeometric data sharply contradict recent claims of a purely local or regional relevance for this marble. Similar evidence for the related black variety is less clear and is limited to the Göktepe black marble found by Borromini while excavating the foundations of the Oratorio dei Filippini in Rome and reused for decorating the building.

Keywords: Göktepe, quarry blocks, marble export.

Introduction

Studies carried out after discovery of the white and black marble quarries at Göktepe clearly demonstrate that these marbles were among the most prized varieties used in Roman times for the production of high quality portraits and idealised sculptures[1]. In addition it has emerged[2] that in the past, before the discovery of the quarries, the petrographic and isotopic similarities between Carrara and Göktepe marble commonly led to the identification of most Göktepe artefacts as being of Luna marble from Carrara, while the existence of a new, different marble variety of unknown provenance was only rarely recognized[3].

The marble of Göktepe exhibits a very characteristic and unique pattern of trace impurities that in most instances can be conveniently exploited to obtain a reliable identification. Typical Göktepe trace values include very high Sr and low Mn concentrations that are not paralleled by any other fine-grained marble used in antiquity. The low concentration of Mn is also responsible for the characteristically low EPR intensity of Göktepe marbles. Isotopes, despite the similarities mentioned above, can, actually, be quite diagnostic. Differences with respect to Carrara, though small, are easily recognizable and very characteristic also for the reason that Göktepe artefacts generally exhibit extremely homogeneous values clustered around $\delta^{18}O \sim -2.5$ and $\delta^{13}C \sim 2.9$ ‰ PDB[4]. The consequence, fully confirmed by this study, is that fine-grained white marbles exhibiting isotopes close to the above values almost certainly originate from Göktepe, even if additional analyses are desirable to obtain conclusive proof. Based on the above criteria the number of the white, black and bichrome Göktepe artefacts safely identified has rapidly increased and now

[1] Bruno *et al*. 2015; Attanasio *et al.* 2019a.
[2] Prochaska *et al*. 2018.
[3] Barbin *et al*. 1999.
[4] Attanasio *et al*. 2015.

includes almost 300 portrait and ideal sculptures. Pertinent examples are famous portraits such as the bust of Hadrian *Leitstück* of the type called Stazione Termini (Rome, Palazzo Massimo, inv. 124491) or the statue of Commodus as Heracles (Rome, Musei Capitolini, inv. 1120). Göktepe ideal sculptures include, among many others, the statue of Aphrodite of the Hera Borghese type (Rome, Museo Palatino, inv. 51) and the sculpture of the elder Niobid (Florence, Uffizi, inv. 302). Both are over life size statues, showing that, even if typical Göktepe quarry blocks are generally small- to medium-sized, the quarries, when necessary, could provide large monolithic blocks. The black variety was also popular and prized for sculpture as demonstrated by the old and young Centaurs from the Hadrian's Villa signed by the Aphrodisian sculptors Aristeas and Papias (Rome, Musei Capitolini, inv. 656, 658) or the over life-size statues of Dacian prisoners in the courtyard of the Palazzo dei Conservatori (Rome, Musei Capitolini, inv. 773, 779). The latter demonstrate that in the case of black Göktepe marble, too, huge blocks were still available, though not common.

Analyses carried out on a large number of well-dated artefacts indicate that the marble of Göktepe, already known since the Julio-Claudian period, started to be regularly used at the very beginning of the 2^{nd} century AD in Trajanic times. Soon afterwards, during the reign of Hadrian, it met with exceptional popularity becoming one of the most prized varieties used at Rome for high-quality sculpture. In later times the trend did not change and Göktepe remained among the top sculptural marbles till late antiquity[5].

Figure 1: Sample images of two fragmentary Göktepe blocks tested at Ostia, inv. 54071(**a**) and inv. 54067 (**b**), presently in the repository of quarry marbles in the gardens outside the Museo Archeologico Ostiense. Maximum fragment sizes are ca. 50 cm (Photo: M. Bruno).

Many of the high-quality sculptures mentioned above were undoubtedly manufactured in Rome by renowned metropolitan ateliers, implicitly suggesting that the importation of raw marbles from the Aphrodisian quarries of Göktepe in Caria to Rome took place on a regular basis. So far, unfortunately, clear evidence on this issue has not been reported. Recently, however, we have been able to obtain new data demonstrating the presence at Ostia and Fiumicino of several fragmentary sculptural blocks of white Göktepe marble. In the case of the black variety no similar blocks could be found. Black Göktepe marbles, however, were brought to light by Borromini while excavating the foundations of the Oratorio dei Filippini (mid 17^{th} century) and used for the decoration of the building. His notes, though not fully clear[6], seem to suggest that also in the case of black Göktepe marbles (bigio morato and nero antico) raw quarry blocks were imported.

[5] Attanasio *et al*. 2019a.
[6] Borromini 1725, 75.

Materials and methods

18 marble samples drawn from white marble blocks at Ostia and Fiumicino and one sample of the black marble used by Borromini were analyzed. Experimental analytical procedures and methods for establishing the provenance graphically or using statistical data analysis have been described in detail elsewhere[7]. The probability parameters given in Tab. 1 are defined as follows:

RP (relative or posterior probability): Probability that the sample belongs to some group, within the assumption that it originates from one of the groups in the selection. Low values (<60%) indicate that the sample may belong to different groups.

AP (absolute or typical probability): Distance-dependent parameter measuring the absolute probability that the sample belongs to the chosen group and is a typical representative of its properties. The threshold is 10%, corresponding to samples on the edge of the 90% probability ellipse. Low values indicate outliers or samples not belonging to any group in the selection.

Göktepe and Carrara white marble quarry blocks at Ostia and Fiumicino

Over the years several marble blocks and other quarry items found at Portus and Ostia, mostly coming from the Fossa Traiana, have been reported[8]. Within the present context, especially interesting are 14 quarry blocks mostly found at Ostia in via Redipuglia and published a few years ago in a huge, systematic monograph dealing with the presence and use of marble at Ostia[9].

Using isotopic and petrographic data the blocks were all identified as Carrara marble[10]. However, literature data (Tab. 1, bold values) and newly measured isotopes (Tab. 1, nos. 7 and 9) show that 12 blocks[11] can be split into two groups including 9 and 3 items, respectively. The former group is very homogeneous with values ranging from -2.6 to -3.0 for oxygen and from 2.5 to 2.9 for carbon. The second group is different in the sense that at least one isotopic value is close to 2.0 or lower. Following the above considerations on Carrara and Göktepe isotopes and their diagnostic value it may be suggested that the nine marble blocks of the former group are all good Göktepe candidates (Fig. 2). Attempting to widen the number of tests, six additional fine-grained white marble blocks were analyzed. Five of them are now outside the Museo delle Navi Romane at Fiumicino, whereas the latter (FB) is found together with other quarry blocks in an abandoned field close to the town of Fiumicino[12]. Isotopic data strongly suggests that blocks NR1-NR5 are made of Carrara marble, whereas block FB is again a clear example of Göktepe marble.

It must be stressed, however, that, isotopic analysis used alone without the support of other analytical techniques is often unable to provide unquestionable provenances. In fact, different marble sites frequently exhibit heavy superpositions that make it difficult to draw safe conclusions. Carrara/Göktepe discrimination appears to be especially difficult because similarities are not limited to isotopes, but include also grain size, petrographic properties and the overall macroscopic aspect of the stones.

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[7] Attanasio *et al.* 2015; Prochaska 2013.

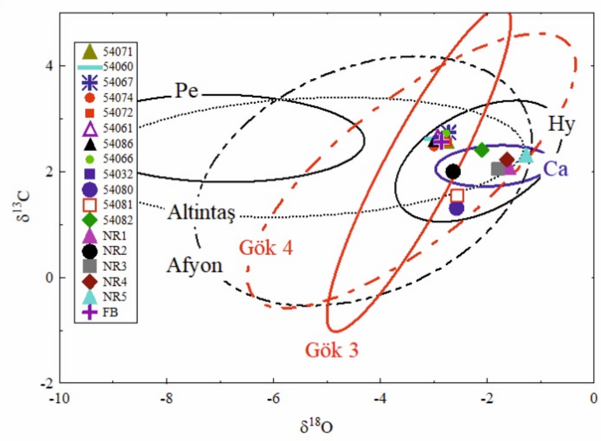
[8] Baccini Leotardi 1979; 1989; Pensabene 2007 and references therein.

[9] Pensabene 2007.

[10] Lazzarini *et al.* 2007.

[11] Two blocks listed in the original paper (Lazzarini *et al.* 2007, tab. 1, blocco no. 7 and tab. 2 inv. 36768) could not be identified. Therefore, only 12 of the original 14 blocks are considered here. On isotopic grounds the two missing blocks are almost certainly made of Carrara marble.

[12] The field is found at the end of via dell'Ippocampo near the school "C. Colombo". GPS coordinates are: 41.777328 Lat N; 12.233607 Lat E. The quarry blocks abandoned there include several different white varieties as well as colored marbles such as cipollino or pavonazzetto.



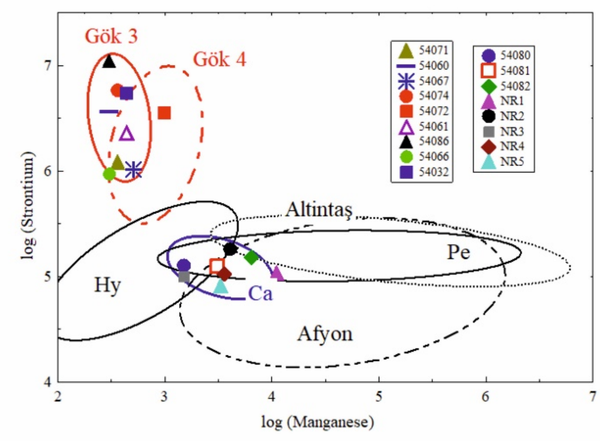


Figure 2: Isotopic values of the 18 white marble blocks tested at Ostia and Fiumicino compared to quarry data for fine-grained white marbles (Graph: D. Attanasio).

Figure 3: Sr and Mn trace data for 17 white marble blocks sampled at Ostia compared to quarry values for fine-grained white marbles (Graph: D. Attanasio).

Therefore, the blocks were re-sampled and complete analyses, including isotopes when necessary, grain size measurements and trace and/or EPR analyses were carried out. The most important newly-measured variables, i.e. trace concentrations and EPR intensities, fully confirm the provenances suggested above using isotopes and grain size. Blocks 1-9 exhibit the high Sr and low Mn values that are typical of Göktepe, whereas blocks 10-12 from via Redipuglia and the newly-tested blocks 13-17 from Fiumicino all show Sr and Mn values that rule out any possible Göktepe provenance and identify the blocks as Carrara. In the case of block no. 18 no trace data could be measured and therefore the corresponding data point is not present in the graph of Fig. 3.

Nonetheless Göktepe provenance is reliably demonstrated for this block by simultaneous exploitation of EPR, isotopic and grain size data, as indicated by the probabilities listed in Tab. 1.

No	Inventory or label	MGS (mm)	δ^{18}O (‰)	δ^{13}C (‰)	EPR intensity (%)	EPR linewidth (%)	Sr (ppm)	Mn[13] (ppm)	Fe (ppm)	Marble	Rel./abs. probabilities (%)
1	54071	0.7	-2.74	2.57	5.3	49.8	434	5	74	Göktepe 3	86 / 40
2	54060	0.55	-2.94	2.62	2.0	46.4	706	4	80	Göktepe 3	100 / 65
3	54067	0.5	-2.72	2.73	3.0	55.7	409	7	76	Göktepe 3	100 / 35
4	54074	0.6	-2.99	2.47	3.7	56.7	860	5	91	Göktepe 3	100 / 95
5	54072	0.6	-2.56	2.73	19.8	44.6	697	12	49	Göktepe 4	100 / 85
6	54061	0.55	-2.66	2.92	2.6	40.1	578	6	62	Göktepe 4	93 / 20
7	54086	0.9	-2.99	2.58	2.3	44.6	1136	4	59	Göktepe 3	100 /15
8	54066	0.7	-2.76	2.72	3.1	55.1	393	4	68	Göktepe 3	100 / 42
9	54032	0.55	-2.91	2.58	3.9	46.1	844	6	67	Göktepe 3	83 / 30
10	54080	0.55	-2.57	1.31	38.1	52.6	164	16	164	Carrara	70 / 45
11	54081	0.45	-2.55	1.54	33.2	56.5	162	25	98	Carrara	85 / 45
12	54082	0.5	-2.09	2.41	52.1	55.7	178	37	81	Carrara	86 / 40
13	NR1	0.6	-1.59	2.07	-	-	152	49	192	Carrara	92 / 95
14	NR2	0.5	-2.64	1.99	-	-	191	29	285	Carrara	81 / 98
15	NR3	0.8	-1.79	2.04	-	-	147	16	131	Carrara	55 / 99
16	NR4	0.7	-1.63	2.22	-	-	151	27	62	Carrara	80 /100
17	NR5	0.5	-1.27	2.30	-	-	135	26	110	Carrara	79 / 98
18	FB	0.4	-2.85	2.55	3.2	57.7	-	-	-	Göktepe 3	100 / 99
19	Oratorio	0.1	-4.08	1.14	2.4	51.8	-	-	-	Göktepe 1/2	98 / 75

Table 1: Analytical data for 19 samples taken from 18 white marble blocks at Ostia and Fiumicino and one black sample from the marble decoration of the Oratorio dei Filippini built in Rome by Francesco Borromini in the mid 17th century. Isotopic data in bold are excerpted from Lazzarini *et al*. 2007.

[13] Mn concentration values have been corrected for the blank contribution (8 ppm). See Attanasio *et al.* 2019b.

To conclude, it is important to stress that the Göktepe items that were tested are mostly fragments[14]. Some of them may have belonged to the same block, thus reducing the total number of blocks that have been identified. At this stage, unfortunately, there are no clear analytical indications on this issue and the strong similarity of isotopic data, though striking, cannot be used to infer a number of blocks smaller than the ten fragments that were tested. Tight homogeneity of isotopic data, in fact, is a characteristic and almost always valid property of Göktepe quarry or artefact marbles[15]. It is precisely such homogeneity that in most instances makes possible safe isotopic discrimination between Göktepe and Carrara. Isotopic data, therefore, cannot be used to argue that the number of individual Göktepe blocks identified at Ostia and Fiumicino is smaller than the number of fragments that were analyzed. Beside, such a conclusion would also be contradicted by the variable values exhibited by trace and EPR data.

On the possible presence of black Göktepe quarry marbles at Rome

In comparison with the approximately 230 Göktepe white marble sculptures identified so far in Rome, the number of black Göktepe artefacts is much smaller and does not exceed 40 units. They mostly comprise ideal sculptures and a few architectural elements, whereas the white sculptures are predominantly portraits. On a quantitative or qualitative basis, therefore, there are no compelling reasons to believe that black Göktepe quarry marbles were imported regularly to Rome in a manner similar to the white variety[16]. Of course, intricately carved and fragile sculptures such as the black Centaurs of Hadrian's Villa could not be transported as finished artefacts. It is possible, however, that these and other black items were imported as roughly-outlined pieces to be completed in Rome by Aphrodisian sculptors perhaps connected with the workshops in Aphrodisias.

The importation, in fact, may have taken place only sporadically as a minor collateral aspect of the import of white Göktepe quarry marbles. As a matter of fact, no black Göktepe block or fragment thereof, has been so far identified in Rome. The only possible evidence of black marble import is provided by the observation that this stone was used by Borromini to decorate the monumental door leading to the main Oratorio room in the Oratorio dei Filippini (Fig. 5). Based on the presence of characteristic, yellowish, cross-shaped calcitic inclusions, the use of Göktepe marble was first suggested on macroscopic grounds and then confirmed analytically as shown by the data reported in Tab. 1 and the graphs of Fig. 6.

In his *Opus Architectonicum* Borromini writes[17] that large amounts of the black stone, that he calls "pietra di paragone", were found while excavating the foundations of the building and that he immediately decided to use this material for the jambs of the door. Unfortunately, he does not specify whether raw quarry marbles or worked artefacts were found. It may be argued, however, that valuable architectural pieces such as columns or similar would have been mentioned explicitly by Borromini and used as such rather than cut into pieces and re-used. Therefore, the hypothesis that he found black Göktepe quarry marbles can be reasonably put forward. It is also worth noting that the find spot of the marbles is in the area of Campus

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[14] The only probably exception is fragment no. 18, which because of its size and shape appears to be a single, individual block of marble.

[15] On this issue see Attanasio *et al.* 2015, 16, 21, where the isotopic distribution of white Göktepe quarry marbles and the characteristic presence of "core" and "tail" samples is discussed in some detail.

[16] The total number of black artefacts is, in fact, relatively limited and they do not include portraits of emperors or members of the Roman elite that, under normal circumstances, would have been necessarily made in Rome where the portrayed personages lived.

[17] Borromini 1725, 75: "…et è ornata di pietra di paragone..., havendo a questo punto sotto di essa nel cavare i fondamenti fatto ritrovare la provvidenza Divina quantità grande di detta pietra…" ("…and is decorated with touchstone….that right in this spot Divine Providence directed us to find while excavating the foundations….".

Martius where several marble yards and ateliers existed in antiquity[18]. The conclusion is therefore that Borromini probably found raw black Göktepe quarry marbles stockpiled in the yard of one of the many workshops present in the area. Such marbles may represent a rare example of the occasional import of black marbles to Rome suggested above.

Figure 4: View of the Oratorio dei Filippini (piazza della Chiesa Nuova, Rome) built by Francesco Borromini between 1637 and 1667 on the right side of Santa Maria in Vallicella (Chiesa Nuova) mother Church of the congregation (Photo: D. Attanasio).

Figure 5: The large door leading to the main Oratorio room with a detail of the yellowish inclusions visible in various parts of the Göktepe black marble jambs (Photo: D. Attanasio).

Briefly commenting on provenance results and the graphs of Fig. 6, it may be stressed that in the case of black Göktepe marbles isotopic data are of little help[19]. As opposed to the white variety, in fact, they exhibit wide variability giving rise to a broad ellipse heavily superposed to many other isotopic fields. However, simultaneous use of different analytical methods, including not only isotopes but also trace data, EPR spectroscopy and grain size information, in this case permits clear discrimination and reliable identification of the Oratorio marble as Göktepe nero antico as shown by the graph of Fig. 6[20].

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[18] Maischberger 1999.

[19] Besides Göktepe other marble sources taken into account are Ain el Ksir, Thala, Jebel Aziz and Jebel Oust in Tunisia, Mountanistika and Vytina in the Peloponnesos, and the so-called nero di Colonnata a fine-grained black limestone present at Carrara, particularly in the district of Colonnata. Other black Roman stones are coarser in grain (bigio antico) and cannot be confused with the marbles discussed here.

[20] For more details on our approach to black stone identification and provenance see Attanasio *et al.* 2015; 2017.

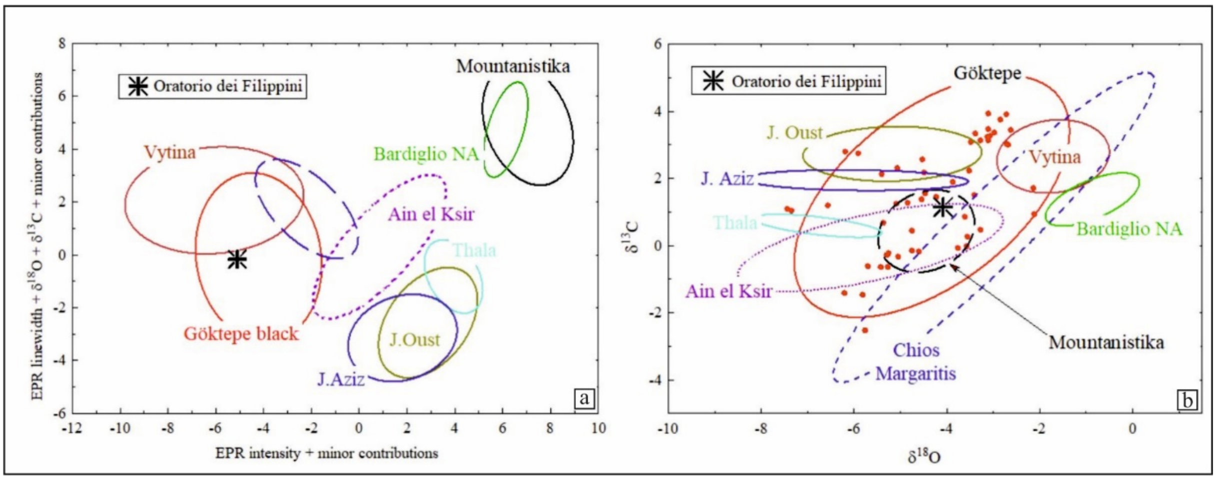

Figure 6: Isotopic (**a**) and statistical (**b**) graphs comparing the Oratorio dei Filippini black sample with the most important fine-grained black marbles, nero antico or bigio morato, used in Roman times (Graphs: D. Attanasio).

Conclusions

Congruent with the many Göktepe white marble sculptures identified at Rome, most of which were probably produced locally by renowned urban ateliers, this work provides unquestionable evidence of the presence in the marble yards of the capital of raw quarry blocks imported from Göktepe to support urban statuary production. Something similar probably happened also in the case of the black Göktepe marble. In this case, however, conclusive evidence is still lacking and it may be suggested that the import was much smaller in scale and probably sporadic.

Compared to the number and size of quarry blocks imported from other famous sites such as Carrara, Paros and Mt. Penteli that still survive, the total amount of white Göktepe raw marbles that has been identified is smaller and includes mostly small fragments of blocks. Considering that the presence and distribution of known quarry marbles is not expected to change substantially in the future it would be interesting to understand the reasons for such a limited presence of Göktepe quarry marbles. A tempting, though purely tentative explanation is simply the possibility that this variety was so highly valued and sought after that it was used until it was almost completely exhausted.

Whatever is the case, identification at Rome of imported Göktepe marbles satisfactorily completes the picture of the history and use of this precious stone that, quarried in Asia Minor near Aphrodisias, found limited local use[21] and was mostly exported to Rome to be used by famous urban ateliers to portray emperors and members of the roman elite.

These results are especially important now that new studies seem to challenge previous conclusions on the exceptional importance, wide circulation and high appreciation of the marble of Göktepe. A recent paper[22] publishes analytical data, particularly strontium trace data, that have been shown to be erroneous[23]. If included in the marble database this data would greatly worsen the discrimination of fine-grained white marbles, hampering the correct identification of Göktepe white artefacts. Another study, besides criticizing our analytical and statistical approach, claims that the site was too small for the many Göktepe sculptures identified so far[24]. According to this paper, the quarries had mostly local to regional relevance

[21] A study carried out at Aphrodisias on 93 artefacts, predominantly sculptural, Attanasio *et al.* 2014, demonstrates that the share of Göktepe marble is approximately 25%.
[22] Brilli *et al.* 2018.
[23] Attanasio *et al*. 2019b; Brilli *et al*. 2019.
[24] Wielgosz-Rondolino *et al.*, 2019.

and it was only rarely their marbles might have reached other provinces or Rome. The main argument is the result of volumetric measurements that, however, cannot take into account the unknown depth of the quarries or the original height and profile of the terrain. In any case, even ignoring these aspects, the relatively small volume calculated by Wielgosz-Rondolino et al. in order to downplay the eminent importance of the Göktepe quarries is more than enough for thousands of sculptures, most of which still await discovery. Three already-published artefacts from the Hadrian's villa were re-examined and confirmed the provenance already reported. No other attempt to question the multitude of Göktepe published data using new analyses or re-interpreting known results was made. As a matter of fact, now that the Göktepe quarries are widely known and methods for identifying their marbles are well established, sculptures made using this marble continue to be regularly discovered at Rome and elsewhere[25].

The data reported here add a new piece to the overall picture and demonstrate, as expected, that the white marbles of Göktepe were regularly brought to Rome to supply the production of high quality ideal and portrait sculpture. There is no doubt that in the future new data collected using already-established analytical procedures or new methods, that still need to be validated, will confirm the existing picture, providing new insights into the use and circulation of Göktepe marbles.

[25] Lapuente *et al*. 2012; Attanasio *et al*. 2019a; Brilli, Savin 2019.

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ON THE NOMENCLATURE OF THE GRECO SCRITTO MARBLE: *SCRIPTA CURSIVA VS. SCRIPTA MONUMENTA*

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For Khufu Scipione

Abstract

This paper concerns the distinctive physical appearance of the marble called greco scritto and the metaphoric reference made to writing and the appearance of scripted text in its very name. Few marbles carry such names. According to the website for the Corsi Collection of Decorative Stones at Oxford, the name was that used by the scalpellini, or stone cutters themselves. The coloration of the marble may be described as black-on-white, which as the Corsi website further states, "alludes to the almost black markings looking like Greek letters, although at other orientations they are seen to be joined." These variations in patterning and orientation of the marble are of special interest and deserve greater examination in reference to the name, because the joined letterform is the necessary feature defining any script as cursive ("scritto"). The opposite of scripta *cursiva* is *scripta monumenta* or *scripta quadrata*, the legibility of which is more secured.

Keywords: Greco scritto marble, nomenclature, internalized inscription.

Introduction

The subject of the nomenclature of the black-on-white greco scritto marble requires going back to the origins of a very arresting name, surely one of the most unusual in marble studies[1]. For an epigraphist or calligrapher, the name is provocative because it essentially describes what will be termed here an "internalized inscription", occurring naturally within the marble matrix (Fig. 1).

An internalized inscription evokes something quite different from an inscription produced by human labor on the surface of the stone, which then acts as a carrier for the text, whether carved, painted, or three-dimensionally fixed. The search for meaning starts with Faustino Corsi's "Catalogo ragionato d'una collezione di pietre di decorazione", the first of its kind, published in Rome in 1825 with an 1827 supplement, now available on the University of Oxford website for the Corsi Collection of Decorative Stones, launched in 2012[2]. Corsi, who was a Roman lawyer much interested in ancient marbles and their provenance, not only gave descriptions of all 1,000 of the marble tablets in his collection, but also as the website states, "correlated names used by Roman marble workers [scalpellini] with those used by ancient and contemporary authors in this carefully-referenced work. He also pioneered the geological classification of decorative stone collections, and cited exceptional examples of stones to be seen in the churches and monuments of Rome"[3]. Scalpellini are further defined as

[1] I am grateful to ASMOSIA XII for their organization of this conference in proximity to Ephesos, especially A. Bahadir Yavuz, who was one of many present at Izmir who had dealt with greco scritto and the Ephesos database of marbles. Their shared expertise is acknowledged.

[2] University Of Oxford 2012: Corsi Collection of Decorative Stones, www.oum.ox.ac.uk/corsi/credits, accessed 5 May 2020.

[3] University Of Oxford 2012: "Homepage" of the Corsi Collection of Decorative Stones, www.oum.ox.ac.uk/corsi, accessed 5 May 2020.

"the marble cutters of contemporary Rome"[4]. In searching this database, three samples are shown with the designation greco scritto (Nos. 99, 100, and 912). Nos. 99 and 100 are considered definitive in provenance: from the Algerian site of Cap de Garde, the quarries of which have long been considered the locus for this stone; the third is not as definite and the color dominance is essentially reversed. But no sample, it turns out, was so labeled greco scritto by Corsi himself. The most diagnostic of the three is No. 99, but Corsi in his catalogue entry 46.12 for the sample called it marmo cipollino or *marmor carystium*. For the actual attribution of the name, therefore, we need to go to a slightly later source, the 1842 catalogue published by the Italian Francesco Belli of Rome[5], also a lawyer and collector and who with his brother Tommaso assembled at least two early marble collections[6]. Belli's interest in marble and mineralogy was pervasive, and there are in fact multiple collections and publications associated with him, including the collection at Bari, the subject of the multi-faceted contribution already cited, by R. Conte *et al* in ASMOSIA X[7]. The seminal study by D. Attanasio, A. B. Yavuz, M. Bruno, J. J. Herrmann Jr., R. H. Tykot, and A. van den Hoek, "On the Ephesian Origin of the greco scritto Marble" in ASMOSIA IX, credits Belli in Entry 17, no. 86 of his 1842 catalogue with bestowing the name[8]; but the scalpellini, it must be assumed, had already made it quotidian. It is worth recalling that "scalpellare" means "to chisel", as in sculpture, or to cut away stone with the chisel, as in the cutting of inscriptions; and in this case, it gives the person manipulating or working the stone a distinct authority for the important act of naming. A third 19th century source that deals with nomenclature is the "Handbook of Ancient Roman Marbles" by H. W. Pullen, who wrote of these matters for the first time in English in 1894[9]. Pullen puts marmo greco under black or grey marbles with five sub-categories: greco brecciato scuro with "mottled and clouded grey" coloration; greco dislocuto featuring "parallel lines of grey, interrupted and turned out of their course"; greco scritto which he identifies as being a yellowish - or greenish-white marble, "suffused with grey and scrawled with marks like letters"; greco scritto confuso where the so-called letters are "indistinct"; and greco venato with very fine and parallel lines of gray, "occasionally zigzag"[10]. Pullen's breakdown of what the "script" really looks like in the marble matrix is important because of the descriptive variation he introduces. The coloration of the greco scritto marble may simply be described as black-on-white or even the reverse as with Corsi's No. 912 sample[11], but even in the same sample, the configuration may seem more "joined" or more "disjointed" depending on which surface is exposed. These variations in patterning and orientation of the marble are normal but of special interest and deserve greater examination in reference to the name, because the "joined letterform" is the necessary feature defining any script as cursive (Fig. 1). The opposite of *scripta cursiva* is *scripta monumenta* or *scripta quadrata*. These terms should all have been familiar to the stonecutters who influenced the naming of the greco scritto marble because they were working in the Roman tradition.

[4] University Of Oxford, "Corsi's catalogo" of the Corsi Collection of Decorative Stones, www.oum.ox.ac.uk/corsi/catalogue/home, accessed 5 May 2020.

[5] Conte *et al*. 2015, 501.

[6] Pullen 1894, 7-8.

[7] Conte *et al*. 2015, 485-502.

[8] Attanasio *et al*. 2012, 245.

[9] Pullen 1894, 6, where Pullen also states that Corsi was "half a century" ahead of him, with the first such work ever published in Italian. It was, in fact, 69 years.

[10] Pullen 1894, 46-47.

[11] University Of Oxford, Corsi Collection of Decorative Stones, www.oum.ox.ac.uk/corsi/stones, accessed 5 May 2020.

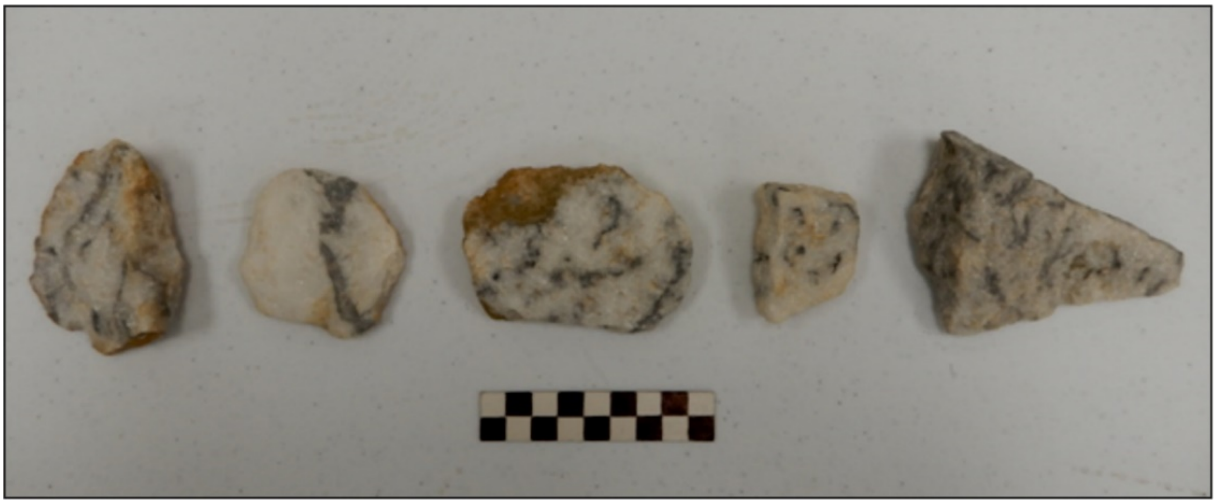

Figure 1: Samples of greco scritto marble from the Ephesos Hasançavuslar quarries (Photo: P.A. Butz).

There is with the greco scritto marble an important differentiation involving nomenclature: the qualitative implications of the name versus the scientific analysis. Similarly, parian marble long carried superlative connotations attached to its name, but scientific analysis of the various quarries on Paros mitigated them. The Hekatompedon Inscription, for example, was once called parian for qualitative, aesthetic reasons; scientific analysis proved the marble to be Hymmetian, yet the inscription should lose nothing in its aesthetic value[12]. The ASMOSIA IX article on greco scritto cautions, “Since a clear nomenclature that can characterize the lithotype and its macroscopic appearance exactly and univocally is crucial in marble studies, the possible misapplication of the term greco scritto should be carefully considered when attempting to provenance marble artifacts”[13]. “When attempting to provenance” is a critical phrase. The scientific conclusion that was reached by the authors is as follows: what should be considered the true greco scritto profile is safely from the Hasançavuslar quarries at Ephesos, not the Cap de Garde quarries near ancient Hippo Regius as was formerly believed[14]; yet, as stated above, the Algerian site is still promulgated on the Corsi Collection website for all three of its samples.

We are justified, however, in pursuing the qualitative definition of greco scritto because the name is qualitative, even metaphorical, and the issues of nomenclature must start here. How would the Roman “scalpellini” have assessed the markings that so distinguish it? To begin with, as the name indicates, they called it “Greek script”, not “Latin script”. *Scripta monumenta* normally alludes to imperial Roman lettering, interchangeable with the notion of a quadrate, upright, and squared Roman letterform. *Quadrata* letterforms were built with serifs, thanks to the use of the chisel-edged brush for their underpainting. The theory was demonstrated thoroughly by E. Catich in his 1968 study, “The Origin of the Serif”, published by the Catich Gallery at St. Ambrose University. In a series of magnificent double spreads for each letter of the Roman alphabet, Catich first demonstrates on the left of the double spread (in olive green) the rendering of the individual underpaintings with their serifs made possible using the chisel-edged brush as tool, followed on the right (in terracotta orange) by the finished product as the Roman letter cutter would have achieved it using the flat chisel. Catich further translates the imperial Roman letterform into a contemporary artwork of his own: an exemplar showing the entire Roman alphabet in gilded lettering, a technique in which he was a specialist, with the serifs highly regularized[15]. The serifs are allowed to create joins along

[12] Butz 1995, 65-72, Butz 1999, 255-260.
[13] Attanasio *et al*. 2012, 245.
[14] Attanasio *et al*. 2012, 253-254.
[15] Catich 1968, rev. ed. 1991, 160, Fig. 162.

the baselines of the exemplar, true to imperial examples such as the Trajan Inscription itself. But such joins do not compromise the definition of *scripta cursiva*, the exact opposite of *quadrata* in that the curvature of the cursive letterform may very likely change the axis, obviating the upright requirement. The ancillary term for *scripta cursiva* is *scripta actuaria*, meaning that the script moves. Indeed, the movement it creates is easy, swift, and forward-driven, qualities handwriting can share. Catich shows how the tool to produce such writing is no longer the chisel-edged brush paired with the flat chisel for formal lapidary cutting; rather it is the stylus, ideally at home on a wax tablet, whose equivalent is the pointed brush or pointed chisel for work on a hard surface, maintaining immediacy of the movement while simultaneously striving for greater permanency[16]. The script we call Roman rustica takes on the characteristics of both, as shown in the famous displays of chisel-edged brush lettering from Pompeii, such as the example seen in the House of *Aulus Trebius Valens* advertising candidates seeking voter support[17]. Although this script clearly reads as upright, Catich calls it *scriptura actuaria*. The letters average some 2 feet in height and they compress and expand. The relationship of these forms of writing to each other is further shown in the chart Catich devises for their development from antiquity to the Middle Ages[18], and it is important to see how he places the cursive script in the center of the chart, its influence disseminating outwards from the prime position surprisingly not occupied by the lapidary capitals, which one might expect to constitute the backbone of the heritage of Roman lettering and hence the Western tradition itself.

As a consequence of this discussion, the question that we are obliged to ask is the following: Is the “Greek” in greco scritto, on some level, pejorative? Considering Pullen’s extended subcategories and the variety of added descriptors such as “brecchiato scuro”, which essentially qualifies the purity of the stone by calling it a mottled or clouded; other modifiers such as “dislocutio” and “confuso”, which are self-explanatory and negative in force; even “venato” used for the veined appearance of the marble as opposed to a preferred parallelism present in some banding — the answer must be yes. Perhaps the most extreme of these is the descriptor “confuso”; related to it is “unintelligible”. The ASMOSIA IX article opens with the following explanation: “greco scritto is a medium to coarse, white to gray marble bearing numerous thin, convoluted dark veins, which are in some way reminiscent of unintelligible writing...”[19] Again, in the concluding paragraph, the assessment is repeated: “...a marble identified by the presence of dark marks resembling unintelligible writing”[20]. Instead of the highly subjective “unintelligible” or “confused,” I suggest a different set of descriptors for the marks constituting the writing: “abstracted” or even “segmented”, “dotted”, or “abbreviated”, all reinforcing the idea of an internalized inscription that is embedded in and part of the marble matrix itself and hence necessarily occurring in segments (Figs. 2, 3, 4).

A strong comparison from the tradition of Greek ceramics comes to mind: the white-ground *lekythoi* of the Early Classical and Classical periods, specifically the work of the artist known as the Inscription Painter[21]. The white-ground *lekythos* is a form of pottery associated with burials, often given as an offering to the dead and itself depicting funerary subject matter. One of the Inscription Painter’s most important vases, indeed his “name vase”, depicts a large funerary stele crowned by another vase, a kantharos, and this central composition flanked by two women[22]. The stele is “inscribed” and bears five lines of abstracted text, each consisting of repeated dots or very short strokes. The arrangement of

[16] Catich 1968, rev. ed. 1991, 144-145, Figs. 148-151.
[17] Catich 1968, rev. ed., 1991, 156, Fig. 160.
[18] Catich 1968, rev. ed. 1991, 157, Fig. 161.
[19] Attanasio *et al.* 2012, 245.
[20] Attanasio *et al.* 2012, 254.
[21] Boardman 1989, 130-131.
[22] Boardman 1989, 135, fig. 257.

the dots is very regular, running nine dots for lines 1 and 2, and eight dots for lines 3, 4, and 5. The alignment is such that it qualifies as rectified *stoikhedon* in format[23], the five lines of dots being almost perfectly aligned on the vertical, giving the whole sequence added validation as to its epigraphic purpose despite the fact that the dotting is not recognizably alphabetic; this, in any case, is no "nonsense inscription". The treatment of the Inscription Painter contrasts with the work of the Achilles Painter, who famously uses very legible alphabetic inscription on a minute scale, although never a signature[24]. He, in fact, favors a three-line *kalos* inscription in rectified *stoikhedon* for his *lekythoi*, and his inscriptions are formal, upright and monoline in the established tradition of Greek vase painting[25]. In the case of both artists using *stoikhedon*, there is a shared concept that letterforms function as segmented, repetitious ornament, which I believe is at the heart of the nomenclature of the greco scritto marble as well. The best examples of "true" greco scritto, as the ASMOSIA IX article puts it, are distinctly ornamental in this sense[26].

Figure 2: Detail of greco scritto sample with the hidden letterform "phi" (Photo: P.A. Butz).

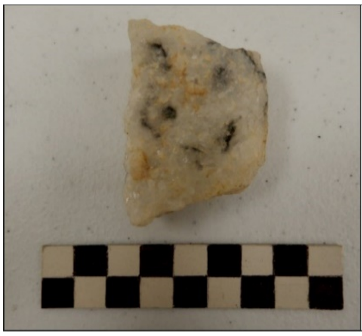

Figure 3: Detail of greco scritto sample with "dotted theta" and other abbreviated forms (Photo: P.A. Butz).

Figure 4: Detail of greco scritto sample with "lunate sigma" and other segmented forms (Photo: P.A. Butz).

A relevant monument that does not have a definitive marble provenance[27] but visually suggests greco scritto marble, is well worth mentioning in this context of ornament. Dating to the second century BC, the Arkhelaos Relief arguably depicts Ptolemy IV and Arsinoe III

[23] Butz 2010.

[24] Boardman 1989, 132. Boardman refers to the Achilles Painter as "the paragon" of High Classical vase painting, whether red-figure or white-ground.

[25] Boardman 1989, 135-137, figs. 261-266, especially fig. 261.

[26] Attanasio *et al.* 2012, 245. The purpose of the ASMOSIA IX article, of course, is to clarify the scientific identification of the marble, shedding light on the Hasançcavuslar quarry at Ephesos as the "true" source, despite similarities from Cap de Garde and other locations.

[27] Higgs 2016, 137, for the default designation "Marble, H. 475/8 in. (121 cm)".

crowning Homer into divinity and hence reflects the influence of the Alexandria literati[28]. So named for the signature of the artist Arkhelaos of Priene, the relief is also known as the Apotheosis of Homer, who is seated on the bottom register. The even, vertical gray veining of the marble, like lines of text, is striking and fits with the subject matter, serving to connect the four registers of the relief and routing the passage of Homer's influence through all levels of literary inspiration and personifications to the top, where Zeus is likewise crowned in eternal memory. There is dotting along with veining in certain areas, particularly along the baseline. My suggestion is that the subliminal implications of embedded writing and internalized inscription so reflected in the name greco scritto, including its banded variants, its mistaken attributions, and its conscious simulations, might well have been recognized by the literati in antiquity as much as the contemporary "scalpellini" and deliberately used for a composition like this. Found in Italy, allegedly at Bovillae in the seventeenth century, it is interesting to consider the use proposed by Peter Higgs: "The panel may have been part of a larger monument, celebrating a host of victorious poets whose brilliant works shone through at one of the many well-established and more recent festivals of drama in old and new Greek cities alike"[29]. We could even imagine such a display including a variety of specialty marbles for the subject matter associated with the various poets. The Arkhelaos Relief is one major artwork that deserves precise marble analysis simply for the insight it could offer on meaning and intent in the choice of marble in antiquity for such a "poem in stone"[30].

The format of the Arkhelaos Relief is highly architectural, from the curtained skene on the first register and upwards through the fantastic mix of architecture and landscape to the reclining figure of Zeus on Mt. Olympus. greco scritto marble was used for architecture, especially at Ephesos, as delineated thoroughly in the ASMOSIA IX article (Fig. 5).

Figure 5: View of greco scritto columns on site at Ephesos. ASMOSIA XII, October 2018 (Photo: P.A. Butz).

From Ephesos, 11 artifacts were sampled, 7 of which were identified as "true" and 4 of the "veined variety" of the marble, all coming from the local Hasançavascular quarries with only one exception[31]. Furthermore, all 11 were architectural: 10 columns and 1 cornice. A list of 58 samples, which includes the Ephesos group together with contributions from North African sites, especially Leptis Magna, as well as Ostia and Rome, confirms that the architectural use of this marble outweighs any other[32]. At Ephesos, the use of the marble in the terrace houses is also noted, and it prompts inquiry into the importation of greco scritto at other sites with important house architecture, like Delos. ID 1802 (Delos E 775), one of the

[28] Butz 2017, http://www.getty.edu/publications/artistryinbronze/.
[29] Higgs 2016, 137.
[30] Higgs 2016, 137.
[31] Attanasio *et al.* 2012, 253.
[32] Attanasio *et al.* 2012, 252-252, tab. 2.

bilingual Greek and Latin inscriptions that is part of my projected bilingual corpus, comes from a house context and would have functioned as a sculptural centerpiece in one of the rooms. It displays a muted coloration of white and gray streaked marble in the preserved base, clearly not greco scritto, but the question of decorative marbles and their systematic use in Delian houses needs much more study. The bilingual architraves of the Agora of the Italians, the largest structure on the island and ultimately left unfinished, exhibit a mixture of marble colorations, many blocks of which have distinctive gray banding. The marble monument of Munatius Plancus occupying one of the eastern niches has significant variations in all of its parts: ID 1695, 1696, and 1697 (Delos E 95, 78, and 96). Notably, the banded statue base is signed by Agasias of Ephesos, who is also credited for the Fallen Warrior or Gaul on the north side of the Agora and whose signature appears on one of the bases (ID 1699, Delos E 93 and 94). Returning to the Plancus Monument, on a very white marble revetment in the second level of the niche is the inscription crediting Aristandros of Paros, son of Skopas, with the restoration, which would have followed the sack of the island by Mithradrates in 88 BC. While marble studies have been done on the Delian quarries, it would be well worth investigating this "potpourri" in the Agora of the Italians and, most of all, the houses for which Delos is so well known for any use of "true" greco scritto marble comparable to Ephesos. At the very least, the light and dark aesthetic generally associated with greco scritto marble is abundantly present on Delos.

In conclusion, greco scritto may be called an epigrapher's marble because of the appearance of embedded writing and internalized inscription in the matrix. If one were to think of a parallel across artistic media, a mosaic composed in *opus vermiculatum* would do very well: segments of tesserae, sometimes straight, sometimes twisting and turning, all set in a common compositional matrix. My argument is that the greco scritto marble deserves special attention for this phenomenon; and its qualitative nomenclature, part of its historiographic identity as much as any of the valuable scientific analyses, needs to be taken into account. The two major sites that now have been associated with the production of the marble, Hasançavuslar at Ephesos and Cap de Garde in Algeria, the former by rigorous scientific proof, the latter, as it turns out, by exactly the opposite--largely qualitative application of the nomenclature--both need to be acknowledged in some official language of our profession. The statement put forward at the end of the ASMOSIA IX article, "All the data presently available, however, strongly support the single provenance hypothesis [that is, Ephesos, Hasançavuslar quarries] and suggest that the name greco scritto should not be extended to related veined varieties"[33] is extremely valuable. But when one looks at the isotopic data in the charts backing the study, it is remarkable how, although there is no overlap to speak of between the two sites, they rest perfectly side by side and both produce the visually distinct dotted variety and the veined variety. Would it be possible to apply a four-way system that designates the Ephesos Hasançavuslar quarries as "greco scritto A" (quantitative and qualitative) and the Cap de Garde quarries as "greco scritto B" (qualitative alone), each with a subset for dotted and banded? "greco scritto C" (qualitative) would likewise be those additional North African quarries already identified or tentatively identified and discussed in the ASMOSIA IX article as producing comparable specimens. "greco scritto D" is the "rogue" category that simulates the marble in question, its use seemingly deliberate for effect and too far removed from the principle signatures for scientific consideration of any kind. Nevertheless, it acknowledges and accommodates Corsi's initial identification of cippolino for what turns out to be "greco scritto B", Cap de Garde Banded, under the new typology proposed here.

[33] Attanasio *et al.*, 2012, 254.

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NEW DATA ON THE PHRYGIAN STATUES FROM THE BASILICA AEMILIA IN THE ROMAN FORUM

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Abstract

The survey of the marble fragments of the Oriental statues from the Basilica Aemilia in the Roman Forum offered an opportunity to re-examine the materials held by the Parco archeologico del Colosseo. We studied the *disiecta membra* of the bodies in pavonazzetto and giallo antico marble, and the nude parts made of white marble that complete the sculptures, such as the finely-crafted heads with traces of pigment and a few hands. Archaeometric analyses of the white marbles reveal the use of parian marble (Lychnites variety) for the heads and hands, and of pentelic marble for the plinths. The hundreds of fragments examined turned out to be of special interest for the study of the posture and garments of the statues. This allowed us to propose a virtual reconstruction model of the statues belonging to the architectural decorations of the Augustan period Basilica.

Keywords: Sculpture, Oriental statues, archaeometric analyses, virtual reconstruction.

Introduction

The Basilica Aemilia is located along the north side of the Roman Forum, within the present-day Colosseum Archaeological Park (Parco archeologico del Colosseo)[1].
The best-documented phase of the building dates to its reconstruction after the fire of 14 BC, to which most of the surviving structures and architectural decorations belong[2].

An idea of the original splendour of the Augustan renovations is provided by Pliny the Elder, who included the Basilica among the wonders of Rome, together with the Forum of Augustus and the Temple of Peace. Specifically, the building stood out for the presence of *columnis et* (or *e) Phrygibus*, interpreted by many scholars as a reference to the phrygian statues[3].

As is known, a key feature of the Augustan figurative programme was the monumental statues of Orientals, in the coloured marbles pavonazzetto and giallo antico, most of which currently survive only in a fragmentary state due to the transformations and spoliations suffered by the building from late antiquity onwards.

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[1] We wish to thank Dr. Alfonsina Russo, Director of the Parco archeologico del Colosseo and Dr. Patrizia Fortini, responsible for the Roman Forum area and Scientific Director of the Forum Museum (the former "Antiquarium forense") currently in the planning stage, for supporting this study and publication.

[2] For previous studies and references to the Basilica Aemilia, see Bauer 1993 a and b.

[3] "*non inter magnifica basilicam Pauli columnis e Phrygibus mirabilem forumque divi Augusti et templum Pacis Vespasiani Imp. Aug., pulcherrima operum, quae umquam vidit orbis?*" Pliny, NH, XXXVI, 10*2* (Gaio Plinio Secondo Storia Naturale, V, Mineralogia e storia dell'arte, Libri 33-37, Torino 1988, p.658). On the two different readings *columnis e Phrygibus* and *columnis et Phrygibus*, and the interpretations of Pliny's text, see Schneider 1986, 120-125 and more recently Schneider 2016, 417-418.

Brief summary of previous studies

The study and reassembly of the statues began immediately after the discovery of the fragments in the early 20th century under the direction of Giacomo Boni[4], as attested by both period photographs and archive documents.–In later years, the work was continued by Bartoli[5], Romanelli, Carettoni[6] and in particular by Fabbrini, who devoted several years to the study of these finds, which remained largely unpublished[7]. Finally, the statues were first exhibited in the area of the Basilica and later in the Forum Antiquarium.

The Deutsches Archäologisches Institut in Rome, together with the more recent studies on the archaeological finds conducted by Schneider[8], Bauer[9], Ertel-Freyberger[10], Lipps[11] and, above all, the work of Bitterer[12], made it possible to undertake a more thorough examination of the sculptures and to formulate hypotheses on their original placement.

According to Bauer[13], the Orientals were placed inside the building in the central nave between the first and second orders, above the entablature of the first order. We think this is the best hypothesis and in our forthcoming publication we explain our data for this theory. However, according to Freyberger, the "Barbarians" were placed outside the building, on the attic of the porticus in front of the Basilica[14].

For reasons of space, we cannot discuss the question of the identity of the characters represented in the Basilica Aemilia, which scholars have interpreted in various ways[15].

The study of the oriental statues

The new Forum Museum, currently in the planning stage, provided an opportunity to re-examine the numerous fragments held in storage[16]. Together with the finds selected for display, this rearrangement makes it possible to propose a reconstruction of an ideal model of this statue type, which will be addressed below.

The statues, made from the prestigious coloured marbles pavonazzetto and giallo antico, are dressed in a short tunic held fast beneath the chest or at waist height, oriental *bracae* (trousers), a cloak and headgear of the phrygian type. The nude parts of the body, the faces and hands were made separately of white marble. The statues were almost 2.5 metres tall and were placed on square plinths about 75 cm high for a total height of more than three metres (Fig. 1).

The general posture is that of standing statues resting on one weight-bearing leg with the arm on that side of the body raised and bent at right angles; the other leg was flexed and shifted slightly backwards, with the corresponding arm extended along the side of the body. Overall, the finds indicate the presence of two mirror-image models that alternated in the architectural decoration of the Basilica.

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[4] Vaglieri 1903, 10.
[5] Bartoli 1912.
[6] Carettoni 1948.
[7] Fabbrini 1972, 64.
[8] Schneider 1986.
[9] Bauer 1988; ID. 1993.
[10] Ertel-Freyberger 2007; ID. 2017.
[11] Lipps 2007; ID. 2011.
[12] Bitterer 2007a /b.
[13] Bauer 1988, Abb. 98-99.
[14] Freyberger 2007.
[15] Consoli, Violante *in press*, Atti del Convegno alla Curia Iulia, 6 Giugno 2019. See Schneider 2012; ID. 2016; Coarelli 1985, 296-298; Isager 1986; Rose 2005, 62.
[16] For some years, the Archaeological Superintendence of Rome (Soprintendenza Archeologica di Roma), later the Archaeological Park of the Colosseum, has been working to reopen the historic former "Antiquarium forense" with a new layout, under the direction of Dr. A. Russo and with the scientific consultancy of Dr. P. Fortini.

Figure 1: Basilica Aemilia. Statues of Orientals historically displayed in the cloister of the Forum Antiquarium (invv. 421003, 421008).

The goal of the project, undertaken by a large working group[17], was to construct an ideal three-dimensional model of the statues. Here, we show some preliminary results of the work currently in progress. Tens of fragments of the Oriental statues, selected among the most significant, were scanned using a structured light scanner and virtually reassembled, creating an eidotype (or ideal type) representing the sum of these fragments (Fig. 2).

Some key questions about the general posture of the statues remain open, such as the exact position of the arms and hands, and the inclination and rotation of the heads. It should be noted that we have chosen to turn the heads towards the side with the extended arm and bent leg rather than in the opposite direction, though we are aware that the known figurative tradition presents both iconographies. To support our choice, in addition to the known examples, we could mention the posture of the “Barbarian” statue from Terracina discussed by Cassieri in this volume[18].

The statues couldn’t be seen in the round: they must have been placed against a wall or a pilaster as attested by the roughly worked rear surface and the presence of sockets used to fix them to the wall[19] (Fig. 3a).

Among the over seven hundred (700) fragments held at the Roman Forum, we examined busts, torsos, limbs and drapery, hands and arms (Fig. 3b), severely worn and intentionally broken into tiny pieces for reuse as building materials or to make lime. Most of these were made of pavonazzetto marble together with few fragments made of giallo antico marble and one partially reassembled statue that is difficult to interpret (Fig. 4).

[17] The reconstruction of the eidotype was carried out as part of the “Basilica Aemilia Project” promoted by the Archaeological Park of the Colosseum with the Director Dr. Alfonsina Russo, the Scientific Direction of Dr. Patrizia Fortini, the Direction of Restoration by Dr. Giovanna Bandini. The creation of the prototype involved different professionals: Francesca Consoli and Sabrina Violante for the archaeological aspects, Silvia Borghini for the restoration, Bruno Angeli for the photographic documentation, Studio Azimut with Luca Fabiani, Maurizio Necci and Tommaso Calvo for the graphic reconstructions and the 3D acquisitions.

[18] See Cassieri 2023.

[19] The rear of all the Oriental statues have as lot in which to insert the anchor pin positioned at the height of the *scapulas* and the folds of the drapery are in lessaccurate low-relief, although some details of the cloak are still well worked such as the hood and the sequence of V-folds on the back.

Figure 2: Basilica Aemilia. Oriental statues, hypothetical reconstruction based on the three-dimensional model, the eidotype, developed on the basis of the surviving fragments, virtually assembled on the model. The posture of the specimens was originally specular and alternating (Drawing: L. Borrello; 3D model: Studio Azimut)

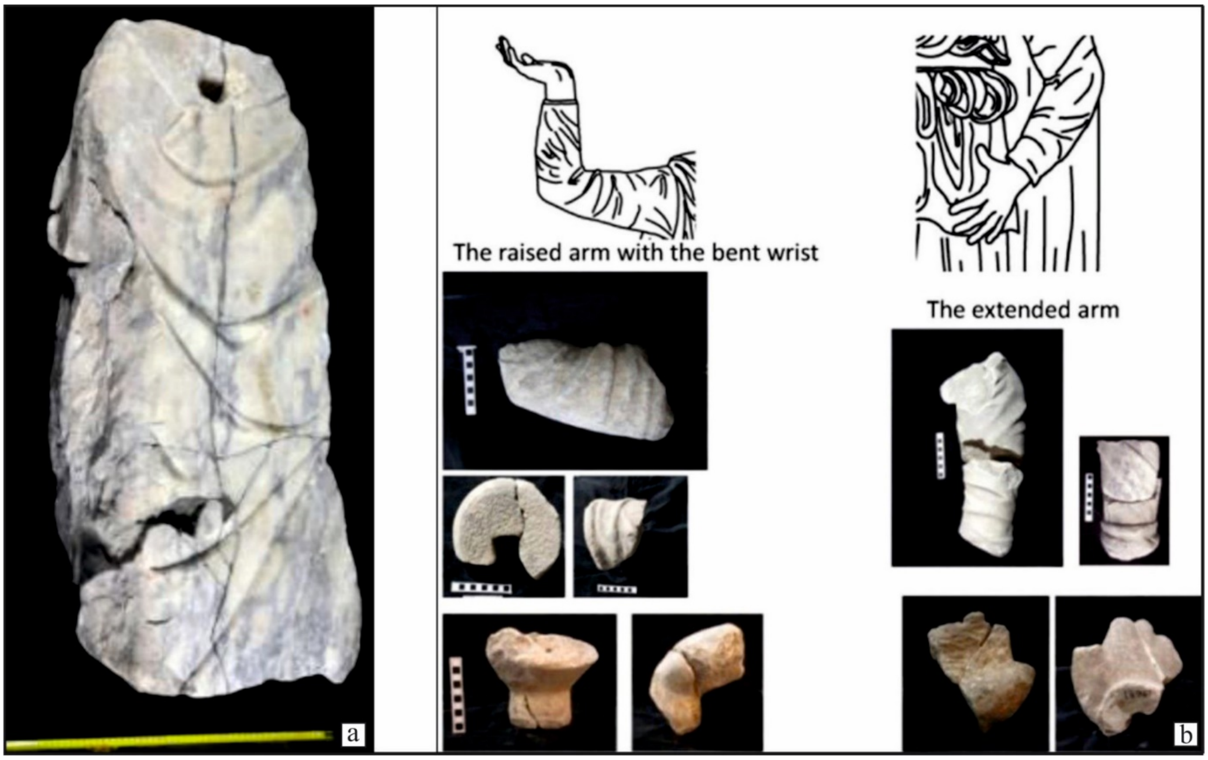

Figure 3: Basilica Aemilia: **a**. Rear view of af an Oriental Statue (inv. 593528); **b**. The pinsockets and assembly systems of the arms and hands of the Oriental Statues.

"*Pilei*", the typical phrygian caps characterizing the iconography of "Barbarians", are also present and their inner surface presents a concave profile worked with a chisel.

As mentioned, the statues were completed with parts in white marble, such as the heads, hands and plinths.

Figure 4: Basilica Aemilia, Statue of Orientals in giallo antico recomposed from numerous fragments: note the hood at the top and the lower limbs on the right (inv. 421007).

In the Forum Antiquarium there are currently twelve marble heads and a fragment of a neck from the Basilica Aemilia whose characteristics are compatible with these statues, as demonstrated by Bitterer[20] (Fig. 5). These heads are severely damaged and the very worn surfaces indicate exposure to fire.

The iconography, common to all the statues, shows a male figure with idealized features, depicted at an unknown youthful age. The face, belonging to the Hellenistic tradition, is a full oval with large almond-shaped eyes, a broad nose with large, rounded nostrils, and fleshy lips. Contrasting with the placid face is the voluminous wavy hair with curly locks, characterized by the *anastolè* motif above the forehead, in accordance with the iconography extremely common in portraits of Alexander the Great (Fig. 5)[21]. Despite the poor conservation, there are significant traces of red colour, clearly visible on some locks of hair, less soon others (Fig. 6). In some cases, the lips are highlighted in a dark red colour.

Traces of colour also remain on the eyes of some of the heads, on the irises, which are not carved, as well as on the eyelashes and eyebrows. In particular, the eye of one of the heads (inv. 3130) presents traces of Egyptian blue, as is highlighted by the visible induced luminescence images (VIL). Further in-depth analyses of these aspects are underway.

[20] Bitterer 2007 a/b.

[21] As already noted by Freyberger 2004, the heads were previously associated with the busts kept in the Forum Antiquarium.

Figure 5: Basilica Aemilia. Twelve heads of Orientals and a fragment of a neck. (Forum Antiquarium).


Figure 6: Basilica Aemilia. Oriental head with clear traces of colour on the hair (invv. 3132, 3137).

All the heads share iconographical and technical characteristics indicative of the group's unitary nature. We can distinguish between two slightly different types, one with a soft rounded face and another with harder, square features. Though serially produced, these sculptures are of excellent workmanship, inspired by aesthetic ideals of Greek origin.

All the heads are obliquely cut on the back, finished with a chisel and scalpel, with a slightly convex central part and a lowered outer edge. This served to assemble the heads with their phrygian caps (Fig. 7)[22].

[22] Contemporaneously with the conference held on June 6, 2019 in the Curia Iulia in the Roman Forum, a small exhibition, still open, was inaugurated. For the occasion, two phrygian caps were mounted on two Oriental heads. Specifically, head 3132 was assembled with what was probably its original cap, while head 3130, the best-preserved since it also had a neck, was combined with the most exemplary cap among those that have survived, though it was probably not originally pertinent.

Figure 7: Basilica Aemilia. Oriental head with phrygian cap (inv. 3130), assembled for the exhibition in the Curia Iulia, Rome June 2019.

The head was also anchored to the cap with a pin inserted into a rectangular socket that ran obliquely from the head to the base of the phrygian cap where a similar socket is also present. The necks, flaring towards the base, were inserted into the corresponding cavities cut into the upper parts of the busts; these cavities have a rough surface and lack sockets except for a single specimen that preserves a socket serving to reinforce the attachment of the head to the body.

We identified a few pieces belonging to this statue series (currently six); among them was the type with the wrist bent at a right angle and the palm turned upwards in the act of supporting something. The hand of this type was hinged on the raised arm, worked separately from the bodies of the statues and in turn hooked onto the bust at shoulder height, as shown by the depression with a socket visible there.

Other fragments of hands belong to the arm extended along the side of the statue, worked from the same block as the bust presenting the unfinished palm close to the drapery of the garment.

Stolen heads

Based on the photographic archive documentation, another two heads, reported lost already in 1960, appear to belong to the same series. Research on the antiques market led us to identify one of the lost heads in a 2011 auction at Sotheby's.

The report filed with the Comando Carabinieri Tutela Patrimonio Culturale, allowed us to start procedures (still in progress) to recover this piece[23]. This identification may help to shed light on the presence in the Park storerooms of another three heads, similar to the others in iconography and form, but in a different material, also described as coming from the Basilica Aemilia and attributed to the same series. These are made of plaster mixed with large pieces of marble that increase their weight. The surfaces are treated in such a way as to simulate antiquity. These are probably reproductions made when the original heads were stolen. The archive photos of the Antiquarium, taken after the Second World War, show the series of heads on display on the first floor of the building, together with the lost heads and the casts, thus providing a *terminus ante quem* for the robbery[24].

[23] The investigations and the recovery procedure are currently underway, and we therefore prefer to postpone the discussion of this aspect to another occasion.

[24] A mineral and petrographic characterization of one cast (Inv. 3131) was performed. Calcite, $CaCO_3$, hydromagnesite, $Mg_5(CO_3)_4(OH)2{\cdot}_4(H_2O)$, dolomite, $MgCa(CO_3)_2$ and aragonite, $CaCO_3$ are the main components of the material used. It was made by mixing lime, obtained by burning a dolomitic stone, with an aggregate made of marble fragments of different sizes. A finish with lime and ochres was applied to the surface.

Archaeometric analyses of marbles

Preliminary macroscopic inspection shows variations in grain size. It is worth noting that the visual analysis was in part compromised by the unfinished conservation work and the severe heat exposure suffered by the materials, which certainly altered the marble's original appearance. For these reasons Bitterer, with reference to the heads, surmised that marbles of different qualities were used[25].

A multi-analytical study of samples obtained from ten heads, four hands and one plinth was undertaken to identify the marble type and provenance, with mineral and petrographic studies of thin sections, and mineralogical and geochemical analyses of powders.

The original white surface of the marble was completely covered with black deposits; microchips of marbles were therefore collected from the innermost part of the sculptures after cleaning the surfaces. A significant decohesion of the marble grains was observed in numerous heads and hands. The samples analyzed provided remarkably homogeneous results. The X-ray diffraction analyses, performed on powders obtained from each microsample, revealed only the presence of calcite, confirming that a pure white marble was used.

The petrographic observations of thin sections, performed under an optical microscope using polarized light, associated with specific software for the morphometric analysis of the main microstructural parameters, show a variability in maximum grain size, ranging from 0.8 to 2.5 mm. The marbles can be described as fine to medium grained. The maximum grain size is considered a relevant diagnostic parameter for the identification of the provenance of a marble, as it is closely connected with the metamorphic grade and maximum temperature reached by the marble during its genesis.

	MGS	Fabric	Microfabric/ crystal boundaries	$\delta^{18}O$ ‰ V-PDB	$\delta^{13}C$ ‰ V-PDB	Marble
3127 head	2 mm	He	Mosaic /embayed-straight	-3.27	5.22	Paros 1
3130 head	2 mm	He	Mosaic /embayed	-3.03	5.42	Paros 1
3132 head	2 mm	He	Mosaic /embayed-straight	-3.03	5.42	Paros 1
3133 head	1.8 mm	He	Mosaic /embayed	-3.00	5.11	Paros 1
3134 head	1.2 mm	He	Polygonal/embayed	-4.07	4.84	Paros 1
3135 head	1.6 mm	He	Mosaic /embayed	-3.48	4.85	Paros 1
3136 head	1 mm	He	Polygonal/embayed	-3.16	5.27	Paros 1
3137 head	2.5 mm	He	Polygonal/embayed	-3.24	5.17	Paros 1
3138 head	1..5 mm	He	Polygonal/embayed	-3.65	4.28	Paros 1
3139 head	1.2 mm	He	Mosaic/curved	-2.91	5.38	Paros 1
3140 head	0.9 mm	He	Mosaic /embayed	-3.19	5.36	Paros 1
3141 head	1.5	He	Mosaic /embayed-straight	-3.69	4.83	Paros 1
3142 head	1.3 mm	He	Mosaic /embayed	-3.09	5.27	Paros 1
18790 hand	0.80 mm	He	Mosaic /embayed-straight	-4.07	4.58	Paros 1
18793 hand	0.8 mm	He	Mosaic /embayed	-3.13	4.58	Paros 1
18941 hand	0.8 mm	He	Polygonal/embayed	-3.68	4.17	Paros 1
18962 hand	1 mm	He	Mosaic /embayed-curved	-3.09	5.31	Paros 1
18963 hand	1 mm	He	Mosaic /embayed	-3.38	5.48	Paros 1
21561 hand	1.2 mm	He	Mosaic /embayed	-3.55	4.78	Paros 1
18969 finger	1 mm	He	Mosaic /embayed	-3.00	5.11	Paros 1
18786 finger	2.5 mm	He	Mosaic /embayed	-3.36	5.36	Paros 1
437371 base	1mm	Ho	Mosaic, slightly lineated and strained	-5.06	2.59	Pentelic

Table 1: Petrographic features, isotopic signatures and hypothetical provenance of the samples analysed Ho: Homeoblastic, He: Heteroblastic).

Others relevant information can be obtained by defining the fabric type and main features of the microstructure, obtained through petrographic observation of thin sections, related to the type and degree of metamorphism that gives rise to the marble. The fabric of the

[25] Bitterer 2007.

samples examined is mainly heteroblastic, and the grain size of the calcite crystals ranges from a minimum of 0.2 mm to 2.5 mm.

The petrographic observation of thin sections of the marbles reveals that the microstructure varies from mosaic to polygonal with prevalently embayed crystal boundaries, sometimes curved, rarely straight (Tab. 1). No shape orientation of calcite crystals was observed.

Some microphotographs of thin sections of the marbles examined show a typical heteroblastic fabric with a mosaic microstructure and embayed crystal boundaries (Fig. 8).

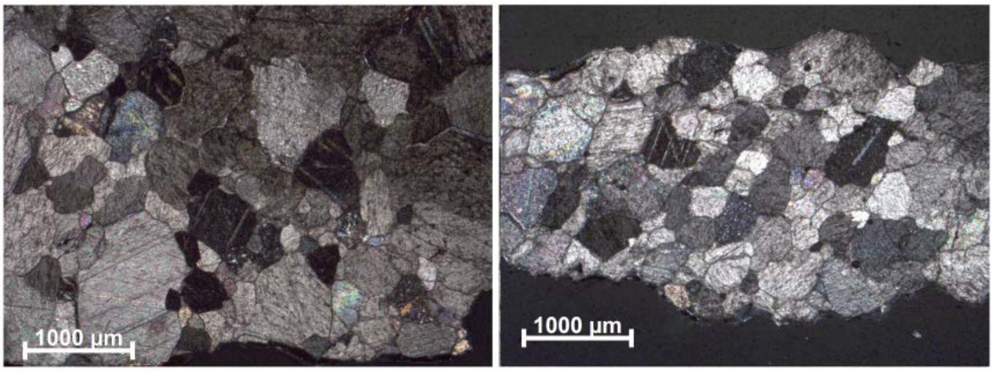

Figure 8: Basilica Aemilia. Microphotographs of thin sections of samples 3142 (head) and 18793 (hand) at different magnifications, showing the typical heteroblastic fabric with mosaic microstructure and embayed crystal boundaries.

The isotopic data reveal that the $\delta^{13}C$ values range from 4.17 ‰ to5.48 ‰, while the $\delta^{18}O$ values range from -2.91‰ to -4.07‰[26].

After comparing the data obtained with those from quarry marble databases[27], the use of parian marble (Lychnites variety) for the heads and hands was proposed .

The marble used for the plinths is characterized by fine grained calcite, traces of micas, a mosaic microfabric, slightly lineated and strained, and the isotopic signature $\delta^{18}O$ -5.06, $\delta^{13}C$ 2.59, the latter allowing for its identification as Attic pentelic marble (Fig. 9).

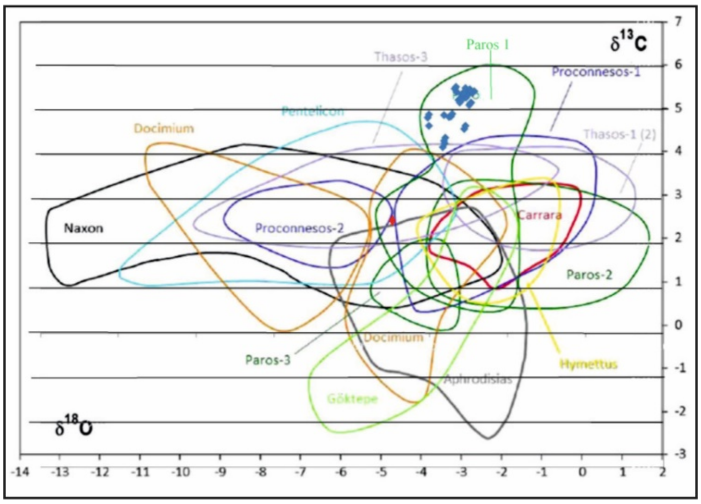

Figure 9: Basilica Aemilia. The isotopic features of the marbles analyzed: blue marks Paros 1 marbles, red mark pentelic marble from the plinth.

[26] A detailed description of the main features of each sample collected is provided in tab. 1.
[27] Gorgoni *et al.* 2002; Attanasio 2003: Attanasio *et al.* 2006; Antonelli, Lazzarini 2015.

Conclusions

Over 700 fragments were examined in the storage rooms of the Antiquarium of the Roman Forum, offering an improved understanding of the finds of the Oriental statues. There are sixteen heads, of which twelve are in the "Forum Antiquarium", three are "lost", and one is currently in the "Museo dei Mercati di Traiano"[28]. This allows us to suggest the presence of a minimum of sixteen statues in the architectural decoration of the Basilica Aemilia. Eight busts, the upper part of the body, can be identified with certainty, seven in pavonazzetto and one in giallo antico, alongside six hand fragments.

As is known, the statues of "Barbarians" were displayed on squared plinths decorated with acanthus scrolls[29]. There are at least five more or less undamaged plinths, but twenty fragments of medium-large size and a large number of smaller ones also belong to these. The decorative motif, of attic tradition, is very close to that present on a group of pillars of the Basilica Aemilia[30].

The phrygian statues were placed inside the building in the central nave on the top of the cornice of the first order in axis with the columns[31]. This hypothesis is based on several observations, of which the more technical are as follows: firstly, the analyses and cleaning of the Oriental heads undertaken during this project showed that the finds (heads, busts and limbs) show no signs of outdoor exposure. According to the restorers there aren't traces of exposure to atmospheric agents such as corrosions due to limestone; the surfaces are smooth and well preserved[32]. Furthermore, in the Augustan period, the presence of coloured marble on the façade of public buildings in Rome seems premature, as its use was, as is known, reserved for interior decorations[33]. Finally, purely from the point of view of the measurements, the overall height of the statues seems compatible with this sector of the Basilica.

It is worth remembering that the statues of "Barbarians" from the Basilica are the oldest Roman sculptures in pavonazzetto marble alongside the famous statues of kneeling "Barbarians"[34]. In the wake of the diplomatic triumph attained with the return of the Parthian standards, Augustus used the representation of a row of standing Orientals in the act of supporting something to glorify the universal dominion of Rome.

Mineralogical, petrographic and isotopic analyses, presented here for the first time, indicate the use of parian marble for the white parts (hands and heads) and confirms the use of Pentelic marble for the statue bases, already hypothesized based on a visual inspection.

The choice of parian and pentelic marble, alongside the sculptural characteristics, suggests that these works were made by highly-skilled sculptors, probably attic artists working in this building[35]. The use of pentelic marble for the plinths is particularly interesting since, in the context of the white marbles used in the Basilica, it differs from the Luni marble present in the remainder of the architectural apparatus and displays similarities with Pentelic marble of the well-known frieze of the Basilica Aemilia representing the origins of Rome[36]. The use of prestigious parian Lychnites for the white parts is a

[28] To the series originally preserved in the "Forum Antiquarium" we must add another head that probably belongs to this series and is currently held in the Trajan's Markets Museum (Museo dei Mercati Traianei); see Ungaro 2007; Ungaro *in press*; Zanker 1986, Bitterer 2007.
[29] Lipps 2011, 140-143.
[30] Mathea-Förtsch 1999, 142-143; Lipps 2011, 129-140; Pensabene 1982, 149-163.
[31] As already proposed by Bauer 1988, fig. 98-99 and despite the most recent theory advanced by Ertel-Freyberger 2016.
[32] Consoli, Violante *in press*.
[33] Pensabene 2002a.
[34] Schneider 1986; Bruno *et al.*, 2015, 381-383; Dodero 2010, cat. 54-55, 137-144; Lipps 2016.
[35] Bruno, Bianchi 2015, 105-107; Pensabene 1982, 160.
[36] Arya 2000, 317, fn. 1: isotopic analysis by N. Herz.

particularly important aspect of this high-level sculptural production, for which the Greek statuary marble par excellence was used[37].

It is well known that in Rome parian marble was used for various portraits of the imperial family in the Augustan period[38] and above all for one of the most important statues of the emperor, the Augustus of Prima Porta[39] which, according to some scholars[40], shares with the statues from the Basilica Aemilia the theme of the return of the parthian standards. Fragments ascribed to the monumental statue from the Hall of the Colossus in the nearby Forum of Augustus were also in parian marble[41]. Indeed, the Forum of Augustus shares its iconographic and dynastic programme with the Basilica Aemilia, and it is no coincidence that the iconographic and imperial propaganda choices are identical.

Credits

Photographs by Bruno Angeli – PARCO.
Three-dimensional reconstruction of the prototype by Azimut, working group Sabrina Violante and Francesca Consoli with Silvia Borghini.

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[37] Pensabene 2002b, 212; Bruno 2013, 17-19.
[38] La Rocca 2013, 173, 175.
[39] Liverani 2000, Maniatis *et al.* 1998.
[40] Coarelli 1985, 296-298.
[41] Zanker 1986; Ungaro 1997.

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COLUMNS OF FELIX ROMULIANA (SERBIA)

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Abstract

Felix Romuliana was a retreat villa of the Emperor Galerius at Gamzigrad (Serbia), the remains of which include a fair number of stone fragments belonging to its columnar architecture. In recent years, work has been undertaken with the help of students from the University of Ljubljana to comprehensively analyse the column remains. The material for analysis comprised 83 bases or parts thereof, 227 fragments and three complete shafts, as well as 72 fragments of Ionic and Corinthian capitals recovered during the archaeological excavations undertaken at the site from 1953 onwards. The text below focuses on the column remains in marble, white and coloured. The white marbles mostly came from Prokonnesos and Pentelicon, but also from Thasos and Berkovica. Coloured marbles comprising *marmor thessalicum, marmor troadense, marmor syenite* and pink Berkovica marble (BG) were only used for column shafts and even there rarely.

Keywords: Felix Romuliana, Roman columns, white and coloured marbles.

Introduction

The "retreat palace"[1] or villa of the Emperor C. Galerius Valerius Maximianus (c. 260 – 311), named *Felix Romuliana* and located near the present-day village of Gamzigrad (Zaječar, Serbia) (Fig. 1), was built over a short period between 293 and 311[2]. Its remains consist of monumental fortification walls with towers and two main gates (East and West), lower parts of the buildings in the interior, as well as architectural elements that are considerably less well-preserved[3]. Once extremely rich in imported white and coloured marbles, used in two residential complexes, three temples and baths for architectural members (columns, entablatures, door frames etc.) and a range of *opera sectilia*, the villa was almost completely stripped of its marble, which was used most probably for the production of lime[4] and possibly cannon balls[5].

Archaeological excavations have been taking place at *Felix Romuliana* since 1953[6], unearthing numerous fragments of architectural elements that have not previously been studied in detail[7]. In spite of a high level of fragmentation, they are of importance in the

[1] Duval 1997, 148; Bülow 2011.
[2] According to Vasić Č. 1995; Vasić Č. 1997, 149, it was constructed between 303 and 310. For different opinions, see Vasić M. 2007 and Bülow 2016.
[3] For a detailed description, see Bülow *et al.* 2009; Srejović *et al.* 1978; Srejović 1985; Čanak-Medić, Stojković-Pavelka 2011.
[4] Breitner notes that several limekilns were presumably found west of the Temple of Jupiter; Bülow *et al.* 2009, 137.
[5] See Greenhalgh 2005, 19-21.
[6] For the history of research, see Živić 2010.
[7] A catalogue of the surviving column shafts, bases and capitals from Palace D1 and several other elements from other parts of the villa is published in Čanak-Medić 1978, 177-218. The fragments of architectural elements unearthed during later excavations are summarily presented in Srejović 1983, 88-92. Breitner published a brief analysis of the architectural decoration of the villa in Bülow *et al.* 2009, 136-142.

Figure 1: Location of Felix Romuliana in the province of Dacia Ripensis.

general context of the Late Roman imperial architecture (Palaces of Diocletian in Split, of Galerius in Thessaloniki and Sofia, imperial palace in Sremska Mitrovica etc.), but even more so in their well-defined and very short period of use.

The great majority of the architectural elements was excavated in Palace D1 and the Temple of Jupiter (Fig. 2). That said, it is only possible to more precisely locate those fragments that either bear the number of the square grid in which they were excavated or were published with these data[8]. The markings inscribed on the fragments have alas faded on many of the fragments stored in the open.

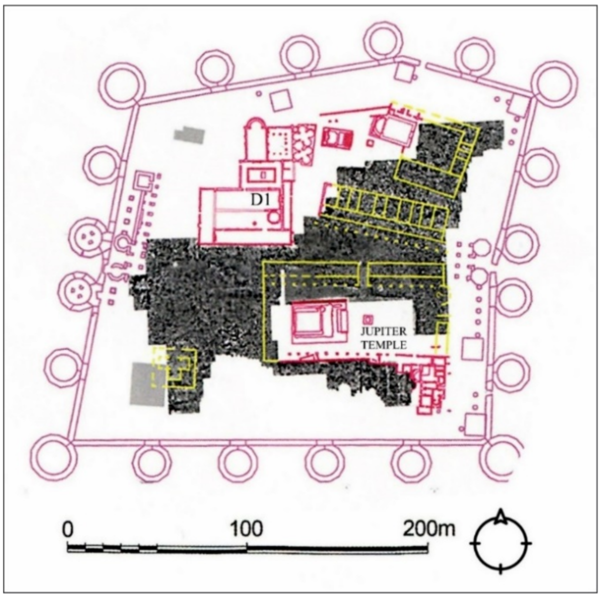

Figure 2: Plan of the retreat villa after Bülow *et al.* 2009.

Destruction and reuse

The shape of the fragments reveals the most effective manner of breaking up large pieces of marble for reuse. For the column bases, the first step was to break off the projecting parts of the square plinths, as well as of both tori; the remaining core was then broken up into smaller pieces. For the Ionic and Corinthian capitals, the volutes and parts of the abacus were

[8] Čanak-Medić 1978.

detached first; the resulting core was broken up further, first vertically and then horizontally. The shafts of white marble were first broken up horizontally into short pieces, usually less than a metre long. These were cleft into segments as you would with a tree trunk (Fig. 3). The long triangular-sectioned pieces were finally broken up into short pieces. The shafts of other marbles (*marmor troadense*, *marmor thessalicum*, *marmor syenite*) were only broken into short cylinders and not cleft lengthwise. One, of *marmor troadense*, shows the early stage of producing a spherical object, possibly a cannon ball or a stone vessel.

Seven almost complete Attic column bases have been discovered in addition to numerous fragments (76 in total). Six are preserved at more than half their original size (8%), twelve are not larger than one quarter (16%) and 58 are medium-sized to small fragments (76%). Only three column shafts survive to their complete length, unintentionally broken widthwise. The remaining 68 shaft parts survive as variously large fragments[9].

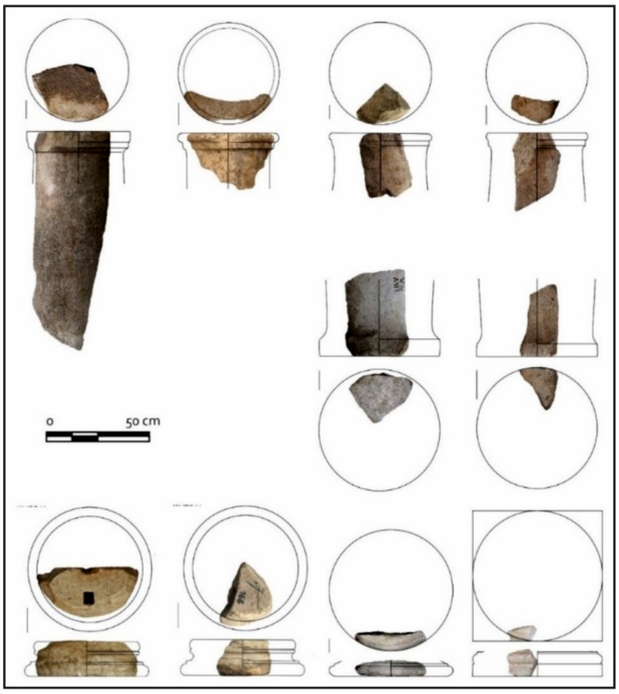

Figure 3: Fragment forms of column shafts and bases.

Spatial distribution

In addition to three complete column shafts and seven more or less complete bases, there were 220 fragments of different sizes recorded at the site that belonged to different parts of columns. The total number of all column parts (base, shaft, capital)[10] is made up of three numerically almost identical groups (37% bases, 31% shafts, 32% capitals) that correspond with the three elements of a column and corroborate the representative nature of the surviving fragments in spite of the high degree of fragmentation.

Unfortunately, only 59 fragments and complete parts (26%) have a precise findspot within the villa. Their spatial distribution suggests that the process of fragmentation largely took place where the fragments originally stood, though some degree of fragment migration within the site is also to be expected.

The markings on the 83 recorded bases or their parts show that 27 (32.5%) can be located as to their position within the site's square grid. Of the 71 recorded shafts or their parts, 22 (31%) can be located in this way, as well as six (13.6%) of the 44 Ionic capitals and

[9] 57% in the size of 10–40 cm, 20% of 41–80 cm and 23% of 81–197 cm.

[10] 83 (37%) whole complete and fragmented bases, 74 (31%) whole and fragmented column shafts, 44 (19%) fragments of Ionic capitals and 29 (13%) of Corinthian capitals.

four (13.8%) of the Corinthian capitals. All of the spatially determinable fragments and whole parts come from two investigated complexes: Palace D1 and the *templum cum porticibus* dedicated to Jupiter. A single column is known to have originated from the interior of the baths located in the SE corner of the villa. The palace is known to have yielded seven column bases (of the type without plinth), three shafts, two Ionic and two Corinthian capitals. The north, south and east porticoes of the temple and the temple itself revealed 20 bases, 18 column shafts, four Ionic and two Corinthian capitals.

Bases

The column bases[11] used in different architectural contexts at *Felix Romuliana* are without exception of the "Greek" Attic-Ionic type[12] with the upper torus in line with the scotia's upper fillet, with or without plinth[13]. They are generally similar to the bases used in two other Tetrarchic palaces – Diocletian's Palace in Split[14] and Galerius' Palace in Thessaloniki[15], where only the "Greek" Attic-Ionic type was used. The bases from the Tetrarchic palace in *Sirmium* (Sremska Mitrovica, Serbia) have not yet been published.

Two large groups of column bases stand out for their size (Fig. 4). The first (B3) measure 62 cm in lower diameter and 52-53 cm in the diameter of the upper torus. They include fourteen bases without (B3a; base height of 17 cm) and ten bases with plinths (B3b; base height of 18-19 cm). They bear a round dowel hole at the centre of the upper torus bedding surface, some have two additional rectangular dowel holes, one on either side of the round hole. The resting surface bears two eccentric and rectangular dowel holes. The seven spatially determinable base fragments show that the bases of this group were used in Palace D1. Two other fragments without plinth have a reconstructed lower diameter of 66 cm and the upper diameter of 55 cm; they most likely belong to Group B3a.

The second group (B4) consists of 23 bases with plinths, measuring 70-74 cm in plinth length, 60-62 cm in upper torus diameter and 25-29 cm in height (one base is 33 cm high). Seven better-preserved bases have a round dowel hole at the centre of the bedding surface and a square hole at the centre of the resting surface. Complete or fragmented iron dowels encased in lead survive in five of the holes. The bases of this group do not appear to have been finished, one is only half finished[16]. Five of the fragments of this group have been found in the area of the Temple of Jupiter, hence we may ascribe the group as a whole to this architectural complex.

Five core fragments of the column bases without plinth measure 22-23 cm in height and roughly 78 cm in the reconstructed lower torus diameter. They bear a square dowel hole at the centre of the bedding surface. To these we can add two more fragments of a similarly-sized lower torus, recovered from the area of Palace D1; they are likely the bases of the same group (B4).

[11] For the terminology of column bases, see Ginouvès 1992, 70-74, and Wesenberg 1994.

[12] Vitruvius (III 5, 1-3) states the proportions of the Attic bases. Much has been written on this subject from the 18th century onwards, Stuart, Revett 1762-1794; for the summary of the research, see Dirschedl 2013, 285. The Late Antique and Early Byzantine column bases have not often been discussed as a specific category of architectural elements; on the subject, see the synthetic article by Joachim Kramer 1970, with earlier references.

[13] It would appear that the Ionic-Attic bases without plinth are specific to the architecture of Felix Romuliana, as they are unknown in either the palace of Galerius in Thessaloniki, those of Diocletian in Split and Izmit, or the imperial palace at Sremska Mitrovica.

[14] Hebrard, Zeiller 1911; Mirnik 1990; Mcnally 1996.

[15] Demadiou 2015.

[16] See Asgari 1992.

The two largest bases from the site, without plinths (B5), also come from the palace, and measure 95 cm in their lower diameter and 82 cm in the upper torus diameter (base height of 26 cm), as does a small base without plinth (B2) with a lower diameter of 49 cm and an upper torus diameter of 39 cm (base height of 15 cm). In size, it is similar to a base with plinth (B1) that measures 46 cm in plinth width and 33 cm in upper torus diameter (base height 17.5 cm). The smallest column base (B0) from the site is fragmentary and has a 40 cm wide plinth. The findspot of both of the two small bases is unknown.

The column bases from the palace are all smoothly finished. In contrast, the bases from the temple appear unfinished; most are roughly dressed with a toothed chisel and at least one appears at the quarry production level. Their sizes vary by several centimetres in all groups, particularly in those from the temple complex.

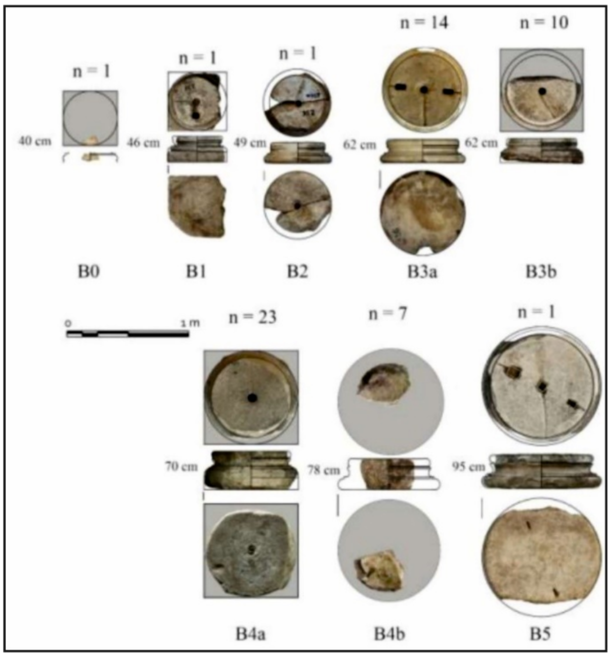

Figure 4: Forms and groups of coloumn bases.

Shafts

Column shafts (Fig. 5) are almost all of white Prokonnesos marble, but some also of Thasos and Pentelikon marbles; fragments of coloured marbles are rare.

The column shafts of Prokonnesos marble are of two kinds. Most (31) terminate above in an astragal moulding, below in a flare. Some (9) terminate above and below in the same, but inverse flare, with the fillet slightly conical in some cases.

Only three shafts survive to a complete length. One comes from Atrium H of Palace D1 and is 415 cm, i.e. 14 *pedes* high[17] (lower fillet diameter 57 cm, astragal diameter 52.5 cm)[18]; it is not completely finished. One comes from the temple complex and is 398 cm or 13.5 *pedes* high (lower fillet diameter 54 cm, astragal diameter 45 cm). The third comes from the baths and is 355 cm or 12 *pedes* high (lower fillet diameter 46 cm, astragal diameter 39

[17] Čanak-Medić 1978, 104, 207, Fig. 197; published height of 414 cm.

[18] Because of the specific fragmentation of the moulded shaft terminals, it was in most cases only possible to reliably reconstruct the diameter at the astragal or lower fillet. The reconstructed height is based on the average (smaller) diameter above the flare.

cm). The first two terminate above in an astragal and fillet moulding, the third one in a fillet[19]. All share a classic canonical 1:8 ratio between lower shaft diameter and height[20].

The diameters of the upper and lower parts of the column shafts vary slightly within individual size groups, making it very difficult to reconstruct the original size from fragments, particularly small ones. The surface finish also varies, from rough with a toothed chisel to smooth.

Most shaft fragments (37) belong to the group with the astragal diameter of 48–52 cm and the lower fillet diameter of ca. 58 cm. Some of them are smoothly dressed, others finished with a toothed chisel. Thirteen fragments were found in the temple complex. The only three known pieces recovered from the palace also fall into this group; the shaft from Atrium F is finished, i.e. smoothed[21], not so the two shafts from Atrium H[22]. The completely surviving shaft found in the temple complex, with the astragal diameter of 44–45 cm and the lower fillet diameter of 54 cm, is apparently unlike any other shaft fragment from the site.

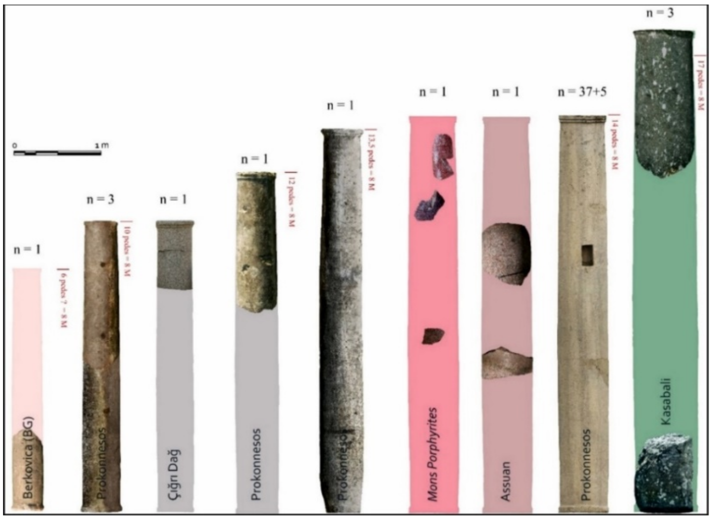

Figure 5: Form and size of coloumn shafts.

The column shafts that terminate above in a fillet include five with a maximum upper diameter of 48–50 cm. One of them was found in the temple area, hence we may ascribe the group as a whole to this architectural complex. One complete column shaft and two fragments, with a maximum upper diameter of 39 cm and the lower fillet diameter of 46 cm, come from the bath complex. The findspots for one fragment with maximum upper diameter of 31 cm and for two others with lower fillet diameter of 34 cm, are unknown.

Ten of the coloured column shaft fragments belong to three shafts of *marmor thessalicum*. Their astragal diameter varies from 60 to 62 cm, the lower fillet diameter from 64 to 67 cm; the reconstructed height of these shafts is 17 *pedes* or 503 cm.

The only column shaft of *marmor troadense* measures 43.5 cm in astragal diameter and 12 *pedes* oz. 355 cm in reconstructed height. The lower part of the shaft of pink Berkovica marble has a lower fillet diameter of 27 cm and a height of 6 *pedes* or 177 cm.

[19] The 520 and 420 cm of column shaft length as published in Srejović 1983, 48, Fig. 44, cannot be confirmed.

[20] Wilson 2000, 150-151.

[21] Čanak-Medić 1978, 208, fig. 199.

[22] Čanak-Medić 1978, 207, fig. 197. The only completely surviving column shaft, found broken in two upon discovery, has a round central dowel hole on the bedding surface and a similar but smaller and eccentrically-positioned hole beside it, and no pour channel.

The fragmentary red porphyry shafts have different diameters (52 cm, 40 cm, 30 cm), indicating that they belonged to several columns. At least one was roughly 14 *pedes* high. The two fragments of pink Aswan granite measure 51–52 cm in diameter, with the likely height being 14 *pedes* or 414 cm.

Ionic and Corinthian capitals

The 72 fragments of white marble capitals comprise 43 from Ionic (Fig. 6) and 29 from Corinthian capitals (Fig. 7). Two of the Ionic examples, recovered in Palace D1, have an echinus base diameter of 41–42 cm[23]. The Ionic capitals from the temple complex have an echinus base diameter 49–50 cm[24]. The fragmentary conservation of the capitals of Felix Romuliana does not always allow their exact typological identification. The most relevant or best-preserved fragments belong to normal Corinthian capitals of the Asiatic type.

Figure 6: Fragment of Ionic capitals.

The Corinthian capitals are formally highly varied and belong to different types within the proposed classifications[25]; practically no two large pieces are the same. They vary much less in size. Seven or eight capitals are approximately of the same size, with a preserved or estimated height of 60-61 cm and a lower diameter of 47-50 cm[26]. As such, they would correspond with the largest size group of column shafts made of Prokonnesos marble. Two of these capitals were found in the temple complex and are made of Prokonnesos marble[27], while two others of Prokonnesos marble were presumably recovered from Palace D1[28]. Two of the capitals of Prokonnesos marble have a decorated abacus. On one, the decoration is clearly visible and consists of a cable pattern above and a pattern of water plant leaves with a midrib below. The same abacus moulding decoration is found on several fragments of similarly sized abaci; these were possibly chipped off the same or similar capitals during the process of breaking up for reuse. The abacus decoration on the second capital is poorly visible, particularly the upper pattern; the lower pattern may be either water leaves without a midrib or a hollow tongue. There are several small abacus fragments with a similar decoration, consisting of a cable pattern and water plant leaves without the midrib. Formal variations continue on the helices. One capital has moulded unsymmetric helices; all other helices are

[23] They would correspond with 11 pedes or 355 cm high column shafts, but no such fragments have been identified among the surviving remains from the site.
[24] For such Ionic capitals, see Beykan 2012.
[25] E.g. Pensabene 1986; Fischer 1992.
[26] Breitner 2011, 146, writes of a series of five Corinthian capitals from the large temple, but does not specify them.
[27] One published in Breitner 2011, 146, fig. 4, the other in Srejović 1983, 49, fig. 44.
[28] One excavated in 1961 in Atrium F of Palace I, Čanak-Medić 1978, cat. no. 51, 208-209, the other found by chance in 1958, Čanak-Medić 1978, cat. no. 63, 214.

unmoulded, on one capital the unmoulded helices are connected with a short bar. The capitals further show differences in the shape of the leaves. They are arranged in two tiers on most fragments, with four folioles in the lower lobe and five in the medial lobe where visible; the leaves are either contiguous or separate. All fragments bear cauliculi in the shape of simple triangular knobs. One capital, found by chance in the temple complex, is smaller and measures 50 cm in height[29]. An even smaller capital (height 37 cm; lower diameter 34.5 cm),[30] from the palace complex (either Palace D1 or D3), has a single tier of contiguous, almost crammed leaves showing unusually low relief towards the bottom, with three folioles in the lower lobe and four in the medial lobe, as well as upturned leaves instead of helices. This capital is made of Prokonnesos marble.

Apart from the formal diversity, the Corinthian capitals from Felix Romuliana show a differentiated use of stone, with Proconnesian, Thasian and Pentelic[31] marbles used alongside local limestone. It is a diversity known from other sites as well, notably the Palace of Diocletian in Split[32] and Sirmium[33]. The three sites also share the bulk of construction activities in the Tetrarchic period and a number of different forms of Asiatic capitals, with parallels across the Mediterranean.

Provenance analysis of the white marbles in Romuliana's architecture

The marble analysis involved a total of 90 fragments of architectural elements (83) and veneer slabs (7). For geological reasons, the wider area around Romuliana is lacking in marble. The macroscopic analysis of the marble fragments and the general petrographic characteristics and isotopic composition of the white marble samples points to prokonnesian, pentelic and thasian marbles. These were selected as reference groups and examined using a multivariate discrimination analysis based on the results of the isotope analysis, the trace element analysis of the structure bound trace elements and the chemical analysis of microinclusions[34].

Figure 7: Fragments of Corinthian capitals.

[29] Čanak-Medić 1978, 214, fig. 214.
[30] Čanak-Medić 1978, cat. no. 63, 217.
[31] Two fragments of unknown findspots have been identified as made of Pentelic marble. One is a piece of the abacus, the other of the lower kalathos, but neither can be determined as to their form.
[32] Mcnally 1996; Matetić 2009.
[33] Jeremić 1995; Maver *et al.* 2009
[34] For the methods used, see Prochaska, Attanasio 2020.

The isotope diagram (Fig. 8) shows that the compositional fields of the Prokonnesos and Thasos samples overlap to a considerable degree, while those of the Pentelic and Berkovica marbles are clearly separated. The majority of the samples plot into the Prokonnesos/Thasos area preventing a clear separation and assignment of the samples on that basis alone. A group of seven slab and veneer samples, as well as one column base, characterised by a very light O-isotopic composition, falls well outside these fields and a corresponding equivalent of quarry samples. A similar isotopic composition to these fragments has been observed in the architectural pieces of pink marble from Felix Romuliana. The source of this marble is in Moesia Superior, near present-day Berkovica in the vicinity of Montana (Bulgaria)[35].

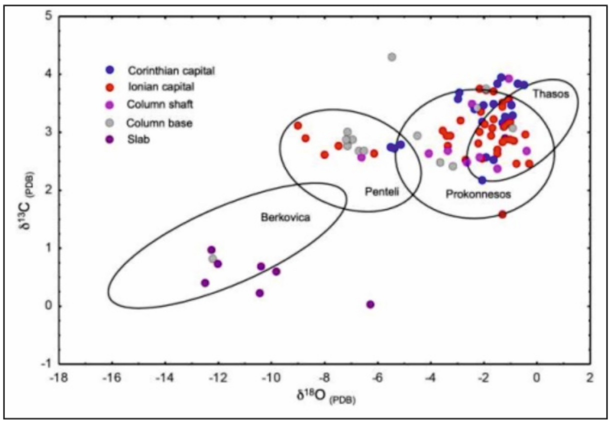

Figure 8: Isotope diagram of the white marble samples from Felix Romuliana. The values for prokonnesian, thasian and pentelic marbles are presented as statistical 90% probability ellipses. The overlap of the former two prevents a clear assignment of individual samples (Graph: W. Prochaska).

To overcome the problem of overlapping data, a multivariate discrimination analysis was performed using the Statistika and SPSS software packages. The best discrimination between the marble populations and the best reassignment was achieved when using the Mg, Fe, Mn, DS, Li/Na, Cl/Na, K/Na, Br/Na, I/Na, δ^{18}O‰, δ^{13}C‰ variables (Tab. 1). The table clearly shows the improvement in the attainable discrimination and a very high degree of separation of the datasets, with almost no uncertainties left.

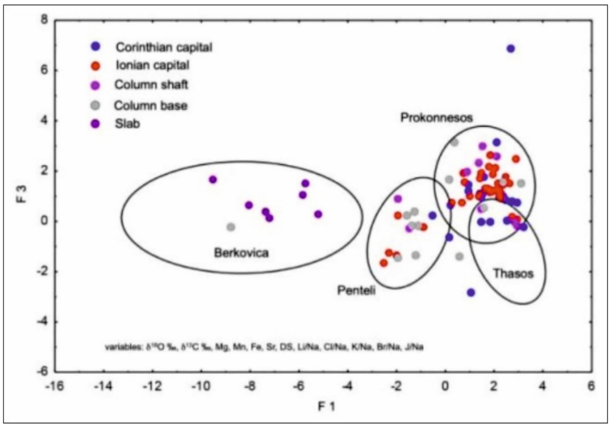

Figure 9: The bivariate diagram with the two most powerful canonical factors of the multivariate calculation (Graph: W. Prochaska).

The bivariate diagram (Fig. 9) with the two most powerful canonical factors of the multivariate calculation shows that the compositional fields of the considered marble provenance areas are largely separated when considering a larger number of variables. It has to be borne in mind, however, that the graphic display is only an approximation because a

[35] See Prochaska, Živić 2018.

multidimensional system cannot be displayed in a bivariate diagram. The correct degree (numerical data) of assigning a given sample to a certain population can only be achieved by a mathematical, statistical calculation.

The white and coloured marbles of Felix Romuliana

Analyses[36] show that three intact column shafts and fragments of others from Atria F and H of Palace D1 were made of Prokonnesos and Thasos marbles. Of the numerous other shaft fragments made of white marbles and coming from the area of the Jupiter temple with porticoes, most were made of Proconnesos marble. The shaft fragments analysed from this group include one of thasian marble. The findspot for the shaft fragment of Pentelicon marble is unknown.

Of the coloured marbles, ten fragments with unknown findspots belong to three shafts of *marmor thessalicum*. Three belong to a single shaft of *marmor troadense*, two fragments are of *marmor syenite*. Three shaft fragments are of *lapis porphyrites*; one of these was used as an inlay to repair a damaged shaft and was found in the floor of the East Gate, while another fragment shows part of a cavity prepared for repair. Also found were two fragments of smaller column shafts of pink Berkovica marble[37]. For one the original position is unknown, while the other was reused as a stoup in the Early Byzantine complex southeast of the Temple of Jupiter.

The macroscopic analysis of the marble used for column bases, confirmed by chemical, as well as ^{18}O and ^{13}C stable isotope analyses, shows that those without plinths used in Palace D1 were made of Pentelic marble. The bases with plinths from the large temple are all made of Prokonessos marble. The bases with plinths of pentelic marble most likely come from Palace D1, as do those of thasian marble. One large base with plinth was made of white Berkovica marble. The Ionic capitals and their fragments recovered in Palace D1 are of pentelic, those from the temple area of prokonnesian, some also of grey thasian marble. The Corinthian capitals are made of prokonnesian (16 fragments), thasian (2) and pentelic marbles (3).

Conclusion

The intensive destruction and reuse has left the columns that once adorned the luxurious architecture in Felix Romuliana in a very poor state of conservation. The best-preserved of the elements found during the decades of investigation of the site are column bases. Their measurements suggest at least five different groups: B1 46/33 cm (1 piece), B2 49-39 cm (1), B3 62/53 cm (24), B4 74/58-60 cm (30) and B5 95/82 cm (2), which may help us in reconstructing the different sizes of the columns. Groups B3 and B4 come in two variants, either with or without plinth. The bases of Group B3 are linked to Palace D1 and made of Pentelic marble, those of Group B4 are linked to the Temple of Jupiter and made of prokonnesian marble. Some of the latter survive in quarry condition. The column shafts corresponding to the B4 bases are those of white Proconnesos marble as well as of red porphyry and pink Aswan granite, measuring 58/48 cm in diameter and 415 cm or 14 *pedes* in height, which is consistent with the classic canonical 1:8 ratio[38]. The white marble column shafts originate from both Palace D1 and the Temple of Jupiter, and show a predominance of a standardised column size. The B3 bases cannot positively be associated with any of the

[36] Analyses by Walter Prochaska.
[37] Defined by Walter Prochaska.
[38] Wilson 2000, 150-151.

column shaft fragments, but possibly with two Ionic capitals[39]. Badly damaged fragments of a shaft made of thasian marble found in Atrium F of Palace D1 could correspond to these Ionic columns[37]. It is also not possible to tie any of the column shaft fragments to the B1[40] and B5 bases[41]. The B2 bases may correspond with only two shaft fragments[42]. Most Ionic and Corinthian capitals correspond with the B4 bases and associated column shafts.

The surface finish of some shafts and even more so the bases suggests that parts of the excavated temple complex were not completely finished at the time of Galerius' death. The column shafts from Atrium H of Palace D1 indicate that this part of the palace was also not fully finished.

The results of the marble analyses have shown the predominant use of two white marbles for bases and shafts: pentelic (but also thasian) in Palace D1 and prokonessian in the temple complex. The recovered Corinthian and Ionic capitals were mainly made of prokonessian alongside thasian and pentelic marbles. One base with plinth made of white Berkovica marble also confirms the use of this regional marble for architectural elements[43]. Together with several other architectural fragments of the same marble, two small column shafts of Berkovica pink marble are the little of what remains of an unknown building (or its part). Other coloured marbles cannot reliably be linked to any of the known buildings or complexes despite some reconstruction attempts that link the shafts made of *marmor thessalicum* to the Temple of Jupiter[44].

The considerable diversity of columns in both size and material reflects the architectural complexity of Galerius' villa on the one hand, and opens the possibility of an at least partial use of spoliated elements in the villa on the other. Some of the bases without plinth for example, made of pentelic marble, show damage and repair prior to being built into the villa (Fig. 10), which would suggest they were removed from their original setting and reused in Romuliana. The column shafts of pentelic marble could also belong to this presumably reused group of elements. In contrast, the unfinished state of several bases of Prokonnesos marble[45] (Fig. 11) and their half-finished products, coupled with the unfinished state of numerous column shafts is irrefutable evidence of these column elements being used in their quarry state. The Ionic capitals of Prokonnesos marble associated with the latter are poorly preserved, but nevertheless show a fairly high degree of formal homogeneity; the Corinthian capitals made of grey prokonnesian are formally diverse, but more or less the same size. The forms of the bases indicate deliberate differences in the design of at least two buildings (Palace D1 and the Temple of Jupiter). Inasmuch as we can discern from the publications, these features distinguish Felix Romuliana from the known architectural complexes of the same category – Galerius' Palace in Thessaloniki[46], Diocletian's Palace in Split[47] and the imperial palace in Sremska Mitrovica[48], none of which yielded bases without a plinth.

The white marbles used in Romuliana all came from quarries in the eastern Mediterranean with the exception of the regional quarry at Berkovica. The products of prokonnesian marble undoubtedly came directly from the quarry, possibly also those of

[39] The column shafts would be 355 cm or 12 pedes high.
[40] The corresponding column shaft is 237 cm or 8 pedes high.
[41] The corresponding column shaft is 622 cm or 21 pedes high.
[42] The shafts would be 296 cm or 10 pedes high.
[43] White, grey and coloured marble from Berkovica was mostly used for slabs and opus sectile floors. See Djurić, Prochaska 2021.
[44] Čanak-Medić, Stojković-Pavelka 2010, 82, fig. 45.
[45] These are closely comparable with the bases from the palace of Galerius in Thessaloniki; Demanidou 2015.
[46] Demanidou 2015.
[47] Hébrard, Zeiller 1911.
[48] Jeremić 2016.

thasian; the same is less certain for the products of pentelic marble. What is certain is that all these quarries lie close to the presumed supply route that led across the sea to the mouth of the Danube. With the exception of the two coloured marbles from Egypt (red porphyry and pink granite), the quarries of other coloured marbles (*marmor thesalicum, marmor troadense*) were also located close to this route that continued up the Danube to the likely reloading point.

Figure 10: Fragment of a column base of Pentelic marble, without plinth and with clamp holes.

Figure 11: Fragment of a column base of Prokonnesos marble in quarry condition.

Although it is possible that half-finished products were being transported up the Danube to the confluence with the Timok and up the Timok to the immediate vicinity of Felix Romuliana, it seems logistically more likely that cargo was reloaded in *Ratiaria* (modern Arčar, BG) on the Danube and from there transported on land to the construction site. The marble from Berkovica was also transported on land, via Montana (*civitas Montanensium*) and along the same road from *Ratiaria*[49]. The products of the white and coloured marbles from Berkovica recovered at Felix Romuliana also indicate that workshops from the stonemasonry centre at Montana[50], geographically closest to Romuliana of all major centres, may have played a significant role in finishing the architectural elements at the villa.

[49] See Lemke 2016.
[50] See Ivanov, Luka 2015, 252-254.

Lab no.	Sample no.	Artifact	Quarry	Absolute probability	DS	$MgCO_3$	Fe ppm	Mn ppm	Sr ppm	Li/Na	Cl/Na	K/Na	Br/Na	I/Na	SO_4/Na	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰
5475	FRM 074	Corinthian capital	Proconnesos	53,5	9262	1,00	48	16	151	0,053	1068	537	1,1	7,8	81,1	-2,37	3,40
5945	FRM 211	Corinthian capital	Proconnesos	68,8	3025	1,27	49	10	154	0,116	1061	506	3,1	15,9	1349,5	-0,91	3,28
5956	FRM 226	Corinthian capital	Proconnesos	40,1	866	0,44	84	35	155	0,559	647	555	5,7	18,3	3192,9	-2,08	3,17
5962	FRM 232	Corinthian capital	Proconnesos	72,3	1180	1,11	75	33	198	0,866	826	462	3,2	32,4	2542,6	-1,33	3,94
5965	FRM 235	Corinthian capital	Proconnesos	84,4	1416	1,08	75	11	144	0,405	1288	397	3,9	8,5	1355,8	-1,21	3,26
5969	FRM 240	Corinthian capital	Proconnesos	76,0	1681	1,14	108	11	144	0,374	1974	319	5,1	10,1	671,9	-1,32	3,15
5981	FRM 252	Corinthian capital	Proconnesos	13,8	1483	5,68	110	12	303	0,986	956	404	12,6	72,1	6831,0	-1,21	2,90
5986	FRM 258	Corinthian capital	Proconnesos	4,9	955	0,70	46	17	143	0,285	922	440	5,7	45,0	18180,8	-1,63	3,48
5988	FRM 260	Corinthian capital	Proconnesos	64,4	2957	0,80	49	11	139	0,076	1444	259	3,8	9,3	1026,4	-0,96	3,48
5963	FRM 233	Corinthian capital	Proconnesos	0,0	2854	5,57	244	17	684	0,385	456	564	3,7	17,1	1212,8	-1,92	2,57
5940	FRM 206	Corinthian capital	Proconnesos	7,7	2234	0,89	74	31	247	1,375	1378	2072	4,2	19,5	593,8	-3,00	3,58
5987	FRM 259	Corinthian capital	Proconnesos	96,6	1210	0,87	106	51	247	1,028	1102	440	3,0	31,6	6009,8	-2,95	3,69
5994	FRM 267	Corinthian capital	Proconnesos	45,3	979	0,70	55	47	191	0,574	612	308	0,6	32,1	15225,1	-0,47	3,82
8480	FRM 268	Corinthian capital	Proconnesos	96,3	9781	0,99	111	24	172	0,12	88	40	0,6	4,2	4091,7	-2,02	3,46
8481	FRM 269	Corinthian capital	Proconnesos	51,0	11059	1,60	76	45	124	0,794	346	63	1,4	5,2	4078,6	-1,50	3,84
8482	FRM 302	Corinthian capital	Proconnesos	65,8	2500	2,93	104	36	160	1,371	1176	457	4,1	20,8	2303,7	-2,08	2,17
5941	FRM 207	Corinthian capital	Penteli	29,2	3948	1,17	274	60	161	1,222	1998	340	2,8	2,2	115,7	-5,38	2,73
5947	FRM 215	Corinthian capital	Penteli	41,0	10104	1,06	274	53	168	0,915	2589	102	4,1	1,8	71,0	-5,12	2,79
8465	FRM 007	Corinthian capital	Penteli	0,1	15605	1,27	469	74	187	1,159	4764	149	4,6	2,5	179,3	-5,50	2,75
5966	FRM 236	Corinthian capital	Thasos	67,3	1867	0,76	49	40	189	0,302	1390	1374	1,1	22,1	1038,5	-0,71	3,84
5992	FRM 264	Corinthian capital	Thasos	70,8	1100	0,49	57	27	243	0,677	951	445	3,0	98,2	38586,7	-0,70	3,84
5995	FRM 270	Ionic capital	Proconnesos	92,7	4056	1,06	75	16	204	0,869	1384	216	10,3	24,7	6529,6	-1,64	2,53
5942	FRM 208	Ionic capital	Proconnesos	51,9	3142	2,01	231	13	234	1,131	1336	583	8,3	53,0	1669,8	-1,23	3,09
5943	FRM 209	Ionic capital	Proconnesos	58,0	3017	2,03	186	11	137	1,125	1488	578	5,7	9,2	1233,2	-1,50	2,69
5948	FRM 218	Ionic capital	Proconnesos	82,6	4466	4,62	99	10	160	0,283	1408	240	6,4	11,0	784,9	-1,30	3,52
5949	FRM 219	Ionic capital	Proconnesos	89,4	2550	2,70	106	11	145	0,134	1790	261	8,2	10,2	1242,1	-1,64	3,72
5950	FRM 220	Ionic capital	Proconnesos	68,7	1696	1,41	41	10	143	0,124	886	452	3,8	19,3	1597,2	-1,28	3,44
5952	FRM 222	Ionic capital	Proconnesos	49,1	2167	1,39	64	9	203	0,206	1401	326	11,9	51,8	1092,2	-1,31	1,58
5954	FRM 224	Ionic capital	Proconnesos	88,2	1977	1,85	95	14	280	0,649	1775	475	10,2	35,8	3962,8	-1,99	3,15
5955	FRM 225	Ionic capital	Proconnesos	96,0	2845	1,52	61	10	175	0,264	1220	235	4,3	22,5	2694,4	-1,67	3,08
5957	FRM 227	Ionic capital	Proconnesos	51,4	2962	1,44	102	11	257	0,325	1251	239	14,9	68,9	1514,3	-1,50	2,63
5958	FRM 228	Ionic capital	Proconnesos	77,1	4293	1,66	65	10	236	1,135	1317	258	7,3	16,8	1519,8	-3,53	3,04
5959	FRM 229	Ionic capital	Proconnesos	92,1	2028	0,94	61	9	187	0,280	1505	405	8,8	22,2	963,2	-2,06	2,56
5960	FRM 230	Ionic capital	Proconnesos	87,5	5429	4,51	171	18	196	1,322	1937	234	10,9	31,5	550,2	-3,36	2,77
5961	FRM 231	Ionic capital	Proconnesos	97,8	4076	1,29	50	8	168	0,164	1313	134	8,5	30,3	809,7	-2,10	3,36
5968	FRM 239	Ionic capital	Proconnesos	96,4	4067	1,29	80	17	184	0,521	1420	122	6,7	32,0	333,1	-2,87	3,19
5970	FRM 241	Ionic capital	Proconnesos	91,2	2389	1,42	77	15	159	0,259	1693	246	5,7	12,6	908,8	-1,66	3,22
5971	FRM 242	Ionic capital	Proconnesos	99,6	2304	0,88	59	10	157	0,111	1581	207	7,5	21,3	1142,1	-2,20	2,80
5972	FRM 243	Ionic capital	Proconnesos	62,9	3250	1,26	67	10	145	0,290	1645	511	7,6	30,6	952,6	-3,38	2,95
5973	FRM 244	Ionic capital	Proconnesos	42,6	2622	1,53	80	13	249	0,762	1152	329	13,4	35,5	2331,3	-1,18	2,89
5974	FRM 245	Ionic capital	Proconnesos	75,7	2817	1,47	51	10	177	0,283	1341	167	7,8	23,3	1243,1	-1,04	3,57

Table 1: Median contents of the analyzed variables. Stable isotopes are presented in the usual δ quotation. The results of the fluid analyses are normalized to Na*1000. DS (dissolved solids in ppb) is the sum of the main ions (Na, K, and Cl in ppb) of the leaching procedure. Trace element contents are given in pp.

Lab no.	Sample no.	Artifact	Quarry	Absolute probability	DS	$MgCO_3$	Fe ppm	Mn ppm	Sr ppm	Li/Na	Cl/Na	K/Na	Br/Na	I/Na	SO_4/Na	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰
5975	FRM 246	Ionic capital	Proconnesos	97,4	2704	1,57	80	12	143	0,733	1485	246	4,6	7,3	642,7	-1,75	2,95
5977	FRM 248	Ionic capital	Proconnesos	67,1	1781	0,85	49	10	143	0,246	1085	257	6,7	18,4	554,8	-0,85	2,85
5978	FRM 249	Ionic capital	Proconnesos	42,8	2609	6,25	42	10	209	0,209	1676	263	6,0	14,2	1866,7	-1,18	3,13
5979	FRM 250	Ionic capital	Proconnesos	76,2	5137	1,22	53	10	133	0,045	1139	125	6,7	23,4	752,4	-1,00	2,87
5980	FRM 251	Ionic capital	Proconnesos	99,6	3014	2,51	99	30	158	0,303	1286	271	2,8	6,2	2253,2	-2,14	3,01
5982	FRM 253	Ionic capital	Proconnesos	85,1	2470	1,67	77	16	153	0,169	1759	258	5,0	8,4	1070,1	-2,18	3,76
5983	FRM 255	Ionic capital	Proconnesos	77,7	3927	2,04	221	19	203	1,180	1471	193	8,4	52,2	1619,8	-2,68	2,52
5984	FRM 256	Ionic capital	Proconnesos	82,3	2991	2,01	75	16	145	0,161	1738	301	4,9	8,5	9732,2	-1,91	3,73
5985	FRM 257	Ionic capital	Proconnesos	22,4	3607	1,07	55	16	126	0,207	1659	1006	8,7	15,2	1468,2	-3,26	2,94
5989	FRM 261	Ionic capital	Proconnesos	74,6	2908	0,79	66	10	144	0,433	1237	404	7,0	13,6	8081,3	-1,31	2,83
5991	FRM 263	Ionic capital	Proconnesos	65,2	3630	1,30	85	18	153	0,549	1274	196	7,9	33,9	1531,6	-1,03	3,19
5993	FRM 265	Ionic capital	Proconnesos	56,7	2141	0,91	72	11	171	0,468	1107	227	9,2	26,7	7028,9	-0,78	2,45
5463	FRM 061	Ionic capital	Penteli	84,3	11222	1,52	300	61	177	0,547	2000	215	3,6	2,7	4362,5	-6,11	2,64
5464	FRM 062	Ionic capital	Penteli	42,8	13166	1,28	287	158	160	1,195	2057	558	3,3	2,0	114,1	-7,97	2,61
5944	FRM 210	Ionic capital	Penteli	46,5	8938	1,40	344	219	194	1,272	2564	110	5,5	3,2	73,8	-8,73	2,90
5946	FRM 214	Ionic capital	Penteli	41,5	8878	1,30	129	93	265	1,119	2374	117	4,6	3,4	88,6	-8,98	3,12
5967	FRM 237	Ionic capital	Penteli	80,1	11140	1,93	349	180	159	1,744	2127	93	4,6	2,4	90,7	-7,48	2,76
5976	FRM 247	Ionic capital	Thasos	47,6	6163	1,42	63	19	177	0,596	1542	117	5,4	52,1	1113,5	-0,30	2,46
5951	FRM 221	Ionic capital	Thasos	58,8	1444	1,15	71	28	165	0,627	1384	437	5,7	62,0	500,7	-0,45	2,96
5953	FRM 223	Ionic capital	Thasos	67,6	1001	0,69	42	15	184	0,221	1449	656	4,8	64,9	568,4	-1,08	3,92
5470	FRM 069	column shaft	Proconnesos	47,0	1130	1,25	89	17	191	0,329	989	419	8,7	20,6	3894,6	-1,48	2,38
5939	FRM 189	column shaft	Proconnesos	76,9	5229	2,20	73	8	249	0,289	1178	387	4,7	16,5	668,6	-3,35	2,67
8474	FRM 162	column shaft	Proconnesos	80,0	7634	2,65	106	21	171	1,799	1393	203	4,1	11,4	10298,9	-2,46	3,49
8476	FRM 192	column shaft	Proconnesos	50,8	3857	9,19	116	12	224	0,397	1578	358	7,6	28,2	1891,9	-2,64	2,48
8477	FRM 194	column shaft	Proconnesos	2,9	17033	3,80	193	15	468	1,197	1054	171	4,9	16,3	1628,9	-2,14	2,58
8475	FRM 177	column shaft	Penteli	12,4	4993	1,80	1024	89	221	1,190	1787	271	3,0	3,8	2609,7	-6,59	2,57
5469	FRM 068	column shaft	Thasos	48,6	9370	1,87	78	22	204	0,629	1333	123	4,7	57,0	34,2	-0,39	2,69
8478	FRM 295	column shaft	Thasos	0,0	3103	0,88	840	67	168	2,289	1356	1339	3,4	30,2	542,5	-4,06	2,64
5964	FRM 234	column base	Proconnesos	86,7	1947	1,49	54	9	197	0,216	1292	243	3,7	11,3	424,2	-1,92	3,75
8466	FRM 087	column base	Proconnesos	59,3	2761	1,77	136	20	179	1,114	1327	341	7,1	55,0	4053,6	-2,25	3,41
8467	FRM 096	column base	Proconnesos	4,1	3792	0,68	100	22	366	0,348	473	286	0,4	1,1	3172,5	-4,51	2,94
8470	FRM 100	column base	Proconnesos	47,4	4178	3,35	528	55	230	0,743	1416	823	3,9	5,1	348,6	-3,19	2,41
8471	FRM 103	column base	Proconnesos	37,1	12327	14,90	76	92	164	0,483	1452	167	2,4	10,9	3728,2	-0,91	3,08
5459	FRM 057	column base	Penteli	90,7	7568	1,02	153	45	155	1,209	2113	136	2,8	2,2	121,9	-6,70	2,69
5460	FRM 058	column base	Penteli	86,7	5913	1,16	316	99	199	1,178	2129	230	4,9	3,3	188,5	-7,15	2,77
5461	FRM 059	column base	Penteli	53,5	4449	0,97	279	70	174	0,858	1882	338	3,2	3,2	179,3	-6,49	2,68
5462	FRM 060	column base	Penteli	98,0	7214	1,22	327	115	197	1,334	2063	169	3,9	3,6	140,3	-6,95	2,88
5467	FRM 066	column base	Penteli	14,2	12333	1,13	385	178	184	1,161	2282	135	5,2	5,3	92,2	-3,63	2,48
5468	FRM 067	column base	Penteli	0,5	30458	3,01	1119	150	154	1,683	2164	166	3,2	2,5	168,4	-5,48	4,31
8472	FRM 104	column base	Penteli	72,7	17268	3,62	650	168	182	0,924	2037	300	4,0	3,3	8349,4	-7,18	2,87
8473	FRM 106	column base	Penteli	56,1	20186	2,43	415	137	247	0,780	2128	131	3,9	2,9	1256,6	-7,12	3,01
8469	FRM 098	column base	Berkovica	94,7	4862	0,57	1977	112	168	3,683	1904	1458	2,8	1,1	1492,6	-12,21	0,83
5465	FRM 063	slab	Berkovica	0,4	2582	0,50	889	83	143	0,762	1388	557	2,8	3,7	247,8	-10,41	0,70

Table 1: (*continued*).

Lab no.	Sample no.	Artifact	Quarry	Absolute probability	DS	$MgCO_3$	Fe ppm	Mn ppm	Sr ppm	Li/Na	Cl/Na	K/Na	Br/Na	I/Na	SO_4/Na	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰
5466	FRM 064	slab	Berkovica	0,8	1829	0,55	899	81	156	0,475	1042	700	3,4	6,5	571,2	-9,81	0,60
5471	FRM 070	slab	Berkovica	2,4	2193	0,95	2199	313	229	3,065	868	704	2,7	9,8	115,0	-6,27	0,03
5476	FRM 075	Slab	Berkovica	7,0	2246	0,54	3187	99	150	0,502	937	979	2,1	2,5	322,8	-12,03	0,72
5477	FRM 076	Slab	Berkovica	22,7	3526	0,40	1693	152	135	0,311	1505	609	3,0	0,7	100,5	-12,48	0,40
5479	FRM 078	Slab	Berkovica	78,2	7552	0,53	2154	70	126	0,727	1495	804	1,2	0,6	56,6	-10,46	0,23
5480	FRM 079	Slab	Berkovica	8,0	2461	0,36	949	122	122	0,933	1572	971	2,1	3,7	122,5	-12,24	0,97

Table 1: Median contents of the analyzed variables. Stable isotopes are presented in the usual δ quotation. The results of the fluid analyses are normalized to Na*1000. DS (dissolved solids in ppb) is the sum of the main ions (Na, K, and Cl in ppb) of the leaching procedure. Trace element contents are given in pp. (*continued*).

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SERIAL IMPORTS OF TROAD GRANITE SHAFTS IN THE LARGE EASTERN MEDITERRANEAN ISLANDS

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Abstract

Troad granite was one of the types of stone most commonly used in the Mediterranean for column shafts. It was soon found to be the best substitute for granito del Foro, the production of which was under the direct control of the imperial household and almost exclusively used for buildings in Rome.

In Crete and Cyprus we document numerous shafts made of Troad granite, most of them of medium size, therefore indicating that they came from quarry sectors under the control of private individuals. Here we present a non-exhaustive catalogue of these pieces from these two islands aimed at facilitating an initial analysis of their use, location and provenance. It is also surprising to see that a large number of these shafts were reused in Christian basilicas, a result of the key role that must have been played by certain bishops in the process of dismantling and reusing architectural elements from ancient buildings that had fallen into disuse.

E.G., J.A.D., P.P., I.R.

Keywords: Troad, Cyprus, Crete.

Introduction

Troad granite was one of the most common types of stone used for column shafts from the 2nd century AD in the Mediterranean Basin, together with cipollino, Prokonnesos, Thasos marble and Syenite granite. Troad granite shafts were normally combined with prokonnesian bases and capitals, a fact that presupposes, as Ward-Perkins pointed out, the existence of a standardised production coordinated with that of other quarries and distributed throughout the Mediterranean.

This situation is corroborated in public architecture of Cyprus and Crete, where it is surprising to see the large quantity of shafts made of this stone, many of them reused in large Christian basilicas and medieval castles, together with prokonnesian capitals and bases.

The aim of this research is to analyse the use of Troad granite in those two islands and for this purpose we present a brief preliminary catalogue of the documented shafts made of that material[1]. Though preliminary, the number of pieces compiled is sufficient to study the use of Troad granite in these areas, taking into account their geographical distribution, the most frequently-used sizes, their recovery as *spolia* for use in late Roman constructions.

[1] We are not presenting an exhaustive compendium, as we are aware that we have not included every piece in existence.

A major distribution throughout the Mediterranean

Troad granite shafts are documented throughout the Mediterranean (Tab. 1)[2]. Most of them are small- and medium-sized (between 3-5 m and 6-7 m). They include approximately 45 examples from Tarraco (15 feet high)[3], 11 examples from Astigi (Écija) (20 feet high)[4], 52 examples from Aquileia (12 of them 20 feet high, probably from the stage of the Roman Theatre)[5] and those reused in the Monreale Basilica near Palermo (Sicily). However, there is no lack of gigantic examples in buildings we assume having been of imperial commission, such as those of the Baths of Antoninus in Carthage (40 feet high) and those of the Traianeum in Italica (30 feet high).

Province	No. of shafts
Tarraconense	47
Baetica	25
Gaul	>25
Regio I Latium et Campania	50
Regio II Apulia et Calabria	>6
Regio III Lucania et Brutii	>14
Regio VII Etruria	>4
Regio VIII Aemilia	1
Regio X Venetia et Histria	>52
Sicily	>83
Dalmatia	4
Proconsular Africa	>71
Egypt	>2
Syria and Palestine	>88
Asia Minor	>5

Table 1: Troad granite shafts in the Mediterranean area.

Unlike most of the rest of the Mediterranean, this stone was sparsely used in Rome. Those cases in which it is found in public architecture – in imperially commissioned buildings – are restricted to the Severan period. In this respect, we can cite a shaft fragment belonging to the restoration of the stage in the Theatre of Pompey (with a diameter of 1.10 m, which allows us to estimate its height at approximately 8.90 m); the shafts from the outer zone of the Baths of Caracalla, with a height of about 20 feet; and the reconstruction of the Portico of Octavia, restored with reused material following the fire of AD 191. This absence of Troad granite shafts in the public monuments of Rome could be explained by two factors:

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[2] Previous studies must be considered and mentioned, including Pensabene, Bruno 1998, 20-21, fig. 19; Lazzarini 2009, 462-463, fig. 9. With regard to the studies we have published previously (Rodà *et al.* 2012, 210-227; Pensabene *et al*. 2015, 311-322; Pensabene *et al*. 2018, 613-620), in which we have constantly updated the number and locations of the Troad shafts around the Mediterranean, we can now add some new pieces documented recently by I. Rodà. We refer specifically to 8 shafts found in the town of Uzès, ancient *Ucetia* (Department du Gard, Languedoc-Roussillon, France), currently reused in the ducal palace (four in the main door and four flanking entrance portico at the end of the main courtyard), although they came from the Capuchin monastery. These pieces, with a circumference of some 150 cm and a diameter of some 48 cm, would have been combined not with Prokonnesos marble capitals, as was habitual with Troad granite, but with local white limestone. Another shaft was found reused as a holy water font in the church of Saintes Maries de la Mer in the Camargue (France). We will leave for a forthcoming publication a more detailed study of the shafts in the areas of Türkiye, Syria and Palestine, in which we will present some previously unpublished material. Moreover, recent surveys carried out at Salamis in Cyprus allowed the recording of at least 25 shafts of Troad granite in the Granite Forum of the city. The timing of publication of this article did not allow the inclusion of this data, which however will be treated in forthcoming papers.

[3] Rodà *et al*. 2012, 210-213.

[4] Felipe 2008, 117-128; Felipe, Márquez 2014, 170.

[5] Pensabene 2006, 365-421; Pensabene 2010, 582-644.

- The most frequently used grey granite in Rome in the 1^{st}-2^{nd} centuries AD was that from *mons Claudianus*, whose quarries were under imperial control and whose production was destined mainly for Rome[6]. In fact, the largest known granite shafts come from these quarries and those of Aswan[7]. We can mention the 50-foot-high shafts in Trajan's Forum that, judging by their size, would have belonged to the nearby temple of *Divus Traianus*, as well as the 30-feet-high shafts of the Basilica[8]; seven of the eight frontal shafts of the Pantheon, which are 40 feet high[9]; more than 70 shafts with a height of just under 8 m in the large portico around the Temple of Venus and Roma[10]; several shafts from the Baths of Caracalla with a height of 40 feet[11]; two shafts found abandoned in the quarry with a height of 60 feet, perhaps destined for the Temple of Serapis built by Aurelian in Rome[12]; and finally, some examples in the Baths of Diocletian[13].
- From the Severan period on, Troad granite shafts accumulated in the port warehouses of the Troad, Alexandria and Portus[14], a circumstance that would also have facilitated their use in the *urbs*. The build up of a large number of Troad shafts in the warehouses is demonstrated by the fact that, in later periods, builders frequently used shafts that had never been employed in any building; before for example, in Diocletian's Palace in Split or in Rome, where the presence on some shafts of initials inscribed in those warehouses would support that possibility (for example, on the shafts used in the 6^{th} century AD in the church of Santo Stefano Rotondo[15]).

This accumulation of material in the warehouses of Rome could explain the presence of small and medium-sized Troad granite shafts in various late Roman churches in the city. In reality, above all the shafts that still present half-worked collars would have come from those warehouses. In this case, the incomplete shafts would have been stored awaiting export to the western provinces, which never came about. This is why they were available to be used in the late Roman and medieval periods. However, during that time shafts from ruined or demolished monuments would also have been stored in warehouses.

It was precisely the expansion in the use of grey granito del Foro shafts in the imperial architecture of Rome, together with the fact that this variety of stone, as we have said, was in the hands of the imperial authority and therefore not included in the commercial circuits (it is not found in provincial architecture, except for some small blocks, surplus pieces from the quarries or cutting rejects that were frequently used for plaques or cladding[16]), that favoured

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6 Peacock 1993; Peacock *et al.* 1994; Fant 1993, 159; Corcoran, Delaine 1994, 272; Pensabene 2013, 233.

7 Some of them with a diameter greater than 140 cm. Shafts with a diameter of more than 100 cm can also be observed in the quarries of Sardinia, Elba and Giglio. Only one granite column from one of the quarries located in the southwest of Spain exceeds that size; shafts made with Spanish granite were generally 60 cm or less in diameter, Williams-Thorpe 2008, 82, fig. 5. This author does not indicate exactly which shaft it is or the quarry it would have come from.

8 Pensabene 2013, 232, 238; Pensabene, Domingo 2017, 529-531, 533, tab. 2.

9 Wilson 2000, 190-212, 220.

10 Pensabene 2013, 246.

11 Delaine 1997, 33, 58, 263.

12 Peacock, Maxfield 1997, 214.

13 Pensabene 2013, 240. Other colossal columns in Rome were made of different types of stone, such as Aswan granite, which is found in the Severan phase of the Hall of Worship in the *Forum Pacis*, with 16-metre-high (14.85 feet) shafts; the Proconnesus marble found in the shafts of the temple of Venus and Roma, with 17.76-metre-high columns, or the cipollino marble in the shafts of the Temple of Antoninus and Faustina, with a height of 11.80 m. In Rome, only in very rare cases during the Severan period was Troad granite used to make large shafts.

14 Feuser 2011, 256-273. For the trade of marble from Porto, see Pensabene 2012; Keay *in press*.

15 At least six of these columns in Troad granite have the upper and lower collar unworked. They had obviously been taken from a store to add to those reused from other buildings to make up the number needed, Brandenburg 2009, 143-202; Pensabene 2015, 240, note 303.

16 Fant 1993, 159; Corcoran, Delaine 1994, 272; Pensabene 2013, 233.

the expansion of Troad granite in the provinces, where the elites were always ready to follow the latest fashions from Rome. It was a stone whose tonality and characteristics made it a suitable substitute for granito del Foro and it could be mass produced at a lower cost under a very well developed exploitation system.

P.P., J.A.D., I.R.

The organisation of production and transport

As with those made of cipollino marble, Troad granite shafts were normally accompanied by prokonnesian bases and capitals. Ward-Perkins believed this was evidence of coordination between the Troad, Euboea and Proconnesus quarries, which would have been possible thanks to a production system based on standardised sizes. For example, the Troad granite shafts have heights of 10, 12, 14, 16, 18, 20, 30 and 40 feet.

The fact that most of the Troad granite production was destined not for imperially-commissioned buildings, but for those promoted by the towns and their elites, leads us to believe that the control of their quarries was in private hands. At the same time, the presence of colossal shafts made in this stone and destined for imperially-commissioned projects in the provinces and in Rome also allows us to suppose that there would have been a certain amount of state control. It is possible that this imperial control was exercised mainly in those sectors of the quarries that were specialised in the production of large shafts and only when there was a demand for such items. We have previously indicated in another publication how the probable presence of a district specialised in the production of colossal shafts, such as Koçali, probably presupposes state control of its production[17].

On the basis of the size of the shafts it is possible to establish two possible commercial routes. We would surmise a direct importation from the Troad quarries for the shafts of a larger size, such as those of the Antonine Baths in Carthage (40 feet high with an estimated weight of 55 tons each) or for those reused in the late Roman building in Seville's Mármoles Street, which undoubtedly came from the Traianeum of Italica (30 feet high). We assume they were transported in ships able to carry such a heavy cargo, even more so if the buyer was the emperor himself or the municipality or the governor of the province. On the other hand, the small or medium-sized shafts could have come from the marble stores run by *negotiatores* or the imperial administration, which were situated near the main harbours. One of these would have been Portus and we can suppose that the imperial government would have sent shafts to Africa as a return cargo on the ships that had brought wheat to Rome and the same could have happened in the case of olive oil arriving in Rome from Baetica. Shafts from the private deposits may have been sent to smaller towns or to local customers to decorate the public spaces of their respective municipalities. However, the gaps in our information do not allow us to reconstruct the trading circuits of those shafts with any certainty.

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The presence of Troad granite in Cyprus and Crete

The majority of the Troad granite shafts on the islands of Cyprus and Crete correspond to small and medium-sized examples with a height of around 4-5 m and a diameter of between 44 and 67 cm[18], although we also find some larger examples, such as the four shafts reused in the Basilica of Chrysopolitissa in Nea Paphos, which have a diameter of 93-94 cm (Fig. 1), and an example in the outer row of the so-called "Great Portico" of Gortyna, with a diameter of 85.5 cm.

We have already stated that it is not our aim here to provide an exhaustive catalogue of all the Troad granite shafts present on those islands. Having said that, the pieces we have been able to document, thanks to an *in situ* supervision of the main archaeological sites and

[17] Pensabene *et al.* 2018, 618.
[18] Regarding the value of the latter for the shafts from Cyprus: Williams-Thorpe, Webb 2002, 343 and fig. 2.

the integration into this compendium of the catalogue made by O. Williams-Thorpe and P.C. Webb in Cyprus[19], are sufficient to be able to undertake an initial analysis of the use, location and origin of those shafts (Tab. 2a-2c)[20].

The analysis revealed the large number of imported shafts on both islands: about 94 in Cyprus, to which we have to add numerous fragments with a preserved height of less than one metre[21], and more than 25 examples in Crete, among which we can highlight the examples kept in the *Praetorium* of Gortyna (Fig. 2). Without doubt, the proximity of the islands to the Troad quarries and the possibility of undertaking all the transportation by sea were decisive factors in the mass importation of these pieces.

Figure 1: Shafts reused in the Basilica of Chrysopolitissa in Nea Paphos, Cyprus.

Figure 2: Shafts preserved in the *Praetorium* of Gortyna, Crete.

Nevertheless, despite the large number of shafts, the majority are concentrated in very few places. Of the 94 shafts documented in Cyprus, 89 are from Nea Paphos, only three from Kourion and two (of unknown origin[22]) are in the Nicosia Folk Art Museum. In Crete, all the shafts are concentrated in Gortyna and Heraklion-Knossos.

One challenge we face in the analysis of the use of Troad granite is that many of the shafts are found out of context or reused in later buildings: 3 examples in the Basilica of Kourion (Fig. 3), 22 in the Basilica of Chrysopolitissa in Nea Paphos and its surroundings (Fig. 4), various examples in the Basilica of Gortyna and 12 shafts in the Basilica of Aghios Markos in Heraklion. Nonetheless, in some cases it is possible to identify the origin of these shafts. We know, for example, that a large part of the examples from Nea Paphos came from the porticoes built in the 2nd century AD on the two main roads of the town, the *Cardo Maximus* and the *Decumanus Maximus*[23]. Many of these were reused in the Christian Basilica in Saranda Kolones castle (Figs. 5-6), embedded in the 19th and 20th century walls or displayed in various modern parks and gardens[24]. In fact,

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[19] Williams-Thorpe, Webb 2002, 339-364.

[20] In the "Number of shafts" column we have compiled the data from O. Williams-Thorpe and P. C. Webb's catalogue, while in tabs. 3b and 3c we have included the shafts from two specific buildings where we have personally verified the measurements and other particularities.

[21] Regarding the Troad shafts of Cyprus, see: Williams-Thorpe, Webb 2002, 339-364.

[22] Williams-Thorpe, Webb 2002, 342 and appendix.

[23] Barker 2016a, 15-16.

[24] Barker 2016a, 15.

more than 30 fragments come from the vicinity of the *Decumanus* (Fig. 7)[25]. On the other hand, it is highly likely that the shafts reused in the Basilica of Aghios Markos in Heraklion came from the Roman Theatre of Knossos[26].

Figure 3: Shaft reused in the Basilica of Kourion, Cyprus.

The presence of many Troad granite shafts reused in the Christian basilicas of both islands tells us of the important role played by the bishops of the towns in dismantling ancient public buildings. We know that in the AD 380 some bishops encouraged such actions with the aim of destroying the pagan temples and their cults[27]. It is also likely that they would have participated in the recovery of materials from the main public buildings that had fallen into disuse, such as the Theatre of Nea Paphos, from where some of the *spolia* were reused in the Chrysopolitissa Basilica[28], there, as we have already said, some Troad granite shafts from the portico of the *Decumanus Maximus* were also reused.

It is also significant that the larger Troad granite shafts (24 feet or 7 metres in height), which we assume came from important public buildings, are found reused in the Basilica of Nea Paphos[29], specifically in the two colonnades of the naves on the right of the Basilica, together with examples of the same size in cipollino marble[30]. The presence of these shafts in the Basilica reinforces the notion of the important role played by the bishops in acquiring and dismantling ancient buildings in the towns. We could even believe that some of them may have participated in the sale of these architectural elements, columns and capitals to other regions, particularly to Cyrenaica, where the basilicas, for example that of Apollonia, contain numerous columns in Troad granite, a type of stone rarely used in the Roman public buildings in that region.

Finally, we have to point out that in the Middle Ages Cyprus was frequently exposed to the plundering of architectural elements by the island's invaders. For example, in the 12th century the Normans apparently removed a group of capitals from the Basilica of Campanopetra in Salamis to reuse them in Messina[31].

E.G.

[25] Barker 2016a, 14.
[26] Hood, Smyth 1981, No. 110; Pensabene, Lazzarini 2004, 771.
[27] Deligiannakis 2018, 33.
[28] Barker 2016b, 147. In Crete, around 400 AD there were no less than 15 bishops, Deligiannakis 2018, 30-32.
[29] Barker 2016a, 16.
[30] The Basilica was divided into five naves separated by four colonnades of twelve columns. The two innermost colonnades, which supported reused Asiatic-Corinthian capitals, rested on reused Attic bases (on the side of the plinth 90 x 90 cm and a height of 58 cm) situated on pedestals, while the two outermost colonnades rested on Attic bases situated above very low pedestals formed by small blocks resting directly on the stylobate. The upper torus of these bases is very disfigured and almost aligned with the listel that borders the scotia at the top.
[31] Barsanti 1991, 515-523.

Figure 4: Shaft preserve d in the *Lapidarium* next to the Basilica of Chrysopolitissa in Nea Paphos, Cyprus.

Figure 5: Shafts reused in Saranda Kolones castle in Nea Paphos, Cyprus.

Figure 6: Shafts reused in Saranda Kolones castle in Nea Paphos, Cyprus.

Figure 7: Shaft preserved in the area of the theatre of Nea Paphos (Cyprus), near the *Decumanus Maximus*.

Conclusions

The dimensions of the shafts documented in Cyprus and Crete, whose height generally does not exceed 5 metres, except for a few examples that are as much as 7 m tall, confirm their origin in the sectors of the Troad quarries not directly controlled by the state, but by the city of Alexandria Troas and its elites. Moreover, their dimensions agree with the most common measurements of the shafts exported throughout the Mediterranean.

The presence of a large number of shafts made of this stone on both islands can be explained in part by the role it played as a substitute for granito del Foro. The latter, which was significantly more expensive and whose production was controlled directly by the imperial household, created a fashion that favoured an interest in using grey granite in provincial architecture. The position of the Troad quarries near a port that was well equipped for loading heavy monoliths led to this becoming the most widely distributed grey granite throughout the Mediterranean, as we have had the occasion to observe in various recently published studies[32]. This explains why, in the period of maximum economic development of the islands of Crete and Cyprus, when the elites of the towns wished to adapt their public monuments to the official architecture of the empire, the quickest and cheapest source was the Troad quarries.

Another interesting aspect is the frequent presence of this stone in shafts reused in the early Christian basilicas of both islands, which tells us of the important role played at that time by the bishops in dismantling and reusing the construction and decorative materials of ancient buildings that had fallen into disuse.

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[32] Rodà *et al.* 2012, 210-227; Pensabene *et al.* 2015, 311-322; Pensabene *et al.* 2018, 613-620.

	Town	Building	Position	Provenance	Number of shafts	Measurements and observations
CYPRUS	Kourion	Street	Street between the rear of the Basilica and the Forum area	-	2	Diameter 46 cm. Resting on two bases; the one on the left corresponds to a modern restoration and the one on the right is made of Proconnesus marble.
CYPRUS	Kourion	Basilica	Last column on the left of the chancel of the right-hand nave (Fig. 3).	Reused	1 (KOU2)	Lower diameter 50 cm.
CYPRUS	Kourion	Basilica		Reused	1 (KOU1)	Diameter 52 cm.
CYPRUS	Kourion	Basilica		Reused	1 (KOU3)	Diameter 49 cm.
CYPRUS	Nea Paphos	Odeion	Outside site fence	-	1 (ODE1)	Preserved height 157 cm, lower scape diameter 65 cm, scape height 5 cm, lower diameter 58 cm, current upper diameter 56 cm. (Williams-Thorpe, Webb 2002, 353, diameter 59 cm, not including collars). Shaft fragment with the lower scape. It has a hole in the middle of the lower scape.
CYPRUS	Nea Paphos	Odeion	Outside site fence	-	1 (ODE5)	Height 114 cm, diameter 50 cm. (Williams-Thorpe, Webb 2002, 353, diameter 50 cm, not including collars)
CYPRUS	Nea Paphos	Odeion	Outside site fence	-	1 (ODE4)	Diameter 58 cm. (Williams-Thorpe, Webb 2002, 353, diameter 58 cm, not including collars). Shaft fragment with the upper scape.
CYPRUS	Nea Paphos	Odeion	Outside site fence	-	1 (ODE3)	Height 4.64 m, lower scape diameter 63 cm, lower diameter 57 cm, scape height 6 cm, upper diameter 47 cm. (Williams-Thorpe, Webb 2002, 353, diameter 56 cm, not including collars). Probably preserves its full height.
CYPRUS	Nea Paphos	Odeion	Outside site fence	-	1 (ODE2)	Height 96 cm, diameter 54 cm. (Williams-Thorpe, Webb 2002, 353, diameter 54 cm, not including collars). Shaft fragment with the lower scape. It has several restoration holes on all its sides, in one of them there are up to four perforations.
CYPRUS	Nea Paphos	Street	Road to the south of the Theatre	Portico in the *Decumanus*	>30	Column shaft fragments.
CYPRUS	Nea Paphos	Theatre		Portico in the *Decumanus*	Several shafts	Column shaft fragments.
CYPRUS	Nea Paphos	Saranda Kolones	Below east wall	Reused	1 (SAR1)	Diameter 53 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east wall	Reused	1 (SAR2)	Diameter 62 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east wall	Reused	1 (SAR3)	Diameter 59 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east wall	Reused	1 (SAR4)	Diameter 50 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	1 (SAR5)	Diameter 60 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	1 (SAR6)	Diameter 57 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	1 (SAR7)	Diameter 54 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	1 (SAR8)	Diameter 56 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	1 (SAR9)	Diameter 59 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below east buttress	Reused	2 (SAR10-11)	-
CYPRUS	Nea Paphos	Saranda Kolones	Below NE wall	Reused	1 (SAR12)	Diameter 51 cm
CYPRUS	Nea Paphos	Saranda Kolones	Below NE wall	Reused	1 (SAR13)	-
CYPRUS	Nea Paphos	Saranda Kolones	Car park between Saranda Kolones and sea	-	2 (SAR14a-14b)	-
CYPRUS	Nea Paphos	Saranda Kolones	Below N wall	Reused	7 (SAR15a-17; SAR22-24)	-
CYPRUS	Nea Paphos	Saranda Kolones	Below N wall	Reused	1 (SAR21)	Diameter 61 cm
CYPRUS	Nea Paphos	Saranda Kolones	On bank below N wall		3 (SAR18-20)	-
CYPRUS	Nea Paphos	Saranda Kolones	Above NW wall	Reused	1 (SAR25)	Diameter 51 cm
CYPRUS	Nea Paphos	Saranda Kolones	Above N and E walls	Reused	22 (SAR26-36; SAR38-48)	-
CYPRUS	Nea Paphos	Saranda Kolones	E side, built into limestone wall	Reused	1 (SAR37)	Diameter 58 cm
CYPRUS	Nea Paphos	Saranda Kolones	Above W wall	Reused	1 (SAR49)	-
CYPRUS	Nea Paphos	Saranda Kolones	Above W wall	Reused	1 (SAR50)	Diameter 45 cm
CYPRUS	Nea Paphos	Saranda Kolones	Above W wall	Reused	1 (SAR51)	Diameter 62 cm
CYPRUS	Nea Paphos	Saranda Kolones	In and below castle	Reused	5 (SAR52-56)	-

Table 2a: Catalogue of Troad granite shafts in Cyprus and Crete.

	Town	Building	Position	Provenance	Number of shafts	Measurements and observations
CYPRUS	Nea Paphos	Basilica of Chrysopolitissa	At outside corner of present church	Reused	1 (CHR1)	Diameter 93 cm.
			At outside corner of present church	Reused	1 (CHR2)	Diameter 93 cm
			Outside church, excavated aisle	Reused	1 (CHR3)	Diameter 93 cm
			Outside church, excavated aisle	Reused	1 (CHR4)	Diameter 94 cm
			Outside church, excavated aisle	Reused	1 (CHR5)	Diameter 60 cm
			Outside church, excavated aisle	Reused	1 (CHR6)	Diameter 60 cm
			Outside church, excavated aisle	Reused	1 (CHR7)	Diameter 60 cm
			Outside church, excavated aisle	Reused	1 (CHR8)	Diameter 60 cm
			Outside church, apse end	Reused	1 (CHR9a)	Diameter 60 cm
			Outside church	Reused	1 (CHR9b)	Diameter 61 cm
			WNW corner of excavated site	Reused	1 (CHR10)	Diameter 59 cm
			WNW corner of excavated site	Reused	1 (CHR11)	Diameter 60 cm
			WNW corner of excavated site	Reused	1 (CHR12)	Diameter 61 cm
			At the side of the road outside church	Reused	1 (CHR13)	-
			At the side of the road outside church	Reused	1 (CHR14)	Diameter 53 cm
			At the side of the road outside church	Reused	1 (CHR15)	Diameter 47 cm
			At the side of the road outside church	Reused	1 (CHR16)	Diameter 49 cm
			At the side of the road outside church	Reused	1 (CHR17)	Diameter 58 cm
			Next to the present church entrance	Reused	1 (CHR18)	Diameter 60 cm
			Outside site, ca 30 m from entrance	Reused	1 (CHR19)	-
			Inside site entrance	-	1 (CHR20)	Diameter 60 cm
			Built into base of present church wall	-	1 (CHR21)	-
	Nea Paphos	19th and 20th century walls		Reused	Several shafts (ROMFOR1-2)	Various column shaft fragments
		Parks and gardens		-	Several shafts	Various column shaft fragments
		Limeniotissa Basilica		Reused	1 (LIM1)	Diameter 60 cm.
				Reused	1 (LIM2)	Diameter 66 cm.
	Nicosia	Folk Art Museum	Courtyard outside Museum	Unknown	1 (FAM2)	Diameter 44 cm.
			Courtyard outside Museum	Unknown	1 (FAM3)	Diameter 35 cm.
CRETE	Gortyna	Great Portico	In the external row of the so called 'Great Portico'.	-	1	Height 7 m, lower scape diameter of 85.5 cm. Whole preserved column shaft.
		Praetorium	In the Praetorium and near the church discovered north-east of it	-	Several shafts	(Fig. 2).
		Temple of Apollo Pitius	Included inside the cell of the restoration of the Severan age of the temple.	-	< 8	Height 4.5-4.81 m. of the eight shafts preserved in the interior of the *cella*, only some are made of Troad granite.
		Byzantine Basilica		Reused	Several shafts	In the Byzantine Basilica there are several reused shafts made of Troad granite and other types of marble[33]
	Heraklion – Knossos	Church of Aghios Markos at Heraklion		Reused. Probably from the Roman Theatre at Knossos[34]	12	Different heights of 11.5, 13.5 and 15 Roman feet.

Table 2a: Catalogue of Troad granite shafts in Cyprus and Crete (*continued*).

[33] Pensabene, Lazzarini 2004, 767-773.
[34] Hood, Smyth 1981, nº 110; Pensabene, Lazzarini 2004, 771.

Position	Provenance	Number of shafts	Measurements and observations
Next to the castle entrance, north-western corner	Reused	1	Diameter corresponding to the lower fracture of 60 cm approximately, fragment height 3.5 m. The shaft would originally have had a height of about 6 m. (Fig. 5). Column shaft fragment corresponding approximately to the upper half, with the upper scape.
Next to the castle entrance, north-western corner	Reused	1	Column shaft fragment corresponding approximately to the lower half, with the lower scape. (Fig. 5).
Next to the apse	Reused	1	Column shaft fragment probably corresponding to a lower scape. In the middle and on the fractured side it has a hole in which to fit a staple. (Fig. 6).
Next to the apse	Reused	1	Column shaft fragment probably corresponding to a lower scape. In the middle it has a hole in which to fit a staple and a groove probably designed for reassembling the piece. (Fig. 6).
Next to the apse	Reused	1	Column shaft fragment preserving the upper scape (it is possible to see the torus and the lower flat moulding) with a hole in the middle and a groove in which to pour the lead. (Fig. 6).
Door threshold	Reused	1	Column shaft fragment.
Door threshold	Reused	3	Column shaft fragments.
Door threshold	Reused	1	Column shaft fragment. The lower scape has a hole in the middle.

Table 2b: Catalogue of shafts reused at Saranda Kolones, Nea Paphos, Cyprus, of which we have reviewed the measurements and the surfaces of the scapes.

Position	Provenance	Number of shafts	Measurements and observations
Lapidarium next to the Basilica	Stored to the right side of the entrance	1	Height 4.68 m, lower scape diameter 66 cm, lower diameter 54 cm, upper diameter 47 cm, upper scape diameter 54 cm, scape height 7/8 cm. The shaft height is the approximate equivalent of 8.7 times the lower diameter. Completely preserved shaft (Fig. 4).
	Stored to the right side of the entrance	1	Height 4.75 m, diameter of the lower scape 65 cm, lower diameter 54 cm, scape height 7 cm, upper diameter 47 cm, upper scape diameter 50 cm. The shaft height is the approximate equivalent of 8.8 times the lower diameter. Completely preserved shaft.
	Stored to the right side of the entrance	1	Height 4.70 m, lower scape diameter 66 cm, lower diameter 54 cm, scape height 7 cm, upper diameter 47 cm, upper scape diameter 56 cm. Fragment of a column shaft.

Table 2c: Catalogue of shafts reused in the Basilica of Chrysopolitissa, Nea Paphos, Cyprus, of which we have reviewed the measurements and the surfaces of the scapes.

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YELLOW-AND-WHITE BRECCIA IN CHERCHEL, ALGERIA: LOCAL OR IMPORTED?

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Abstract

Fragmentary remains of a yellow-and-white marble or limestone revetment were discovered in the south pool of the West Baths at Cherchel, Algeria, ancient Caesarea Mauritaniae. This was visibly not the beautiful yellow marbles of North Africa, giallo antico (*marmor numidicum*) from Chemtou in northern Tunisia or the breccia of Kristel in northwestern Algeria, and isotopic analysis confirmed the optical evidence. The isotopic ratios, however, are similar to those of breccia romana from Lez, near Saint-Beat on the northern slopes of the Pyrenees. Lez breccia is otherwise rare around the Mediterranean, and the isotopic similarity may be coincidental. The yellow breccia in Cherchel may well be a local stone whose origin cannot yet be identified.

Keywords: isotopic testing, wall revetment, giallo antico, Lez breccia.

The West Baths at Cherchel and remains of its stone revetment

The most impressive Roman bath building in Cherchel, Algeria, *ancient Caesarea Mauritaniae*, is the West Baths, a structure of the late second or early 3rd century (Fig.1)[1]. Not only is the building large, but it also has a rigorously symmetrical plan, which gives it a special dignity and an almost imperial aura; it resembles the famous baths of the emperors Nero and Trajan in Rome in having a large hot room projecting at the center of a symmetrical row of smaller heated rooms. It also has something of an Asiatic flavor, since the row of hot rooms is backed with a parallel row of cold rooms, much as in the Harbor Baths at Ephesos[2]. This grand layout is, in a sense, no surprise, since it is fully in keeping with the high status of *Caesarea* itself, the capital city of the Roman province of *Mauretania*. *Caesarea* was richly endowed with imported Aegean marbles, particularly in Augustan times, when it was the capital of the independent kingdom of Mauretania, a prized ally of the first Roman emperors[3].

At present the baths are used as a storage area for archaeological materials, and it is not immediately apparent which of the detached elements were excavated in the structure. Some fragments of marble pavements and wall revetments, however, do remain firmly in their original places. In square pools flanking the central cold room (Fig. 1, room A), fragments of a yellow and white incrustation remain trapped in the mortar covering the stairs and walls (Figs. 2-3a-c). To our surprise, this breccia was evidently not the famous yellow-and-white *marmor numidicum* (giallo antico) quarried at Chemtou, Tunisia, in ancient Numidia, the province immediately to the east of *Mauretania*. In most cases the yellow of the Cherchel pieces was weaker than the robust yellow typical of *giallo antico*, and the boundaries between the clasts and the matrix were less well defined (Fig. 3b). In some places the white dominated the yellow (Fig. 3c). At times the matrix can be pale pink and the clasts are pinkish white or even pink. Furthermore, the texture of the revetment was porous

[1] Stirling 2016, 265.
[2] Yegul 1982, fig. 9.
[3] Herrmann *et al*. 2017.

("vuggy") and subject to cracking, unlike the hard, smooth surface and cohesive structure of giallo antico. The overall appearance of the better pieces of the revetment were somewhat comparable to the breccia gialla in Borghini's handbook of colored ancient marble[4].

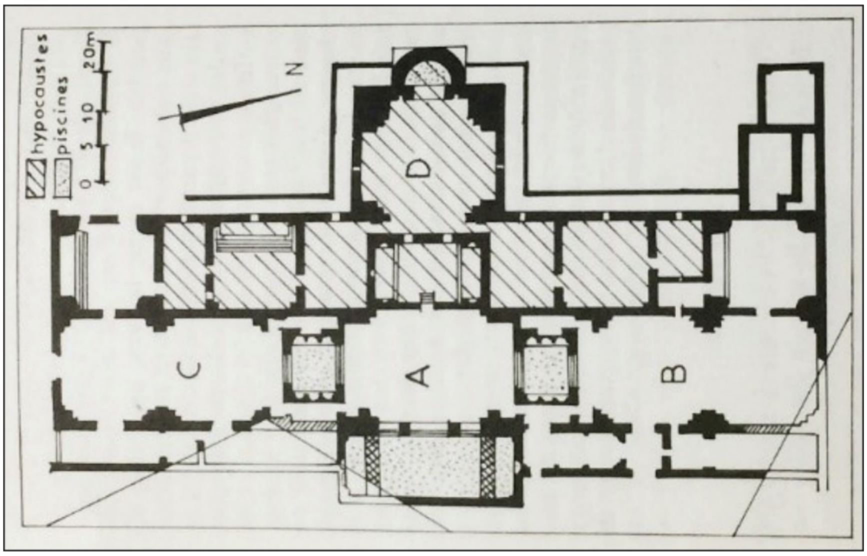

Figure 1: Cherchel, West Baths. A: frigidarium; D: calidarium, (Leveau 1984, Fig. 17).

Figure 2: Cherchel, West Baths, frigidarium pool with marble revetment on steps and walls (Photo: A. Van Den Hoek).

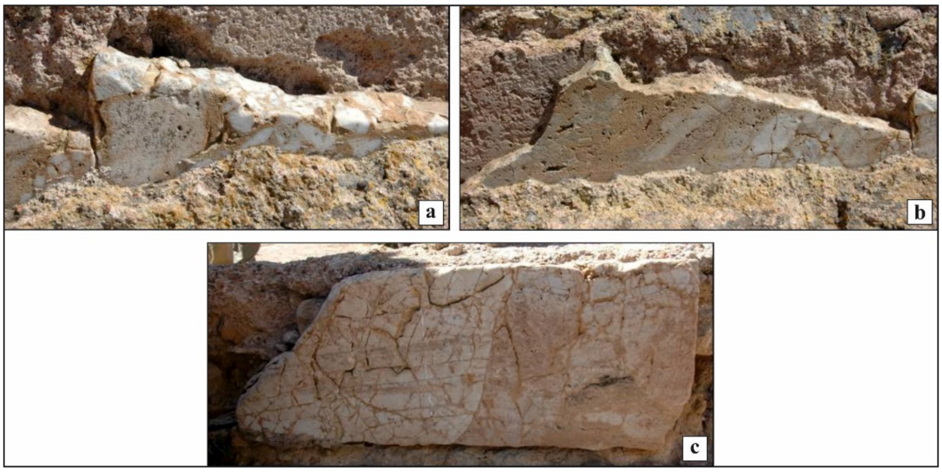

Figure 3a-c: Cherchel, West Baths, frigidarium pool, marble revetment on steps and walls (Photo: A. Van Den Hoek).

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[4] Borghini 1989.

Isotopic analysis of the stone revetment

A tiny chip from a piece of the Cherchel revetment was analyzed at the University of South Florida. Stable isotopes of carbon and oxygen were determined by the customary methods, and maximum grain size was measured:

Cherchel, West Baths, breccia gialla from steps of S. Pool of frigidarium. USF 10980, $\delta^{13}C$ 1.1, $\delta^{18}O$ - 13.0 maximum grain size 2 mm.

Algeria itself has only one known quarry that produces a yellowish breccia; it is located at Kristel on the coast near Oran in the western part of the country and within the territory of the ancient province of Mauretania. One sector of the Kristel quarry produces a breccia with yellow clasts, but its red matrix makes it impossible to confuse with the yellow matrix of the Cherchel revetment. Moreover, the isotopic values of Kristel are quite different from those of the Cherchel plaque[5].

Isotopic comparisons can be extended further: Walter Prochaska has generously provided us with his unpublished diagram of the isotopic fields of several yellow marble quarries certainly or probably used in antiquity (Fig. 4). He includes only the quarries in which he has personally collected samples, and his harvest includes some whose isotopic characteristics are otherwise unknown. He has positioned our sample in the diagram, and it becomes clear that Chemtou does not match the Cherchel breccia isotopically any more than it does macroscopically. Among the other yellow breccias Prochaska has investigated, only a quarry from Ephesos could be a plausible source. Some of his photographs of the Ephesos breccia showed either a monochrome yellow or yellow clasts[6], but one photograph show white clasts in a yellow matrix, as at Cherchel (Fig. 5).

Figure 4: Yellow breccia from Ephesos (Photo: Walter Prochaska).

[5] Herrmann *et al*. 2017, 782-783, figs. 14, 17.
[6] Prochaska website.

Isotopically, however, there is a better possibility than the Ephesos quarry. Annie and Philippe Blanc published a study of a yellow-and-white breccia from the Pyrenees, which also resembles the revetment fragments in Cherchel (Figs. 6-8)[7]. This breche romaine or breccia romana comes from the quarry of La Pène-Saint-Martin at Lez near Saint-Béat. Lez breccia, furthermore, has an isotopic signature almost identical with that of the Cherchel fragment; the yellow matrix is particularly close (Fig. 9). The breccia of Lez can also have rather pallid areas, as at Cherchel (Figs. 3c, 8). The two breccias also have a pinkish tint in some of the clasts.

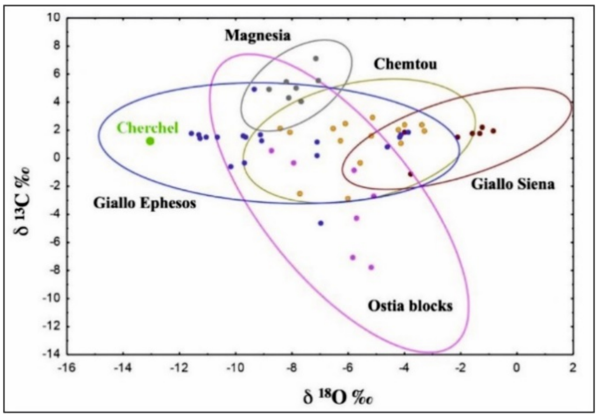

Figure 5: Isotopic values of some yellow marble quarries with sample from revetment of frigidarium pool, West Baths, Cherchel (Graph: Walter Prochaska).

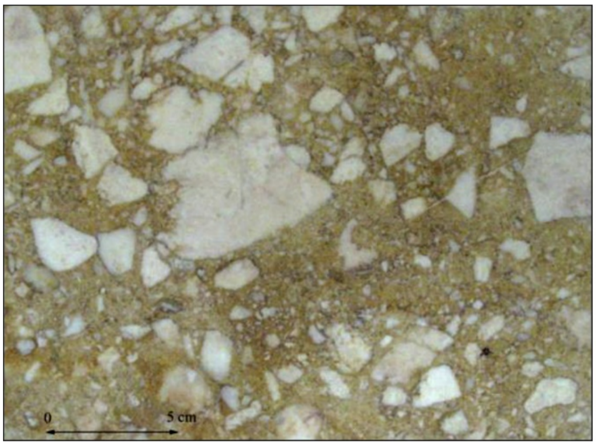

Figure 6: Lez breccia (Roman breccia) in the Museum of Marble, Bagnères-de-Bigorre (Photo: Blanc, Blanc 2009, Fig. 4).

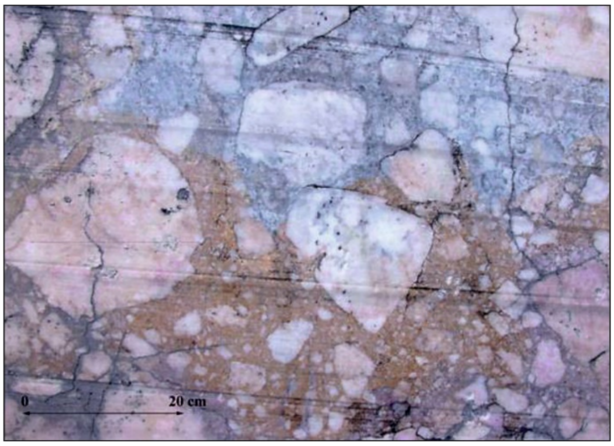

Figure 7: Lez breccia (Roman breccia) photographed in the quarry at Lez (Photo: Blanc, Blanc 2009, Fig. 3).

Figure 8: Lez breccia, "Roman breccia" (Photo: Blanc, Blanc 2009, Fig. 9).

[7] Blanc, Blanc 2009.

A few other fragmentary revetment slabs that could be Lez breccia are preserved in the pavement of archaeological scraps in the courtyard of the Cherchel Museum (Fig. 10). A rain brought out their white clasts and, in this case, a strong yellow-orange matrix. The fragments resemble the more orange sample from Lez (Fig. 7). An additional similarity between the breccias of Cherchel and Lez is the black areas in the matrix that appear in both.

Until recently Lez breccia had not been seen on the shores of the Mediterranean; it is widely diffused in Gallo-Roman sites but only in areas to the north of the Pyrenees. Antonelli *et al.* and Blanc and Blanc have pointed out that it is apparent absent in Provence.[8] But in their study of marble at Urbisalvia near the mid-Adriatic coast of Italy, Fabrizio Antonelli and Lorenzo Lazzarini have identified several examples of Lez breccia[9]. It should be noted that the isotopic values for the Lez quarry they report are substantially different from those reported by the Blancs (Fig. 9). Apparently the yellow-and-white breccia has considerable variations isotopically.

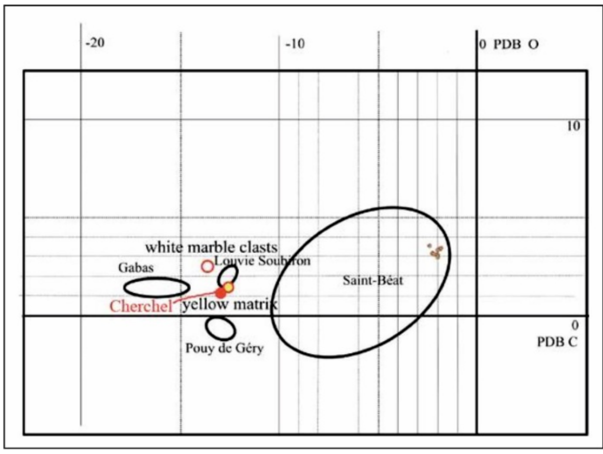

Figure 9: Stable isotopic ratios of carbon and oxygen of Lez breccia (yellow dots) compared with Pyrenean marbles. Diagram with the sample of revetment (red dot) from the West Baths, Cherchel (Graph: Blanc, Blanc 2009, Fig. 7).

Figure 10: Cherchel, Museum courtyard pavement: yellow-and-white breccia (Photo: A. Van Den Hoek).

Limestone wall revetments of local origin in Algeria

The similar isotopic signatures of the yellow and white breccias at Cherchel and Lez could be coincidental. Colored limestones of uncertain but apparently local origin were used in other important buildings in ancient Algeria. Antonelli, Lazzarini, Cancelliere and Dessandier have discussed “a yellow-pinkish fossiliferous limestone” that was used for revetments at Djemila in western Numidia, near the border with Mauretania[10]. The Djemila limestone is much less spectacular than the vividly colored red and yellow marbles of Chemtou and Kristel, and it seems likely that it would have come from a more-or-less local source. The researchers, however, were unable to locate the quarries in a survey of the Djemila region. The same or a similar limestone was used for column shafts also at Djemila[11]. Like the fossiliferous limestone of Djemila, the yellow-and-white stone at Cherchel could well have come from some as-yet-unknown local or regional quarry.

[8] Blanc, Blanc 2009, 490; Antonelli *et al*. 2002.
[9] Antonelli, Lazzarini 2013, 301-303, 311, figs. 6a, 10b, tab. 1.
[10] Antonelli *et al.* 2010, 580-581, fig. 4.b-c.
[11] Herrmann *et al*. 2017, 782, 785, fig. 16, appendix I, USF10902.

Considerations on the use of colored stone revetments in Cherchel

The use of the rather unimpressive yellow breccia in the West Baths is surprising in consideration of the riches of the region's quarries. As noted above, giallo antico (*marmor numidicum*) was easily accessible at Chemtou in northern Tunisia, and yellow-and-red breccia was produced at nearby Kristel on the western Algerian coast near Oran. The Kristel breccias, however, may have been exploited only on a small scale in antiquity[12]. When it was built, the West Baths was an ambitious and extravagant structure in the capital city of a province; it was large in size and had a symmetrical layout echoing major bath buildings around the Empire. The absence of the most attractive regional colored marbles and the use of a somewhat similar but inferior product in the building are striking. In spite of the grandeur of the building, an unspectacular yellow-and-white breccia was apparently used as an economy measure.

Perhaps considerations of political status could have been responsible for the absence of giallo antico in the West Baths. The importance and prestige of Caesarea might have fallen after the Early Imperial period. As noted above, Cherchel has a rich assemblage of colorful marble column shafts from the Aegean and from Chemtou, but they could have been imported almost entirely in the time of Augustus and Tiberius, when Mauretania was an independent kingdom and an important ally and an agent of Roman control of North Africa[13]. Only small traces of giallo antico revetments survive in Caesarea; a few unprovenanced revetment slabs of giallo antico brecciato appear embedded in assemblages of marble scraps in sculpture pedestals in the Cherchel museum. Proximity to Chemtou apparently did not lead to abundant or continuous access to its products. It may be that later emperors found the province unworthy of lavish embellishment after its subjugation and may not have wanted to allocate the prized *marmor numidicum* for revetments in *Caesarea*. The splendid assemblage of Roman marble sculptures in the West Baths, including handsome portrait busts of the second century, however, may argue against this line of explanation. The city certainly remained the most important site for Roman marble sculpture of the middle Imperial period in North Africa, as the catalogue of its collections testifies[14].

Another explanation for the apparent absence of North African yellow marble in the West Baths at Cherchel could be a chronological one. The revetment may not have been the original decoration of the bathing pools but may stem from a later period when production had been halted, interrupted, or reduced at Chemtou and Kristel. Lea Stirling has pointed out that the West Baths were renovated in late antiquity, perhaps in the Theodosian period, and that many of its statues were transferred there at that time[15]. The existing decoration could have been applied in this late phase, and the absence of giallo antico in the yellow and white marble revetment at the West Baths of *Caesarea Mauretaniae* may indicate that there was a serious shortage of this colorful marble in late antiquity. It should be noted that giallo antico ("Libyan" marble) was used in Hagia Sophia in Constantinople during the sixth century but in small quantities[16]. It apparently was scavenged material, as was some of the alabaster there[17].

Acknowledgments

Our thanks go to the Ministry of Culture of Algeria, Mourad Betrouni, director of Patrimoine Culturel; Mohamed Dahmani, Algiers; the Cherchel Museum and especially Nedherie Hebbache and Kader Bensalah.

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[12] Antonelli *et al*. 2010, 582, fig. 4b., 6, 7; Herrmann *et al*. 2017, 782, figs. 14-15, appendix I, USF10900a-b.
[13] Herrmann *et al*. 2017.
[14] Landwehr *et al.* 2012.
[15] Stirling 2016, 264-265.
[16] Herrmann, Van Den Hoek 2019, 345-346, figs. 1-2.
[17] Herrmann, Van Den Hoek 2019, 346, fig. 6.

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COLOURED MARBLE COLUMN SHAFTS FROM SOME CITIES OF AFRICA PROCONSULARIS AND BYZACENA. QUANTITATIVE AND ANALYTICAL DATA

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Abstract

This contribution deals with the origin and diffusion of the coloured marbles used for columns in the African provinces. Given the extensive use of coloured shafts in many centres of *Africa Proconsularis*, the first step was to distinguish the local carved stone shafts from those carved in the marbles of the "Imperial" quarries. This paper presents the results of research, based on the study of the cities of Carthage Thuburbo Maius, *Bulla Regia* and Ammaedara, where the column shafts could be measured. In sum, we have not considered the local stone shafts as a second choice in relation to those imported from the "Imperial" quarries, since in our opinion, both had aesthetic, economic and social meanings.

Keywords: Coloured shafts, Roman Africa, imported marble.

Introduction

We offer here the first fruits of research carried out on the use of coloured marbles in Proconsular Africa. We want to immediately emphasise that in order to establish the lithotypes used in the columns, we were obliged to use optical identification. Laboratory analysis was only possible in a few cases which mainly concerned the so-called black marbles, such as the limestone of Djebel Oust, Djebel Aziz, Ain el Ksir and Thala[18] and the Hippo marbles[19]. We have chosen to rely on our long-standing knowledge of the so-called imperial marbles for their identification which has allowed us to isolate the groups of marbles from African quarries. To determine their origin, we cross-referenced the still-insufficient data published on Algerian and Tunisian quarries with those that could be hypothesized through the proximity of certain quarries to the places of use, or through the importance of some regional quarries.

Finally, it is necessary to explain why we use 'so-called imperial marbles' as a term for imported marbles. This denomination identifies marbles that were known to be used by the emperors, either in Rome or in any other of the building complexes commissioned by them. Nevertheless, quarry production was not entirely destined for Rome and we have expressed the opinion[20] that the procurement and leasing system of the quarries allowed their *conductores* to distribute the blocks and columns on the private market. It was not, therefore, the imperial administration that sold the columns, at least not directly, it was the lease-holders, or possibly the owners of quarry sectors that were not intended, or not always intended, for production for Rome. We wish to cast light on the relationship between the ruling class and the use of marble. Marble shafts are not only

[18] Agus *et al.* 2007.
[19] Antonelli *et al.* 2009, to which are added unpublished analyses by M. Brilli.
[20] Pensabene 2013.

a prestigious element endowed with a high aesthetic value, they also have an "ideological" meaning, expressing a social status.

As a first step, we will present here the data from the sites we have taken into account, i.e. Carthage, Thuburbo Maius, Bulla Regia, Sufetula and Ammaedara (Fig. 1). The lithic qualities generally used in public architecture can offer broader information about the relationship between Rome and the provincial ruling classes. This relationship is manifested in the difference between the use of so-called imperial marbles with that of local ones.

Figure 1: Map of Tunisia with the cities considered in yellow (Photo: Google Earth).

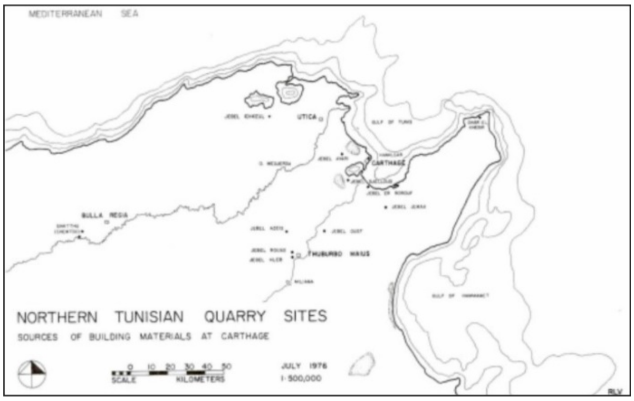

Figure 2: Northern Tunisian quarry sites.

We have focused on column shafts since they represent the most costly and ostentatious elements of any architectural structure and express the high economic standing of the sponsors, whether public or private. By counting the shafts, differentiated according to the type of the stone for each site or monument we have prepared tables illustrating the diffusion of a certain material in a determined area.

The data gathered for each site was then synthesized to obtain a general picture of the diffusion of the most common local and imported marbles in the African area under study.

During this first investigation, we were able to enumerate 667 shafts and we also to measure the principal dimensions of a large part of them (291): vis. the height of shafts, the diameter, if possible, the height and projection of the scapes. At Carthage alone, we measured 245 shafts; the rest of the material that we were able to take into consideration is scattered between the sites of Bulla Regia, Ammaedara, Sufetula and Thuburbo Majus. We have therefore made a distinction between imported and local materials.

It transpired that the most frequently imported marbles to be used were (Tabs. 1, 2): cipollino (99), Troad granite (74), Aswan granite (28), Mons Claudianus granite (21) and pavonazzetto (21). However, at Carthage the most numerous shafts are breccia corallina (101). Unfortunately, doubts remain as to how many local quarries of breccia there actually were. There are also many shafts of giallo antico in Carthage. Although the quarries are located in Proconsular Africa, they should be considered together with the so-called imperial marbles.

Regarding the stones of African origin, the majority are from Djebel Oust (68)[21], Cap de Garde (49)[22] to which we can add many shafts in local pale limestone for which we have yet to establish a precise origin (Tabs. 3, 4).

[21] Brilli *et al.* 2010.

The introduction of the site of Sufetula to this study serves as an example to illustrate the exceptional case of a city where only local materials were used: here marble seems to have been completely unknown. Obviously, there may well have been many different factors. Nevertheless, a not negligible reason was the possibility of working the local stone - a rather pale limestone - which permitted a minute rendering of detail, in a manner quite similar to that of marble.

Somewhat different is the situation at Thuburbo Maius, since shafts of imported cipollino coexisted with local materials. As a provincial centre in the middle of its hinterland, the supply of coloured stones could only be brought at great expense. Though large and flourishing, we believe the city used materials that were largely quarried in the nearby mountains, which offered a variety of coloured limestones, some of which were attractive and inexpensive. Only rarely did the city resort to importing precious marbles. Most of the material comes from the Djebel Klab and the Djebel Rouas quarries, only 2 km distant from Thuburbo (Fig. 2), but also from Djebel Oust, 20 km North West of the city (Fig. 3). This limestone offered the advantage of resembling marble once polished. Its fine grain and chromatic variety made it desirable, however its porosity and lack of homogeneity were flaws that hampered the extraction of large monoliths. The Forum of Thuburbo is the only complex to be built in imported marble. In fact, the 37 portico shafts are in cipollino (Fig. 4). Some of these shafts are whole and still standing. They have a lower diameter of 49 cm, which corresponds to a height of approximately 3.92 m (the whole column with base and capital should be 5.20 m high). The other monuments were all built in local material.

Figure 3: Djebel Oust quarry.

From the point of view of road connections, Bulla Regia was well positioned: it was built on the road connecting Carthage and Hippo. Furthermore, one could reach the harbour of Thabraca via a passage through the Khroumierie Mountains. Above all, Bulla Regia was located on the alluvial basin of the oued Mejerda, a fact that assured a good road system for the transport. Despite access to marine commerce and overseas products, the ratio between local and the imported marbles is decidedly in favour of the former. We find here stones of various colours that are often not present elsewhere and which are difficult to identify, for example, the marble of Cap de Garde and some grey limestones, such as the black limestone from Thala and several imported marbles like cipollino (Fig. 5), of a very high quality.

[22] Herrmann *et al.* 2012a; Herrmann *et al.* 2012b.

However, it should be noted that giallo antico columns are missing. Despite the proximity of the quarries, they were evidently too expensive for the city and its elite, who could only cope with small blocks for revetment slabs and simple mouldings. This explains why in the so-called Monument in *opus reticulatum*[23], not only the local materials were employed, but also mouldings in giallo antico. With Bulla Regia one has to take into consideration the vicinity of the Simitthus quarries, a few kilometres away. Our opinion is that the city could use only sectors of the quarry that were not under imperial administration, perhaps limited to areas offering a stone of lesser quality.

The ancient Ammaedara (modern Haidra), one of the most imposing Roman sites in Tunisia, sits on a highland at the crossing of the great road between Carthage and Theveste. It represented an outpost with the role of protecting the fertile valley from the raids of the tribes from the mountain areas, a role performed since the time of *Augustus* by *Legio III Augusta*. Our study centred mainly on the Forum and the *Capitolium*. There is a clear contrast between the portico, with marble columns from the Cap de Garde quarries (near *Hippo Regius*), though not among the most expensive, and the temple which instead was entirely built in local limestone. The same limestone is used as the principal building material throughout the whole city.

Figure 4: Thuburbo Maius, Forum.

Figure 5: Bulla Regia, Basilica.

The columns in the temple consisted of superimposed drums. There may be different reasons for this choice. In the first place, we should underline the geographical position of Ammaedara: the city stands in an inland area, a great distance from the sea that lay both to the North and the East. The river that serves her, though very important for the water supply was ill-suited for the transport of heavy goods. Because of its location, it is obvious that the use of the most sought-after stones was much more expensive, since their overland transport costs raised the price. Clients and their economic means evidently represent another reason: it is likely that the colony itself financed the buildings and was disposed to purchase marble column shafts of small and medium size. In fact, among the surviving shafts in the portico, we have identified only one in cipollino and one in Troad granite, but the overall majority is in a material which, after an autoptic analysis, appears to be Cap de Garde marble. It is a pale,

[23] Beschaouch *et al*. 1977, 18.

fully grey veined marble, and mostly characterized by undulated, oblique and parallel streaks running along the whole height of the shafts. At times, the streaks become thicker, to the extent that they create real grey bands alternating with white veined ones (Fig. 6). The crystal structure offers rather large grains and crystals (Tab. 5). The lower diameter measures 50 cm. Based on the proportions of their diametres (eight in all) we estimate their height to be 4 m. The actual height of the shaft is 4.14 m, with a minimal difference from theoretical calculation. We suppose the dimensions of this column correspond to the standard measurements of the shafts intended for export from the Cap de Garde quarries. It seems that the data gathered at Haidra and Carthage (see after) also favour this thesis. Shafts of analogous size represent by far the majority among those in grey veined marble considered in our research. We were able to identify just seven: four at Ammaedara (not all of them from the portico around the Capitolium) and three at Carthage. What is interesting is that in two different sites, Carthage and Ammaedara, we have found shafts of the same size. The Ammaedara ones are characterized by a neat upward tapering: we notice that the upper scape diametres – usually corresponding to the lower diametres – are always smaller by 1-2 centimetres. From simple observation, their marble is certainly similar to one of the varieties of the Annaba marble and it cut perpendicularly to the veins (Fig. 7). The typology of the shafts varies: the measured shafts are either of the grooved type (from Carthage), or with grooves that have been filled, or else of the smooth type as in Bulla Regia, Carthage and Ammaedara.

Figure 6: Ammaedara, Forum

Figure 7: Ammaedara, Forum.

Another consideration regards a fragment, among the “standard” ones found at Haidra, which is partially unfinished. Again, it comes from the portico around the *Capitolium* and presents a lower diameter of 51 cm, while the unfinished part has a diameter of 58 cm. This is a very important *datum* since it supports the hypothesis that the shafts arrived from the quarries in a semi-worked state and were finished off at the site. In the quarries the working of the columns was normally carried out before extraction, in order to speed up processing time. The columns were exported in a rather rough state and would have been tapered and polished at their final destination. In this particular case, evidence in support of this could be, for instance, the more pronounced tapering of the Ammaedara shafts (Fig. 8) in comparison to the Carthage ones – where the upper scape is wider than the lower – depending perhaps on choices made by the master builder himself.

Figure 8: Ammaedara, Basilica II.

The Christian basilicas of Haidra have also been a key element of our research because of the quality of the re-used materials: Basilica II has brought to light many fragments of marble shafts of which 22 are in cipollino, two in Troad granite and one in breccia corallina. Basilica V offers seven broken shaft drums in grey marble from Cap de Garde whose aspect and measurements are similar to those of the columns in the square of the *Capitolium* where they might belong.

Obviously, the most numerous data come from Carthage, the capital of Proconsular Africa from 29 BC. We should deal separately with the Antonine Baths. The column shafts and all the other marble elements belonging to the architectural decoration of the baths were almost entirely re-used, exported or sold during centuries of neglect. The remaining fragments, however, offer a great deal of information. From the whole marble shafts used for the decoration of the *frigidarium* we can identify an impressive quantity of granite from several places of origin. For it we can estimate a grand total of more than 192 cubic metres, to be subdivided between the grey granite (152 cubic metres to be in turn, divided between non identified granite and Troad granite) and the red one from Syene (40 cubic metres). 36 shafts in giallo antico, for a total amount of 144 cubic metres, decorated the two squared *palaestrae* that preceded the rooms, which led into the *frigidarium*. Several fragments in cipollino come from 8 shafts (corresponding to a quantity of marble of 19.50 cubic metres) of two warm pools adjacent to the *palaestrae*. We can also identify 10 fragments in pavonazzetto from the Docimium quarries in Phrygia attributable to shafts that would have been almost 6 m high. Less easily-identifiable is a white-pinkish breccia used in column shafts of which we were able locate fifty eight fragments. Close examination revealed the nature of this stone to be very similar to the so called “breccia corallina” also quarried in Asia Minor.

Because of the immense quantity of precious marble, it seems clear that there was an intervention by the emperor, wishing to endow the city with *thermae* that would surpass those in Africa for grandeur and luxury and be comparable to those in Rome itself.

33 shaft fragments in giallo antico some of which were fluted (Fig. 9), originated from the great judicial Basilica in Byrsa. In the Theatre[24], we counted just 130 column stumps (smooth, fluted, cabled or spirally fluted) sculpted in a large variety of imported coloured marbles, among them cipollino, granite, fior di pesco, pavonazzetto, proconnesian, Djebel Oust limestone and breccia corallina.

In the area of the amphitheatre we were able to identify a large quantity of shafts in Djebel Oust stone: a reasonable number were in grey marble (Fig. 10.), three were in a kind of pinkish breccia that was difficult to identify and only one fragment in grey granite, identified as Troad. By comparing the reconstructed dimensions, it appears evident that we are dealing with shafts that all belong to the same order with columns of an overall height of about 4.85 m.

[24] Picard, Baillon 1992, 11-27; Ros 1996, 449-489.


Figure 9: Carthage, Byrsa.


Figure 10: Carthage, Amphitheater.

The measurements turned out to be crucial and so we extended this aspect of our research. Besides the shafts, we also measured some of the capitals and bases - in order to better understand the relationship between each individual element within a complete column or a whole order.

On the basis of this data, it has been possible to carry out hypothetical reconstructions of the elevation of some buildings and often to attribute shafts either to a specific architectural structure, or to one of its orders or a room. The measurements also offered the opportunity to make some considerations about the production of the architectural elements in the quarry itself. We thus compared the dimensions of the shafts in the same material to verify the hypothesis of a speeded-up standardized production system. From the measurements it has been possible to establish sets of recurring sizes for the various marbles, using the lower diameter as a parameter and reconstructing an indicative height of the whole shaft. The tables (Tab. 6) show the sets of measurements and indicate the height of a shaft reckoned in metres and Roman feet of 29.57 cm. From this simple representation, a large majority of shafts with a lower diameter of 50 cm and a height of c .4 m has emerged and they are of many different types, including some local ones, such as the marbles of Hippo or the limestone from Djebel Oust. Among the 241 elements in the table, more than 60 belong to this group of measurements. The others are divided in the other groups going from a minimum of 3 shafts with a lower diameter of 80 cm, to a maximum of 30 shafts with a lower diameter of 60 cm. This data may be significant when analyzing the production in the quarries destined for export. In fact, the expedient of identical measurements for the shafts in the same marble, noticed even in localities far away from each other, may indicate an import of finished or semi-finished elements, directly from the quarry of production. For instance, the analogous dimensions of the shafts in Cap de Garde grey marble from Ammaedara and Byrsa suggest a serial production of 4 metre shafts that were quick to make and easy to export.

The fact that the shafts of a larger size (with a lower diameter - between 80 and 150 cm) are those coming from the imperial quarries, and therefore of greater value and importance, is also apparent. These include those made from africano, cipollino, giallo antico, Troad granite, rose-coloured granite from Aswan (syenite) and another rose-coloured granite perhaps from the Egyptian eastern desert. The grey marble in Byrsa might be an exception (fluted and with a 90 cm diameter) since it possibly comes from Cap de Garde (Hippo): it is yet to be demonstrated that this was an imperial property. Regarding the size, we should specify that the partially-worked shafts corresponded to classical proportions. From the measurements of the whole shafts, we have been able to verify the correspondence of the height to the module of the lower diameter (more or less repeated eight times) as reported on table (Tab. 7).

As regards the numbers of marble column shafts, there is a sharp contrast between Carthage – a coastal centre and the capital of the province – and the inland cities. If in the former the preponderance of imported material is very clear, this relationship reverses itself as we move away from the coast toward Sbeitla. Here we have found no use at all of imported shafts: neither of the main marbles from Proconsular Africa (such as the numidian, black or grey marble) nor of the shafts, and all buildings including the most representative (such as the *Capitolium*) are in the same pale limestone that was locally extracted. But of course there are exceptions, as we have seen in Ammaedara and Thuburbo Maius, with its portico of the Forum in cipollino columns, a phenomenon that might explained by the favourable economic conditions of the elite which allowed them to pay the transport costs.

For the veined grey marbles, both the one with parallel bands and those with thin intricate veins, as well as the more recognizable greco scritto traditionally attributed to Cap de Garde (Algeria) most of the archaeological data comes from the site of the ancient Ammaedara and precisely from the portico of the *Capitolium*, whose columns are hypothesized to be made out of the grey marble from Hippo[25]. To have further data to compare with, we introduced into this study data from the site of Ostia and the isotopic analysis of a quarry sample kept in the collection of the University of La Sapienza in Rome, whose provenance from Cap de Garde is assured.

The most important *datum* is the confirmation of the Algerian origin of the shafts found at Carthage and Ostia with its typical undulated and parallel veins. At the same time, we had to exclude the same origin for the revetment slabs from Ostia in "greco scritto" (Figs 11-12). It would seem that the marble from Cap de Garde, with a larger grain (MGS between 2.20 and 6.66 mm)[26] was preferred and also exported, for the shafts.

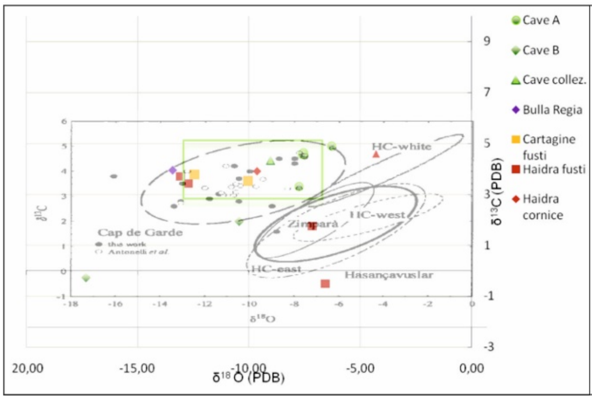

Figure 11: Results of the isotopic analyses of the archaeological samples of Tunisia overlapping with the isotopic fields of the Cap de Garde and Hasançavuslar marbles (Attanasio *et al.* 2012).

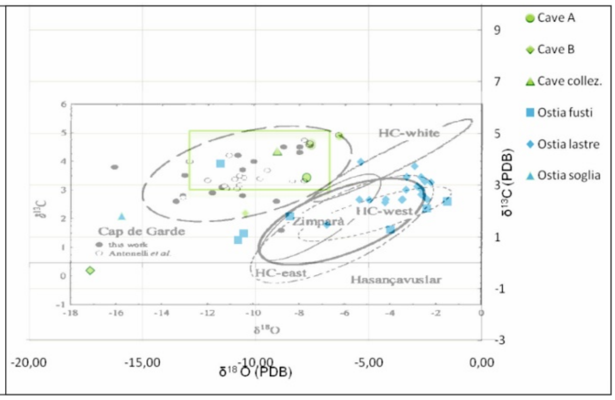

Figure 12: results of the isotopic analyses of the archaeological samples of Ostia overlapping with the isotopic fields of Cap de Garde and Hasançavuslar (Attanasio *et al.* 2012).

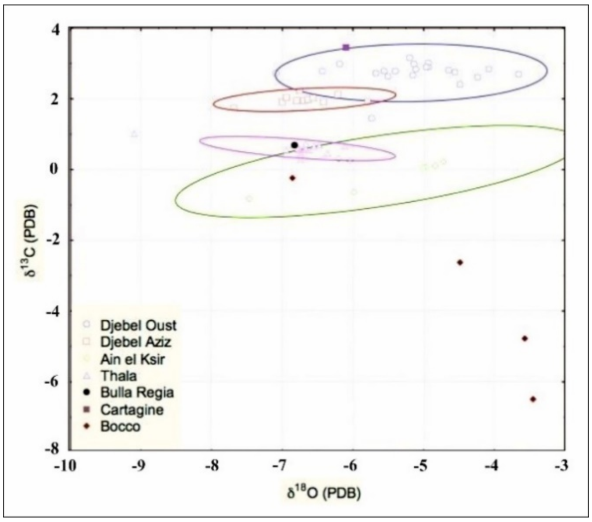

Figure 13: Isotopic fields of the North African black marble quarries and archaeological samples from Carthage, Bulla Regia and the monument of Bocco from the Musei Capitolini.

[25] Antonelli *et al.* 2009.
[26] Antonelli *et al.* 2009.

We have dedicated special attention also to the local stones, not only to the famous giallo antico, but mainly to the "black ones" just because of the difficulty of identifying them through basic autoptic analysis. With regard to quarries, we refer a great deal to the formations of Djebel Oust, Djebel Aziz, Ain el Ksir and Thala. On the whole, their stone turns out to be more numerous at Carthage and Thuburbo Majus for probable and partially different reasons. Above all, for both cities, we should consider the relative vicinity of the major quarries of these materials, such as those of the Djebel Oust, and Djebel Aziz (besides Djebel Keddek for Carthage) which are in the very region of Thuburbo. Concerning Carthage, we should point out that these materials stand side by side with more prestigious marbles, while at Thuburbo the local limestone represents almost the totality of the material used for the shafts.

Evidently, in the capital the local types of limestone (such as the black) were greatly appreciated and did on the whole satisfy the huge demand for the needs of the large and numerous building projects within the city. In this case the isotopic analyses were carried out on quarry samples. (Fig. 13). They have demonstrated that the various Tunisian bigi morati often display similar features, but possess highly differentiated isotopic values, which is fundamental to identifying the provenance of the various architectural elements.

Acknowledgements

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Lithotype	Carthage	Bulla Regia	Ammaedara	Sufetula	Thuburbo Majus	Total
Africano	13	-	-	-	-	13
Bigio	14	-	-	-	-	14
Bigio africanato	2	-	-	-	-	2
Bigio antico of Asia Minor	-	-	-	-	-	0
Bigio lumachellato of Lesbos	4	-	2	-	-	6
Breccia corallina	95	4	2	-	-	101
Breccia coralline chiara	5	-	-	-	-	5
Breccia di Sciro	-	-	-	-	-	0
Cipollino	59	4	25	-	11	99
Cipollino marino	4	-	-	-	-	4
Cipollino rosso	1	-	-	-	-	1
Diorite	-	-	-	-	-	0
Fior di Pesco	1	-	-	-	-	1
Mons Claudianus granite	21	-	-	-	-	21
Grey pinkish granite	13	-	-	-	-	13
Mysian granite	1	-	-	-	-	1
Troad granite	63	5	6	-	-	74
Pavonazzetto	21	-	-	-	-	21
Pavonazzetto, brecciated	6	-	-	-	-	6
Portasanta	1	-	-	-	-	1
Proconnesos	3	-	-	-	-	3
Aswan granite	28	-	-	-	-	28
Verde antico	4	-	-	-	-	4
Total	359	13	35	-	11	418

Table 1: Distribution of imported marbles on the examined sites.

	Carthage							Bulla Regia				Ammaedara						Thuburbo Maius						
Lithotype	Antonine Baths	Theatre	Amphitheatre	Byrsa	Basilica	Colonnaded building	Total	Building in opus ret. and portiocoes	Espl. E	Espl. O	Total	Capitolium	Bas. 1	Bas. 2	Bas. 5	Others	Total	Capitolium	Summer Baths	Winter Baths	Temple of Cereri	Portico of Petronii	Total	Total
Cipollino	12	40	-	2	-	5	59	-	4	-	4	-	-	-	-	-	25	11	-	-	-	-	11	99
Cipollino marino	-	3	-	-	-	1	4	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	4
Cipollino rosso	-	-	-	1	-	-	1	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	1
Breccia di Sciro	-	-	-		-	-	0	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	0
Fior di Pesco	-	-	-	1	-	-	1	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	1
Proconnesos	-	3	-		-	-	3	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	3
Africano	-		-	13	-	-	13	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	13
Pavonazzetto	10	9	-	2	-	-	21	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	21
Pavonazzetto, brecciated	-	3	-	3	-	-	6	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	6
Troad granite	27	8	1	27	-	-	63	-	5	-	5	1	3	2			6	-	-	-	-	-	-	74
Mysian granite		1	-		-	-	1	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	1
Breccia Corallina	58	21	-	16	-	-	95	-	4	-	4	-	1	1	-	-	2	-	-	-	-	-	-	101
Breccia Corallina Chiara	-	5	-	-	-	-	5	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	5
Bigio	-	3	5	6	-	-	14	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	14
Bigio of Lesbos	-	-	-	4	-	-	4	-	-	-	0	-	-	-	-	-	2	-	-	-	-	-	-	6
Bigio africanato	-	-	-	2	-	-	2	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	2
Granito del Foro	-	5	-	4	-	12	21	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	21
Mons Claudianus granite	13	-	-	-	-	-	13	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	13
Aswan granite	14	-	-	12	-	2	28	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	28
Verde antico	-	-	-	4	-	-	4	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	4
Portasanta	-	-	-	1	-	-		-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	1
Total	134	101	6	98	0	20	359	0	13	0	13	2	4	25	2	2	35	11	0	0	0	0	11	418

Table 2: Distribution of imported marbles of the examined monuments.

Lithotype	Carthage	Bulla Regia	Ammaedara	Sufetula	Thuburbo Majus	Total
Sandstone	1	-	-	-	-	1
Bigio of Jebel Oust	52	-	-	-	16	68
Breccia giallo rosata	2	-	-	-	4	6
Breccia rosata	6	-	-	-	-	6
Green breccia, africano-like	1	-	-	-	-	1
Limestone of Djebel Aziz	-	-	-	-	-	-
Limestone of Djebel Keddel	-	-	-	-	-	-
Limestone of Jebel Rouas	5	-	-	-	7	12
Light local limestone	3	18	-	-	-	21
Different local limestones	-	24	-	-	-	24
Cap de Garde	14	2	33	-	-	49
Djebel Oust (?), pinkish light	5	-	-	-	10	15
Djebel Oust, brecciated africano-like	8	-	-	-	-	8
Giallo Antico	34	-	1	-	-	35
Local granites	0	-	-	-	-	-
Ain el Ksir black	-	1	-	-	-	1
Thala black	-	-	-	-	-	-
Total	131	45	34	0	37	247

Table 3: Distribution of local marbles on the examined sites.

	Cartagine							Bulla Regia				Ammaedara						Thuburbo Maius						
Lithotype	Antonine Baths	Theatre	Amphitheatre	Byrsa	Basilica	Colonnaded building	Total	Building in opus ret. and portiocoes	Espl. E	Espl. O	Total	Capitolium	Bas. 1	Bas. 2	Bas. 5	Others	Total	Capitolium	Summer Baths	Winter Baths	Temple of Çereri	Portico of Petronii	Total	Total
Giallo antico	-	-	-	2	32	-	34	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	35
Cap de Garde	-	-	-	14	-	-	14	-	2	-	2	25	-	-	7	1	33	-	-	-	-	-	0	49
Djebel Oust, bigio	-	-	48	4	-	-	52	-	-	-	0	-	-	-	-	-	0	-	-	-	-	16	16	68
Djebel Oust, brecciated	-	-	-	8	-	-	8	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	8
Djebel Oust (?) pinkish light	-	5	-	-	-	-	5	-	-	-	0	-	-	-	-	-	0	10	-	-	-	-	10	15
Djebel Aziz	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
Djebel Keddel	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
Ain el Ksir	-	-	-	-	-	-	0	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	1
Thala	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
Bigio rosato	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
Djebel Rouas limestone	-	1	-	4	-	-	5	-	-	-	0	-	-	-	-	-	0	-	5	-	2	-	7	12
Yellow pinkish breccia	-	2	-	-	-	-	2	-	-	-	0	-	-	-	-	-	0	-	-	4	-	-	4	6
Pinkish breccia	-	-	3	3	-	-	6	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	6
Green breccia, africano-like	-	-	-	1	-	-	1	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	1
Local light limestone	-	3	-	-	-	-	3	-	-	18	18	-	-	-	-	-	0	-	-	-	-	-	0	21
Dıfferent local limestones	-	-	-	-	-	-	0	10	10	4	24	-	-	-	-	-	0	-	-	-	-	-	0	24
Arenaria	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	0	1
Giallo antico brecciato, bad quality	-	-	-	-	-	-	0	1	-	-	-	-	-	-	-	-	0	-	-	-	-	-	0	1
Total	0	12	51	36	32	0	131	11	12	23	46	25	0	0	7	2	34	10	5	4	2	16	37	248

Table 4: Distribution of local marbles on the examined monuments.

Lithotype	Quantity	Lower diameter (cm)	Shaft height, reconstructed (m)	Shaft height (Roman feet)
Africano	4	50	4	13
	2	65	5,2	18
	1	70	5,6	19
	2	90	7,2	24
Bigio	3	38	3,04	10
	6	45	3,6	12
	2	50	4	13
Bigio africanato	1	51	4,08	14
Bigio, Lesbos-like	3	57	4,56	15
Breccia Corallina	3	45	3,6	12
	8	50	4	13
	18	70	5,6	19
Cipollino	5	40	3,2	11
	6	50	4	13
	3	56,5	4,52	15
	4	60	4,8	16
	3	70	5,6	19
	1	90	7,2	24
Cipollino marino	1	48	3,84	13
Cipollino rosso	1	38	3,04	10
Fior di Pesco	1	52	4,16	14
Mons Claudianus granite	2	43	3,44	12
Mysian granite	2	50	4	13
Pinkish granite (Sardinia-like)	3	150	12	40
Troad granite	4	40	3,2	11
	3	45	3,6	12
	3	50	4	13
	1	55,5	4,44	15
	8	60	4,8	16
	1	96	7,68	26
	7	150	12	40
Pavonazzetto	2	50	4	13
	3	60	4,8	16
	7	75	6	20
Pavonazzetto, brecciated	3	50	4	13
	1	70	5,6	19
Portasanta	1	53	4,24	14
Prokonnesos	33	55	4,4	15
Aswan granite	2	45	3,6	12
	4	50	4	13
	5	60	4,8	16
	8	90	7,2	24
Verde Antico	5	60	4,8	16
Green stone (not limestone)	3	35	2,8	9
Red breccia rossa with large yellow clasts	1	41	3,28	11
Breccia rosata	46	3,68	12	
Breccia rosata (Djebel Oust?)	10	83	6,64	22
Green breccia, africano-like	1	61	4,88	16
Light limestone	1	56	4,48	15
Beige limestone	1	26	2,08	7
Local limestone	2	35	2,8	9
	5	44	3,52	12
	1	56,5	4,52	15
Black limestone	1	50	4	13
Cap De Garde	1	29	2,32	8
	8	40	3,2	11
	1	44	3,52	12
	11	50	4	13
	2	90	7,2	24
Djebel Oust	5	40	3,2	11
	9	50	4	13
Djebel Oust, brecciated	2			
Djebel Rouass	3	35	2,8	9
	3	40	3,2	11
	1	50	4	13
	1	60	4,8	16
Giallo Antico	2	50	4	13
	1	65	5,2	18
	1	70	5,6	19
	3	80	6,4	22

Table 5: Dimensional groups of shafts in imported and local marbles.

Site	Lithotype	Lower diameter (cm)	Shaft height (cm)	Height/Diameter ratio	Exceeding height (cm)
Carthage	Granite	53	413	7,79	-11
Bulla Regia	Green stone (not limestone)	35	261	7,46	-19
Bulla Regia	Green stone (not limestone)	28,5	210	7,37	-18
Ammaedara	Granito troadense	46	415	9,02	47
Ammaedara	Cipollino grigio	50	414	8,28	14
Ammaedara	Cipollino	66	467	7,08	-61
Ammaedara	Cipollino grigio	51,5	409	7,94	-3
Sufetula	Light limestone	56	483	8,63	35

Table 6: Verification of the 1: 8 dimensional ratio between the lower diameter and the height of the shaft

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ASIATIC COLOURED MARBLES IN ROMAN ARCHITECTURE IN ARLES (FRANCE)

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Abstract

This study seeks to understand the chronological use and context in Roman Antiquity of coloured marbles from archaeological sites in *Arelate* (Arles, France), preserved at the Musée Départemental Arles Antique or *in situ*. Macroscopic identification based on comparison with reference systems was applied to all samples.

Several of the marbles appeared to be Asiatic, and they were used as veneers, cornices and column shafts in both private and public contexts. While a few examples are preserved *in situ*, the majority were found in various filling layers, especially destruction and abandonment layers. The most common Asiatic marbles are africano, greco scritto and pavonazzetto, but granito violetto and breccia corallina were represented as well.

This study confirms the use of some Asiatic coloured marbles in Arles from the end of first century BC to Late Antiquity for wall revetments and pavements, as well as column shafts in both private and public contexts.

Keywords*:* Coloured marble, France.

Introduction

Arles is located in France (Fig. 1) and bisected by the Rhône River. The city first developed on a rocky mound on the left bank (540-530 BC) then on the right bank. When Caesar opposed Pompey, Arles supported him, entitling it in 46-44 BC to become the *Colonia Iulia Paterna Arelate Sextanorum*. Settlers of Italic origin subsequently arrived and monumental Roman urbanisation began. The Augustan period (Fig. 2) witnessed the building of the city walls, the Theatre and the Forum with its cryptoporticus. The latter site is where the *clipeus virtutis* in Carrara marble was discovered, a replica of the gold one offered to Augustus by the Roman Senate in 27 BC. The Theatre was built on top of the rocky hill and could accommodate 10,000 people. From the stage wall at least two fully preserved column shafts still remain, framing the royal door, one in africano, the other in bardiglio of Carrara.

During the Flavian period (Fig. 2), the city wall opened toward the amphitheatre built on the rocky hill. Several streets developed during the 1st century AD (the Van Gogh Hospital, Sainte-Luce Commandery and the Esplanade). The portico court on Truchet Street and the one at the Cemetery can be attributed to the same period. The extension of the city outside the walls is attested to the south, around the *Cardo*, with baths and shops on the Esplanade site. Further outside the walls, the circus was probably built around the middle of the 2nd century AD. Finally, domus, richly decorated with marble, were built at the same time on the Crédit Agricole and Trinquetaille glassworks sites. Between AD 260 and 280, a fire ravaged much of Arles but the city regained importance in the early 4th century AD. In AD 313, Constantine transferred the state mint to Arles and organized a large council of Western bishops the following year. His son, Constantine II, was born there in AD 317. The city then acquired new important buildings like the baths (Fig. 2:12), and also enlarged and embellished certain monuments such as the Forum (a pediment supported by two columns, still visible today on the Place du Forum, dated between AD 324 and 326) and the circus (new decorations at the southern end of the spina and addition of the obelisk). In Saint-Césaire, the probably public building from the end of the 4th century AD received a large apse at the beginning of the 6th century AD. In 406, an invasion of Gaul by the Vandals led to the transfer of the seat of the prefecture of Gaul from Trier to Arles. Chosen as a residence by Constantine III (408-411 AD), the city benefited from the generosity of the future Constantius III, and witnessed the installation of the Council of the Seven Provinces in AD 418. But under pressure from the Visigoths, Arles fell in AD 475/476 and the prefecture and the mint closed. During the 5th century AD, the rooms under the cavea of the circus were occupied and the spoliation of the ancient Theatre was organized[1]. Many marble fragments of veneers and statues, dated to the end of the 4th - 5th centuries AD, were found in a Rhône dump. Finally, the spoliation of the circus took place between the mid-6th and mid-7th centuries AD.

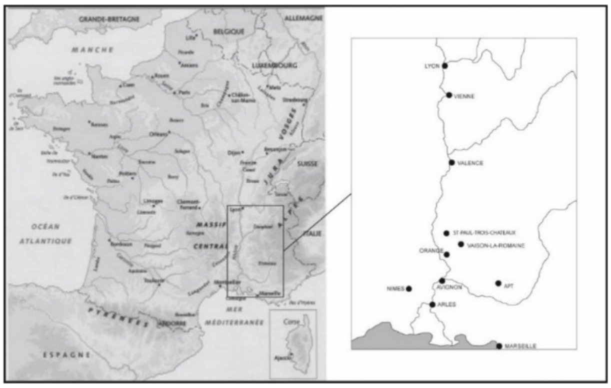

Figure 1: Map of France, details of the Rhône Valley with the location of the city of Arles and the Rhône delta.

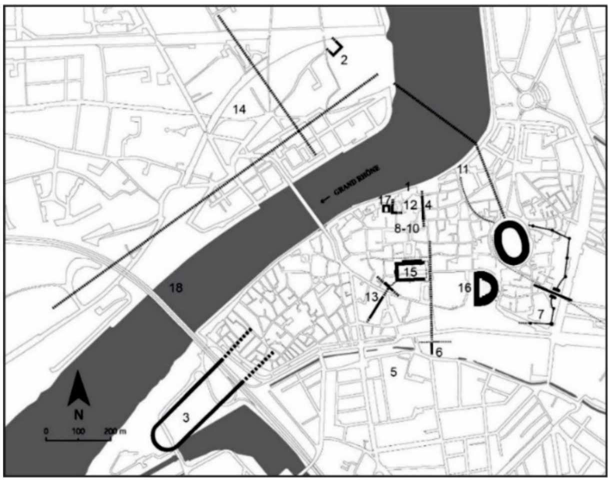

Figure 2: Archaeological sites of Arles: **1**. Bizalion; **2**. Cemetery of Trinquetaille; **3**. Circus; **4**. Sainte-Luce Commandery; **5**. Crédit Agricole; **6**. Esplanade; **7**. Saint-Césaire; **8**. 3 Sauvage Street; **9**. 22 Sauvage Street; **10**. 26 Sauvage Street; **11**. Suarès Square; **12**. Baths of Constantine, **13**. Van Gogh Hospital; **14**. Trinquetaille glassworks; **15**. Forum and cryptoporticus; **16**. Ancient theatre; **17**. Truchet; **18**. Rhône (river).

Marbles from Asia Minor in Roman Arles

This study focused on the coloured marbles discovered during the archaeological excavations carried out in Arles since the 1960s, as well as those left *in situ*[2]. These items are kept in the depots of the Musée Départemental Arles Antique and consist mainly of slabs, but also fragmentary column shafts, blocks and mouldings. The coloured marbles were identified by macroscopic analysis and measured in order to make comparisons of quantity (volume)

[1] Ηονορατ Δε Μαρσειλλε, La vie de Saint-Hilaire, 20,13-18. The marble dump and other items discovered during INRAP excavations in 2007 (2012 report, p.101) may come from the decoration of the ancient theatre. The text written in the years 475-480 mentions, during the episcopate of Saint-Hilaire (who died in 449), the pillaging of the theatre to build the basilicas during which the deacon Cyril was wounded by falling marble blocks.

[2] Remeau 2015. I use the term "marble" in the ancient and non-geological sense. So, I include not only the marbles but also the breccias, porphyries and granites used during Roman Antiquity because they too could be beautifully polished.

and chronology[3]. Their forms were also studied to understand their function. The coloured marbles discovered in Arles came from all around the Mediterranean (Italy, Greece, Türkiye, Egypt, Tunisia, Spain and France). The most frequently used, according to archaeological findings, were bardiglio of Carrara (Italy), africano (Türkiye), cipollino (Eubea), fior di pesco (Eretria), giallo antico (Tunisia) and greco scritto, although the latter requires physico-chemical analyses to really know where it comes from. Of the approximately 7,200 items studied, the marbles from Asia Minor represented about 19% including the greco scritto. They were (in ascending order, without considering the volume of 24 column shafts): Troad granite, breccia corallina, pavonazzetto, greco scritto and africano.

Breccia corallina

Breccia corallina is a red matrix of various shades, rich in white, pink and yellowish clasts[4]. It is found in several quarries of Asia Minor, in Bithynia or in the Karaburun peninsula[5]. This marble was identified in 42 items (including 5 *in situ*), with varying degrees of certainty, and represents about 0.024265 m^3 (Tab. 1) at 8 sites (Fig. 2: 2, 3, 7, 13-15, 17, 18). Its identification was difficult because there were different varieties and the very small fragments made observation difficult.

This marble appeared in Arles, only as slabs (Tab. 1), from the end of the 2nd century AD, or earlier in filling layers of the circus site (late 1st century AD)[6]. It is found in destruction and abandonment layers from Late Antiquity and in sites where earlier public or semi-public buildings were constructed in the 1st century AD and destroyed in the 3rd century: the portico courtyard of the cemetery (late 1st century AD) and that of Truchet Street and the Forum (cryptoporticus). It was an important stone used around the Mediterranean from the 1st century AD[7]. It was probably introduced to Rome in Augustan times, but it is not found in imperial building projects in any period, and other early attestations are scarce[8]. Thus, it represents either a provincial fad, or perhaps a private market with a lower cost than imperial marbles.

Most of the fragments were discovered in public or semi-public places, but also in pavements of the later rich domus at the glassworks site. Four rectangular slabs were found on this site in *opus sectile* of domus (late 2nd - mid-3rd centuries AD) (Fig. 3). In room VI, the pavement contained two tiles both included in an *opus sectile* QrQ-type[9] (30 x 30 cm square module), today preserved in the permanent collection of the Musée Départemental Arles Antique. In room IV, the pavement covered the corridor along the basin which contained two large slabs. Another large slab was used in the undated Saint-Césaire presbyterium pavement (from the 4th century AD building or its 6th century extension). This slab may come from the pillaging of the ancient Theatre as suggested in the 5th century text by Saint-Hilaire[10].

[3] For my thesis work, only coloured marbles were studied because the identification of white marbles requires a set of physico-chemical analyses, geological knowledge and financial resources that I could not implement.
[4] Borghini 1989, 166.
[5] Bruno *et al.* 2012, 568.
[6] Remeau 2019. The circus was built, according to the study of wooden posts, in the middle of the 2nd century AD whereas some settlement layers of the rooms under the *cavea* are dated, by ceramics, to the end of the 1st century AD. The backfill in which the foundations are built as well as the construction filling of the *cavea* are of the same date.
[7] Lazzarini 1998.
[8] Barker and Fant 2019, chapter 17, Revetment wall in the east wing, paragraph 1944.
[9] Guidobaldi 1985, 183.
[10] See fn. 1.

Volume of breccia corallina by site					
Site	**Fragments**	**Archaeological context**	**Useful dimensions**	**Dating**	**Volume (cm^3)**
Circus	1 small fragment	Occupation of the *cavea* of the *circus*	-	End of the 1st century AD	9.6
Glassworks	4 rectangular slabs	In room VI, two slabs included in an *opus sectile* QrQ-type (30 x 30 cm square module)	15 x 15 cm and 10 x 20 cm	End of the 2nd - middle of the 3rd centuries AD	15232
		In room IV, the pavement covers the corridor along the basin containing two large slabs	86.5 x 114 x 2 to 2.5 cm and 92 x 88 cm x 1.5 cm		
Cryptoporticus	1 squared face slab	Unknown	Width 3 cm	Undated	1233
Truchet Street	4 veneers one with a squared face	In a post abandonment layer of the place	-	End of the 3rd century - beginning of the 4th century AD	201.6
	3 veneers	Occupation layers or filling layers	-	5th - 6th centuries AD	
Saint-Césaire	1 large slab	*In situ* within the *presbyterium* pavement undated	55 x 70 cm	The 4th century building or its extension in the 6th century AD	5775
	3 rectangular slabs	Filling layers	With one complete (1.6 x 5.4 cm);	7th - 8th centuries AD	158
Rhône	1 veneer	Layer	-	Late 3rd century AD	1502
	1 "band-type"	Dump	Width 3.5 cm	4th-5th centuries AD	
	20	Layers	-	Modern and contemporary	
Cemetery	2 veneers	Filling layers	-	Undated	65
Van Gogh Hospital	1 veneer	Base of a soil near the *Cardo*	-	Undated	88

Volume of breccia corallina by typology		
Typology	**Number of fragments**	**Volume (cm^3)**
Slabs	34	1997
Slabs with squared face	2	1250.4
Fragments with one polished face	1	9.6
Large paving marble *in situ*	3	20381.5
Rectangular and squared tiles *in situ*	2	626
The thickness of the slabs varied from 0.3 - 0.7 (*circus*, end of 1st century AD) to 3 cm (cryptoporticus and Rhône).		

Table 1: Volume of breccia corallina by sites and typology.

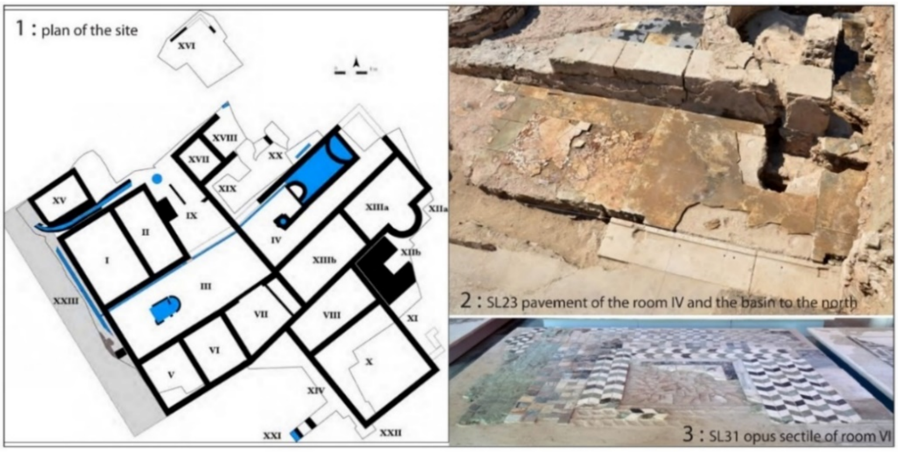

Figure 3: Trinquetaille Glassworks (Map 1 and photo 2: Rothé and Genot 2013, fig. 63 and fig. 173; photo 3: D. Remeau).

Africano

This brecciated marble is composed of a matrix, black, grey-brown or dark-green with marble fragments pink, white, yellowish and grey-blue, in which crystals of different sizes are included[11]. The great quarry near Teos was identified in 1996 by Ballance. Since then, other quarries have been found from the village of Turgut and of Küçukkaya[12].

This marble is attested in Arles, mainly as slabs, but also as column shafts and blocks[13]. In total, 107 items were studied and have a volume of 0.0356 m^3 (Tab. 2). 15 column shafts (7.34 m^3) and 5 blocks (0.361 m^3), as well as 30 slabs *in situ* in the *opus sectile*

[11] Borghini 1989, 133.
[12] Bruno *et al.* 2012, 567.
[13] 22 identifications are uncertain.

of the glassworks (0.016 m^3) and 2 shapeless reused slabs from the Sainte-Luce Commandery (0.00085 m^3) must be included. Africano is present in 14 sites (Figs 2: 1-4, 6, 8, 10, 12-13).

From the Augustan period, around 20 - 10 BC, africano was present in the original decoration of the ancient Theatre, in column shafts, worked blocks and slabs, on the imperial model, associated with the lunense bardiglio and the giallo antico. It was *in situ* on the pavement apron, in the reconstructed *orchestra* and on the royal door, with a bardiglio column shaft (Tab. 2). In the garden of the Theatre, 14 other smooth shafts were deposited.

Africano may have been used for other monuments such as the Truchet portico and the contemporary Forum, since it was discovered in the form of thick moulded slabs in the cryptoporticus stock. It may also have been used in the *circus* during its renovation (late 3rd - early 4th centuries AD), even perhaps in its first phase. Slabs with fractures[14], were discovered in a zone rich in marble at the end of the spina (Fig. 5, US 596). This zone (end of the 1st century AD) presented a collapsed wall covered with veneering which suggests the destruction of a building before the construction of the circus. But the presence of fragments and pieces with fractures, cutting traces, squared faces, fragments of abandoned cut blocks and especially elements with triangular profiles, but smooth faces that could be unfinished or broken mouldings, suggests a work area perhaps related to the decoration of the circus[15] or another building[16].

In addition, africano seems to have been used in the decoration of the semi-public baths of the Esplanade (late 1st - middle of the 3rd centuries AD) and perhaps in the public baths (late 3rd - early 4th centuries AD). Finally, it was present in several pavements and wall revetments of a *domus* on the glassworks site (late 2nd – mid-3rd centuries AD). It was used in room VI in rectangular or squared form (the same size as breccia corallina), in the *opus sectile* and for the framing of the *emblema*. In room IV, it was discovered in place as an insert for the preparation of a pavement, in the one which borders the basin and in the destruction layer after the spoliation (Fig. 3). It was also in parietal veneers in the destruction levels (second half of the 3rd century AD) of room XIIIA. Africano occurrs mainly in the form of veneering, but also as column shafts and inscribed slabs. It had to be imported in block form and transformed into slabs on site as suggested by one found in the Rhône (Fig. 4).

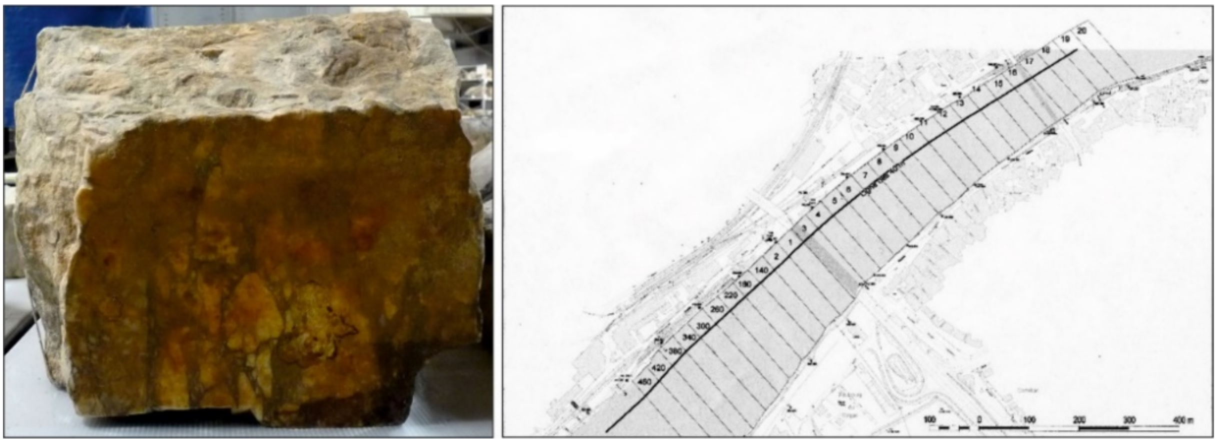

Figure 4: Africano block from zone 380 and Rhône zoning (Photo: D. Remeau).

[14] A “fracture” is a trace left on the block from the removal of a previously cut slab. It is characterized by a remainder of protruding material whose width corresponds to the thickness of the slab and whose edge has a break along its entire length.

[15] See above fn. 6.

[16] Concerning all the coloured marbles of the *circus* of Arles, see Remeau 2019.

Volume of africano by site					
Site	**Fragments**	**Archaeological context**	**Useful dimensions**	**Dating**	**Volume (cm^3)**
Unknown (called "ancient collection" of the museum)	3 inscribed slabs	Unknown	-	-	3180
Ancient Theatre	8 veneers	Dump located in alveoli 22	-	5th century AD	4599
	1 slab	*In situ* on a *bardiglio* pavement of the apron highlighted	-	20 – 10 BC	?
	Many fragments	In the reconstructed floor of the *orchestra*	-	20 – 10 BC?	?
	15 smooth columns	1 column still *in situ* on the royal door with a *bardiglio* column and 14 other smooth column shafts deposited in the garden of the ancient Theatre	See Figure 10	20 – 10 BC	7340000
	4 blocks	Deposited in the garden of the Ancient Theatre	Length: 46 to 71 cm Width: 30 to 65 cm Thickness: 16 to 38 cm	20 – 10 BC?	335408
Baths	1 veneer	Layer outside the apse of the *tepidarium*	-	Undated	15
Bizalion	1 slab	Unprecise stratigraphic context	-		302
Cemetery	1 slab	*Domus* context	-	Undated	70
Circus	8 veneers	A zone rich in marble at the end of the spina and the track around	--	End of the 1st century AD	1508
	2 veneers with fractures				
	1 with two perpendicular smooth faces				
	1 with squared face				
	3 veneers, one with a fracture	Filling layers of the southern end of the spina	-	End of the 3rd - beginning of the 4th centuries AD	
Cryptoporticos	19 moulded slabs	The stock of limeburners	Between 1.8 and 4 cm thick	5th century AD	20200
	1 slab				
Esplanade	3 veneers	Layers of destruction of the semi-public baths: Rooms 3, 4 and 5-6	-	End of the 3rd - end of the 4th centuries AD	945
	1 band-type slab	Layers of destruction of the semi-public baths: Room 4	Width 3.4 cm		
	1 veneer	unknown	-	Undated	
Glassworks	12 rectangular slabs, 10 squared slabs and 7 veneers	In room VI, rectangular or squared slabs included in an *opus sectile* QrQ-type (30 x 30 cm square module) and rectangular veneers for the framing of the *emblema* and the edge of the pavement	15 x 15 cm and 10 x 20 cm; Width of the band of the framing: 15 cm	End of the 2nd century AD - middle of the 3rd centuries AD	13312
	1 insert for the preparation of pavement and one rectangular slab in the pavement	In room IV, the pavement SL23 covers the corridor along the basin	Slab: 58 x 31 cm		2697
	2 veneers	In room IV, in the destruction layer after the pillage	Between 1.5 and 1.9 cm thick and have traces of mortar	2nd half of the 4th century AD	544
	1 veneer	In room XIIIA, fire-related collapse layer		2nd half of the 3rd century AD	
Glassworks	1 veneer	In room XIIIA, recovery trench	-	2nd half of the 4th century AD	
	1 slab	Filling layers, room XV		Middle 5th century AD?	
26 Sauvage Street	1 slab	Concrete repair of the 4th century AD paving above the pedestal	-	5th century AD (reuse)	399
3 Sauvage Street	1 slab	Soil preparation	-	Post 3rd century AD	
Truchet Street	15 veneers, 1 squared face, 3 band-types and 1 fragment	Filling layers or late Roman occupations installed on the Augustan square	Band type width of 3.6 to 4.1 cm	4th - 5th centuries AD	1437
Sainte-Luce	2 shapeless veneers	Reused in a pavement	-	5th century AD (reuse)	846
Rhône	14 veneers	Layers	-	Unknown or contaminated	2289
	9 veneers	Dump	-	4th - 5th centuries AD	
	1 block	Dump	Width 3.5 cm	4th-5th centuries AD	25678
	1 smooth shaft	Layers	See Figure 10	Modern and contemporary	287868
Van Gogh Hospital	3 veneers	Filling layers around or on the way	-	Between Flavian period and the 6th century AD	110

Volume of africano by typology		
Typology	**Number of fragments**	**Volume (cm^3)**
Slabs	82	13340
Molding slabs	20	19090
Inscribed slabs	3	3180
Slabs with 1 squared face	2	102
Fragment with two polished perpendicular faces	1	536
Fragments with one polished face	1	104
Squared tiles *in situ*	10	2162
Rectangular tiles *in situ*	12	3702
Large paving marble *in situ*	8	724
Blocks	5	361090

Table 2: Volume of africano by sites and typology.

Troad granite

Troad granite has a medium grain and overall violet-grey appearance. The crystals are white and purple mixed with small black inclusions; some of them appear as real points of the granite structure[17]. Extraction sites have been identified on Ciğri Dağ (*Neandreia*), a mountain near the villages of Kayacik, Uluköy and Koçali, where Yedi Taşlar is located. Monolithic column shafts were found abandoned in these quarries[18].

In Arles, Troad granite is present at 7 sites (Tab. 3; Fig. 2: 3, 5, 7, 13, 15-16, 18) with 28 items (0.0031 m^3).

Troad granite was essentially used for shafts and seems to have been introduced in Arles in a private context between the middle of the 2nd century AD and the middle of the 3rd century. Indeed, a column of small module was found in a domus (Crédit Agricole site). However, this granite was used especially in monumental public contexts at the beginning of the 4th century AD, perhaps related to the presence of Emperor Constantine in *Arelate* in AD 310 and 316. One larger column is still in place from the tetrastyle entrance added to the Forum between AD 324 and 326 according to the inscription on the pediment above[19]. The obelisk from the circus, moved in 1675 to the Place de la République, was also made from this marble, as the analysis of L. Lazzarini and A. Blanc confirmed[20]. The study of coloured marbles discovered at the circus also showed the presence of Egyptian marbles in abandonment layers, as well as traces of repair at the southern end of the spina in the 3rd - 4th centuries AD, suggesting that a new decoration was installed at this time, possibly related to the Emperor Constantine[21]. The erection of an obelisk certainly requires effort and technical and financial means, and the quarries for this granite were perhaps imperial property at that time. Three column shafts, of the same module as that of the Forum, and currently in the garden of the ancient Theatre, came from Saint-Césaire site (Tab. 6) according to M. Heijmans[22]. Two others, slightly smaller in diameter, were discovered in the Rhône. At Saint-Césaire, 25 fragments were found and 11 presented a smooth convex profile, more or less curved, suggesting the presence of columns (Tab. 6).

The majority come from destruction or abandonment layers (6th and 12th centuries AD), eight from the destruction of the ambo, and one in the recovery trench of a wall (possibly 6th century) that extends the chancel barrier. To this, four columns must be added, of which one is still visible on site and three others were deposited in the ancient Theatre. This data suggests the use of this granite mainly for shafts, perhaps used in the two colonnades of 14 columns of the 4th century AD building.

Given the acme of this marble diffusion in Late Antiquity, its production primarily for column shafts, and the possibility of quarries on imperial property[23], we can assume Constantine used this granite to mark the unity of the empire after the defeat of Licinius in 324 AD.

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17 Borghini 1989, 236.
18 Pensabene 1998, 7.
19 The metal letters of the inscription were attached to the wall. They have disappeared but the fixing holes are still visible. The letters were reconstructed based on these holes making it possible to decipher the missing inscription.
20 Charron, Heijmans 2001, 373, Annie Blanc in the report of 28 October 1991.
21 Charron, Heijmans 2001, 378.
22 Marc Heijmans, excavation director of Saint-Césaire, CNRS research engineer, MMSH, Aix-en-Provence.
23 Borghini 1989, 236.

Volume of Troad granite of by site					
Site	**Fragments**	**Archaeological context**	**Useful dimensions**	**Dating**	**Volume (cm^3)**
Crédit Agricole	1 column	Found during the excavation in two pieces in room 4, it is now recomposed and exposed in the archaeological crypt with its white marble capital.	See Figure 10	Middle of the 2^{nd} century AD and the middle of the 3^{rd} century AD	150000
Circus	1 fragment	Contemporary general recovery of the last phase of pillage of construction materials	-	End of the 5th century AD or 6^{th} century AD	5
	1 obelisk	Unclear context, it was discovered in the area of the spina and moved in 1675 to the centre of the large town square	Height: 17 m	Unknown	?
Forum	1 column	*In situ*, left column of the tetrastyle entrance added to the Forum between 324 and 326 AD according to the inscription recomposed from the holes still visible today on the pediment above.	See Figure 10	324-326 AD	-
Saint-Césaire	4 fragments probably of columns (smooth convex face)	Filling in of the medieval salvaged trench, in a heap of boulders from the ancient massif supporting the chancel barrier, demolition after recovery of the facings of a pillar, and unknown context.	-	Antiquity and Medieval context	2126
	21 fragments, some with a smooth face	The majority comes from destruction or abandonment (6^{th} and 12^{th} centuries AD), 8 come from the destruction of the *ambo*.	-	6^{th} and 12^{th} centuries AD	787
	4 columns smooth shafts	3 deposited in the garden of the ancient Theatre and 1 deposited on the site	See Figure 10	Undated	2970000
Rhône	1 veneer	Zone 5, layer	Width: 1.5 to 1.7 cm	End of the 4^{th} century AD – beginning of the 5^{th} century AD	43
	2 column shafts	Zone 5, dump (column left in the river, two samples were taken)	See Figure 10	4^{th}-5^{th} centuries AD	-
Van Gogh Hospital	1 fragment probably of columns (smooth convex face)	Filling layer in which a Late Antiquity wall was built, at the edge of the ancient road.	-	Between 1^{st} century AD and Late Antiquity	155

Volume of Troad granite by typology		
Typology	**Number of fragments**	**Volume (cm^3)**
Slabs	1	43
Fragments with one polished face	1	625
Fragments with one polished and curved face	5	2281
Fragments	14	167

Table 3: Volume of Troad granite by sites and typology.

Pavonazzetto

Pavonazzetto is a marble composed of an almost diaphanous white background with purplish veins and spots, from mild to darker tones, arranged with a certain regularity[24]. The quarries were located near Iscehisar (*Docimium*) by Afyon in Phrygia and were controlled by the administration located at the ancient Synnada[25]. About 50 km north-west of *Docimium*, there was another extractive site with the same type of marble, in Altintas, where monolithic blocks and column shafts were extracted. These quarries were also run by the administrative centre of Synnada[26].

This marble was present in Arles at 15 sites totalling 209 items (Tab. 4; Fig. 2: 1 to 4, 6 to 8, 11 to 18) for a volume of 0.111 m^3.

Pavonazzetto was mainly used for moulded elements (cyma) and moulded slabs, some of which have a squared face, as found in the 5^{th} century AD stock in the cryptoporticus (Fig. 5)[27]. It was in use at the end of the 1^{st} century AD in the *circus* or in an earlier building. It may have been used for public monuments between the 1^{st} and 3^{rd} centuries AD, because it was discovered in Late Antique destruction layers (the Forum, the Truchet courtyard, the ancient Theatre and the baths), and for semi-public buildings (Esplanade baths and Cemetery courtyard, destroyed in the 3^{rd} century AD). Pavonazzetto has been one of the most prized of the "imperial" marbles[28] since the Augustan period because it was used in public monuments

[24] Borghini 1989, 264.
[25] Borghini 1989, 264-265.
[26] Waelkens 1982, 39.
[27] The presence of squared faces suggests an imported block, cut in Arles, whose end veneers have been used.
[28] Barker, Fant 2019, chapter 17, Porticus 60, paragraph 1928.

in Rome, frequently with africano and giallo antico. It is therefore not surprising to find it in large quantities in public contexts, notably in the Forum built in the Augustan period.

Pavonazzetto was discovered *in situ* in the basin (room IV) of a rich domus (glassworks site) and in the destruction layer deposited directly onto the mosaic of another room (XIIIA) where it was part of the parietal decoration (2nd -mid-3rd centuries AD). Lastly, it was reused in the 5th century AD pavement in Sainte-Luce.

The moulded slabs and the cyma of the cryptoporticus indicated a monumental wall revetment probably of the Forum (end of the1st century BC). In private contexts, it was used between the late 2nd and the middle of the 3rd centuries AD for parietal decoration and reused in a pavement in the 5th century AD. It was discovered in all the ancient thermal baths in Arles.

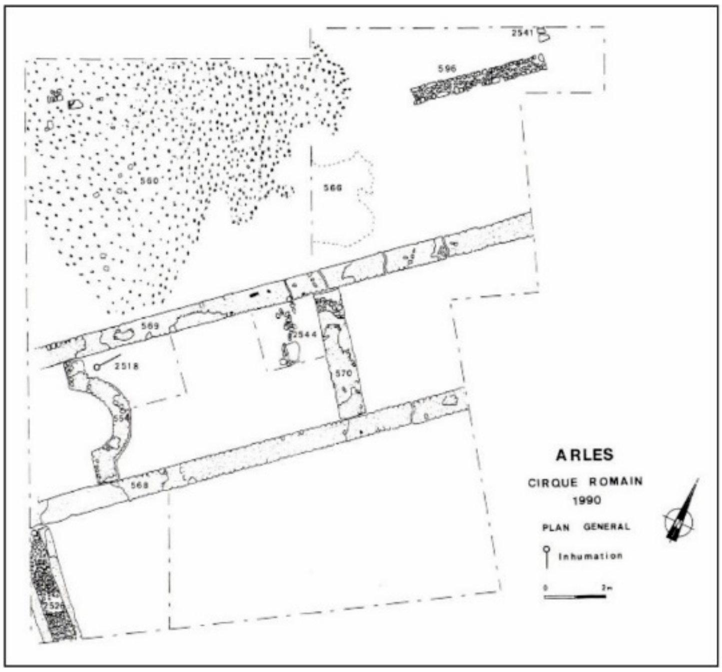

Figure 5: Maps of south end of the spina of the circus, location of the marble zone (Archives of the MDAA).

Volume of pavonazzetto by site					
Site	**Fragments**	**Archaeological context**	**Useful dimensions**	**Dating**	**Volume (cm^3)**
Ancient Theatre	2 slabs, one with a frame moulding	Dump located in alveolus 22	-	5th century AD	168
Bizalion	1 slab	Unprecise stratigraphic context	-	Roman Antiquity	42
Cemetery	2 veneers	Filling of the courtyard	-	Late Antiquity	192
	1 band-type veneer	Filling layer in a context that may be a public building near the courtyard	Width 2.4 cm	Late 3rd - early 4th centuries AD	
Circus	2 slabs	In an area rich in marble at the end of the spina	-	End of the 1st century AD	1634.5
	1 slab	Filling layer of the arena		1st half of the 2nd century AD	
	7 slabs of which one with a squared face et 1 token (reuse)	Dump, *spina*'s trench, occupation of alveoli and abandonment		4th – 6th centuries AD	
Cryptoporticus	59 moulded veneers of which 5 have a squared face	The stock of limeburners	Between 1.2 and 7.5 cm thick	5th century AD	87752.5
	45 moulded elements of which 3 have a squared face		Between 2.5 to 8.3 cm thick		
Esplanade	3 slabs whose 2 mouldings	Destruction of the baths (rooms 2 and 3)	-	End of the 3rd century AD	1261.5
	3 slabs and a small twisted column shaft	*Cardo* sector but the context is unspecified and undated	Column diameter: 4.5 cm	Undated	
Glassworks	2 thin veneers	In layers of two adjacent rooms (II and IX)	-	End of the 2nd century AD	1793.6
	1 veneer	In room IV, in place but it is difficult to say if it is an insert or cladding knowing that the basin is completely covered with white marbles, *bardiglio* and shale	-	End of the 2nd – middle of the 3rd centuries AD (phase 4)	
	1 veneer	In rooms XIII-XII-VIII, filling of wall recovery trench	-	End of the 4th century – 6th century AD (phase 6)	
	1 veneer	In room XIIIA, destruction layer lying directly on the mosaic	-	End of the 4th century – 6th century AD (phase 6)	
	2 veneers	In room XIIIA, in two fillings of wall trenches	-		
	1 square tile (probably *pavonazzetto*)	In room VI, in the *opus sectile*	14.5 x 14.5 cm	End of the 2nd century AD – middle 3rd centuries AD (phase 4)	
	1 astragal slab, 1 moulded slab or element, 1 moulded slab, 1 slab	Contaminated or undated layers in room VIII, XI (moulded element), XIII (slab whose moulding forms an angle), XIIIA	-	Undated	
3 Sauvage Street	1 slab	Trench wall of the baths, installed over an older wall (from 230 AD) which burned since some others marbles are blackened by fire.	-	Post 230 AD	484.4
	1 slab	Destruction layer	-	Anterior to 200	
	1 slab	Destruction layer above the 3rd century AD *Cardo*	-	Post 3rd century AD	
	1 band-type veneer and 1 slab	Layer inside the apse of the baths' *tepidarium*	Width 4.5 cm	Between 540 and 600 AD	
Suarès square	3 thin veneers	Burned layer under the private baths of a 4th century AD *domus*	-	Middle of the 3rd century AD	78
Truchet Street	15 veneers	Filling layer levelling the square containing 69 marble veneers	--	Late 3rd - early 4th centuries AD	614
	1 veneer	Filling layer containing 48 marble veneers		4th - 5th centuries AD	
	3 fragments	In Late Antiquity grounds and a medieval pit		Late Antiquity and Middle Ages	
Saint-Césaire	5 veneers	Medieval and later layers	-	Notably from the 12th – 13th centuries AD	6556
	1 slab	In a pit		Second half of the 4th century AD	
	1 tile	In the pavement of the small church		Around 400 AD	
	1 slab	Ayer of the Early Empire (perhaps reworked)		Early Empire	
Sainte-Luce	1 slab	Reused in a 5th century AD pavement	-	5th century AD (reuse)	245.5
	1 band-type veneer	Ground	Width 2.3 cm	13th century AD	
Rhône	6 veneers and 2 moulded elements	Zone 5, dump	-	4th-5th centuries AD	9894
	1 slab	Zone 5, layer		2nd century AD	
	1 slab	Zone 5, layer		1st century AD	
	17 veneers	Zones 3, 4, 5, 10, 11, 13 and 16 whose contexts are undated or contaminated		Undated	
Van Gogh Hospital	2 slabs	Filling of the Flavian paving under the 13th century Trinitarian gardens	-	Between Flavian period and the 13th century AD	239
	1 slab	Reused in a late wall along the Flavian paving			
Volume of pavonazzetto by typology					
Typology		**Number of fragments**	**Volume (cm^3)**		
Slabs		88	7942		
Molded slabs		61	38239		
Molded slabs with 1 squared face		5	5471		
Slabs with 1 squared face		2	6165.4		
Molded elements		46	48157		
Molded elements with 1 squared face		3	4125		
Molded element or slab		1	258		
Astragal		1	154		
Token		1	47.6		
Fragment with 1 polished face		1	36		

Table 4: Volume of pavonazzetto by sites and typology.

Greco scritto

This white marble has large crystals and fine veins, such as real streaks or short segments, varying from grey-blue to grey-black, and with bluish spots or simple speckles[29].

The “real” sources of greco scritto (without large veins or bands) would be the various quarries of Hasançavuslar, near Ephesos, that produced several types of marble: a white marble, a dark grey and a speckled one. There were three districts, Zimpara and East and West Hasançavuslar, which are difficult to differentiate isotopically. Some districts still bear traces of ancient activities[30].

The greco scritto of Cap de Garde in Algeria is isotopically different from that of Türkiye. Visually it is more banded than the latter, but this is difficult to distinguish on small veneering fragments. This is why in the absence of isotopic analysis of the items studied, I prefer not to distinguish between these two sources. The greco scritto could be shipped with another marble among the most important in Arles. Even though the shorter and easier maritime route between Southern France and North Africa seems more logical, the quantity of africano (including blocks and columns) is most important than giallo antico of Tunisia.

In Arles, 1,030 items of this marble were identified from 16 sites representing a total volume of 0.153 m^3 (Tab. 5 and Fig. 2: 1 to 8, 11 to 18). Most of the fragments were veneer, some moulded, mouldings elements, slabs with inscriptions and an astragal slab (one *in situ* at the Crédit Agricole domus, (Fig. 6).

Greco scritto was imported to Arles from the end of the 1st century AD (circus) and used especially for revetment slabs in private contexts (Crédit Agricole domus, mid-2nd century - late 3rd century AD) and semi-public contexts (Esplanade baths, in place on the entrance and the swimming pool, 1st century AD). At the Crédit Agricole site it was used for a parietal decoration made with large veneers of greco scritto, 111 cm long and 33 cm wide (as can be seen in room 2, Fig. 6). A sill in the wall was made above the large veneers, at 33 cm high, with an astragal slab forming a recess in the wall of 2.3 cm. These large veneers could be greco scritto from North Africa because it shows large bands.

Figure 6: View of the astragal in greco scritto from the parietal decoration of room 2 at Crédit Agricole (Photos: D. Remeau), and map of the site (Archives of the MDAA).

[29] Borghini 1989, 237.
[30] Attanasio *et al.* 2012, 245.

Volume of greco scritto by sites					
Site	**Fragments**	**Archaeological Context**	**Useful Dimensions**	**Dating**	**Volume (cm^3)**
Ancient Theatre	8 veneers, 1 (on surface), 1 slab with a squared face	Dump located alveolus 22	-	5th century AD	1076
Baths	2 veneers	Layer outside the apse of the *tepidarium*	-	Middle Ages	46
Bizalion	2 slabs	Unprecise stratigraphic context	-	Antiquity ?	367
Cemetery	14 slabs, 1 moulded slab, 3 band-type veneers	In the destruction layers of the 4th and 5th centuries AD except one in the layer of fire of the 3rd century AD.	Width of band-type: 4.4, 3.7 and 3.2 cm. one of them has a triangular end	3rd century AD and 4th and 5th centuries AD	1238
	2 tokens	Unprecise context of a roman *domus*	-	Undated	
Circus	2 slabs and 1 fragment with a polished face	Filling layers in which the foundations of the spina are built	-	30-90 AD	6240
	1 slab	Construction phase, lime layer, cavea east	-	End of the 1st century AD	
	2 slabs and 1 fragment with a polished face	Layer above and below the gravel of the circus track	-	End of the 1st century AD	
	20 slabs and 6 slabs with a squared face, 1 fragment	Zone rich in marbles with painted plasters, tiles and bricks at the south end of the *spina*	-	30-90 AD / end of the 1st century AD	
	3 slabs and 1 astragal slab	Backfill after construction of the foundation walls	-	End of the 1st century AD – beginning of the 2nd century AD	
	2 slabs	Backfill above the foundation sill	-	Between the 2nd century AD and Late Antiquity	
	1 « moulded » element (cyma) without mouldings, 11 slabs, 1 slab with a squared face	Restoration of the decoration of the south end of the *spina*		End of the 3rd century – beginning of the 4th century AD	
	1 band-type veneer with a squared face	Dump, in the bend of the circus		4th centuries AD	
	1 slab	Recovery of *spina* walls	-	Undated	
	1 slab	Recovery of the meta secunda wall of the *spina*	-	Undated	
	5 slabs, 1 inscribed slab	Filling layers covering the walls of the necropolis outside the circus	-	1st half of the 6th century AD	
	11 slabs	Layer of abandonment covering the walls of the *cavea*	-	End of the 5th century AD – 6th century AD	
	1 slab	Alluvial deposits of the Rhône	-	Modern period	
	2 slabs	Occupation under the later layers of the alveolus XV	-	Undated	
	3 slabs	Unknown or excluding stratigraphy	-	Undated	
Crédit Agricole	124 slabs, 3 astragal slabs and 2 band-type veneers	Marbles from the destruction of the *domus* but without stratigraphic precision	Astragal slabs: 1 / 1.3 / 1.5 /1.7 cm thick 2 Band-type: 8 cm width	150 – 275 AD	
	1 slab	Marble in place, room 1, west wall	88 x 9.5 x 1 to 1.2 cm	150 – 275 AD	43584
	1 slab	Marble in place, room 1, east wall	68 x 28 x 1 to 1.3 cm		
	1 slab	Marble in place, room 1, south wall	9.2 x 12 x 1.5 cm		
	3 slabs and 1 astragal slab	Marble in place, room 2, west wall (2.3 cm is the dimension of the horizontal surface of the astragal not embedded in the mortar and therefore visible, the veneer being 3.8 cm wide in total and 1 cm thick)	Astragal slab: 14 x 3.8 x 1 cm 1: 104 (imprint =111cm) x 33 x 1.2 to 1.5 cm 2: 88.5 x 20.5 x 1 to 1.1 cm 3: 41.5 x 16 x 1.4 to 1.5 cm		
	3 slabs	Marble in place, room 2, south wall	1: 178.5 x 13 x 0.8 to 1.2 cm 2: 46.5 x 7 x 1.5 cm 3: 109.8 x 30.5 x 0.8 to 1.5 cm		
	2 inserts	Marble in place, room 1, south wall	-		
	1 insert	Marble in place, room 3, east wall	-		
Cryptoporticus	20 moulded slabs and 1 with a squared face	The stock of limeburners	Between 1.4 and 4 cm thick	5th century AD	33440
	5 slabs and 2 with a squared face				
	2 moulded elements (cyma) and 1 with a squared face		Between 1 and 3.2 cm thick		
	1 carved slab	The stock of limeburners (carved slab with a flower and its stem passing over a molding)	32.5 x 22 x 6 cm		

Table 5: Volume of greco scritto by sites and typology.

Volume of greco scritto by sites					
Site	**Fragments**	**Archaeological Context**	**Useful Dimensions**	**Dating**	**Volume (cm^3)**
Esplanade	2 veneers	Layer of destruction to the east of *Cardo*, maybe material of the room 21	-	Undated	8006
	1 veneer	Level of flat ceramic shards, room 21	-	Undated	
	1 slab	North of the room 19	-	Undated	
	2 slabs and 1 with a squared face	Dump filling the gutter of room 25	-	Undated	
	3 veneers	Baths: recovery of the walls of the room 3	-	Undated	
	4 slabs	Baths, room 3: Filling layer post pillage	-	End of the 4th – first quarter of the 5th centuries AD	
	1 slab	Baths, room 3: recent level	-	Undated	
	4 veneers and 1 with a squared face	Baths, room 4a: wall plinths, in place	-	End of the 1st century AD – third quarter of the 3rd century AD	
	3 veneers	Baths, room 4: wall plinths, in place	-		
	17 slabs and 1 with a squared face	Baths, room 4: Filling layer post pillage	-	End of the 4th – first quarter of the 5th centuries AD	
	15 slabs	Baths: dump of the limeburners	-	End of the 4th century AD ?	
	1 slab and 1 with a squared face	Baths: rubble against a wall	-	Undated	
	1 slab with a squared face	Baths: surface collection	-	Undated	
	1 slab	Baths, rooms 5-6: destruction layer	-	Undated	
	4 slabs and 1 with a squared face	Baths, room 6: technical US	-	Undated	
	11 slabs	Filling layers near the *Cardo*	-	Undated	
	9 slabs and 1 with a squared face	Unknown	-	Undated	
Glassworks	39 slabs	Room IV, fire layer	-	Middle of the 3rd century AD	12267
	55 slabs	Room IV, destruction of the room	-	2nd half of the 4th century AD	
	1 threshold slab, 2 rectangular tiles, 2 triangular tiles	Room VI, in place, threshold	Rectangular: 28 x 24.5 cm; 14.5 x 3 cm Triangular: 14 x 4; 12 x 4.5 cm	End of the 2nd century AD - middle of the 3rd centuries AD	
	1 moulded slab, 1 lozenge slab, 6 slabs	Room VIII	-	Undated or 6th century AD	
	1 veneer	Room IX, soil preparation	-	1st half of the 2nd century AD	
	1 slab	Room X, layer on the mosaic pavement	-	4th century AD	
	1 slab	Room XI	-	End of the 3rd century AD	
	2 almond shaped slabs, 9 slabs, 1 with a squared face	Room XII, destruction filling layer on concrete floor or others filling layers	1: 4.1 x 1.8 x 0.8 cm 2: 4.2 x 1.5 x 0.7 cm	End of the 4th – beginning of the 5th centuries AD	
	52 veneers	Room XIIIA, destruction of the room	-	4th - 5th centuries AD	
	3 slabs	Room XV, filling layers	-	5th century AD	
	3 slabs	Room XXI, filling layers on the floor	-	1st half of the 3rd century	
	7 veneers, 1 with a squared face, 1 moulded slab	General layer of site destruction	-	Late Antiquity	
	28 slabs, 1 astragal slab	1980s excavation filling layers (rooms XII, IV, VIII, XII)	-	Contaminated	
	15 slabs, 4 astragal slabs, 1 band-type veneer	Unknown	Astragal thick: 1.2 to 1.3 cm Band type width 4 cm	Undated	
Sant-Césaire	6 slabs	Filling layers	-	2nd century AD or Early Roman Empire	2257
	5 slabs, 1 band-type veneer	Destruction near the pavement or abandonment of the site	Band type width 2 cm	Late Antiquity (5th – 6th c. AD)	
	8 slabs, 5 band-type veneers	Filling layers and demolition	Band type width of 1.5 to 2.8 cm	Middle Ages	
	5 slabs, 1 band-type veneer, 1 slab with a squared face	Filling layers and demolition	Band type width 2 cm	Modern and Contemporary periods	
	4 slabs, 2 moulded slabs, 1 band-type veneer	Unknown or excluding stratigraphy	Band type width 2.3 cm	Undated	
Sainte-Luce	2 veneers	Filling layer on the pavement	-	5th century AD	56
3 Sauvage Street	2 slabs	Filling layer and pillage	-	Late Antiquity	80
Suarès square	1 slab	Destruction of a wall	-	Middle Ages	109
Truchet Street	32 veneers, 1 moulded slab, 3 squared face, 7 band-type veneers	Filling layers or late Roman occupations installed on the Augustan square	Band type width of 3.2 to 5.8 cm	4th - 5th centuries AD	3260

Table 5: Volume of greco scritto by sites and typology (*continued*).

Volume of greco scritto by sites					
Site	**Fragments**	**Archaeological Context**	**Useful Dimensions**	**Dating**	**Volume (cm^3)**
Rhone	173 slabs and 6 with a squared face, 2 moulded slabs, 2 astragal slabs, 2 band-type veneers, 2 triangular tiles, 5 fragments with a polished face, 1 slab with fracture	Zone 5	Band type width: 2.5 / 7.2 cm	Undated	52734
	1 slab	Zone 5, layer	-	2^{nd} century AD	
	2 slabs	Zone 5, layer	-	Second half of 2^{nd} century - first half of 3^{rd} century AD	
	1 slab	Zone 5, layer	-	2^{nd} century AD – 4^{th} century AD	
	10 slabs	Zone 5, layer	-	4^{th} century AD	
	65 slabs and 3 with a squared face, 1 band-type veneer, 1 astragal slab	Zone 5, layers	Band type width: 7.8 to 8.3 cm	4^{th} – 5^{th} centuries AD	
	2 slabs	Zone 5, layers	-	5^{th} century AD	
	2 slabs and 1 with a squared face, 1 moulded element	Zone 5, Arles-Rhône 7 wreck	-	Undated	
	2 slabs	Arles-Rhône 8 and 10 wrecks area	-	Undated	
	1 slab	Zone 7	-	Undated	
	17 slabs and 1 with a squared face	Zone 13	-	Undated	
	1 slab and 1 moulded element	Zone 15	-	Undated	
	1 moulded element, 1 slab	Zone 17	-	Undated	
	1 slab	Zone 28	-	Undated	
	2 slabs	Unknown	-	Undated	
Van Gogh Hospital	8 veneers	Filling layer around or on the way	-	Between Flavian period and the 6^{th} century AD	1085
	2 veneers	In a pit along the way	-	10^{th} – 13^{th} centuries AD	
	6 veneers	Filling layers	-	Undated	

Volume of greco scritto by typology		
Typology	**Number of fragments**	**Volume in cm^3**
Slabs	910	79700
Slabs with 1 squared face	34	8990
Inscribed slabs	4	14111
Molded slabs	26	1081
Molded slabs with 1 squared face	1	1628
Astragal slabs	12	620
Molded elements	7	4648
Small column shaft	2	41496
Fragments	10	4100

Table 5: Volume of greco scritto by sites and typology (*continued*).

Greco scritto was used at the end of the 1^{st} century AD in the circus, in the layers related to the construction phase (levelling and filling layers of the rooms under the cavea). About thirty moulded veneers or moulded elements were discovered in the stock of the cryptoporticus, one of which was a complete pilaster base. It may also have been used in the decoration of the courtyard at the Truchet site built at the same time. At the glassworks, it was present in the *opus sectile* of room VI (Fig. 3) and especially in the destruction layers of rooms IV and XIIIA (late 2^{nd}– mid- 3^{rd} centuries AD domus), and in the abandonment layers and filling of looting trenches. At the end of the 3^{rd} - beginning of the 4^{th} centuries AD, it seems to have been used to repair the southern end of the circus spina. It is also to be found in the 5^{th} century AD dump at the ancient Theatre which may be related to the decoration of this monument. At other sites, it was mainly found in destruction or abandonment layers, usually dating from the end of the 3^{rd} to the 5^{th} centuries AD, and in medieval and modern layers.

Conclusion

This study has identified five coloured marbles from Asia Minor used in Arles during Antiquity. Prevalence by volume, in increasing order (not including shafts) is: Troad granite, breccia corallina, pavonazzetto, greco scritto (if Turkish) and africano. These Asian marbles were mostly used as slabs, and some had squared faces suggesting importation in blocks. Africano was found at the circus in a late 1st century AD context, with fracture traces indicating block-cutting on site. Without a dated context, it was the only Asian marble discovered in blocks in the Rhône (in an area in front of the circus). It seems possible that marble workers came to the riverside to work the marble: finishing the columns, mouldings and cutting the blocks into slabs. The cutting of stone blocks often took place near ports and could lead to silting-up as reflected by the edict found at Ephesos, issued by L. Antonius Albus in 146-147 AD[31]. The area of the circus being by the river, it cannot be ruled out that the marble blocks were deposited and worked in this area in the 1st century AD for the decoration of the circus or for another earlier building[32].

Troad granite is only found in public contexts and especially in column shafts. Africano column shafts are also found, as well as blocks and slabs, in private and public contexts, but mainly the latter. Pavonazzetto, an imperial marble like the previous ones, has been discovered in both contexts, but primarily intended for public buildings as suggested by the thick slabs and cyma of the cryptoporticus. Finally, breccia corallina and greco scritto are more common in private contexts, particularly in the form of large slabs, as paving for the former and as wall revetments for the latter.

In pavements, geometric shapes in these marbles were found only in the *opus sectile* of room VI of the glassworks site: a QrQ module made of rectangles and squares with framing dated between the end of the 2nd century AD and the middle of the 3rd century AD. It was composed of breccia corallina, africano, greco scritto (triangular tiles too) and pavonazzetto. These marbles were also used in another pavement (room IV) on the same site and with the same dating, which borders a basin also covered with marble. Findings here included breccia corallina, africano and pavonazzetto in inserts, as well as greco scritto in the fire layers. Finally, pavonazzetto and africano were reused in a 5th century AD pavement, probably in a private context.

With regard to wall decorations, the marbles found in place confirmed the use of greco scritto, especially in the form of large unframed veneers (on the Esplanade and Crédit Agricole sites). For the other marbles, the very well documented destruction layer of mosaic room XIIIA at the glassworks site confirmed parietal use of pavonazzetto and africano perhaps to frame the cipollino panels. Only pavonazzetto was used for the moulded elements (cyma) discovered in the cryptoporticus stock in particular (45 elements), maybe the monumental decoration from the Forum, and in the glassworks site but in an undated private context.

These Asian marbles appeared in Arles from the end of the 1st century AD except for the Troad granite which arrived in the 3rd century or late 2nd century in a private context. The africano and the granite were also imported for column shafts related to monumental programmes(Tab. 6), the former during the Augustan period and the latter in the Constantinian period. All marbles were used for public and semi-public buildings and costly domus.

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[31] Bruno 2002, 179-193.

[32] See above fn. 6.

Table of Column shafts recorded in Arles						
Site	**Diameter (m)**	**Height preserved (m)**	**Dating**	**Contex**	**Number of shaft**	**Total volume (m^3)**
Africano column shafts					**15**	**7.32**
Ancient Theatre, *in situ*	0.80 about	8 about; full	20-10 BC	Public	2	4.02
	0.80 ab.	0.86	20-10 BC			0.43
Ancient Theatre ? deposit in the garden	0.56	0.70	20-10 BC ?	Public ?	12	0.17
	0.066	0.68				0.23
	0.70 ab.	0.67				0.26
	0.56	0.86				0.21
	0.70 ab.	0.54				0.20
	0.52	1.20				0.25
	0.60	0.35				0.10
	0.80 ab.	0.55				0.15
	0.80 ab.	0.65				0.33
	0.60	0.68				0.19
	0.70 ab.	0.70				0.27
	0.70 ab.	0.56				0.22
Rhône river	0.45	1.81	?	?	1	0.29
Troad granite column shafts					**9**	**9.61**
Ancient Theatre ? deposit in the garden	0.45	0.74	20-10 BC ?	Public ?	1	0.12
Crédit Agricole site	0.29	2.33 full	Middle 2nd century AD – mid-3rd century AD	Private	1	0.15
Forum, *in situ*	0.70 – 0.80	3.60	324-326 AD	Public	1	1.59
Saint-Césaire site (deposit in the ancient Theatre)	0.70 – 0.80	0.93	?	Public ? Church ?	3	0.41
	0.70 – 0.80	1.85	?			0.82
	0.70 – 0.80	2.30	?			1.02
Sainte-Césaire site	0.52	3.4 full	?		1	0.72
Rhône river	0.55	4	4th – 5th centuries AD	?	2	1.90

Table 6: Table of column shafts in Asiatic marbles in Arles.

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MULTIMETHOD MARBLE IDENTIFICATION FOR THREE AUGUSTAN INSCRIPTIONS IN *EMPORIAE* (NE HISPANIA)

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Abstract

Emporion, the Greek port located on the coast of northern Catalonia, received classical marbles and their associated influences. The emblematic sculpture of Asclepius-Serapis evidences marble importation dating back to the end of the 2nd century BC. Once the Roman city of *Emporiae* was established, the use of marble as epigraphic supports begins in the 1st century BC, with a remarkable boom in Augustan times. With the aim of establishing in which cases marble was imported from the Greek world or from other closer sources such as the Pyrenaean marble from Saint-Béat, three Augustan inscriptions on coarse-grained marble have been studied: a plaque dedicated to Marcus Agrippa, one to Tutela and another with the testament of Cornelia Procula. Results from a multi-method analytical approach, combining polarized-light microscopy, cathodoluminescence and IRMS with C and O stable isotope analysis helped us to identify the marble sources. Although they are macroscopically very similar, the analytical parameters obtained have served to differentiate one Saint-Béat marble from the other two with a common Cycladic origin.

Keywords: *Emporiae*, marble, Augustan inscriptions.

Introduction and aim of the study

Emporion (Ampurias/Empúries, Northern Catalonia) was founded by Phokaian Greeks on a small island at the mouth of the river Fluvià, in a region inhabited by the Indigetes (Fig. 1A). Situated on the coastal commercial route between Massalia (Marseille) and Tartessos in the far south of Hispania, the city developed into a large economic and commercial centre as well as being the largest Greek colony in the Iberian Peninsula. During the Punic Wars, *Emporion* allied itself with Rome, and Publius Cornelius Scipio initiated the conquest of Hispania from the city in 218 BC, though it remained an independent city-state. However, in the civil war between Pompey and Julius Caesar, it opted for Pompey, and after his defeat it was stripped of its autonomy. A colony (*Emporiae*) of Roman veterans was established to control the region. Indeed, a key role was played by Julius Caesar's lieutenants, who were elected as city patrons[1]. From the Flavian period onwards, the city began to decline, eclipsed by the power of Tarraco (Tarragona) and Barcino (Barcelona)[2].

Among the archaeological heritage of the city a splendid sculpture of the god Asclepius-Serapis stands out (Fig. 1B). Dated to the end of the 2nd century BC and made of pentelic and parian white marbles[3], it documents the importation of marble at a time preceding the foundation of the Roman colony in the late 1st century BC[4]. The use of marble

[1] Rodà 1986-1989.
[2] Aquilué (ed.) 2012, Rodà 2016.
[3] Provenance assigned by A. Àlvarez after unpublished petrographic analyses.
[4] Vv.Aa. 2007

in Roman *Emporiae* was significant. In particular, when the third volume of Catalogne's Romaines Inscriptions (= IRC III)[5], was published in 1991, three of them of considerable size and carved on marble, drew our interest. The pieces could be dated back to the early years of the Empire, a moment of great power for the city, a fact that is further emphasized by the early use of various *marmora*[6]. The three inscriptions were engraved on white and coarse-grained marbles. They are IRC III 17, 24 and 36 respectively[7].

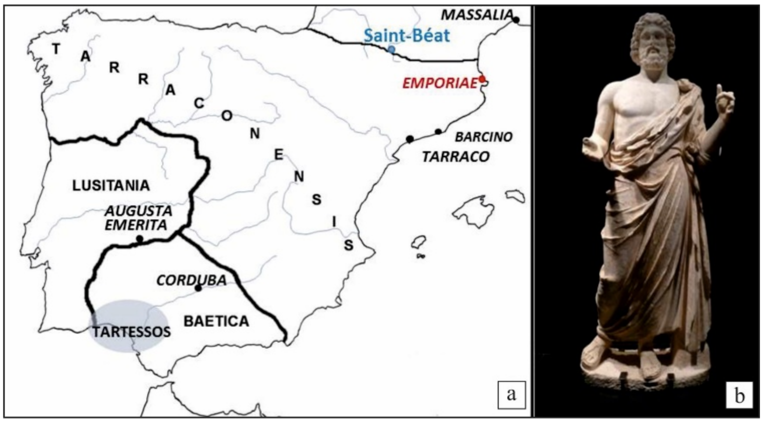

Figure 1: **a**. Map of Hispania with the location of sites named in the text; **b**. Asclepios-Serapis from *Emporion/Emporiae* (Photo: MAC – Empúries).

At that time no archaeometric analysis was made, but macroscopically it was hypothesized that they could be marbles from Saint-Béat quarries in the French Pyrenees. Consequently, due to the archaeological relevance of these three very unique pieces, all corresponding to the public sphere and in particular to the *Emporiae* Forum, it was considered of interest to check this hypothesis in the context of the research focused on the Pyrenean marbles[8] and their use in ancient times[9]. Therefore, this paper reports their archaeometric study following a well-established multi-method analytical approach. The results are compared with the analytical database of Pyrenean (French-Iberian) and other classical marbles from the Mediterranean territories.

The inscriptions under study

A small chip of each inscription was taken, numbered as 1, 2 and 3 in the following order:

1. The Tutela temple and statue erection, IRC III, 17, (Fig. 2).

A plaque with smooth epigraphic field but moulded cornice on the back, dedicated to Tutela. Palaeographically it is dated back at very early imperial time, and the text evidences

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[5] Fabre *et al*. 1991.

[6] About the early use in *Emporiae* of diverse *marmora*, i.e., pavonazzetto (IRC III, 21, del 15-20 d.C.), see Rodà 2004, 417.

[7] Comes, Rodà 2002, nn. 32, 136, 34, with photographs; Fabre *et al.* 2002, 84-85.

[8] This research is part of the objectives of the projects funded by Ministerio de Ciencia, Innovación y Universidades: Har 2015-65319-P (Mineco/Feder, UE) and PID2019-106967GB-I00 "*Sulcato marmore ferro*. Canteras, talleres, artesanos y comitentes de las producciones artísticas en piedra en la Hispania Tarraconensis". and the Trans-Pyrenean Project "MARMOL" funded by the regional governments of Aragon-New Aquitaine.

[9] Royo *et al.* 2015, 2018; Royo, 2016 (Ph D Thesis, unpublished), Aguarod, Lapuente, 2020.

the erection of a temple (*aedes*) and a statue (*signum*) for the Roman goddess Tutela by the local magistrate (*IIvir*) Caius Aemilius Montanus at his own expense (*de sua pecunia*)[10].

2. A dedication to Agrippa IRC III, 24, (Fig. 3).

Plaque with smooth epigraphic field but moulded cornice in its back (similar to the one described above) dedicated to Marcus Agrippa as the city patronus. It is an inscription that closes a cycle of tributes to prestigious patrons of *Emporiae*[11]. being the only one engraved in marble, since the others are of various local limestones[12]. Dated between 19 and 18 BC, this inscription is one of the oldest examples of marble use for inscriptions in this area of Hispania.

Figure 2: The Tutela inscription IRC III, 17, (Photo: Authors, with permission of MAC-Empúries).

Figure 3: The Agrippa inscription (IRC III, 24) (Photo: Authors, with permission of MAC-Girona).

3. The Cornelia Procula testamentary disposition IRC III, 36, (Fig. 4).

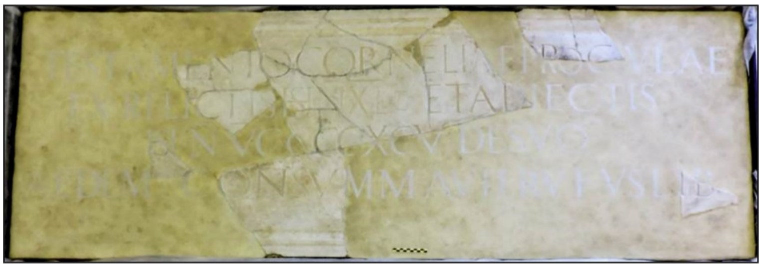

Figure 4: The Cornelia Procula inscription, IRC III, 36 (Photo: Authors, with permission of MAC-Girona).

A very fragmentary plaque – the current restoration dates to 1950, but the reading was reinterpreted later in IRC – with an epigraphic field framed by moulding commemorates Cornelia Procula. This woman funded the erection of a temple by will and testament, to which a pecuniary complement from an unknown former slave of hers (*libertus*) is added. The inscription is an outstanding evidence of female euergetism in Tarraconensis, that can be dated roughly to the first half of 1st century AD, quite plausibly under Augustus or Tiberius[13].

[10] *C(aius) Aemilius C(ai) f(ilus) / Gal(eria tribu) Montanus aed(ilis) II(duo) vir / aedem et signum Tutelae / sua pecunia fecit*.

[11] *IRC* III 25 to 29, Rodà 1986-1989.

[12] *M(arco) [Agrip]pae / pat[rono]*.

[13] *[Testa]mento Cornelia[e P]roc[ulae] / [ex rel[ictis HS (sestertium) N(ummis) XL (quadraginta millibus) / et ad[iectis] / HS (sestertium) n(umis) V[C]CCCXCV (quinque millibus quadringentis nonaginta quinque [de suo] / [aedem] consum[mavit --- l]ib(ertus).* It is the dedication of a temple according to the testament of the private Cornelia Procula that bequeathed the amount of 40,000 sesterces to which her liberto had to add another 5,495 ones.

The temple it refers to is of modest dimensions and could be identified with nr.7 of the Forum of *Emporiae*.

Typologically all three inscriptions are plates: that of Cornelia Procula (IRC III 36) with moulding that frames the epigraphic field (Fig. 4); though, the other two, have a very interesting formal similarity. The epigraphic field in both is not moulded, instead they have moulding on the four sides of the back, so that, once the plates are embedded in the corresponding wall, the moulding would be visible, creating a certain aerial effect (Fig. 5). As we will see below, the archaeometric analyses of the three pieces confirm, that the type of marble is the same for IRC III 17 and 24, but different for IRC III 36.

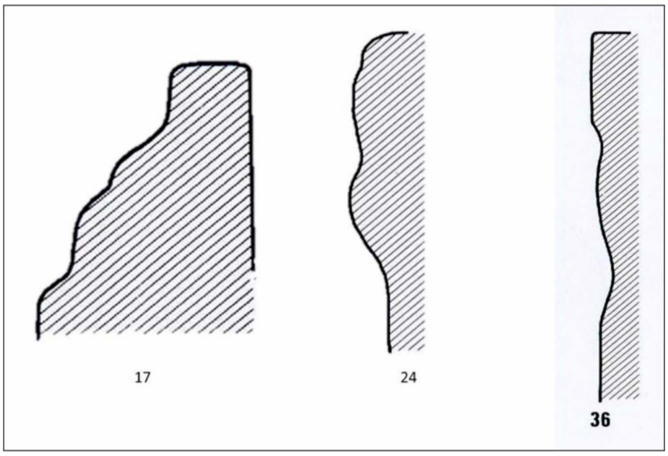

Figure 5: Moulding from IRC III, 17 (fig. 2, p. 11), 24 (fig. 3, p. 12) and 36 (fig. 3, p. 12).

Methodology

A multi-method analytical approach, combining polarized-light microscopy, optical-cathodoluminescence and IRMS with C and O stable isotope analysis has carried out to discriminate the marble sources. Experimental procedures were developed according the methodology described elsewhere (Lapuente, 2014; Lapuente *et al.* 2014; Lapuente, Royo 2016). The polarizing microscope was systematically used for studying mineralogy and texture parameters. Particular attention was paid to fabric and grain size, measuring the Maximum Grain Size (MGS) and describing Boundary Grain Shape (BGS). Concerning CL features, their intensity, colour and distribution were observed and photographed.

Results and discussion

Macroscopically all are coarse-grained marbles, compact and well crystallized. Visually, the white marble in plates nr. 1 and nr. 2 look similar with a slightly yellowish tone due to the presence of a patina, more accentuated in plate nr. 2. In plate nr. 1 the presence is well visible of sporadic isolated very coarse grey grains embedded in a matrix of white crystals (Fig. 6A). The measured MGS is 4.3 mm in those sporadic grains and light-transmitting shows a medium halo around (Fig. 6B). On the contrary, in plate nr. 2 the patina prevents the MGS from being properly measured and reduces light transmission. Concerning with plate 3, the white marble exhibits a greyish tone emphasized by the presence of frequent larger grey grains, with MGS of 3,2 mm, in a clear heteroblastic texture (Fig. 6C).

Regarding petrography and CL-features (Fig. 7), all samples are pure calcitic coarse-grained marbles with isotropic fabric, slightly heteroblastic texture in samples 1 and 2, but well-defined heteroblastic texture in 'core-mantle', in sample 3. Sample 1 and 2 exhibit curved and slightly embayed GBS, but rare straight ones are also present. They display fine and frequent thick twins, from tabular and occasionally lensed (types II and III after Burkhard, 1993). Their MGS, measured on the thin-sections are 2.5 mm and 2.2 mm, respectively. Their CL-patterns are quite similar with very faint intensity but seem to be heterogeneous in distribution. However, in sample 3, GBS is curved and embayed with frequent thick twins (types II, III and IV) and signs of syn-tectonic recrystallization, with a MGS of 2.9 mm. Its CL-microfacies is brownish faint intensity but homogeneous.

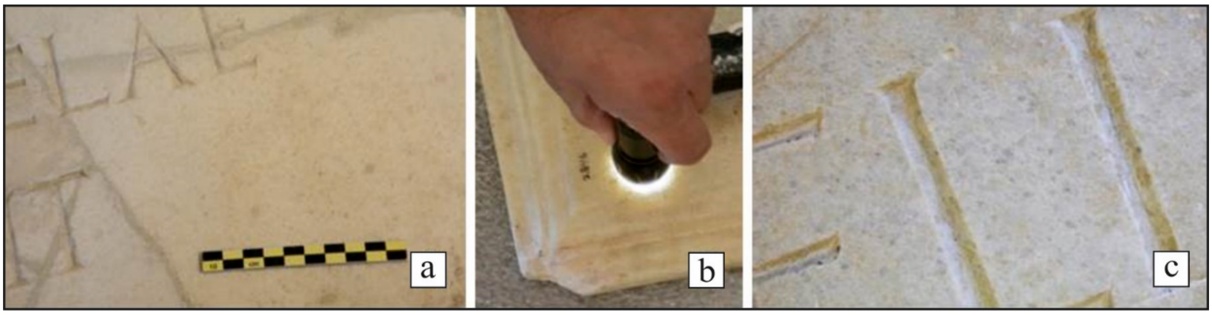

Figure 6: Different macroscopic views: **a**-**b**. Plate nr. 1; **c**. Plate nr.3.

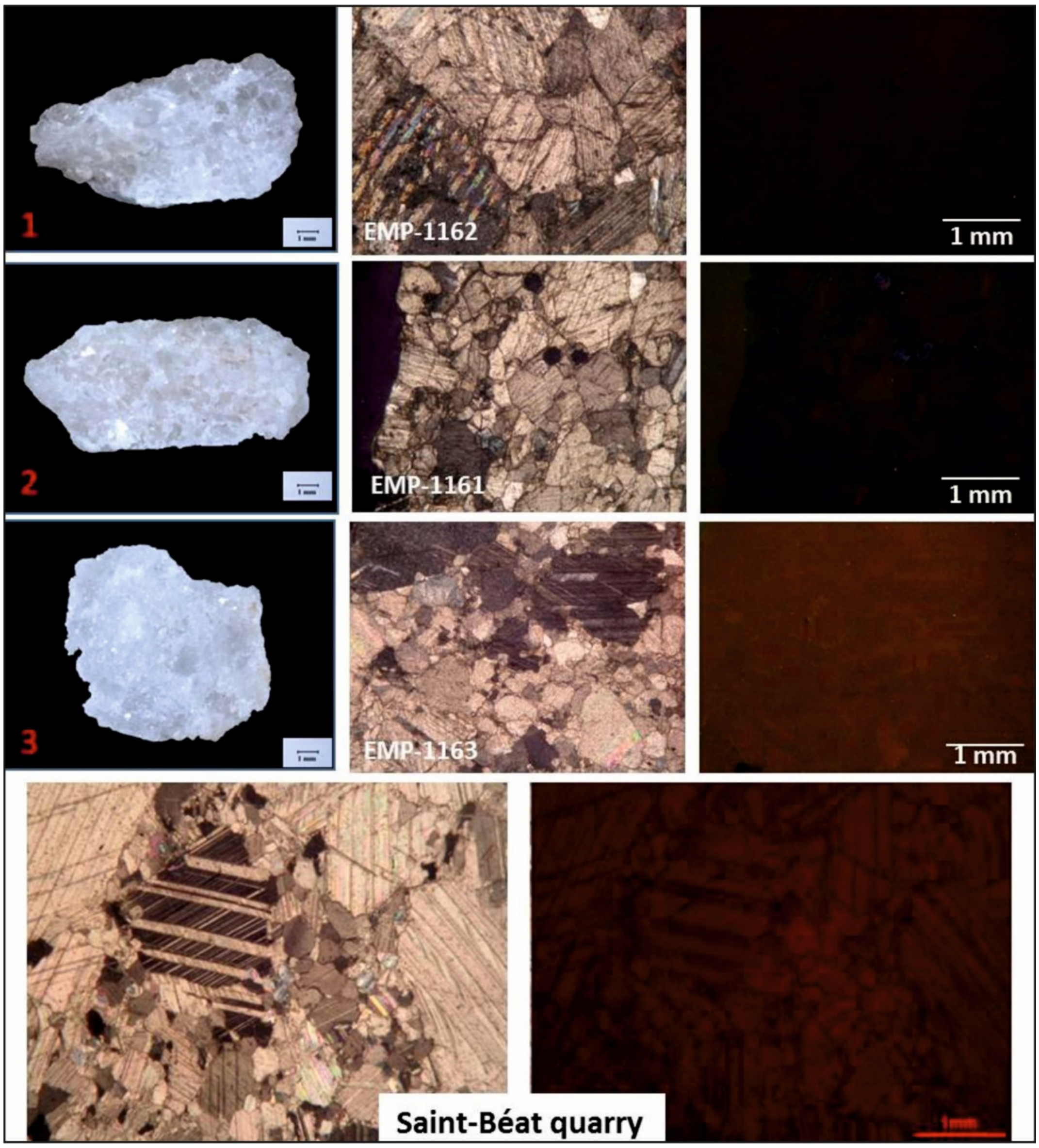

Figure 7: Petrographic, in crossed nicols, and CL-images of the respective analyzed samples 1, 2 and 3; and images of Saint-Béat marble quarry taken under the same analytical conditions.

Concerning the isotopic signature of samples 1 and 2 are quite similar (Fig. 8). Their C and O isotopic values, with respect to PDB, are 1.8 ‰ ($\delta^{13}C$) and -1.9 ‰ ($\delta^{18}O$) in sample 1, and 2.0 ‰ ($\delta^{13}C$) and -1.5 ‰ ($\delta^{18}O$), in sample 2. However, isotopic data in sample 3 are rather different: 3.7 ‰ ($\delta^{13}C$) and -1.5 ‰ ($\delta^{18}O$).

Comparing their petrography and CL-patterns with the analytical database of the Pyrenaean marble quarries, only sample 3 is compatible with the data of Saint-Béat marble (Fig. 7), while the other samples need additional parameters to be identified. However, isotopic signatures (Figs. 8a, 8b) along with MGS (Fig. 9) help to discriminate them from the classical marbles and confirm the Saint-Béat origin of sample 3.

Samples 1 and 2 fit well with data of the Paros-2(3) isotopic field and plot outside the Pyrenaean isotopic field of Saint-Béat (Royo *et al.* 2018) (Fig. 8a). They also overlap the Prokonnessos-1 isotopic field; however their petrographic and CL features serve to reject this marble source, due to their difference with the homogeneous blue CL-microfacies typical from Marmara island marble (Blanc *et al*. 2000). On the contrary, they are also compatible with those exhibited by marbles from the quarries of Paros-2(3). Concerning the isotopic data of sample 3 plots in the C and O isotopic diagram fall not only into the Saint-Béat quarry isotopic field (Fig. 8a), but also into the area commonly exhibited by other archaeological samples analyzed from Hispania and Gaul (Lapuente *et al.* 2009; Costedoat, 1995), assigned to this provenance. Furthermore, their isotopic signature has been plotted on the diagram proposed by Attanasio *et al.*, (2016), where also the same identifications are obtained. In addition, although the isotopic signatures of samples 1 and 2 are also compatible with those of Miletos or Herakleia whose $\delta\ ^{18}O$ ranges from -1.05 and -3.96 ‰; and $\delta^{13}C$ from 1.18 to 3.86 ‰ (Attanasio *et al.* 2006), the MGS of this turkish aegean coast marble is considerably finer (Fig. 9), so this source must be discounted.

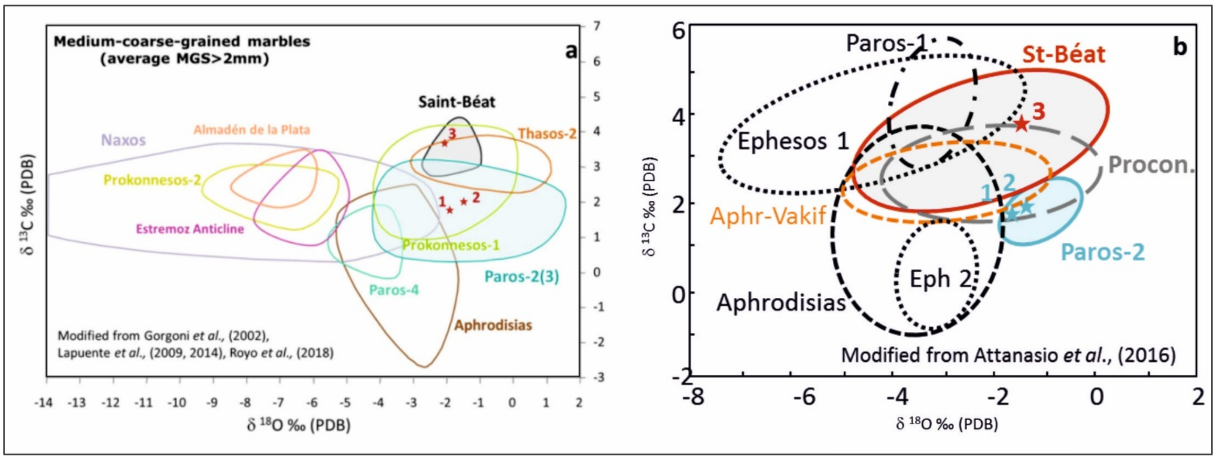

Figure 8a: Isotopic signature of the inscriptions plotted on the diagram for classical marbles with addition of the white Iberian marbles from the Ossa Morena and the updated Saint-Béat from the French Pyrenees.

Figure 8b: The same marble identifications are obtained using the isotopic diagram by Attanasio *et al.* 2016, which includes the most important quarries of Saint-Béat.

Conclusions

Comparing the results of the multi-method analytical approach with the available database, samples 1 and 2 match well with marbles collected in quarries of the Cycladic island of Paros, in particular with those outcropping in the Chorodaki and Aghios Minas valleys, to the South of Marathi (Gorgoni *et al.* 2002). Sample 3, however, is assigned to the Gaul area quarry district of Saint-Béat.

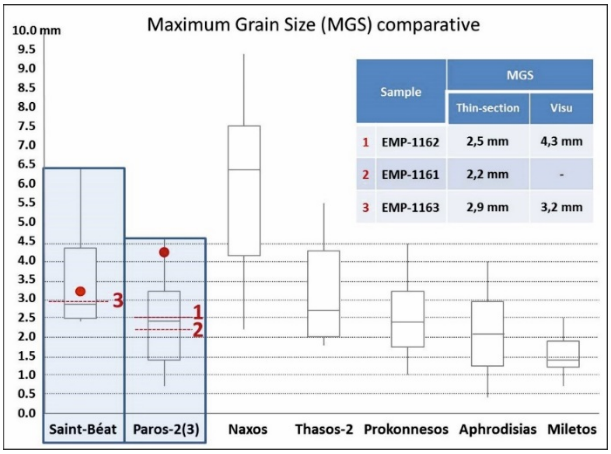

Figure 9: Maximum Grain Size of samples 1 and 2 match well with the size of Paros-2(3), even the macroscopic measurement of 4,3 mm (represented by a point), however other marble source isotopically compatible such as Miletos must be discarded considering this parameter. MGS of Sample 3 is very close to the median size of the Saint-Béat quarry samples.

In both cases the identified marble source agrees with the archaeological criteria, since, according to their formal features, inscriptions nr. 1 and nr. 2 are quite similar, but nr. 3 is somewhat different in several features, such as its largest dimensions, the epigraphic field being framed by moulding and the smooth back. The common marble identification in plates dedicated to Tutela and Agrippa (nr. 1 and nr. 2), points further to the suggestion of having been manufactured in the same workshop. Furthermore, both inscriptions have a clear precise public purpose: homage to an illustrious *patronus* dedicated by the municipality (nr. 1) and a public religious building erected by a magistrate (nr. 2). So, it is quite likely that they were destined to a similar place of public exhibition. On the contrary, nr. 3 is totally a private initiative, although its precise terms are not available.

In addition, it is interesting to note that in a different Hispanic context another fragmentary inscription made in a macroscopically similar white marble has been recognized, though it has not yet been analyzed. This piece comes from *Augusta Emerita* (present-day, Mérida) and is dedicated to *Bocchus*[14], most likely identifiable with the influential person *Lucius Cornelius Bocchus*, from the Tiberian period. It remains, therefore, to be corroborated that this was made from a similar marble to that of the Tutela and Agrippa since, in addition, the *emeritensis* has a similar type of moulding on the back.

Finally, once again there is a clear need to review the data of provenance made years ago in certain emblematic archaeological pieces, carried out without performing contrasting analyses with an adequate comparative database, which of course today offers accuracy thanks to the higher number of quarry samples analysed using the same methodology.

Acknowledgements

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[14] Stylow, Villanueva 2009, n. 11 (= *HEp* 19, 2010, 19 = *AE* 2010, 662). On Bocchus, see Cardoso; Almagro-Gorbea (eds.), 2011. The inscripcion is located at Museo de Arte Romano de Mérida (inv. C.M.M. Inv. 6025/342/38).

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THE PROVENANCE OF COLOURED MARBLES AND GRANITES USED FOR COLUMN SHAFTS PRESERVED AT BYRSA (CARTHAGE, TUNISIA)

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Abstract

The archaeological site of Byrsa/Carthage is situated on a hill at about 20 km east-northeast of the modern town of Tunis. From the middle of the 19th to the 20th centuries, several excavations were undertaken on this site by different international archaeological teams who uncovered a Punic settlement largely covered by Roman ruins including a Forum, a Basilica and temples. Nearly 300 architectural fragments connected to these monuments were discovered; they are mostly preserved in the open air Byrsa/Carthage Museum and remained so far largely unpublished. Among these, we have identified the stone material of 191 column shaft fragments of granites and coloured marbles on the base of their macroscopic characteristics (colour, fabric and grain size), and also taking their measurements. Some twenty lithotypes have been found, coming from four different geographic areas: *Africa Proconsularis*, Egypt, Greece and Asia Minor.

Keywords: Byrsa/Carthage, column shafts, granites, coloured marbles.

Introduction

Granites and marbles were highly appreciated by the Romans during imperial times. They used these materials for building and decorating both their public monuments and private, sumptuous dwellings. In *Africa Proconsularis*, the economic growth led to an important urban development during the High Empire. In particular, Carthage, located at 22.4 km east-northeast of Tunis (Fig. 1), was one of the most famous Roman towns in the province of *Africa* which experienced an unprecedented urban growth.

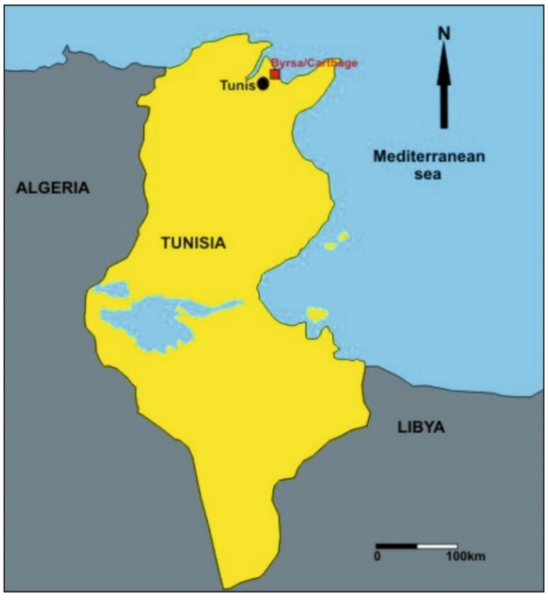

Figure 1: Location map of Byrsa/Carthage.

Many public monuments and rich houses were decorated with architectural elements made of granites and marbles. Most of these stones were imported from towns of the Roman Empire, as attested by the excavations undertaken during the 19th and 20th centuries[1]. Architectural elements (bases, column shafts, capitals, architraves, friezes and cornices) discovered during the excavations were exhibited in the whole open air area of the Byrsa/Carthage Museum in which important Roman public monuments were built (Forum, Basilica, temples, etc.). Most of the first archaeologists who excavated this site[2] did not pay enough attention to the architectural elements they discovered, that was why the following researchers[3] found it difficult to determine to which Roman building these architectural elements may have belonged. Among the large number of architectural elements (nearly 300 fragments) exhibited on the site, we have chosen to study the granite and coloured marble column shafts being well-preserved and numerous. Their primary origins have been systematically identified on the base of their macroscopic characteristics: colour, fabric and grain size. The Roman monuments to which all the column shafts belonged are very difficult to determine precisely. Nevertheless, according to the results of the excavations in the eastern Basilica and its surroundings[4], together with our inquiry with archaeological colleagues and a member of the Tunisian excavation team from 1977 to 1983, we may consider that all the architectural elements exhibited in the area of Byrsa/Carthage Museum were unearthed from the Roman civic monuments located on the hill of Byrsa.

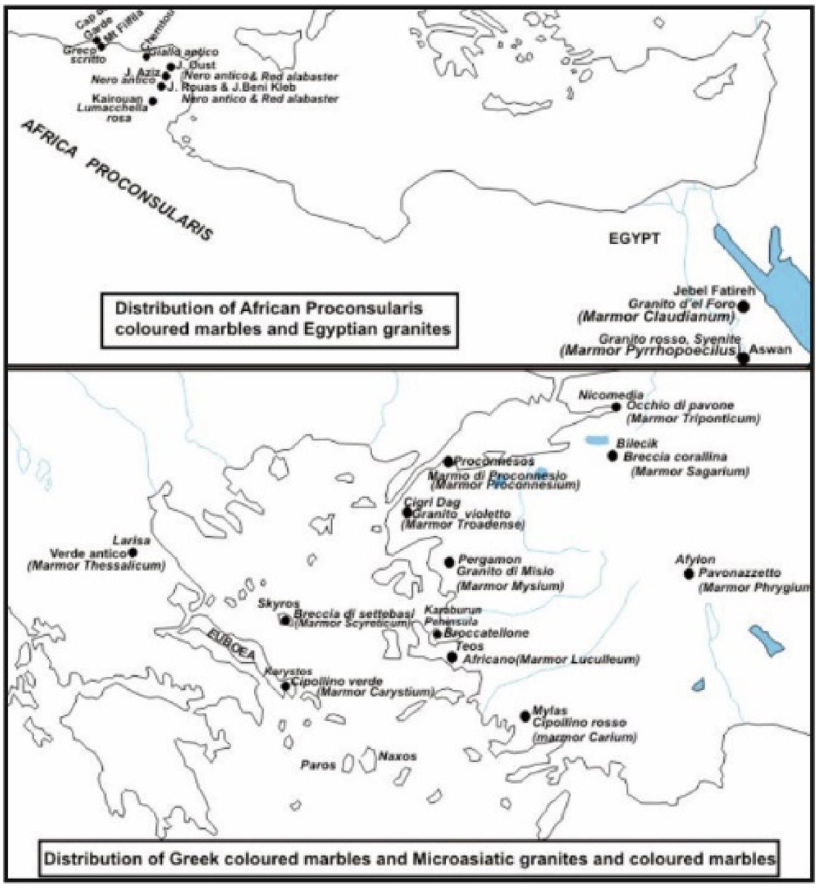

Figure 2: Distribution map of the coloured marbles and granites.

[1] Beule 1861; Lapeyre 1930; Lancel 1974-1976 and1977-1978; Gros 1977-1980; Morel 1983.
[2] Beule 1861; Lapeyre 1930; Lancel 1974-1976 and 1977-1978; Morel 1983.
[3] Few researchers wrote about the origin of the coloured marbles of the architectural elements, see Hermann *et al.* 2012, 304-305; Lazzarini *et al.* 2012, 439-443.
[4] Gros 1977-1980, 61 and 73-74.

Marbles of *Africa Proconsularis*

Column shafts preserved at the archaeological site of Byrsa show that the majority (100/140 or 71 %) of these architectural elements were made of *Africa Proconsularis* stones (Fig. 3). Five different types of *marmora* were used to carve these column shafts: *marmor numidicum*, greco scritto, bigio morato, red alabaster and lumachella rosa.

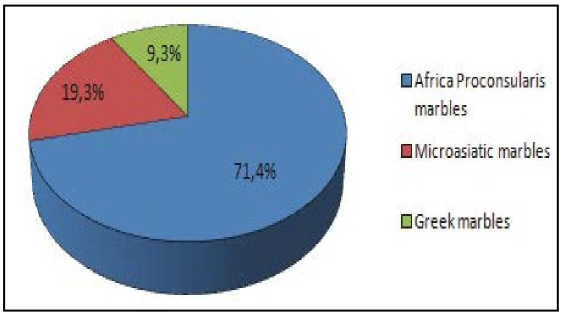

Figure 3: Percentage of the different coloured marbles provenances

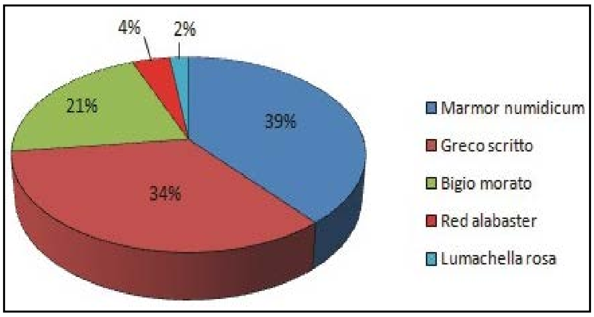

Figure 4: Percentage of the *African Proconsularis* coloured marbles

Giallo antico (*marmor numidicum*)

Marmor numidicum was essentially extracted from open air and underground Roman quarries at the Jebel Chemtou and from a few open air quarries at Jebel El Hairech located near the archaeological site of *Simitthus* in the governorate of Jendouba[5] (Fig. 2). Geologically, giallo antico is a limestone of the Lower Jurassic which has a compact microcrystalline texture already used under the late Numidian kingdom[6]. Its colour varies from yellow with white, red/brown veins to pink with rare black stains and veins[7]. Giallo antico was more used than the other four marbles to carve column shafts found at Byrsa. It constitutes 39 of the total number (100) that is 39% of column shaft fragments registered at Byrsa (Fig. 4). The decorations on many of these column shafts are still visible. We can distinguish rudented, fluted, twisted and smooth column shafts (Fig. 5 and Tab. 1).

Greco Scritto

The name of this marble was bestowed in the first half of the 19th century by the Italian marble collector Francesco Belli[8]. Known quarries of greco scritto are located at Hasançavuslar in the proximity of Ephesos (Türkiye), at Cap de Garde near *Hippo Regius* and at Mont Filfila close to *Rusicade* (Algeria) (Fig. 2). Also in Proconnesos (the island of Marmara, Türkiye) and near ancient *Neapolis Macedoniae* are known marble varieties that show the same macroscopic appearance. This marble is a white-to-grey medium-coarse grained (generally between 2 and 6 mm) marble characterized by fine grey-blackish veins and dark grey-to-bluish spots, which resemble scrawled writing[9]. Column shaft fragments represent 34 of the total number (100) that is 34% (Fig. 4). From the decorations, column shafts are fluted, smooth, twisted or rudented (Fig. 5 and Tab. 1). On the basis of some macroscopic, microscopic and isotopic analyses, most of these architectural elements were carved in greco scritto from Cap the Garde and Mont Filfila[10].

[5] Rakob 1993, 363-366; Röder 1993, 17-50; Younes 2014, 163-166.
[6] Pliny, NH V, 22; Rouvier 1985, 31-49.
[7] Younes 2014, 165-166.
[8] Belli 1842, 17.
[9] Antonelli *et al.* 2009, 351-365; Attanasio *et al.* 2012, 245-254; Herrmann *et al.* 2012, 300-309; Younes 2015, 48-49.
[10] Herrmann *et al.* 2012, 304-305.

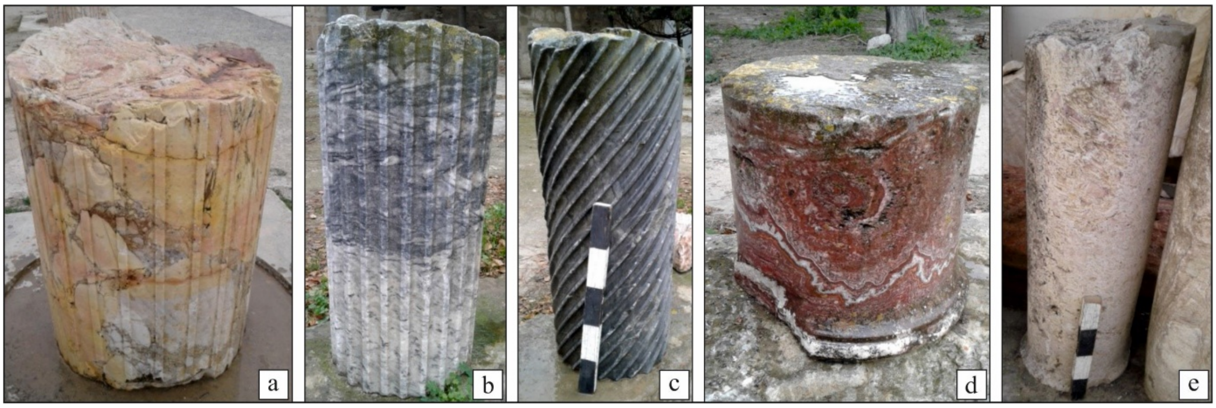

Figure 5: Fragmentary column shafts of *Africa Proconsularis* coloured marbles: **a**. rudented giallo antico; **b**. fluted Greco scritto; **c**. twisted bigio morato; **d**. smooth alabastro rosso; **e**. smooth lumachella rosa.

Bigio morato, nero antico

Bigio morato or black limestone was extracted from many Roman open air quarries located at Jebel Oust (Zaghouan), Jebel Aziz, Jebel Rouas, Jebel Beni Kleb (El Fahs) and Ain el Ksir (Chemtou). Geologically, these bigio morato varieties are limestones (sometimes slightly dolomitic) of the Lower Jurassic with a microcrystalline texture, often containing microfossils[11], whereas bigio morato of Ain el Ksir belongs to the lower Eocene limestone and is of a beautiful absolute black colour[12] (Fig. 2). The other limestones are compact [13] and their colour varies from black to grey with white stains/spots and veins. Column shafts made of black limestone are less represented than those carved in *marmor numidicum* and greco scritto: 21 fragments of the total number (100) that is 21%. (Fig. 4). The column shafts registered are twisted, rudented and smooth (Fig. 5 and Tab. 1). Without microscopic examination of thin sections and isotopic analyses of samples taken from these column shafts it is impossible to determine their quarries of origin.

Alabastro rosso (red calcite alabaster)

Red calcite alabasters were extracted from many Roman underground and open air Tunisian quarries situated at Jebel Rouas, Jebel Beni Klab (El Fahs) and Jebel Oust (Zaghouan)[14] (Fig. 2), as well as from other places in Algeria and Asia Minor. Geologically the Tunisian calcite alabasters consist of large banded deposits formed in fissure ridges contained in Lower Jurassic black/grey limestones[15]. Their microcrystalline texture is moderately compact, and the colour is dark red-to pink, often with yellow-brownish and cream-white strips/ veins/ spots[16] (Fig. 5). The number of column shaft fragments of these alabasters in Byrsa is very low, since only 4 smooth fragments (for an overall percentage of 2%) have been registered (Fig. 4 and Tab. 1). The precise quarries from which these Byrsan lithotype were extracted are still unknown for the lack of specific archaeometric analyses.

[11] Rouvier 1985, 52-54; Yunes 2014, 271.
[12] Younes 2014, 171-172.
[13] Lazzarini *et al*. 2006, 59-70; Agus *et al.* 2007, 71-82; Brilli *et al.* 2010, 994-1005; Younes 2014, 169-172.
[14] Younes 2019.
[15] Rouvier 1985, 52-54.
[16] Mielsch 1985, 40; Agus *et al.* 2007, 387; Lazzarini *et al*. 2012, 439-443.

Lumachella rosa

Lumachella rosa, a fossiliferous (nummolitic) limestone, was extracted in Roman times from a still unidentified quarry-site situated in the region of Kairouan (central Tunisia)[17] (Fig. 2). This lithotype is characterized by a creamy-pink matrix almost filled by small (millimetric-to centimetric) whitish shells of Nummolites resembling small coins and occasionally of yellow-to red colour (Fig. 5). Few Lumachella rosa column shafts are registered in the site of Byrsa, namely 2 fragments with a smooth surface (Fig. 4 and Tab. 1). The presence of some column fragments in the Antonine baths further testifies the local import of this beautiful stone to Carthage.

Greek marbles

Column shafts made of Greek coloured marbles are little represented at Byrsa. Only three types of these marbles have in fact been identified: verde antico, cipollino verde and breccia di Settebasi. They represent 13 column shaft fragments out of a total of 140 that is 9 % (Fig. 3).

Verde antico (*marmor Thessalicum*)

Verde antico, quarried on Mount *Mopsius* near the village of Kasabali, in province of Larissa, Thessaly, is a Cretacic ophicarbonate breccia (Fig. 2). This marble is characterized by a light green matrix with dark green/black, grey, white, black clasts[18]. The two main component minerals are the green antigorite and the white calcite. Five smooth column shaft fragments are recorded at Byrsa (Fig. 6 and Tab. 2). Since this stone began to be quarried in Hadrianic times, such columns could only have been installed in monuments dating to that period, or later.

Figure 6: Fragmentary column shafts of Greek coloured marbles: **a**. smooth verde antico; **b**. smooth cipollino verde; **c**. smooth breccia di Settebasi.

[17] Corsi 1833, 121-122; Belli 1842 , 271; Mielsch 1985, 41; Gnoli 1988, 206.
[18] Gnoli 1988, 206; Lazzarini 2007, 232; Agus *et al.* 2007, 388.

Cipollino verde (*marmor Carystium*)

This true marble was quarried on and around Mount Ochi near ancient *Karystos*, and at Styra, southern Euboea (Fig. 2). It is a Cretacic green marble containing white calcitic bands alternated with green ones rich in silicate minerals, particularly K-mica, chlorite quartz and plagioclase in discrete quantities determining its classification as an impure chlorite-marble[19]. This lithotype is characterized by a marked schistosity, and two main varieties, one with parallel strata, and one with waving veins. It was named for its resemblance to an onion (cipollino) when sliced crosswise[20]. *Marmor carystium* which was usually considered as one of the most common marbles in the Roman Empire, is peculiarly less represented at Byrsa than *marmor thessalicum*: 7 smooth column shaft fragments (Fig. 6 and Tab. 2).

Breccia di Settebasi (breccia di Sciro)

This marble, indicated by Strabo as *Ποικίλη λίθος τῆς Σκυρίας*[21]was considered to be among the first polychrome stones which started to replace the white marbles in Rome during the Augustean period. Breccia di Sciro is a Triassic calcareous metabreccia extracted from various places of the Skyros Island[22] (Fig. 2). It was well appreciated by the Romans for its compact texture and its beautiful colours from brown to whitish with pink, red, brown and grey clasts fixed by a purplish/yellow/brown/red cement[23]. This marble is the least represented among the coloured column shafts at Byrsa: only 1 smooth column shaft fragment (length x diameter: 104cm x 58cm) (Fig. 6 and Tab. 2).

Microasiatic granites and marbles

Microasiatic column shaft marbles are ranked second after the *Africa Proconsularis* ones: 27/140 that is 19 % of the total marbles (Fig. 3), whereas the Microasiatic granite column shafts are better represented than the Egyptian ones: 31/51 that is 61 % (Fig. 7). Seven types of marbles (pavonazzetto, breccia corallina, proconnesio, broccatellone, occhio di pavone, africano, cipollino rosso) and two types of granites (granito violetto, granito misio) have been identified.

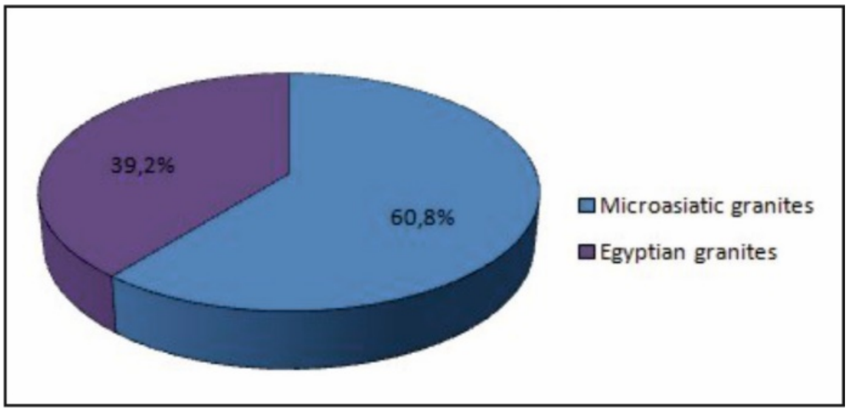

Figure 7: Percentage of microasiatic and egyptian granites.

[19] Lazzarini, 2007, 183-203.
[20] Gnoli 1988, 183; Lazzarini 1998, 207-210; Agus *et al.* 2007, 388.
[21] Strabo IX, 437.
[22] Lazzarini, Turi 1999, 117-118; Cancellieri 2000, 61; LazzarinI 2007, 161-181.
[23] Lazzarini, Turi 1999, 117-118; Agus *et al.* 2007, 388; Carmelo 2010, 26.

Granito violetto (*marmor troadense*)

Troad granite is a quartz monzonite (magmatic plutonic rock with a grainy structure composed of orthoclase, plagioclase feldspar, hornblende, quartz and biotite)[24]. It was quarried from the 2nd c. A.D. on the slopes of Çigri Dâg in the western Troad, just inland from Alexandria Troas in Türkiye[25] (Fig. 2). This is a grey lithotype with medium-sized (1-3 cm) greyish, violet spots and black stains of smaller size[26]. *Marmor troadense* is well represented at Byrsa: 27 smooth column shaft fragments out of a total of 51 have been registered (Fig. 8 and Tab. 3).

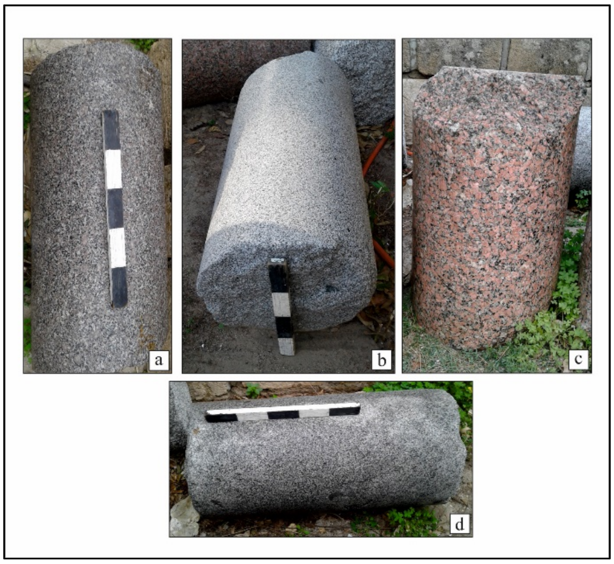

Figure 8: Fragmentary column shafts of microasiatic and egyptian granites: **a**. smooth granite violetto; **b**. smooth granito misio; **c**. smooth granite rosso di Assuan; **d**. smooth granite del Foro.

Granito misio (*marmor mysium*)

Mysian granite is characterized by a homogeneous texture composed of quartz, plagioclase, K-feldspar, biotite, rarer hornblende and several accessory minerals[27]. The quarries, also productive from the 2nd century AD on, are located in the area of Kozak, 20 km west of Pergamon in ancient Mysia (NW Türkiye)[28] (Fig. 2). This stone is a grey, fine-grained granodiorite, also quarried in Byzantine times and still exploited[29]. Column shaft fragments of *marmor mysium* are much less numerous than *marmor troadense*: 4 smooth surfaced fragments are recorded at the Byrsa site (Fig. 8 and Tab. 3).

Pavonazzetto

This lithotype has many Latin synonyms: *marmor phrygium*, *marmor synnadicum* and *marmor docimium* which are related to their geographical origin, whereas the synonym pavonazzetto was given by the stone-cutters during the pre-Renaissance period due to the presence of violet spots[30]. *Marmor phrygium* is a metamorphic rock quarried at *Dokimeion* (modern İşcehisar), 23 km to the northeast of Afyon in Phrygia[31] (Fig. 2): A very similar marble was quarried al Altıntaş. It is a white or slight yellowish fine-grained marble white,

[24] Birkle, Satir 1994, 143-146; Lazzarini 2010, 140.
[25] Ponti 1995, 291-293; Gnoli 1988, 152-153; Carmelo 2010, 26.
[26] Cook 1973 14; Ponti 1995, 291-293; Carmelo 2010, 26; Agus 2007, 389.
[27] Lazzarini 1998, 112; Lazzarini 2010, 140.
[28] Lazzarini Sangati 2004, 76; Agus *et al.* 2007, 389.
[29] Lazzarini 2010, 140; Agus *et al.* 2007, 389.
[30] Gnoli 1988, 169-171; Agus *et al.* 2007, 391.
[31] Röder 1971, 255- 257; Mielsch 1985, 59; Lazzarini *et al.* 1985, 48-50; Agus *et al.* 2007, 391; Carmelo 2010, 26; Attanasio *et al.* 2015, 753-754.

sometimes yellow and grey-blue clasts together with violet and pink veins/stains[32]. This marble was more often employed than the other six marbles to carve column shafts conserved at Byrsa: 10 of the total number (27) that is 37% of column shaft fragments (Fig. 9). As for decoration, they are rudented and fluted (Fig. 10 and Tab. 3).

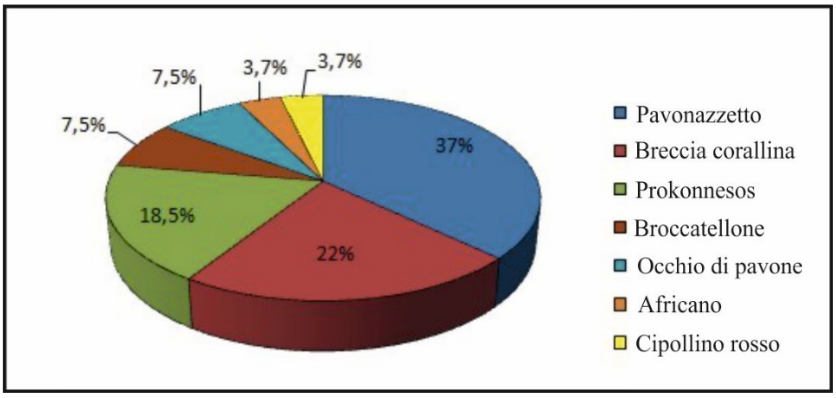

Figure 9: Percentage of microasiatic white and coloured marbles.

Breccia corallina (*marmor Sagarium*)

This rock is a sedimentary monogenic calcareous breccia quarried in nncient Bithynia near Vezirhan (province of Bilecik, Türkiye) and not far from the important river *Sagarius*, from which it took its name[33] (Fig. 2). Another source of the same stone has been identified in the Karaburun peninsula (province of Izmir)[34]. Breccia corallina consists of angular white pink clasts of different size resting in a compact matrix, of which several chromatic varieties are distinguished: pink, grey, brown and bright coral red[35]. Column shafts carved from *marmor sagarium* are less numerous than the previous listed ones: 6 smooth fragments out of 27 have been inventoried at Byrsa (Figs 9, 10 and Tab. 3).

Proconnesio (*marmor proconnesium*, *marmor cyzicenum*)

This lithotype was quarried on *Marmara Adasi* (Türkiye), on the north side of the island, ancient *Prokonnesos*[36] (Fig. 2). It is a medium grained white marble mostly foliated and showing grey bands, lines, stains, often perfectly isoparallel in it[37]. *Marmor proconnesium* is ranked third after pavonazzetto and breccia corallina: 5 smooth column shaft fragments out of 27 have been registered at Byrsa (Figs. 9, 10 and Tab. 3).

Broccatellone

This marble was extracted from quarries located on Gerence Bay, Karaburun Peninsula (Türkiye)[38] and not far from Vezirhan. Broccatellone is a breccia with violet cement, and rather large purple and light yellow clasts resembling the canary's feathers (Fig. 2)[39]. It is less represented than the previous ones: only 2 smooth column shaft fragments have been recorded at Byrsa (Figs. 9, 10 and Tab. 3).

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[32] Röder 1971, 256- 259; Lazzarini *et al.* 1985, 48; Carmelo, 2010, 28; Agus *et al.* 2007, 391.
[33] Gnoli 1988, 238-239; Lazzarini 2002, 58-60; Agus *et al.* 2007, 387-388.
[34] Bruno *et al*. 2012, 562-572.
[35] Gnoli 1988, 239; Carmelo 2010, 26; Lazzarini 2002, 59-60.
[36] Vitrivius, X, 2; Gnoli 1988, 263-264; Asgari 1992,73; Attanasio 2003, 194-199.
[37] Gnoli 1988, 263-264; Asgari 1992,73; Walker 1993, 57-58.
[38] Bruno *et al.* 2012, 563, 568-569; Hermann *et al.* 2017, 780.
[39] Corsi 1833, 152.

Occhio di Pavone (*marmor Triponticum*)

This rock is a fossiliferous sedimentary limestone containing haematite (red and pink varieties) or limonites (beige and brown varieties), quarried near the modern village of Kutluca (in ancient Bithynia) in the province of Izmit not far from the ancient road connecting this town (*Nicomedia*) to *Konstantinopolis* (Istanbul)[40] (Fig. 2). *Marmor triponticum* is characterized by a red, beige, pink or purple background with circular or oval white macrofossils (rudists) that, when cut crosswise have a circular shape similar to the "eyes" in the tail of a peacock[41]. At Byrsa it is as represented as broccatellone, with 2 smooth column shaft fragments (Figs. 9, 10 and Tab. 3).

Figure 10: Fragmentary column shafts of microasiatic coloured marbles: **a**. rudented pavonazzetto; **b**. smooth breccia corallina; **c**. smooth *proconnesium*; **d**. smooth broccatellone; **e**. smooth occhio di pavone; **f**. fluted africano; **g**. smooth cipollino rosso.

Africano (*marmor Luculleum*)

Marmor Luculleum took its Latin name from the consul *Lucius Licinius Lucullus* who introduced this marble to Rome during the 1st century BC. It is a sedimentary calcareous meta-breccia, mainly constituted of calcitic (micritic) clasts more or less stained red, or fully coloured, by haematite[42]. This marble was mainly quarried near ancient Teos, now Sığacık, in the KaraGöl area, but also at, Küçükkaya and Turgut in Türkiye[43] (Fig. 2). There exist two main types of africano: one, more common, with a black matrix, and one

[40] Lazzarini 2010, 142-143; Carmelo 2010, 26.
[41] Gnoli 1988, 210; Lazzarini 2010, 142; Carmelo 2010, 26.
[42] Lazzarini 2010, 141; Carmelo 2010, 26.
[43] Mielsch 1985, 54; Gnoli 1988, 174; Agus *et al.* 2007, 389; Lazzarini 2010, 141; Carmelo 2010, 26; Bruno *et al.* 2012, 567.

with a green one.[44] Only a single smooth surfaced column shaft fragment was identified at Byrsa (Figs. 9, 10 and Tab. 3).

Cipollino rosso (*marmor carium, marmor iassense*)

This stone was called cipollino rosso by the Italian stone cutters during the Renaissance period for its most common appearance similar to a sliced red onion. It is a metamorphic impure, calcitic marble coloured by haematite, with an insoluble residue of quartz, plagioclase chlorite and K-mica[45]. *Marmor Iassense* was quarried near the Greek Roman town of Iasos in the province of Milas (Türkiye)[46] (Fig. 2). It appears in several varieties but the two more commons, the veined and the brecciated, are characterized by a dark red matrix with white and grey veins or clasts, respectively[47]. Cipollino rosso was as little represented as africano marble with only one smooth column shaft fragment (Figs. 9, 10 and Tab. 3).

Egyptian granites

Egyptian granites are less represented than Microasiatic ones at Byrsa (20/51, that is 39.2%, Fig. 7). Two types were used to carve column shafts conserved at Byrsa: the red Aswan granite (*syenite)* and the granito del Foro.

Syenite (*marmor Pyrrhopoecilus*, Granito rosso di Aswan)

This is a magmatic rock of the Precambrian period with abundant, usually centimetric, pink K-feldspar porphyrocrysts. The main mineralogical assemblage consists of pink alkali-feldspar, colourless quartz, white plagioclase, and black mica in addition to small crystals of apatite, ilmenite and magnetite as accessories[48]. Aswan red granite was quarried in the Nile's East bank now occupied by the city of Aswan, ancient *Syene*, hence its name (Fig. 2). It is a coarse to very coarse-grained stone with pink and dark red colours[49]. *Marmor pyrrhopoecilus* is represented in Byrsa monuments by ten smooth column shaft fragments (Fig. 8 and Tab. 4).

Granito del Foro (*marmor Claudianum*)

It is a tonalite-gneiss of Proterozoic age composed mainly of plagioclase, feldspar, hornblende, biotite and lesser amounts of quartz, with traces of epidote and other rare accessory minerals[50]. This granitoid rock outcrops on the *Mons Claudianus*, now Gebel Fatireh in the Eastern Egyptian desert, a region situated between the Nile River and the Red Sea[51] (Fig. 2). Granito del Foro is medium grain-sized and features a white-greyish ground (due to the presence of plagioclase and quartz crystals) with blackish spots (biotite and hornblende)[52]. At Byrsa it is less well-represented than the *Syenite*: 9 smooth column shaft fragments. (Fig. 8 and Tab. 4).

[44] Gnoli 1988, 174; Agus *et al.* 2007, 389; Lazzarini 2010, 141; Carmelo 2010, 26; Bruno *et al.* 2012, 567.
[45] Lazzarini 2010, 141; Carmelo 2010, 28.
[46] Gnoli 1988, 243-244; Agus *et al.* 2007, 388; Lazzarini 2010, 141; Carmelo 2010, 28.
[47] Agus *et al.* 2007, 388; Lazzarini 2010, 141; Carmelo 2010, 28.
[48] Kelany 2010, 88; Carmelo 2010, 28; Serra *et al.* 2010, 962-968; El-Gohari 2011, 30; Borghi *et al.* 2015, 6.
[49] Kelany 2010, 87-88; Carmelo 2010, 28; Bianchini 2010, 105; Wefers, Mangartz 2014, 85-86.
[50] Corsi 1845, 210-211, 213-214; Antonelli *et al.* 2010, 919-921; Carmelo 2010, 30.
[51] Corsi 1845, 210-211, 213-214; Antonelli *et al.* 2010, 919-921; Carmelo 2010, 30; Tumova *et al.* 2016, 40.
[52] Corsi 1845, 210-211, 213-214; Gnoli 1988, 148; Antonelli *et al.* 2010, 919-921; Carmelo 2010, 30.

Conclusions

The study of the 191 column shaft fragments exhibited in the whole open area of the Museum of Byrsa led to the identification of fifteen types of coloured marbles and of four granites. Concerning the coloured marbles, 100/140 (that is 71 %) are "local", from *Africa Proconsularis* (*marmor numidicum*, greco scritto, bigio morato, alabastro rosso, lumachella rosa), 27/140 (that is 19 %) were imported from Asia Minor (pavonazzetto, proconnesio, breccia corallina, brocatellone, occhio di pavone, africano, cipollino rosso) and 13/140 (that is 9 %) from Greece (verde antico, cipollino verde, breccia di settebasi). As far as the granites are concerned, 31/51 (that is 61 %) were carried from Asia Minor (granito violetto, granito misio) and 20/51 (that is 39 %) from Egypt (syenite, granito del Foro). Thus, as expected, the African marbles were more used (71 %) than the imported coloured marbles from Asia Minor and Greece (28 %). Granite column shafts are all with a smooth surface, whereas coloured marble ones are also fluted, twisted and rudented. Nevertheless, the total number of column shaft fragments registered does not really reveal the totality of the number of these architectural elements used to decorate the Forum, basilicas, temple, etc. Indeed many coloured marble and granite column shafts were reused in Medieval Muslim constructions such as the mosque of Zitouna (Tunis) and the mosque of Okba at Kairouan[53]. Furthermore, it is difficult to determine from which monuments all these column shafts come since most of the archaeologists who have excavated the area of Byrsa did not give enough, or precise enough, information in their archaeological recording of these architectural elements. Therefore, only general information was provided on the purpose of the architectural elements (bases, column shafts, capitals, architraves, friezes and cornices) in the civic and religious monuments located on the archaeological site of Byrsa Hill. Apart from the coloured marbles, other white limestones and marbles were used to carve column shafts, bases and capitals. These limestones were very probably extracted from local quarries close to the archaeological site of Byrsa/Carthage. As for the marbles, minero-petrographic and isotopic analyses of samples taken from these architectural elements will permit determination of their provenance.

Many types of imported granites and coloured marbles recorded in the whole open air area of the Museum of Byrsa/Carthage (cipollino verde, verde antico, breccia di settebasi, africano, pavonazzetto, breccia corallina, cipollino rosso, proconnesio, sienite, granito violetto, granito del foro) were identified at the archaeological sites of *Utica, Uthina, Thuburbo Maius, Leptiminus, Thapsus, Thysdrus, Thaenae, Gigthi* and *Meninx*. Archaeological surveys and excavations in the harbour cities will very probably allow us to register new data concerning imported granites and coloured marbles. Their presence at Carthage and in all these Roman cities asserts not only their economic and social prosperity but also the great importance of the trade network between Carthage and the other cities of the Roman Empire.

[53] Lazzarini 2006, 205-214.

N°	Decoration	Sizes L. x d. (cm)	State of preservation	N°	Decoration	Sizes L. x d. (cm)	State of preservation
Marmor numidicum column shaft fragments				Greco scritto column shaft fragments			
1	**Rudented**	323x72	Moderately good	6	*Idem*	75x57	*Idem*
2	*Idem*	297x72	*Idem*	5	*Idem*	99x45	Moderately good
3	Idem	287?	Bad	6	*Idem*	75x57	*Idem*
4	*Idem*	264x72	Moderately good	7	*Idem*	70x57	*Idem*
5	*Idem*	261x72	*Idem*	8	*Idem*	69x37	Bad
6	*Idem*	216x72	*Idem*	1	**Smooth**	178x56	Moderately good
7	*Idem*	155x72	*Idem*	2	*Idem*	176x25	*Idem*
8	*Idem*	130x72	*Idem*	3	*Idem*	165x30	*Idem*
9	*Idem*	126x72	*Idem*	4	Idem	153x37	Bad
10	Idem	122x72	Bad	5	*Idem*	141,5x30	*Idem*
11	*Idem*	120x48	Moderately good	6	*Idem*	126x34	Moderately good
12	*Idem*	117x72	Idem	7	*Idem*	120x45	*Idem*
13	*Idem*	107x72	*Idem*	8	*Idem*	111x33	*Idem*
14	*Idem*	102x72	Idem	9	*Idem*	110x56,5	Bad
15	*Idem*	97x72	*Idem*	10	*Idem*	107x35	Moderately good
16	*Idem*	96x72	*Idem*	11	*Idem*	83x29	*Idem*
17	*Idem*	77x72	Bad	12	*Idem*	77x45	Bad
18	*Idem*	75x72	Moderately good	13	*Idem*	73,5x30	Moderately good
19	*Idem*	74x72	*Idem*	14	*Idem*	47x28	*Idem*
20	*Idem*	68x76	Bad	1	**Twisted**	87x45	*Idem*
21	*Idem*	64x65	Moderately good	2	*Idem*	63x42	*Bad*
22	*Idem*	52x72	*Idem*	3	*Idem*	46x47	*Idem*
23	*Idem*	50x60	*Idem*	Total: 34			
24	*Idem*	32x65	*Idem*	Black limestone column shaft fragments			
1	**Fluted**	256x94	*Idem*	1	**Smooth**	142x38	Moderately good
2	*Idem*	194x65	*Idem*	2	*Idem*	132x36	*Idem*
3	*Idem*	179x65	*Idem*	3	*Idem*	128x39	*Idem*
4	*Idem*	108x65	*Idem*	4	*Idem*	104x50	*Idem*
5	*Idem*	106x65	*Idem*	5	*Idem*	94x36	*Idem*
6	*Idem*	82x65	*Idem*	6	*Idem*	75x40	Bad
7	*Idem*	81x ?	*Idem*	7	*Idem*	74x40	*Idem*
8	*Idem*	68x94	*Idem*	8	*Idem*	71x37	*Idem*
9	Idem	49x40	*Idem*	9	*Idem*	69x32	*Idem*
1	**Smooth**	242x ?	*Idem*	10	*Idem*	65x46	Moderately good
2	*Idem*	121x58	Idem	11	*Idem*	65x42	Bad
3	*Idem*	117x45	*Idem*	12	*Idem*	65x40	Moderately good
4	*Idem*	63x30	*Idem*	13	*Idem*	53x36	Bad
5	Idem	47x33	Bad	14	*Idem*	51x37	*Idem*
1	Twisted	92x35	Moderately good	15	*Idem*	51x26	Moderately good
Greco scritto column shaft fragments				16	*Idem*	50x42	Bad
Total: 39				17	*Idem*	49x43	*Idem*
1	**Fluted**	376x72	Moderately good	1	**Twisted**	109x40	Moderately good
2	*Idem*	256x85	Bad	2	*Idem*	84x42	*Idem*
3	*Idem*	250x85	*Idem*	3	*Idem*	83x36	*Idem*
4	*Idem*	130x50	Moderately good	1	**Rudented**	76x55	*Idem*
5	*Idem*	83x36	*Idem*	Total: 21			
6	*Idem*	71x60	*Idem*	Alabastro rosso column shaft fragments			
7	*Idem*	64x35	Bad	1	**Smooth**	146x40	Medium
8	*Idem*	51x94	*Idem*	2	*Idem*	122x34	*Bad*
9	*Idem*	20x94	*Idem*	3	*Idem*	65x40	*Idem*
1	**Rudented**	148x36	Moderately good	4	*Idem*	40x41	Moderately good
2	*Idem*	127x41	*Idem*	Total: 4			
3	*Idem*	108x42	Bad	Lumacchella rosa column shaft fragments			
4	*Idem*	102x50 ?	*Idem*	1	***Smooth***	102x30	Moderately good
5	*Idem*	99x45	Moderately good	2	*Idem*	55x40	*Idem*
				Total: 2			
				Total column shaft fragments: 100			

Table 1: Column shafts of *Africa Proconsularis* coloured marbles at Byrsa.

N°	Decoration	Sizes L. x d. (cm)	State of preservation
Cipollino verde column shaft fragments			
1	**Smooth**	154x30	Moderately good
2	*Idem*	146x45	*Idem*
3	*Idem*	145x40	*Idem*
4	*Idem*	105x60	*Idem*
5	*Idem*	105x55	Bad
6	*Idem*	35x60	*Idem*
7	*Idem*	24x52	*Idem*
Total: 7			
Verde antico column shaft fragments			
1	***Smooth***	148x50	Moderately good
2	*Idem*	71x45	Bad
3	*Idem*	64x50	*Idem*
4	*Idem*	62x30	*Idem*
5	*Idem*	61x29	Moderately good
Total: 5			
Breccia di settebasi column shaft fragments			
1	**Smooth**	104x58	Moderately good
Total column shaft fragments: 13			

Table 2: Column shafts of Greek coloured marbles at Byrsa.

N°	Decoration	Sizes L. x d. (cm)	State of preservation	N°	Decoration	Sizes L. x d. (cm)	State of preservation
Granito violetto column shaft fragments				3	*Idem*	108x ?	Very bad
1	**Smooth**	186x70	Moderately good	1	**Fluted**	126x62	Moderately good
2	*Idem*	158x42	*Idem*	2	*Idem*	96x60	*Idem*
3	*Idem*	145x42	*Idem*	3	*Idem*	82x60	Bad
4	*Idem*	141x33	Bad	4	*Idem*	78x62	*Idem*
5	*Idem*	136x42	Moderately good	5	*Idem*	64x60	Moderately good
6	*Idem*	128x45	*Idem*	6	*Idem*	54x60	*Idem*
7	*Idem*	125x42	*Idem*	7	*Idem*	? (difficult to measure)	Good
8	*Idem*	122x42	*Idem*	Total: 10			
9	*Idem*	113x42	*Idem*	Breccia corallina column shaft fragments			
10	*Idem*	112x42	*Idem*	1	**Smooth**	220x62	Moderately good
11	*Idem*	108x42	*Idem*	2	*Idem*	147x62	Bad
12	*Idem*	106x40	*Idem*	3	*Idem*	120x62	*Idem*
13	*Idem*	104x35	*Idem*	4	*Idem*	116x58	*Idem*
14	*Idem*	94x42	*Idem*	5	*Idem*	99x48	*Idem*
15	*Idem*	93x42	*Idem*	6	*Idem*	73x62	*Idem*
16	*Idem*	92x50	Bad	Total: 6			
17	*Idem*	90x43	*Idem*	Proconnesian column shaft fragments			
18	*Idem*	90x ?	*Idem*	1	**Smooth**	233x32	Moderately good
19	*Idem*	87x46	*Idem*	2	*Idem*	100x ?	*Idem*
20	*Idem*	85x42	*Idem*	3	*Idem*	53,5x20	Moderately good
21	*Idem*	80x42	*Idem*	4	*Idem*	53x36	Bad
22	*Idem*	73x42	*Idem*	1	**Fluted**	45x60	*Idem*
23	*Idem*	54x52	*Idem*	Total: 5			
24	*Idem*	52x40	Moderately good	Broccatellone column shaft fragments			
25	*Idem*	47x48	*Idem*	1	**Smooth**	185x44	Moderately good
26	*Idem*	42x50	*Idem*	2	*Idem*	146x50	*Idem*
27	*Idem*	? (Difficult to measure)	Good	Total: 2			
Total: 27				Occhio di pavone column shaft fragments			
Granito di misio column shaft fragments				*1*	**Smooth**	74x31	Moderately good
1	**Smooth**	159x58	Moderately good	2	*Idem*	56x31	*Idem*
2	*Idem*	92x45	*Idem*	Total: 2			
3	*Idem*	87 x 42	*Idem*	Cipollino rosso column shaft fragments			
4	*Idem*	29 x 50	Bad	1	**Smooth**	108x36	Moderately good
Total : 4				Africano column shaft fragments			
Total of column shafts fragments: 31				1	**Smooth**	117x50	Moderately good
Pavonazzetto column shaft fragments				Total column shaft fragments: 27			
1	**Rudented**	142x72	Moderately good				
2	*Idem*	130x50	*Idem*				

Table 3: Microasiatic granite and marble column shafts at Byrsa.

N°	Decoration	Sizes L. x d. (cm)	State of preservation
Granito del Foro column shaft fragments			
1	**Smooth**	143x38	Moderately good
2	*Idem*	128x43	*Idem*
3	*Idem*	95x43	*Idem*
4	*Idem*	46x52	*Idem*
5	*Idem*	44x52	*Idem*
6	*Idem*	42x60	*Idem*
7	*Idem*	34x30	*Idem*
8	*Idem*	30x50	*Idem*
9	*Idem*	30x47	*Idem*
Total: 9			
Total column shaft fragments: 20			
Sienite column shaft fragments			
1	**Smooth**	121x45	Moderately good
2	*Idem*	115x57	*Idem*
3	*Idem*	112x47	*Idem*
4	*Idem*	102x47	*Idem*
5	*Idem*	72x28	*Idem*
6	*Idem*	62x42	*Idem*
7	*Idem*	50x47	*Idem*
8	*Idem*	43x40	Bad
9	*Idem*	41x45	*Idem*
10	*Idem*	35x47	*Idem*
11	*Idem*	34x47	*Idem*
Total: 11			

Table 4: Egyptian granite column shafts at Byrsa.

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PROVENANCE IDENTIFICATION II:

OTHER STONES

PORPHYRITE PEBBLES OF THE ADDA RIVER (ITALY) IN COMPARISON WITH PORFIDO SERPENTINO

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Abstract

Dark green "porphyrite" pebbles (5-8 cm long) featuring pale green rectangular phenocrysts and looking like the "porfido serpentino" of Greece are present in alluvial deposits of the Adda river (southern Lombardy - Italy). The pebbles pertain to thin andesite dikes ("Porfiriti Auctorum") connected to Cenozoic plutonism of Valtellina (Northern Lombardy) and they were often present in pebble pavements of Lombardy. By contrast, the renowned "porfido serpentino" of the southern Peloponissos, classified as "basaltic andesite - trachyandesite" and occurring as pebbles only, was largely employed in Roman architecture (for cornices, tiles, tesserae etc.).

The visual correspondence may suggest a use of these pebbles during the Roman period, but the use of the greek porphyry always in combination with other coloured marble in all of the archaeological sites of Lombardy, argues against a hypothesis of the use of local pebbles as a surrogate.

Keywords: Porphyrite, porfido serpentino, Adda, Lombardy.

Introduction

"Porphyrite" pebbles looking like "porfido serpentino", are present in many loose deposits of the rivers flowing in the plain of Lombardy, a region of Northern Italy; these materials were used to make pebble pavements in the streets and squares of Southern Lombardy. Meanwhile, true porfido serpentino (Green porhyry), quarried at Krokeai near Sparta (Lakonia, Greece), was a coloured marble, highly priced in Roman times according to Diocletian's Edict (Giacchero 1974) and largely used for decorative purposes by Roman craftsmen (Lazzarini 2007). Lombard porphyrites are also comparable to such other rare varieties as "porfido Vitelli" or "porfido verde antico risato" (Krokeai), the "black porphyry" of Wadi Umm Towat (near Gebel Dokhan, Eastern desert, Egypt) or the "granito a morviglione" of Saint Raphaël (Var, Provence, France).

It is worth considering if these Lombard pebbles were incidentally used in the Roman period as a surrogate for the very expensive Greek porphyry, so the features of both Porphyrite and porfido serpentino have been compared.

Characters

2.1 Porphyrite: a uniform ground of dark green colour (5G 4/1 - Munsell Book of Color) and scattered rectangular crystals, sometimes crossed, of pale green (size 5-15 mm).

2.2 Porfido serpentino: a ground of different shades of green-blue colour (5BG 3/1 or 10BG 5/1) and scattered rectangular crystals, sometimes crossed, of whitish to light green (size 5-15 mm) and small black crystals. This stone was always in high favour with ancient authors: all described the peculiar snakeskin appearance with the tender green colour as the grass, the brightness of the polished surface or the hardness to the work. A survey of ancient authors' quotations is offered by Gnoli (Gnoli 1988, 141-144) and by Lazzarini (Lazzarini 2007, 45-46).

Occurrence

3.1 Porphyrite: loose sediments made of pebbles (50-80 mm long) and cobbles deposited along the Adda river course, i.e. near Boffalora and Montanaso, north of Lodi (Carta Geologica 1971). This kind of pebble is also present in morainic deposits of the Adda glacier laid out along the mountain slopes; the valley was run across by the glacier during the Quaternary expansions and is now occupied by the water basin of lake Como (i.e. Camnago Volta, south-east of Como).

These porphyrites were already reported by Breislak (Breislak 1822, 9-10), who pointed out the crossed feature of some white phenocrysts, showing up on the dark ground: "(...) Un'altra roccia, non così comune, e che si incontra in masse piuttosto piccole, specialmente tra i ciottoli del selciato della città di Milano, è un porfido il quale, quando è levigato, presenta un fondo nerastro o verde cupo, altre volte grigio scuro. La pasta è dura, compatta (…). In questa pasta sono disseminati moltissimi feldspati (…), che sovente s'incrociano, e quando la pietra è levigata compariscono bianchi, opachi ed hanno una bella apparenza sul fondo nero oscuro della roccia (…)".

3.2 Porfido serpentino: a peculiar character of this stone is the absence of a quarry located in a rock outcrop; the supplying of the suitable material was made by the collection of pebbles and fragments on an area east of the village of Krokeai, about 20 km south of Sparti (the ancient Lacedaemonia). The words of Pausanias perfectly illustrated this character; this Lydian Author, in chapter XXI, 4 of the third book of his "Description of Greece", devoted to the southern region of Lakonia and written in the second half of the 2nd century, reported the occurrence of greek porphyry: "As you go down to the sea towards Gythium [on the Mani pensinsula, the eastern shore of gulf of Lakonia] you come to the lacedaemonic village called Croceae and a quarry. It is not a continuous stretch of rock, but the stones they dig out are shaped like river pebbles; they are hard to work, but when worked sanctuaries of the gods might be adorned with them, while they are especially adapted for beautifying swimming-baths and fountains. (...)" (Pausanias 1918).

Geological setting and provenance

4.1 Porphyrite: the so-called "porfiriti Auctorum" are referred to plenty of dikes connected to Caenozoic plutonism and set discordantly into Palaeozoic Crystalline Basement or into Mesozoic sedimentary cover of Northern Lombardy (Valtellina and Bergamasc Prealps).

These dikes outcropping in the catchment basins of river Adda and river Serio, were accurately described in different sheets of Carta Geologica d'Italia.

4.1.1 Adda catchment basin (Sondrio province)

A) Massive, decimetric to plurimetric andesitic to basaltic dikes, colour from grey-green to dark grey and black, usually porphyryc because of plagioclase and/or hornblende phenocrysts, most rarely aphiric; sometimes they bear lumps of femic minerals or inclusions of wall rocks. Mineralogical composition includes hornblende, zoned plagioclase and biotite, sometimes diopside phenocrysts; the groundmass is made of glass quartz, plagioclase and biotite, often transformed in sericite and chlorite; apatite and iron oxides are ancillary minerals. Outcrops: Gran Zebrù area (east of Bormio); Oligocene (Carg 2012a).

B) Porphyric andesite, green coloured (5G 4/1 - Munsell Book of Color) with aphanitic to very fine-grained groundmass and amphibole-plagioclase phenocrysts (2-10 mm), locally oriented; they may contain dark inclusions (size 2 - 10 cm). They are intruded both in the Variscan metamorphic and in the sedimentary sequence, and transect Alpine structures (Porfiriti Auctorum). Outcrops: Trivigno, south-east of Tirano; upper Cretaceous - lower Paleocene (Carg 2011a).

C) Porphyrites, intermediate rocks with grey to greenish-grey micro-crystalline groundmass (5BG 4/1 - Munsell Book of Color). The groundmass contains locally altered phenocrysts of plagioclase and, to a minor extent, of hornblende. The dikes vary from a few decimetres to a few metres in thickness and they are often discordant with the main foliation of the host rocks.

Outcrops: Prasomaso, Sazzo a few kilometres east of Sondrio, and between Livrio and Venina valleys, few kilometres south of Sondrio; Eocene (Carg 2011b; Crespi, Gandini 1960). Note: Porphyrite B matches the porfido serpentino; Porphyrite C matches sometimes the “granito a morviglione”.

4.1.2 Serio catchment basin

The valley of river Serio, a tributary of river Adda (val Seriana - Bergamo Prealps), also contains some outcrops of andesite dikes.

D) Andesite showing porphyric texture made of plagioclase and hornblende phenocrysts (up to centimetric size) in a fine groundmass, seldom with biotite and quartz; apatite, titanite, magnetite and pyrite are among ancillary minerals. Outcrops: central val Seriana area, Premolo; Tertiary (Carg 2012b).

E) Sub-volcanic and filonian bodies intruded into the Mesozoic succession. Decametric dikes of basaltic porphyrites, with plagioclase phenocrysts and microcrystalline groundmass, with plagioclase, pyroxenes and ore minerals; low-depth intrusive bodies, pluridecametric, with andesitic to trachi-andesitic and basaltic composition, sometimes with oriented texture, with green hornblende and plagioclase phenocrysts in a plagioclase and ore minerals groundmass (5BG 5/1). Outcrops: central val Seriana area (Selvino, Pradalunga, Gaverina, valle Rossa); Upper Paleocene - Lover Oligocene (Carg 2012c).

4.2 Porfido serpentino: the stone was classified as a “basaltic andesite-trachyandesite” (Lazzarini 2007, 57-58) belonging to a volcano-sedimentary series, Tyros beds, late Paleozoic, located in Lakonia.

Microscopic features

The traditional method of optical microscopy on thin sections (Nikon Eclipse E400 Pol - Nikon Pol objectives) was employed to enhance the microscopic characters.

5.1 Porphyrite: samples coming from the andesite dykes (type A) and matching the aspect of porfido serpentino were examined. The mineralogical composition shows highly altered rectangular phenocrysts of plagioclase (size 5-15 mm) together with crystals of hornblende enclosing laths of zoned plagioclase, granular epidote and acicular ilmenite.

5.2 Porfido serpentino: samples coming from Krokeai and picked up by first hand were examined. The mineralogical composition shows phenocrysts (size 5-15 mm) of plagioclase (albite-oligoclase); phenocrysts (size 1-3 mm) of augite-pyroxene; crypto-crystalline groundmass made of partially devetrified glass and containing chlorite, calcite, epidote, opaque minerals.

Use in architecture

6.1 Porphyrite: pebbles are easily visible in the pavements, made of regularly-shaped river sediment, laid in many squares or streets of the towns of southern Lombardy, as at piazza della Vittoria in Lodi or piazzetta Reale near the Cathedral of Milan. This is a common use of river pebbles in a region with a dearth of material to make pavements, and porphyrite pebbles are laid together with dozens of other metamorphic, magmatic and sedimentary lithotypes.

Other uses of these pebbles are unknown

6.2 Porfido serpentino: one of the most employed within the “coloured marble”, spread in the whole roman world (Lazzarini 2007, 47-55). In particular, this porphyry was found in many Roman archaeological sites of the present-day territory of Lombardy from *Mediolanum* (Milan) to *Brixia* (Brescia), from *Novocomum* (Como) to *Cremona* (Cremona), used as rod-shaped moulded cornices or as geometric-shaped tiles for flooring or as slab fragments to make the ground of figurative panels (Bugini, Folli 2005, 162-163).

Conclusion

The examination of the porphyrite pebbles coming from loose deposits of the river Adda (Central Lombardy) implies a significant question: is it possible to conceive the use of these pebbles during the Roman period as a surrogate for the “porfido serpentino” of the Peloponnese? Different points must be evaluated: the visual aspect (crossed crystals) is almost identical; the occurrence as pebbles without an identifiable quarry site is similar; the average size of the Adda pebbles is less than the Peloponnesian pebbles; the microscopic features are contrasting, but they are detectable only by scientific analyses. Finally, another important detail seems to be remarkable: the large availability of Greek colored marbles in the Roman architecture of Lombardy. “cipollino”, but also “rosso antico”, “fior di pesco” and “porfido serpentino” are brought together in the materials unearthed in Lombard archaeological sites. On the basis of these points, it is possible to exclude the use of porphyrite pebbles of Adda during the Roman times.

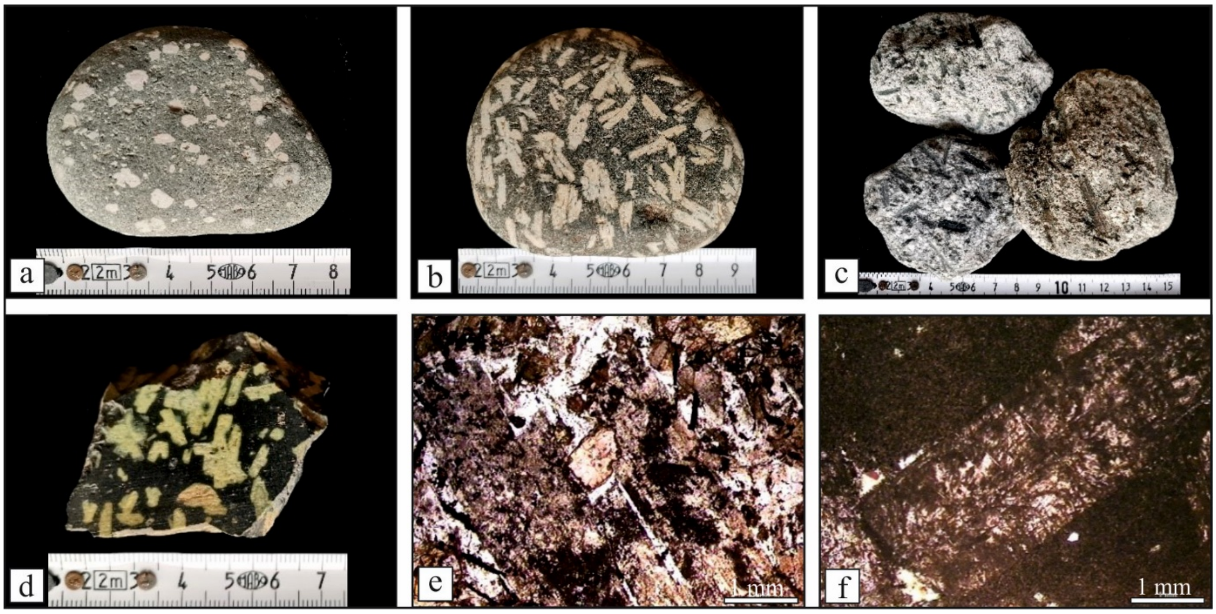

Figure 1: **a**. Porphyrite Adda type B; **b**. porphyrite Adda type C; **c**. porphyrite Serio type E; **d**. porfido serpentino; **e**. thin section of Porphyrite Adda type A; **f**. thin section of porfido serpentino.

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NEW DATA ON THE STONE FURNITURE OF THE EARLY CHRISTIAN CHURCH AT BILICE IN THE ROMAN PROVINCE OF DALMATIA

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Abstract

The article investigates early Christian church furniture from Bilice near Šibenik, a very important archaeological locality in the Roman province of Dalmatia. The site was excavated at the beginning of the 20th century, when church furniture of great interest was found. Archaeological excavations of the early Christian site in Bilice resumed in 2016 new fragments of church furniture have been found during the fieldwork. These probably also belong to the early Christian church. One of the newly found fragments has been petrographically analysed.

Petrographic observation and additional comparison with the Seget stone variety excavated in the quarry near the town of Trogir allows us to conclude that the stone used for the church furniture was from this quarry.

Keywords: Bilice, church furniture, Seget quarry.

The triconch church in Bilice and its stone monuments

Early Christian churches from Late Antiquity are known at many localities in the Roman province of Dalmatia, many of them on the basis of remains of their foundation walls. A large number of buildings have also survived in the frames of later building phases, especially in the coastal towns whose life continued without interruption. Having in mind the general state of preservation of early Christian architecture, the complex at Bilice near Šibenik belongs to the group of churches with preserved foundation walls of the sacral building. That has been proved by recent archaeological revision work which started in 2016 as a project of the Archaeological Department of the Faculty of Humanities and Social Sciences of the University of Zagreb[1]. Before they began, the locality was neglected and covered with dense Mediterranean vegetation. The remains of the church architecture were hidden below a thin layer of humus. Such a state called for action, if for no other reason than because the locality has been known to be very important on the basis of the first archaeological excavations conducted at the beginning of the 20th century. The form of the early Christian architecture at the locality in Bilice has been known, as well as its significance. A special significance of the locality has also been underlined by the old discoveries of stone sculpture, very original and important among the vast number of monuments of early Christian stone sculpture in Dalmatia. A basic knowledge of the early Christian locality of Bilice is necessary for the theme of this article, and will take up its first part.

The early Christian church in Bilice is located about 100 m from the south shore of the Prokljan Lake (Fig. 1). The site with the church has local name Dedića punta, after the name of the land owner. The first excavations were carried out at the beginning of the 20th century,

[1] The project has been supported continuously from inception by the Ministry of Culture of the Republic of Croatia.

according to archival sources mostly in 1909[2]. After the excavations, a few works containing descriptions of the findings were published. The most important is a ground-plan of the church architecture preserved in the archival documentation of Luka Jelić and published in the second half of the 20th century[3]. The archaeological revision work has largely confirmed that ground-plan. Its important place in the archaeological literature of the second half of the 20th century revolving around the church architecture in Bilice was not unjustified.

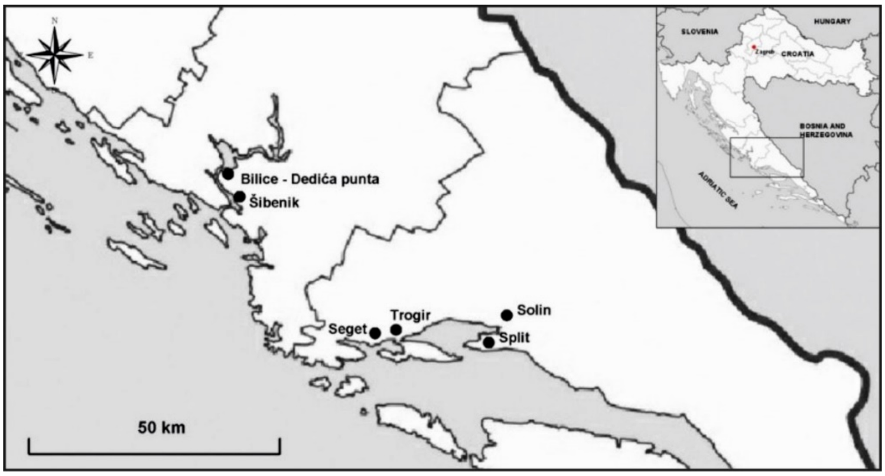


Figure 1: Location map of the Bilice church (Dedića punta) and Seget quarry (Drawing: A. Maričić).

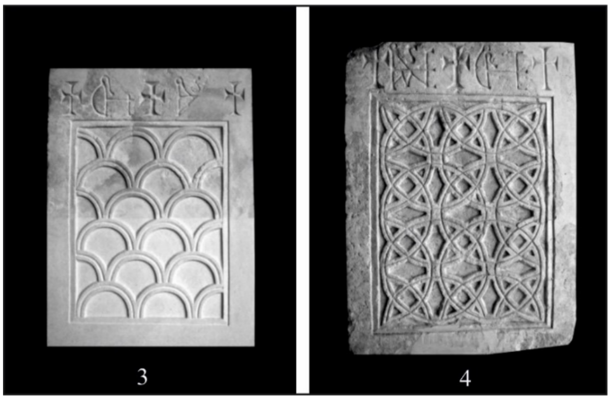
The church architecture in Bilice can be described as a sacral complex, because the church proper is a nucleus surrounded by several rooms built subsequently on the north and south sides and by a narthex at the front (Fig. 2). The church itself is a single-nave building with a triconchal eastern termination, where a presbytery was located. The presbytery occupied only the space in and before the main conch, which was marked by the line of altar-screen separating the two main parts of the church – that for the clergy and that for the congregation. The two lateral conches were outside of the presbytery and served as auxiliary rooms.

Triconch churches are found in early Christian architecture outside of Dalmatia and there are many interesting examples[4]. In early Christian Dalmatia, triconch churches were quite numerous and, according to some differences, they have been divided in the literature in narrower groups[5]. The church from Bilice belongs to the group with connected conches, along with triconch churches at Pridraga near Zadar and Sutivan on the island of Brač[6]. It is interesting to note the existence of a great similarity in the appearances of the church furniture from Bilice and Pridraga. That speaks of the origin of the furniture as being in the same workshop or it may be the result of existence of identical models available in the workshops of different stonemasons[7]. The similar sacral complexes in Pridraga and Bilice had several architectural phases, of which the first was limited to a triconch church alone as a self-sufficient building, while the auxiliary rooms were later additions. The first phase (the triconch church only) can be dated to the end of the 5th or to the 6th century. The auxiliary rooms including the narthex, were probably built during the 6th century.

[2] A detailed review of the archival sources is presented in Jarak, Jukić-Buča 2017, 129-153.
[3] Gunjača 1978, 72.
[4] Examples come from Italy, France, Greece, north Africa, Egypt. See Krautheimer 1986, passim; Cambi 1984, 45-54.
[5] Cambi 1984, 45-54; Vežić 2011, 27-66.
[6] Cambi 1984, 45-54; Vežić 2011, 27-66; Josipović 2018, 9-21; Belamarić, 1994, 64-68.
[7] Mišković 2015, 7-20.

Figure 2: Bilice, Dedića punta – aerial view of the triconch church (Photo: M. Vuković).

In the first excavations of the Bilice church very interesting pieces of the church furniture were discovered. The most famous are fragments of the two plutei of the altar-screen. The fragments were sufficient for a reconstruction of the plutei, now held in the Museum of Croatian archaeological monuments in Split (Figs. 3, 4).



Figures 3-4: Bilice, reconstructed chancel screen panels. Photo from the Archives of the Museum of Croatian Archaeological Monuments, Split.

Both plutei have the same ground conception of decoration and shape in the main field and edges. The main rectangular field is delimited by the flat simple edges. The upper edge differs from the bottom and lateral ones with regard to dimensions. The upper edge is much higher and bears monograms and crosses. The very similar appearance of the monograms and crosses on the upper borders of both plutei suggests special reasons for their incorporation. Their meaning has not been clearly solved in spite of contributions from several authors[8]. The decoration of the main field of the plutei consists of only one motif that covers the whole field. On one pluteus the shells (*squammae*) make up the decoration, and on the other the intersected circles. The last motif belongs to the highly-developed geometric phase of early Christian sculpture, and shows similarities with early medieval ornamental patterns pointing to a dating of the Bilice plutei at the end of the early Christian production. The extension of the upper edges described already speaks also of the production of the plutei at the same time. This is characteristic of early medieval plutei, which have a prominent upper section that differs in width from the main slab field. On the Bilice plutei, a higher upper band was necessary for the insertion of the monograms and that is the reason for the change of dimensions of the upper edge. Speaking of the ornamentation of the main field of the plutei, both ornamental patterns have analogies in early Christian period. For the motif of shells there are many analogies throughout the early Christian period. The second motif of intersected circles is not present so much on early Christian stone monuments in Dalmatia. In spite of that

[8] Novak 1929, 517-530.

some analogies exist and as precisely-dated examples it is possible to mention the stone sculpture of the south church in Srima, a locality in northern Dalmatia not far from Bilice[9]. The intersected circles are executed on the Srima ambo slab dated to the second half of the 6th century. On the basis of all relevant elements (the features of the main fields and borders, the manner of carving of ornaments, their shape and membership of certain groups of ornamental patterns), it is very probable that the Bilice plutei belong to the second half of the 6th century.

The plutei were made of limestone which has not been petrographically analysed. The similar slabs from Srima have been petrographically analysed and the results indicate white limestone from the quarry of Splitska on the island of Brač[10].

In the new revision excavations in Bilice, a few stone fragments with profiles were found (Figs. .5, 6, 7). They probably belong to the furniture of the triconch church. The first fragment (Fig. 5) has nicely carved profiles on the front side. Two carved straight lines and rounded profile are visible. Under them there is a rest of recessed quadrangle. The remains of an oval perforation, a sign of a secondary use of the monument, is also visible on the preserved fragment. The fragment was probably, according to its width and type of decoration, part of the pilaster of an altar screen.

Figures 5-7: Bilice, fragment of the church furniture (Fig. 5, photo: M. Vuković; Figs. 6-7, photo: M. Jarak).

The other two fragments (Figs. 6, 7) were probably parts of the edges of altar-screen plutei or ambo plutei. One fragment has a small part of the main field preserved as well. Rounded profiles and straight lines on both fragments suggest that they were parts of the edge of some slabs from an altar-screen or ambo plutei. The preserved fragments reveal the high edges of the plutei, recalling features of the plutei with monograms from the same locality. Although the newly found fragments with profiles differ from the plutei with monograms which have flat edges, it must be underlined that both types of edges belong to early Christian church furniture in Dalmatia. Edges with profiles, very similar to the newly found fragments in Bilice, are known e.g. from Srima, where they belong to the ambo plutei[11]. It is especially important to note that the Srima ambo plutei with profiled edges have the same ornamental decoration as the plutei with monograms from Bilice (*squammae* and intersected circles). The ambo plutei from Srima demonstrate a connection between the old and new stone monuments from Bilice and testify to their identical dating (second half of the 6th century). Securely-dated early Christian plutei with profiles from Srima and other localities in Dalmatia allow us to

[9] Gunjača. 2005, 73-188.
[10] Gunjača. 2005, 74.
[11] Gunjača. 2005, 106-115, 155-157. Several examples of ambo plutei with profiled edges have been recently discussed in Jarak 2018, 887-894.

draw the conclusion that the fragments with profiles from Bilice were parts of the early Christian church furniture. The archaeological context also supports an early Christian dating. Namely, the fragments were found inside the walls of the early Christian church architecture suggesting their early Christian provenance.

All three new fragments from Bilice were made of white limestone. Petrographic analysis has been done for the first fragment (Fig. 5), and its results are displayed as follows.

Petrographic analysis of the stone sample from Bilice

The aim of this part of the paper is to lay out a petrographic analysis of the stone sample from the Bilice church furniture. In addition, it is very important to draw a conclusion about the possible origin of the stone or the quarry that was the potential source for the church furniture manufacturing. In line with that aim, the paper presents the results of the macroscopic and microscopic analysis of stone specimens from the church furniture. Additionally, petrographic analysis of the stone sample from Seget quarry was undertaken. The Seget stone variety is excavated in the quarry near town of Trogir, Croatia (Fig. 1). Stone excavation in the Seget quarry dates to the third century BC.

Methods

Petrographical analysis was conducted at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb. Micropetrographic analysis was performed on the thin sections of the samples by a Leica DM LSP petrographic microscope. Microphotographs were taken with a Canon EOS 1300D digital camera. All thin-sections were stained by Alizarin red S and K-ferricyanide (according to the procedure proposed by Evamy and Shearman) in order to distinguish carbonate minerals present within[12]. Classifications after Dunham with the modifications after Embry and Klovan and Flügel were used for distinguishing and describing various carbonate rocks in the field[13]. Classifications after Folk were applied in micropetrographical analysis of thin sections[14].

Results

Petrographic analysis was done on the furniture sample from Bilice church and on a sample from Seget quarry near Trogir.

Petrographic characteristics of a stone sample from Bilice church furniture

Macroscopic analysis

According to the petrographic observation, the stone sample is white to light grey fine-grained limestone consisting of numerous macroscopically visible allochems or bioclasts (Fig. 8). Macroscopic analysis reveals an uneven distribution of gray grains across the white rock mass. Bioclasts of calcite composition that are mostly smaller than 2 mm have prismatic forms of uneven thickness. With the diluted HCl solution, the sample reacts aggressively. It can also be observed that the grains are more densely packed in some zones of the sample and form a grain-support. As a result, it can be concluded that the sample is bioclastic limestone classified as packstone.

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[12] Evamy, Shearman 1962.
[13] Dunham 1962; Embry, Klovan 1972; Flügel 1982; Flügel 2004.
[14] Folk 1959; Folk 1962.

Microscopic analysis

In the thin section of the sample, numerous fossils or bioclasts are visible (Fig. 9). The fragments of rudist bivalves dominate in the sample. Other bioclasts include echinoids, bryozoans and foraminifers. Bioclasts are distributed throughout the thin section and relatively well sorted, the medium densely packed with various dimensions that range from 0.1 to 1 mm. There are also several larger bioclasts (fragments of rudists) with a size of around 2 mm. Allochems are bound together with the micritic matrix that is partially dolomitized since dolomite crystals with the rhombohedral shape are also observed. According to the micropetrographical analysis, the sample is determined as bioclastic limestone and classified as biomicrite.

Petrographic characteristics of the Seget variety

Macroscopic analysis

The Seget variety is a white to light grey limestone (Fig. 8). It consists of macroscopically visible small grains of gray bioclasts of various dimensions, but generally not exceeding 2 mm. Bioclasts of anhedral form are densely distributed throughout the sample. They show grain-support. Based on this, the stone is determined as bioclastic limestone classified as packstone.

Microscopic analysis

The sample is rich in bioclasts dominated by rudist bivalves (Fig. 9). Other bioclasts, observed in thin section are briozoans and echinoids. The dominant binder in the thin section is micrite. Based on the fact that the sample contains micrite as a binder and bioclasts whose dimensions are not more than 2 mm, it was concluded that the Seget stone sample was bioclastic limestone classified as biomicrite.

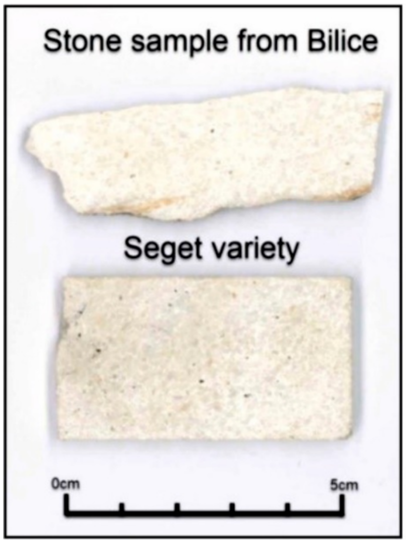

Figure 8: Stone sample from the Bilice church furniture and a sample of the Seget variety (Photo: A. Maričić).

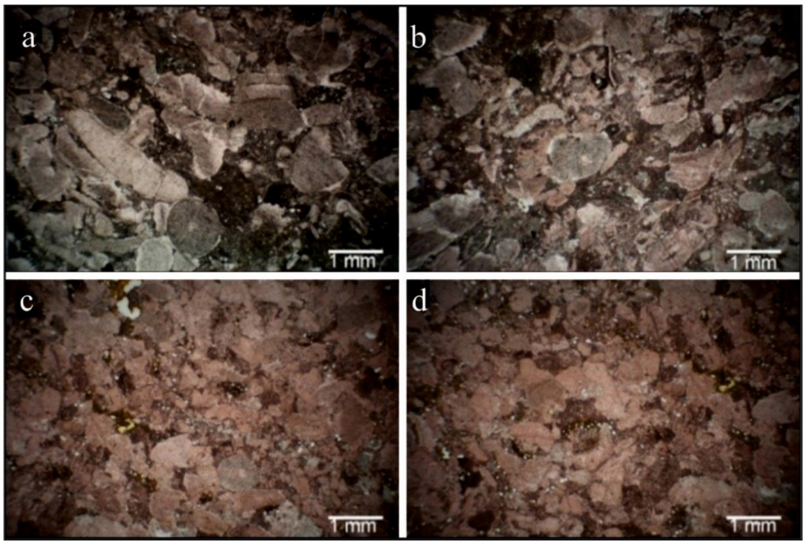

Figure 9: Microphotographs of a stone sample from the Bilice church furniture **a**-**b** and a stone sample of the Seget variety **c**-**d** (Photo: A. Maričić).

Discussion and conclusion

In ancient times, along the Adriatic coast, there were many active quarries especially in Istria and on the islands of Vis, Korčula, Brač as well as others. The most numerous and significant were quarries on the island of Brač, which supplied the famous workshop in Salona and other workshops at the eastern Adriatic coast[15]. The existence of good stone certainly led to an increase in the number of masonry workshops. In addition, the tradition of stone excavation and processing progressed from year to year. In stone-cutting workshops the stone was decorated according to specimens originating from larger centres such as those in Rome, Aquileia and Salona near Trogir. The last-mentioned centre in Salona also used besides the Brač limestone other stone of good quality, for example from the Seget quarry[16]. The motifs found on the liturgical furniture in Salona could be found all over the Adriatic coast[17]. However, differences in quality and method of manufacturing can be observed. The influence of Salona in culture is confirmed by the large number of early Christian churches discovered, equipped with specific sculptures, and decorated with murals and mosaics[18]. Many localities with nicely-modelled furniture were connected with the Salona stonemasonry workshops. A Salonitan workshop origin has been suggested for the furniture in Srima and also in Bilice. In this article, based on the petrographic analysis, the previous assumption of a Salonitan workshop origin for the Bilice church furniture can be confirmed by the fact that at least one part of the furniture was made of limestone from the Seget quarry. The composition and structure of the stone sample from Bilice and the manner of its processing can now contribute to our knowledge of early Christian stone sculpture and the work of ancient stonemason's workshops.

After macroscopic and microscopic analysis, it was found that the stone sample from the Bilice church furniture showed similar petrographic characteristics to the Seget stone variety. Based on the above, it could be presumed that Seget natural stone variety was used for the manufacture of the church furniture in Bilice. It should also be emphasized that the Seget quarry belongs to the group of quarries that began the exploitation and processing of stone from the 3rd century BC[19]. The quarry is still active today which further supports the assumption of Seget as a variety which was used to make church furniture.

The sample from the furniture shows a great similarity in petrographic characteristics to the sample from the Seget quarry. Comparing their micropetrographic characteristics, similarities were observed in the amount, dimensions and type of bioclasts. Both samples were classified as packstone or biomicrite lithotype with rudist bivalves as the dominant bioclasts in the micritic matrix. Additionally, the arrangement of bioclasts within the thin section and the fact that the bioclasts have grain-support is noteworthy. Considering all the above it can be assumed that the stone used for the making of the furniture was excavated from this quarry.

The natural stone Seget of the Upper Cretaceous age is a limestone of homogeneous to micro-layered structure, greyish with visible bioclasts mostly smaller than 2 mm. The stone variety is exploited in the quarries of Seget and Kučić Cava near Trogir and Salona[20]. The

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[15] For general information on quarries see Marinković, Miliša 2015. Among other works see e.g. Zaninović 1997, 37-45; Katić 2009, 28-34; Parica 2012, 345-353; Popović 2012, 107-128.

[16] As an example can serve furniture from the Gata church, made of different limestones but with common workshop features that point to the same Salonitan origin of the sculpture. See Jeličić –Radonić 1994,71-156, 187-193. Petrographic analysis shows that the limestones originate from Seget and several Brač quarries.

[17] Sculpture found in Salona has been published in Duval *et al*. 1994.

[18] On the churches see Chevalier 1995, passim. General picture is presented in Cambi 2002.

[19] Marinković, Miliša 2015.

[20] Tomašić *et al*. 2009.

Seget quarry was named after the word *seco*, which in Latin means to cut or break[21]. A bad feature of this stone is its inhomogeneity due to micro-layers, but this is not so dangerous because the transition between different sizes of bioclasts is gradual with good growth[22]. Due to the very high intergranular porosity, Seget stone shows significantly high values of capillary absorption of water[23]. Aspects that most probably played a major role in the selection of stone for the manufacturing of church furniture should be emphasized. The selection of stone was influenced by the proximity of the quarry from which the stone was extracted, the possibility of the stone's exploitation and processing, the quality and dimensions of the stone blocks, and the mode of transportation (most probably by sea). The Seget quarry is geographically located closest to the towns of Salona, Trogir and Šibenik and its surroundings, which could also suggest a connection between stone from that quarry and stone from the church furniture in Bilice.

In addition to the determination of macroscopic and microscopic characteristics, for further analysis, a detailed paleontological determination of microfossils and powder X-ray diffraction are recommended. For a more detailed and accurate determination of the origin of the stone the taking of samples is recommended from other ancient quarries that are still or have been so in that part of Croatia and by carrying out analyses on more samples.

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[21] Marinković, Miliša 2015.

[22] Tomašić *et al*. 2009.

[23] Tomašić *et al.* 2009.

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ON THE PROVENANCE, USE AND DISTRIBUTION OF GRANITO VERDE A ERBETTA. NEW INVESTIGATIONS ON ITS OCCURRENCE AND PETROGRAPHIC AND GEOCHEMICAL PROPERTIES

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Abstract

The Romans used a variety of stones to decorate the walls and floors of private and public buildings. The remains of incrustation made from nearly 50 rock types originating from regional and Mediterranean quarries were detected in Roman Colonia Ulpia Traiana (Xanten) and Augusta Treverorum (Trier). One of the stones, especially common in Trier, but also in other Roman sites in Belgium and northern France, is a green diabase with yellow to greenish speckles. A rock with similar macroscopic features also occurs in more distant Roman sites such as Italy and Spain. It was named granito verde a erbetta by modern Italian stonemasons and vaguely attributed to the sources in Wadi Umm Wikala in the Eastern Desert of Egypt where rock varieties remotely resembling it were quarried in Roman times. However, macroscopically similar rocks also outcrop near Trier.

To clarify the origin of this Roman green ornamental stone, a number of archaeological samples from Germany, Belgium, France, and Spain were analysed with petrographic and geochemical methods and compared with geological specimens from various diabase sources around Trier (Germany) and from Wadi Umm Wikala (Egypt). Macroscopic, petrographic and geochemical features of all the studied archaeological samples correspond very well to reference samples from deposits close to Hinzenburg and Pluwig in the Ruwer valley in the immediate vicinity of Trier, and show no similarity with the samples from supposed quarries Wadi Umm Wikala in Egypt.

Keywords: Granito verde a erbetta, provenance, petrography and geochemistry.

Introduction

One of the most frequently used decorative rocks in the north-western Roman provinces is a dark green diabase with yellow to white-greenish, tiny, mostly needle-shaped plagioclase phenocrysts. Up to now, little was known about the origin of this rock. Fragments discovered in the ruins of Roman buildings in *Gallia Belgica* and in *Germania inferior* were described in the literature as Trierer Diabas or Grünstein[1]. Rocks with the same macroscopic features, discovered in Rome or other Roman sites were called granito verde a erbetta (translated: grass green granite) by modern Roman stone masons. Presumably based on its similarity with two Egyptian *marmora* (granito verde della sedia di San Lorenzo and granito verde della sedia di San Pietro) this rock was attributed to the Egyptian deposits of Wadi Umm Wikala in the Eastern Desert[2]. However, in the literature on the quarries in Wadi Umm Wikala, no extraction of granito verde a erbetta is mentioned[3]; indeed, the opposite is stated: 'No one has yet reported seeing quarries for any of these stones'[4]. To date, no other deposits

[1] Grebe 1874-1877, 77; Grebe 1914-15; Stoetzel/Fischer, 1994, 5-14, no. 10. Locations Grüneberg and Hockweiler were considered as possible Roman diabase sources.
[2] Gnoli 1971, 134; M. C. Marchei in: Borghini 2004, 228.
[3] Brown, Harrell 1995; Sidebotham *et al*. 2001; Klemm, Klemm 1993, 408–411. Nr. 23 in the catalogue of J. Harrell: http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/Quarries/Hardst_Quar.html.
[4] Brown, Harrell 1995, 231.

in Egypt in which diabase (dolerite) with the same macroscopic features as the so called granito verde a erbetta are known. Other diabases are described in Rod el-Gamra near Gebel Urf Hamam (dolerite porphyry, Nr. 31)[5] and southeast from Aswan (grey-green dolerite), which were used as stone tools (rock hammers) due to their extreme hardness[6]. However, their macroscopic features clearly deviate from granito verde a erbetta and can therefore be excluded as potential raw material.

The fact that granito verde a erbetta was rarely used in Rome (see chapter use and distribution in this paper) and the Mediterranean provinces, but very often in *Gallia Belgica*, and here noticeably often in the area of Trier[7], has led the authors to assume that the rock may not originate from any Egyptian quarries, but from *Gallia Belgica*.

Occurrences of diabase, some of them remotely similar to granito verde a erbetta[8], exist also in Spain (Pyrenees, Iberian Range, Catalan Coastal Ranges and Beltic Cordillera[9]). However, up to now, there is no evidence from Roman archaeological sites in these regions that these stones were used for decorative purposes. Furthermore, it can be expected that if a stone (for whatever purpose) is extracted from a certain origin, it should be found especially frequently close to its origin. The fact that the granito verde a erbetta was one of the most widely-used decorative stones in Trier, corresponds to the assumption of a local origin.

Sampling and analytical methods

In order to verify the hypothesis of an origin of granito verde a erbetta within *Gallia Belgica*, the first field surveys were carried out in 2013 and reference geological samples were collected, followed by further field visits and sampling in 2017 and 2018. In the region around Trier numerous outcrops occur with various macroscopic varieties of green diabase. Eight of them (Kürenz 1, Kürenz 2 (Grüneberg), Pluwig, Hockweiler, Saarburg, Sterres, Serrig und Hinzenburg) were studied by the authors in order to collect geological data for comparative analyses and to search for traces of Roman quarrying activity.

In the region around Trier, 51 samples from different diabase sources and ten archaeological samples were collected for the petrographic and geochemical characterization[10]. The studied archaeological objects are incrustations from Trier (No. Tr 312) and Xanten (Nos. CUT 1765, CUT 1782 and CUT 2392), both in Germany, Tongeren, Belgien (no. Tongr), Andilly-en-Bassigny, France (Nos. AeB1 and AeB2; Fig. 1a-h) and Carranque, Spain. Unfortunately, for this study no comparative samples could be obtained from Rome, where incrustations from granito verde a erbetta are also known (see chapter use and distribution in this paper). Two samples were taken from blocks with sawing traces, both found in Trier (Nos. Tr1 and Tr2[11], Fig. 1j-k), and one sample from the so-called Ruwer-

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[5] Nr. 31 in the catalogue of J. Harrell: http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/Quarries/ Hardst _Quar.html.

[6] Klemm, Klemm 1993, 421 f.; 451 pl. 13.6.

[7] Ruppienė, Prochaska 2018; Ruppienė 2021.

[8] Many thanks to Pilar Lapuente for sharing photos with diabases (associated with Keuper Facies) from Huesca province.

[9] Lago *et al*. 1999; Lago *et al*. 2000. We are told by Pilar Lapuente that diabases associated to Keuper facies exist also in a number of Spanish outcrops such as Aulet (Sopeira, Huesca province), Estopiñan, Camporells (also in the provinces of Huesca and Lérida, but also in the provinces of Cantabria and Navarra among others. A geochemical comparison with the published data show that the artefact samples do not correspond to the rocks published there. However not only tholeiitic diabases but also alkaline ones exist in the Iberian Range (Lago San José *et al*. 2000).

[10] Petrographic analyses were performed on all ten archaeological samples. Due to the small size of the specimen from the Villa Carranque unfortunately no geochemical analyses could be carried out on this sample. It was only studied petrographically. However, due to the importance of ensuring the provenance source of the Spanish sample, geochemical analyses will be carried out in the near future.

[11] Tr1 (RLM-Trier, EV 1956,51 FNo. 445; Inv. 76.25); Tr2 (RLM-Trier, Palett 133).

aqueduct (Fig. 1i). For comparative purposes, James Harrell provided two quarry samples from Wadi Umm Wikala: One sample is the so called granito verde della sedia di San Lorenzo, the second is granito verde della sedia di San Pietro (Fig. 2a-b). Macroscopically, these stones look quite different from the archaeological samples examined (especially the coarser variety di San Pietro), but they served us as comparative samples anyway, since the deposits from which they come were considered in the past as a possible origin of granito verde a erbetta. Egyptian diabases from Rod el-Gamra near Gebel Urf Hamam[12] and from Aswan[13] were not included into this study, because they differ macroscopically significantly from the archaeological samples (dolerite porphyry: nearly black colour, larger – up to 15mm – phenocrysts; dolerite from Aswan: less pronounced ophitic texture).

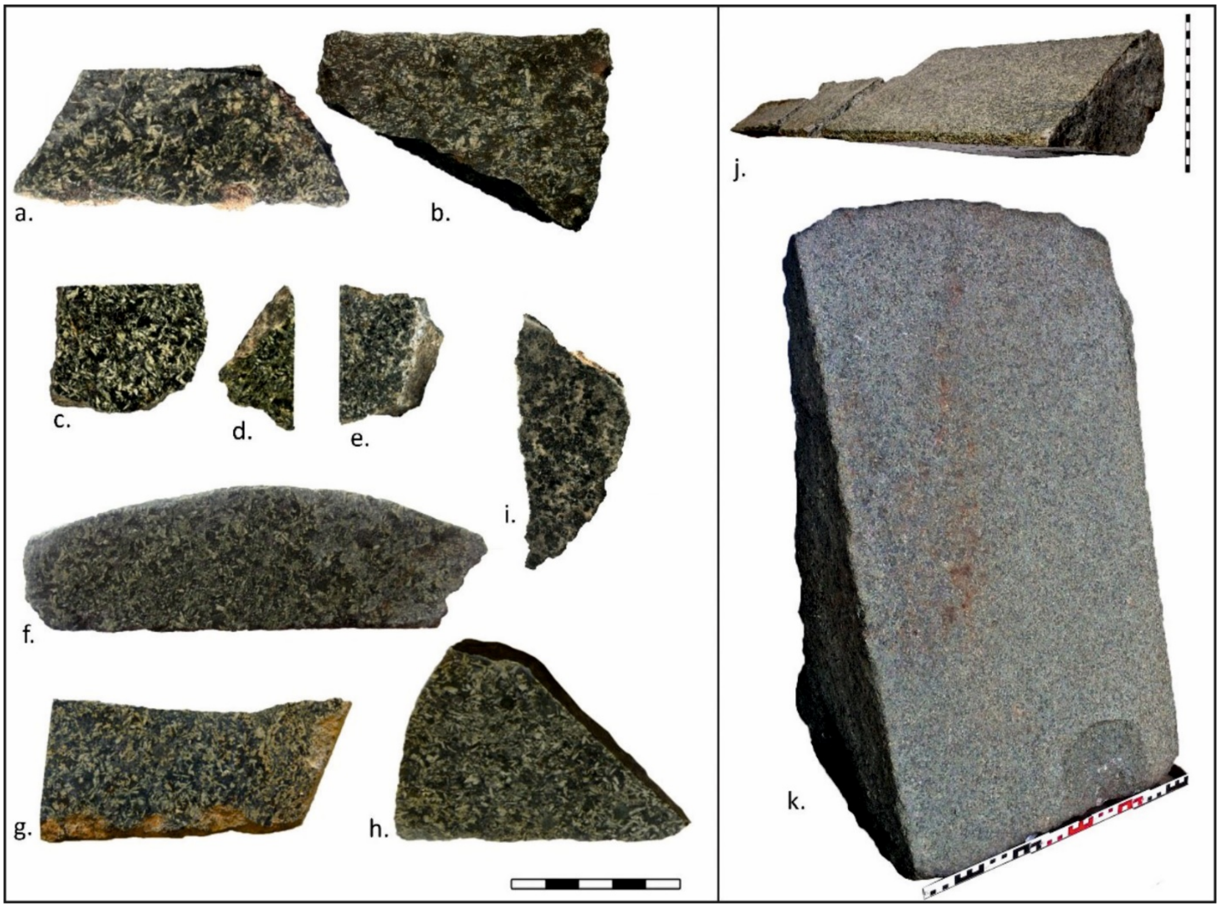

Figure 1: Analysed archaeological samples. Incrustations: **a**. Trier; **b**. Andilly-en-Bassigny; **c-e**. Xanten; **f**. Carranque; **g**. Tongeren; **h**. sample of a block with sawing traces, Trier (Nr. Tr1); **i**. sample from aqueduct; **j-k**. Diabase blocks with sawing traces (Photo: V. Ruppienė, Figs. 1a-i. k; Th. Zühmer, Fig.1).

Archaeological and geological samples were analysed petrographically by polarizing microscopy, in unclear cases phase determination was supported by Raman spectrometry. The major element compositions were analysed by wavelength-dispersive X-ray fluorescence spectrometry (XRF), the trace elements by laser-ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS).

[12] Nr. 31: http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/Quarries/Hardst_Quar.html.
[13] Klemm, Klemm 1993, 421 f.; 451, pl. 13.6.

Figure 2: Geological samples from Wadi Umm Wikala in Egypt. **a**. Granito verde della sedia di San Lorenzo; **b**. granito verde della sedia di San Pietro, (Photo: V. Ruppienė).

Geological background

Geologically, Granito verde a erbetta is a low metamorphic volcanic rock of basaltic composition, where low grade metamorphism led to the typical green colour, caused by the mineral chlorite. Traditionally, these rocks are referred to as "Diabas" in German-speaking Europe, which is in conflict with the International Union of Geological Sciences (IUGS)-recommendation, which defines "diabase" as synonymous for "dolerite" or "microgabbro"[14]. Since these rocks are generally mapped as "Diabas" in German geological maps, in the following the present study will continue using the traditional name and refer to Granito verde a erbetta as "diabase" instead of using the correct definition "metabasalt".

The diabase-occurrences in the region of Trier originally were Devonian submarine volcanic flows in the Rhenohercynic Ocean, which were affected by diagenesis and low-grade metamorphism during the Vasiscan Orogeny. Today, they are present as intercalated bodies in the Lower Devonian slates of the Rhenish Massif, with dimensions from a few metres to several 10s of metres.

Quarries

Geological samples for comparative analyses were taken from the following locations: Kürenz 1, Kürenz 2 (Grüneberg), Hockweiler, Pluwig, Hinzenburg, Saarburg, Serrig and Sterres (Fig. 3). Some of the sampled occurrences are small outcrops (Saarburg, Kürenz 1), some are abandoned, medium to large quarries with traces of modern exploitation (Hockweiler, Kürenz 2, Serrig, Pluwig and Hinzenburg). The 'Sterres'-diabase is an active quarry. Due to overprinting by younger quarrying activity, no Roman quarrying traces could be observed at any of sampled locations. Diabase occurrences Kürenz 2 (Grüneberg), Hockweiler, Pluwig, Hinzenburg, and Sterres provide a raw material which is suitable to be extracted as blocks, which are large enough to be processed to tiles in rock saws.

The diabase varieties macro- and microscopically most similar to Roman incrustations were found in Hinzenburg and Pluwig, whereas the specimen from all other occurrences clearly differ macro- and microscopically from the archaeological samples.

The deposits of Hinzenburg extend on both sides of the river Ruwer. On the right is a large modern quarry (Fig. 4a), where material was extracted for the construction of the Hochwaldbahn (railway line). The intensive mining activity overprinted any traces of older quarrying. Nowadays, the size of the quarry is about 60 x 50 m. The height of the northern quarry wall is about 30 m. The numerous blocks of stone that can be found in the quarry obviously are remnants of modern mining.

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[14] Le Maitre *et al.* 1989, 60.

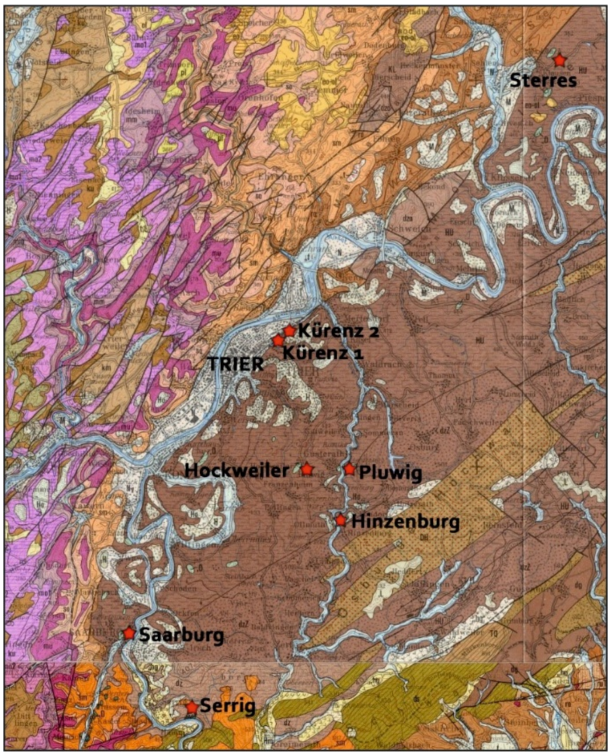

Figure 3: Geological map of the area with sampled locations (Image: GÜK200 © BGR, Hannover, 2016).

Directly on the opposite side of the Ruwer river, another much smaller, also probably modern quarry is situated (Fig. 4b). South from this small quarry, debris of slate and diabase can be observed, filling artificial pits. Shallow depressions reach upslope to the plateau edge, probably representing the negative shapes of the extracted diabase (Fig. 4d). On its northern side, one of the depressions is bordered by a towering slate cliff (Fig. 4c), probably marking the border of the former diabase extraction. The intensive quarrying reversed the relief: Where diabase used to outcrop as a hard rock in the soft slate, the depressions are now filled with extraction waste.

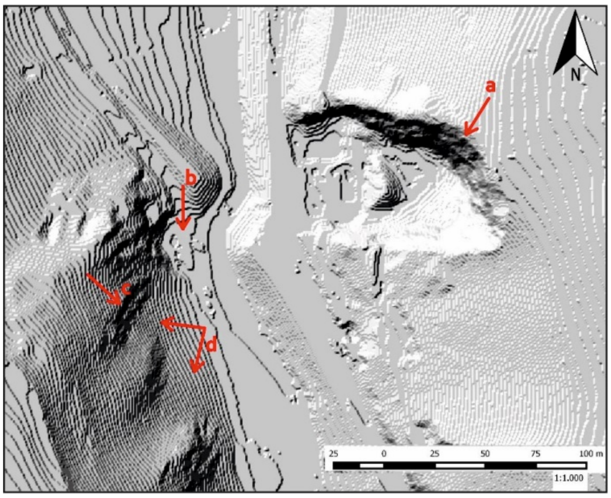

Figure 4: LIDAR scan. Diabase quarries near Hinzenburg. The large modern quarry (a), the smaller modern quarry (b) and the depressions in the slope filled with slate and diabase debris (d) bordered by slate cliff (c) (Photo: ©GeoBasis-DE / LVermGeoRP <01.12.2019 [edited data]>).

The less common type of diabase, marked by whitish-to-greenish speckles, also used for incrustations, originates from the deposits at Pluwig. Here, comparable to the Hinzenburg deposits, a large modern quarry area is situated on the left side of the Ruwer river (Fig. 3). No ancient quarrying traces could be observed. The variety, which is petrographically most similar to the archaeological samples, comes from an area right beside the road that runs directly along the Ruwer.

The diabase used for the construction of the Ruwer aqueduct was most likely extracted from the deposits on the Grüneberg (occurrence Kürenz 2, Fig. 3). Reference samples were collected in the small modern quarry. These occurrences, too, have been used in modern times, probably for the extraction of railway ballast.

Macroscopic features

The studied archaeological samples can be subdivided into three macroscopic varieties: Type 1 (Fig. 1a–d. f-h. j-k) shows an ophitic texture with light green to yellowish feldspars embedded in a dark green matrix. Most of the feldspars are tiny and needle-shaped, and distributed in the matrix without any preferred orientation. This type comprises most of the studied archaeological samples and corresponds to the diabase from Hinzenburg. Type 2 is represented by only one sample from Xanten (CUT 2392, Fig. 1e) and some additional samples from Trier, which are not included in this study. It has a less pronounced ophitic texture with whitish to greenish speckles of plagioclase (instead of laths/needles) in the dark green-grey matrix and shows the best optical compatibility with some samples from Pluwig. Type 3 is the sample of the aqueduct of dark green, almost black colour, with evenly distributed brownish plagioclase (Fig. 1i).

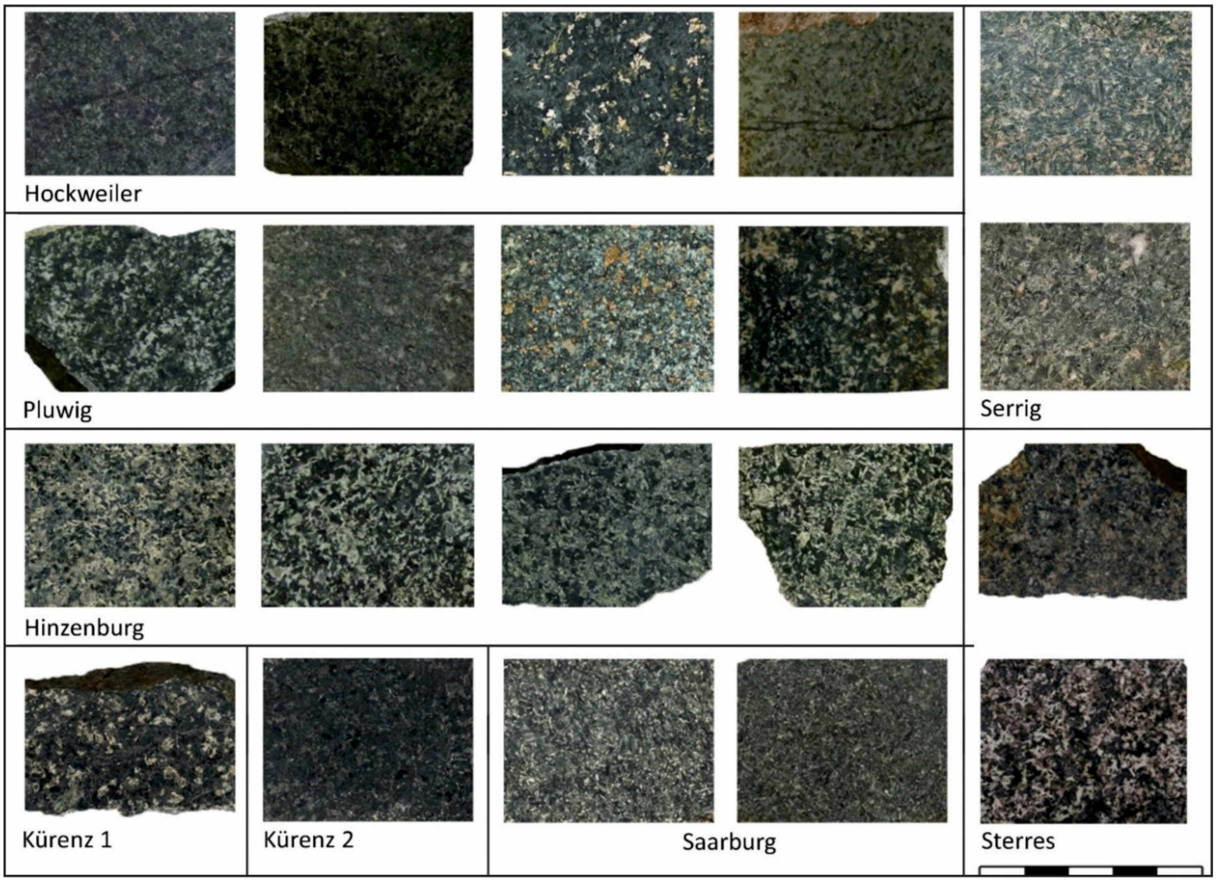

Figure 5: Diabase specimens from various occurrences in the Trier region. (Photo: V. Ruppienė).

Geological samples from the various deposits show variable macroscopic features. Specimens from Hockweiler are either of an almost uniform dark to light green colour, or have phenocrysts of whitish to yellowish colour. The diabase from Hinzenburg has an ophitic texture with light green needle-shaped feldspar included in the dark green matrix (similar to archaeological samples of Type 1). Some geological samples from Pluwig have a light green colour with white feldspar phenocrysts, whereas others are of dark green colour with whitish to light green speckles of plagioclase (similar to archaeological samples of the Type 2). Samples from Kürenz 1 and 2 are of a quite uniform dark grey-green colour with no or few dark brown-green plagioclase phenocrysts (similar to the Type 3, aqueduct sample). Samples from Saarburg have a similar colour and texture as the archaeological samples, but the phenocrysts of feldspar in geological samples are finer. Specimens from Sterres display a noticeable darker matrix, very dark green or almost black, with feldspar of white or light green colour. Samples from Serrig are of dark green colour with green and brownish phenocrysts (Fig. 5).

Analytical results

Petrographic characteristics

Under the microscope, the studied Roman incrustations fragments show the closest match with the diabases from the Hinzenburg and Pluwig deposits, the diabase blocks with sawing marks with diabases from Hinzenburg, while the Ruwer aqueduct sample was most likely quarried in Kürenz 2 (Grüneberg). None of the archaeological samples corresponds petrographically to the Egyptian specimens.

Characteristic for the Hinzenburg diabase-type and for most-investigated incrustation samples (except CUT 2392) is a green matrix with numerous filigree lath-shaped plagioclases. The matrix consists of heavily altered amphiboles (actinolite), chlorite, opaque inclusions and leukoxene. Quartz and calcite are also present in variable proportions, as well as apatite of mostly prismatic shape. The characteristic green colour of the rock is caused by the alteration product chlorite. Chlorite is most commonly found together with actinolite. Plagioclase (of albitic composition) is mostly lath-shaped and heavily altered due to the low-grade metamorphism. The alteration product of plagioclase is epidote, responsible for the greenish colour of the mineral. Occasionally, polysynthetic twinning is observed in the less altered plagioclases. Actinolite is frequent, probably the product of hydrothermal alteration of pyroxene. Some of the actinolite crystals are quite intact and hypidiomorphic in shape (up 6–7 mm), whereas others are strongly altered to a mixture of chlorite and fibrous actinolite. Large leucoxenes, up to several millimetres are characteristic, mainly composed of titanite, indicating an original ilmenitic composition (Figs. 6a-b; 7a–d). Samples of Pluwig and archaeological sample CUT 2392 show a similar composition to the samples from Hinzenburg, but deviate slightly in a different degree of alteration and quantitative distribution of minerals. The matrix consists mainly of chlorite, calcite, apatite, quartz and small epidote and contains phenocrysts of plagioclase. The plagioclase is almost completely replaced by epidote, sometimes an albitic rim is preserved. In contrast to the Hinzenburg samples (Type 1), where actinolite is present in shape of large crystals, in Type 2 it is preserved only as tiny needles distributed within abundant chlorite. Calcite and quartz are more frequent than in the Type 1. Accessory minerals are apatite (crystal-laths >1 mm length are frequent), ore minerals (occasionally idiomorphic) and leucoxene dominated by titanite[15] (Fig. 6c-d).

The aqueduct sample also consists of heavily altered feldspars (epidotized) and mafic minerals. Actinolite, pleochroitic brown hornblende (<5%) and strongly altered clinopyroxenes can be observed. Clinopyroxenes are occasionally marginally altered into fibrous actinolite. The sample also contains minerals (orthopyroxene? olivine?) which are nearly completely or completely altered to chlorite (of anomalous blue and violet colour). Additionally, apatite, calcite, leucoxene and opaque minerals are present.

[15] For the petrography of diabase from Hinzenburg and Pluwig see also: Ruppienė, Gluhak 2018, 55-57, fig. 3-4.

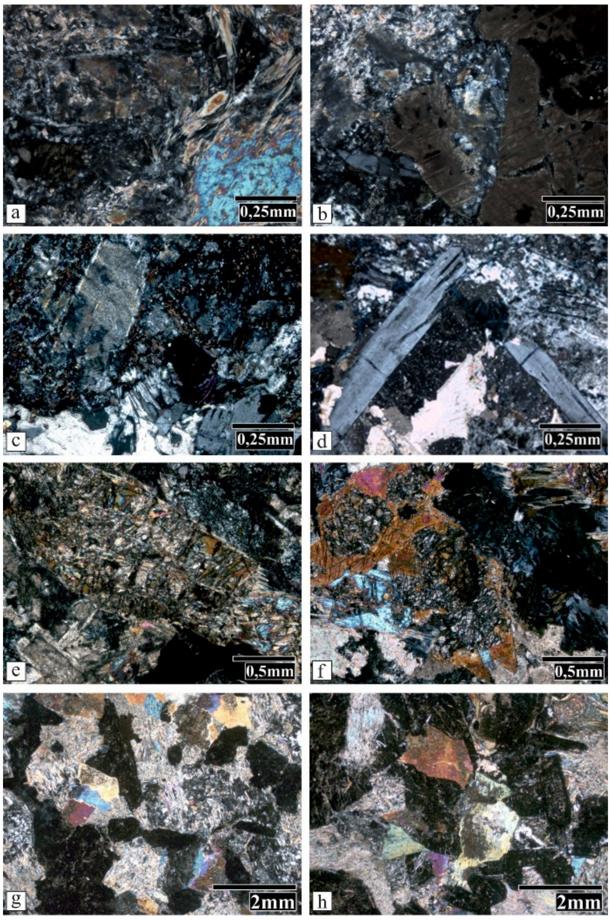

Figure 6: Photomicrographs. **a-b**. diabase samples from Hinzenburg: **a**. altered plagioclase and actinolite; **b**. brown leucoxene, altered plagioclase and apatite. **c-d**. diabase samples from Pluwig: **c**. altered plagioclase in the matrix with anomalous coloured chlorite, opaque inclusions and calcite; **d**. brown leucoxene, apatite, calcite, chlorite and decomposed plagioclase. **e-f**. diabase sample from Kürenz 2: **e**: strongly altered clinopyroxene, actinolite and plagioclase, opaque inclusions, no longer identifiable mineral completely decomposed to chlorite; **f**. diabase sample from aqueduct, strongly altered clinopyroxene, actinolite and plagioclase, opaque inclusions, calcite, no longer identifiable mineral completely decomposed to chlorite; **g-h**. samples from Wadi Umm Wikala: **g**. granito verde della sedia di San Lorenzo strongly altered plagioclase and amphibole; secondary quartz; **h**. granite verde della sedia di San Pietro. All pictures in cross polarized light (Photos: V. Ruppienė).

Similar characteristics were also observed in the samples from the occurrence Kürenz 2 (Grüneberg). Other than the archaeological sample, the geological specimens show a slightly higher proportion of clinopyroxene and a lower proportion of actinolite (Fig. 6e-f). Despite this deviation, the sample from the aqueduct presumably originates from this occurrence, especially as diabase appears for the first time as building material in the aqueduct when it runs past the Kürenz 2 occurrence.

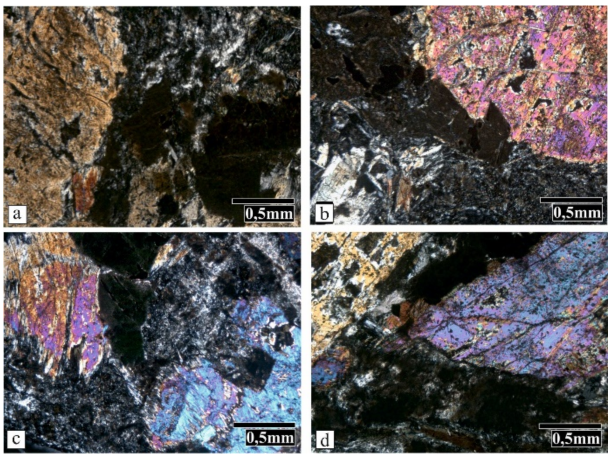

Figure 7: Photomicrographs. Archaeological samples: **a**. Xanten = CUT 1765; **b**. Trier = Tr2; **c**. Villa Carranque; **d**. Andilly en Bassigny. Characteristic of all samples are strongly altered plagioclases (epidotized), actinolite and chlorite, associated with brown leucoxene. These features were observed also in diabases from Hinzenburg (Fig. 6a-b). All pictures in cross polarized light (Photos: V. Ruppienė).

The provenance of archaeological samples from the Egyptian quarries (Wadi Umm Wikala) can be excluded due to petrographic characteristics. Both types, granito verde della sedia di San Lorenzo (fine grained) and di San Pietro (medium to coarse grained), are metagabbros. They both consist mainly of heavily altered amphibole and plagioclase. In the

San Lorenzo variety the alteration products of plagioclase are chlorite and sericite. Amphibole is strongly to extremely altered to chlorite. Three different types of chlorite were observed: one with grey, one with anomalous blue and one with brown interference colour. Secondary quartz and epidote (mainly alteration product of amphibole) are also present. The San Pietro variety is also a pervasively altered metagabbro. Unlikely the fine-grained type, the San Pietro variety contains a considerable amount of epidote (frequently in idiomorphic shape), which is both the alteration product of plagioclase and amphibole[16] (Fig. 6g-h).

Whole rock geochemistry

The results of the geochemical analyses of both geological and archaeological samples are presented in Tab. 1.

Already the major element composition of the artefact samples clearly excludes their provenance from Wadi Umm Wikala in Egypt (see Fig. 8a-c). Instead, they plot within the geochemical compositions of the Ruwer diabases. The origin from the Ruwer diabases is further confirmed by the comparison of the trace element composition (Fig. 8d). However, while the diabases from Kürenz1 and 2, Sterres and Serrig can be excluded as possible sources based on their major element compositions, so far only archaeological sample CUT 2392 is possibly produced from the Pluwig diabase (see MgO-Al_2O_3 and MgO-CaO in Figs. 8b. c). All other archaeological samples lie in the same geochemical ranges as the diabases of Pluwig, Hockweiler, Saarburg, and Hinzenburg. As the geochemical data cannot be used to differentiate between the latter occurrences, the petrographic analyses above provide the decisive criteria.

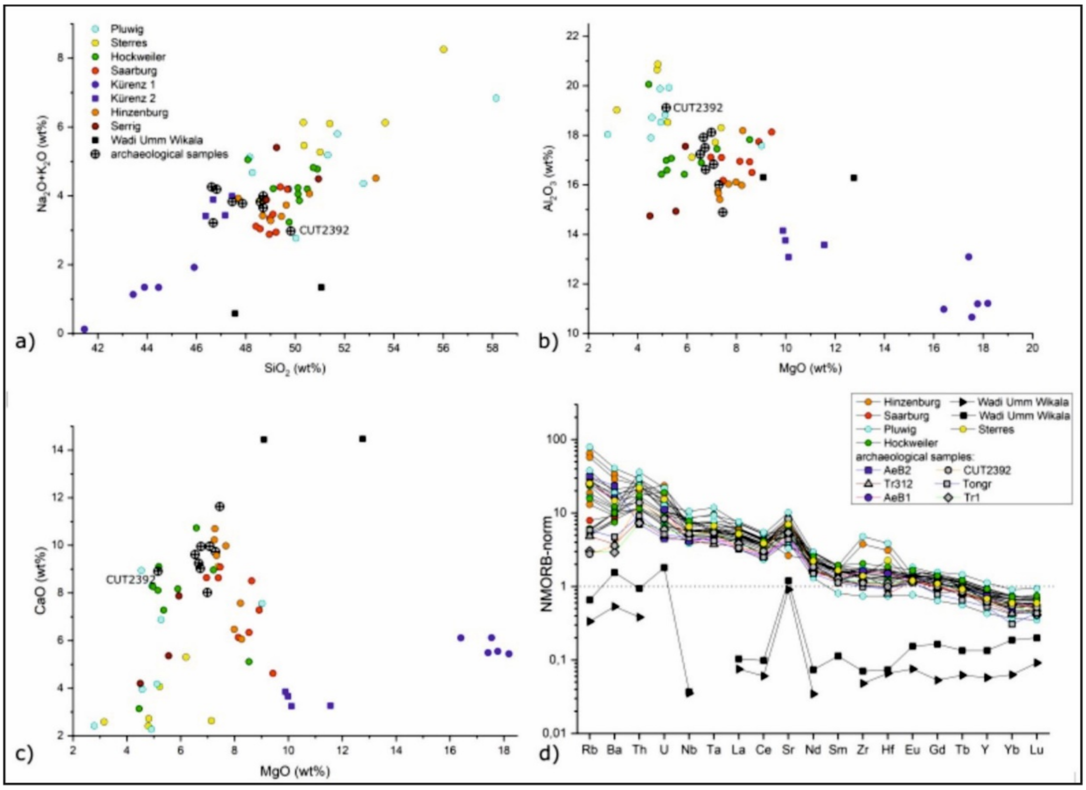

Figure 8: **a-c**. Major element compositions of the archaeological samples in comparison to the geological samples; **d**. trace element composition of selected archaeological samples in comparison to the geological samples. MORB (middle ocean ridge basalt)-data from Sun/Mcdonough 1989).

[16] For petrography see also: Klemm, Klemm 2008, 292–293; Brown, Harrell 1995, 227, tab. 2.

Use and distribution

The diabase from Trier (granito verde a erbetta) is one of the most frequently-used rocks in the province *Gallia Belgica* and the neighbouring provinces and was predominantly used for wall and floor incrustations. Numerous fragments were found in the area of the so-called Konstantinbasilika (the former audience hall in the late imperial palace) and at many other places in Trier and its surroundings, in various buildings in Xanten and Cologne, in villas near Froitzheim and Jüchen (Germany), Echternach (Luxembourg), Andilly-en-Bassigny (France) and in Merbres-Le-Château (Belgium), in a private house in Arlon (Belgium), in various places in Tongeren (Belgium), in the Forum of Autun, in the sanctuary of Imphy, in Besançon and Rheims (France)[17]. Even if the geochemical fingerprint could not be provided in this study[18], it is very likely that the incrustations from the late-antique luxury villa in Carranque (Spain)[19] are also made of diabase from Trier, as suggested by the excellent macroscopic petrographic correspondence[20]. The great macroscopic compatibility with the Trier diabase indicates that this rock was also used for incrustations in Rome: One fragment from Basilica Argentaria (Forum of Caesar) is preserved in the collection J. Röder in the Römisch-Germanisches Museum in Cologne, three further fragments come from the area of the Forum of Augustus in Rome[21]. A rectangular plate of this material can be seen in the floor in San Giovanni in Laterano in Rome. The presence of the diabase in several 19th-century rock collections[22], with objects originating mostly from the ruins of the city of Rome, attests its use also in other ancient buildings of Rome. Inspired by the striking green colour of the rock and the filigree strip-shaped inclusions, the modern Italian stonemasons called this stone granito verde a erbetta (grass green granite).

In addition to incrustations, diabase was used to produce inscription plates. Preserved are also a column drum (about 40 cm in diameter), a relief fragment, a cornice, a pilaster base, fragmented mortar[23] (Fig. 9) and several ointment palettes (Liersberg, Nida-Heddernheim and Tongeren)[24].

A less attractive variety of this rock (grey-green coloured) was used by the Romans as undressed building material for the construction of e. g. the Ruwer aqueduct or for metalling an earlier road system inside the town of Trier.

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[17] Trier, Konstantinbasilika: Ruppiene, Prochaska 2018. – Trier, Barbara baths: Dodt 2014, 64 fig. 17c; 66. – Trier-Euren, development area Hontheimstraße, EV 1989,9, FNo. 4. – Roman villa "Ob dem Lieserpfad", Wehlen, Bernkastel-Wittlich, Collection Schäffer; EV 1986,20. – Xanten: Ruppienė 2015, 179-180 tab. 77, fig. 116. – Villa Colone: Fischer 1994, 103. – Villa Jüchen: Fischer 1994, 96. – Villa Froitzheim: Fischer 1994, 97. – Echternach: Bintz *et al.* 1981, 146 fig. 135,2; 152. – Andilly-en-Bassigny: Ruppienė, Gluhak 2018b. – Villa in Merbres-Le-Château: Dumont *et al.* 2018, 262 f. fig. 1. – Villa Arlon: Henrotay 2015, 164 f. Abb. 3. – Tongeren: Dreesen *et al.* 2015, 109 fig. 3,12; 115; Vanderoeven 2018. – Autun, Imphy, Besançon and Reims: Brunet-Gaston 2015, 942 f. fig. 3.

[18] The size of the sample was too small for geochemical investigation.

[19] Villa Carranque: García-Entero, Álvarez 2012, 142 f. fig. 5,7; García-Entero *et al*. 2021.

[20] The origin of diabase from the sources in Pyrenaean region and in other places in the Iberian Range (which, regarding the distance, are a little closer to the archaeological site Carranque) is even more doubtful: Firstly although diabases are very common igneous rocks in the Iberian Peninsula, no local diabases used in ancient artifacts have been found to date, except in Neolithic utensils (P. Lapuente personal communication) and secondly, the quite small number of granito verde a erbetta fragments found in the Villa Carranque rather indicate that they – as many other incrustations made of various Mediterranean stone types – were imported from abroad.

[21] Bianchi, Bruno 2010, 61, tab. 7.

[22] Corsi Collection (Nr. 828: http://www.oum.ox.ac.uk/corsi/stones/view/828). – Coll. Alceo Feliciani (Mielsch 1985, 70 No. 810 Pl. 24). – Coll. Gismondi (Evangelista, Lazzarini 1998, 413 No. 124. – Coll. De Ravenstein in Cinquantenaire Museum, Brüssel.

[23] Inscription plate: Gose 1961, 468 f. fig. 75. – Column: not published. – Relief: Inv. 1970,543, RLM-Trier. – Pilaster base: PM 5149, RLM Trier. – Cornice: Inv. 1976,20, RLM–Trier. – Mortar: EV 1999,100, RLM Trier.

[24] Liersberg: Trierer Zeitschrift 2012/13, 352 fig. 51g. – Nida-Heddernheim: Kohlert, Németh 1990, 83-84. – Tongeren: Reniere *et al*. 2018, 290-291, tab. 1. 293 fig. 2,7.

Figure 9: Archaeological artefacts from diabase (granito verde a erbetta). **a**. Mortar, EV 1999,100, RLM Trier; **b**. Pilaster base, PM 5149, RLM Trier; **c**. Inscription plate, Inv. 51,8, RLM Trier. (Photo: Th. Zühmer).

The fact that the diabase from Trier was not only locally and regionally used, but also traded in more distant provinces, testifies to a certain value of this stone in Roman antiquity. An interesting find confirms this assumption: In Trier some wall painting fragments of an extraordinary high quality were found (find context unknown), imitating the diabase (Fig. 10). As a rule, Roman wall paintings imitated *marmora* such as giallo antico, porfido verde antico, rosso antico, porfido rosso or pavonazzetto, some of the most valuable and sought-after decorative stones. Most probably the diabase had, due to its attractive colour and excellent physical properties, a reputation similar to the popular decorative stones from Mediterranean quarries, and was by no means regarded only as their cheap replacement. Albeit with much more filigree inclusions, the diabase bears a certain resemblance to the precious porfido verde antico, which, according to Diocletian's edict of maximum prices, was one of the most expensive *marmora* of antiquity (250 denars)[25]. Without a scale for comparison, these two stone varieties show an excellent match in the colour of the matrix (dark green) as well as in the colour and shape of the plagioclase phenocrysts and can thus be easily mistaken for each other by layman (Fig. 11).

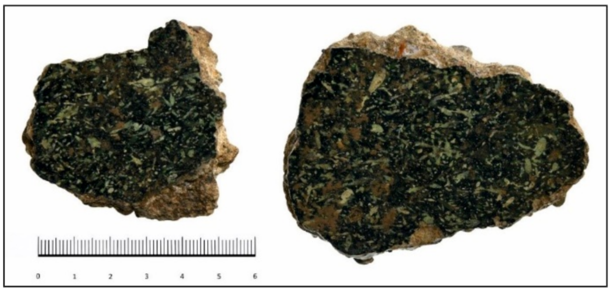

Figure 10: Fragments of Roman wall painting from Trier imitating diabase, EV 2018, 112, (Photo: Th. Zühmer).

Another example from Trier demonstrates the special value of the diabase even in the post-Roman period. The cathedral treasury in Trier owns a portable altar of Saint Willibrord with a central decorative plate of diabase[26] (dated in the 8th century and in the description falsely referred to as a green porphyry). In general, only the most valuable stones were used for the decoration of the altars[27] (e.g. green and red porphyry).

[25] Lauffer 1971.
[26] Staal 2001, 162-164 Fig. 193.
[27] Ermischer 2012, 79-80.

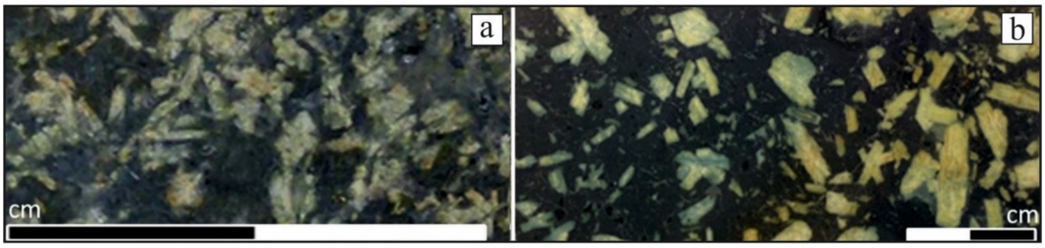

Figure 11: **a**. diabase from Trier; **b**. porfido verde antico (Photo: V. Ruppienė).

In fact, long before the Roman era, the Trier diabase was extensively exploited for practical purposes. The earliest artefact, a polished adze blade, so far unique in its kind, dates back to the Early Neolithic. Quite regularly diabase was used locally for the production of quernstones during the Bandkeramik Early Neolithic (ca. 5200 – 4800 BC). On the undressed surfaces of the quernstones the cleavages are still preserved, which shows that they were produced from rocks directly quarried from the outcrops and not from rocks transported by the rivers. The location of the outcrops close to the right bank of the Moselle (Fig. 3) suggests that the diabase quernstones were distributed via the Saar and Moselle rivers. They were most probably used until the Late Bronze age (ca. 900 BC). A unique item is a Late Bronze Age casting mould for sickle blades, for which diabase was selected as it would not burst when exposed to heat, as other rocks may do.

Diabase was by far most frequently used during the Younger Neolithic to the Bronze Age (ca. 4800 – 2000 BC): Many hundreds of polished small and big axe blades[28] along with a few perforated axes were spread as far as about 120 kilometres around the outcrops, particularly towards the south and southwest[29]. It can be assumed that beyond that distance, as well as to the north and east, more specimens occur. However, a study on the distribution and provenance of these artefacts is missing so far. Nevertheless, "diabase" stone axes are mentioned here and there throughout central Europe and it remains open to debate whether they represent products of the Trier area outcrops or of possible occurrences east of the Rhine[30] or further north[31] even from glacial drift[32]. However, a precise petrographic assignment of these Stone Age artefacts to the individual outcrops was beyond the scope of this study. The assumption that they were produced from the diabase occurrences presented here is based on the study of Schmidt[33], the only one so far.

Nevertheless, the lithological characterisation of the Roman decorative stones and the identification of their quarries is doubtlessly a first and important step also towards fingerprinting, sourcing and mapping of diabase stone axe blades in the Trier area and beyond.

Conclusions

Petrographic and geochemical analyses have provided new information on the origin of the so-called granito verde a erbetta, a decorative material widely used in the Roman period. An Egyptian origin from Wadi Umm Wikala, as hypothesised in the past, could be clearly excluded due to significant differences in petrography and geochemistry. Instead, the authors' assumption about the origin of the diabase from the regional deposits in the Trier area was confirmed. The compatibility of geological and archaeological samples in their

[28] Dehn, Schmitt 1938; Boecking 1970; Stein 1971.
[29] Maisant 1971, fig. 5.
[30] Marschall *et al*. 1954; Kegler-Graiewski 2007.
[31] Knippels 1988.
[32] Schut 1991.
[33] Schmitt 1939.

macroscopic, petrographic and geochemical features suggests that the diabase-occurrences Hinzenburg and Pluwig were the sources of granito verde a erbetta.

Moreover, an important reference for a Roman use of rocks from the Ruwer-area is given by the ancient author Ausonius. He describes in his poem 'Mosella' (written about AD 370 in Trier) the beauty of the landscape along the river Mosel and mentions its tributary river Ruwer (Erubris)[34]. Elaborating on the Ruwer, Ausonius states that it is famous because of its marble and describes a shrieking noise caused by water-powered stone saws, driving through smooth blocks. Since only slate and diabase outcrop in the area, and as it makes no technical sense to cut slate with a stone saw, Ausonius most likely speaks of saws cutting the diabase. The Ruwer-diabase is in fact perfectly suited as ornamental stone because of its beautiful dark green colour. Both occurrences, Pluwig and Hinzenburg, provide material from which blocks can be extracted which are large enough to produce ornamental elements. Furthermore, the occurrences were well-accessible, the blocks could be easily extracted along the cracks or fissures in the rock, then directly sawn to tiles close to the quarries with stone saws driven by the water power of Ruwer, and finally transported to the Moselle and further to Trier or other destinations. No other rock in this region was used in more different forms than the diabase, had a greater popularity or wider distribution in antiquity. The physical characteristics (hardness, high density and polishability), but also its attractive dark green colour made it a popular stone for tools, architectural parts and decorative purposes.

Also the discovery of several blocks of granito verde a erbetta with sawing traces in Trier (Figs. 1j-k and 12) supports that it has its origin from local sources. So far, no blocks of imported ornamental stones, with or without sawing traces, were discovered in Trier or other Roman sites in Germany. It can be assumed that rocks for decorative purposes were imported (or, respectively, exported) not as large blocks, which would be heavy and hard to handle, but in a prefabricated state as tiles[35].

The result that this stone was most probably also used outside the regional borders corresponds to what we know about Roman stone trade. The investigations on the provenance of incrustation material from Trier show that in addition to the popular Mediterranean *marmora* (pavonazzetto, giallo antico, porfido verde antico, porfido rosso antico etc.) a number of stones in Trier were imported from distant quarries, which mainly provided their own immediate region with decorative stones. For example, incrustation fragments of porfido bigio (Mount Estérel, near Fréjus), further Pyrenean breccia di Lez and cipollino mandolato rosso / verde (the latter also in the shape of small columns) were found in Trier[36]. The Pyrenaean stones were transported over a distance of ca. 1300 km via land and river to Trier. Although none of these stones were a particularly sought-after commodity in Roman times, they obviously had enough value to be traded over great distances far beyond regional borders. Thus, the fact that the Trier diabase was traded probably even as far as Spain and Italy seems less surprising, especially as we are dealing with a *marmor* that was valued for its attractive colour and pattern, as well as for its excellent physical properties such as hardness and good polishability. Furthermore, based on the fact that this rock was increasingly mined and used in the 4th century, when Trier was established as the Imperial Residence, it can be assumed that the Trier diabase carried a special symbolic meaning, which contributed to its superregional distribution.

[34] D. Magnus Ausonius: Mosella, 359-364.
[35] Ruppienė 2018, 418-420.
[36] Ruppienė 2021, in press.

Figure 12: Block of diabase with parallel saw cuts from Trier, inv. 1976, 25; GDKE, Rheinisches Landesmuseum Trier, (Photo: Th. Zühmer).

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	SiO_2	Al_2O_3	Fe_2O_3 (total)	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	Sc	V	Co	Ni	Ga	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
geological samples																																							
Saarburg1	49,02	17,13	12,63	0,16	7,40	8,65	2,76	0,13	1,89	0,24	29,3	254	53,4	97,9	20,3	3,03	624	23,8	124	19,2	51,3	12,8	28,8	3,56	16,8	4,55	1,47	4,76	0,74	4,71	0,92	2,60	0,37	2,23	0,31	3,28	0,78	2,50	0,49
Saarburg2	49,15	17,13	12,38	0,17	6,97	8,65	3,38	0,08	1,86	0,23	32,6	275	56,8	91,3	22,4	3,20	721	22,0	98,0	13,2	64,1	12,6	28,0	3,68	15,7	4,23	1,39	4,91	0,75	4,38	0,89	2,38	0,34	2,03	0,30	2,78	0,71	1,37	0,32
Saarburg3	48,46	16,52	12,58	0,17	8,64	8,52	3,06	0,06	1,78	0,22																													
Saarburg4	49,38	16,23	12,57	0,17	7,49	9,12	2,91	0,04	1,85	0,24																													
Saarburg5	49,70	16,93	12,26	0,17	8,54	6,34	4,07	0,13	1,66	0,21	31,6	245	59,3	140	21,2	2,73	334	20,4	119	10,2	51,1	10,9	25,1	3,26	15,0	4,08	1,37	4,11	0,65	3,84	0,81	2,24	0,28	1,78	0,27	3,58	0,63	1,44	0,38
Saarburg6	49,40	16,95	12,95	0,17	8,14	6,13	4,14	0,11	1,77	0,23	26,3	218	56,5	137	19,6	4,43	522	18,1	106	10,4	58,3	10,5	23,6	3,08	13,1	3,25	1,22	3,61	0,51	3,01	0,70	1,75	0,24	1,43	0,22	2,00	0,67	1,37	0,34
Saarburg7	48,58	18,13	13,92	0,20	9,43	4,62	2,87	0,17	1,82	0,24																													
Saarburg8	48,98	17,74	11,99	0,16	8,91	7,28	3,17	0,18	1,42	0,18																													
Pluwig1	52,78	19,88	12,41	0,22	4,91	2,28	3,92	0,44	2,83	0,32																													
Pluwig2	48,17	17,58	10,50	0,41	9,03	7,56	4,57	0,55	1,46	0,17	45,0	395	64,0	140	28,6	44,4	527	26,6	142	24,7	257,5	18,2	39,2	4,96	21,2	5,07	1,86	5,47	0,83	4,93	0,96	2,78	0,38	2,29	0,32	3,90	1,56	3,51	0,59
Pluwig3	51,74	18,72	12,25	0,44	4,58	3,96	4,35	1,45	2,18	0,33																													
Pluwig4	51,40	18,85	12,17	0,50	5,12	4,18	2,70	2,49	2,28	0,30																													
Pluwig5	49,76	19,94	11,76	0,14	5,27	6,88	3,96	0,23	1,87	0,19	21,5	150	30,6	71,3	13,8	21,1	369	12,0	54,7	9,0	118,7	8,15	17,4	2,23	9,52	2,12	0,79	2,36	0,38	2,41	0,47	1,25	0,16	1,14	0,16	1,52	0,55	1,68	0,34
Pluwig1a	50,22	17,97	12,93	0,14	4,55	8,98	2,59	0,19	2,22	0,21	42,1	243	61,2	142	23,6	16,9	916	24,2	131	17,0	132,3	17,9	38,4	4,94	21,0	4,96	1,57	5,30	0,77	4,66	0,95	2,48	0,34	2,00	0,29	3,15	1,02	2,84	0,69
Pluwig2a	58,18	18,04	9,63	0,18	2,79	2,42	6,01	0,84	1,54	0,37																													
Pluwig3a	48,31	18,54	12,65	0,16	4,94	8,30	2,83	1,84	2,19	0,23	45,2	187	63,7	175	26,5	9,17	299	31,5	356	20,3	71,3	19,1	41,0	5,28	21,5	5,07	1,49	5,80	0,98	5,81	1,06	3,21	0,45	2,77	0,43	7,93	1,23	4,33	1,03
Hockweiler 1	51,07	17,88	10,50	0,23	8,57	5,13	3,37	1,43	1,62	0,21																													
Hockweiler 2	50,59	16,46	12,63	0,16	4,97	8,28	3,41	0,80	2,38	0,31	29,8	158	33,8	95,4	20,6	2,84	590	22,7	118	18,3	47,3	11,2	26,8	3,33	15,7	4,28	1,37	4,47	0,70	4,42	0,86	2,43	0,35	2,07	0,29	3,04	0,73	2,33	0,45
Hockweiler 3	49,82	20,35	14,30	0,14	4,52	3,19	0,79	3,48	3,15	0,27																													
Hockweiler 4	50,22	16,61	12,46	0,14	5,19	9,12	2,76	1,10	2,13	0,27	26,4	203	39,7	87,2	17,0	13,1	585	15,0	76,8	10,9	76,4	9,78	21,6	2,78	12,1	3,21	1,15	3,03	0,58	2,86	0,64	1,63	0,19	1,28	0,21	2,02	0,65	1,70	0,38
Hockweiler 5	50,33	17,05	12,63	0,14	5,18	8,14	2,85	1,23	2,20	0,25	43,0	313	77,0	183	27,0	3,43	422	25,9	152	13,0	63,0	13,6	31,2	4,07	18,8	5,13	1,70	5,15	0,81	4,82	1,01	2,80	0,39	2,22	0,34	3,82	0,80	1,79	0,46
Hockweiler1a	50,91	17,13	11,89	0,18	5,38	7,30	3,47	1,37	2,08	0,30																													
Hockweiler2a	50,12	16,42	12,33	0,17	5,89	8,17	3,96	0,27	2,38	0,27	29,0	231	37,6	89,2	17,8	8,78	447	17,6	112	11,7	61,3	12,2	26,4	3,43	14,0	3,28	1,17	4,41	0,56	3,42	0,61	1,84	0,28	1,58	0,21	2,81	0,64	2,09	0,90
Hockweiler3a	49,86	17,48	11,19	0,16	7,23	8,98	3,16	0,09	1,67	0,18	36,0	285	59,8	96,4	23,1	3,25	738	22,7	101	13,6	64,1	12,7	28,2	3,73	15,9	4,31	1,41	5,00	0,76	4,45	0,90	2,40	0,34	2,05	0,30	2,57	0,73	1,38	0,31
Hockweiler4a	48,20	16,94	10,54	0,16	6,59	10,76	2,82	2,24	1,55	0,19																													
K2a	47,17	13,58	15,10	0,18	11,56	6,82	3,27	0,17	1,93	0,23																													
K2b	46,69	13,77	14,09	0,20	9,99	9,02	3,66	0,24	2,10	0,26																													
K2c	46,37	13,08	16,33	0,22	10,11	7,38	3,24	0,17	2,75	0,34																													
K2d	47,44	14,15	14,78	0,20	9,89	6,94	3,85	0,14	2,31	0,29																													
K1a	43,44	11,21	18,45	0,21	18,19	5,44	1,04	0,10	1,68	0,24																													
K1b	41,46	13,10	19,21	0,57	17,42	5,50	0,10	0,02	2,29	0,33																													
K1c	43,89	11,20	18,02	0,21	17,78	5,54	1,23	0,12	1,75	0,26																													
K1d	45,91	10,98	16,31	0,21	16,41	6,11	1,81	0,12	1,88	0,26																													
K1e	44,47	10,65	17,51	0,22	17,55	6,12	1,23	0,11	1,86	0,27																													
Sterres1	53,65	20,65	9,76	0,29	4,79	2,41	5,90	0,22	2,06	0,26																													
Sterres2	48,63	18,30	11,02	0,15	7,38	9,11	3,47	0,38	1,40	0,15	30,5	192	43,2	103	18,4	14,1	634	19,2	103,4	15,2	93,8	13,0	29,1	3,81	16,2	4,35	1,23	4,03	0,62	3,74	0,77	2,02	0,31	1,82	0,27	4,66	0,88	2,65	0,73
Sterres3	51,02	17,72	13,65	0,24	7,14	2,63	5,17	0,11	2,10	0,22																													
Sterres4	56,02	19,02	8,50	0,16	3,15	2,59	8,11	0,15	1,92	0,40																													
Sterres5	50,33	20,87	12,37	0,27	4,81	2,73	5,23	0,90	2,32	0,18																													
Sterres6	51,41	18,52	11,30	0,31	5,22	4,07	5,15	0,95	2,78	0,29																													
Sterres7	50,37	17,12	12,35	0,37	6,20	5,31	4,76	0,70	2,57	0,26																													
Hinzenburg1	50,67	16,01	11,51	0,17	8,23	7,58	3,66	0,41	1,53	0,23	33,5	205	51,1	118	20,1	14,6	786	20,6	112	15,3	116	15,5	33,5	4,28	18,2	4,28	1,37	4,57	0,67	4,02	0,82	2,15	0,29	1,74	0,23	2,75	0,88	2,47	0,62
Hinzenburg2	47,71	18,19	13,28	0,16	8,26	6,06	3,08	0,85	2,14	0,27	33,9	317	50,5	111	23,1	36,3	428	21,4	114	19,8	214	15,0	32,4	4,06	17,4	4,14	1,53	4,46	0,68	4,03	0,79	2,28	0,31	1,89	0,26	3,22	1,27	2,89	0,50
Hinzenburg3	53,37	16,14	10,12	0,14	8,00	6,48	4,27	0,24	1,01	0,21	33,2	146	49,0	134	20,8	7,31	237	24,6	280	15,9	57,7	15,3	33,0	4,21	17,2	4,37	1,19	4,61	0,78	4,63	0,85	2,57	0,36	2,22	0,34	6,37	0,97	3,47	0,84
Hinzenburg4	49,72	15,76	11,41	0,16	7,26	10,24	2,89	0,85	1,53	0,18	30,1	223	44,8	104	20,7	32,0	556	18,0	81,8	13,4	183	12,4	26,7	3,40	14,5	3,21	1,20	3,58	0,57	3,65	0,76	1,78	0,24	1,74	0,24	2,33	0,83	2,85	0,54
Hinzenburg5	48,77	16,06	11,98	0,18	7,70	10,00	2,92	0,50	1,64	0,25	31,4	211	46,5	111	20,3	15,8	703	21,2	114	16,7	107	14,6	32,8	4,26	18,2	4,85	1,38	4,50	0,69	4,18	0,87	2,27	0,35	2,05	0,30	3,16	0,98	2,97	0,84
Hinzenburg6	49,68	15,48	12,23	0,18	7,36	9,61	3,12	0,30	1,81	0,23	32,0	271	43,4	103	20,9	10,5	530	20,7	132	13,7	74,4	14,7	31,9	4,11	16,8	3,91	1,41	5,26	0,67	4,09	0,73	2,21	0,33	1,91	0,25	3,39	0,76	2,51	1,11
Hinzenburg7	49,12	15,69	11,77	0,18	7,29	10,73	2,88	0,41	1,70	0,23	29,1	239	45,9	101	20,0	15,7	696	17,7	97,3	12,9	93,0	11,8	26,1	3,34	14,5	3,84	1,38	3,62	0,70	3,68	0,77	1,96	0,25	1,54	0,25	2,45	0,77	2,04	0,47
Serrig1	49,25	17,55	11,84	0,15	5,94	7,87	5,16	0,24	1,79	0,20																													
Serrig2	50,95	14,93	14,57	0,26	5,55	5,36	4,29	0,20	3,32	0,57																													
Serrig3	48,83	14,75	18,80	0,25	4,50	4,20	3,74	0,14	4,30	0,48																													
GvdSdSLorenzo	47,56	16,28	8,12	0,13	12,76	14,47	0,55	0,03	0,08	0,02	36,0	99	56,3	134	8,5	0,19	81,8	1,62	3,55	0,08	3,37	0,19	0,45	0,09	0,25	n.n.	0,08	0,20	0,04	0,17	0,04	0,13	0,04	0,19	0,04	0,14	n.n.	0,05	n.n.
GvdSdSPietro	51,06	16,30	7,55	0,11	9,09	14,44	1,29	0,05	0,10	0,01	49,3	167	33,1	31,5	11,2	0,37	108	3,76	5,21	0,09	9,8	0,26	0,74	0,14	0,54	0,30	0,16	0,61	0,09	0,58	0,12	0,38	0,05	0,57	0,09	0,15	n.n.	0,11	0,085
archaeological samples																																							
CUT2392	49,83	19,12	11,96	0,18	5,16	8,91	2,91	0,06	1,64	0,22	15,6	181	38,1	58,8	23,7	1,55	747	17,4	83,0	12,2	22,7	8,38	22,6	3,00	13,5	2,97	1,28	3,68	0,56	3,50	0,64	1,90	0,22	1,66	0,24	2,05	0,71	1,67	0,39
CUT1765	47,91	17,25	12,73	0,17	6,53	9,62	3,53	0,25	1,74	0,27																													
CUT1782	48,76	16,02	12,55	0,17	7,30	9,74	3,13	0,53	1,59	0,22																													
Tongr	46,66	18,14	13,40	0,18	6,99	8,03	4,14	0,13	2,06	0,27	20,9	242	51,5	90,5	21,3	3,28	395	14,8	73,2	10,6	29,7	8,10	18,7	2,48	10,9	2,97	1,17	2,88	0,44	3,03	0,62	1,42	0,16	0,94	0,20	1,92	0,56	1,10	0,24
AeB1	48,77	17,52	12,05	0,17	6,74	9,04	3,59	0,41	1,47	0,25	22,7	193	42,8	90,9	21,9	13,9	427	18,3	119	9,6	100	8,79	19,3	2,59	11,3	3,42	1,24	3,59	0,55	3,40	0,68	1,89	0,23	1,71	0,25	3,07	0,60	1,59	0,52
AeB2	48,64	16,63	11,88	0,16	6,75	9,96	3,34	0,49	1,90	0,24	29,2	248	44,1	85,4	20,9	17,5	427	20,9	75,3	10,3	147	10,2	19,5	2,82	13,6	3,55	1,35	4,16	0,63	3,85	0,73	1,86	0,24	1,41	0,19	1,99	0,57	0,84	0,21
Tr1	47,51	17,93	12,36	0,16	6,67	9,26	3,72	0,12	2,00	0,27	21,5	250	43,3	89,0	21,2	1,70	487	17,7	88,0	11,6	18,4	9,62	21,4	2,98	12,2	3,39	1,22	4,00	0,65	3,51	0,67	1,70	0,23	1,72	0,19	2,28	0,71	0,88	0,28
Tr2	46,76	16,86	13,51	0,18	7,09	9,97	3,10	0,12	2,18	0,23	27,9	354	51,5	97,8	22,6	2,72	487	17,1	114	9,8	23,6	8,82	19,2	2,67	11,9	3,38	1,20	3,55	0,55	3,21	0,61	1,67	0,21	1,30	0,23	1,64	0,50	0,97	0,23
Tr312	46,82	14,89	12,36	0,17	7,45	11,63	3,34	0,85	1,95	0,54																													

Table 1: Major and trace element composition of geological (diabase from the Trier area and metagabbros from Wadi Umm Wikala) and archaeological samples.

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NEW PETROLOGIC AND GEOCHEMICAL METHODS TO DETERMINE LOCAL PROVENANCE OF NON-MARBLE BUILDING STONE USED IN THE SANCTUARY OF THE GREAT GODS, SAMOTHRACE, GREECE

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Abstract

The island of Samothrace is the result of continuous tectonic activity in the Northern Aegean region and more specifically the Great Anatolian Fault that shears its southeastern margin.

This high energy environment formed a variety of rocks, many of which were used in the construction of the buildings in the Sanctuary of the Great Gods. Establishing a system of classification has help clarify local building history. Petrographic analysis correlates specific building sites with at least three island quarries. The choice of construction stone was based on physical attributes and engineering properties. Limestones and dolomites with open cavities (vugs) were light weight yet strong and thus well suited for foundations, while basalt, trachyte, and rhyolite were mainly limited to the lowest level of foundations or large-scale polygonal retaining walls. The carbonates show varying degrees of post-installation weathering and degradation, most notably in the increased volume of cavities created by the plucking out of various sized pebbles. In a sanctuary famed for its innovative architecture built of imported marble, our current investigation emphasizes the fundamental role of local stone as a major component in the process.

Keywords: Samothrace, provenance, petrology.

Introduction and purpose

The island of Samothrace is the result of continuous tectonic activity in the Northern Aegean region and more specifically the Great Anatolian Fault that shears the southeastern margin. Faulting, earthquakes, uplift, landslides, and floods produce a rugged terrain. This high energy environment formed a variety of rocks, many of which were used in the construction of the buildings in the Sanctuary of the Great Gods. While archaeological investigation of the Sanctuary reaches back to the 15th century (Lehmann 1998; Wescoat 2017), the geologic history of the site has received less study (Xanthopoulou, 2009) and is the emphasis of this paper. Although famous for its buildings of imported marble (Maniatis *et al.* 2012), every structure in the Sanctuary used locally sourced stone in some capacity. Limestone and dolomitic limestone were the most commonly used, along with harder rocks such as basalt, porphyritic trachyte, and rhyolite. Since many of these stones would eventually be covered by earth or plaster, their aesthetic properties were less significant than their structural strength and workability, as well as the proximity of the quarry and the volume and consistent availability of material. Quarries located on the island fit most of these requirements, save for volume. It could be that there are additional quarries or that the known quarries were exhausted of stone.

One of the main purposes for this study was to develop a quantitatively-based description and classification of all non-marble building stone used in the Sanctuary. This required representative rock sampling from both inside and outside the Sanctuary for location of source quarries and provenance. To support a new rock classification, rock samples were analyzed using both detailed petrographic analysis of thin-sections combined with total, whole-rock, chemical analyses. Another purpose was to use this new classification as the basis for documenting the material of every block across the Sanctuary. The resulting data have contributed to our understanding of broad trends in building history, architectural energy and island economy.

Regional geology

Samothrace island is located in the northern Aegean Sea. The island is part of a tectonically active region controlled by ongoing seismic activity along the bordering North Anatolian Fault. The island represents a tectonic horst and, the adjacent fault, a half-graben. It contains a wide variety of structurally juxtaposed rocks as part of the greater Circum-Rhodope Tectonic Belt (Meinhold, Kostopoulos 2013). This belt (Fig. 1, insert) is noteworthy for the numerous ophiolite slices, including Samothrace (Piper 2002).

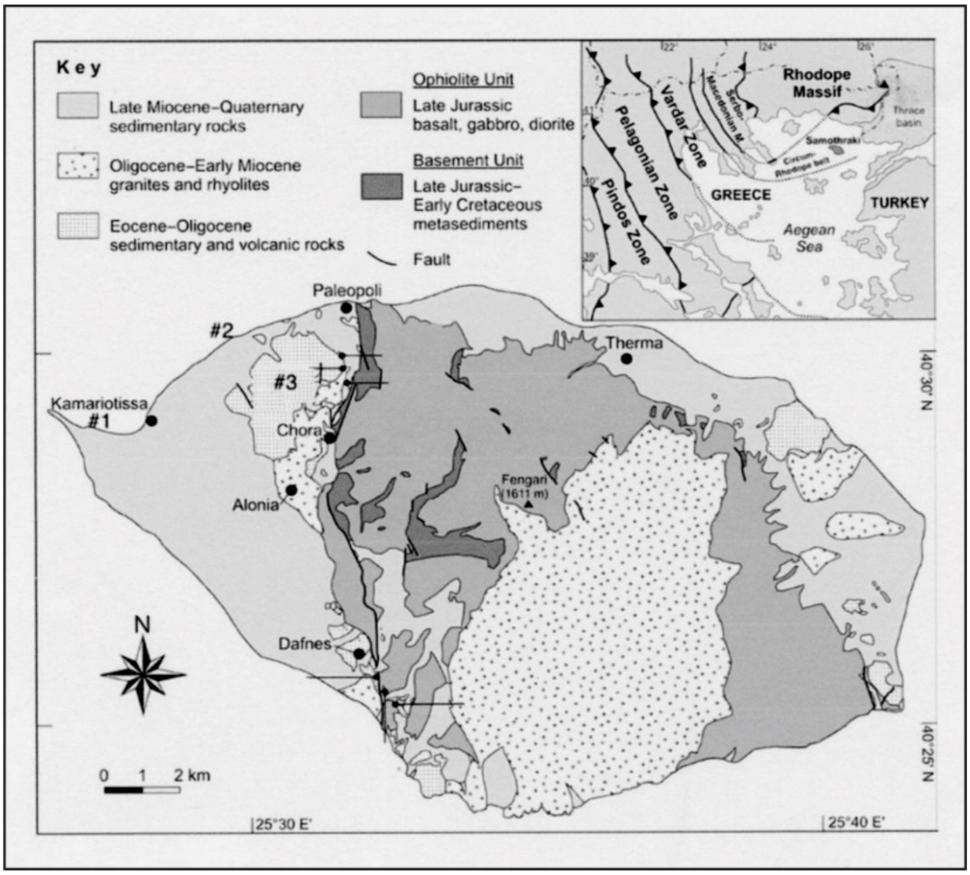

Figure 1: General geologic map of the island of Samothrace (modified after Heimann *et al.* 1972). Insert map showing Samothrace within the major geotectonic zones. #1 on map is the dolomitic limestone quarry at Akrotiri Point, #2 is the quarry for the pebbly, vuggy limestone, #3 is the porphyritic trachyte quarry at Mt. Toyrli, “Paleopoli” is the site of the Sanctuary of the Great Gods.

The island is small (178 km^2) and rugged (Mt. Fegari, 1611 m), with steep sided ridges (Saos) (Koglin *et al*. 2009). Steep slopes range between 15-30, resulting in high erosion rates and deep ravines. There are five major rock units: 1. Mesozoic basement complex of low-grade metamorphic rocks, 2. Late Jurassic dismembered ophiolite complex, 3. Eocene andesite to trachyte volcanics, 4. Miocene granite intrusion, 5. Quaternary fluvial and alluvial fan deposits (Seymour *et al.* 1996).

Sampling and analytical methods

Geologic sampling for quantitative analyses of the non-marble stone used in the Sanctuary adhered to strict controls outlined in the sampling permits. Typical rock samples were taken away from direct observation, usually under ledges or in crevasses. For petrographic and chemical analyses the samples needed to be as unaltered and representative of the rock type as possible. Samples were cleaned and diamond-sawed into three pieces: one for chemical analysis, one for thin-sectioning, and one for reference. Whole-rock, 57-chemical element, analyses using XRF, INAA, and titration (FeO) methods are shown in Tab. 2. Standard thin-sections were analyzed for mineral shape, size, and identification using a petrographic microscope equipped with the automatic stage point counter. These methods provided for close comparison between thin-section and chemical analysis for each rock sample.

One of the major efforts in this study was to develop a symbology showing the range in rock types and their location of use within the Sanctuary. This symbology was also applied to the quarry sites and other locations outside the Sanctuary. As shown in Tab. 1, the symbology has been matched with a color code used to identify the rock type of each block (Fig. 2). It is informative to note that in the earlier monumental buildings, a wide variety of rocks types were used (i.e. the Eastern Hill complex), whereas during intensive building activity in the third century, only one or two types were used (i.e., Stoa).

Petrology of sanctuary rocks

The choice of stone used by the Sanctuary builders is clearly deliberate, both for building stone and accent stone (Fig. 3). All foundation stones are from local quarries. In addition, many buildings, especially those of more utilitarian function such as dining rooms, theater and Stoa, were entirely constructed with local stone, while others were of local stone with marble accents, chiefly in doorways or thresholds. Local stone is mainly igneous rock, both volcanic and plutonic, and a variety of limestones. They range from rather pure limestone ($CaCO_3$) to dolomitic limestone ($CaMg(CO_3)$). Fossils of mainly Miocene Epoch age (23-5 Ma) include reef-building, stony coral (Scheractinia) and a variety of mollusks, bivalve pelecapods (genus Ostrea and Pecten). Gastropods, nummulites and bryozoans are also present. The carbonate rocks also contain varying amounts of clastic material ranging from medium to coarse-grained size. The clasts consist of fossils, basalt, rhyolite, jasper, and quartz of sub-rounded shape. Many of the carbonate blocks used in the foundations of the buildings contain large vugs or cavities.

It might seem that these openings would lessen the engineering strength of the foundations in buildings such as the Rotunda of Arsinoe II. However, even though these walls stand over thirteen courses high, they show little sign of weakness. Two source quarries for these vuggy carbonate rocks were discovered less than 8 km southwest of the Sanctuary along the shoreline. The quarry at Akrotiri supplied dolomitic limestone to the foundation and walls of the Stoa. The vugs in these rocks are due to selective resorption and dissolution of fossils, with concomitant dolomitization of the limestone (Fig. 4a). The second shoreline quarry, only about 4 km west of the Sanctuary, was a source for vuggy pebbly limestone. The rock contains a high proportion of rounded clasts ranging from sand-size to pebbles and cobbles. At this site, the vugs were produced by progressive plucking of large clasts liberated from the rock by erosion (Fig. 4b). This rock was used in many buildings in the Sanctuary, notably the Rotunda of Arsinoe II, Hieron, Propylon of Ptolemy II, as well as the Neorion and the adjacent Hestiatorion.

In addition to its great variety of tectonically emplaced igneous, metamorphic and sedimentary rocks, Samothrace has steep slopes, high rainfall and snowmelt. The result is rapid erosion, torrential stream transportation, landslides and deposition of clastic sediments in large alluvial fans, especially in the region of the Sanctuary. These fans are ephemeral and slowly work their way towards the shore to form sand and gravel beach deposits. Moving further offshore these deposits are mixed with marine carbonates and are slowly cemented to form a wide variety of biogenic clastic rocks such as calcareous sandstone and the more commonly used pebbly limestones. Other sedimentary rocks are formed mainly by marine organisms (coral reef builders, gastropods, pelecopods, and bryozoans). These form more massive fossiliferous reef limestones. With time, salt water reflux exchanged calcium in the limestone for magnesium, producing a secondary dolomitic limestone, also commonly used in the Sanctuary.

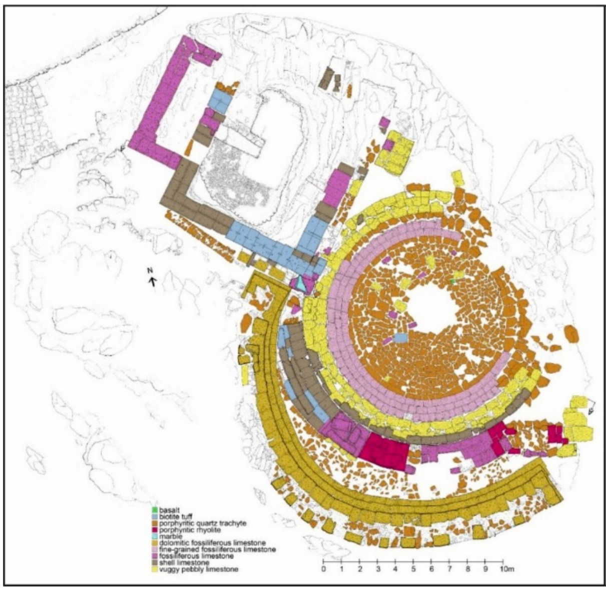

Figure 2: Plan showing rock types used in the Eastern Hill complex in the Sanctuary of the Great Gods, see Tab. 1 for symbology (Photo: American Excavations Samothrace).

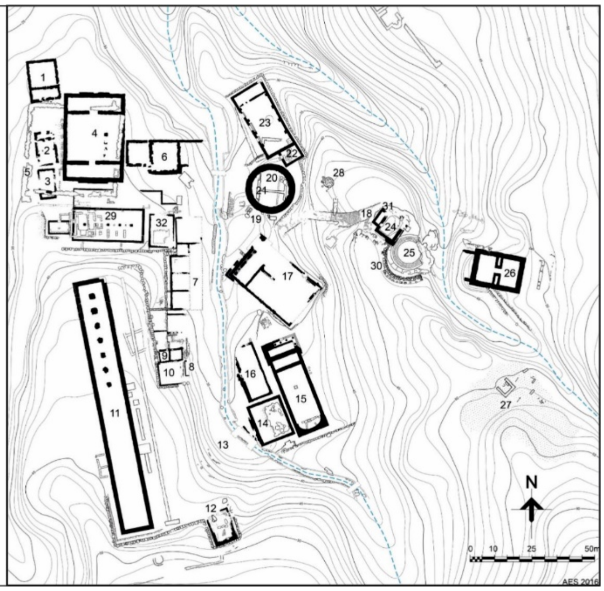

Figure 3: Actual state sketch plan of the Sanctuary of the Great Gods. (Plan: American Excavations Samothrace). Locations mentioned in text: **11**. Stoa; **12**. Nike Monument; **14**. Altar Court; **15**. Hieron; **19**. Sacred Rock; **20**. Rotunda of Arsinoe II; **25**. Theatral Circle; **26**. Propylon of Ptolemy II.

The carbonate sedimentary rocks on Samothrace comprise about 8% of the island, both along the shoreline and inland. In general, pure limestone has a chemical composition close to pure calcite ($CaCO_3$) with CaO = 56 wt% and CO_2 = 44 wt.%. With increasing magnesium substitution limestone is converted to dolomite $(Ca,Mg)CO_3$ with CaO = 30 wt%, MgO = 22 wt%, and CO_2 = 48 wt.%. Most of the carbonate rocks sampled on Samothrace and chemically analyzed from outcrops, quarries, and Sanctuary stone range from almost pure limestone to dolomitic limestone (MgO ranging from 14-20 wt.%, Tab. 1). Almost all the carbonate rocks contain varying amounts of clastic grains of quartz, jasper, magnetite, basalt, trachyte porphyry, rhyolite, and granite ranging from 1% to 15% by volume. Such rocks are within the category of carbonate siliciclastics.

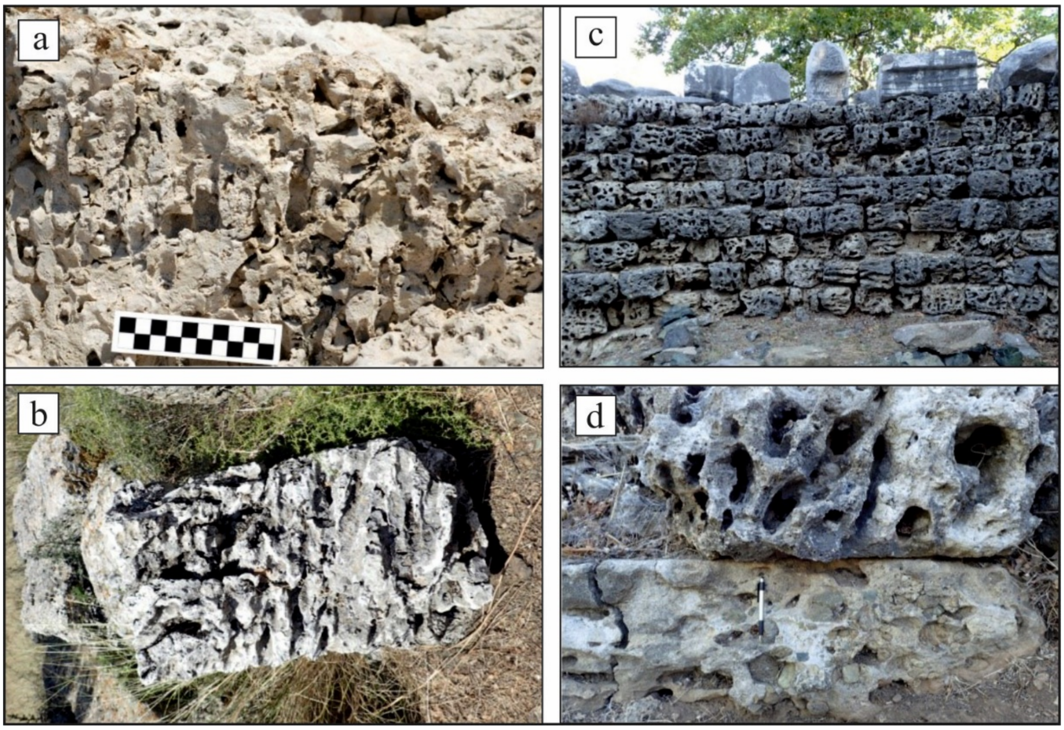

Figure 4: **a**. Ancient quarry at Akrotiri showing dolomitic limestone used in the Stoa; **b**. Foundation block in the Stoa showing advanced dissolution of dolomitic limestone; **c**. Foundation and walls of the Rotunda of Arsinoe showing vuggy pebbly limestone; **d**. Close up photo of vuggy pebbly limestone showing plucking out of pebbles (Photos: Authors).

In the Sanctuary, the closest to pure calcite are shell limestone and fossiliferous limestone from the locations listed in Tab. 1, with chemical analysis shown in Tab. 2. Shell limestone is very distinctive being comprised almost entirely of broken shell fragments, preferentially aligned and loosely cemented together. Vuggy limestone displays cavities (Fig. 4c) enlarged after emplacement in the Sanctuary due to dissolution. This is an important building stone used in foundations and walls in the Sanctuary (Tab. 1 and Fig. 4d). It consists of varying percentages and sizes of rounded grains or clasts of quartz, jasper, calcite, limestone, basalt, rhyolite and trachyte imbedded in a matrix of limestone. The source quarry is along the shore west of the Sanctuary where partially worked blocks can still be found (Fig. 5). Weathering and dissolution of the carbonate matrix liberated many of the clasts, leaving rounded vugs. These vugs further enlarged and coalesced over time. It appears that the integrity and strength of the building stone was not seriously compromised by this process.

It is difficult to differentiate limestone from dolomitic limestone in the field. Dolomite tends to be a bit harder and shows more vugs, but this should not always be trusted. Chemical analysis showing CaO and MgO wt.% values is more instructive. The limestone samples from Samothrace range from 0.5 to 4.5 wt.% MgO, whereas the dolomitic limestone ranges from 14.0 to 20.0 wt.%, MgO Locations in the Sanctuary for the dolomitic limestone, some with fossils, and most with vugs are shown in Tab. 1. Of special mention is the dolomitic limestone used to construct the foundation, walls, colonnades and entablature of the Stoa. The Stoa is one of the few major buildings in the Sanctuary constructed without any marble components, but our analysis of over 1750 surviving blocks from the building demonstrate that the masons carefully discriminated in their choice of the two main types of dolomitic stone for different parts of this building. The dominant type, light gray in color with extensive cavities, predominated (1146 samples). It was used especially in the foundations and less complex ashlars such as wall stretchers, anta, pilaster, frieze and architrave blocks.

Figure 5: Excavated block of vuggy pebbly limestone from shoreline quarry west of the Sanctuary showing plucking out of pebbles. Similar rocks were used in the Rotunda of Arsinoe II and the Propylon of Ptolemy II (Photo: Authors).

A denser dolomitic limestone, light tan in color and with fewer cavities, was reserved for the blocks requiring more complex precision carving (588 samples). These blocks include the Doric column drums and capitals, interior Ionic column drums and capitals, geison blocks, anta capitals, and the binding courses. The quarry located near Akrotiri has reef limestone very similar in texture and composition to the Stoa (Fig. 6). This quarry shows channels for extracting blocks and partially quarried blocks similar in size to the Stoa wall blocks. In addition, a small amount of third type of rock, a fine-grained limestone, was quarried for some of the Ionic column drums and fragments of base (17 samples). The fact that fragments assigned to the Ionic half column from the south wall are of both materials suggests that masons were willing to mix these two types stone, which share similar properties, within the same architectural element. The thick layer of plaster applied to the entire superstructure would have masked any visual differences between all three types of stone.

Figure 6: Ancient quarry at Akrotiri showing partially excavated blocks (Photo: Authors).

The clastic or fragmental rocks used in the Sanctuary are cemented with calcite (calcium carbonate) with a matrix of crushed fossil fragments and carbonate mud (micrite). Many of these rocks straddle the boundary between clastic and carbonate rocks, called carbonate-siliciclastic rocks. The clasts range from silt-size to cobbles and represent most of the rock types on Samothrace. Of note, are the distinctive blocks of calcareous sandstone used in the Nike Monument. It can be argued that this rock could also be classified as a clastic limestone rather than a calcareous sandstone. However, the rock has a distinctive sandstone clastic texture and thus warrants the calcareous sandstone name (Fig. 7). It makes for poor building stone and was used in antiquity only in the Nike Monument. However, its rarity in the ancient building record allowed us to identify spoliated blocks from the Nike Monument recycled in the large Byzantine Building constructed over the Neorion (Fig. 3, no. 29). Another distinctive building stone is the pebbly mudstone limited to the foundations of the

Altar Court and the entire small Doric Rotunda east of the Rotunda of Arsinoe II (Fig. 3, no 28). It is a highly siliceous, low carbonate (Tab. 2), sedimentary breccia that has a muddy matrix that crumbles easily, particularly when exposed. As part of the subterranean foundations of the Altar Court the rock worked effectively, but the extremely few and highly fragmentary remains of the Doric Rotunda bear witness to its fragility as a building material (McCredie *et al.* 1992, 262-272).

Evidence of volcanic activity on Samothrace consists of volcanic tuff, tuff breccia, porphyritic trachyte, porphyritic rhyolite, rhyolite breccia, pillow basalts, and dikes (Vlahou *et al*. 2006) The igneous rocks from Samothrace used in the Sanctuary are mainly basalt, porphyritic trachyte, porphyritic rhyolite and volcanic tuff (Vlahou *et al.* 2001). Basalt occurs as sheeted dikes, pillow basalts, and breccias. They are part of the Samothrace Ophiolite complex that outcrops within the Sanctuary and the ridge to the east (Tsikouras, Hatzipanagiotou 1995). It comprises about 31% of the island's area (Skoulikidis *et al*. 2013). K-Ar age dates of 154+/-7Ma and 155+/-7Ma are given by Seymour *et al*. (1996). This ophiolite represents former sea-floor rocks that were tectonically uplifted as a horst adjacent to the down-faulted North Anatolian Fault on Samothrace's southeastern border. Since basalt is fine grained, it is usually classified on the basis of its chemical composition (Tab. 2). As such, they are classed as tholeiitic, continental margin type. The hardest of the igneous rocks, basalt was only occasionally trimmed to create a level surface for a superposed or adjacent ashlar. It was used extensively in its freeform to construct the massive stone retaining walls and ravine channels that shape the Sanctuary. In buildings, it was employed as the lowest courses of the foundation.

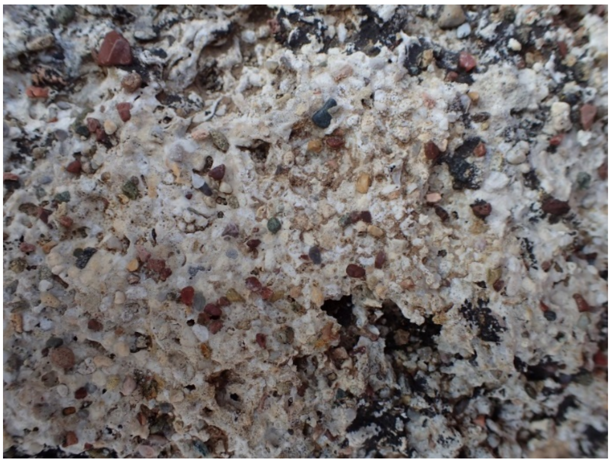

Figure 7: Close-up view of calcareous sandstone from the krepis of the Nike Monument in the Sanctuary of the Great Gods. (field of view 60 mm). Note variety of clasts consisting of basalt, jasper, fossils, limestone, quartz, and rhyolite (Photo: Authors).

The pillow-structure in the basalt is distinctive and, together with the yellow-green alteration and interstitial purple jasper, creates a strikingly powerful visual effect. In addition, the basalt contains the mineral magnetite (Fe_3O_4) which interferes with normal earth magnetism. The magnetic field strength in the Sanctuary is unusually strong and compass needles sway wildly depending on nearby rock types, particularly basalts. One pair of pillow basalt boulders southeast of the Rotunda of Arsinoe II appears to be called out by a contiguous paving of biotite tuff; Karl Lehmann's identification of the configuration as a sacred rock altar should not be dismissed out of hand, given the energy and beauty of this stone (Fig. 3, no. 19, Fig. 8) and the importance of magnetism to the cult (Lehmann, 1950, 8-10; Lehmann, 1951, 3-4; Lehmann, 1998, 72; Blakely, 2012, 61-64).

Figure 8: Oceanic basalt showing rounded pillow-structure with interstitial red jasper from the Sanctuary. Identified as a Sacred Rock by Lehmann in 1998 (Photo: Authors).

Porphyritic trachyte, with its distinctive large pink feldspar phenocrysts up to 10 cm. in length (Fig. 9b), is well exposed at the nearby quarry on Mt. Toyrly (Fig. 9a) as well as in outcrops in the immediate vicinity of the Sanctuary. Its chemistry varies somewhat due to secondary alteration and nearness to contact with other rocks. At the contact the rock is highly brecciated, sheared, and chemically altered (Fig. 9c). This border facies looks much like the porphyritic rhyolite blocks used in the Sanctuary. The proximity of this rock, as well as its capacity to be easily worked into rough ashlars or huge polygonal blocks, made it a convenient construction material for retaining walls. Porphyritic rhyolite also occurs within the immediate vicinity of the Sanctuary. It has a reddish-purple color and, on close examination, a brecciated and sheared texture (Fig. 9d). In many examples the “porphyritic” texture is actually formed by angular lithic fragments of trachyte. Chemical analyses (Tab. 2) are very similar to porphyritic trachyte, although the visual properties of the two stones are different. Its deep red color made it an excellent accent stone but its weaker structure did not favor major construction. It is used sparingly for monument platforms, statue bases, screen walls and theater seats, as well as in another context in relation to the theater than we have not yet determined with confidence.

Volcanic biotite tuff, buff-colored, soft, and very porous, is used sparingly in the Sanctuary, but in important contexts. It forms the wall of the Orthostate Structure, one of the earliest surviving structures in the Sanctuary, as well as the paving surrounding the basalt boulders, which, given its elevation, also must belong to an early phase of the Sanctuary. Small fragments of blocks found in the lowest courses of the theater and in the vicinity of the diazoma suggest it was used in the first and final rows of the lower koilon. In the other contexts, it appears as recycled material in foundations or paving. Collectively, the evidence indicates that this softer material was the type of stone preferred in early construction, and its reuse suggests the existence of other early structures that have not yet been located.

A large, coarse grained granite intrusion, K/Ar dated at 14.5+/-0.3 and 14.5+/-0.5 Ma, occupies about 32% of the area of the island (Seymour *et al*. 1996; Christofides *et al*. 2000). However, this rock was apparently too difficult to quarry and use in the Sanctuary. Aside from clastic pebbles, the only granite in the Sanctuary is a pink granite statue base thought to be exotic (Lehmann 1962, pp. 98-100).

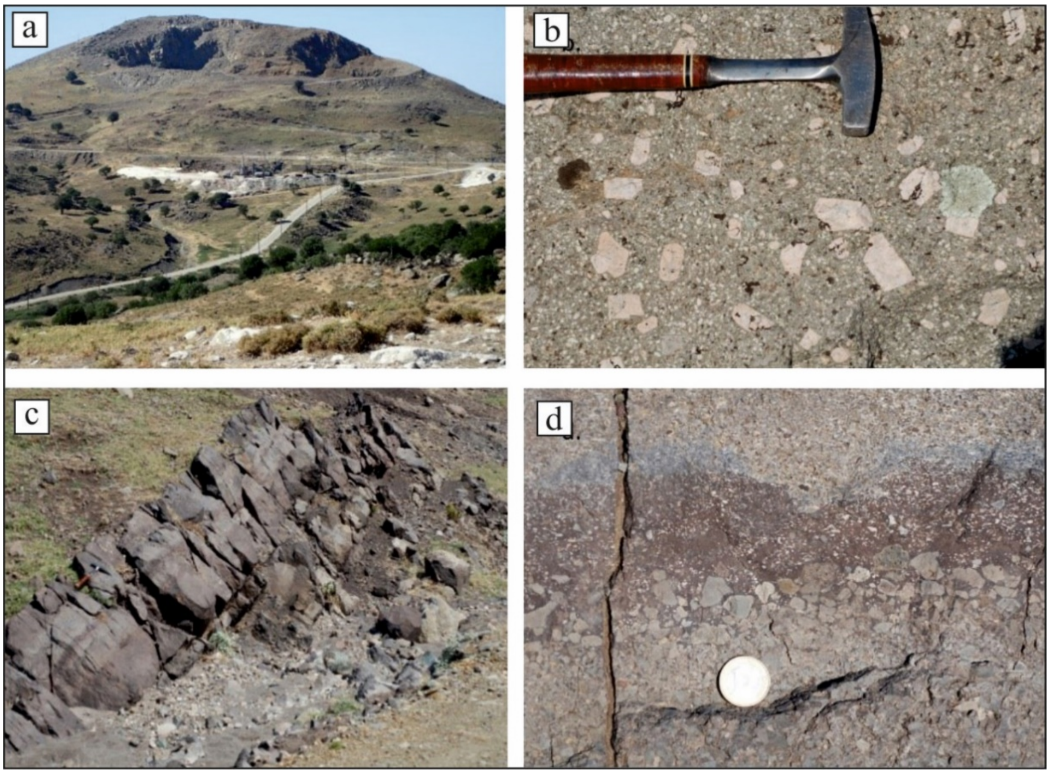

Figure 9: **a**. View of Mt. Toyrli, source of quarried porphyritic trachyte blocks used in the Sanctuary; **b**. Close-up view of porphyritic trachyte in the Sanctuary. Note exceptionally large and well-formed feldspar crystals; **c**. Outcrop of contact zone of porphyritic trachyte with country rock. Note chilled, purplish-color, resembling what is called porphyritic rhyolite; **d**. Close-up view of porphyritic trachyte contact zone near Mt. Toyrli, showing highly brecciated texture (Photos: Authors).

Interpretation and future work

Samothrace has had a violent tectonic history that has both created and destroyed the landscape over time, including the Sanctuary site. These geologic changes will continue to expose the Sanctuary to catastrophic episodes. Most of the rock types used in the Sanctuary reflect this environmental instability. They represent a high energy, interposition of igneous and sedimentary processes, producing a variety of limestone, dolomitic limestone, pebbly limestone, calcareous sandstone, and mudstone. Igneous components include sea-floor basalts, volcanic trachyte, rhyolite, and tuff. In identifying the variety of rock types from the island used within the Sanctuary, the current work has provided a basis upon which to better understand building history and economy, and it has established further criteria for assigning building material to particular structures or architectural phases. Moreover, it offers critical data for site management and architectural conservation within this volatile but majestic landscape.

Acknowledgments

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Type	Subtype	Name	Color_na	ExampleRGB	Hexa_no	RGB	CMYK	Locations
Sedimentary	Carbonates	Dolomitic fossiliferous limestone	Light orange		E5C22C	229, 194, 44	12, 20, 96, 0	Dedication of Philip III and Alexander IV, Theatral Circle, Rotunda, Anaktoron, Sacristy, Lower Stoa Retaining walls
Sedimentary	Carbonates	Dolomitic limestone	Dark brown		8E6A4F	142, 106, 79	38, 54, 70, 19	Hall of Choral Dancers, Hieron, Lower Stoa Retaining Walls, Room C, Room D, Room E, Room J, Room H, Stoa, Building I, Building 2
Sedimentary	Carbonates	Vuggy pebbly limestone	Yellow		F0EA4D	240, 235, 77	8, 0, 83, 0	Propylon of Ptolemy II, Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Rotunda, Hieron, Hall of Votive Gifts, Anaktoron, Sacristy, Lower Stoa Retaining Walls, Room A, Room B, Room F, Room H, Stoa, Neorion, Hestiatorion, Milesian Dedication, Building A, Building 1, Building 2
Sedimentary	Carbonates	Shell limestone	Medium brown		AF9A82	175, 154, 130	32, 36, 50, 2	Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Hall of Votive Gifts, Altar Court, Protoanaktoron, Anaktoron, Lower Stoa Retaining Walls, Neorion, Hestiatorion
Sedimentary	Carbonates	Fossiliferous limestone	Pink		D271AD	210, 113, 173	14, 68, 0, 0	Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Hieron, Anaktoron, Room F, Room J, Neorion, Hestiatorion, Roman Cult Building, Building 2
Sedimentary	Carbonates	Fine-grained Fossiliferous limestone	Light creamy pink		E5B6D8	229, 182, 213	7, 33, 0, 0	Propylon of Ptolemy II, Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way
Sedimentary	Clastic	Clastic limestone	Tan		E2D9B5	226, 217, 181	11, 11, 31, 0	Propylon of Ptolemy II, Hieron, Lower Stoa Retaining Walls
Sedimentary	Clastic Sandstone	Calcareous Sandstone	Medium purple		BA7EB7	186, 126, 183	26, 58, 0, 0	Nike Monument
Sedimentary	Clastic Sandstone	Pebbly mudstone	Purple		8374B5	131, 116, 181	53, 59, 0, 0	Doric Round Building, Altar Court
Igneous	Volcanic	Basalt	Green		47B85F	71, 184, 95	71, 0, 85, 0	Propylon of Ptolemy II, Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Rotunda, Altar Court, Hall of Votive Gifts, Protoanaktoron, Anaktoron, Sacristy, Theater, Lower Stoa Retaining Walls, Room A, Room D, Room E, Room F, Room J, Room H, Stoa, Nike Monument, Nike Precinct, Roman Cult Building, Milesian Dedication, Building 1, Building 2, Building 3
Igneous	Volcanic	Porphyritic quartz trachyte	Orange		DA8F28	218, 143, 40	13, 48, 100, 1	Propylon of Ptolemy II, Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Rotunda, Altar Court, Hall of Votive Gifts, Protoanaktoron, Sacristy, Theater, Lower Stoa Retaining Walls, Room D, Room E, Room F, Room J, Room H, Milesian Dedication, Building A, Building 2
Igneous	Volcanic	Biotite tuff	Light gray Creamy glue		91BBE4	145, 187, 228	41, 16, 0, 0	Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Rotunda, Hall of Votive Gifts, Anaktoron, Theater, Builiding 2
Igneous	Volcanic	Porphyritic rhyolite	Red		D81D65	216, 29, 101	10, 99, 40, 0	Dedication of Philip III and Alexander IV, Theatral Circle, Sacred Way, Hall of Choral Dancers, Hieron, Altar Court, Anaktoron, Theater, Lower Stoa Retaining Walls, Room C, Milesian Dedication
Metamorphic	Non-foliated	Marble	Bright blue		63C8DC	99, 200, 220	55, 0, 13, 0	Propylon of Ptolemy II, Dedication of Philip III and Alexander IV, Sacred Way, Rotunda, Hieron, Room E, Hestiatorion, Neorion, Roman Cult Building, Building A, Building 2, Building 3
Mineral		Fine-grained jasper	Dark maroon		751116	117, 17, 22	31, 100, 95, 43	Nike Monument
Mineral		Quartz	Dull light blue		B7E4F2	183, 228, 242	24, 6, 0, 5	Protoanaktoron, Lower Stoa North
Ceramic		Terracotta	Salmon peach		EFB08E	239, 176,142	4, 35, 43, 0	Altar Court, Theater, Room J, Nike Precinct

Table 1: Rock symbology used to map and classify building stone used in the Sanctuary of the Great Gods (American Excavations Samothrace).

Sample	S3X	S11	S13X	S14X	S29	S30	S35X	S2X	S12	S21	S23	S40X	S16X	S6X	S8X
Rock Type	Basalt Dike	Basalt Dike	Basalt	Basalt	Basalt	Basalt	Basalt	Qtz.Trac. Porp	Trac. Porp.	Trac. Porp.	Trac. Porp.	Trac. Porp.	Rhyolite	Rhyolite	Rhyolite
Location	West Of Chora	Nike Boulder	Near Neorian	Near Neorian	S.Altar Court	S.Altar Court	Upstr. Propylon	Rd. Near Chora	Theat. Circle	Milesian Ded.	Eastern 3Hills	Quarry 3	Upstream Nike	Upstream Propylon	Quarry 3
Weight %															
SiO_2	56,94	45,83	49,91	49,78	53,57	57,87	45,61	61,03	61,57	55,81	63,69	62,73	64,96	59,43	59,58
Al_2O_3	17,64	15,48	14,71	16,05	15,68	19,03	12,63	14,48	15,02	12,53	15,01	15,8	13,94	15,27	17,96
TiO_2	0,854	1,941	1,475	0,691	0,73	0,916	1,189	0,721	0,558	0,422	0,481	0,774	0,718	0,661	0,749
Fe_2O_3	6,11	4,59	4,92	6,08	6,14	6,36	5,14	2,58	3,31	3,57	1,67	4,3	6	4,77	6,68
FeO	2,8	6,7	5	0,2	1,9	1,9	4	2	1,4	1,1	2,4	0,7	0,5	0,2	0,4
MnO	0,067	0,201	0,249	0,193	0,156	0,056	0,25	0,099	0,1	0,108	0,093	0,075	0,145	0,21	0,057
MgO	1,63	6,12	5,51	0,36	5,49	3,21	3,41	2,66	3,1	3,15	1,97	1,47	0,54	0,54	1,78
CaO	3,16	8,17	12,04	11,64	4,17	0,93	9,35	4,37	2,68	6,4	3,36	3,13	2,77	5,51	1,25
Na_2O	1,37	3,06	3,55	0,07	3,32	1,59	0,83	3,01	5,91	2	3,84	3,27	3,3	2,59	8,48
K_2O	1,89	1,47	0,41	0,25	0,31	1,75	2,86	4,87	0,28	3,63	3,56	5,27	2,37	3,69	0,95
P_2O_5	0,18	0,22	0,17	0,12	0,21	0,3	0,17	0,71	0,28	0,12	0,35	0,71	0,44	0,19	0,35
LOI	5,61	4,16	2,13	14,2	8,37	6,1	14,62	1,86	4,41	10,27	3,07	1,42	4,01	6,72	1,62
LOI2	5,29	3,41	1,57	14,18	8,15	5,89	14,17	1,63	4,25	10,14	2,8	1,34	3,96	6,7	1,58
Total	98,55	98,69	100,6	99,65	100,2	100,2	100,5	98,62	98,79	99,24	99,76	99,71	99,75	99,82	99,91
Total 2	98,24	97,94	100,1	99,63	100	100	100,1	98,39	98,63	99,11	99,49	99,63	99,7	99,79	99,86
Fe_2O_3(T)	9,22	12,04	10,48	6,3	8,25	8,48	9,59	4,81	4,87	4,8	4,34	5,08	6,56	5	7,12
ppm															
Sc	20	42	37	14	29	21	26	13	15	14	11	14	11	15	11
Be	3	< 1	< 1	1	2	3	2	8	4	2	7	8	2	3	1
V	230	336	303	156	237	188	175	111	130	95	106	106	80	41	232
Cr	80	220	250	< 20	170	50	200	< 20	30	100	20	< 20	< 20	< 20	< 20
Co	25	50	47	14	30	22	26	11	12	13	9	13	8	5	17
Ni	30	90	150	< 20	50	< 20	80	< 20	< 20	20	< 20	< 20	< 20	< 20	< 20
Cu	140	70	30	50	220	70	100	20	30	40	20	10	< 10	20	70
Zn	140	150	100	60	90	120	60	90	90	60	60	140	80	80	70
Ga	20	19	18	15	16	18	13	20	19	14	20	19	14	16	13
Ge	2	1	2	2	< 1	1	< 1	2	1	1	2	1	2	< 1	< 1
As	< 5	< 5	< 5	7	< 5	< 5	< 5	6	6	5	< 5	10	< 5	< 5	23
Rb	69	51	12	12	12	58	102	168	8	113	154	176	93	136	24
Sr	673	108	121	171	151	154	109	888	468	308	882	946	139	283	699
Y	20	38	29	14	18	21	32	19	17	19	18	19	26	34	28
Zr	201	122	91	78	153	239	160	426	201	119	273	515	168	285	142
Nb	10	10	9	3	5	9	7	18	13	7	22	20	7	10	5
Mo	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2

Table 2a: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods.

Sample	S3X	S11	S13X	S14X	S29	S30	S35X	S2X	S12	S21	S23	S40X	S16X	S6X	S8X
Rock type	Basalt Dike	Basalt Dike	Basalt	Basalt	Basalt	Basalt	Basalt	Qtz.Trac. Porp	Trac. Porp.	Trac. Porp.	Trac. Porp.	Trac. Porp.	Rhyolite	Rhyolite	Rhyolite
Location	West of Chora	Nike Boulder	Near Neorian	Near Neorian	S.Altar Court	S.Altar Court	Upstr. Propylon	Rd. Near Chora	Theat. Circle	Milesian Ded.	Eastern 3Hills	Quarry 3	Upstream Nike	Upstream Propylon	Quarry 3
ppm															
Ag	1,8	1,1	0,7	0,5	< 0.5	0,7	< 0.5	4,1	1,7	0,8	2,1	1,6	1,4	0,9	< 0.5
In	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Sn	3	1	< 1	< 1	2	3	1	5	3	< 1	4	6	< 1	1	2
Sb	0,9	< 0.5	< 0.5	< 0.5	< 0.5	0,7	0,8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1,6	0,7	< 0.5
Cs	6,4	3,2	1,1	1,1	1,5	8,3	11,8	7,9	0,8	4,7	2,9	10,1	4	8,9	< 0.5
Ba	623	125	110	128	373	202	90	1485	2392	403	1471	2132	1145	455	111
La	64,4	8,6	6,4	17,2	29,5	33,2	16,1	79,4	73,6	25,4	106	80,1	36,8	44,5	26,7
Ce	106	20,1	15,1	33,1	58,8	71,8	33,9	148	128	48,4	182	155	71,6	91,1	51,2
Pr	11,7	3,05	2,36	3,99	6,99	8,01	4,21	16,7	14,3	5,57	18,7	17	8,89	10,5	6,26
Nd	40,4	15,3	11,6	15,7	27,1	30,4	17,5	59,5	51,4	20,9	62,6	60,5	35,3	39,1	25,2
Sm	6	4,7	3,6	3,4	5,1	6,1	4,2	9,3	7,7	4,2	8,9	9,5	7,2	7,8	5,3
Eu	1,4	1,64	1,22	0,85	1,34	1,39	1,37	1,94	1,67	0,88	1,77	2,09	1,5	1,75	1,3
Gd	4,6	6,5	4,9	3,1	4,3	4,7	5	6,4	5,2	3,8	5,6	6	6,2	6,9	5
Tb	0,7	1,2	0,9	0,5	0,6	0,7	0,8	0,9	0,7	0,6	0,7	0,8	1	1	0,8
Dy	4,1	7,7	6	2,9	3,5	4,2	5,3	4,2	3,7	3,5	3,8	4	5,4	6,2	5
Ho	0,8	1,6	1,2	0,6	0,7	0,8	1,1	0,8	0,7	0,7	0,7	0,7	1	1,2	1
Er	2,4	4,6	3,5	1,7	1,9	2,1	3,1	2,3	1,9	2,1	2	2,1	2,8	3,6	3
Tm	0,37	0,69	0,54	0,26	0,28	0,32	0,47	0,34	0,29	0,33	0,3	0,32	0,45	0,54	0,46
Yb	2,3	4,4	3,4	1,6	1,9	2,1	3,1	2,1	1,9	2,2	1,9	2,1	2,9	3,7	3
Lu	0,34	0,63	0,51	0,22	0,32	0,32	0,49	0,33	0,27	0,32	0,28	0,31	0,41	0,58	0,48
Hf	4,5	3	2,3	1,9	3,3	5,1	3,4	9,7	4,4	2,8	6	12,2	3,7	6	3,2
Ta	1	1,7	2,3	0,3	0,3	0,6	0,5	1,3	1	1,1	3,5	1,4	0,5	0,8	0,4
W	5	2	< 1	2	1	5	4	4	3	1	3	3	2	2	2
Tl	3,7	0,5	0,1	< 0.1	0,2	3,1	1,6	1,3	0,2	0,5	1,2	1,6	0,5	0,9	0,6
Pb	130	10	< 5	34	40	108	10	53	61	19	60	65	21	33	39
Bi	4,8	< 0.4	< 0.4	< 0.4	0,8	3,1	< 0.4	0,4	0,9	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Th	27,3	1	0,8	5,6	13,2	24,8	3,1	32,7	28,9	15,8	44,6	36,2	14,8	24,5	9,7
U	3,9	0,6	0,4	1,2	3,7	2,5	1	8,3	9,5	3,3	11,8	8,2	4	6,5	2,5

Table 2a: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods (*continued*).

Sample	S-7	S-17	S-24	S-1X	S-4	S-26	S-32	S-33	S-41	S-43	S-44	S-37X	S-5	S-19	S-31
Rock type	Biotite Tuff	Tuff	Tuff	Vug,peb,xlt. ls	vug.xlt.ls.	Vug.ls	Peb.vug.xlt.ls	Fos.ls	Vug.ls.	Vug. ls.	Vug.ls	ls.	Shell ls	Shell ls	Shell ls
Location	Ded.Alex Iii	Inside Rotunda	Miles. Ded.	Quarry 2	Theat. Circle	Stoa	Rotunda	Choral Dancers	Propylon	Hieron	Hieron	Rd.Near Port	Theat. Circle	Votive Gifts	Votive Gifts
Weight %															
SiO_2	58,27	38,23	51,72	6,86	4,04	6,45	14,03	1,44	10,76	2,63	1,66	2,06	3,75	4,41	4,35
Al_2O_3	14,81	10,88	14,65	1,83	1,16	1,84	3,66	0,42	2,72	0,77	0,52	0,64	1,34	0,81	1,02
TiO_2	0,367	0,269	0,483	0,119	0,063	0,162	0,348	0,019	0,216	0,059	0,035	0,033	0,055	0,024	0,036
Fe_2O_3	1,79	1,63	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	0,9	< 0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
MnO	0,084	0,16	0,125	0,119	0,049	0,3	0,088	0,372	0,055	0,126	0,104	0,072	0,042	0,046	0,051
MgO	1,1	3,04	2,2	0,91	0,95	5,95	1,35	0,42	1,15	0,9	0,98	0,56	0,37	0,32	0,32
CaO	3,42	21,16	7,56	48,95	51,39	41,9	42,32	52,96	44,75	51,92	52,61	52,94	52,47	53,29	51,28
Na_2O	1,46	2,01	2,26	0,4	0,14	0,3	0,73	0,05	0,52	0,13	0,11	0,09	0,17	0,13	0,16
K_2O	10,27	3,58	3,77	0,25	0,2	0,17	0,36	0,08	0,3	0,12	0,08	0,12	0,18	0,18	0,2
P_2O_5	0,17	0,22	0,14	0,06	0,04	0,1	0,12	0,07	0,08	0,04	0,05	0,05	0,06	0,14	0,12
LOI	-	19,37	11,1	39,33	41,15	39,79	34,18	42,7	36,75	42,21	42,72	42,66	41,59	41,06	41,51
LOI2	-	19,36	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	92,75	100,7	99,04	99,91	99,98	99,4	99,77	98,84	98,91	99,39	99,31	99,59	100,6	100,7	99,46
Total 2	92,64	100,6	-	-	-	-	-	-	-	-	-	-	-	-	-
$Fe_2O_3(T)$	2,8	1,74	5,05	1,07	0,78	2,43	2,6	0,3	1,63	0,49	0,43	0,37	0,57	0,29	0,41
ppm															
Sc	4	4	13	2	1	6	7	< 1	5	1	< 1	1	1	< 1	< 1
Be	2	4	3	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
V	63	51	105	27	17	94	65	9	37	29	18	9	15	10	8
Cr	30	< 20	90	< 20	< 20	20	50	< 20	30	< 20	< 20	< 20	< 20	< 20	< 20
Co	7	3	15	< 1	< 1	5	3	< 1	1	< 1	< 1	< 1	< 1	< 1	< 1
Ni	< 20	< 20	30	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Cu	40	20	30	20	< 10	80	10	10	10	30	20	20	30	< 10	< 10
Zn	110	90	60	100	< 30	430	< 30	< 30	30	40	< 30	< 30	< 30	< 30	< 30
Ga	16	12	16	2	1	2	4	< 1	3	< 1	< 1	< 1	2	< 1	1
Ge	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
As	< 5	6	< 5	< 5	< 5	9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Rb	274	110	117	14	11	7	16	4	13	6	4	5	8	6	7
Sr	125	722	307	395	307	165	313	375	253	364	397	506	1425	363	322
Y	19	10	20	5	4	11	9	4	6	4	4	7	5	4	5
Zr	202	122	144	21	18	23	39	7	28	11	9	9	14	9	13
Nb	21	10	7	3	< 1	1	2	< 1	1	< 1	< 1	< 1	2	1	< 1
Mo	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2

Table 2b: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods.

Sample	S-7	S-17	S-24	S-1X	S-4	S-26	S-32	S-33	S-41	S-43	S-44	S-37X	S-5	S-19	S-31
Rock type	Biotite Tuff	Tuff	Tuff	Vug,peb,xlt. ls	Vug.xlt.ls.	Vug.ls	Peb.vug.xlt.ls	Fos.ls	Vug.ls.	Vug. ls.	Vug. ls	Ls.	Shell ls	Shell ls	Shell ls
Location	Ded.Alex III	Inside Rotunda	Miles. Ded.	Quarry 2	Theat. Circle	Stoa	Rotunda	Choral Dancers	Propylon	Hieron	Hieron	Rd.Near Port	Theat. Circle	Votive Gifts	Votive Gifts
ppm															
Ag	2	1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
In	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Sn	3	1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sb	0,8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	1,5	8,6	7,8	4,4	2,6	1,6	4,5	< 0.5	3	1,9	1,3	1,6	0,8	< 0.5	0,7
Ba	723	1420	464	428	190	68	315	216	117	72	44	47	75	81	55
La	36	42,9	27,6	5,8	4,9	4	6,1	2,1	5,3	2,9	2,2	2,3	7,5	5,1	5,2
Ce	69,1	76,2	54,1	10,7	8,5	7,3	12,2	3,8	9,7	5,2	3,9	3,1	17	10,6	11,6
Pr	7,96	8,39	6,14	1,3	1,03	0,93	1,49	0,43	1,22	0,59	0,45	0,44	1,74	1,2	1,23
Nd	28	29,4	21,3	4,9	3,7	4	5,7	1,5	4,5	2,4	1,7	1,6	6,9	4,6	4,8
Sm	4,8	4,4	4,5	1	0,7	0,9	1,5	0,3	1	0,5	0,4	0,4	1,5	1,1	1
Eu	1,07	1,2	1	0,23	0,15	0,33	0,44	0,08	0,3	0,11	0,1	0,1	0,32	0,23	0,24
Gd	4,1	2,8	3,9	0,9	0,5	1,4	1,6	0,3	1	0,5	0,4	0,5	1,2	0,9	0,9
Tb	0,6	0,4	0,6	0,2	< 0.1	0,2	0,3	< 0.1	0,2	< 0.1	< 0.1	< 0.1	0,2	0,1	0,1
Dy	3,5	2,1	3,8	0,9	0,6	1,5	1,6	0,2	1	0,5	0,4	0,5	0,9	0,8	0,7
Ho	0,7	0,4	0,7	0,2	0,1	0,4	0,3	< 0.1	0,2	0,1	< 0.1	0,1	0,2	0,2	0,1
Er	2,1	1,1	2,1	0,5	0,3	1,1	1	0,1	0,6	0,3	0,2	0,3	0,5	0,4	0,3
Tm	0,33	0,15	0,3	0,08	< 0.05	0,17	0,15	< 0.05	0,09	< 0.05	< 0.05	0,05	0,06	0,05	< 0.05
Yb	2,4	1	1,9	0,5	0,2	1,2	0,9	0,1	0,6	0,3	0,3	0,4	0,4	0,3	0,3
Lu	0,36	0,14	0,29	0,07	< 0.04	0,18	0,14	< 0.01	0,09	0,05	< 0.01	0,05	0,05	0,04	0,04
Hf	4,4	2,8	3,7	0,4	0,3	0,5	0,9	< 0.2	0,6	0,2	< 0.2	< 0.2	0,3	< 0.2	0,3
Ta	5,9	1,7	0,7	0,7	< 0.1	< 0.1	0,2	< 0.1	0,1	< 0.1	< 0.1	< 0.1	0,6	1,1	< 0.1
W	2	6	2	2	< 1	1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tl	1,3	0,7	0,3	0,4	0,3	0,3	< 0.1	0,2	< 0.1	< 0.1	< 0.1	0,4	0,2	< 0.1	< 0.1
Pb	57	63	21	22	9	366	60	10	11	137	70	18	36	6	14
Bi	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Th	22	19,4	19,4	2	1,5	1	1,8	0,9	1,6	0,9	0,7	0,6	2,1	1,8	1,9
U	5,9	4,6	3,6	3,1	2,3	1,3	0,6	4,6	0,6	6,3	5,4	0,6	0,6	0,5	0,8

Table 2b: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods (*continued*).

Sample	S6	S10	S-25	S-45	S-20X	S-39X	S-34	S-42	S18	S-27	S8X	S15X	S22	S-28
Rock type	Foss.dol.ls	Dol. ls	Vug.dol.Ls	Lt.tan dol. ls.	Dol.ls	Dol. ls	Dol. ls.	Dol. ls.	Calc.peb ss.	Calc. ss.	Siltstone	Jasper	Peb.mudstone	Mudst. breccia
Location	Ded.Alex III	S. end Stoa	Stoa	Stoa	Quarry1	Quarry 1	Anaktoran	Propylon	Nike	Nike	Basal Series	Near bridge	Altar Court	Altar Court
Weight %														
SiO_2	4,7	8,17	12,04	7,6	1,03	1,38	1,22	13,21	15,15	11,4	74,45	72,47	49,06	46,64
Al_2O_3	1,47	2,05	3,25	2,26	0,33	0,21	0,53	3,46	2,18	1,52	11,12	7,31	14,53	14,17
TiO_2	0,072	0,181	0,278	0,216	0,013	0,008	0,018	0,292	0,101	0,084	0,495	0,445	0,805	0,73
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MnO	0,303	0,231	0,224	0,251	0,03	0,034	0,045	0,388	0,04	0,03	0,1	0,081	0,155	0,161
MgO	17,76	14,37	16,9	13,54	19,15	18,67	20	15,02	1,94	1,7	1,65	1,42	2,11	1,95
CaO	30,7	31,95	26,07	31,96	31,98	31,63	30,91	27,01	42,76	45,45	0,96	6,92	6,08	8,62
Na_2O	0,49	0,41	0,74	0,4	0,41	0,34	0,25	0,68	0,41	0,21	0,33	0,26	1,13	1,35
K_2O	0,25	0,23	0,32	0,22	0,07	0,05	0,1	0,38	0,36	0,15	2,41	0,14	4,21	4,24
P_2O_5	0,11	0,09	0,1	0,08	0,05	0,06	0,09	0,1	0,11	0,08	0,08	0,05	0,48	0,48
LOI	43,08	40,44	38,5	40,75	46,31	46,37	46,17	37,56	34,46	37,72	3,9	-	13,31	14,97
LOI2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	100,1	99,32	100,3	98,72	99,53	98,9	99,62	100	98,76	99,52	100,4	96,97	99,05	99,52
Total 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fe_2O_3(T)	1,16	1,2	1,91	1,45	0,17	0,16	0,3	1,92	1,25	1,17	4,91	7,88	7,17	6,21
ppm														
Sc	2	5	6	5	1	< 1	< 1	6	3	3	10	10	14	13
Be	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	< 1	2	2
V	37	44	65	39	10	7	9	49	29	23	97	102	118	90
Cr	< 20	30	40	30	< 20	< 20	< 20	40	230	220	80	80	< 20	< 20
Co	4	6	8	7	< 1	< 1	< 1	12	3	3	13	16	12	12
Ni	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	60	60	60	80	< 20	< 20
Cu	50	40	20	30	< 10	< 10	< 10	50	10	10	50	20	40	30
Zn	190	300	270	260	< 30	< 30	< 30	430	40	< 30	80	50	80	80
Ga	2	3	4	3	< 1	< 1	< 1	4	2	2	15	11	15	14
Ge	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	3	1	< 1
As	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	5	< 5
Rb	9	11	13	11	3	< 2	4	16	13	6	91	3	98	86
Sr	227	158	210	148	311	414	326	218	302	433	24	279	497	529
Y	5	6	8	7	2	2	4	8	8	8	21	7	27	25
Zr	16	31	39	38	5	4	6	44	21	15	164	51	147	152
Nb	< 1	2	2	1	< 1	< 1	< 1	2	2	1	11	22	5	5

Table 2c: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods.

Sample	S6	S10	S-25	S-45	S-20X	S-39X	S-34	S-42	S18	S-27	S8X	S15X	S22	S-28
Rock type	Foss.dol.ls	Dol. ls	Vug.dol.ls	Lt.tan dol. ls.	Dol.ls	Dol. ls	Dol. ls.	Dol. ls.	Calc.peb ss.	Calc. ss.	Siltstone	Jasper	Peb.mudstone	Mudst. breccia
Location	Ded.Alex III	s. end Stoa	Stoa	Stoa	Quarry1	Quarry 1	Anaktoran	Propylon	Nike	Nike	Basal Series	Near bridge	Altar Court	Altar Court
ppm														
Mo	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	3	< 2	< 2
Ag	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1,5	< 0.5	1,3	< 0.5
In	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Sn	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	3	< 1	1
Sb	2,9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	2,1	2,7	3,8	3,8	< 0.5	< 0.5	1	4,1	0,9	0,7	3,4	0,5	2,9	2,8
Ba	100	71	92	65	34	23	27	148	118	34	269	53	716	691
La	3,1	4,4	5,4	4,4	1	0,7	1,7	6,5	7,5	4,8	20,8	7,4	36,5	34,2
Ce	5,7	8,4	11,2	8,5	1,9	1,2	2,9	14	11,7	7,4	40,9	12,3	73,4	71,3
Pr	0,7	1,06	1,34	1,09	0,24	0,15	0,36	1,63	1,65	1,08	4,74	1,43	9,19	8,79
Nd	2,6	4,3	5,5	4,3	1	0,5	1,5	6,2	6,2	4,3	17,8	5,7	36,6	34,9
Sm	0,5	1	1,3	1	0,2	0,2	0,3	1,4	1,3	1	3,6	1,2	7,4	7,2
Eu	0,13	0,26	0,39	0,31	< 0.05	< 0.05	0,08	0,41	0,34	0,25	0,75	0,42	1,76	1,83
Gd	0,6	0,9	1,4	1	0,2	0,2	0,3	1,4	1,3	1,1	3,4	1,3	6,2	5,8
Tb	0,1	0,2	0,2	0,2	< 0.1	< 0.1	< 0.1	0,2	0,2	0,2	0,6	0,2	0,9	0,8
Dy	0,6	1	1,4	1,2	0,3	0,2	0,2	1,5	1,3	1,1	3,7	1,4	5,3	4,9
Ho	0,1	0,2	0,3	0,2	< 0.1	< 0.1	< 0.1	0,3	0,3	0,2	0,8	0,3	1	0,9
Er	0,4	0,6	0,8	0,7	0,2	< 0.1	0,1	0,9	0,8	0,6	2,4	0,9	2,9	2,6
Tm	0,06	0,08	0,12	0,11	< 0.05	< 0.05	< 0.05	0,13	0,11	0,09	0,38	0,13	0,46	0,4
Yb	0,4	0,5	0,8	0,7	0,1	0,1	0,1	0,8	0,7	0,6	2,6	0,9	2,9	2,7
Lu	0,06	0,08	0,11	0,1	< 0.04	< 0.01	< 0.01	0,12	0,1	0,09	0,41	0,14	0,44	0,39
Hf	0,3	0,7	0,8	0,8	< 0.2	< 0.2	< 0.2	1	0,5	0,3	3,6	1	3,1	3,5
Ta	< 0.1	0,1	0,1	< 0.1	< 0.1	< 0.1	< 0.1	0,1	0,3	< 0.1	1,3	7,6	0,4	0,3
W	1	1	2	1	< 1	< 1	< 1	2	1	3	2	2	6	< 1
Tl	0,6	0,1	0,4	0,2	< 0.1	< 0.1	< 0.1	0,2	< 0.1	< 0.1	0,5	< 0.1	0,2	0,2
Pb	197	118	241	173	< 5	6	< 5	329	15	6	22	9	22	21
Bi	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Th	0,9	1,3	1,8	1,2	0,4	0,2	0,6	2,4	1,7	0,8	9,9	1,6	13,6	12,9
U	1,9	2,8	0,9	0,8	2,4	2,1	2,7	1,4	1,1	0,8	1,9	0,4	3,7	3,7

Table 2c: Whole-rock chemical analyses of rocks from Samothrace, both within and outside the Sanctuary of the Great Gods (*continued*).

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ADVANCES IN PROVENANCE TECHNIQUES, METHODOLOGIES AND DATABASES

POLISHED STONE SLABS AND *OPUS SECTILE* TILES FROM THE PROMONTORY PALACE AT CAESAREA MARITIMA

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Abstract

Over 1500 worked and polished stone slabs were uncovered during archaeological excavations of King Herod the Great's Promontory Palace at *Caesarea Maritima*, and include varieties of marble, limestone, breccia, alabaster, porphyry and granite. Snyder created a database that has the capability of discriminating among the huge variety and number of pieces to discern their associations and similarities across time and space. By analyzing the varieties of stones as well as the sizes and shapes of the *opus sectile* tiles, we are able to determine the type of decorations initially used by King Herod, the nature of subsequent renovations, and the approximate date of the Palace's final use.

Keywords: *Caesarea Maritima*, Promontory Palace, *opus sectile*.

Introduction

Archaeological excavations of the Promontory Palace at Caesarea Maritima began in 1976 under the direction of the late Prof. Ehud Netzer and L.I. Levine of the Hebrew University of Jerusalem, and continued on a larger scale from 1990 to 1996 under Prof. Kathryn Gleason and Prof. Barbara Burrell, at first under the aegis of the University of Pennsylvania, and later of Cornell University and the University of Cincinnati. Current research is supported by the Louise Taft Semple Fund of the Classics Department, University of Cincinnati.

Excavations revealed architectural remains from the Herodian through Byzantine periods (37 BCE-640 CE). The Promontory Palace is comprised of two connected palaces built by King Herod the Great: the more private Lower Palace, probably built between 22 and 15 BCE, and the more ceremonial and public Upper Palace, added between 15 and 10 BCE (Fig. 1). After the Herodian period, the complex continued to be used in the Late Roman and Byzantine periods as the Praetorium of the Roman governor.

Over 1500 worked and polished stone slabs were uncovered, but none *in situ*. Although architecturally termed "ancient marbles", petrologically these stones include marble, breccia, alabaster, porphyry, granite, limestone and bituminous chalk (bitumen)[1]. While limestone and bitumen were quarried in Israel, the remainder were imported from various countries around the Mediterranean (Fig. 1) Pensabene, Bruno (1998). During the centuries the Promontory Palace was in use, the complex underwent renovations that included the import of numerous stone varieties, depending on their popularity and availability, resulting in over 30 varieties being identified here.

[1] Our thanks to Prof. Lorenzo Lazzarini, Venice, Italy, and Matthias Bruno, Rome, Italy, for their expertise and assistance in identifying the materials from which the ancient tiles and slabs were crafted.

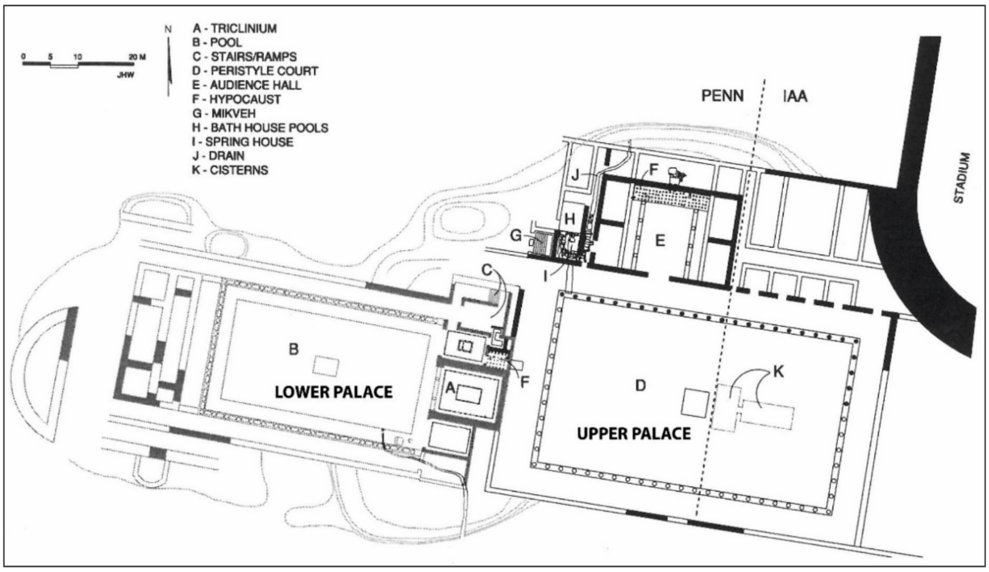

Figure 1: Plan of Upper and Lower Palaces, c. 15 BC (Plan: J.H. Williams in Gleason *et al*. 1998, Fig. 4c).

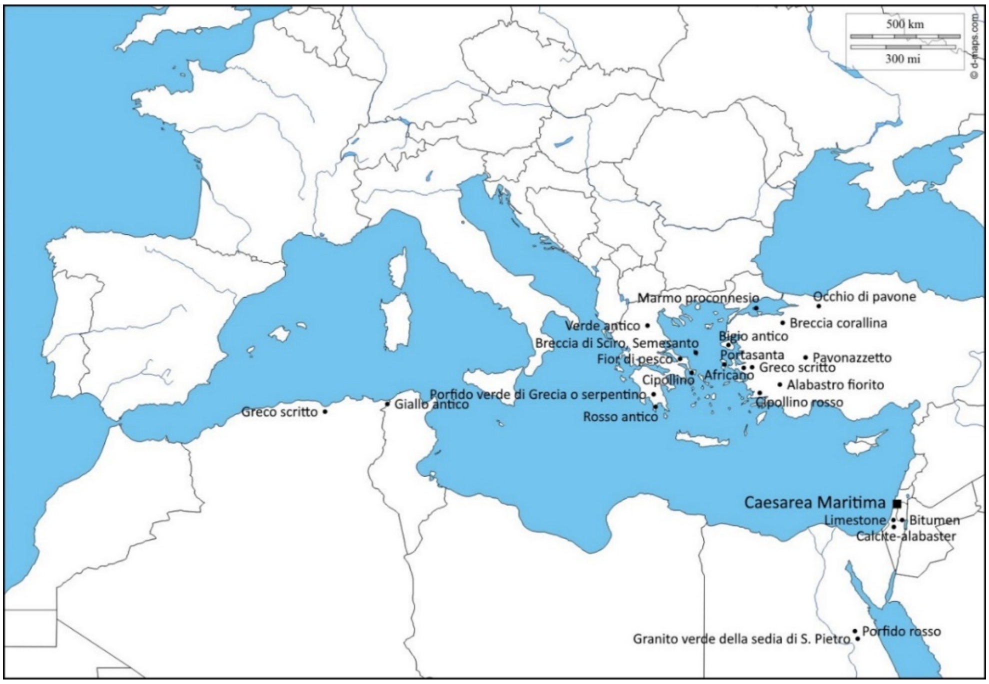

Figure 2: Ancient Marble Sources (Blank Mediterranean Sea map courtesy of d-maps.com: https://d-maps.com/carte.php?num_car=3140&lang=en).

The elegance, durability and versatility of imported marble would make it a foremost choice for decorative architectural elements in Israel from the Roman period on (Fischer 1998: 284). Josephus noted Herod's use of imported materials at *Caesarea*: "But what was especially notable about this construction was that he got no material suitable for so great a work from the place itself, but completed it with materials brought from outside at great expense" (*Antiquities* 15.331-341). Further, "He also adorned [*Caesarea Maritima*] with the most magnificent palaces, displaying here, as nowhere else, the innate grandeur of his character" (*Wars* 1.408). As has long been noted, however, despite Josephus' descriptions of *Caesarea*'s buildings as "white stone", Herod's use of marble in this and other building projects was actually limited to *opus sectile* tiles and a few furnishings, such as the threelegged marble *labrum* found in Lower Herodium (Fischer, Stein 1994, 79-85; Netzer *et al*. 2013, 144-145).

By the beginning of the 2nd century CE, the Romans had developed a marble quarrying and trading system, and *Caesarea* became the marble harbor of Roman Palestine. Marble began to appear in sculptures and pedestals for inscriptions (Burrell 2018, 341-346). The marble slabs found in the Promontory Palace also reflect the city's appetite for this new and lavish architectural style.

Marble usage within the Promontory Palace

The 1500 slabs in this assemblage consist of finds discovered in datable fills in occupational layers of the Palace and in debris above the original floor levels of the site. Their original uses may be broadly categorized as *opus sectile* tiles, wall revetments, and floor pavement slabs.

Opus sectile *tiles*

King Herod the Great introduced to his kingdom the latest trend in Roman flooring, *opus sectile* tiles. *Opus sectile* (Latin "cut work") is a technique for paving floors and walls with cut and polished polychrome stone tiles to create geometric patterns or figurative scenes. The floors appeared at least by the 4th-century-BCE in Greek architecture, such as in the Altar Court at Samothrace (Dunbabin 1999, 254). By the late 2nd century BCE, the *opus sectile* technique had been adopted by the Romans, for example, in the *cella* of the Temple of Apollo (Blake 1930, 35, Pl. 6.1), and in the vestibule, the *impluvium* of the atrium, and the *tablinum* in the House of the Faun in Pompeii (Blake 1930, 38-39, Pl. 6.3-4). Initially, use of these tiles was limited to the central area of a floor, surrounded by a simple white mosaic background, but during the Augustan Age, the popularity of *opus sectile* increased, entire floors were paved in this technique, and standard geometric patterns were established (Guidobaldi 1985, 176ff; Dunbabin 1999, 259). Non-marble materials such as limestone and slate had been used in the earliest *opus sectile* floors, but ancient marble, both Italian and imported, became the fashion in the Roman world in the mid-1st century BCE (Blake 1930, 35-41; Guidobaldi 1985, 223-224; Dunbabin 1999, 254-255).

In Herodian structures, evidence of *opus sectile* use – *in-situ* tiles, tile impressions in foundational mortar, and/or scattered tiles and fragments – was found primarily in *triclinia* and bathhouses, with the materials and tile patterns varying from site to site. Evidence of *opus sectile* use has been recovered at these Herodian sites: Banias (Netzer 1998, 13; Bar-Nathan, Snyder, in press), Cypros (Snyder, Avraham 2013, 178-202), Herodium (Netzer *et al*. 2005, 33-36; Porat *et al*. 2018, 155; Snyder (forthcoming), Jericho (Rozenberg 2008, 526-543), Masada (Foerster 1995, 158-161), Machaerus (Loffreda 1981, 87; Vörös 2015, 332-335), Tiberias (Hirschfeld, Galor 2007, 214, 221-224)[2], and on the Temple Mount (Snyder *et al*. 2016, 56-59). With the use of *opus sectile* tiles prevalent in Herod's architecture, it would be consistent with his style to find them in his Promontory Palace at Caesarea.

When the *opus sectile* craft was first imported for Herodian projects, it is quite possible that well-trained and experienced masons were brought from Rome to work with local craftsmen, a common practice in the Roman Empire (Foerster 1995, xviii, xxi; Rozenberg 2008, 533). On-site *opus sectile* workshops at Herodian palaces are indicated by the discovery of waste marble fragments at Jericho, polished tile fragments embedded in the mortar under the *opus sectile* tiles at Cypros and Upper Herodium, and the piecing together of

[2] This structure is believed to be the palace of Herod's son Herod Antipas mentioned by Josephus in *Vita* 64-66.

tile segments to create full tiles at Jericho and Cypros (Rozenberg 2008, pl. B70.13.3-4, Ills. 738-739; Snyder, Avraham 2013, figs. 8.21-23; Snyder *forthcoming*).

An *opus sectile* floor dating to the 1st century CE was found in the *Caesarea* theater, about 120 m SE of the Promontory Palace. The original floor of the semicircular orchestra was paved with 14 successive layers of frescoed plaster, then later with an *opus sectile* floor of white and colored marbles (Albriccia 1966, 109).

Opus sectile floors continued to be used in what today are Israel, the West Bank, and the westernmost part of Jordan on a limited basis in the Late Roman period (70-324 CE), and enjoyed a resurgence of popularity in this region of the Levant in the Byzantine period (324-640 CE), particularly in churches and bathhouses.

A unique and innovative *opus sectile* style developed in the Byzantine period featured elaborate, ornate patterns with many curvilinear-cut tiles. Tiles were not only cut into small geometric shapes and long narrow bands, but also into circles, circle segments, tear drops, floral designs, and narrow curved circular and spiral strips (Fig. 3). While most *opus sectile* floors were constructed on-site using geometric-shaped tiles laid directly onto foundational mortar, this style used pre-fabricated *opus sectile* panels. During the excavations of Caesarea by Porath, a Byzantine-era workshop where these panels had been manufactured was discovered about 150 m NE of the Promontory Palace. The intricately prepared *opus sectile* tiles were placed face down in the desired pattern on a flat surface, then covered with a layer of binding plaster. A matrix of pottery sherds was placed over the plaster to form a backing for the entire panel. Once the plaster solidified, the complete multi-layered panel could be delivered to the customer. The materials used at the workshop included colorful marble, limestone, alabaster, slate, porphyry and granite (Porath 2000, fig. 57; Dray 2011, 141-148, figs. 1-15; Snyder 2018, 13-18). *Opus sectile* floors using these pre-fab panels were discovered in Jerusalem in Byzantine churches on the Mount of Olives (Bliss, Dickie 1898, 220-221) and on Ketef Hinnom (Barkay 1986, 16; 2000, 89; Avner, Zelinger 2015, fig. 19.2).

Figure 3: *Caesarea*, Promontory Palace, *opus sectile* tiles with curvilinear edges (Photo: F. Snyder).

Based on their size, shape, material, color and craftsmanship, approximately 600 tiles and fragments from the Promontory Palace assemblage can be identified as potentially being *opus sectile*. Some can be dated to the time of Herod while others are more typical of later, especially Byzantine, styles.

Wall revetments

Wall revetments, thin panels of marble or marble-like materials mortared to walls, were utilized to add elegance, luxurious coloring, and the beauty of nature to the architecture of buildings. However, there is no evidence of revetment use in Herod’s palaces. Instead, *in-situ* frescoed walls, like those in the Northern Palace at Masada, give the illusion of an alabaster wall (Rozenberg 2008, Ills. 382-386). In the Promontory Palace, the *triclinium* in the

Lower Palace has traces of frescoed wall-plaster likewise imitating marble walls or revetments (Gleason *et al.* 1998, 29).

Use of actual marble revetments began in this region in the Late Roman period and continued into the Byzantine period. Popular marbles for revetments were the gray-streaked white prokonnesian marble and green cipollino verde whose alternating light and dark veins could be used to create interesting designs by juxtaposing halved and quartered panels (Greenhalgh 2009, 201, 625).

Over 800 slabs and fragments from the Promontory Palace stone assemblage can be identified as potential wall revetments. Their thickness generally ranges from c. 1.5 to 2.5 cm. One definitive sign that a marble slab was used as a revetment is small holes, c. 0.6 cm in diameter and c. 1.5-2.0 cm deep, drilled inward along the edge of the slab for anchoring the revetment to the wall with metal pins. Multiple slab fragments from the Palace have these drilled holes.

Figure 4: *Caesarea*, Promontory Palace, *torus* moulding strips, four of marmo proconnesio surrounding one of greco scritto (Photo: F. Snyder).

Torus *moulding strips*

A decorative element often used with wall revetments is a narrow marble moulding strip with a long, convex, well-polished edge, semicircle in profile, known in architecture as *torus* moulding (Fig. 4). This convex edge could be used as a vertical or horizontal decorative border between two revetment panels or as a horizontal finishing moulding above the dado panels (Ball 2002, 572-573, fig. 29; Greenhalgh 2009, 625). Another use was as a raised dividing element between the floor and a small inset pool, like the moulding strips found surrounding the sides of a small pool in the *triclinium* of the lower Promontory Palace (Blake 1930, pl. 31.1).

In the Promontory Palace material 53 *torus* moulding strip fragments were recovered: 50 of white or prokonnesian marble, and one each of greco scritto, cipollino rosso/rosso antico, and breccia di Sciro.

Floor pavement slabs

Marble floor slabs were typically rectangular and thick, with a polished upper surface and a chipped or point-chiseled lower surface. One complete marble floor slab was found *in-situ* in the Lower Palace. Another 110 slabs were found, ranging in thickness from 3.0 to 6.9 cm, the thickness suggesting these may have been used as flooring. Twenty-two of the thicker slabs have a point-chiseled lower surface, and are either white or prokonnesian marble.

Figure 5: Marbles and breccias: **1**. pavonazzetto; **2**. rosso antico; **3**. bigio di Lesbo; **4**. portasanta; **5**. semesanto; **6**. verde antico; **7**. marble, variety uncertain; **8**. occhio di pavone; **9**. giallo antico; **10**. Greco scritto; **11**. africano; **12**. cipollino; **13**. breccia pavonazza; **14**. white marble; **15**. prokonnesian marble; **16**. portasanta; **17**. breccia di Sciro (Photos: F. Snyder; Illustration: J. Wallrodt).

Ancient decorative marble varieties

A sample slab or *opus sectile* tile from each material from which the Promontory Palace polished slabs were made are presented here: Marble and breccia (Fig. 5) and other Miscellaneous Stones (Fig. 6).

Figure 6*:* Other miscellaneous stones: **1**. slate, **2**. local limestone; **3**. bitumen; **4**. mica schist; **5**. granito verde della sedia di San Pietro; **6**. porfido rosso; **7**. porfido verde di Grecia o serpentino; **8**. alabastro fiorito; **9**. local limestone; **10**. local calcite-alabaster; **11**. imported limestone, variety uncertain (Photos: F. Snyder; Illustration: J. Wallrodt).

Discussion

The *opus sectile* tiles and polished ancient marble slabs that remain from the many phases of the Promontory Palace at Caesarea provide us with clues to its extravagant interior decorations over its centuries of use. Although the slabs and tiles were generally not found *in situ*, it is possible to begin to differentiate among materials from the Herodian, late Roman and Byzantine periods by comparing the stone varieties recovered here with those found in comparable sites in Israel. In addition, a small group of stones was found within a specific datable context in the palace (Fig. 7). The sizes, shapes and materials of some of the *opus sectile* tiles provide further dating evidence.

Herodian period materials

Imported stones used for *opus sectile* tiles and stone vessels from Herodian palaces provide vital information for determining which materials from the Promontory Palace can be dated specifically to the Herodian period. The palaces at Banias, Cypros, Herodium, Jericho, Machaerus, Masada and Tiberias were used as royal residences only during the Herodian/Early Roman period and not during the Late Roman and Byzantine periods, as was not the case at the Promontory Palace at *Caesarea*. Therefore, a comparison was made between the imported stones from these Herodian palaces and those from *Caesarea* to define which stone varieties most likely were imported during the earliest phase of the Promontory Palace.

Tab. 1 presents imported stones found at various Herodian palaces. This table is a result of a 10-year study by one of the authors of this article (Snyder) focusing on the materials used for *opus sectile* tiles and objects made of imported stones found in these palaces. In the table, an “X” represents *opus sectile* tiles, and an “O” represents some another object, such as a stone vessel or table.

Since the imported materials from the Promontory Palace are of mixed dates, the materials associated with floors and walls in Late Roman and Byzantine period structures in Israel were eliminated, resulting in Tab. 2[3]. This reduced the list in Tab. 1 from 31 materials of possibly mixed dates to ten having a very high probability of being specifically from the Herodian period. Of these ten stone varieties, five are represented in the Caesarea assemblage. Three of Herod’s favorite imported materials, africano, giallo antico and portasanta, whose quarries went out of use by the end of the Roman period, are represented here. These three have been found at every Herodian site which used *opus sectile* tiles of imported stones. The numbers in the Caesarea column represent the number of stone slabs of that variety found in the Palace.

One locus of the Promontory Palace provided information useful for determining materials used specifically during the Herodian period (Fig. 7). The stratified complex of stairs and ramps connecting the Upper and Lower Palace levels (Area C, Fig. 1 above) saw use during all phases of the building’s occupation. The material in the upper debris layer P3013 of the ramp consists of sand and pebbles mixed with pottery sherds and contained 28 polished stone slab fragments that had been used, then discarded, and incorporated into the ramp fill (Gleason *et al.* 1998, 40-43, Fig. 10). The stone varieties in P3013 were africano, breccia di Sciro, giallo antico, limestone, pavonazzetto, portasanta, and white marble (varieties uncertain). All pottery in debris layer P3013 is dated to the 1st century CE, thus the stone slabs in this locus likewise had been discarded in the 1st century CE, indicating they were part of the early construction phase of the building.

Imported stone use during the Herodian period was limited to *opus sectile* tiles and a few stone objects. There is no evidence of any other architectural use of imported stones in any Herodian structures. Therefore, the stone slabs from debris layer P3013 can be assumed to represent some of the *opus sectile* tiles used in the Herodian phase of the Palace.

Late Roman period materials

Imported marble was used in the Roman period in the region of modern Israel, the West Bank, and the westernmost part of Jordan mainly during the 2nd and 3rd centuries CE,

[3] Marble slabs and *opus sectile* tiles have been recently found at archaeological sites in Israel dating to the Late Roman and/or Byzantine periods, and their archaeological reports are now being prepared for publication. My thanks to Dr. Rachel Bar-Nathan, Israel Antiquities Authority, and Prof. Adi Erlich, University of Haifa, for allowing me to view the slabs and tiles from Ashkelon and Beit She’arim, respectively.

and was part of the Imperial system of marble quarrying and trade. This importation continued on into the Byzantine Period. The primary usage of marble was for architectural elements in public monumental projects, and some for sculptures and sarcophagi. About 80% of these imported architectural elements are made of prokonnesian marble (Fischer 1998, 257-258).

Marble slabs of marmo proconnesio, white marble and cipollino verde, the varieties most popularly used as wall revetments in Late Roman and Byzantine buildings in Israel, account for over half of the stone slabs from the Promontory Palace. This volume of slabs indicates later renovations of the Palace included the replacement of earlier frescoed walls with the then-popular marble cladding. Unfortunately, with out-of-context marble slabs from the Palace, it impossible to differentiate between those of the Late Roman and those of the Byzantine periods. Therefore, in this report, the materials from these two time periods must be treated together.

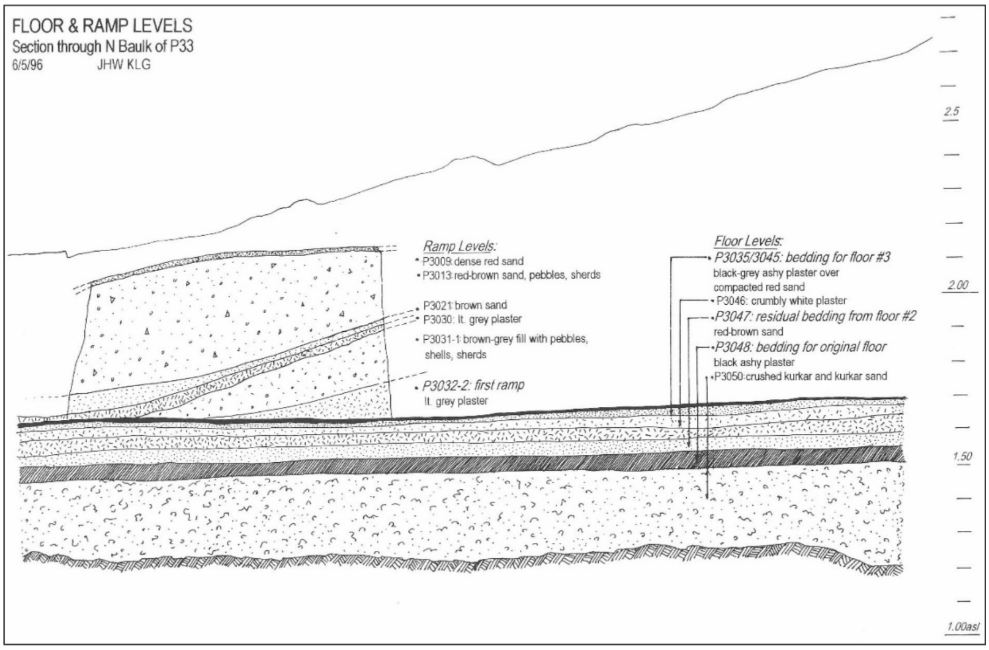

Figure 7: Section of stairwell/entry area showing ramp sequence (after Gleason *et al.* 1998, Fig. 10). Note debris layer P3013.

Byzantine period materials

One particular *opus sectile* style is distinctive to the Byzantine period in Israel: prefabricated *opus sectile* panels that utilized very intricately cut tiles to create elaborate and ornate designs. From the Promontory Palace assemblage, approximately 200 small, thin *opus sectile* tiles with many curvilinear edges are consistent in size, shape, material, color and craftsmanship with those found in the Byzantine *opus sectile* workshop just NE of the Palace (Dray 2011; Snyder 2018). The tile shapes include circle segments, tear drops, flower petals, fleur-de-lis, hearts, shields, and long narrow straight, circular and spiral strips (Fig. 3 above). The tiles were fashioned from colorful marble, limestone, alabaster, slate, porphyry, and granite. Some of these tiles were made from africano and giallo antico, stones which were no longer quarried in the Byzantine period, suggesting that the material is in secondary use.

Opus sectile panels for walls and floors featuring tiles with multiple curvilinear edges have been discovered in Italy in cities like Rome, Pompeii, Herculaneum, and Ostia, dating back to late antiquity (e.g., Guidobaldi, 1985, pls. 5.6, 6.3-6; Dunbabin, 1999, figs. 270, 276). To date, tiles with multiple curvilinear edges have only been discovered in contexts from the Byzantine period onward in the area of Israel, the West Bank, and the westernmost part of

Jordan. This intricately-cut style of *opus sectile* tile was used in this region primarily in Byzantine-era churches, but was also found in the residential neighborhood in Caesarea just NE of the Promontory Palace.

These tiles attest to the building's continued renovation and use well into the Byzantine period. The last days of the workshop have been dated by its excavators to late-6^{th} or early-7^{th} century CE, suggesting that the Promontory Palace was still in use at this time (Dray 2011, 148).

Conclusion

Although the ancient marble slabs are broken and not *in situ*, the imported materials themselves can sometimes reveal their dates of use. The popularity of the marble varieties, the limited quarrying dates, and the sizes and shapes of the tiles give us a picture of the lavish architectural style of the Promontory Palace and its longevity. From this study we may now suggest the following:

In addition to using *opus sectile* tiles of local limestone and black bituminous chalk (bitumen), King Herod the Great decorated his Promontory Palace at Caesarea Maritima with *opus sectile* tiles made of imported stones consistent in size, shape, material, color and craftsmanship with those used in his other major palaces. Some of his favorite varieties – africano, giallo antico, and portasanta – were found here.

Renovations during the Late Roman and Byzantine Periods included the replacement of Herod's frescoed walls with revetments of imported marble, particularly gray-streaked white prokonnesian marble and light-and-dark-green-streaked cipollino verde.

The distinctive curvilinear *opus sectile* tiles, consistent with those from the nearby Byzantine-era workshop where prefabricated *opus sectile* panels were constructed, suggest that the Promontory Palace continued to be utilized into the late 6^{th} or early 7^{th} century of the Byzantine Period.

It is hoped that this study of the marble varieties used in the Promontory Palace in the Herodian, Late Roman and Byzantine periods will add to the corpus of knowledge of the use of marble in the Levant during these periods.

Type of stone	Banias	Caesarea	Cypros	Herodion	Jericho	Machaerus	Masada	Tiberias
Africano	X	X	X	X	X		O	X
Alabastro egiziano o cotognino	X	O		O	O		O	
Alabastro fiorito	X	X					O	
Alabaster, variety uncertain	X							
Bigio antico	X	X		X	X			
Breccia di Aleppo	X							
Breccia corallina	X			X				X
Breccia corallina giallastro	X							
Breccia pavonazza		X	X					
Breccia di scrio	X	X	X	X				X
Calcite-alabaster (local)		X						
Cipollino rosso/Rosso antico	X	X						
Cipollino		X						
Fior di pesco	X							X
Giallo antico	X	X	X	X	X			X
Granito della colonna	X							
Granito verde della sedia di San Pietro		X						
Greco scritto		X						
Limestone, black & white, variety uncertain								
Marble, variety uncertain		X						
Marmo proconnesio		X						
Mica schist		X						
Occhio di pavone		X						
Pavonazetto	X	X			X			
Porfido rosso		X				O		
Porfido verde di Grecia o serpentino		X						
Portasanta	X	X	X	X	X	O		X
Semesanto		X						
Slate		X						
Verde antico		X						
White marble, variety uncertain	X	X	X	O				

Table 1: Imported stones found at Herodian palaces, including mixed-dated materials from the Promontory Palace.

Type of stone	Banias	Caesarea	Cypros	Herodion	Jericho	Machaerus	Masada	Tiberias
Africano	X	X (25)	X		X		O	X
Alabastro fiorito	X	X (25)					O	
Alabaster, variety uncertain	X							
Breccia di Aleppo	X							
Breccia corallina giallastro	X							
Breccia pavonazza		X (2)	X					
Fior di pesco	X							X
Giallo antico	X	X (99)	X	X	X			X
Granito della colonna	X							
Portasanta	X	X (22)	X	X	X	O		X

Table 2: Imported stones found only in Herodian-era palaces and not in later structures.

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QUARRIES AND GEOLOGY:

QUARRYING TECHNIQUES, ORGANISATION,

TRANSPORT OF STONES, NEW QUARRIES,

STONE CARVING AND DRESSING,

HAZARDS TO AND PRESERVATION OF QUARRIES

STONE QUARRY SITES AT KOURION IN CYPRUS: NEW ARCHAEOLOGICAL AND GEOLOGICAL DATA

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Abstract

Despite Cyprus' key position in the eastern Mediterranean, the island has been entirely neglected in studies of the quarrying and use of stone during the Roman period. It is surprising that such a well-connected island as Cyprus has never been systematically investigated from the perspective of Roman stone exploitation. Recent archaeological surveys carried out by the present author at the city of Kourion and its surroundings have produced new data on ancient quarries, as well as the topography and geological formation of stone supplies. The study of the quarries together with a detailed analysis of the public Roman buildings within the site demonstrate the substantial reliance on localised exploitation of natural resources for the construction of the walls and paving of the floors. Local sources of suitable limestone are available in the immediate proximity of Kourion and the quarrying marks still *in situ* confirm an extensive exploitation until recent times.

Keywords: Cyprus, Kourion, stone quarries, tomb-cutting.

Description of the area

The ancient city of Kourion extends 900 metres east-west along a narrow plateau and rises to an elevation of 80 metres above sea level overlooking the fertile valley of the river Kouris and the bay. The plateau which Kourion occupies is an outcrop of calcareous soft and easily-workable limestone which features steep cliffs on three sides[1]. These cliffs were extensively quarried, especially on the south and east sides, with the aim of providing building materials for the public and private buildings as well as for the defensive structures. Evidence from Kourion consists of an interrelated combination of Ptolemaic, Roman and Byzantine buildings.

The remains from the Imperial Roman period, especially from the 2nd century AD onwards, are the best preserved and they also have been included in a restoration programme which sought to recreate their original ancient splendour. The archaeological area is vast, it includes remains from within the ancient city of Kourion and from outside. The site of Kourion can be divided into two areas: the east and the west. In the east part are the remains of the Greco-Roman Theatre and the House of *Eustolios*. Moving to the west it is possible to see the remains of the Roman Forum, the baths, the nymphaeum, the Early Christian Basilica and private houses such as the House of the Gladiators, the house of *Achilles* and the House with the earthquake evidence which is located in between the two areas. Moreover, outside the city lie the remains of two early Christian basilicas, a Roman stadium and the monumental Sanctuary of Apollo *Hylates* which remained continuously in use from the late 8th century BC to the second half of the 4th century AD[2] (Fig. 1). In addition there is more archaeological evidence dating from the Roman period. This consists of rock-cut funerary material which has been found at the foot of the site to the east and northeast as well as along the calcareous cliffs of the valley to the north of the site (Fig. 1).

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[1] Edwards *et al*. 2010, 221.

[2] For an archaeological guide of Kourion site, Christou 1996.

Figure 1: Satellite image with the location of the sites in red, location of the quarrying evidence in yellow and rock-cut tombs in green (Photo: Google Earth modıfied by M. Astolfi).

Local geology

The Kourion area geologically falls within the autochthonous sedimentary succession zone, also called Circum Troodos. The main topographic feature is the acropolis of Kourion which consists of a considerable outcrop of the Pakhna formation (Fig. 2).

The formation of the Pakhna unit is related to the subduction of the African plate beneath Cyprus which is characterised by deep-water carbonates and much more frequent shallow-water bioclastic and terrigenous sediment upward. The lithology related to the Pakhna unit presents beds and lenses of bioclastic limestone, which is a type of calcarenite with layers of well-cemented shells, and argillaceous biomicrite[3]. This limestone sequence which formed in the Miocene shows considerable variations in hardness, texture and inclusions[4]. The sequence seems to characterise the Kourion Acropolis and the entire area all along the limits of the site as well as to the north, following the palaeo-channel system of the western branch of the Kouris river.

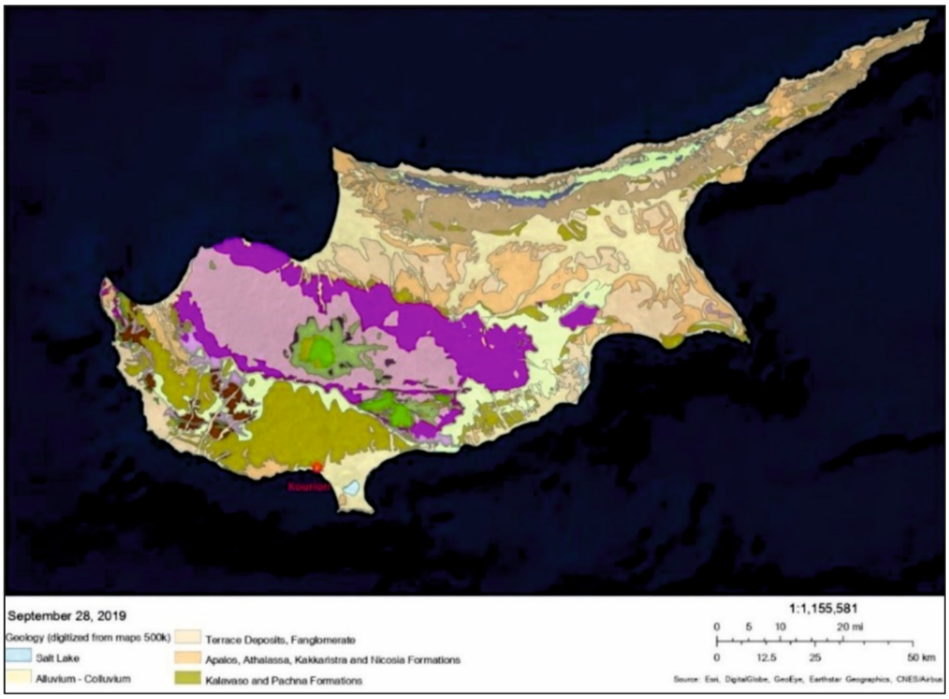

Figure 2: Geological map of Cyprus with the detail of Kourion, after the Geological Survey Department of Cyprus (Photo: https://gsd.maps.arcgis.com/apps/View/index .html? appid =e6f54157fe8640cc853df09bf2e75dd7).

[3] Bullard 1987, 53.
[4] Bullard 1987, 54.

Sedimentary Pakhna formations are those of the rocky cliffs along the road immediately outside the entrance to the main archaeological site. Here the cliff faces present several claw-tooth chisel and stonemason's pick marks, all along the lower section of them, reflecting the extensive quarrying that took place at this site[5]. Exposures of the Kafkalla and Havara formations are also common as geological features[6]. The main outcrops of these formations are the aeolian and young alluvial sediments transported down by the Kouris river, which make up the plain east of the Kourion acropolis[7].

Stone quarries beneath the city at Amathus Gate

The entire area around the city of Kourion city must have functioned in antiquity as both stone quarry and necropolis. Evidence of stone quarrying activity as well as tomb-cutting are clearly visible beneath the site, along the west, south and northeast sides of the cliffs. The upper part of the cliffs is composed of chalky marls, deposited in shallow waters and these are soft, friable and yellow (Fig. 7). They now appear to be extremely weathered into horizontal ledges but the faces still show straight joint fractures crossing the rock in a north-south direction (Fig. 7)[8]. The presence of these fractures must have contributed to the weathering of the cliff and must have influenced decisions regarding quarrying and tomb-cutting in the area. The natural joints were most likely exploited by tomb-cutters and quarrymen, who could more easily align a block or a facet along a joint and have the advantage to avoid having to cut it[9]. The lower layer instead consists of a harder grey limestone, very suitable for tomb-cutting and quarrying and this corresponds to the chamber tombs and quarry floor particularly visible in Area B (Fig. 7)[10].

Trial excavations at the site of the Amathus Gate Cemetery by Danielle Parks from 1995 onwards and subsequent further investigations by Michael Given have highlighted an intense stone exploitation of the area immediately below the site[11]. Here the rock surface has been completely altered by the quarrymen who sought to gain access to the stone in order to supply the city with suitable building materials used in the construction of buildings and fortifications. Evidence of this is confirmed by the consistent and regular traces of quarried blocks and tomb-cutting located between the area around the Amathus Gate Cemetery, along the west and south sides of the Acropolis, and the outcrops immediately beneath the northeastern cliff. The stone cutting evidence is visible at the foot of the Acropolis starting from the Amathus Gate entrance in the middle of the west side and concluding under the northeast side of the cliff (corresponding to the areas named A, B, C, D, E, F, G) (Fig. 3)[12].

The first area to be encountered leaving the city gate, to the left of the main route, is A where the remains of narrow channels for the cutting of the blocks, finished blocks and cut blocks are still *in situ* (Fig. 4).

The blocks are mostly rectangular in shape and their dimensions vary (preserved block lengths are 1.50, 1.20, 1.10, 1.05, 1.00, 0.96 m, widths are 0.66, 0.55, 0.53, 0.51 m and lengths 0.40 and 0.30 m). Moreover, beds of removed blocks and wedge-holes have also been uncovered. Given the cutting marks along the wall of the cliff it is likely that the quarry face extended for approximately 3 m, from the bottom upward. As the average thickness of the blocks is 30 cm for each it seems reasonable to estimate that at least ten layers of blocks were

[5] Edwards *et al.* 2010, 224.
[6] Rapp 2003, 463.
[7] Xenophontos 1996, 183.
[8] Given 1998, 180.
[9] Bullard 1987, 55-59; Parks *et al*. 1998, 178,180.
[10] Given 1998, 180.
[11] Parks 1996, 127-133; Parks 1997, 271-276; Parks *et al.* 1998, 171-185; Parks *et al.* 2000, 233-243.
[12] Parks *et al.*1998, 171-185.

removed. Similarly, in Area B, to the east of Area A, there lie a number of quarrying beds as well as a series of Late Hellenistic chamber tombs featuring both *arcosolia* and *sarcophagi* which were continually used until the 3rd century AD. However, following the severe earthquake in the 4th century AD it is likely that quarry practises changed the tombs' layout. The disruption caused by the earthquake saw an urgent need for new building materials which led to the exploitation of the standing structures. This can be detected in tombs which were altered by the removal of ceilings and the interior walls of the chambers as well as the lowering of floor levels. Therefore, the quarrying activity localised along the south flank of the bluff might not have been very extensive, instead it probably consisted of short-lived operations that looked to provide stone for specific purposes on a local basis only. This phenomenon is confirmed by the presence of pit graves, dug in the quarry surface, which were most likely created after the establishment of the quarry when it was, probably, no longer in use. Grave goods and ritual materials such as pottery, jewellery, lamps and coins allow us to date the pit graves to the late 4th century AD[13].

Figure 3: Satellite image with the location of the quarries and rock-cut tombs beneath the city of Kourion (Photo: Google Earth modıfıed by M. Astolfı).

Figure 4: Evidence of cut blocks still *in situ* in Area A (Photo: M. Astolfı).

The remains of quarrying activity can also be detected in areas C, D and F and G which are all part of the same hard grey limestone outcrop surrounding the sides of the Acropolis. One ledge of limestone exists in areas C and D where quarry faces must have been established in antiquity which subsequently saw multiple layers of blocks cut from them. In area C, along the northern edge, an outcrop in hard grey limestone emerges and here a quarry face was established. Based on the cutting marks, the face must have been approximately 1.40 m high and produced several layers of blocks, the contour of which is in some instances still visible[14] (Fig. 5).

Areas F and G show some evidence of stone quarrying along two rocky ridges which mark their respective eastern edges (Fig. 3), however, the remains are extremely weathered and difficult to interpret[15]. As for Area E, we do not have quarrying evidence but only the top layer of a flat plateau in hard grey limestone which contains cist graves (Fig. 8). However, the creation of this platform may have been connected to quarrying activities prior to the cutting of cist graves. It is not certain whether these latter quarries were in use for a small period of time following the earthquake or they were exploited continuously throughout the Roman imperial period. These cliffs may have been the main source of stone the Roman architects of Kourion relied upon for building purposes.

[13] Given 1998, 179.
[14] Given 1998, 182.
[15] Given 1998, 179-183.

Figure 5: Quarry face with cutting marks and wedge holes along the northern cliff of Kourion site in area C (Photo: M. Astolfi).

Figure 6: Evidence of cut blocks still *in situ* in the valley north of Kourion (Photo: M. Astolfi).

Based on the evidence found both at the Amathus gate's quarries and in the valley north of Kourion all the aforementioned quarrying sites must be considered as belonging to the open ground type with the quarrymen working directly on the flat horizontal surface of the stone marking out squares on the rock beds[16]. The system adopted to cut the blocks out was similar to the one still in use in the modern quarries in Cyprus and consists of cutting down very narrow trenches to delimit the block, then making a long incision at the base with the pick and fixing a variable number of iron wedges into the resulting groove; after this stage constant and continuous blows of the hammer upon the wedges were used to split the stone in a very precise way[17].

Stone quarrying and tomb-cutting evidence in the valley north of Kourion

As noted above the area surrounding the base of the acropolis was not the only one to be used for funerary exploitation and quarrying activity in antiquity. A survey of the valley which extended north of Kourion indicates that the rocky ridges flanking it bear evidence of Late Hellenistic and Early Roman rock-cut chamber tombs as well as minor traces of quarrying (Fig. 1, in green). Regular chamber tombs with *loculi* and *arcosolia* are easily distinguishable along the northern and western cliffs of the valley (Fig. 1, in green) and are carved out of the local soft and powdery limestone, ranging in some instances from reddish to yellowish colour (Fig. 9). The chambers bear traces of continual reuse over time and it is likely that these were quarried in later phases in order to supply either the city or the Sanctuary of Apollo with building blocks as well as materials for mortar, plaster and stucco. Moreover, in the same area located at the westernmost edge of the limestone ridge, lying to the west side of the valley, a clear quarry platform has been identified. This appears to be of the same open ground type already referred to at the Amathus Gate quarries and it presents the outlines of the half-finished blocks (Fig. 6) still *in situ* (measuring 52 cm x 1 m) with the negative imprint subsequent to the removal of the block.

It is likely that more quarry platforms associated with this one were present in the immediate surroundings. However, due to severe and extensive farming practices and continued stone exploitation it is nearly impossible to see traces of them. Despite the proximity of the valley to the Amathus Gate the limestone outcrops featuring in the former area seem to differ slightly from the grey deposits beneath the site of Kourion. This however did not prevent Kourion's inhabitants from exploiting the surrounding territory as a burial ground and to seek stone building resources as well.

[16] For types of quarries and methods of extraction see Adam 1994, 26-27. As for a discussion about other Cypriot quarries related to cities' exploitation see Koželj, Wurch-Koželj 2017, 93-111; Wylde 1982, 57.

[17] Jeffery 1915, 162, fig. 3; Adam 1994, 29-31; Wootton *et al.* 2013, 2-3.

Stone exploitation and use at Kourion

In addition to the preliminary study of the limestone quarries surrounding Kourion a detailed analysis of all the Roman buildings within the site was undertaken to understand the uses of individual stone types. For the purpose of this preliminary study the investigation and identification of the local stone has been exclusively based on a first-hand observation of the evidence. However, a future archaeometric approach may add new information to the data already acquired. This enabled me to identify the stone used in the private and public buildings at Kourion as coming from the quarries discussed above. Two main types of limestone have been identified in the area of the Kourion acropolis: a hard grey layer that can be found on the lower part of the Kourion cliffs, especially as outcrops and ridges which sit in close proximity to the base of the acropolis, and a softer yellow limestone featuring in the upper and greater part of the acropolis[18] (Fig. 7).

Figure 7: Detail of the layering of the cliff in area B where the upper yellow layer consists of chalky marls, very weathered, and the lower one relates to the hard grey limestone of the chamber tombs and quarry floor (Photo: M. Astolfı).

Figure 8: Rocky plateau in grey limestone from Area E with detail of cist graves (Photo: M. Astolfı).

Figure 9: Details of rock-cut tombs carved along the western ridge of the valley north of the Kourion Acropolis (Photo: M. Astolfı).

The yellow type is widespread, forming the highly weathered and thickly-bedded cliffs all along the west, south and northeastern sides. The hard grey limestone appears to be the most common among the wall structures, likely because it was harder. It seems to have been mainly cut for grand buildings necessitating large square blocks and fortifications. Moreover, the same type also appears to be used in combination with the softer yellow variant in small blockworks and rubble structures. The data collected during this investigation therefore demonstrate the substantial reliance on localised exploitation of natural resources based on the availability of suitable stone commodities in the immediate environs.

[18] Given 1998, 180.

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THE "PORTASANTA-LIKE" MARBLE FROM THE AKÇAKAYA QUARRY ON THE LIMONTEPE NEAR IZMIR

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Abstract

Limontepe is located a few kilometres south from the city centre of Izmir. At its summit, at a location known as Akçakaya, are the remains of a Hellenistic and Roman settlement, while on the slopes of the hill many small to medium sized quarry fronts with typical stepped faces are visible. The Akçakaya – Limontepe lithotype has a wide range of varieties. It appears as pinkish breccia with different light to dark tonalities, sometimes a deep dark red-violet cement and frequent small calcite veins. These chromatic peculiarities are very similar to the more renowned *marmor chium*, quarried on the Greek island of Chios. Some column shafts of Akçakaya breccia are present in the marble depots of the Agora of Smyrna, attesting a local use of this pinkish-coloured marble. Archaeometrical analyses have been undertaken on quarry samples and on two shafts from the Agora depots.

Keywords: Portasanta-like marble, provenance, archaeometry.

Introduction

The well-known *marmor chium*, known better by the name portasanta given by Italian stonemasons in the 16th century[1], was quarried at several sites on the island of Chios in the Aegean Sea[2], just in front of the Karaburun peninsula. The main quarry district is that of Latomi, located only a few kilometres to the north of the harbour city of Chios. Large and impressive quarry fronts are still well preserved there, along with a large amount of abandoned quarry items, some of which are collected in the garden of the nearby church of Panagia Latomitissa[3].

The portasanta marble, a pinkish tectonic breccia, was one of the first coloured marble imported to Rome as attested by several monuments of the Augustan age, among them the House of Augustus on the Palatine Hill, the Forum of Augustus and the Temple of Concordia in the Forum Romanum. The quarries were certainly imperial property, as attested by inscriptions and lead seals amid the abandoned items at the quarries, at the marble yard at Trajan's harbour near Ostia[4] or the urban one along the left bank of the Tiber at the foot of the Aventine hill in Rome[5]. The best quality Chian marble was exploited until

[1] Corsi 1845, 95-96.
[2] Gnoli 1988, 172-173; Lazzarini 2007, 122-124.
[3] Pensabene, Lazzarini 1998, 151-153.
[4] Baccini 1979, 28-29; Baccini 1989, 45-51; Pensabene 1995, 99-106.
[5] Bruzza 1870, 184-187.

the 2nd century AD when apparently the nature of the extracted marble changed to become more greyish, a variety generally dated to the end of the 2nd – beginning of the 3rd century AD. Even though Chios is very close to Asia Minor, this high-status imperial marble is not widely distributed in the ancient cities of the coastal region. Some few portasanta marble fragments have been seen in Erythrai (now Ildır), more to the north at Phokaia (now Foça), and in Ephesos, while no evidence has been found at Pergamon, Sardis or Izmir.

During a systematic survey of the marble column shafts now in the depots of the central area of the Agora of Smyrna many different marble qualities have been identified, many of local or regional provenance, from Karaburun, Manisa, Beyler and Tirazli, granites from Mysia and the Troad, and others from Caria, including Iasos and Euromos. Several have also been imported from Greece, from Lesbos, Skyros, Euboea and Thessaly. Only one came from *Africa Proconsularis*, the Numidian giallo antico from the Simitthus quarries. In this huge tally of more than 600 fragmentary column shafts, 18 items of a pinkish breccia, have also been preliminarily identified as portasanta in consideration of the proximity of ancient Smyrna to the island of Chios. However, closer inspection of the lithotype of these shafts has allowed us to note a very strong similarity, but also significant macroscopic differences to the Chian marble, due to its different colours and breccia varieties. This evidence has therefore made it possible to understand that these shafts are of an unknown marble, perhaps of local origin, similar to the portasanta marble and whose quarries had not yet been discovered.

By chance, during archaeological surveys undertaken in the surroundings of Izmir it was possible to discover several exploitation areas on Limontepe (Fig. 1), where in fact a pinkish to greyish tectonic breccia, similar to that of the shafts recognized in the depots of the Agora of Smyrna, had been exploited in ancient times.

Figure 1: Location of Limontepe south of Izmir (Photo: Google Earth modıfied by M. Bruno).

The Limontepe hill and its quarries

The Limontepe, also known locally as Akçakaya, which literally means "white rock", is a hill well visible from afar and located along the road leading in the direction of Tirazlı and Kavacık. It is in a dominating position on the south coast of Izmir Bay and the road to Urla/Klazomenai. (Fig. 2). Due to its geomorphological characteristics the Limontepe was occupied from Hellenistic times by a large settlement and a part of the outer defences of Smyrna extended at least to the very top of the hill. There some citadel wall remains and a very well-preserved large, deep water cistern (Fig. 3) is visible as well as several rock cuttings in the outcrop probably to be attributed to some structures of the same period[6]. All over the slopes of the hill many ancient artefacts are still lying around, small to medium parallelepiped blocks (Fig. 4), which of course can be attributed to buildings of Hellenistic period, but there are also some rough and unfinished column drums. On the other

[6] Göncü *et al*., 2019, 23-24.

side, several extraction sites or small pits are also preserved all over the slopes of the hill from bottom to top, probably destined for column shaft production, but these places testify of course only to a limited exploitation of the rock (Fig. 5).

Figure 2: Limontepe. Overview of the hill from the south; in the distance the gulf of Izmir is partially visible (Photo: H. Göncü).

The Limontepe hill and its quarries

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Figure 3: Limontepe. Hellenistic water cistern on top of the hill (Photo: M. Bruno).

Figure 4: Limontepe. Parallelepiped block of a Hellenistic building (Photo: M. Bruno).

[7] Göncü *et al*., 2019, 23-24.

On the other side, several extraction sites or small pits are also preserved all over the slopes of the hill from bottom to top, probably destined for column shaft production, but these places testify of course only to a limited exploitation of the rock (Fig. 5).

The largest and most important extraction site is located on the top of the hill, on the north-western side of the Limontepe facing a large valley. Here, the largest and tallest outcrop is visible (Fig. 6), but unfortunately the survey in this area was very limited due to the danger posed by collapsed and fractured rocky outcrops.

Figure 5: Limontepe, lower south side. Quarry pit with stepped quarry face (Photo: M. Bruno).

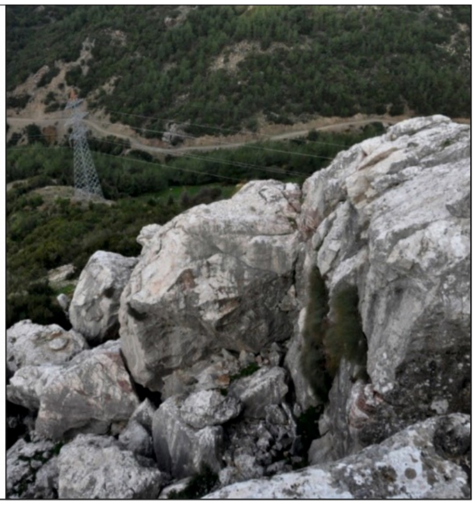

Figure 6: Limontepe, north side. Quarry area with collapsed ancient quarry faces (Photo: M. Bruno).

High quarry fronts preserve traces of heavy pick working, attesting an intensive phase of activity during Roman times, confirmed by the large amount of debris right at the foot of the rock faces. On top of one of these a very large undetached rough-hewn column shaft is still visible (Fig. 7) eloquently illustrating the column shaft production in the Limontepe quarry.

Figure 7: Detail of the previous image with undetached column shaft of medium size (Photo: M. Bruno).

The Limontepe breccia. Marble varieties and preliminary archaeometric data

The Limontepe is located in the so-called Seferihisar High Bornova Melange Menderes Massif (Fig. 8). The pinkish Limontepe breccia is characterized by several different varieties with pinkish to grey clasts of different size in a deep red cement, often crossed by medium to large white calcitic veins (Figs. 9a-c), very similar to that attested by the shafts discovered in the depots of the Agora at Smyrna.

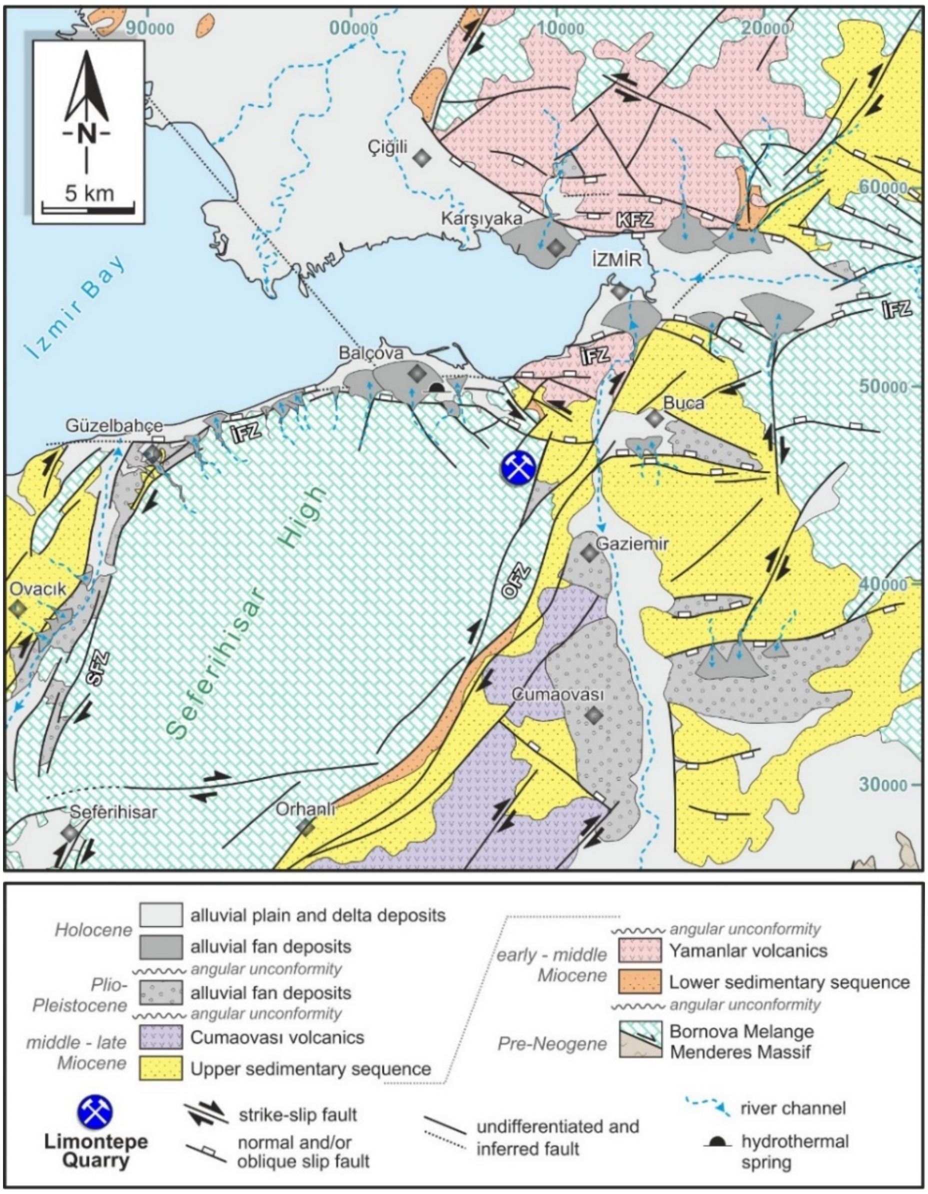

Figure 8: Geological map of the Izmir region, with location of the Limontepe site (Uzel *et al.* 2012, 2013; Emre *et al.* 2018).

Figure 9: **a-c**. Different varieties of Limontepe breccia (Photo: M. Bruno).

Due to its striking similarity to the coloured marble from Chios Island (Fig. 10) a preliminary sampling was undertaken on the Limontepe in order to define the geological and archaeometrical characteristics of the Limontepe coloured breccia in order to compare it with Chios portasanta data drawn from literature. This preliminary archaeometrical approach is based only on stable isotopes of the Chios portasanta marble[8] and that of Limontepe (Tab. 1). Even if the samples considered from Limontepe are quite few, it is possible to notice an almost complete isotopical overlapping with that of the Chios marble. Three column shafts from the Agora in a pinkish breccia very similar to the Limontepe varieties, samples IA 31 (Fig. 11), IA32 (Fig. 12), IA33 (Fig. 13), have been sampled and compared with the Limontepe and Chios data.

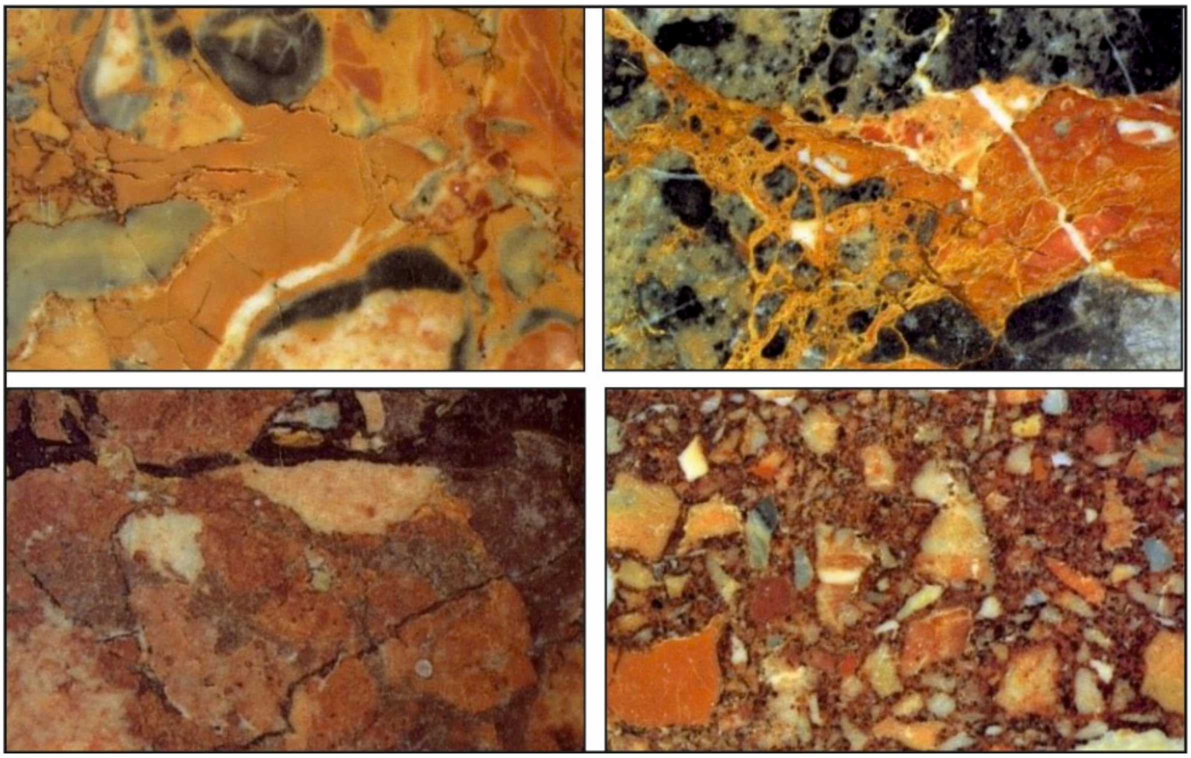

Figure 10: Portasanta marble samples from the Podesti Collection, (Photos: Pensabene and Bruno 1998, cat. 21-24).

Isotopic data (Tab. 2) show that the three columns sampled at the Agora belong to two different types (Fig. 14). IA32 fits Limontepe or perhaps Chios portasanta, whereas IA31 and IA33 are very similar to one another, different from IA32 and hardly fit Limontepe or Chios. Such differences are even clearer in the isotopic/EPR graph (Fig. 15), in which no portasanta is included, because unfortunately no EPR data are available for the Chios quarries. At present it can be stated that IA32 originates very probably from Limontepe whereas IA31 and IA33, despite being macroscopically similar to IA32, cannot be assigned certainly either to Limontepe or Chios. More quarry data from Limontepe would be necessary to establish the precise provenance of IA31 and IA33. However, it may be recalled that other similar breccias and quarries are present not far from Izmir and particularly in the Karaburun peninsula at Balıklıova and at Toprak Alinmis[9].

[8] Lazzarini 2007, 127-131, in part. isotopic data are published at 128, tab.1.
[9] Bruno *et al.*, 2012, 568.

Figure 11: Izmir, Roman Agora, depot. Column shaft cat. 28, sample IA 31, in a dark pinkish breccia of unknown provenance (Photo: M. Bruno).

Figure 12: Izmir, Roman Agora, depot. Column shaft cat. 12, sample IA 32, in Limontepe breccia (Photo: M. Bruno).

Figure 13: Izmir, Roman Agora, depot. Column shaft cat. 30, sample IA 33, in a dark pinkish breccia of unknown provenance (Photo: M. Bruno).

N.	Sample	$\delta^{13}C$ (V-PDB)	$\delta^{18}O$ (V-PDB)
1	L1	3,49	-9,12
2	L2	3,44	-5,40
3	L3	3,41	-5,47
4	L4	3,62	-6,96
5	L5	3,37	-8,75
6	L6	3,76	-5,01

Table 1: Isotopic data of the six Limontepe quarry samples.

Cat. n.	Sample	$\delta^{13}C$ (V-PDB)	$\delta^{18}O$ (V-PDB)
28	IA31	3,08	-2,29
12	IA32	3,22	-8,32
30	IA33	3,48	-1,82

Table 2: Isotopic data of the three Agora column shafts.

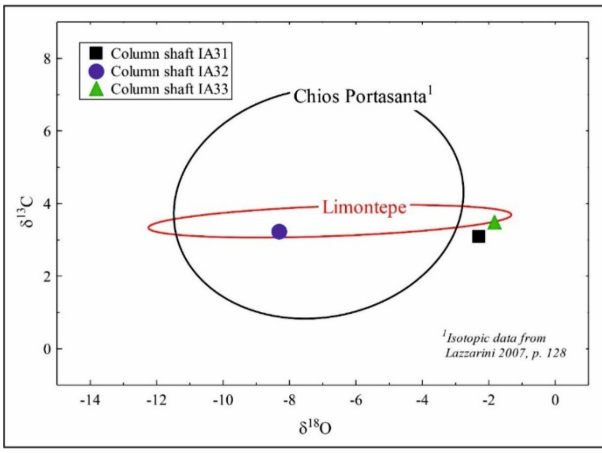

Figure 14: Isotopic graph with Limontepe and Chios data and plotted dots of the Agora columns (Graph: D. Attanasıo).

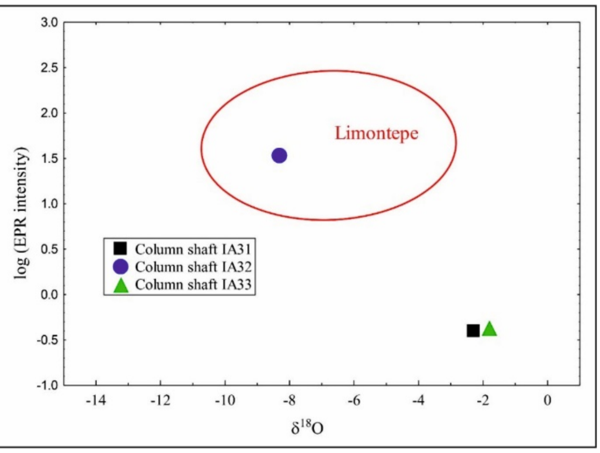

Figure 15: Isotopic/EPR graph with the dots of the Agora column shafts (Graph: D. Attanasıo).

Conclusions

The discovery of the Limontepe quarries, and that of Tirazlı, increases our knowledge of the extraction activities of coloured marbles in the region around Smyrna. Already several years ago, Karaburun unexpectedly revealed itself as an important quarrying area during Roman times for different breccia varieties and for the famous broccatellone, coloured marbles that were used not only locally or regionally but were also exported to other cities of the Roman Empire.

The Limontepe quarries were opened on a hill occupied since Hellenistic period by a settlement whose important remains are still clearly visible on many areas of it. During the Hellenistic period the extraction activities were limited to production of parallelepiped blocks intended for the buildings, as well as some medium-sized column drums. The presence of this settlement subsequently induced the exploitation works during Roman imperial period, of which the high quarry fronts, smaller pits and quarry areas present all over the hill provide clear evidence. The different exploitation sites primarily document the production of medium-sized column shafts, as shown also by the different column shafts in the deposits at the Roman Agora where items from all over the city have been collected. Currently the Limontepe breccia as well as that of Tirazlı[10] is attested only at Smyrna and in no other city of the surrounding areas or the hinterland and would therefore seem to outline a peculiarity of the city of Izmir. Local clients evidently had great need of different coloured marble qualities to adorn the buildings of their city, a necessity that must have encouraged the local or regional research of local coloured marbles reminiscent of the most renowned imperial ones.

If, on the one hand, the breccias of the Karaburun peninsula or the Manisa region could be considered as substitute marbles for the most famous giallo antico of Numidia[11] and that of Tirazlı as a similar phrygian marble[12], a so called pavonazzetto-like marble, the Limontepe breccia can be considered and defined as portasanta-like marble: a replacement marble for the more renowned *marmor chium*, the use of which is not attested in Smyrna despite the proximity of the Chios Latomi quarries.

[10] Yavuz *et al*. 2023.
[11] Gnoli 1988, 246.
[12] Attanasio 2015.

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THE ROMAN MARBLE QUARRY ZONE OF SPITZELOFEN, AUSTRIA. MAPPING, FINDS AND EXCAVATION

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Abstract

Spitzelofen (Austria) is one of the well-known Roman quarry zones in the south-eastern Alpine region. This paper presents preliminary results of ongoing archaeological activities begun on a ridge called Kalkkogel immediately south-west of the proper Spitzelofen ridge. Within this hitherto-unknown part of the quarry zone, 34 terrain features, among them 12 new quarries, have so far been documented by this mapping work. The total size of the quarrying area on the Kalkkogel is estimated to amount to more than 2.400 m². The 29 newly-found Roman quarry tools raise the known examples from 3 to 32. Based on radiocarbon dating of excavated burn residues of a blacksmith's hearth in the debris pile of a quarry on the Kalkkogel, confirmed by the pottery, the stone extraction started here at the latest around the middle of the 1st century AD.

Keywords: South-eastern Alpine region, mapping of quarry zones, white marble.

Introduction

The marble beds in the south-eastern Alpine region are located in the Austroalpine Crystalline of the Central Alps, where paragneiss and granitoid predominate though there are also veins of amphibolite[1]. This geological condition basically restricts any study about marble quarries used in Roman times to these beds, but specifically to those medium- to coarse-grained white marble resources which are appropriate regarding extraction, accessibility and utilisation.

Since the mid-1990s, several marble quarries in the south-eastern Alps and over 800 Roman marble objects in the provinces of *Noricum*, the two *Pannoniae* and *Moesiae* have been geo-scientifically analysed by a combination of methods (including petrographic, stable isotope and trace element analysis)[2], most recently by fluid inclusions chemistry[3]. According to the results of the marble analysis, 14 quarries in the south-eastern Alpine region of Austria – this short overview is limited to the Austrian territory – are considered as having been used in Roman times. In Carinthia, these are the quarries in the marbles of the "Millstatt complex"[4]: Gummern, Krastal and Treffen/Pölling[5]; the quarries in the marbles of the "Pörtschach type"[6]: Pavor-Sekull, Tentschach, Kraig and Tiffen[7]; and the only marble quarry on the Koralpe mountain: Spitzelofen. In Styria, the following quarries are believed to have

[1] This description is based on the geological map 1:500.000 (Datensatz KM500 Austria - Geologie); the lithostratigraphic units of this map were used for fig. 1.

[2] Djurić, Müller 2011. For Carinthia: Müller, Schwaighofer 1999; Steiner 2006. According to the catalogue of Steiner 2005, a total of 215 objects were sampled. Which stone was sampled is only accessible in the unpublished thesis Steiner 2005. For Styria/Štajerska: Djurić *et al*. 2004. According to tab. 8a of this paper, 223 objects were sampled.

[3] Prochaska, Attanasio 2012.

[4] Kieslinger 1956, 214.

[5] Jantsch 1929; Dolenz 1955; Kieslinger 1956, 214-230, 233-234. 237-241; Müller, Schwaighofer 1999, 551-555, 564-565; Thiedig, Wappis 2003, 81, 83-84; Müller 2007.

[6] Kieslinger 1956, 242-244.

[7] Jantsch 1937; Kieslinger 1956, 244-251; Müller, Schwaighofer 1999, 555-558, 562-564; Thiedig, Wappis 2003, 85-88.

been used in Roman times: Salla, Kainach, Galgenberg, Kleinsölk and Öblarn[8]. Within the Salzburg part of the south-eastern Alps, a quarry on Schaidberg is described as Roman[9].

But only six of these marble quarries can be positively identified[10] due to their quarry faces with tool marks or chipping and other waste material in the spoil heaps with characteristic traces of the Roman quarrying technique (Fig. 1), specifically: Gummern, Krastal, Treffen/Pölling, Tentschach, Tiffen[11] and Spitzelofen. From only four of the quarries with such extraction evidence are finds of quarry tools known: Gummern, Krastal, Tentschach and Spitzelofen. Of these latter quarries, roughly-carved-out blocks or semi-finished products and Roman inscriptions on the quarry faces are only attested in Gummern, Tentschach and Spitzelofen.

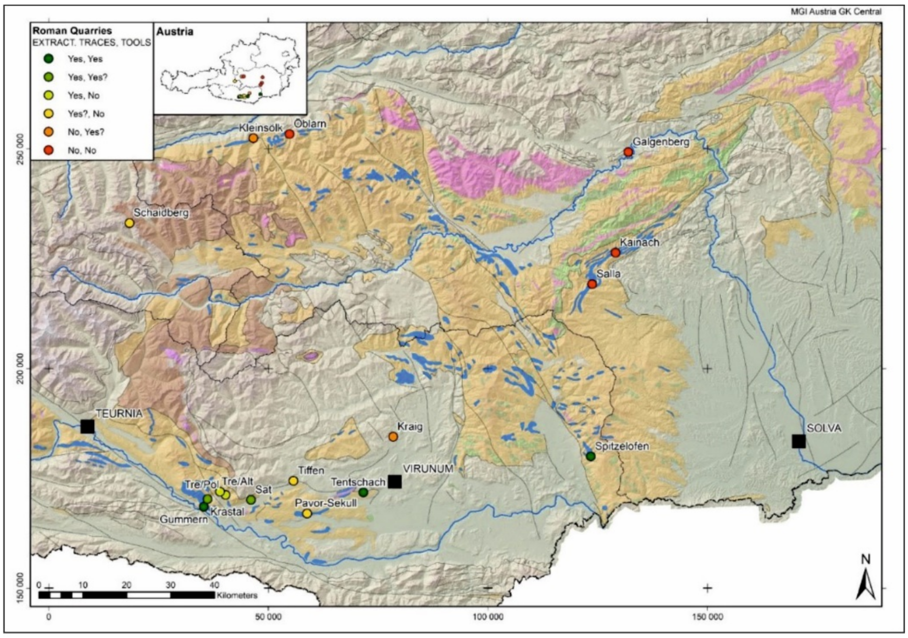

Figure 1: Location of Spitzelofen and other Roman marble quarries in Austria's south-eastern Alpine region, marble beds within the Austroalpine Crystalline in blue, Roman cities in black squares (Map: S. Karl).

Unfortunately, our knowledge of the infrastructure, extent and scale of Roman marble quarries as well as the stone transport down to the valleys – essential parts of the production cycle – is scarce in this region. Although these quarries are archaeological sites at first, they have hardly been tackled by archaeological investigations so far. With the exception now of Spitzelofen, none of these quarries has ever been the subject of archaeological-topographic mapping or surveying. Therefore, information about the dating and scale of the quarries is based indirectly on the analysis of Roman marble monuments[12]. It should also be emphasised that the recent activities at Spitzelofen, together with the old excavations there in the 1920s[13] and in the year 1930[14], as well as a small investigation at Gummern in 1928[15], are the only

[8] Djurić *et al*. 2004, 369-372.
[9] Kieslinger 1964, 332-333; Müller 2007, 33; Djurić, Müller 2011, fig. 4.
[10] Djurić 2019, 10.
[11] Tiffen is still counted here, although no tool marks or tools can be attested. The only evidence is a block found on the south side of the Kronabichl in 1926 with the chiselled letters "BON / PRI", from which Jantsch 1930, 26 assumed that this is the rest of a quarry face, similar to the quarry inscriptions at Gummern.
[12] Djurić, Müller 2011, 113-117; see also Thiedig, Wappis 2003, 88, who are calculating an extracted stone volume of 10,000 m² for Carinthia based on the preserved Roman marble monuments.
[13] Schütte 1923; Schütte 1930.
[14] Jantsch 1931.
[15] Jantsch 1929, 162.

measures that have been carried out in Austria's Roman marble quarries using invasive archaeological methods.

Marble quarries, like other stone quarries, are generally opened up in the immediate neighbourhood of the site where the stone is needed[16]. Due to the wide distribution of marble beds within the Austroalpine Crystalline, the exploitation of marble outcrops in close proximity has to be assumed also for smaller rural settlements, recently proven analytically for Scheiben near St. Georgen ob Judenburg[17] or supposed archaeologically for Wiesenau for a long time[18]. Seemingly, we must expect that even more marble quarries were used in Roman times. Indeed, two further quarry zones in the marbles of the Millstatt complex may recently have been identified: Sattendorf[19] and Treffen/Alt-Treffen[20] (Fig. 1); the last with its impressive quarry faces with tool marks was completely overlooked so far in the archaeological and geological literature.

Archaeological-topographic mapping

The following paper presents preliminary results of newly-undertaken and still ongoing archaeological-topographic investigations of the Roman marble quarry zone of Spitzelofen[21].

These activities have two starting points. One was the construction of a forest road in 2011 by the landowner on the northern flank of a ridge called Kalkkogel (“Lime hill”), located directly south-west of the Spitzelofen proper, which cut into debris piles of new quarries there (Fig. 2). The other was the discovery of several Roman quarry tools and other objects in the course of geological investigations on the Kalkkogel from 2009 to 2011 and during the construction of this forest road. One should note that the existence of Roman quarries on the Kalkkogel was known to the former owner Gudmund Schütte[22] and Franz Jantsch around 1930[23], but this knowledge was afterwards lost.

In the first archaeological campaign in 2015/16, the mapping was concentrated on the Kalkkogel. It also includes the documentation of the new finds and a small excavation in a debris heap where a charcoal layer was exposed by the forest road. In 2019, the mapping work was continued, now with the aim of encompassing the whole quarry zone.

For the mapping, the entire quarry zone was divided into three sectors: Kalkkogel (6.8 ha), the intermediate zone (2.6 ha) and Spitzelofen (2.1 ha). The mapping method is based on tachymetric measurements[24] followed by a manual drawing of all relevant features and elevation lines in the scale of 1:250 and 1:500, depending on the terrain objects. This method, an extended Glutz’ method[25], is recommended in forested landscapes with undergrowth and waste wood, where ALS data do not provide easily readily useful data for archaeological purposes.

It is to be anticipated that the term “Spitzelofen”, established in the literature, will continue to apply to the entire quarry zone, although according to the new topographical results, this zone extends over two neighbouring but distinct rock formations with discrete names: Spitzelofen, 1,066.60 m asl, and Kalkkogel, 1,088.49 m asl.

[16] Russell 2013, 37-38.
[17] Igler *et al*. 2015; Vrabec 2018, 90-95.
[18] Dolenz 1959, 765-766.
[19] Kieslinger 1956, 236-237; Thiedig, Wappis 2003, 84.
[20] Von Jabornegg-Altenfels 1862, 113-114 (he identified these quarries as rock grottos resp. rock sanctuary).
[21] Karl, Fürnholzer 2019; Karl, Steinegger 2017; Karl 2016a; Karl 2016b; Karl 2016c. A monographic publication is in preparation for 2020; see the post scriptum at the end of this paper.
[22] Schütte 1930.
[23] Jantsch 1931, 4.
[24] For the two sectors Kalkkogel and the intermediate zone c. 3.050 ground points were measured.
[25] Glutz 1988.

Figure 2: The new forest road built in 2011, cutting into the debris piles of the new Roman marble quarries on the Kalkkogel, view from east (Photo: A. Hassler).

Quarries

The archaeological-topographical mapping revealed on the Kalkkogel and the intermediate zone a total of 34 terrain objects (shortened GO), of which only the marble quarries will be noted in this paper (Fig. 3).

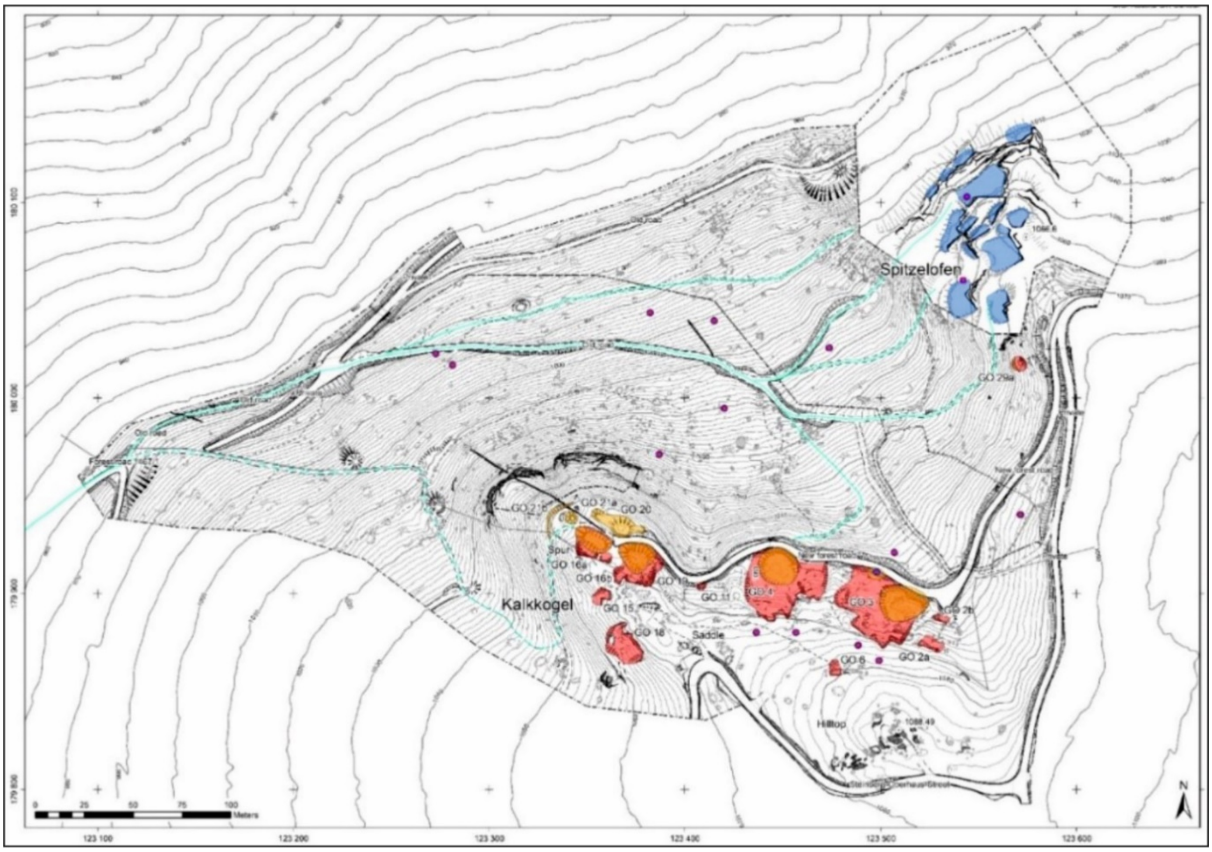

Figure 3: Overall plan of the archaeological-topographical mapping of the marble quarry zone Spitzelofen, quarries in red (already measured) and blue (still only sketched), debris piles and spoil heaps in orange; find spots of quarry tools are marked with magenta dots, quarry paths with cyan lines (Map: S. Karl).

The quarries are located along the northern flank of the Kalkkogel (GO 3, 4, 11, 16a, 16b, 19), lying at elevations ranging from 1,059 to 1,076 m asl, in the south-west of its spur (GO 15, 18) and on its hilltop (GO 6). One quarry is recorded in the intermediate zone (GO 29a). To these quarries, unclear remains of quarry activities in the east (GO 2a, 2b) should be added. All quarries are filled with soil and quarry debris, and their partly pickmarked quarry faces, several meters high, are visible only in some places (Fig. 4).

Figure 4: The quarry GO 4 on the northern flank of Kalkkogel, view from north-west (Photo: A. Steinegger).

The two large[26] quarries GO 3 with 45 x 33 m and GO 4 with 42 x 38 m are of almost the same size (Fig. 5). These quarries are much larger than the well-known quarry on the Spitzelofen with the Saxanus inscription, which has a quarrying area of about 32 x 13 m. By comparison to the quarries on the Kalkkogel, the "Saxanus" quarry is more impressive, as its base was uncovered from debris and soil up to 7 m high during the old excavations mentioned above.

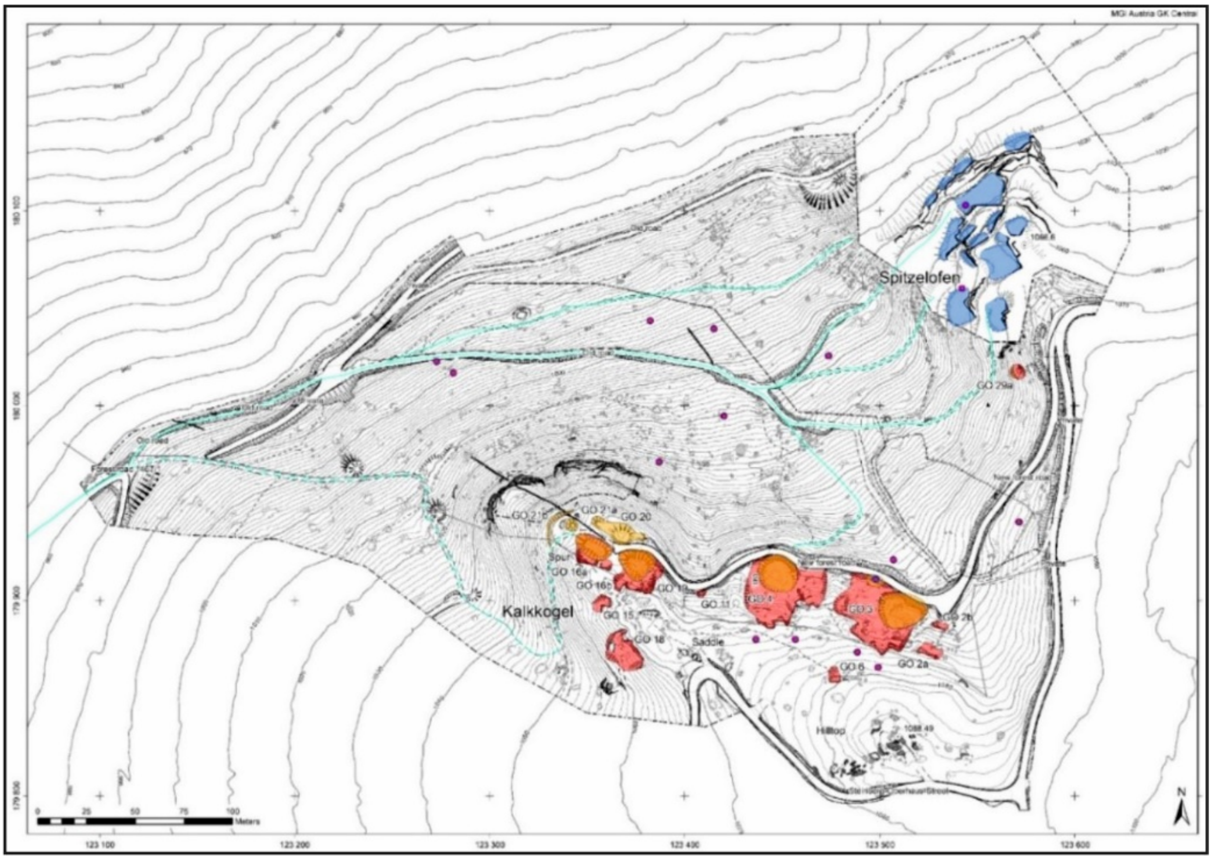

Figure 5: The two medium-sized hillside quarries GO 3 and 4 on the northern flank of Kalkkogel, area of the excavation 2016 in dark red (Map: S. Karl).

In the extreme north-west of Kalkkogel's spur, there is a heterogeneously structured terrain of heap mounds, depressions and terraces (GO 20, 21a, 21b). This section is a large spoil heap, which apparently belongs to an earlier phase of stone extraction, as no quarry in the immediate vicinity can be associated with it (Fig. 6).

[26] Medium-sized according to the schema by Long 2012, 169.

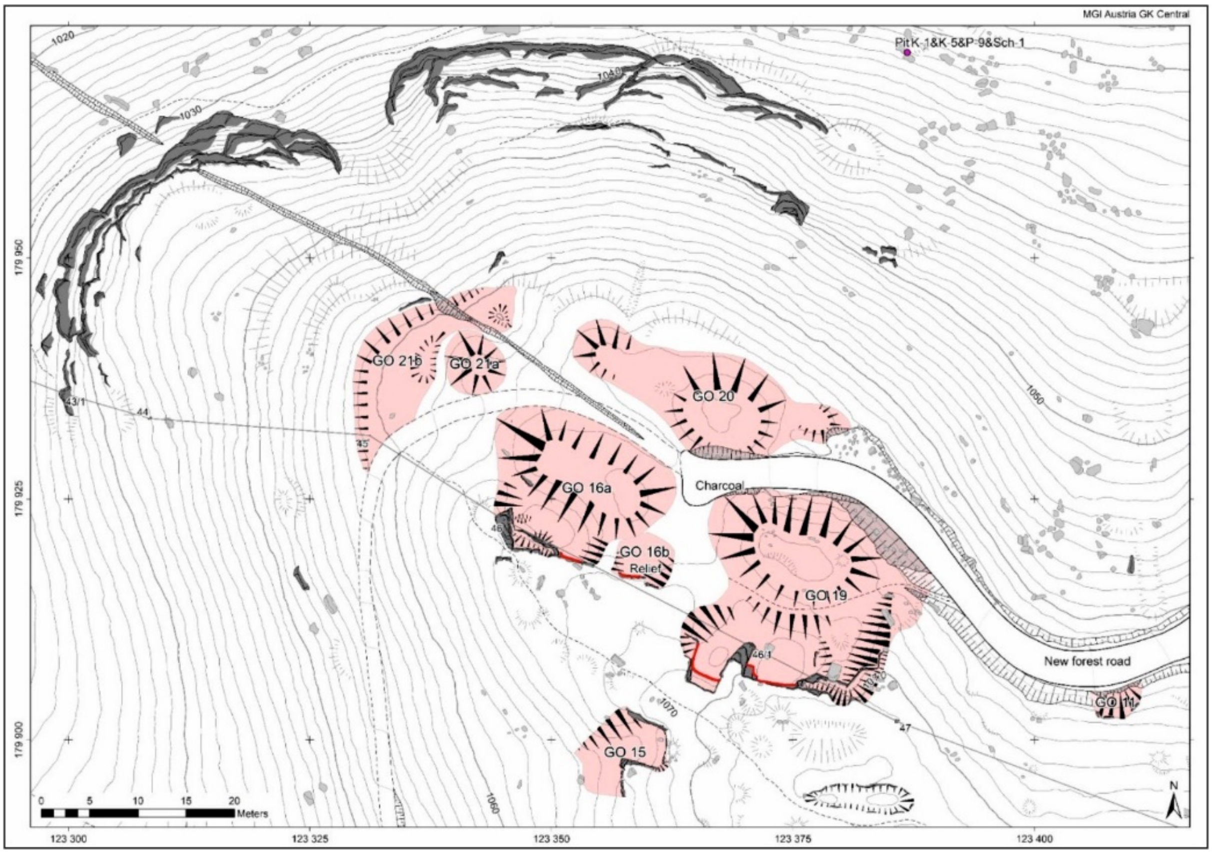

Figure 6: The two pit-like quarries GO 16a and 19 on the spur of Kalkkogel (Map: S. Karl).

This assumed older quarry – the quarry face GO 16b with a relief field[27] might be the rest of it – seems to have been almost completely worked off by two smaller quarries, each with its own debris pile (GO 16a, 19) in front of it. In contrast to the other quarries which use the hillside of the ridges, these small quarries show a different mode of extraction, reaching into the depths and additionally divided into chambers (Fig. 7). To this pit-like quarry type[28] we probably have to add the small quarry GO 6 on the hilltop.

The two isolated quarries on the north of the saddle directly on the new forest road (GO 11) and in the south-west of the spur (GO 15) belong to a smaller chamber-like quarrying type. While the quarries GO 3, 4, 11, 16a, 16b, 18 and 19 were clearly used during Roman times – they have pickmarked quarry faces and/or pickmarked stone material within their debris piles – the small quarries GO 2a, 2b, 6, 15 and 29a cannot yet be dated based on this visible evidence.

Based on this mapping, the extent and scale of quarrying can be examined. The total size of the quarrying areas, taking into account only the sub-zones of Kalkkogel and the intermediate zone, is estimated to be more than 2,400 m². In line with the research on the quarries of Aphrodisias[29], a simple equation was used to calculate the extracted material volume. The surface area of extraction (A) was multiplied with the maximum height difference within this area (H); then the volume (V) was halved to account for the hillside: V=(A*H)/2. According to this calculation, c. 12,000 m³ of marble was extracted on the Kalkkogel. Of course, not all of the extracted material ended-up in blocks or products transported away, a considerable portion landed on the spoil heaps. An estimation of a usable

[27] Karl, Fürnholzer 2019, 201 fig. 4.
[28] Long 2012, 172.
[29] Long 2012, 180; Russell 2016, 261-262.

portion of marble in an amount of about one-quarter to one-third of the extracted volume[30] - 3,000-4,000 m³ - implies a remarkable scale for the quarries at Spitzelofen (Tab. 1), supposed by previous works to be of only local importance based on the marble analysis[31].

Figure 7: The quarry GO 19 on the spur of Kalkkogel, view from north-west (Photo: A. Steinegger).

Quarry	Max. high (m)	Area (m²)	Volume (m³)
GO 2a	1.5	44.0	33.0
GO 2b	1.0	15.0	7.5
GO 3	11.0	995.0	5,472.5
GO 4	11.5	910.0	5,232.5
GO 6	1.0	16.0	8.0
GO 11	2.0	12.0	12.0
GO 15	3.0	36.0	54.0
GO 16a	3.5	59.0	103.25
GO 16b	1.5	20.0	15.0
GO 18	6.0	189.0	567.0
GO 19	5.5	143.0	393.25
GO 29a	1.5	10.0	7.5
	Total	2,449.0	11,905.5

Table 1: Size of the quarrying areas of the quarries on the Kalkkogel and the intermediate zone, calculation of their extracted volumes.

Quarry tools

The tachymetric measurement of the 24 find spots of Roman quarry tools and other finds, such as fibulae, a coin, arrowheads etc., revealed a wide dispersion around the Kalkkogel without significant concentrations close to the quarries (Fig. 3). A total of 29 quarry tools were found: 8 double-pointed picks (including the broken tip from the blacksmith's hearth), 15 wedges, 2 crowbars, 2 bull points ("Setzmeißel"), 1 flat chisel and 1 small wedge-like chisel. Some of them were found as hoards (K-1&K-5&P-9&Sch-1; K-2&P-8; H-4). Together with the three tools from the old excavation in the "Saxanus" quarry of 1930 (2 double-pointed picks and 1 heavy hammer), the quarry zone of Spitzelofen reveals 32 quarry tools with a total weight of almost 70 kg (Fig. 8); to the best of the author's knowledge this represents the most numerous assemblage of marble quarry tools in the *Imperium Romanum*[32]. Concerning the question about the location of the workshops carving semi-finished products within the quarry zone, the near absence of finer stonemason's tools is striking.

[30] Attanasio *et al.* 2009, 326; see also Long 2012, 181; Russell 2016, 263.
[31] Steiner 2005, 107; Steiner 2006, 10; see here n. 12.
[32] See e.g. Bernard *et al.* 1998, 57-66.

Spoil heaps

Based on the stone material in the debris piles of the quarries GO 3, 4, 11, 19 and in the single debris pile GO 20, all exposed by the construction of the new forest road, the spoil heaps consist of poorly-sorted, fine to coarse blocky chippings and other waste material of marble of different quality with an average size of 20-40 cm. Within these debris piles, there are also larger pieces and blocks with a length of up to 1.6 m (e.g. in the debris pile of the quarry GO 19).

A one-day excavation in a small debris pile in front of quarry GO 3 ("Excavation 2016" in Fig. 5) was carried out with the aim of investigating a charcoal band exposed first by the new forest road and then recorded by the mapping work (Fig. 9).

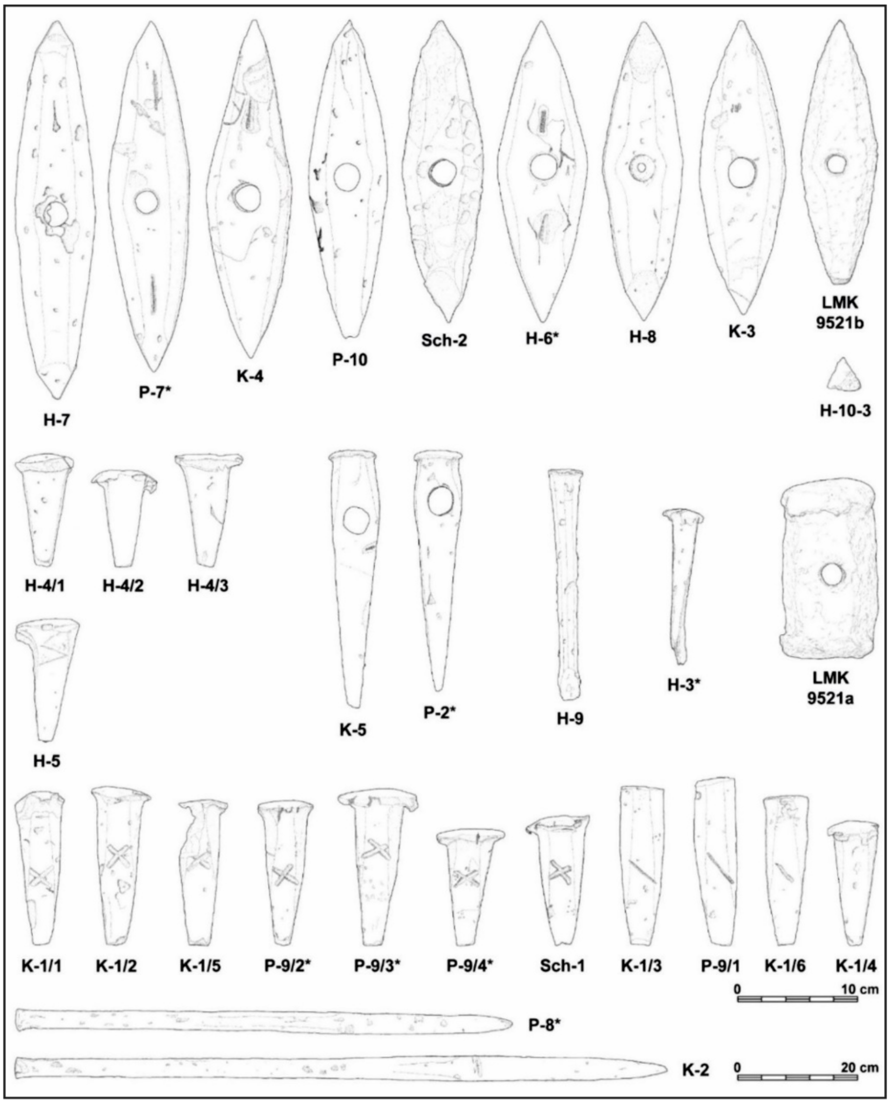

Figure 8: The total of quarry tools from the marble quarry zone Spitzelofen; in the collections of: H = Hassler; K = Kandutsch; P = Prinz; Sch = Dr. Gudmund Schütte Forst- und Gutsverwaltung; LMK = Landesmuseum Kärnten; items marked with * are loans in the Lavanthaus/Wolfsberg (Drawings: K. Schwarzkogler, S. Karl, P. Bayer).

The small excavation provided a stratigraphy of layers of marble waste upon the geological ground. Between the marble layers, a compact charcoal layer (SE 4) was documented, consisting almost completely of pieces up to 9 cm large of charcoal from deciduous (maple, beech) and coniferous (yew, fir) woods embedded in charcoal dust. An archaeobotanical analysis of a material sample revealed mainly vegetative remains of fir, but also spruce, while wild plant remains were sparsely preserved and cultivated plants were only present in an uncertain determined crop (celery?)[33]. Apart from some bones of probably domestic pigs[34] and some fragments of pottery from the Early Roman Imperial Period, the layer included a fragment of a glassy slagged furnace wall made of red clay or re-used brick. Further, the layer was interspersed with small pieces of iron-containing slags, hammer scale and fine-grained amorphous smithing slags[35]. These amorphous smithing slags arise in the hearth, where molten hammer scale dropped down and fused with charcoal dust and other contaminants as small (1-2 mm) particles[36]. Additionally, the broken tip of a pick was found in the material sample of 2011.

Figure 9: Profile section 2016, charcoal layer SE 4 at site H-10 in the small debris pile of quarry GO 3; view from north-east (Photo: A. Steinegger).

This evidence undoubtedly shows the burn residues of a blacksmith's hearth including scraps from an anvil place displaced from nearby. Such smithies were essential for any Roman quarrying to be able to maintain and repair iron tools in a timely manner, especially to sharpen the heavily-stressed picks. Nevertheless, and although smiths are mentioned in ancient texts together with the stonemasons and quarry men working in quarries[37], archaeologically recorded blacksmith's activities within quarry zones are rare in the Mediterranean world. Aside from the imperial granite and porphyry quarries of *Mons Claudianus* and *Mons Porphyrites*[38], iron-working residues in marble quarries are mentioned for Carrara, where traces of "*officinae ferrariae*" and anvils were discovered[39].

Based on the stratigraphy of this debris pile and the radiocarbon dating of the burnt residues, confirmed by the pottery, the stone extraction activity in the related quarry (GO 3) on the Kalkkogel started at the latest around the middle of the 1st century AD[40]. This is the earliest date for a quarry in the south-eastern Alpine region obtained by archaeological and radiocarbon dating methods.

[33] Analysis of wood types: Michael Grabner, Elisabeth Wächter, University of Natural Resources and Life Sciences, Vienna. Archaeobotanical analysis: Andreas G. Heiss, Silvia Wiesinger, Austrian Archaeological Institute, Vienna.
[34] Archaeozoological analysis: Borut Toškan, Institute of Archaeology ZRC SAZU, Ljubljana.
[35] Metallurgical analysis: Daniel Modl, Hans-Peter Bojar, Universalmuseum Joanneum, Graz.
[36] Pleiner 2006, 112-121.
[37] Russell 2013, 212; Bülow-Jacobsen 2009, 143-162 no. 820-840; 183-185 no. 853.
[38] Peacock, Maxfield 2007, 295-296; Peacock, Maxfield 1997, 246-251.
[39] Dolci 1988, 81.
[40] Radiocarbon dating: Curt-Engelhorn-Zentrum Archäometrie, Mannheim. The first radiocarbon dating (Cal 2-sigma: 43 BC - AD 51) is now confirmed by a second one using a small carbonised branch with 18 annual rings: Cal 2-sigma: 36 BC - AD 81.

Quarry paths

A network of quarry paths connects the new quarries lying side-by-side on the Kalkkogel like a gallery on almost the same elevation (1,059-1,076 m asl) and the quarries on Spitzelofen which are located on four stages about 15 m high at elevations ranging between c. 1,005/1,010 m and 1,066 m asl. An old road re-used by the forestry, which starts in the depression between the two quarrying sub-zones on Spitzelofen and Kalkkogel and leads downwards to the west on the northern slope of the Kalkkogel in the direction of the Lavant valley, can be identified as the central stone transport path (Fig. 3). The gradient of this road is between 12-25 % over the first 180 m and varies between 0-29 % over the next 160 m due to a sizeable landslide and modern forest roads modifying the original terrain surface there.

At the starting point of this old road, 1,016 m asl, quarry paths from the upper three quarrying stages of the Spitzelofen sub-zone are bundled. The stone transport from the Kalkkogel, however, is more difficult to determine. But even here – the first part is covered by the new forest road – a path begins north of the debris pile of quarry GO 4, at the lowest point of all the quarries on the Kalkkogel. This path, which has been made almost to disappear by taphonomic and post-depositional processes, crosses the northern slope of the Kalkkogel towards the north-east and then runs to the north-west in the slightly flatter terrain, to the starting point of the central transport road mentioned above.

The central stone transport path leads along the western slope of the Kalkkogel downwards into a well-built road, partly shaped as a sunken path, which runs across the slope to a saddle south-west from the Kalkkogel and then along a ridge in the direction of the Radnigbauer farmstead, 840 m asl (Fig. 10).

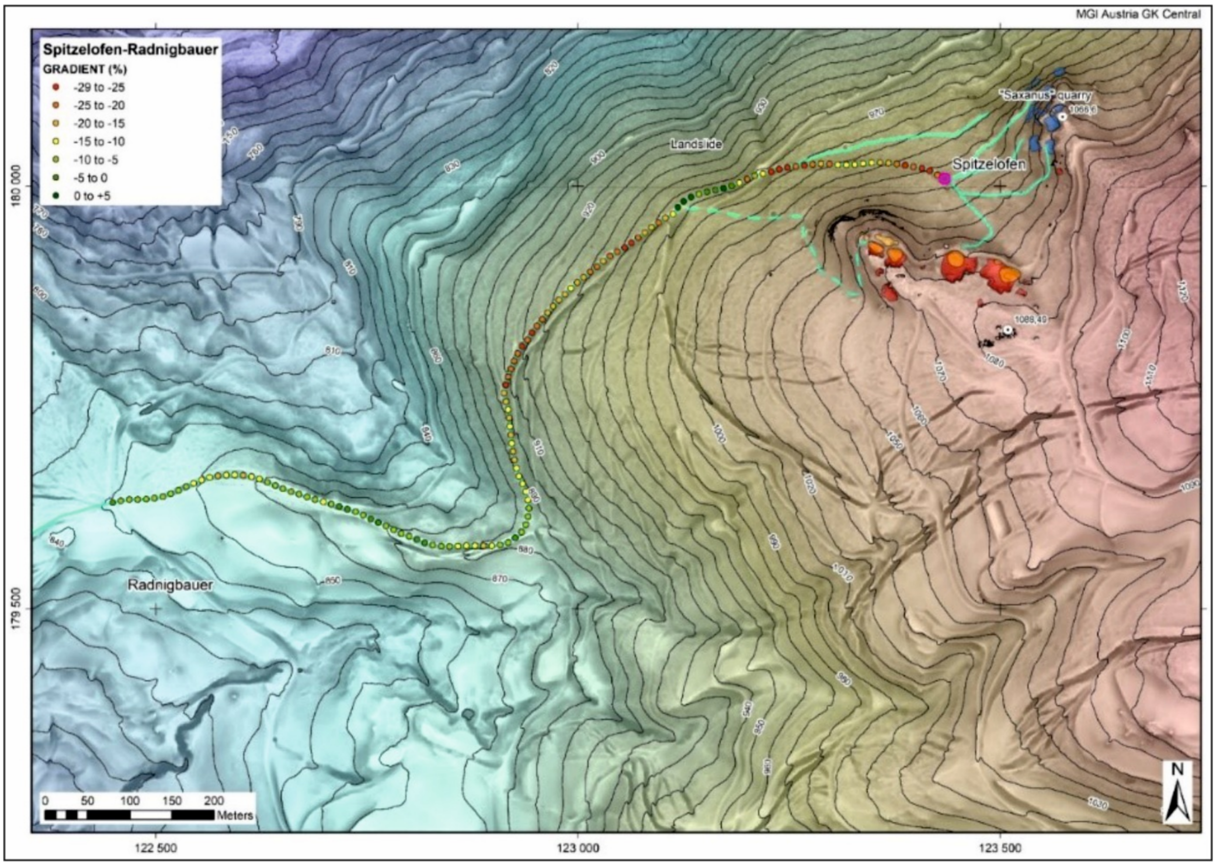

Figure 10: Route and gradient analysis of the path from the central point within the quarry zone of Spitzelofen down to the Radnigbauer farmstead (Map: S. Karl; Source: Land Kärnten – KAGIS; http: //www. kagis. ktn. gv.at).

Due to its origin in this Roman quarry zone, the path is obviously purpose-built as far as this saddle with gradients becoming steadily more even (from 25 to 5 %). This section and its extension to the small village of Ragglbach, 552 m asl, at the beginning of the plain of the Lavant valley is called “Steinberger Heuweg”[41]. Along this route to the plain and onwards to the main Roman road through the Lavant valley, close to the Roman Villa of Allersdorf, the stone transport was organised.

Conclusion

The Spitzelofen quarry zone is of central importance for archaeological research on the production cycle of white marble in the south-eastern Alpine region, as these quarries have not suffered any re-opening in modern times. It provides a vivid illustration of the Roman mode of extraction and quarry infrastructure: different types of quarries, various traces of quarrying techniques, the related quarry tools, remains of smithing, internal quarry paths and a central stone transport path down to the valley.

The enlargement of the previously known quarrying area sheds valuable light on the scale of exploitation and poses a couple of new questions. The various and widely distributed medium-sized and small quarries were exploiting the marble extensively at this site. One might wonder why the remote Spitzelofen marble was preferred to such an extent over other marble resources of the Koralpe mountain at lower elevations and closer to the Roman infrastructure (e.g. at Wolfsberg). To go by the few archaeologically-recorded marble grave monuments and the absence of larger marble buildings, the rural area of the Lavant valley was obviously not the prime market. Where were the customers for the Spitzelofen marble?

A multidisciplinary approach, combining archaeological and geological analysis of the quarries as well as of Roman stone monuments, along with new petrographic and geochemical analysis of the marbles using advances in marble provenancing, is needed. The Koralpe / Saualpe mountains and the Lavant valley present a useful microregion for exploring the exploitation of marble resources in close interaction with Roman settlements and the organisation of the marble supply from a local perspective. In general, it is expected that further investigations of the various quarry zones in the south-eastern Alpine region will shed more light on the production cycle of marble, the debate about products, workshops, quarries and marble resources.

Acknowledgements

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Post scriptum

The montanarchaeological research of the Roman marble quarry zone of Spitzelofen undertaken during two campaigns (2015-2016, 2019-2020) is now completed. The results of this project are comprehensively published as a monographic volume:

Karl S. 2021. Das römerzeitliche Marmorsteinbruchrevier Spitzelofen in Kärnten. Montanarchäologische Forschungen. Mit Beiträgen von P. Bayer, M. Grabner, M. Hainzmann, R. Haubner, C.A. Hauzenberger, A.G. Heiss, K. Layr, D. Modl, W. Prochaska, S.

[41] Schütte 1923, 4.

Strobl, B. Toškan, E. Wächter, M. Weißl und S. Wiesinger. Fundberichte aus Österreich. Beiheft 1, Verlag Berger, Vienna, 240 pages, 133 figures and 62 plates; see the reviews by Bojan Djurić in Österreichische Zeitschrift für Kunst und Denkmalpflege 76, 2022, 113-118 and Arheološki Vestnik 73, 2022, 675-679.

After the publication of this book two activities were undertaken in the quarry zone of Spitzelofen for evaluating and verifying some results and assumptions:

Karl, S., Bayer, P. 2021: Bericht zur Grabung Spitzelofen 2021 (Mnr. 77130.21.01), E-Book-Version der Fundberichte aus Österreich 60, *in press*.

Karl, S., Bayer, P. 2021: Bericht zum Survey Spitzelofen 2021 (Mnr. 77130.21.02), E-Book-Version der Fundberichte aus Österreich 60, *in press*.

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THE EXTRACTION TECHNIQUE WITH SQUARE-HEAD WEDGES AT THASOS (GREECE)

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Abstract

Observation of traces of marble extraction in the ancient quarries of Thasos revealed wedge cuttings with a square-shaped aperture at the front surface, which attest a technique of extraction with square-head wedges that were quite different from the commonly-known rectangular-head wedges. Behind the square section, these cavities have two types of carved volumes: the first one is close to a parallelepiped, and the second one is a truncated pyramidal volume, which imply the use of two different kinds of square-head wedges. Consequently, the represent two related methods of the same technique of extraction using square-head wedges. Remains of such wedges have been discovered at other sites. By mapping the location of these traces on the quarry fronts of Thasos and identifying similar marks on blocks used in ancient buildings, it appears that this technique was used before the practice of the parian technique (using the point chisel between aligned rectangular wedges), at least on Thasos.

Keywords: Thasos, quarrying technique, square-head wedges.

Extant traces of marble extraction identified on the quarry fronts at Thasos can be differentiated into fourteen specific techniques of quarrying in Antiquity[1]. One of these is the '*opai* technique'[2], using square-head wedges[3].

The '*Opai* '

The *opai* or wedge cuttings with a square aperture are uncommon and sparsely distributed: they have been identified only on quarry fronts, which were untouched by the many following centuries of marble exploitation.

The square cuttings measure 0.04 x 0.04 m to 0.055 x 0.055 m (rarely 0.06 x 0.06 m). Two types of *opai* can be distinguished from the carved volume behind the square shaped aperture (Fig. 1):

— The 'I *Opai*' has a parallelepipedic volume (as an I) and the depth from 0.08 to 0.13 m ;

— The 'Λ *Opai*' has a slightly larger aperture (0.055 or 0.06 m), and its carved hollow has a truncated pyramidal volume (as a truncated Λ) with a maximum depth of 0.07 m.

These square cuttings are always aligned, but we observed that the spacing between the *opai* of the two types are different:

— The 'I Opai' have more distant spacing, mostly from 0.15 to 0.60 m, with a few up to 1 m ;

— The 'Λ Opai' have a narrower spacing, ranging between 0.08 and 0.12 m.

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[1] Wurch-Koželj 2017; Wurch-Kozelj 2018, 49-63. Both, Architects, Drs in Archaeology. Independent Researchers. Employed as Permanent Architects at the French School of Athens. We would like to address our special thanks to Samuel Holzman for his contribution in reviewing our English paper.

[2] Kozelj, Wurch-Kozelj, *in press*: 'Τα ίχνη τις εξόρηξης μαρμάρου στην Θάσο, η Παριανή Τέχνη', Lecture given on June 14th 2015 at the fourth international Conference on the Archaeology of Paros and the Cyclades, Paros (10-14 June 2015). The paper, received by D. Katsanopoulou (January 2017), will be published in the next tome of the collection Paros.

[3] And not the 'rectangular-head' wedges. Those also have very different shapes, according to the period of their use.

These distinguishing characteristics signal two methods of an extraction technique using square-head wedges.

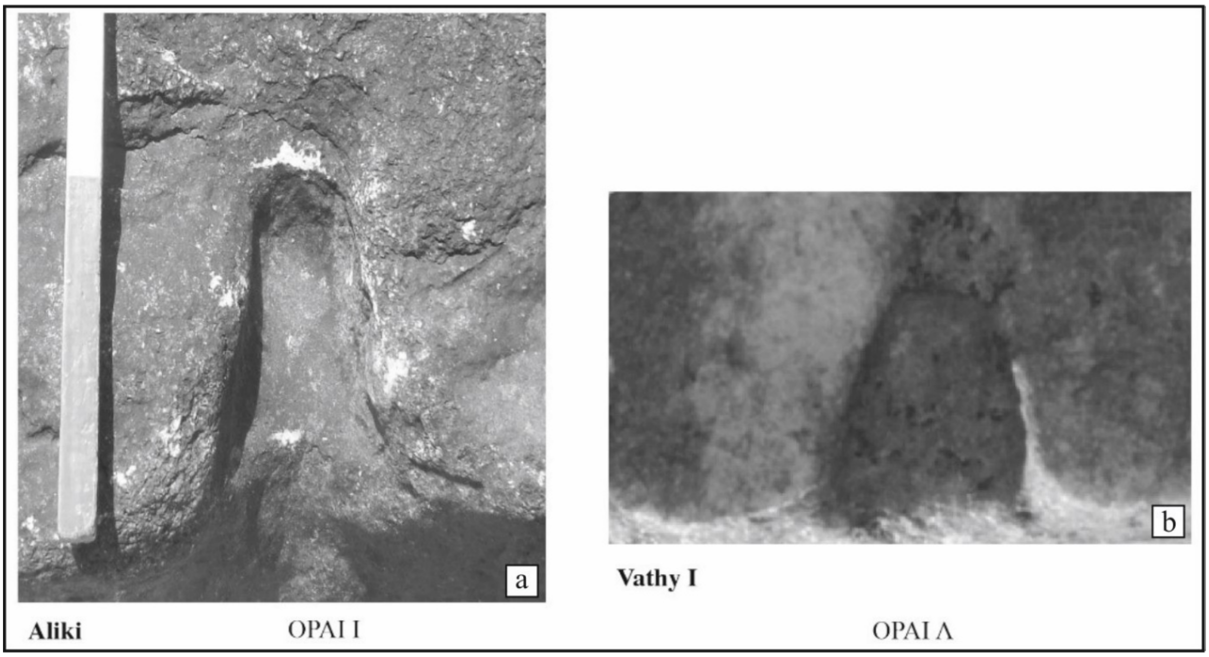

Figure 1: The profiles of the two types of *opai*: **a**. I-shaped opai, Aliki, terrace above the bay; **b**. Λ-shaped *opai*, Vathy I, abandoned block in the quarry.

Techniques of Extraction

The *opai* are mostly located at the edges of quarry fronts, near natural surfaces and deep fissures in the marble bedrock. They are not accompanied by other tool marks or carved channels. Therefore, the dimensions of the blocks extracted are represented by the alignment of the *opai*, which determined the height of each block, and the fissures which established their length and width.

Observations of the various *opai* located on the quarry fronts allow us to reconstruct the process of extracting a block using this '*opai* technique' (Fig. 2):
— select an area of bedrock with vertical fissures appropriate for the length and the width of the block;
— determine the level of the line of wedge cuttings that suits the requisite height of the block;
— carve a line of squared sockets for inserting the wedges. The point chisel and the hammer were used for this operation. At this step, the characteristics of the cuttings - the volume of the opai and their spacing - distinguish the two methods. But both alike follow the same later steps of the technique;
— insert the wedges into the sockets;
— strike the wedges in a repeated sequence until waves of percussive vibration create cracks in the stone (plan de scission, Figs. 2-3);
— these detach the marble block from the bedrock along the crack opened by the wedges; After extraction, the quarry front retains the 'negative of the block' with half of each of the opai; the other half of each of the opai can be observed on the split face of the block taken away (Figs. 2, 6).

The profile of the volume and the spacing between the sockets may be interrelated to produce the best result in matter by maximizing the propagation of the waves of vibration necessary to detach a block.

Tools

The different volumes of the two types of *opai* indicate two types of wedges with square heads. Unfortunately, no tools have yet been found in the quarries of Thasos.

A wedge in the Museum exhibition of Aix-en-Provence (France) is a perfect comparandum of the I-shaped wedge (Figs. 3,1). An iron wedge in the Museum of Kavala (Greece) is also of the square-head variety, but its preservation is too poor to distinguish an I- or Λ-shaped profile (Figs. 3, 2).

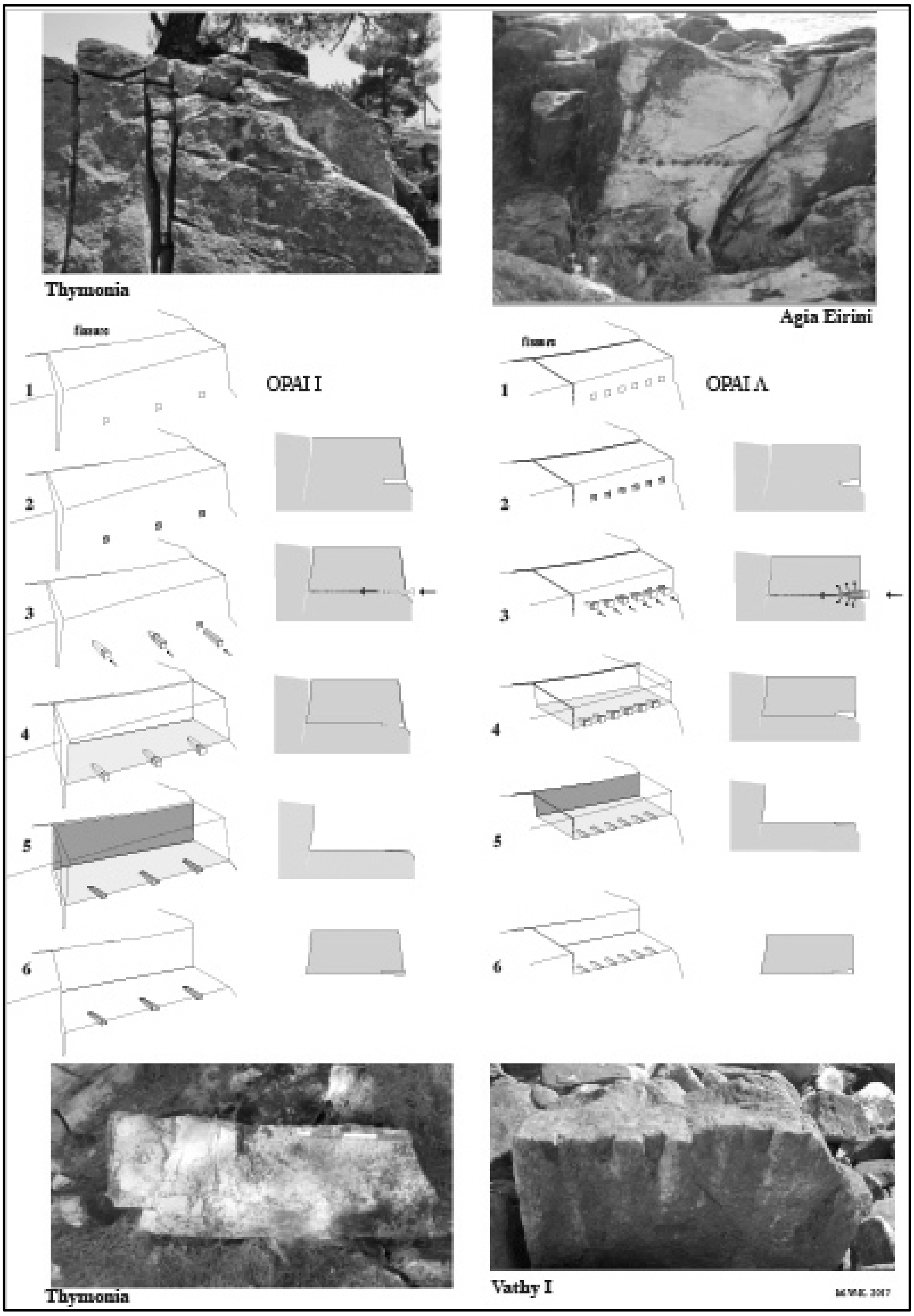

Figure 2: The steps for extracting a block, with the '*opai* technique.

Y. Grandjean[4] published a 'sort of wedge' that was found in the excavation of the area nearby the Silenus Gate (in the South area of the city wall) at Thasos, where a few shops and workshops were discovered. Perhaps this wedge was fabricated or repaired here and was destined for use in a quarry. Here too the state of preservation does not permit the differentiation of an I- or Λ-shaped square-head wedge (Figs. 3,3).

At Mytilini, some tools were found in the quarry 'Anô Latomeia Kourtzi' and were given a preliminary publication by G. Daux in 1962[5]. The wedge looks to be the sort of square-head Λ-wedge (Figs. 3,4) that would match the truncated pyramidal volume of the Λ-opai.

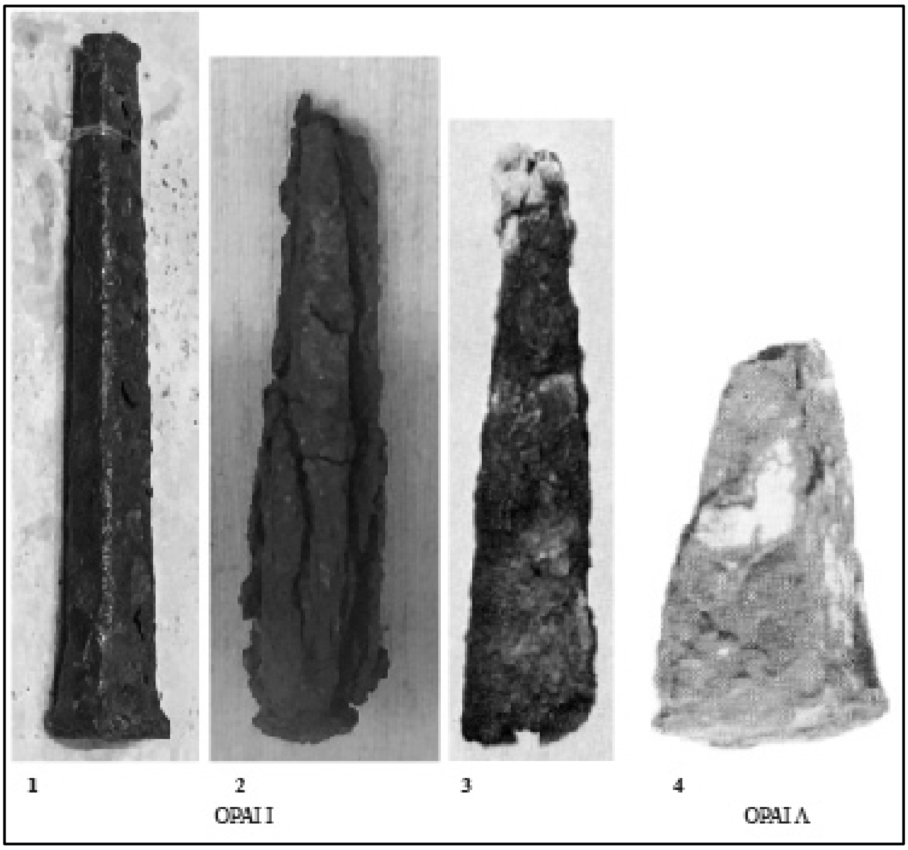

Figure 3: Specimens of wedges. Square-head I wedge: **1**. Archaeological Museum of Aix-en-Provence –France; **2**. Archaeological Museum of Kavala-Greece; **3**. Thasos, a 'sort of wedge' (photo Grandjean 1988, n. 134). Square-head Λ wedge: **4**. Mytilini, quarry 'Anô Latomeia Kourtzi' (Photo: G. Daux, 1962, 879, fig. 4).

Traces of *Opai* at Thasos

At Thasos, traces of opai may be observed on some quarry fronts and also on a few blocks, primarily rough blocks abandoned at the quarry as well as ones used in construction. The I-shaped *opai* are visible on the quarry fronts at Saliara 3, Thymonia, Agios Ioannis Louka, Thasos East-Quarry. Other I-*opai* traces may be recognized on blocks belonging to circular towers located at Agios Ioannis Louka, at Archangelou, and at Thymonia.

One block of the Ag. Ioannis tower has three I-shaped *opai* in the middle of its outer face. Of course these sockets cannot have been used for its extraction, but no other traces have been left on the block to indicate the technique used. Two scenarios are possible: — the I-shaped *opai* belong to an earlier quarry front, which was subsequently exploited, leaving

[4] Grandjean 1988, n. 134.
[5] Daux 1962, 876, 879 fig. 4.

traces of earlier quarrying on the front, which the quarrymen did not care to follow in the extraction of other blocks, so that these remains stayed on the outer face of the block; — the I-shaped *opai* are evidence of a plan for further subdividing the block, but were not used due to changes to the programme.

The half I-shaped *opai* are indicators of the process of extraction, showing the plane where the block was split and detached from the rock. Such traces are visible on a curved block at Thymonia, which belongs to a circular tower, as well as at Aliki, on the large block of the first layer of the megalithic terrace on the northeast of the Bay of the Sanctuaries. The location of these blocks indicates its use in the earliest phase of this Archaic construction, possibly concurrent with the settlement on the island, but before the parian occupation[6]. The Λ-shaped *opai* can be seen at the Acropolis quarries, Vathy II, and Saliara 7, as well as on blocks, including at Saliara 7.

Weathering and later damage have rendered some *opai* indistinguishable between I or Λ. Some indistinguishable *opai* may be observed on the quarry fronts at Agia Eirini and Vathy II.

Some *opai* appear outside of areas of clear quarry exploitation, appearing as a long line of *opai* visible on the marble bedrock, which formed the base for building the archaic terrace located between Thasos and Fanari's quarry. Another line of opai outside a quarry appears on the marble bedrock at the foot of the Pythion, where ceramics from the end of the 7th and 6th centuries BC have been found[7]. Some Λ-*opai* appear in gneiss quarries and show a similar process of quarrying[8] (Fig. 4). Some gneiss blocks built into the city wall of Thasos[9] show that this technique was used for a long time and was perhaps more adaptable to extracting gneiss blocks. The *opai* appear in much smaller numbers than traces of other quarrying techniques. The I-*opai* are mostly clustered in the southeast around Aliki while the Λ-*opai* mostly cluster in the northeast; the unidentifiably-shaped *opai* are also found in the northern part of the island.

Figure 4: Gneiss quarry east of the city wall of Thasos: process of quarrying.

[6] We previously proposed that the Parians first occupied Aliki and its vicinity before they settled the 'bourg minier' (the small mining village focused around the exploitation of the gold mines, the remains of which are earlier than the city of Thasos at Limenas), and from this foothold settled the island and established the city of Thasos. This proposition is founded on the opai remains, and with reference to the "stèle indicatrice thasienne trouvée au sanctuaire d'Aliki", Salviat 1964, 267-287, which indicated the distances between "here and Thasos". Wurch-Koželj 2017.

[7] Grandjean 2011, 94.

[8] Fig. 4 shows the negatives of the extracted blocs on the front face (pink) and on the bottom – scission plans (violet); The prepared block to be extracted is in blue.

[9] The city wall of Thasos was built in 494-491 B.C. Blocks with *opai* are found near the gate of Parmenon. Grandiean 2011, 134, fig. 140. Sond 2003/1 at 76, 26.

The date of *opai* at Thasos

Thus far, we have found no independent evidence indicating either the contemporaneity of the two types of opai - the I-shaped *opai* and the Λ-shaped *opai* - or their sequential use as one technique of extraction evolved into the other.

Curiously, the I-shaped wedges seem closest to the tool used for mining, and could be one of the earliest tools for quarrying[10]. To reach a good mineral vein, miners needed to remove large amounts of rock. Early miners used natural fissures and worked with a kind of 'large point' which could also have been used as the I-shaped square-head wedge.

Perhaps the Λ-shaped square-head wedge could be an adaptation of the I-shaped square-head wedge. The enlarged volume and closer intervals seen between the Λ-shaped opai, probably generated a more effective distribution of the striking force (see. Fig. 2,3), which was transmitted into waves creating the splitting plane that allowed for the extraction of blocks from the bedrock.

It appears that the rectangular-head wedge may be an innovation developed from the square-head wedges. The customary wedge might be a modification for more effective quarrying. The traces of cuttings for rectangular wedges are well-attested in the different techniques employed from archaic to Roman times, and the earliest rectangular wedge cuttings are observed on Thasos in 'the parian technique'[11] and the technique of the "encoignure".

In conclusion, the case of the square-head wedges tells an important story about the lifecycle of a quarrying technique on Thasos. Square-head wedges were effective near the natural top surfaces of marble bedrock, but the reliance of the technique on pre-existing fissures limited its wide application. Square-head wedges were superseded by extraction techniques that allowed for deeper and more precise quarrying as marble extraction on the island intensified. This tool, however, was not wholly abandoned. Instead the square-head wedge appears to have continued in occasional use, especially for the extraction of local gneiss, which has more pronounced foliation than marble and may therefore have proved a more effective application for the tool.

The *opai* technique' using square-head wedges was employed in the early days of marble extraction on Thasos, before the colonization of the island by the Parians.

The distribution of these cuttings with square aperture (Fig. 5) shows two distinct areas where the techniques were used:

— the "Southern area" from Archangelou to Agios Ioannis Louka, including Aliki and Thymonia[12] have I-shaped *opai*;

— the "Northern area" close to Thasos, with the Pythion and the Terrace (between Thasos and the quarry Fanari I) have Λ-shaped *opai*.

As yet there is insufficient evidence to confirm whether the technique was 'local' (that is to say invented by local people) or imported by migrants; but it appears to be a development from earlier mining practices. The appearance of a unique wedge found at Mytilini is itself insufficient to suggest the propagation of the technique from Lesbos. More remains of the technique may await identification in further quarries or on well dated buildings that could bring more certainty to these questions.

[10] The earlier technique of extraction is of course the 'stone splitting' using anything to make a tool acting as a mine bar.

[11] The parian technique use also the chisel-point between the rectangular-head wedges, to promote the scission plan. Wurch-Kozelj, 2018, 51, fig. 2.

[12] We may notice that in the southern area establishment, neither the gold mining area of Koinyra is included, nor the settlement of Ainyra (which still is not precisely located, but mentioned by Herodotus); however, both were known either by the 'Phoenicians', or Thracians, but certainly miners. See Dufeu-Muller 2016, 237-265.

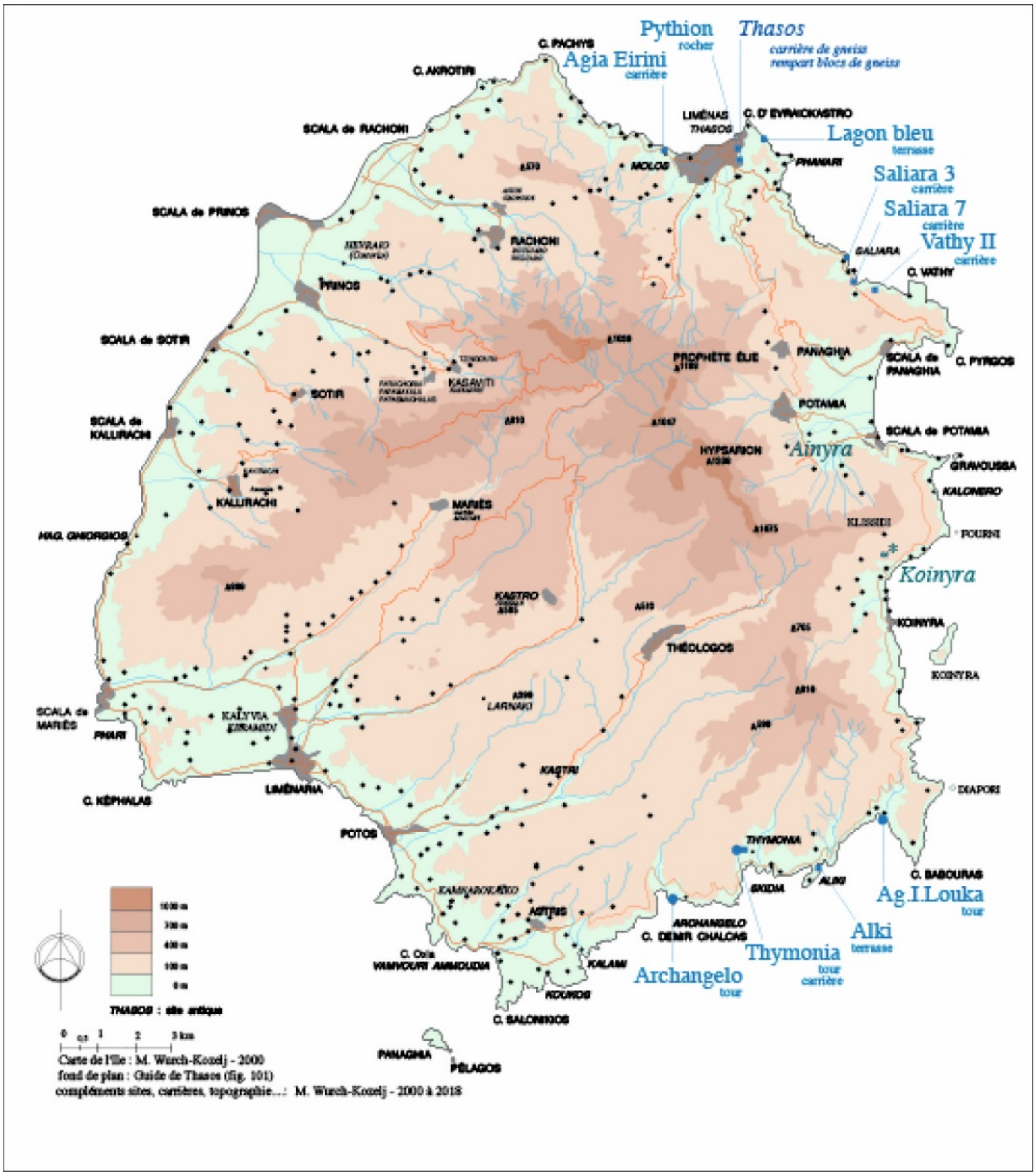

Figure 5: Map of Thasos with locations of the remains of square-head wedges.

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THE ANCIENT QUARRIES OF COASTAL SOUTHERN MYSIA AND MOUNT PINDASOS (MADRA)

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Abstract

The ongoing archaeological surveys around the Gulf of Adramytteion (*Adramyttenos Sinus*), comprising the ancient quarries of coastal southern Mysia as well as the northern skirts of Mount Pindasos (Madra) (as presented here in a manner of "quarry-mapping"), have revealed new evidence that may serve to fill the gap left by the lack of sufficient field researches into the historical topography of the region.

While the geomorphological structure of the region shows diversity, mostly sandstone-limestone combination formations are observed at the coastal quarries. On the other hand, hilltops or slopes of volcanic formation mainly provide inland andesite materials. As is still clearly visible on the sites, the blocks had been extracted from the bedrock by carving horizontal grooves of various size and wedge-holes. Besides the investigation of the quarrying techniques, the distribution of the material in coastal southern Mysia has been another issue of the project. The overall evaluation of the quarries indicates a local usage where the majority of the materials had been documented in use at the small fortified settlements that have also been partly discovered and documented within the frame of the surveys themselves.

Keywords: Adramytteion, ancient quarries, Mysia.

Introduction

In the various ancient sources mentioning the city of Adramytteion (preserved under today's seaside quarter "Ören", part of the Burhaniye district of Balıkesir) such as Herodotos, Xenophon, Thucydides, Strabo, Pliny and Stephanos Byzantinos, the settlement is characterized as a *polis* comprising all the political aspects in Pseudo-Skylax and Aristotle. The strategic location of the city also helped Adramytteion to become one of the *conventus* (court) centres of the Province of Asia[1].

The results of the recent archaeological research at Adramytteion, that had often been referred as a political and commercial centre of the *Adramyttenos Sinus*, have been in rapid ascend. The settlement's continuity from the Chalcolithic Age until the 14th century AD has been clearly documented. The find groups of Late Bronze and dense Iron Age contexts, as well as from the Archaic, Classical, Hellenistic and Roman periods, have revealed the importance of the settlement as a major marine trade spot in connection with many centres of the Aegean Basin. Adramytteion had also been a main spot at the Gulf in the Byzantine Era. This dense urban facility, mostly in between 11th - 13th century AD, had transformed and reorganised the architectural landscape of the city pattern by the re-use of the former architectural elements. The excavation and conservation projects that have been carried out since 2012 were from 2015 joined by a regional survey project has sought to fill the gap in our knowledge of the historical topography of the region[2].

[1] Yağiz 2019, 700-709.

[2] For the ongoing recent projects at Adramytteion and surroundings see Özgen H. M. at T. C. Kültür ve Turizm Bakanlığı KST – AST series in between 2012 – 2019; and also Aykanat, Öztürk 2018, 29-36; Özgen 2018, 243-255; 2019, 405-430.

The focused topography of our recent researches - and the geographical setting of the newly discovered ancient quarries that is mentioned in this paper - is restricted by the eastern extension of Mount Ida (Kaz) to the north and Mount Pindasos (Madra) to the east-southeast and partially to the south (Fig. 1). The region can be considered as the terrain plain of the *Adramyttenos Sinus* with an opening to the southwest faced by the island of Lesbos. Although Adramytteion has been located to the southwestern extension of Mysia, its surrounding territory can also roughly be considered as the conjunction of the Troas, Mysia and Aeolis. This plain territory – the northern part is referred as *Thebes Pedion* in the ancient sources - mainly lies to the northeast – southwest in parallel to the coastline as the inner extensions reach the skirts of Pindasos. The southern part of this coastline, in other words the southern shore of the Gulf, extends until *Hekatonnesoi* and Grylios (Madra Çayı). As well as the researches at Adramytteion, the ongoing field surveys in the surrounding geography has yielded numerous discoveries and details relating to different periods and concepts: prehistoric settlements (beginning from the Neolithic Age), late Classical - Hellenistic forts, rural settlements of the Roman and Byzantine periods, ancient routes and pathways and particular structures such as aqueducts and bridges.

Figure 1: General map of the *Adramyttenos Sinus* (Barrington Atlas of the Greek & Roman World).

Besides these, another important focus for understanding the building facilities, materials and techniques in Adramytteion and its surrounding rural settlements has been the ancient quarries, which are given a scholarly presentation for the first time here. We also attempt to discuss related issues such as the determining factors in choosing the location of the quarries, the techniques used in the quarrying process and the relation between the quarries and the settlement pattern in their vicinities.

Between 2015–2020, by the aid of the surveys mentioned, several quarries have been documented along the coastline and also on the slopes of the hills framing the plain that rise from the streambeds of the Karınca Deresi. Some other quarry spots over the Pindasos (Madra) have also been among the documented sites (Fig. 2).

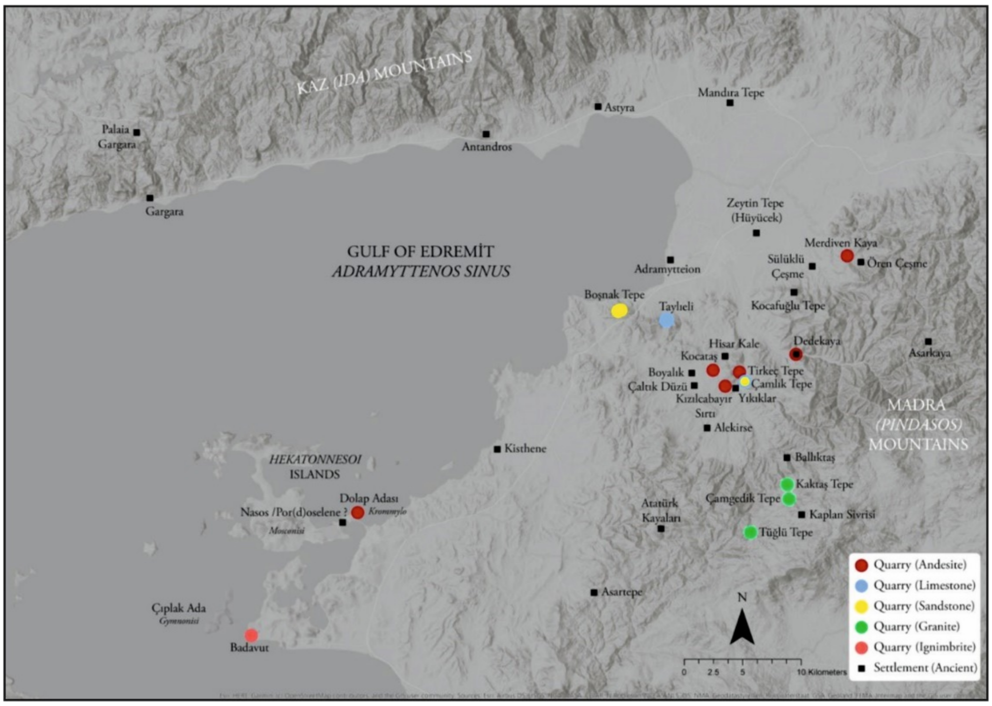

Figure 2: Overview map of quarrying facilities around the southern side of the Gulf (Photo: the archive of Adramytteion Projects).

These quarrying activities were by all means related to the diverse geological and geomorphological formation of the region. The territory is bordered by the granitoid rocks of Evciler to the north and Kozak plateau to the south. Sandstone-limestone transitional formations, which are dated to the middle Miocene, are observed predominantly on the seashore and nearby quarries, while Hallaçlar Volcanic formation of hill tops or slopes - belonging to the well-known Aegean Arc volcanism of the Middle-Upper Miocene mainly provide andesite materials in the interior parts. The quarries of this geographical setting, as the main focus of this paper, are classified below in two territorial definitions; the “coastal” and the “inland” quarries.

The coastal quarries

Just at the southern coast of the Gulf or at the approximate points of the coast where the slopes of the hills begin to rise, four quarries have been documented. Among these, Boşnak Tepe and Taylıeli quarries are located relatively close to the city of Adramytteion. The other two, Dolap Adası and Badavut quarries, are situated far off along the south extension of the Gulf, in the vicinity of the modern Ayvalık district.

Approximately 6 km to the southwest of Adramytteion, at a close point to the shore (1.5 km inland) a row of hills forms a ridged limit for the southern edge of the plain that is formed by the Karınca Deresi alluvial formation. In between this topography, Boşnak Tepe and Ağılkayası Tepesi have an incline towards the shore. On the northern slopes of these hills, with a panorama towards the sea, the systematic sandstone extraction spots can be seen.

The remains of stone-extracting spots at this landscape cover an area of approximately 470x190 m in three sectors as they are named after their local toponym; Boşnak Tepe I, II & III (Fig. 3). These quarrying spots in general can be considered as the major quarry for the city of Adramytteion due to its capacity and location. All three sectors present a vista of incision through the bedrock, something like a valley, running from southeast towards northwest (Fig. 4).

Figure 3: General view of Boşnak Tepe and its vicinity (Photo: The archive of Adramytteion Projects).

At the eastern façade of the Boşnak Tepe-II sector, a visible outcrop of normal / detachment faults can be seen. This geomorphological situation should be an advantageous natural indicator for observing the quality of the material. It must have played a role in assigning the location of the quarrying activity. Although, the geological formation presents a dominantly yellowish sandstone, dense pinkish-reddish colour can also be seen on the stone grain.

Figure 4: Boşnak Tepe II Quarry (Photo: The archive of Adramytteion Projects).

The overall morphological situation as a remnant of the artificial activities gives important clues for the process of quarrying. The stone blocks were extracted from the bedrock by opening various sized lateral grooves. Depending the size and height of the emerging block, two types of grooves have been identified on the site. Smaller grooves, which have 6-10 cm width, should serve for extracting smaller blocks, while the grooves that are 15 cm in width and 50 cm in depth should be used for the larger blocks. The remains of the pecked surfaces in the grooves and the herringbone pattern on the facades of the bedrock clarify that the grooves must have been carved by a quarry pick. In both sectors, dotted horizontal surfaces on the remaining parts of the rock have been occasionally determined and may have had a role in the preparation of the next stage. In two spots, a row of smaller rectangular wedge holes, which are about 5-7 cm in length, 2 cm in width and 2-6 cm in depth, have been carved on the quarry facade to mark the location of splitting (Fig. 5).

Figure 5: Stone extraction traces at Boşnak Tepe Quarry (Photo: The archive of Adramytteion Projects).

After an uncertain duration of activity in the quarry, the site was abandoned as a result of the alteration of the geological strata, the deformation is visible on the current base level of the main spot in the western sector. In addition, the quality of extracted stone deteriorated through the presence of “horn-shaped” formations.

The overall traces give a definite impression of the rational quarrying process for extracting ashlar masonry material which is compatible with the building facilities in the Roman Period of the nearby city of Adramytteion. However, the location is at a closed point of the coastline (over a gentle slope) and a requirement for transportation of the material to Adramytteion by sea seems likely.

Taylıeli is a modern village located on the northern slopes of Kuşça Tepe and Erenler Tepe, 4 km to the south of Adramytteion (Ören). At the eastern outskirts of the village with its remaining morphology, a transitional limestone-sandstone quarry with a step-like form has been discovered (Fig. 6). The extraction techniques applied at this quarry are similarity to those at Boşnak Tepe. The continuous grooves, which are 7-10 cm in width, are still clearly visible.

Figure 6: Aerial view of Taylieli quarry (Photo: The archive of Adramytteion Projects).

Figure 7: Long, continuous groove detail at the Dolap Adasi quarry (Photo: The archive of Adramytteion Projects).

Two perpendicular rock-cut channels, 20 cm wide and approximately 15 m long, are visible in at the incline of the rocky hill where the quarry is located. The distance between these channel-lines is 1.15 m. They call to mind the idea of a pathway for the transportation of the extracted materials for the construction facilities at Adramytteion[3].

Dolap Adası (*Krommydonisi*), is one of the islands of *Hekatonnesoi*, and is located nearby modern settlement of Ayvalık. It is on the passage to Alibey Adası / Cunda (*Mosconisi*) via the modern bridges between the islands and mainland. The volcanic geomorphological formation of the region shows an alteration of andesite-tuff as is shown by the fault on the northeast shore of the island.

The dock-like spots at the coast with the remains of step-like traces of quarrying activities can partly be seen above and below sea level, comprising an area of 20x30 m. The long and continuous lateral grooves on the bedrock (some with a maximum length of 3.7 m) illustrate the stone extraction process on the site (Fig. 7). Its immediate geographical position near the shore must had simplified the transportation costs. The settlement(s) where the quarry stones of Dolap Adası (Krommylo) had been in use can not be clarified. The issue of the localization of Nasos or Pordoselene that is doubtfully located in the vicinity of Alibey Adası may play a role in developing more precise understanding through further research[4]. An ancient settlement at the eastern extension of Alibey Adası / Cunda, 1.5 km to the west of the quarries, is considered important in relation to this localization phenomenon.

The traces of stone extraction at Dolap Adası also drew the attention of the local 19th century traveller and researcher Drakos, as he mentioned the spot as an ancient quarry where yellowish material had been extracted[5].

Figure 8: Badavut quarries at Ayvalık with Çıplak Ada (Gymnonisi) behind (Photo: The archive of Adramytteion Projects).

The Badavut quarries of Ayvalık, which had been a dominant deposit of building activities also for the 19th and 20th centuries, were in use until recent times (Fig. 8). Although systematic quarrying traces are absent, it seems possible that the site might had been used as a quarry for extracting soft purple-coloured ignimbrite blocks in Antiquity. At the southeastern part of Çıplak Ada (Gymnonisi), that is located across the Badavut quarries at a closed

[3] Traces of wheel-tracks 20-22 cm wide, a gauge of 144 cm and maximum depth of 30 cm can be observed in the ancient road constructions; Forbes 1934, 102-103.

[4] For localization discussions of Pordoselene; Stauber 1996, 198-209; Rubinstein 2004, 1047, 1049-1050.

[5] With thanks to Dr. Sercan Sağlam's further discussions on the 19th century sources of Ayvalık region, (planned to be published in a monograph of Adramytteion Researches); Drakos 1888, 5; 1895, 5; Psarros 2017.

distance, a Hellenistic - Roman settlement over a hilltop-terrace has been documented in recent years. The observed material of the wall fragments of this settlement is identical with the geomorphological feature of the Badavut quarry. This evidence can be considered for the relation of Badavut quarry and this settlement in sense of the building material.

The inland quarries

The inland quarries of the region can geographically be classified in two sectors. The first group, comprising six quarries, is located within the southeastern vicinity of Adramytteion (Ören), where the alluvial plain reaches the northwestern skirts of the Pindasos, rising from the streambeds of the Karınca Deresi.

Kocataş hill is situated to the southwest of modern Hisarköy village, which was founded on the outskirts of a fortified hilltop settlement (Hisarkale) of the Late Classical – Early Hellenistic period. The fortified settlement was primarily erected with the aim of protecting and establishing control over the region, and for the same reason it was reconstructed and used in the Byzantine period. On the northern slopes of Kocataş hill, in a direct panorama towards the Hisar Tepe (where the Hisarkale settlement is located), well-preserved spots with long-continuous lateral grooves for stone extractions have been discovered. Beside the familiar step-like remains of quarrying activities, at the northern slope of the hill, a prominent group of traces give a good example of the extraction process, as a partly worked block of 2.5x0.8 m in the surface dimensions is visible. The block is surrounded by lateral channels and had been left for the next process of extraction from the surrounding rock. The geological formation of the hill, which is a volcanically-altered andesite-tuff, displays a lack of conformity with its vicinity[6]. Although Kocataş could be classified as a small-scale local quarry, it would not be inaccurate to relate the activity primarily with the fortified settlement at Hisarkale. Its relatively close distance to Hisarkale (1 km) and the absence of quarrying traces at Hisar Tepe may recommend this idea for the moment.

Tirkeç Tepe (hill) is also located at a close point to the modern village of Hisarköy, and 1.8 km east of Kocataş at a similar geomorphological zone. The surviving morphology of the quarrying activities resembles the familiar rational extraction process. In addition, outstandingly at some parts, vertical facades of outcrops bear the traces of preparation of rounded material extraction operations. The outlines of the circular channel present a diameter of 60 cm. It is hard to offer a clear explanation to clarify the meaning of these vertical circular carvings, but it seems most logical to relate them to extraction work for producing millstones, which played a vital role at the ancient rural economy, rather than building materials like column shafts or drums.

During the recent construction work at Reşitköy Dam, various quarrying spots were unearthed on the south-eastern slope of Çamlık Tepe. The site is located 740 m south of Tirkeç Tepe and also close to the crossroads of the modern villages of Tahtacı and Sübeylidere. The geological formation of Çamlık Tepe quarry offers homogeneous materials in general; while the lower layer presents yellowish sandstone, the upper layer presents limestone. These terrace-spots, are located from 20 to 50 m away from each other in the southwest-northeast direction (Fig. 9).

The lateral grooves and the herringbone patterns surviving from the quarrying facilities are clearly visible on facades. In comparison to the other quarries of the region, the potential capacity of the Çamlık Tepe offers the clear prospect of being one of the major quarries of the vicinity. The Çamlık Tepe quarry is located at a very close point to the

[6] For further interpretation of the andesite-tuff material in relation to the provenance problem see Lazzarini, Visonà 2009.

streambed of the Boğaziçi Deresi, which is one of the streams of the Karınca Dere. This geographical advantage must had played a great role in the transportation of the material won from the quarrying facilities at these parts of Çamlık Tepe.

Another quarry near Çamlık Tepe is located at Kızılcabayırsırtı, on the rocky bed of the Boğaziçi Deresi stream. The morphology of the traces presents a similar rational process of ancient quarrying as seen on the other quarrying spots of the region. The visible processed spot occupies an area of 7x4 m. The lateral grooves and the remnant hollows from the extracted limestone blocks - forming a step-like structure - are visible at the base of the bedrock.

Meanwhile, the remains of an ancient rural settlement at Yıkıklar, which is in close proximity to the Çamlık Tepe and Kızılcabayır quarries, offers a general plan of rectangular rooms in a modular relation with each other, as can solidly be observed from their foundations. The settlement cannot be dated precisely but the ceramic finds range from the Roman period to the end of the Byzantine era. Thus, Kızılcabayır quarry might have played a prominent role for the construction facilities at the mentioned settlement of Yıkıklar.

Figure 9: One of the locations within the Çamlık Tepe quarry (Photo: The archive of Adramytteion Projects).

Another quarrying spot near the Karınca Dere streambed can be identified among the ruins of a fortified settlement called Dedekaya. Two major bedrock outcrops describe the topographical character of the settlement where the architectural traces of the fortification walls were identified over these masses of rocks and around. The settlement is situated within the *chora* of Adramytteion, in a position overlooking the valley of the Karınca Dere stream between the modern villages of Bahadınlı and Karadere. The function of the Dedekaya settlement can be divined by its strategic location for the defence network structure of the plain of Thebe in the Late Classical-Hellenistic period. Meanwhile, amid the remains of the settlement, the rational process of stone extraction traces can be identified at two quarrying locations.

One of them is located 70 m to the southwest of the upper settlement at the incline towards the basin of the Karinca Deresi. The visible traces of stone extraction process occupy an area of 17x24 m. Lateral groves, the marks of tools on facades and familiar extraction traces are visible at the spot. The other locus, on the border of the lower settlement, occupies an area of 7x4 m and give the overall impression of a basin in the absence of the extracted material. With this in mind it may be that afterwards this second spot could have been used in a manner of water reservoir. This situation and also some other observable carvings near the foundation traces of the fortification walls bring to mind that the practical process can also be related with the initial building facilities of the settlement. Additionally, the materials to be used in structures like the fortification walls, could be gathered at some place from the bedrock workings for the structural foundations.

About 12 km inland from the coastline, another quarrying spot, Merdivenkaya, is located near the modern village of Dutluca. The step-like structure of the remaining morphology caused the spot to be named as Merdivenkaya (stepped rock) locally. The overall traces on the rocky surface delimit an area of 8x17 m, presenting mainly as two terraces. The familiar process traces, lateral grooves and tool marks for obtaining andesite blocks are observable. It is not yet possible to make a precise suggestion for the utilisation centre of the material extracted from this spot, as no nearby ancient settlement in close proximity is known. However, considering the location in the *Adramyttene*, as it is on a very direct line to the plain of Thebe, the transportation process to a relatively close location seems feasible.

Radt's survey projects around Okçular/Perperene reveal the potential of the region by documenting granite bowls and half-processed column drums that were scattered between the modern villages of Bağyüzü and Okçular in 1995 and 1996[7]. Lazzarini's petrographic analysis around the Kozak plateau at a close distance identify this local fine-grained granodiorite as "*Marmora Mysium*"[8]. Meanwhile, during the surveys of 2019-2020 near the western quarter of Mount Madra (Pindasos), three granite quarries were discovered and documented; Tüğlü Tepe, Çamgedik Tepe and Kaktaş Tepe. These quarries are mentioned here as the second group of inland quarries in the focus region.

Tüğlü Tepe, located 2 km to the northwest of Hacıbozlar modern village, presents a quarrying location covering an area at the incline of the hill towards the northeast, as the partly-worked rough architectural materials can be seen at the rocky cliff among the pine trees. Several roughly-worked monoliths and fragmentary columns and also a sarcophagus are among the documented finds. The process of extraction is identifiable in some cases near the rock facades through the grooves and other traces of quarrying.

Çamgedik Tepe, the other quarrying spot, is located 2.5 km to the southeast of modern Kuyumcu village. The summit of a secondary rocky hilltop consists of plenty of extracted architectural material samples from the mass of rocks (Fig. 10). Columns and column fragments are visible with the evidence of their extraction process, such as long grooves and wedge holes. Some of the roughly-worked columns have a maximum length of 5.30 m.

Figure 10: Çamgedik Tepe quarry (Photo: The archive of Adramytteion Projects).

[7] Radt 1997, 453–454.
[8] Da Vecchi *et al.* 2000, 145–146.

900 m away from the Çamgedik Tepe, another quarrying area is situated on the southern and western slopes of Kaktaş Tepe. The remains of wedge-holes in exploited granodiorites and nine column fragments are spread over the site.

These inland granite quarries might have served to obtain columns and sarcophagi primarily for Pergamon, like those located in the south of Perperene, as noted in previous studies. Additionally, a similar assumption should also be possible for Adramytteion and different sized-settlements to the north.

Conclusion

The geomorphological formations of the region definitely determined in the spread of the quarrying spots with regard to the topography. The fault mirrors near the quarrying spots at Boşnak Tepe and Dolap Adası and also the visible faults at Taylıeli and Kocataş resemble the situation where the ancient masons would had used these geological indicators in deciding the location of the quarry in regard to the quality of the rocks. The quality must had also been appraised when considering the possibility of exporting or creating marketing demand. Because of the alterations in the stone formations, such as sandstone-limestone combinations and the deteriorations of andesite-tuff, it is likely that the majority of the quarries noted in the region served locally for the political and commercial centres of the Gulf, rather than the long-distance centres overseas. In addition, the needs of the multi-phase building projects at Adramytteion and the fortified or rural settlements in its territory are coming into prominence in this sense at *Adramyttenos Sinus* and at the inland counterpart of *Adramyttene*. With the same view of the situation, the management scales behind these local quarries would had been local rather than a central or imperial order.

In a chronological context, the continuous utilisation of the quarries at the coast of Western Anatolia is a familiar conjecture. Nevertheless, in the absence of sufficient knowledge of the architectural data for the pre-Hellenistic period in the focus region, *Adramyttenos Sinus*, the evidence for such a continuity is not yet sufficient to draw further conclusions. Thus, although they were intensively used in the Roman Period, the majority of the quarry spots forming the focus of this paper had initially served in the Late Classical - Hellenistic Period in relation to the documented settlements in the survey campaigns.

The ongoing archaeological survey comprising the ancient quarries of coastal southern Mysia, presented here in the manner of “quarry mapping”, reveal new evidence that may serve to fill a gap in the historical topography of the region left by the lack of sufficient field research up to now. The preliminary results will shape new questions regarding the chronology and settlement network of the Gulf and its vicinity that may be clarified by more detailed documentation of the quarries in further survey campaigns.

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INSIGHTS INTO THE SERIAL PRODUCTION OF MARBLE RELIEF SLABS IN 2ND CENTURY ATTIKA: ADDITIONAL TECHNICAL OBSERVATIONS ON THE RELIEFS FROM PIRAEUS*

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Abstract

This contribution documents the extant traces of ancient marble piecing on two of the relief slabs from Piraeus Harbour from the discoveries of 1930/31, which brought to light the remains of almost 40 decorative reliefs of the late Hadrianic and early Antonine periods. In this vast collection of materials, as well as within the area of decorative reliefs in general, evidence for the piecing of marble in the workshop is rather rare. I would like to draw attention to this fact, which reveals an interesting, though seemingly subordinate, facet of the serial production of 'decorative' marble reliefs in Roman times.

Keywords: Piecing techniques, pentelic marble, Piraeus reliefs.

Introduction

The Archaeological Museum of Piraeus holds one of the biggest collections of serially produced marble reliefs outside the realm of architectural sculpture in the narrow sense of the word (cfr. e.g. the Sebasteion in Aphrodisias): Several dozen marble fragments were rescued from the sea during the deepening of the harbour basin in the winter of 1930/31[1]. Subsequently, it became clear to specialists, that they constitute the remains of approximately 40 decorative slabs of identical material and size (Pentelic marble of about 1 to 1.3 m [H x W]), depicting several scenes of the famous Amazonomachy of the shield of Phidias' Athena Parthenos (nine scenes), as well as a number of more genuine 'Neo-attic' pieces (fourteen subjects) within their profiled frames[2]. Interestingly, in more than one case, these scenes exist in multiple copies, either having duplicates (six to seven scenes) or even having three variants (three fighting couples of the Amazonomachy)[3]. Judging from their workmanship and style, it has been convincingly argued that we are dealing here with works which date to the late Hadrianic and early Antonine periods, and were thus possibly the output of a single workshop that were meant to be shipped over-seas[4]. The so-called Piraeus reliefs thus provide strong evidence for the ongoing question concerning serial or 'mass' production[5]. and the wider

* I thank D. Andrianou, M. Bruno, Y. Maniatis, S. Perna, V. Ruppiene, and N. Toma for discussion.

[1] Strocka 1967, 39-40. This article results from my occupation with the topic of the serial (re-)production of images in Roman times for my dissertation 'Reproduktion und Bild', in which the Piraeus reliefs form an individual case study (Reinhardt 2019, 67-94 cfr. 135-136. 146-147). The technical aspects discussed here, however, are a topic of their own, one for which I'd like to raise awareness due to the lack of an overarching study on marble piecing in Roman Sculpture. Jacob 2019 and Anguissola 2018, 120-121, and 159-164 have recently referred to this issue. The manuscript was completed in August of 2019.

[2] The standard publication is Stephanidou-Tiveriou 1979, see 6-44 for a list of the fragments and 64-107 for the scenes extant.

[3] Reinhardt 2019, 72-73.

[4] Stephanidou-Tiveriou 1979, 45-52. 56-63; Strocka 1967, 96-96. 100-101. 107-112; Reinhardt 2019, 69-72. 83-84. 87-88 with further references.

[5] Fundamental is Strocka 1979, 158-171. For architectural members, see Toma 2018. In Reinhardt 2019, 60-63. 134-135 I propose a definition for serial pieces in Roman 'decorative' relief sculpture.

dynamics of production and trade in Roman marble sculpture. Seen against this backdrop, some relevance is assigned in what follows to the fact of the reliefs' multiple appearances as well as of some of the depicted scenes within the find. All too often, the assumption of serial (as well as 'mass') production comes hand-in-hand with the implied suspicion of low costs and little care (both with regard to the producer and the commissioner)[6]. Although it is clear that the modern concept of art vs. industry is at stake here, this general suspicion demands a case-based enquiry.

Figure 1: Close-up of the unfinished cornice of fragment inv. no. 2086+2083+ 2058 (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

The Piraeus reliefs are made of pentelic marble[7]. The quality of the workmanship is undoubtedly quite good, showing, for example, the highly-polished surfaces on faces, arms, and legs typical of the High Imperial Age. However, this obviously does not exclude certain technical peculiarities in some pieces: the cornice at the bottom of a relief with Nymphs (inv. no. 2086+2083+2058: Fig. 1), for example, clearly is in no more than a draft-like state[8]. This, however, would hardly suffice to make the Piraeus reliefs an example for hasty workmanship within serial production – rather we are looking at a common, but subordinate, facet within the variance natural to any serially-produced sculpture or complex monument[9]. Another dimension of this specific variance of the Piraeus reliefs is the piecing of marble, of which traces remain on two plaques.

[6] Regarding the dichotomy of 'art' and 'series' see Strocka 1979, 144. 157. 173; Heilmeyer 2008, 243-250.

[7] Stephanidou 1979, 45. Its quality has been described as only moderate, a statement that is sometimes applied to Imperial sculpture made of Pentelic marble, see Kane, Carrier 1992, 124. In reality, however, the raw material used appears to be quite good; veins or crystal defects (see below, case 2) are rare.

[8] Stephanidou, Tiveriou 1979, 29-30 no. N2; Reinhardt 2019, 70 note 464 no. P.N2. Compare, however, a relief fragment in Venice with un-smoothened surfaces, sketched elements, as well as a measurement point, which until now is the only close parallel to the relief inv. no. 2120 from Piraeus, showing the abduction of a woman in a chariot, see Sperti 2004, 804. 814-817 fig. 1. The unfinished cornice on relief inv. no. 2086+2083+2058 clearly distinguishes from this case of unfinished sculpture and should better be declared as an inaccuracy. Similar cases exist among the Piraeus reliefs, but they are not overwhelming in number: on the other relief with Nymphs (inv. no. 2119; see Stephanidou 1979, 94-95), for example, a rectangular area between the frieze and the lower cornice bears an unusual 'wave', which seems to hint at a change of plan (seemingly, the figures were first sketched out next to the lower boarder and then moved upwards); however, this later part was provided with a finished surface, indicating that one was willing to accept it as part of the finished work.

[9] Compare, for example, the existence of tiny discrepancies in the decoration of the Arch of Titus, of the Basilica Aemilia and other monuments: Lipps 2011, 176-179; Maschek 2008, 200-202; Pfanner 1983, 29 fig. 16. On forms of this variance, see Reinhardt 2019, 60-62. 134-135.

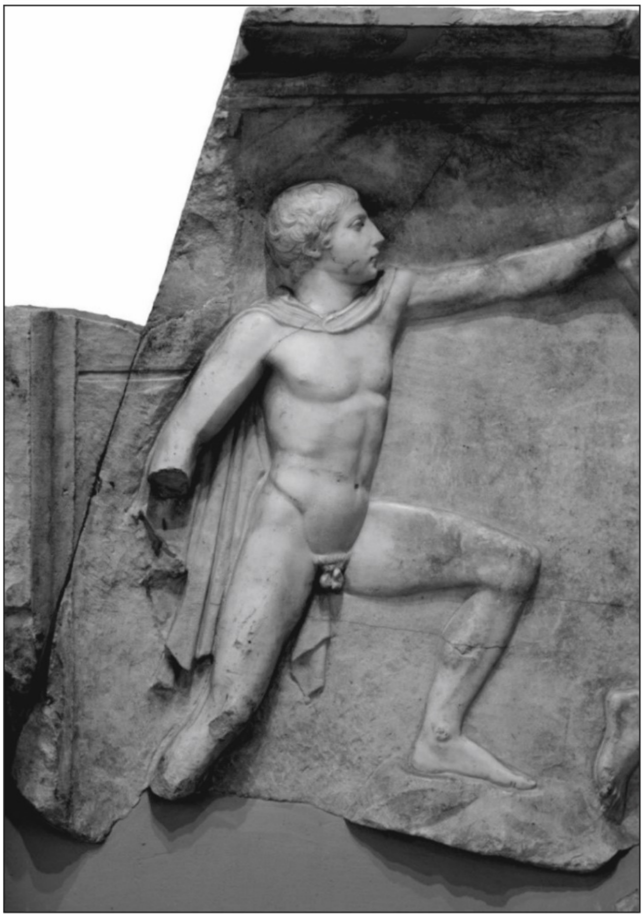

Figure 2: Left side of relief slab inv. no. 2116+ 2028+2059+1834 with pieced angle (Photo: A. Reinhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

Traces of technical measures are extant on the left side of the relief, as well as on the upper part and right side, but the two cramp-marks found there, as well the tiny stud hole on the right (Fig. 3), are modern intrusions[10]. Undoubtedly antique, though, is the piecing of the upper left angle, where a large triangle-shaped piece was added to the main plaque. The addition itself is partially preserved, and it now measures 41 cm, while the original height seems to have reached 70 cm (with a maximum width of 22.5 cm).

In order to guarantee a durable connection between the two pieces, a joint surface with *anathyrosis* was meticulously cut (L 74, 5 cm; Fig. 4; the three small stud holes are modern). Its roughened surface in the middle might point to the use of an adhesive[11]. However, in the centre set a massive dowel, the bedding of which is preserved (L ca. 8.7 cm, diameter 2 cm), and, additionally, a large cramp secured the piecing from above (preserved length 8 cm, width 2.5 cm, depth 2.3 cm, or 3.5 cm at the end: Fig. 5). It is difficult to decide whether this double fixing with metal only relates to the shipping and use of the plaque, or whether it might indicate that the carving/finishing of the plaque took place when the addition was already installed[12]. Unlike in the following case, a reason for the piecing of the upper left angle is not easily recognizable; a default in the material or a spalling of the edge in the workshop are possible explanations.

[10] Stephanidou-Tiveriou 1979, 7 no. A.2; Strocka 1967, 42. See also Reinhardt 2019, 146-147, for a discussion of the modern intrusions, which are present on many pieces on display, but to my knowledge have not been mentioned in literature so far.
[11] See Claridge 1990, 148, 153-154; Nolte 2007, 15-244.
[12] As suggested, for example, in the case of the foot of a Hellenistic draped figure from Pergamum by Hofter 2011, 335-336.

Figure 3: Detail of relief slab inv. no. 2116+ 2028+2059+1834: straightened edge with stud hole – modern intrusions (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

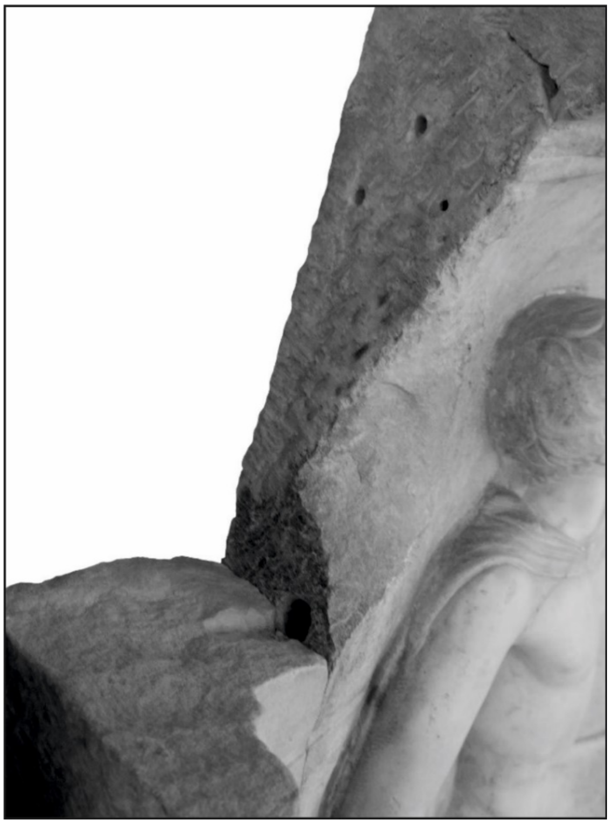

Figure 4: Close-up of inv. no. 2116+2028+2059+ 1834: *anathyrosis* and dowel hole (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

Figure 5: The left angle of inv. no. 2116+2028+ 2059+1834 seen from above: bedding for metal cramp (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

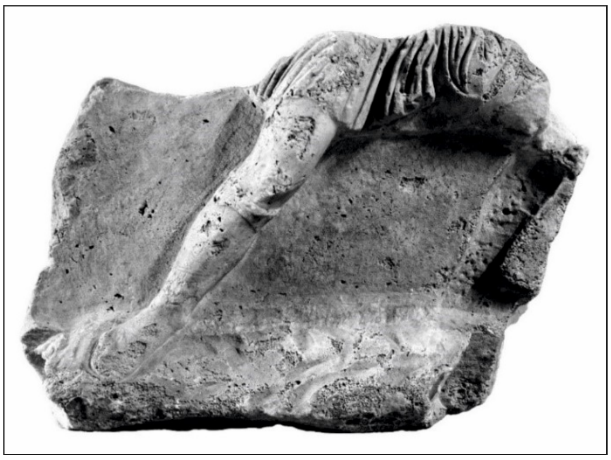

Figure 6: Relief fragment without inventory number: piecing of leg ‘a tassello’ due to a crystal layer (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

In this case[13], a flaw in the marble clearly made necessary the use of additional material and its piecing. The reason for this was obviously a horizontal layer of brittle crystal, which was up to 2 cm thick, just above what has been made the background of the depiction. Still visible is this irregularity of the stone at the inner contour of the leg as well as beneath the figure’s cloth and in the back of the rocky ground. While in these cases the vividness of the relief guaranteed a secure cutting, the diminished height of the second leg in profile seems to have been problematic. The solution applied by the sculptors was to carve this part separately and fit it into an accordingly-shaped cutting in the background of the relief (height 20.5 cm, width 8 cm, depth 2 to 2.2 cm). This measure, which did not necessarily require stubs or dowels, is known as the “a tasselli” method, and is attested several times on column

[13] Reinhardt 2019, 147; only one of the two cases of piecing on this plaque have been mentioned so far, Strocka 1967, 92.

shafts in coloured marble as well as on restored sculpture[14]. However, it seems as if the faulty material also generated problems at the bottom of the relief (Fig. 7): just beneath the attached leg, a second attachment was made, this time affecting the slab over its entire thickness (ca. 18 cm; preserved height 9 cm). This seems to indicate a substantial piecing, perhaps of more than the rocky ground of the scene, but the fragmentary status of the piece does not allow for a full reconstruction. In order to ensure maximum stability, the surface of the join was stepped, allowing the attachment to interlock with the full thickness of the plate[15].

Figure 7: Close-up of the same fragment showing the second join with interlock (Photo: A. Reınhardt, with kind permission of the Archaeological Museum of Piraeus/Copyright Greek Ministry of Culture and Sports).

Finding close comparisons for the piecing of marble when motivated by practical necessities (and not by other reasons)[16] when talking about decorative reliefs is rather difficult. Not only does the lack of overarching study on this topic have an impact on this, but attachments in marble also seem to be relatively rare in this field in general[17]. One reason for this seems to be the phenomenon whereby protruding parts, such as heads and arms, are traditionally arranged within the contour of the image as a whole, which, in turn, is limited to the closed form of the image carrier (the ‘plaque’ or ‘tondo’). Carving a relief, therefore, unlike carving a freestanding sculpture, requires much more considerably a piece of stone, which is big enough for the subject right from the start. The Piraeus reliefs mirror this important precondition insofar as they mainly coincide in height and width, even if their

[14] The two holes in the cutting visible on figs. 6-7 actually derive from sea creatures (toredo) as the remaining shell within as well as in other weathered pieces from the harbour proof, see Strocka 1967, 92. Matthias Bruno pointed me towards these mentioned columns, see Pensabene 2007, 391, Pensabene 1995, 53-54, no. 3-4, figs. 59-65, for which I would like to thank him here. In sculpture, the figured base inv. n. 9987 in the Vatican, Museo Gregoriano Profano, Draeger 1994, 249, n. 88 pl. 27.1, provides a good example: in order to replace the head of a female figure in an ancient restoration phase, a deep cutting was hewn in the relief ground.

[15] This effect is hence similar to interlocking stones in architecture. In the field of architectural sculpture, a relief slab of Pentelic marble in Thebes (Archaeological Museum inv. no. 159) seems to provide a parallel. Presumably due to a material defect, the lower left edge had to be worked separately and added-on; the surface prepared for this join is even, but stepped in the upper part. I thank Johannes Fouquet and Kai Töpfer, who are preparing an article on the piece.

[16] Which might inclde later restorations or primary piecing for the sake of combining different materials. The latter, of course, seems to have been a ‘privilege’ of polychrome freestanding sculpture in *marmi colorati*; however, a less extensive combination of different stones could provide an explanation for the attachment of separately-manufactured minor elements, where the carving out of the same block actually would be normal. This seems to be the case with a helmet as well as with an idol on two relief plates from the monument of Zoilos and the Sebasteion in Aphrodisias, respectively, see Smith 1993, 26 pl. 4, Smith 2013, 240 no. D 29 pl. 134, but this remains an open issue.

[17] In the field of architectural sculpture, the reliefs from the Sebasteion in Aphrodisias provide an instructive example. In several cases, apparently due to faults in the marble, filling pieces were added into cuttings on the upper edge of the panels: Smith 2013, 38 (e.g. 226-227, n. D 21, fig. 182, pl. 124; 244, n. D 31, fig. 192, pl. 136; 252, n. D 37, fig. 199, pl. 145).

friezes differ in terms of composition and in the number of figures depicted. As Theodosia Stephanidou-Tiveriou among others has pointed out, the sculptors responded to the seemingly predetermined size of their relief plaques by varying, for example, the cornice or by adding an intermediate zone under the frieze (but not, e.g., by changing the figures' sizes)[18]. Here, the aspect of the rational, economic work within the given circumstances of the work order is clearly indicated[19].

Seen against this backdrop, it seems indicative in itself that (as far as we know) only two of the almost 40 relief plaques from the Piraeus Harbour bear traces of marble piecing. It is conceivable that these additions were not planned in the beginning: rather, they turned out to be indispensable at a later stage in the workshop, when the plaques were already sawn out of the blocks[20] and the friezes were maybe already sketched. Undoubtedly, the marble additions required additional work that would cost time and money – but nonetheless this was the decision implemented by the persons involved. This allows us to draw the conclusion that the efforts already spent on the plaques in an early state of their fabrication (that is, after the procurement and transport of the raw material, and its initial preparation), together with the work on the friezes started by the sculptors, were deciding factors. The high cost of the raw material, furthermore, was decisive and gave an additional reason to imply the described extra-piecing measures in this context of a 'large-scale order'.

The fact, that the reliefs from Piraeus are serially-produced sculpture from the period, in which there existed the largest output in Roman sculpture that we know of, provides no clear evidence for a decline in terms of quality and craftsmanship connected to modern prejudices on serial (or 'mass') production. This much can at least be said in connection with the domain of luxury marble furnishings.

[18] Stephanidou 1979, 45 (sizes). 47-49 (cornices). 162-167 (figures – cfr. the case the Nymphs: 167); Strocka 1967, 95-96. 99; Reinhardt 2019, 69-76, 81-83 (see notes 481. 574 for the reliefs no. P.Y1-3 forming an exception in so far as they combine two scenes in one frame).

[19] While in the friezes exist several examples for a more complex elaboration: see Reinhardt 2019, 73-80.

[20] It seems as if a block was cut up into two or three plates: Stephanidou 1979, 46-47. 182.

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THE UNKNOWN "PAVONAZZETTO LIKE" MARBLE QUARRY OF TİRAZLI (SMYRNA)

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Abstract

An unknown Roman quarry was discovered recently not far from the village of Tirazlı, up in the mountains south from the western suburbs of Izmir. The quarry produced a "pavonazzetto-like" marble similar to others recently discovered in western Asia Minor. The quarry site is of medium size and many half-finished quarry items are still lying around abandoned in the exploitation area. Four parallelepiped quarry blocks and seventeen column shafts have been catalogued and attest a medium to small column shaft production. Worth noting is a fractured quadrilobe rough column item probably produced for export outside the region. Beside the archaeological survey a systematic sampling of the quarry site was undertaken in order to provide a preliminary marble characterization and a reference data bank to be used for preliminary results on two Roman column shafts from the Roman Agora.

Keywords: Geoarchaeology, Tirazlı, coloured stone, breccia.

Introduction

The famous *marmor phyrigium* was quarried in central Anatolia in the main district of Iscehisar near Afyonkarahisar and in that of Altıntaş more than 40 km to the north of the previous site. During several surveys undertaken in the last 15 years many new unknown quarries were discovered in Asia Minor and several of them have produced a similar marble quality to that of Afyon, known as *marmor phrygium*, Dokimeion marble or pavonazzetto. Many unknown quarries in which similar marble qualities were exploited have been discovered in the ancient Caria region, near Muğla, Milas and Aphrodisias (Fig. 1, 3-6), but also more to the north, up in the mountains near Teos, close to the village of Beyler (Fig. 1, 7). This breccia is even more similar to the Skyros marble, quarried on the Greek island of Skyros located north from Euboea (Fig. 1, 8). All these marble qualities are very similar and could sometimes be easily misidentified and wrongly attributed to the more renowned phrygian imperial marble and for this reason they have been classified as "pavonazzetto-like" marbles[1]. Some years ago during a preliminary survey undertaken in the surrounding region of Izmir, up in the mountains, some 10 km to the south-east of Izmir, another unknown Roman quarry of a "pavonazzetto-like" marble was discovered not far from the village of Tirazlı (Fig. 1, 7).

[1] Attanasio *et al*. 2015.

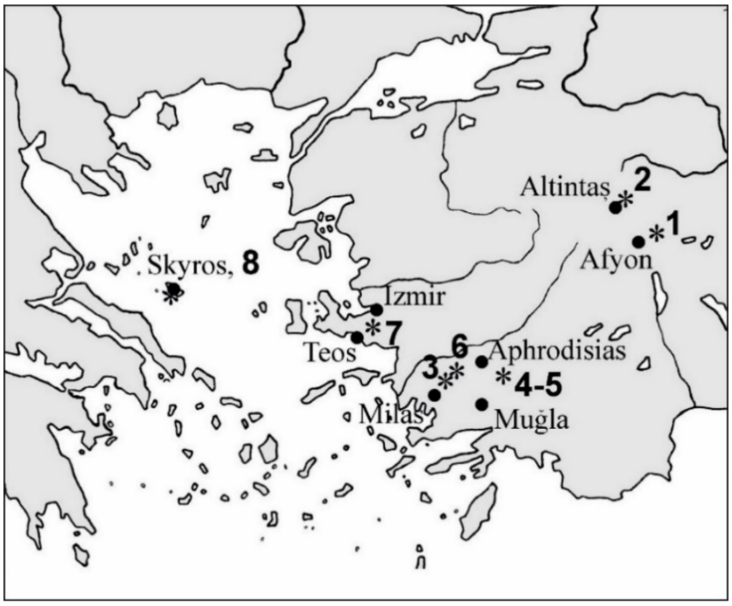

Figure 1: Close-up of the same fragment showing the second join with interlock (Drawing: Attanasio *et al*. 2012, fig.1).

The Tirazlı quarry

The quarry site can be reached from Izmir passing by Limontepe along the road leading in the direction of Kavacık. One and a half km after the village of Tirazlı a dirt track road turns right and passing through the area of Karabağlar the road heads towards Balçova, a western suburb of Izmir. After 1.5 km on a mountain ridge covered by forest the marble quarry, known locally as Kesiktaş (Fig. 2), which means "cut stone", is clearly visible in an open area surrounded by trees (Fig. 3), while on both sides valleys descend towards the coast.

Figure 2: Location of the Tirazlı Kesiktaş quarry southwest from Izmir (Photo: Google Earth modıfied by M. Bruno).

Figure 3: Tirazlı quarry. Aerial overview of the quarry site (Photo: H. Göncü).

The quarry site is of medium size, opened to the south with a quarry front more than 8 metres tall on the northern side (Fig. 4), while many abandoned quarry artefacts are lying around the main extraction area and in the quarry itself. Here five roughly-worked column shafts are still attached at the parent rock (Figs. 5, 6) as well as several large parallelepiped blocks, which were separated by trenches but not detached as the column shafts. On the left side of the main quarry area another still-attached parallelepiped block is clearly visible on the upper side of the western quarry front.

Figure 4: Tirazlı quarry. Overview of the quarry site. Close to the quarry face there are some undetached quarry items (Photo: M. Bruno).

Figure 5: Tirazlı quarry. Aerial overview of the five undetached column shafts and two parallelepiped blocks, from left tom right, (Photo: H. Göncü).

A small horizontal separation trench along the bottom side of the parallelepiped item was prepared for its final separation (Fig. 7). The quarry production was characterized mainly by column shafts of medium size (diameter 60-70 cm). Ten unfinished fragmentary column shafts were catalogued (Fig. 8) to which the 5 still on the quarry floor and not detached from the outcrop must be added. Parallelepiped blocks of medium size were produced too, four are lying around the site (Fig. 9), while five more are still not separated from the rock. Unexpected was the discovery of a fragmentary quadrilobe item (Fig. 10) to be separated after the transport from the quarries to its destination in four different column shafts of medium to small size. The approximate length is about 3 metres, while the diameter of each single shaft is of roughly 40 cm.

Figure 6: Tirazlı quarry. Detailed overview of the five undetached column shafts and two parallelepiped blocks, from left tom right (Photo: M. Bruno).

Figure 7: Tirazlı quarry. Quarry block, cat. 1, still on top of the western quarry front. Along the lower side the separation trench is visible (Photo: M. Bruno).

In the forest, on the northeastern slope of the ridge, a few hundred meters from the quarry site, are the remains of a rough wall probably to be identified with a shelter for the quarry workers during their activity at the site. Close to the workers' house was the transport route for the blocks, which is still clearly visible in the forest. The slipway started near the quarries and can be followed for a while on the slope of the mountain and the valley going down towards the sea, probably reaching after approximately 6 km Balçova, the modern district of Izmir, about 10 km far from the ancient city of Smyrna, very probably the final destination of most of the Tirazlı marble items.

Figure 8: Tirazlı quarry. Fragmentary unfinished column shaft broken at both ends, cat. 8 (Photo: M. Bruno).

Figure 9: Tirazlı quarry. Parallelepiped quarry block, cat. 17 (Photo: M. Bruno).

The Tirazlı quarry is of medium size. The main extraction area, where some shafts and blocks are still attached at the parent rock, has an estimated surface of circa 500 m^2, while the nearby sector on the southeastern side is about 900 m^2 in size, for a gross volume of extracted marble of approximately 6000 m^3 [2]. Considering the main use of the Tirazlı marble for small to medium column shafts we can assume that not more than 40-50% of the exploited marble was definitely used for the final production. The manufacture and trade of the Tirazlı marble, due to its variety and the typology of the quarry items, suggests an exploitation that can generally be assigned to the mid-imperial period.

Figure 10: Tirazlı quarry. Fragmentary quadrilob column shaft, cat. 15 (Photo: M. Bruno).

Figure 11: Tirazlı quarry. Macroscopic aspect of the Tirazlı Kesiktaş breccia (Photo: M. Bruno).

The Tirazlı breccia

The Tirazlı marble quality (Fig. 11) could be identified as a kind of breccia with white, reddish pinkish and sometimes grey clasts in a red violet background cement, macroscopically very similar to some varieties of Beyler breccia from the Seferihisar district near Teos. The

[2] The considered average height is of 4 m.

quarry was opened in the Seferihisar High pre-Neogene Bornova melange Menderes Massif at an approximately height of 600 m above sea level (Fig. 12).

A sampling was carried out in the quarry in order to develop some preliminary analytical results to be compared with other archaeometrical data. The similarity with the Beyler breccia led us to compare the Tirazlı data with those of Beyler and, even if macroscopically not similar, of Docimium Iscehisar. The isotopic data (Tab. 1) define a cloud which is partially overlapping with those of Beyler and Dokimeion (Fig. 13), but if the quarry data are compared on a statistical diagram together with EPR data, a much better discrimination could be done and the relative probability of assignment could be much higher and appreciated (Fig. 14).

Very recently some column shafts of Tirazlı breccia have been identified during the surveys and cataloguing of the architectural elements in the depot of the central area of the Roman Agora of Smyrna. Their marble quality was preliminary identified only on a macroscopic basis and for this reason a sampling of these two items was undertaken in order to verify if this hypothesis could be confirmed by analytical data. The results fit perfectly on the isotopic diagram with the Tirazlı cloud (Fig. 13), but in this case there is a large overlap with the Beyler and also Dokimeion reference clouds. A better discrimination and a much better attribution to Tirazlı could be done with the statistical graph, in which the assignment to the Tirazlı marble and quarries is of 66 and 73 % (Fig. 14).

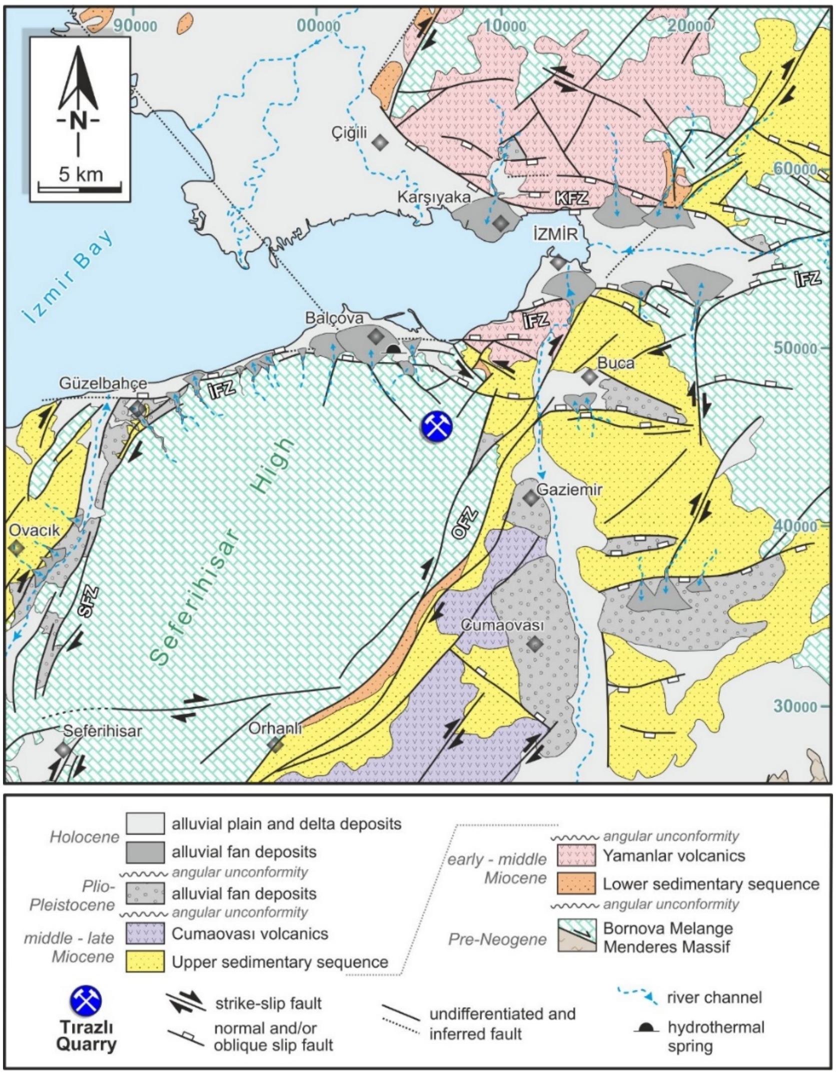

Figure 12: Geological map of the Izmir region, with location of the Tirazlı and Limontepe quarries (Uzel *et al*. 2012; 2013; Emre *et al*. 2018).

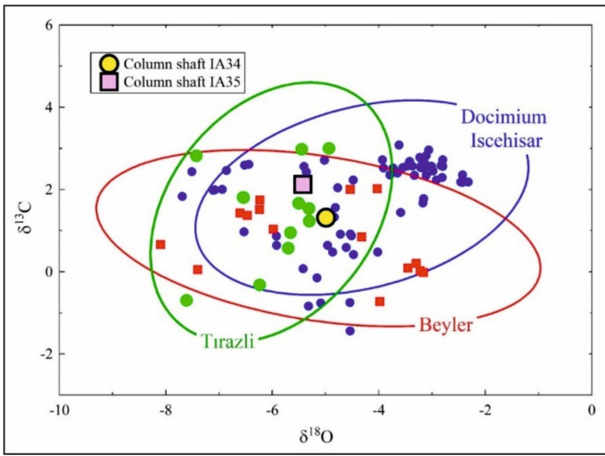

Figure 13: Isotopic cloud of the Tirazlı breccia with the plotted samples compared to those of Beyler and Docimium Iscehisar (Graph: D. Attanasıo).

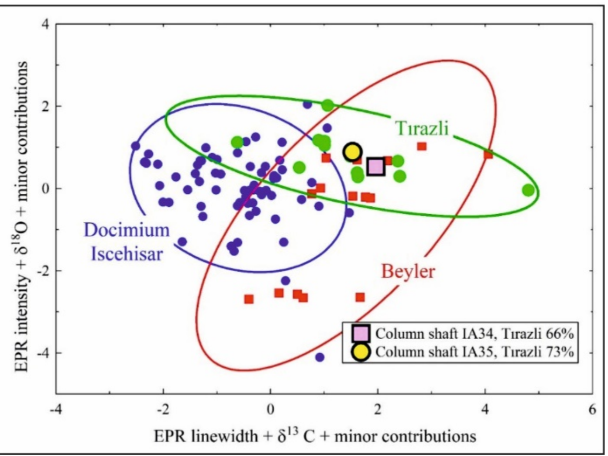

Figure 14: Statistical graph with the Tirazlı and Beyler breccias and the Docimium Iscehisar marble. Minor contributions indicates analytical parameters that contribute less than 10% to the statistical combination of variables (Graph: D. Attanasıo).

The Tirazlı breccia. Production and distribution

Even if the Tirazlı quarry site is not very large, an impressive number of quarry items are still lying around and in the quarry site itself. Several blocks and columns were not detached from the parent rock, attesting that the production program was in progress when, for some reasons, the exploitation was stopped suddenly.

A Total amount of 18 quarry items has been discovered, 13 rough column shafts of medium size, four parallelepiped blocks and one broken quadrilobe column shafts. The column shafts are medium to large in size, due to their average diameter of 60 to 70 cm, which corresponds to a hypothetical original height of the shafts of about 480-560 cm. The parallelepiped blocks were very probably destined to revetment slab production and their maximum length is 3 metres. Unexpected was the discovery of a fragmentary quadrilobe column element, in which the profiles and the dimensions of four medium-small shafts had already been carved. These kinds of quarry items are not very common in Roman marble quarries, but some similar quarry items are known from the Dokimeion quarries near Afyonkarahisar[3], in the breccia quarries of Toprak Alinmis in the Karaburun Peninsula[4] and from the Roman marble yard of the main harbour of Rome at the river mouth of the Tiber near Ostia, where a quadrilobe column in phrygian pavonazzetto marble was discovered [5]. In particular, the quadrilobe item of Tirazlı is very important because it testifies a large medium shaft production destined probably to the export. In fact, this particular shape must have been the most suitable for sea transport of small to medium column shafts, because in this way damage to the precious marble items could be avoided during shipment.

In order to verify the distribution and the use of the Tirazlı breccia the research has been undertaken first looking at the marble elements and column shafts preserved in the archaeological area of the Roman Agora of Izmir. Here, cataloguing a total amount of more than 650 fragmentary column shafts discovered in the Agora itself or coming from all over the ancient city of Smyrna, only two have been recognized macroscopically as the white–pinkish breccia of Tirazlı, further identified analytically, as seen above. One shaft is

[3] The item is now in the gardens of the Archaeological Museum of Afyonkarahisar. Originally the quarry item was a quadrilobe column, later reworked to a trilobe due to damage to the shaft.

[4] Bruno *et al*. 2012, 568.

[5] Pensabene 1995, p. 73, cat. 19, figs. 89, 92.

completely finished and is small in size, while the other one is medium, rough and unhewn with a diameter of cm 55, a total height of cm 222, at one end a collar is protruding, while the other end is flat. The estimated height of the column shaft should be around 480 cm, testifying that once the original shaft consisted of two overlapping elements. Interesting is the rough-worked surface of the shaft on which seven incised rings are visible at regular distances made to define the profile and the *entasis* of the final column[6] (Fig. 15). This technique is not attested on the shafts in the Tirazlı quarry, where probably the items were only roughly worked out and defined only later in Smyrna in a marble yard and atelier or on spot of a large building project.

Figure 15: Izmir, Roman Agora. Rough-hewn column shaft with incised rings in Tirazlı breccia, cat. 196.

Investigations regarding the Tirazlı breccia have been undertaken in all the most important cities of the western coast of *Asia Minor* from Pergamon down to Phokaia, Teos, Metropolis, Ephesos and Magnesia, from Smyrna to Cissus, modern Çeşme, and Erythrae, to the east till Sardes and Philadelphia, but, up to now, no further column shafts, architectural elements or revetment slabs in this new Smyrnaean breccia have been discovered.

Conclusions

The discovery of the medium-sized quarry at Tirazlı enriches a panorama that has expanded considerably, especially in recent years. Asia Minor thus shows even more its great wealth of outcrops of white and polychrome marble that have been exploited in a systematic and intensive way particularly since Roman times. Smyrna had to be one of the richest and most renowned cities during Roman antiquity for its beautiful buildings and monuments and therefore it probably had to find new local sources of coloured marbles to be used for its architectural purposes and building projects. The research, above all, for coloured marbles, similar to the most-renowned ones of exclusive imperial use, must therefore have been very intense, as attested by the various polychrome breccia quarries recently discovered in the Karaburun peninsula or around Manisa. The Tirazlı quarry, together with that of the Limontepe, attest this exploration activity which apparently had to meet primarily the local needs of nearby Izmir. In particular, the Tirazlı quarry was opened on an outcrop of a breccia in some way similar to the most famous and renowned imperial one of Dokimeion and the exploitation at the beginning had to be very intense. Column shafts were the main production, of which many are still lying in the quarries and two others are in the depots of the Roman Agora at Smyrna, while parallelepiped blocks were destined to revetment slab production after cutting. The quadrilobe column shows an attempt to produce export items during a first

[6] For this special technique see Asgari 1992, 73-74, 77, Pensabene 1992.

successful exploitation period of the site. The rough house for quarrymen, where they had to stay during the working periods, and the slipway for the transport of the artefacts down to the coast attest an in-depth production planning. However, it seems clear that after a while the bad quality of the outcrop must have been revealed, crossed as it was by a notable number of cracks and faults, which compromised the integrity of the quarry items, making the exploitation of the quarry not worthwhile. However, since the quarried volume is not insignificant, it seems clear that, at least in the local or regional area, it will be necessary to take into account the pinkish-reddish breccia of Tirazlı, used mainly for column shafts, as it can be confused above all with that of Beyler but sometimes also with that of the island of Skyros.

The local marbles of Smyrna are the pink brecciated Limontepe quality, similar to the renowned *marmor chium* quarried on the island of Chios, and the Tirazlı breccia that recalls, even if remotely, the Asian imperial marble par excellence quarried at *Dokimeion*. It therefore seems evident that there had been an attempt by local contractors or entrepreneurs to find and exploit marbles resembling the imperial, such as pavonazzetto and portasanta, as these were not available for local customers, but were intended only for imperial buildings and monuments of Rome.

	Sample													
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**	**T12**	**IA34**	**IA35**
δ^{13} C	-0,70	1,23	-0,32	1,80	1,81	2,98	2,82	3,00	1,66	1,54	0,95	0,57	112	196
δ^{18} O	-7,61	-5,30	-6,24	-6,54	-6,55	-5,45	-7,43	-4,94	-5,50	-5,31	-5,66	-5,70	1,31	2,12

Table 1: Isotopic data of the Tirazlı quarry samples.

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STONE PROPERTIES, WEATHERING EFFECTS AND RESTORATION, AS RELATED TO DIAGNOSIS PROBLEMS, MATCHING OF STONE FRAGMENTS AND AUTHENTICITY

INVESTIGATION OF WEATHERING AND SURFACE DEPOSITIONS ON CYCLADIC MARBLE FIGURINES

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Abstract

The island of Keros and the islet of Dhaskalio comprise one of the most important archaeological sites in the Cyclades, dating to the Bronze Age. Hundreds of figurine fragments and marble vessels have been found in the Special Deposits South and North (looted) as well as the settlement of Dhaskalio. A scientific examination of the types and degrees of weathering of the figurines found on Keros Special Deposit South and an analysis of the weathering state of the marble is presented. The analyses were performed using a stereoscopic microscope, a petrographic microscope, and a Scanning Electron Microscope equipped with an X-ray analysis system. The examination and analysis showed cracks of different sizes going through the marble grains and soil depositions formed at the surface and while penetrating also inside the grain boundaries. A sequence of weathering events could also be detected. These indicate that the figurines were severely weathered under different environmental conditions and episodes.

Keywords: Figurines, marble, weathering, Keros.

Introduction

Keros Island has an area of 15 km^2, its highest point being some 432 m. Keros was an important site in the Cyclades during prehistory, particularly during the Early Bronze Age, around 2500 BC. For the last few decades the island has been uninhabited. Excavations and surveys have been organized from the 1960s up to the present day and have revealed important settlements and finds including numerous fragments of marble figurines, 'frying pans', marble vessels and metal objects. A number of these artefacts are exhibited in the National Archaeological Museum at Athens and in the Archaeological Museum of Naxos. The majority of the material is stored in the Archaeological Museum of Naxos.

The first excavation of the latest campaign started during the spring of 2006 as part of the Keros-Dhaskalio Project of the University of Cambridge, led by Professor Colin Renfrew. The "Special Deposit South" at Kavos, opposite the small islet of Dhaskalio (Fig. 1), was excavated south of the "Special Deposit North" which was previously extensively investigated in 2006-2008. The structure of the Special Deposit South (which included fragmented materials, thousands of pieces of pottery, marble figurines, and marble vessels) could mean that these materials were brought to Keros island from other Cycladic islands and perhaps also from mainland Greece[1].

Soil history of Kavos

The results of the investigation of the landscape of Kavos showed that during the Bronze Age the landscape was already eroded, extensively modified, and was formed as an open area. In Special Deposit South, there are only a few spots with buried soil survival. Thin

[1] Renfrew *et al.* 2007.

modern organic topsoil can be observed as a result of devegetation, human disturbance, excavation and robber trenching in combination with the natural slope effect and environmental phenomena (winter rains etc.)[2].

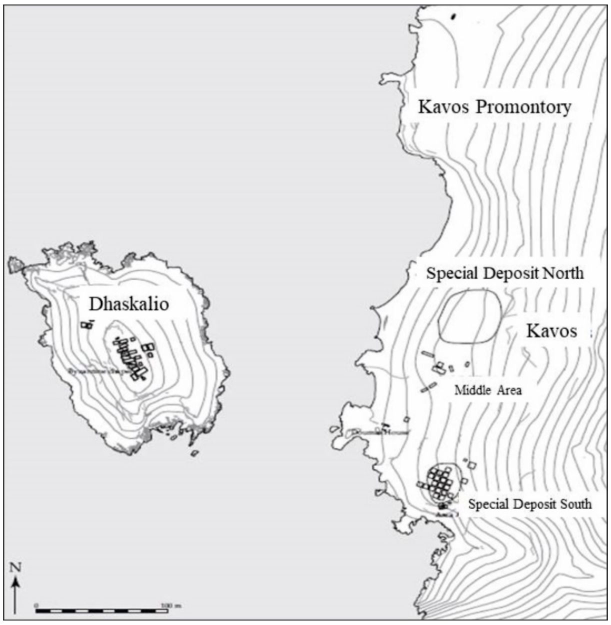

Figure 1: Map of Dhaskalio and Kavos; the two Special Deposits are marked. The excavation of Special Deposit South was conducted during the years 2006-2008, while Special Deposit North was looted in the past (Renfrew *et al*. 2015).

The research of the *in situ* soil survival showed that only the basal one-third of palaeosols survive. More specifically, trenches B4 and G1 have 'pocket' soil survivals which belong to the poorly-developed Mediterranean soil type category. This brown type of soil appears also at Ano Koufonisi. These two trenches exhibit some evidence of silt, pure and impure clay illuviation down-profile. The surface soil disturbance, caused by the removal of trees and vegetation, physical disturbance and the effects of rainwater, are associated with these types of down-profile movement of silt, clay and fine organic matter. An indication of red Mediterranean soil (poorly developed) can be found in the trenches D2 and A1 (where three of the figurines were found). The soil has a very strong red colour with amorphous iron and fine fabric, in and amongst the bedrock fragments. This soil survival appears to be characteristic of the region[3]. Geomorphological analysis of the trenches B3, BA, D1-D3 (and RA) has been completed. Charcoal, bone fragments, plant tissues and cells as well asexcremental fabric were also included in the soil[4]. An extensively modified, open and eroded landscape was already present by the time of the Early Bronze Age activities on Keros and Dhaskalio[5].

Types of marble weathering

There are different types of weathering according to environmental conditions. The acidic environment, produced when the soil includes different types of acid, such as humic acids (from biodegradation of organic matter), nitric or sulphuric acids, is one of the important factors. These acids penetrate the soil and dissolve the calcium carbonate crystals of marble around the edges[6]. The marine environment at the coastal archaeological sites, like Kavos and Dhaskalio, also greatly influences the weathering of marble objects. The salty water in the atmosphere and soil can cause damage to the marble. The ions of Na, K, and Cl

[2] French, Taylor 2015.
[3] French, Taylor 2015.
[4] French, Taylor 2015.
[5] French, Taylor 2015.
[6] Maniatis, Tambakopoulos 2015.

that exist in the water enter during wet conditions in the marble pores and in the grain boundaries, and then, during drying, crystallize to salts like NaCl, KCl, or $K_2(CO_3)$ which expand causing detachment of the marble grains[7]. Temperature changes, exposure to fire, and surface depositions are also main factors in the weathering processes. These aggressive weathering factors are often present in the upper layers of the burial soil. Objects that are buried in deeper layers (with no plant activity or microorganisms) and in low-acidity soil, rich in fine calcium carbonate, are better preserved. A fine calcareous surface coating can protect the object from further erosion. On Keros, more preservative conditions could be found in some parts of Special Deposit North and in Dhaskalio where most of the marble objects were buried deep in calcareous soil and hence well-preserved. In contrast, in the Special Deposit South, the majority of the marble objects were heavily eroded[8].

Preliminary research

A previous examination of the marble figurines was performed by Maniatis and Tambakopoulos (2015). The weathering types of marble were studied and classified. Firstly, the different environmental factors were identified, the chemistry of the soil, temporal environmental changes during the millennia (air, soil etc.), and location changes (different areas of exposure and burial). The weathering extent was grouped and categorized into different degrees. This was then checked against the marble type, the provenance of marble, the burial location and depth, and the figurine variety[9].

The investigation showed a difference in weathering between the three locations; Special Deposit North, Special Deposit South and Dhaskalio. The more corrosive environment was in the Special Deposit South (more acidic, less calcareous environment). Regarding the variety, Spedos type are commonest among the figurines and have a much stronger degree of weathering than the other varieties. The depth of burial did not affect the weathering since, at the same depth, different weathering degrees were observed. The figurines that displayed the highest degrees of weathering indicate the possibility that the figurines were exposed in one environment (wet, salty, hot or cold etc.) but ended-up buried in a different one. This accords with the work of French and Taylor (2015) who observed a continuously-changing soil environment and very few spots with original soil survival. The investigation of the marble provenance has been done by Tambakopoulos and Maniatis (2018), whose analyses showed that the marble of the figurines originated in SE/CE Naxos[10].

Samples and experimental techniques

In order to examine the preservation state of the Keros figurines a number of techniques were applied. In total, 6 samples of figurines found in the Special Deposit South at Kavos during the excavation periods 2006-2008 were collected by Maniatis and Tambakopoulos during the previous examination at Naxos Museum. The samples come from the figurines with code numbers: SF 1303, SF 2804, SF 6274, SF 20167, and SF 25077. The samples were in the form of several small particles scratched from the weathered surface of the objects. They were examined in two states: First in the As Received (ASR) state with a stereoscopic optical microscope and the Scanning Electron Microscope (SEM) to observe the surface condition and depositions, and second, after being embedded in resin and the polished cross-sections produced from each sample examined under a petrographic optical microscope and the SEM again.

[7] Maniatis, Tambakopoulos 2015.
[8] Maniatis, Tambakopoulos 2015.
[9] Maniatis, Tambakopoulos 2015.
[10] Tambakopoulos, Maniatis 2018.

Examination with a stereoscopic Optical Microscope: This preliminary examination of the samples' ASR provides information on various aspects of the preservation state of the sample. The colour, the size, and the surface depositions were identified and each sample was photographed. After that, the most representative particles of each sample were collected for further examination and analysis under the SEM without any preparation. The SEM achieves a higher magnification with a greater depth of field than the optical microscope, thus enabling a more detailed examination of the sample. In addition, the analytical facility attached (EDX) allows the chemical analysis of the sample as a whole or of particular grains, inclusions, depositions etc.

Petrographic Microscope examination of polished surfaces: The polished sections were examined with different light conditions (polarized and unpolarized light) and colour photos of the cross-sections were taken.

Scanning Electron Microscopy of the polished surfaces: The polished cross-sections can give details of the micromorphology and chemistry of the grains as well as the variation from the surface to the interior of each grain and the nature and thickness of any deposition layers. The combination of high magnification and compositional analysis is necessary to observe the weathering condition of the Cycladic figurines. Due to the small size and number of particles from each sample, it was not possible to undertake any further analyses.

Results

Special Find 2804 was identified as torso fragment of a folded-arm figurine of Spedos type[11]. The marble has a Maximum Grain Size (MGS) = 0.9 mm, the colour is white and it has a high translucency. It is categorized as Weathering Degree (WD) 5, (the highest WD for all figurines is 6)[12]. Under the optical microscope, the erosion is identified as medium and it has medium cracking. It has a thin soil deposition (yellowish brown), with no biological deposition. The figurine has limited mica and localized white calcitic depositions at specific places on its surface, such as the part at the right shoulder (Fig. 2).

Two particles were analyzed in the ASR and polished state under the SEM. The whole structure and analysis of the crust shows a deposition composed of calcite and soil, which consists of multiple layers. This crust is possibly a result of various environmental episodes. The diluted calcite originates either from the surface of the figurine itself or from the surrounding calcitic objects and rock fragments. It has then been deposited as a crust of carbonates mixed with soil on the surface of the figurine. The crust is not deposited uniformly on the whole surface of the figurine but in specific locations, which is an indication that it was created inside the soil. Possibly, those parts of the artefact were lying closer to or in contact with a source of dissolved calcium carbonate. Depending on the weather, climatic conditions, and microenvironment inside the soil (such as underground water rich in diluted carbonates, fires, acidity from plant roots, microorganisms etc.) different effects can be seen on the surface of the figurine. The marble crystals of the figurine itself may have been diluted and recrystallized as calcium carbonate at the surface creating a crust encasing soil from the environment.

The sample embedded in the resin was a fragment of the crust. Under the SEM showed that the crust has a maximum thickness of about 300 μm. Large or smaller inclusions and minerals of different shapes can be noticed in the whole section of the crust (Fig. 3). This crust is formed by different layers which have similar compositions, such as layers of pure calcite – 1st and 3rd layers - in combination with parallel layers of calcite with higher concentration of Si, Al and Mg – 2nd and external layers - (Tab. 1). Inclusions such as mica,

[11] Renfrew *et al.* 2015.
[12] Maniatis, Tambakopoulos 2015.

K- and Na-feldspars can also be observed (Tab. 1). At higher magnification the rounded marble crystals can be observed as a product of recrystallization (Fig. 3). The microstructure and the chemical composition of the white crust layer indicates that it is made by diluted calcium carbonate deposited on the surface of the figurine in different environmental episodes thereby trapping different amounts of soil in the separate layers. It is possible that this crust was created in underground conditions.

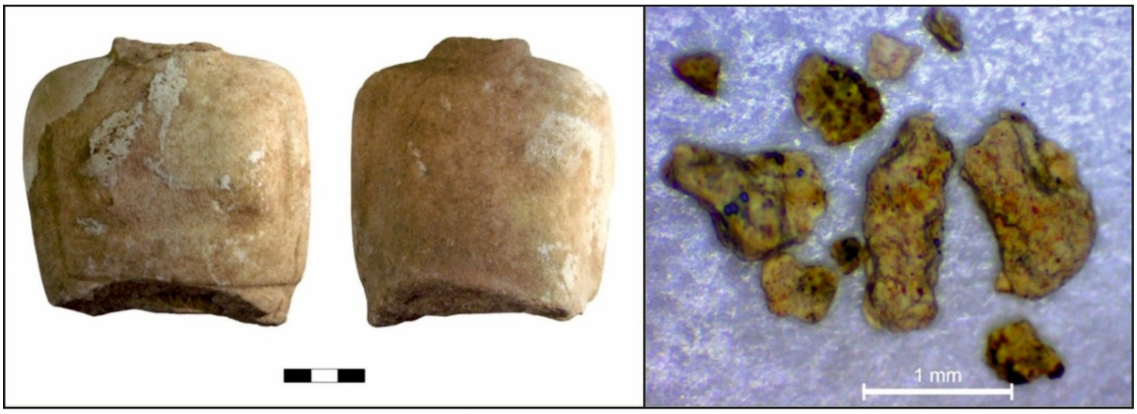

Figure 2: Photo of SF 2804. Left side: a folded-arm figurine of Spedos type (torso fragment). Right side: a general photo of the sample under a stereo-optical microscope. The white crust, light brown and black depositions on the crust can be seen (Photo: Y. Maniatis, V. Anevlavi).

On other parts on the figurine, a brown-reddish soil layer has been deposited. The composition of this soil layer indicates fine clay with typical and characteristic chemistry found on most of the figurines examined.

Special Find 1330 was identified as a leg fragment of a folded-arm figurine of the Spedos type (Fig. 4)[13]. The sample consists of smaller and larger particles representing aggregates of marble crystal grains, mostly white and transparent. Remains of yellowish-brown depositions are common in several aggregates and more rarely black spotty depositions (black sporia) can be seen (Fig. 4). This particular figurine has been categorized by macroscopic examination as a heavily weathered figurine (WD = 5)[14].

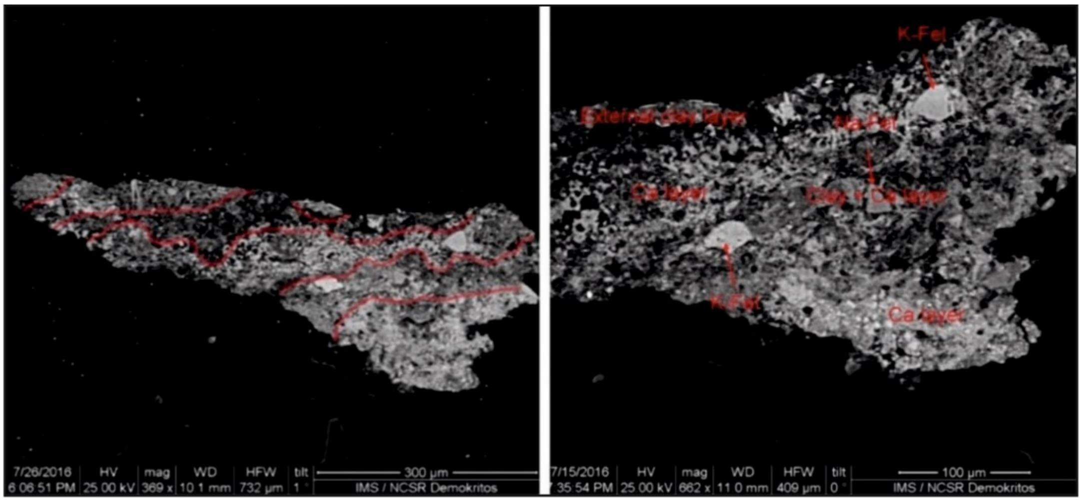

Figure 3: SEM photo of SF 2804. Different layers of weathering are detected. Each layer is separated by red lines and variations in colour of the layers can be observed. Different sizes of inclusions can be noticed. The layers are marking different environmental episodes during the burial of the figurine underground. The larger inclusions are K- and Na-feldspars (Photo: V. Anevlavi).

[13] Renfrew *et al* 2015.

[14] Maniatis, Tambakopoulos 2015.

No An.	Sample	SPECTUM	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl_2O	K_2O	CaO	TiO_2	MnO	Fe_2O_3	total %
25077															
		ASR													
1	**A**	Deposition	0.68	3.42	20.58	49.55	0.68	0.63	0,28	2.83	13.35	0.88	0.37	6.77	100
2	**B**	Deposition	1.48	3.14	19.11	53.84	0.21	0.48	0,14	3.33	11.06	0.84	0.14	6.25	100
		Polished													
3	**A**	Clean marble	n.d.	1.23	0.44	1.04	0.64	0.37	0,16	0.40	93.64	0.74	0.53	0.83	100
4	**A**	Deposition	0.58	3.02	20.87	45.27	0.82	n.d.	0.62	2.52	18.06	0.87	0.30	7.06	100
5	**B**	Clean marble	0.26	1.08	0.53	0.72	1.07	0,67	0.25	0.42	93.40	0.42	0.37	0.79	100
6	**B**	Deposition	0.39	4.29	8.20	31.60	0.73	1,99	0.93	1.73	45.36	0.51	0.38	3.88	100
7	**B**	Inclusion	0.74	1.49	33.60	47.65	0.52	0,38	0.19	10.58	3.41	0.52	0.20	0.74	100
20167															
		ASR													
1	**A**	Deposition	0.46	2.30	20.61	55.77	n.d.	n.d	0.26	5.14	8.54	0.96	0.21	5.74	100
2	**A**	Deposition	0.47	2.94	18.98	49.55	0.24	n.d.	0.63	2.56	5.58	1.24	11.25	6.57	100
3	**B**	Deposition	0.55	2.52	14.77	36.06	0.55	0.58	0.14	1.94	37.48	0.53	0.25	4.64	100
		Polished													
4	**A**	Clean marble	0.89	1.63	0.64	0.77	1.03	n.d.	0.37	0.35	93.11	0.37	0.28	0.56	100
5	**A**	Deposition	0.83	2.45	13.98	29.78	0.88	n.d.	0.84	2.23	43.26	0.95	0.36	4.44	100
6	**B**	Clean marble	0.45	0.71	0.87	1.11	1.11	1.49	0.78	0.38	91.87	0.42	0.41	0.39	100
7	**B**	Deposition	0.37	2.56	19.17	52.41	0.32	3.41	0.61	3.38	10.13	0.58	0.20	6.85	100
8	**B**	Inclusion	0.62	1.52	33.00	48.66	0.19	0.63	0.47	11.01	3.31	0.13	0.11	0.35	100
6274															
		ASR													
1	**A**	Clean marble	1.00	1.95	8.05	15.29	0.98	0.83	0.44	0.89	66.41	0.39	0.53	3.23	100
2	**A**	Deposition	0.73	2.90	17.31	41.04	0.45	0.21	0.59	2.48	27.81	0.54	0.30	5.66	100
3	**B**	Deposition	0.54	1.81	10.01	19.46	n.d.	0.14	0.40	1.03	63.14	0.46	0.39	2.63	100
		Polished													
4	**B**	Clean marble	n.d.	1.14	0.32	0.50	0.58	0.89	0.37	0.30	94.73	0.49	0.37	0.31	100
5	**B**	Deposition	0.70	2.06	18.31	64.17	0.35	0.89	0.98	2.99	1.66	0.85	0.39	6.65	100
2804															100
		ASR													
1		General	0.16	2.48	4.60	10.8	0.86	0.87	0.29	0.68	76.90	0.18	0.28	1.94	100
2		Deposition	0.68	3.89	23.79	49.3	0.86	0.92	0.22	2.49	12.00	0.41	n.d.	5.42	100
3		**Polished**													100
4		1st layer	0.83	1.91	0.93	2.02	0.65	1.68	0.97	0.43	88.80	0.18	0.47	1.17	100
5		2nd layer	0.37	2.1	3.01	6.05	n.d.	1.34	0.76	0.78	83.30	0.37	0.42	1.53	100
6		4th layer	0.87	2.53	1.90	2.55	n.d.	1.39	0.89	0.46	86.80	0.44	0.92	1.23	100
7		External l.	0.14	2.71	22.16	57.30	n.d.	0.31	0.3	3.36	2.93	1.40	0.29	9.12	100
8		Inclusion	0.35	14.00	17.43	47.40	n.d.	0.36	0.38	5.77	1.04	1.06	0.87	11.35	100
1330															
		ASR													
1		Clean marble	0.52	0.43	0.94	1.24	0.60	0.90	0.37	0.40	94.00	n.d.	n.d.	0.49	100
2		Deposition	0.77	1.87	3.74	7.02	0.88	1.00	0.4	0.50	82.00	n.d.	0.30	1.41	100
3		Sulfur dep.	0.93	1.91	7.54	13.2	0.40	18.00	0.18	0.60	55.00	n.d	n.d.	1.88	100
		Polished													
4		Clean marble	0.32	1.64	0.50	0.49	0.77	0.50	0.34	0.30	93.00	0.45	0.50	0.84	100
5		Inclusion	0.31	0.21	0.32	0.29	43.2	n.d.	0.05	0.20	55.00	0.16	0.20	0.51	100

Table 1: Chemical analysis of oxides – Data from SEM –EDX. The samples were analyzed ASR (As Received) and polished. *n.d. = not detected.*

Figure 4: Photo of SF 1303. A folded-arm figurine of Spedos type (leg fragment). Left side: a general photo of the sample. Right side: different sizes of aggregates, mainly of rounded shapes, containing a different number of grains of white, grey, yellowish colour, photo under stereoscope (Photo: Y. Maniatis, V. Anevlavi).

The detailed examination and analysis of the grains showed that the origin of the depositions on the surface is the soil itself, while the cracks of the crystals show that the marble was first weathered and then buried. The analyses of the ASR grains and the polished cross-section under the SEM showed that the inner parts of the grains are pure and consist mainly of calcitic marble with a very limited absorption of elements from the soil (Tab. 1). However, the surfaces are eroded and a brown-yellowish soil has been deposited on them and within the grain boundaries. Cracks and broken parts were noticed in the grains as well as inclusions from the soil wedged in the cracks (Fig. 5).

These are all indications that the marble grains or group of grains have been detached by acidic attack and exposure to changing environmental conditions and then buried in the ground. During this burial, soil was deposited on the surface of the already detached grains or inside the grain boundaries and cracks making the disintegration even faster.

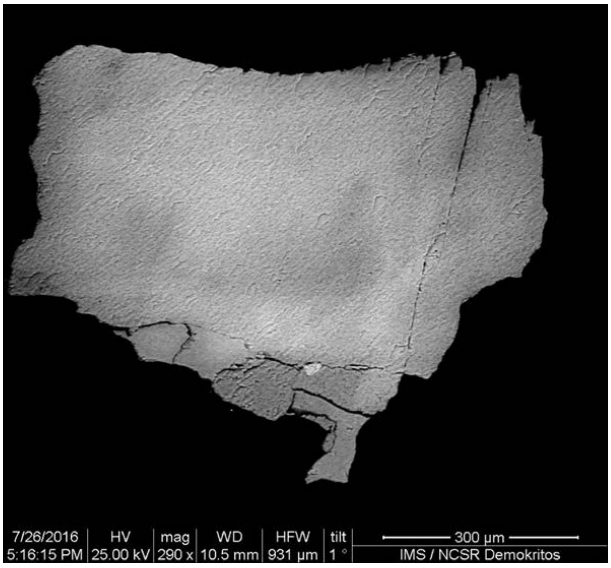

Figure 5: General image of the polished sample SF 1303. The natural surface is at the top and appears eroded. Large cracks on the right top part can be detected. More intense cracking can be observed at the lower part, Photo under SEM (Photo: V. Anevlavi).

Special Find 6274 is a waist-pelvis-thighs fragment of a folded-arm figurine of Spedos type (Fig. 6)[15]. This particular figurine has been categorized by macroscopic examination as a heavily-weathered figurine (WD = 5)[16]. The sample is separated into two parts. The first part (Sample A) is only one large white grain with yellowish-brown spotty depositions. It is part of a crust (recrystallized marble). The second part (Sample B) consists of several weathered marble particles, most of them with thick brown and dark brown depositions (Fig. 6). The combination of the analysis from sample A and B showed that the preservation state of this figurine is bad.

As it appears different layers of marble surface were exposed to alternating environmental conditions (sun, sea, salt), most likely in the open air, and eroded loosing grains and producing cracks. The layer of clay detected around the grains (Tab. 1) most likely indicates that the figurine was finally buried under soil and the repeated severe erosion ceased. Therefore, this figurine was most likely initially exposed to open air environmental conditions where the marble absorbed salt from the sea spray and then dried in the sun. This allowed the salts to crystallize and expand, detaching the marble grains. This cycle was repeated continuously causing extensive damage to the figurine. Finally, the figurine was buried under soil in more stable underground environmental conditions. The layer of clay around the grains constitutes the last "environmental episode" of the weathering procedure.

[15] Renfrew *et al.* 2015.

[16] Maniatis, Tambakopoulos 2015.

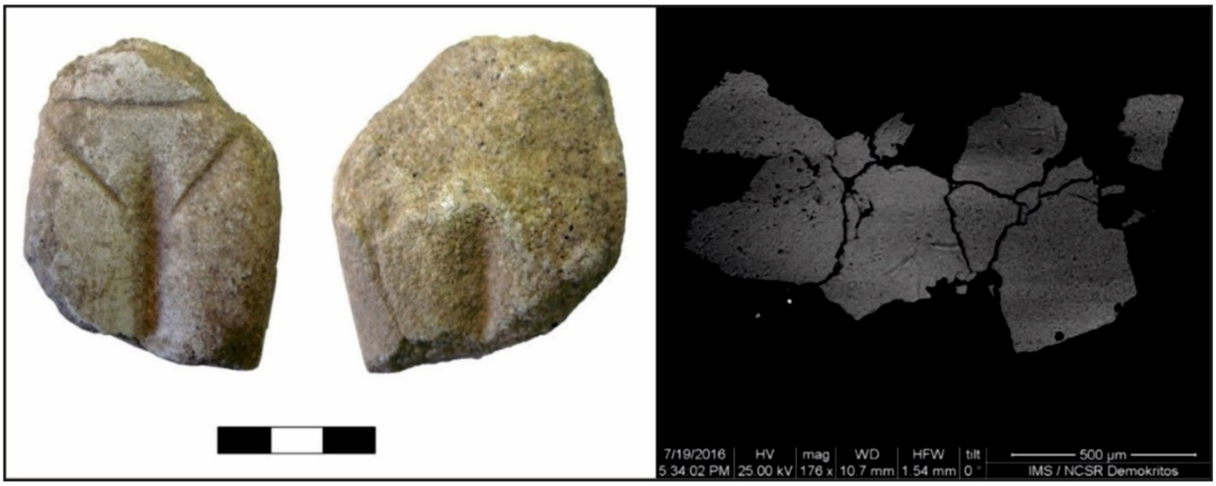

Figure 6: Photo of the SF 6274. A waist-pelvis-thighs fragment of a folded-arm figurine of Spedos type. Left side: a general photo of the sample. Right side: A general image of the polished sample SF 6274_B. The particle is detached in many large and smaller pieces. The surface is severely weathered. Voids can be noticed at the left part. Deposition can be observed in the lower left part of the particle (Photo: Y. Maniatis, V. Anevlavi).

Special Find 20167 was identified as upper legs fragment of a folded-arm figurine of Spedos type (Fig. 7)[17]. This particular figurine has been categorized by macroscopic examination as a heavily-weathered figurine (WD = 4)[18]. It is separated into two parts. The first (Sample A), includes medium and small marble particles with yellowish-brown depositions. The second (Sample B) includes parts from white crusts, probably pieces of recrystallized marble grains.

The detailed examination and analysis of the grains obtained from this figurine confirm the extensive weathering. The chemical analysis showed chemical compositions with increased iron oxides (Tab. 1).

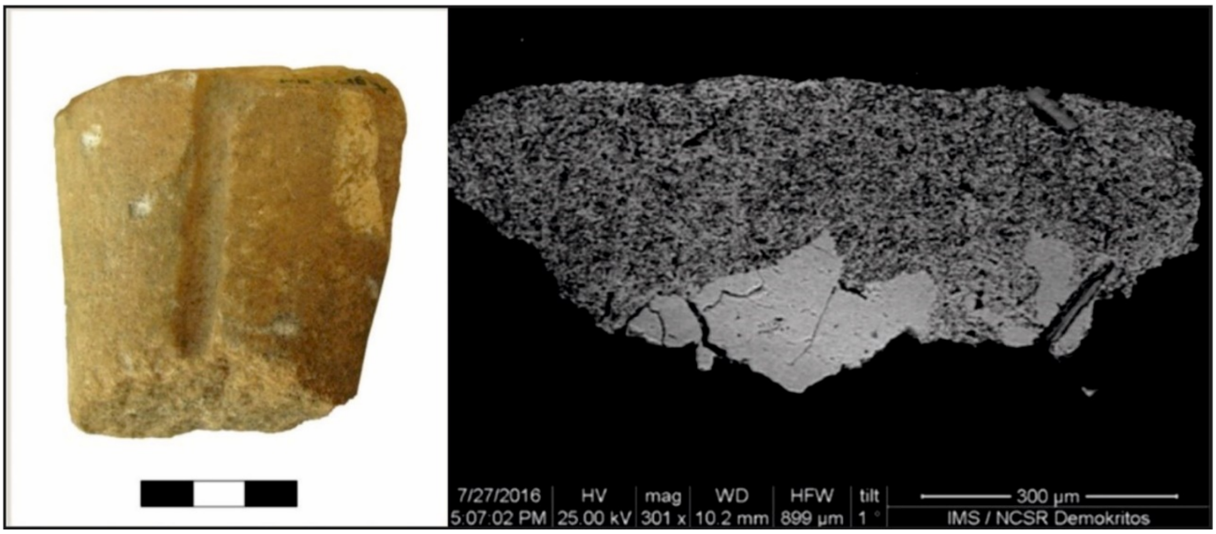

Figure 7: Photo of SF 20167. An upper legs fragment of a folded-arm figurine of Spedos type. Left side: a general photo of the sample. Right side: a general image of the polished sample 20167_B. A thick crust can be seen (maximum thickness 150μm). Clear marble crystal can be observed under the crust. Two large inclusions were noticed on top and bottom on the right part of the particle (Photo: Y. Maniatis, V. Anevlavi).

[17] Renfrew *et al.* 2015.
[18] Maniatis, Tambakopoulos 2015.

Polished samples showed significant damage to the marble crystals of the figurine. Large cracks have also been observed on both polished samples. The cracks are possibly made by an acidic attack in the soil. The Polished sample B is a thick crust of recrystallized marble grains (Fig. 7). In addition, the polished samples showed a thin clay layer on the surface of the crust. This clay layer is consisted of soil, feldspars inclusions, and quartz minerals etc.

Special Find 25077 was identified as the upper legs fragment of a folded-arm figurine of Spedos type (Fig. 8)[19]. This figurine has been categorized by macroscopic examination as a heavily-weathered figurine (WD = 5)[20]. It is separated into two samples. Both of the samples include medium and small marble grains with yellowish-brown depositions.

Figure 8: Photo of the SF 25077. A folded-arm figurine of Spedos type (upper legs fragment). Left side: a general photo of the sample. Right side: a general image of the polished marble grain. Deposition spots with different size minerals can be seen on the top and at the middle left and right part of the particle. Chemical analysis showed iron inclusions, marble pieces, quartz, K-feldspars etc. (Photo: Y. Maniatis, V. Anevlavi).

The analyses of the ASR particles showed the typical clay depositions (Si and Al) (Fig.4). The polished particle of sample A is not very corroded. The right side of the Figure 8 shows the whole section consisted of a single marble grain with clay depositions around it. Despite the surface depositions the marble surface has not been affected. On the polished particle of sample B, the surface of the crystal is corroded and there are few voids. The detailed examination and analysis of the grains confirms the extensive weathering and determined that the damage extends to the individual grains. It also identified the marble was first weathered and then buried.

Conclusion

Microscopic and SEM examinations and analyses were performed in order to observe the preservation state of 5 marble figurines and identify the different types of weathering. The samples were analyzed in two forms, as received (ASR) and polished.

The detailed examination and analysis of the grains in each sample confirmed the previous macroscopic analysis of Maniatis and Tambakopoulos (2015). Thin or thicker clay depositions have been seen on each sample (rich in Fe) by observing the ASR particles. While the polished samples showed the extensive weathering damage extending to the individual grains, it also identified the origin of the depositions on the surface. Finally, the fact that the

[19] Renfrew *et al.* 2015.
[20] Maniatis, Tambakopoulos 2015.

marble figurines were first exposed to open atmospheric conditions and then buried can be confirmed, indicating that their present environment as found in the soil must be a much later episode.

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GEOLOGY, PETROGRAPHY, GEOMECHANICAL PROPERTIES, ANTIQUE QUARRIES AND UTILIZATIONS OF HEREKE PUDDINGSTONE (BRECCIA DI HEREKE): A FORGOTTEN ANCIENT DECORATIVE STONE IN ISTANBUL (CONSTANTINOPLE)

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Abstract

Natural stones used in historical buildings in Istanbul, which form the historical identity of the city, have an important role in the history of civilizations. The Ancient city center known as the "Historical Peninsula of Istanbul" can be considered a museum decorated by different types of natural stones. In ancient times, the Hereke puddingstone (aka. breccia di Hereke) quarried in the Kocaeli Peninsula region was widely used for decorative elements in important historical landmark buildings and cultural heritage structures such as churches, palaces, and building complexes adjacent to mosques in Istanbul. Because of stone deterioration in the historic buildings of Istanbul, both conservation and restoration works for those structures are in need of urgent attention.

In this study, potential source areas to supply the Hereke puddingstone around the Izmit (Nicomedia)-Hereke district in the Kocaeli Peninsula region for current restoration projects were investigated. The locations of ancient quarry sites producing stones with required properties for the restoration projects were determined both in the field and via laboratory studies.

Keywords: Hereke puddingstone, stone deterioration, restoration.

Introduction

The Hereke puddingstone from Kocaeli region has prevalently been used throughout history as a decorative element in many buildings in İstanbul's ancient city center, today's "Historical Peninsula". This decorative natural stone coming from the Kocaeli region which has a historical and cultural significance is known to have been used not only in the close vicinity of its place of origin but also in notable landmark buildings in Italy since ancient times, particularly during the Byzantine and Ottoman periods (Figs. 1-4).

Stone deteriorations and consequent damage due especially to atmospheric impacts over time in many masonry elements made of various natural stones including the Hereke Puddingstone in significant monumental buildings in Istanbul such as the Süleymaniye and Sultanahmet Mosques and Topkapı Palace have made conservation and restoration works necessary for most of these buildings. Over the last decade, many of them have undergone restoration and such works are underway for others. These restoration works are obviously of significant importance for the protection of the architectural and aesthetic features of those monumental cultural heritage structures; however, it is equally important to pay attention to the use of "the best alternative" natural stones in these works and to investigate the potential source areas of such stone.

Figure 1: Hereke puddingstone on the garden walls of Kaiser Wilhelm Mansion in Hereke.

Figure 2: Bronze portrait of Hannibal of Carthage inserted into a 20-ton block of the Hereke puddingstone in the yard of TUBITAK campus in Gebze.

Figure 3: Serpent-decorated water vessel, *phiale*, caved in Hereke puddingstone in Hagia Sophia Museum.

Figure 4: Hereke puddingstone used as lateral pediment cladding on the main arched gate of St. Mark's Basilica in Venice, Italy.

Due to the reasons above, this study investigates potential source areas around Kocaeli's İzmit county, Hereke district to supply the Hereke puddingstone for restoration work in Istanbul's historic buildings. Ancient quarry sites and other locations that can provide stones with the required properties for the restoration projects were determined and samples have been tested and analyzed in the laboratory to define their material properties.

Location of the study area

Nicomedia, now Izmit in Kocaeli province, within the wider area known as "Bithynia" in the ancient era was the capital of The Eastern Roman Empire before Constantinople and served as an important port and trade center throughout history due to its geographical location. Today, the region is an important industrial center.

The Kocaeli province consists of Izmit, Gebze, Körfez, Derince, Kandıra, Gölcük and Karamürsel counties. The geographical area of this study is located in Kocaeli province, Körfez county, north of the Bay of Izmit (Fig. 5).

Figure 5: Location of the study area and site location map.

Geological setting of the study area

The Kocaeli Peninsula geologically consists of Paleozoic, Permo-Triassic, Late Cretaceous- Middle-Eocene, Late Oligocene-Early Miocene, Pliocene and Quaternary sedimentary rocks and Permian, Permo-Triassic and Late Cretaceous magmatic rocks (Fig. 6).

Paleozoic-age units are covered by Permo-Triassic rocks with transgressive gradation. The units in this age range, like Paleozoic units, are in three sequences slightly differing from each other. The first and the most widespread of them (the Kocaeli Triassic Sequence) starts with river sediments consisting of pebbles, sandstone and mudstone-shale at the bottom. These sediments are overlaid with coastal-shallow marine sandstones. The marine sequence, consisting entirely of shelf sediments, is composed bottom to top, of siltstone, shale, clayey limestone, dolomite and dolomitic limestone, nodular clayey limestone and siltstone-shale alternations, and nodular limestones in ammonitico-rosso facies, sandstones intercalated with marls, sandstone-shale alternation and clastic limestone-conglomerate (Çerkeşli Formation-Norian). Late Cretaceous-Middle Eocene sediments are transgressively overlaid on Paleozoic and Permo-Triassic units. This sequence starts with terrestrial-shallow marine conglomerates, sandstones (Teksen Formation; Santonian-Campanian), conglomerate (Hereke Formation; Late Campanian-Early Maastrichtian); (Lapis Hexecontalithos / breccia di Hereke / puddinga di Hereke / breccia frutticolosa; Gnoli 1988; Ducrot 1998; Pullen 2018) and bioclastic limestones (Kutluca Formation; Late Campanian-Early Maastrichtian; *marmor Triponticum* / occhio di pavone; Gnoli 1988; Lazzarini 2004; Pullen 2018; Altınlı 1968; Abdulselamoğlu 1977).

The Hereke Puddingstone corresponds to the Hereke Formation (Kh) in this sequence (Fig. 6). The Hereke Formation is named after the Hereke district. It is generally composed of 90-95% limestone and dolomite pebbles and iron-aluminum carbonate cement conglomerate. With these features, the unit can be defined lithologically as “conglomerate”. In the light gray, white, beige, locally pink-colored, medium-thick bedded and sometimes massive structured unit, the pebbles derive from the Triassic limestones and dolomites, generally found at the base. The pebbles forming the skeleton are well rounded. The unit has a gradual transition from pebble to fossilized limestone from the bottom up. The stratification of the conglomerates is unclear. In the unit, which is generally poorly graded, the grain size decreases from bottom to top. The color and appearance of the outcrops in the field are similar to the Kutluca Formation. The formation contains fossils at the lateral transition to Rudist-bearing limestone (Kutluca Formation) at less gravelly levels. The age of the unit is defined as Late Campanian-Early Maastrichtian (Upper Cretaceous; Erguvanlı 1949; Altinli 1968).

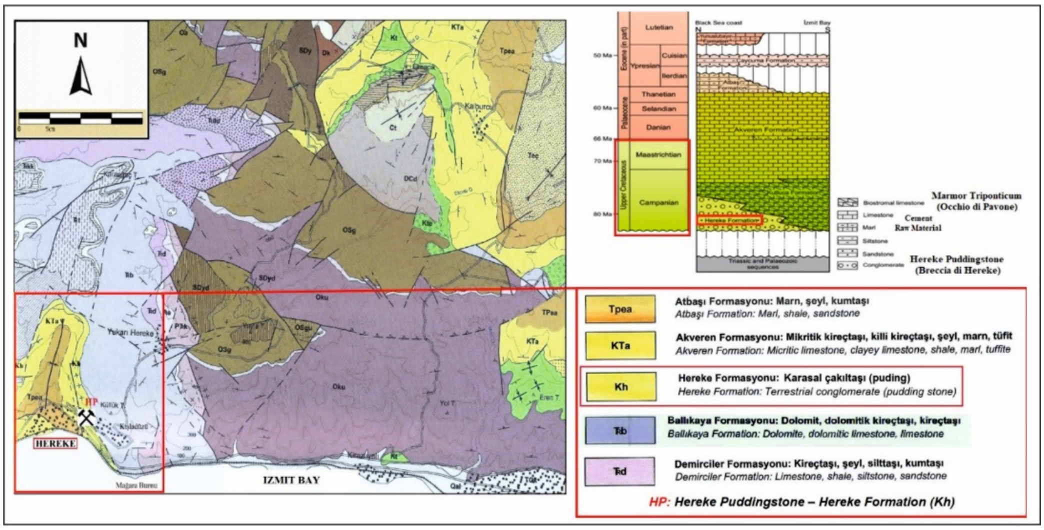

Figure 6: Geological map and stratigraphic column section of the study area and its vicinity (Gedik *et al*. 2005; Sarıgul *et al*. 2017).

Field studies

The ancient quarries of Hereke puddingstone are mostly known to extend through the Mağaraburnu locality to the east of Hereke suburban railway station (Erguvanli 1949).

Another ancient quarry location indicated with the “HP” symbol on the geological map given in Fig. 6 is located on the left slope of the valley adjacent to the Hereke-Kışladüzü quarter. Today, this quarry has remained within the settlement area and transportation network. However, the Hereke Formation (Kh) has been mapped over a large area on both sides of the valley extending to the north on the northwest side of the quarry (Fig. 6). The conglomerate levels encountered in this region are very similar in color and pattern to the stone used in many historical landmark buildings in the vicinity and in Italy (Fig. 7). Other ancient quarries are close to the shore and today under the TEM motorway (Figs. 8 and 9). It is known that the blocks produced from these quarries in ancient times were easily transported to Hereke’s Port and thence to nearby regions and Italy, St. Mark’s Basilica – Venice (Lazzarini 1997) by sea (Erguvanlı 1949; Sayar, Erguvanlı 1955) (Figs. 8, 9).

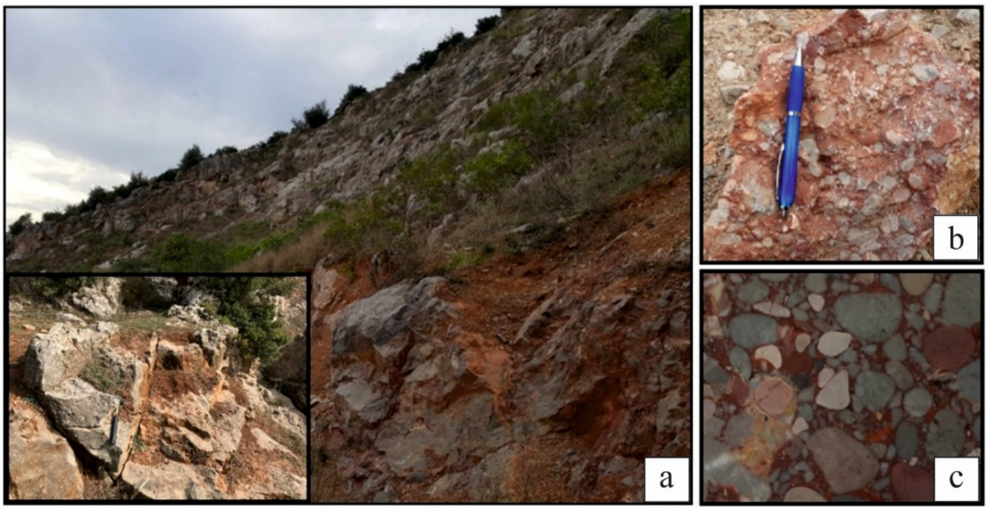

Figure 7: The Hereke Formation, which forms the valley slope to the northwest-west of Kışladüzü quarter of Yukarı Hereke locality (**a**), and the Hereke puddingstone quarry opened in the ancient era (upper area) with production marks and recently (lower area) in this field, a view of the block taken from the quarry production face (**b**) and a polished sample of a cut slab (**c**).

As a result of the research carried out in the field and in the laboratory, it was found appropriate to evaluate the site in the study area as a potential resource of the best alternative stone that can be used instead of the original stone in restoration works.

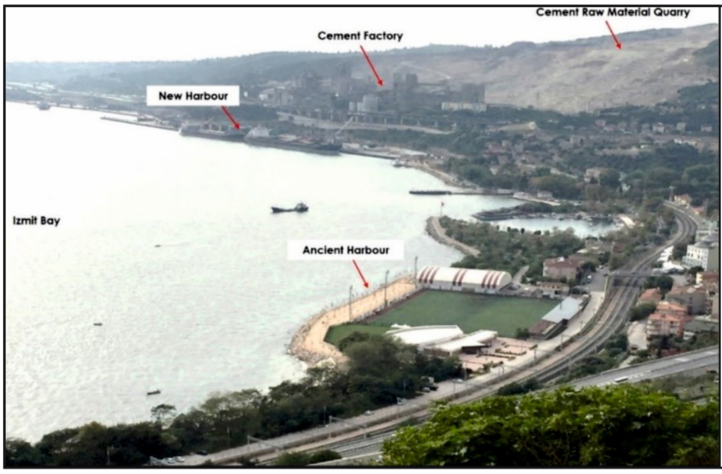

Figure 8: The ancient port where the Hereke puddingstone blocks produced from the ancient quarries were traded. Today, a synthetic turf football pitch sits on the site (view from the ancient quarry site).

Figure 9: Abandoned Hereke puddingstone blocks (size of 1.50x0.80x0.80 m.) near the ancient harbor.

Laboratory studies

In order to determine the material properties of building and cladding stones, stone samples taken from ancient and recently-opened quarries in the field were investigated in the laboratory. Petrographic analysis and physico-mechanical tests were carried out. Physico-mechanical tests were performed stepwise on stone samples prepared from blocks in accordance with the natural stone standards in stages (Fig. 10).

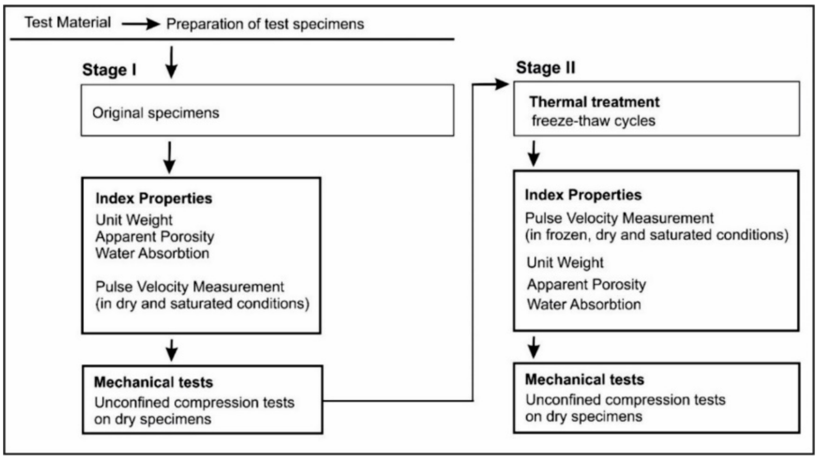

Figure 10: Flowchart of laboratory analysis and tests performed within the scope of the study.

In the first step, petrographical identification was made and then physical and mechanical properties of the samples which were not subjected to the freeze-thaw process were determined.

In the second stage, frost loss in weight, ultrasonic wave (pulse) velocities and unconfined compression tests after freezing were applied to samples subjected to the freeze-thaw process (Mahmutoğlu *et al*. 2015). The results obtained in these two cases were compared and it was determined whether the natural stone type subject to the study was affected by atmospheric conditions.

Petrographical analysis

The macroscopic and microscopic properties of the type of natural stone subject to the study were determined with the help of polished plates and thin sections prepared from the blocks taken from the quarry site (Fig. 6, HP).

The Hereke puddingstone samples from the ancient quarry in Hereke-Kışladüzü quarter were found to macroscopically consist of poorly-sorted conglomerates with coarse and round pebbles of different sizes. Gray, beige, white and pink colored conglomerate pebbles are derived from polygenic lithologies of Triassic micritic and sparitic limestone, dolomitic limestone and dolomite. In the conglomerate samples taken from the study area, pebble size varies between 0.2 and 4 cm (Fig. 11). According to Pettijohn (1975)'s conglomerate classification, the Hereke puddingstone falls into the "petromict orthoconglomerate" group.

Figure 11: Macroscopic view of the Hereke puddingstone sample taken from the quarry.

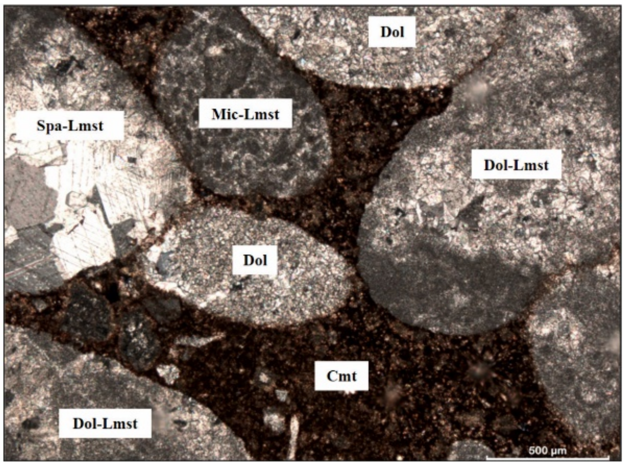

Figure 12: Photomicrograph of the thin section the Hereke puddingstone under polarizing microscope (CL, 2.5X). Abbreviations: Spa-Lmst: Sparitic Limestone; Mic-Lmst: Micritic Limestone; Dol-Lmst: Dolomitic Limestone; Dol: Dolomite; Cmt: Cement.

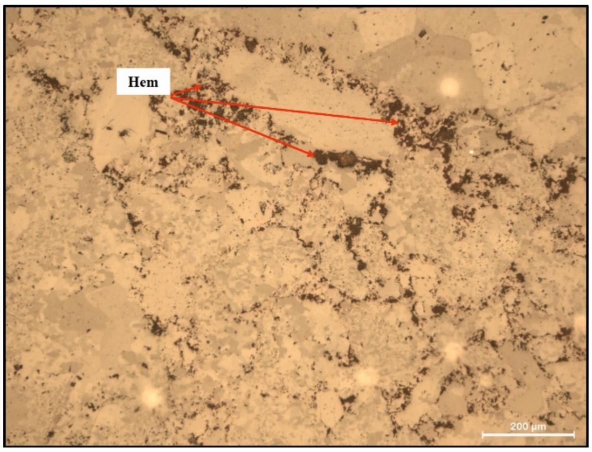

Figure 13: Photomicrograph of a polished section of the Hereke puddingstone under ore microscope (RL, 5X). Abbreviation: (Hem: Hematite).

By the examination of thin sections prepared from natural stone samples under polarizing petrography and ore microscopes, it was found that the binder cement entirely consists of a lithified carbonate mud colored by iron oxide (Hematite). In some of the pebbles forming the skeleton of the stone, secondary calcite veins and sparitic grains were observed (Figs. 12, 13). It was also found that in some places, the bond between the cement and the grains weakened due to dissolution and that micro-voids were formed in the texture.

XRD and XRF analyses were also performed on natural stone samples. The XRD analysis revealed that the source of the red color in the binder cement of the natural stone is "Lepidocrocite (Hydro-hematite)" mineral; besides this, some amount of "Kaolinite" clay mineral was also found in the cement (Fig. 14).

In XRF analyses, concentrations of the major oxide components of the natural stone in % and loss on ignition (LOI) ratio were calculated (Tab. 1).

Oxides	**SiO_2**	**Al_2O_3**	**Al_2O_3**	**MgO**	**K_2O**	**MnO**	**TiO_2**	**P_2O_5**	**Fe_2O_3**	**LOI**	**TOTAL**
(%)	1.25	0.72	51.08	2.35	0.14	0.02	0.03	0.02	1.76	42.56	**99.97**

Table 1: XRF analysis results of the Hereke puddingstone

According to the analysis results, the major oxide constituents of the natural stone, namely high CaO, MgO and total Fe_2O_3 values along with the LOI ratio were found. CaO and MgO values and the LOI ratio are due to the limestone, slightly dolomitic limestone and dolomite composition of the pebbles forming the natural stone and the binder cement composed of carbonate mud. The reason for the high total Fe_2O_3 value is the presence of lepidocrocite (hydro-hematite) mineral found in the binding cement of the natural stone.

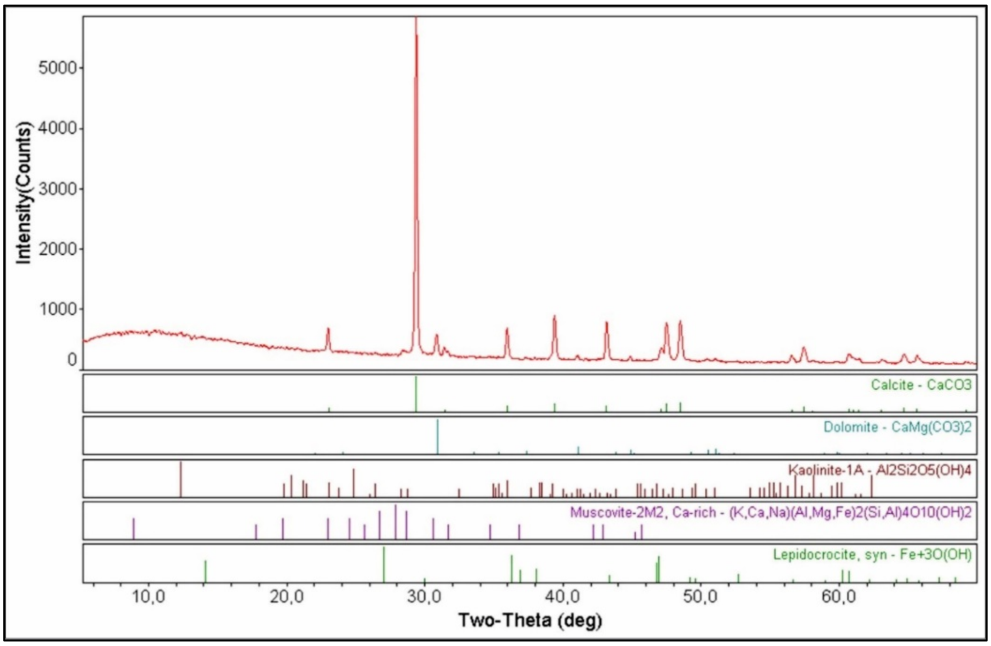

Figure 14: XRD diffractogram and mineralogical composition of the Hereke puddingstone.

Physico-mechanical tests

The physical properties of the stone samples taken from the ancient quarry in the study area were determined according to the TS 699 (2009) standard. Tests were repeated on 10 different cubic samples (4x4x4cm, 5x5x5 cm, 7x7x7 cm) prepared from representative block samples. The average values obtained from the physical tests performed in the first stage of the experimental program (Fig. 10) are given in Tab. 2. These values comply with the limit values recommended in the relevant building and cladding stone standard (TS 11145 1993). The hardness of the samples taken from the Hereke puddingstone is between 3-4 Mohs. Ultrasonic wave velocity (Vp and Vs) measurements were performed on the same samples. At the end of the first stage (before freezing-thawing), the average P and S wave velocities of the samples were Vp = 6304 m/s and Vs = 6000 m/s respectively. After the second stage (after freezing-thawing) no significant change in Vp and Vs wave velocities was observed. This indicates that there will be no wear on the stone due to freeze-thaw. The same samples were then subjected to mechanical tests under the conditions prescribed by the same standard (TS 699 2009) to determine the mechanical properties. The mean values obtained from the repeated mechanical tests on the samples representing the first and second stages are given in Tab. 2. The values in Tab. 2 show that the unconfined compressive strength of natural stone samples taken from “HP” quarry is slightly affected by freeze-thaw. On the other hand, the impact and wear resistance values of all the samples are in accordance with the limit values proposed in the relevant building and cladding stone standard (TS 11145 1993). In addition, the weight loss calculated in the second stage of the experimental program was found to be negligible, but the repetition of freeze-thaw cycles may lead to the detachment of pebbles.

g_d	g_s	n_{eff}	W_a	S_{c-bf}	S_{c-af}	W_{fl}	IR	A_s	V_p	V_s
g/cm^3	g/cm^3	%	%	MPa	MPa	%	kgf/cm^2	cm^3/ 50cm^2	m/s	m/s
2.71	2.72	0.77	0.28	55.20	52.20	0.30	12.00	10.78	6304	6000

Notations: g_d: Dry unit volume weight; g_s: Saturated unit volume weight; n_{eff}: Effective porosity; W_a: Water absorption; s_{c-bf}: Compressive strength; s_{c-af}: Compressive strength after freezing; W_{fl}: Loss of weight after freeze-thaw cycles; IR: Impact resistance; A_s: Surface abrasion resistance; V_p: P-wave velocity; V_s: S-wave velocity.

Table 2: Physico-mechanical properties of the Hereke puddingstone.

Deteriorations in the Hereke puddingstone used in historical buildings

The most commonly-observed and identified stone deteriorations in the Hereke puddingstone, which is used in various architectural building elements of historic landmarks in Istanbul, are as follows (ICOMOS 2008):

* Erosion & Dissolution: Loss of components, clasts (pebbles) and powdering of cement
* Gap: Missing part
* Crack: Fracture
* Splintering & Chipping
* Abrasion & Corrosion
* Black Crust
* Glossy Aspect
* Discolouration: Faded colour

The most common stone deteriorations in the Hereke puddingstone are caused by atmospheric agents. The main reason for deterioration is the different composition and the different behavior of grain and cement. Due to the heterogeneous nature of the stone, the intergranular bond weakens and breaks-down over time. In some cases, it is essential to replace the worn stone elements with new ones of the same stone in order to eliminate the damage in the architectural building elements caused by this situation (Fig. 15).

Figure 15: Degradation and destruction of the Hereke puddingstone used in the gate arch of Süleymaniye Mosque (**a**) and in the portico column of the inner courtyard of the Sultanahmet/Blue Mosque (**b**) (Photos: Angı 2010a; 2010b).

On the other hand, it is often witnessed that imitation material has been used instead of the Hereke puddingstone (original stone) in the extensive restoration work on the historic buildings in Istanbul in recent years (Fig. 16). In particular, it has been observed that artificial materials that cannot compare to the original in terms of color and appearance, do not provide the visual and functional properties sought in the architecture and wear out in a short time.

Figure 16: Examples of imitation stone applications used instead of the Hereke puddingstone in the frames of courtyard windows in the restoration of Yavuz Selim Mosque (dark colored parts are covered with imitation materials made of pigmented mortar).

Conclusion

In this study, potential source areas that could be used to replace the Hereke puddingstone, one of the ancient decorative stone types of Kocaeli, were found and investigated in the Hereke vicinity in the Kocaeli Peninsula.

As a result of the study, it was found that the stone in an old quarry site, which can be used for the restoration of historic and cultural buildings of different periods in Istanbul, can be obtained from the valley slope adjacent to Yukarı Hereke, Kışladüzü quarter. This area, where the best alternative stone source is located, is suitable for stone production today. The stone samples taken from the region were found to bear the characteristics required in natural stone standards. Based on the fact that the use of imitation materials in the existing restoration practices deteriorates the architectural authenticity of the buildings, it is recommended that the best alternative stones could be selected and obtained from the potential sites identified as a result of this study and used for the restorations mentioned.

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TERRACINA (ITALY). AN ORIENTAL “BARBARIAN” STATUE DISCOVERED IN THE ROMAN THEATRE

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Abstract

Terracina (*Anxur-Tarracina*) was strategically located around 100 km south of Rome, at the centre of a nexus of roads, including the Via Appia, and was equipped with a port. The town flourished from the 2nd century BC.

The archaeological excavations carried out by the Superintendence in the Roman Theatre, built on the northern side of the Forum in c. 60 BC and subjected to significant renovations in the Augustan age, have revealed a large part of the construction and numerous valuable artefacts. The colossal statue (2.4 metres tall) of an oriental “barbarian”, found in fragments near the Theatre’s *scaenae frons* in 2007, recently reassembled and so far unpublished, is particular extraordinary. The figure is worked in *marmor numidicum*, and is represented wearing exotic clothing and leaning against a pillar.

The statue can be compared to the larger-than-life depictions of Orientals that we find, carved in precious coloured marble, in important public buildings in Rome (such as the Basilica Aemilia). Based on comparisons, it is possible to date the work to the mid Julio-Claudian period.

Keywords: Oriental “barbarian” statue, giallo antico marble, Roman Theatre, Terracina.

Introduction

The focus of this article is the monumental sculpture of an Oriental “barbarian” in giallo antico found in fragments in 2007 during the excavation of Terracina’s Roman Theatre and recently subjected to a challenging restoration which aimed to make it suitable for display (Fig. 1).

Even by comparison with Lazio’s other ancient cities that maintain continuity into the present day, Terracina boasts an extraordinary archaeological record that never ceases to amaze.

Located around 100 km south of Rome within a vast gulf in the Tyrrhenian coast, the town was built on a spur of the Ausoni mountains that descends to the sea. Terracina enjoyed an exceptional strategic position, playing a central role in land communication routes, first of all on the Via Appia - a fundamental axis between Rome, southern Italy and the east - and maritime routes. The former Volscian centre (*Anxur*) became a Roman colony in 329 BC, assuming increasing economic and commercial importance, in part due to its port.

From the end of the 2nd to the beginning of the 1st centuries BC, the increase of wealth arising from the traffic of goods in the Mediterranean and the strengthening of a mercantile class resulted in a first phase of urban transformation and the spectacular reconstruction of the extra-urban sanctuary at Monte Sant’Angelo, one of the great sacred complexes of late Republican Latium.

Between the end of the Republic and the beginning of the Empire a monumental reconstruction of the Foro Emiliano was undertaken, while a second Forum with a more commercial purpose was built in the lower city[1] (Fig. 2).

[1] Local elites and high-ranking families from Rome with interests in this area were involved in the construction and/or reconstructions of the “Tempio Maggiore”, the Theatre, the Basilica, the porticoes surrounding the Forum and its monumental entrance arches.

Figure 1: Statue of an Oriental, Terracina, ex Civic Museum "Pio Capponi", (Photo: T. Böhm).

Figure 2: General view of the Forum Emiliano with its original limestone slab paving, Terracina, Italy, (Photo: N. Cassieri).

The abundance of imported coloured marbles and the high quality of the works suggest the involvement of skilled workers, perhaps from Rome, who were clearly well-versed in the new types of sacred and civil architecture and decoration, which they frequently reference[2].

In this monumental context we find the Theatre, with its *post scaenam porticus*, established on the northern side of the square in the years 70-60 BC and completely renovated in the Augustan age. The final building phase, primarily restorative, occurred in the Severan age or later (late 2nd - early 3rd century AD) [3]. The building leans in part against the natural slope (Fig. 3).

Excavations have revealed the two *aditus maximi*, part of the *cavea* with two rows of seats that concluded with a vaulted corridor, some of the orchestra with *bardiglio* and portasanta slabs, and, finally, a section of the scenic building featuring a double order of columns on its façade. Here, the lower order was characterized by large monolithic drums in bardiglio (4.8 metres high) with bases and ionic capitals in white marble (Fig. 4); the upper order was possibly made up of columns in africano marble with Corinthian capitals[4].

The far east and north corridor walls and the marble slab flooring are all that remain of the *porticus post scaenam* which overlooked the square. The impressive barbarian statue was

[2] For example, in the aforementioned "Tempio Maggiore" the cella walls were made of thick white marble panels, as in the so-called "Temple of Augustus" at Pozzuoli (*Puteoli*). The floor was made up of giallo antico and pavonazzetto marble slabs, arranged in a chequerboard pattern, just like in the Hall of the Colossus in the Forum of Augustus (Cassieri 2016, 35-42). For an incisive synthesis on the use of coloured marble in Rome under the Julio-Claudians and the technical and administrative aspects of the quarries, see Pensabene 2002, 3-11, 15-24.

[3] Unfortunately, the archaeological investigations carried out between the 1990s and 2017 by the Superintendence, under the direction of the author, demonstrate that various sectors of the complex lie largely underneath an intensely built-up neighbourhood. Research is only possible in the area where modern buildings were destroyed by the 1943 bombings.

[4] It should be noted that the context is somewhat compromised by modern constructions, since their foundations often reach the ancient levels.

Figure 3: Roman Theatre, east sector: *parascaenium*, *aditus maximus* and part of the *cavea*, Terracina, Italy (Photo: N. Cassieri).

Figure 4: Roman Theatre, *scaenae frons,* column in bardiglio, Terracina, Italy (Photo: N. Cassieri).

found in the area of the scenic building, between the podium of the *scaenae frons* and the front of the *pulpitum*, along with numerous other marble objects[5].

There is a possibility that works were amassed here in a post-ancient spoliation phase of the complex, before being transported elsewhere either for reuse in new buildings or to be made into lime.

The sculpture, 2.4 metres tall (2.31 metres at the tip of the headgear), was carved from two blocks of giallo antico (the upper measured 0.9 metres; the lower 1.58 metres), which in this case present a shade of intense yellow with brown-red veins and breccias (Figs. 5-6).

Figure 5: Roman Theatre. Upper half of the Oriental statue at the moment of discovery, Terracina, Italy, (Photo: N. Cassieri).

Figure 6: Roman Theatre. Lower part of the statue at the moment of discovery, Terracina, Italy, (Photo: N. Cassieri).

[5] These comprise statues of priestesses of Isis, male portraits, epigraphical fragments (including an exceptional inscription of the triumvir Lepidus), architectural elements which are, in part, still under study, and (from the orchestra area) a votive altar with a dedication to Jupiter Anxur, the town's eponymous deity (Cassieri 2016, 42-45; Cassieri *et al*. 2020).

The blocks were evidently carefully selected so as to present a homogeneous overall surface where the streaks corresponded to the intended colouristic and volumetric effect[6].

The statue was discovered in three main large pieces and some smaller fragments. After piecing together the latter, the first block – which includes the head, right arm and torso with part of a pillar behind – lacks significant parts and features very extensive fractures. In particular, the left arm is missing in its entirety (it should be assumed that this was sculpted partly in the first and partly in the second block)[7], and has detached itself from the shoulder in correspondence with a vein that runs obliquely through the stone. The front of the bust also presents notable gaps[8].

The lower half of the figure, incomplete at the feet and plinth, was carved in the second block. In ancient times, a portion of the torso had already detached itself from this block along an oblique vein at the belt: the damage had been repaired by means of two parallel brackets across the fracture, as indicated by four holes visible on the left side (Fig. 7). We are unable to date the initial break, this could have occurred during sculpting or when the work had already been completed, or perhaps during transportation. As a result of successive

Figure 7: The join-point between the two blocks and the remains of an ancient restoration, (Photo: T. Böhm).

[6] The giallo antico marble was extracted from *Simitthus* (modern Chemtou, Tunisia) by the Numidian kings from the second half of the 2nd century BC onwards and was utilized for official architecture. It was swiftly exported to Rome where it became especially prized. From c. 27 BC, in conjunction with the foundation of the *Colonia Iulia Augusta Numidica Simithensium*, the quarries became part of the imperial property (Röder 1988, 91-96; Pensabene 1994, 275-277, 321-323).

[7] Our statue is exceptional, since generally the upper limbs were sculpted separately and attached later.

[8] Based on limited investigation, it is possible that the statue was already missing it in ancient times, before the definitive abandonment of the site.

disturbance, this part of the sculpture detached itself again and has recently been restored. The relocated fragment has a regular cut and a well-polished surface with a quadrangular hole that corresponds, with a perfect alignment, to another hole in the upper block. A wooden tenon was inserted here to fix the two parts of the sculpture together. The pillar starts from the base and rises above the figure's head: the moulded part is only visible in the upper half of the statue (Fıg. 7); below, in fact, the block is very rough, like a sort of "spur" tapered at the bottom and partly hidden by the mantle. This would have been inserted into a wall and would therefore not have been visible. The upper face of the same pillar, chiselled using a *subbia*, is devoid of any trace of holes that may have anchored it to an overhead architectural element (such as an architrave, frame or capital). The head and hands are missing: this is unsurprising as these were usually sculpted separately and then added later; white marble was almost surely used to reproduce the complexion.

On the other hand, two non-corresponding forearm fragments in giallo antico were recovered at the excavation. One is presumed to belong to the left arm, while the other seems to refer to a different sculpture altogether, thus implying the existence of a second, similar type, which is also suggested by the discovery of the tip of another phrygian cap. The restoration (Fig. 1) reinstated the image of a foreign male figure, who stands with his weight on his right leg: the corresponding arm raised and bent at a right angle with the forearm lifted vertically. This position is confirmed by part of a marble prop that connected it to the pillar. In the wrist section, the remains of an iron pin for grafting on the missing hand are visible, yet these provide insufficient evidence to accurately reconstruct its position. The left leg is bent and falls to the side.

Based on comparisons and on consolidated iconographic traditions dating back to the late Hellenistic age, it seems safe to assume that the missing arm was lowered, bent at the elbow and fell more or less alongside the body[9].

The figure is covered by an oriental-style costume from head to toe, with tight trousers (*bracae*) traversed by thick horizontal ruffles and a long-sleeved tunic that reaches the knee. This is fastened under the chest by a *cingulum* and held by a second, hidden belt at hip-height, whose effects we see in the bulge (*kolpos*) of the fabric over the girdle and the lively play of folds beneath, following an iconographic variation that is well-documented by other examples[10].

The cloak, perhaps tied above one of the shoulders, descends to the ankles on both sides, falling in vertical folds with a rather simplified zigzagging overlapping hem. A phrygian cap, with the tip folded forwards without distinction from the mantle, covers the figure's head; closed shoes in soft leather, tied by strings and with a fringed lapel, clothe the feet.

Even though the depiction of fabric is abundant, the clothes by no means conceal the plastic consistency of the body. The volume of the drapery changes depending on the anatomical structure they cover: groups of multiple V-shaped folds are fuller and more undulating on the right side, where they were easily visible, whereas shallower and flatter folds are found on the opposite side, insubstantial due to the presence of the arm. The inattentive sculpting of the rear side confirms an intended frontal mode of view.

It is worth noting the good state of conservation of the work that preserves the vivid polychrome surface sand the sharp definition of the carving, safeguarded by centuries spent

[9] The first example of oriental figures with an engaged leg and raised arm/trailing leg and lowered arm configuration is on the bronze tablet inscribed near Hanisa (Cappadocia) with a relief depicting two young men in "supporting" poses on columns, from the second half of the 2nd century BC (Schneider 1986, 206-207, tav. 34, 1; Bitterer 2007a, 546-547, fig. 63).

[10] Schneider 1986, 19 and 98-99 (offering the examples of sculptures in Palazzo Altemps, in the Vatican and a small statue from Egnatia in Bari); Bitterer 2007a, 544-545.

buried in a soil free of components that could have damaged the marble. It seems that a preliminary dating to the first half of the 1st century AD can be proposed on account of the treatment of the material and by comparison with contemporary sculptures.

This kind of clothing is attested both in the Early Hellenistic period in the eastern Greek environment[11], where it was usually worn, and also more generally in Roman iconography to portray not only foreign peoples (Parthians, Phrygians etc.), but also divinities and historical or mythical characters (Attis, Ganymede, Mithras, etc.) from the Near East and Asia Minor[12]. The use of this iconographic model, outside its usual context and translated in the Augustan age for the first time into larger-than-life statues in precious, coloured marble, is charged with subtler meanings that go beyond a rampant taste for the exotic. The depictions of these unusual characters from remote regions of the empire in their sumptuous clothing become instruments for political and ideological propaganda, aimed at enhancing the achievements of the *Princeps* and the Roman ruling class, and therefore a way of exhibiting power and supremacy over subjected barbaric populations and the resources associated with their territories.

The example of Terracina is included in a small group of imposing statues of Orientals sculpted from expensive imported stones, which were created under Augustus in two versions, the "kneeling" and the "standing" type, and both exhibit the supporting gesture (Stützgestus); their elevated celebratory value guaranteed them a place in the most important monuments.

In Rome, the first type finds its oldest application in the famous group (now in Naples and Copenhagen) of three eastern barbarians in pavonazzetto, kneeling and bearing shelves, of unknown origin and restored with numerous additions[13]; the second type finds its greatest expression in the extraordinary array of at least eighteen standing figures, carved in pavonazzetto and giallo antico[14], which adorned the Basilica Aemilia with the function of pseudo-telamons[15]. These adorned the reconstruction of the Basilica after the fire of 14 BC, a project financed by *Paullus Aemilius Lepidus*, his friends and Augustus himself[16].

The statues were also identified as belonging to the Augustan age due to their white marble heads, which are stylistically similar to those of Jupiter Ammon. These embellished the attic of the porticoes of the Forum of Augustus and have been dated reliably[17]. According to Schneider's appealing interpretation[18], these sculptures had a marked encomiastic tone, glorifying the "victory" of Augustus over the Parthians in 20 BC, symbolized by the return of the *signia* and of the prisoners captured during the defeat at Carrhae in 54 BC.

The deliberately generic term of "Orientals" adopted by Schneider to define the statues of the Basilica Aemilia, and subsequently utilized more broadly, derives from the

[11] See the "Sarcophagus of Alexander", 310 BC (Istanbul Museum) with the scene of the battle of Issos, found in Sidon, which can perhaps be identified with the sarcophagus of King Abdalonymos, and the statue of the so-called "Servant" from the mausoleum of Belevi, an ancient village near Smyrna, Landwehr 2000, 74-75.

[12] Schneider 2007, 50-53, 60-79; Schneider 2016, 411-412; on the restriction of the term "Asians" to the people from the geographical regions indicated above, ibid. 402-403.

[13] The hypothesis that they constituted the support of a large triumphal bronze tripod, Schneider 2002, 84-85 fig.1, has recently been challenged by Lipps, Lipps 2016, 203 ff.

[14] An uncertain reading of Pliny, NH, XXXVI, 102, suggest that around 70 AD he consider these "Phrygians" to be one of the wonders of the world, see Schneider 2016, 416; Lipps 2016, 227.

[15] Lipps 2016, 232.

[16] This decorative enterprise was the subject of a specific request on the part of Lepidus for authorization from the Senate, as mentioned by Tacitus, Ann. 3, 72 "*Isdem diebus Lepidus ad Senatum petivitut basilicam Pauli, Aemilia monimenta, propria pecunia firma retornaretque*".

[17] For bibliography on this subject, see Consoli *et al*. 2023.

[18] Schneider 2002, 84-91.

youthful faces with ideal features and clear complexions, framed by long wavy locks. Such elements, according to a stereotype of Roman art, characterized people of oriental origins[19].

Both iconographic schemes are widely diffuse, particularly the standing one. This form is taken up in Rome by two magnificent sculptures of unknown origin: the first one dates to the Julio-Claudian age and is sculpted in giallo antico (Palazzo Altemps, Rome); the other, from the Severan age and in Beyler breccias (Asia Minor), is depicted leaning against a pillar (Chiaramonti Museum, Vatican City).

There is no doubt that both belonged to unidentified public architectural contexts. The example from Terracina looks similar to the "Dacian" of Palazzo Altemps[20] (2.3 metres tall) which, despite significant additions and alterations in the 16th century, is almost its mirror image, reproducing the distribution of weight and also, in part, the attitude of the upper limbs (Fig. 8).

Figure 8: Statue of an Oriental in giallo antico, Palazzo Altemps, Rome, (Photo: T. Böhm).

Our sculpture differs from this on account of its slightly larger dimensions and, above all, the presence of the pillar instead of the mantle, which expands considerably at this point and is as rigid as a slab, descending from the shoulders to the ground with the probable function of ensuring stability. This leads us to imagine the statue leaning against a wall or a pillar, etc. For stylistic and compositional reasons the most recent studies attribute it to the Julio-Claudian period, although not without significant oscillations[21].

Even more similar to our example is the torso of an "Oriental in a supporting gesture" in badly-preserved pavonazzetto (1.14 metres tall; original height estimated at 1.9-2.0

[19] Bitterer 2007b, 155 n.2; Schneider 2016 ,411-414.

[20] The addition of head and hands in dark marble; the giallo antico integration of the cap, the left arm up to the armpit, the right forearm, the front side of the right leg, part of the plinth and the lower part of the support.

[21] Schneider (1986, 201-202) attributes it to 40-70 BC; Bitterer (2007a, 547) to the mid - 1st century AD; Landwehr (2000, 76-79) to after 22 AD.

metres). This statue possibly pertains to the Forum of Cherchel, ancient Iol-Caesarea Mauretaniae, where it might have decorated a prestigious public building[22] (Fig. 9).

The statue, carved from a single marble block, depicts a male figure standing on his left leg, in contrast with our example from Terracina: the only part of the bust that remains is the right shoulder with its connection to the arm, which was lowered, while the other must have been raised. The figure wears the characteristic oriental dress with sleeves, secured by a belt under the chest, and perhaps composed of two overlapping tunics of different lengths, not easily recognizable due to the damaged surface; a cloak falls from the shoulders, behind which there is a pillar with unpolished facets, sculpted from the same block. The Cherchel sculpture also had a white marble head or face, worked separately and inserted subsequently into the figure or into the hollow of the hood[23].

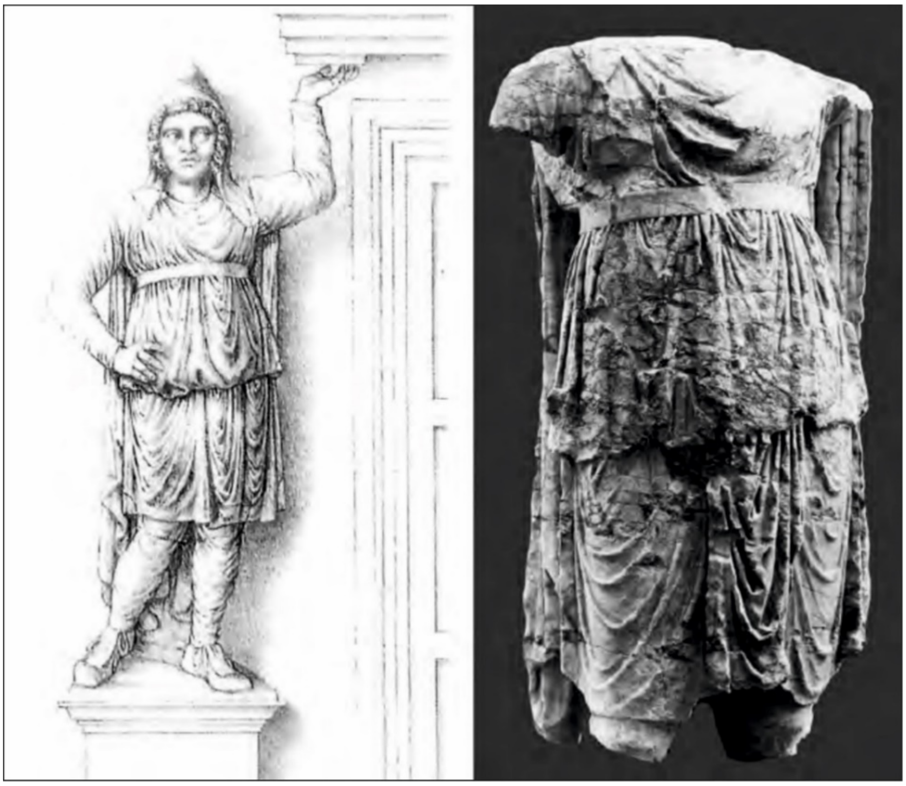

Figure 9: Torso of an Oriental in pavonazzetto and its hypothetical reconstruction by Landwehr, Archaeological Museum, Cerchel, Algeria.

On account of the pillar, Landwehr[24] believes that the statue could have acted as a structural prop, unlike others with which it is usually associated, only superficially concerned with the gesture of supporting (Basilica Emilia, Palazzo Altemps and Vatican Museums). The scholar attributes the sculpture to the Augustan period, to the time of Juba II (52 BC- AD 23) of Mauretania. This estimation is based on the stylistic characteristics alone due to the absence of other contextual elements. Moreover, based on the assumption that the statues found in the Roman Forum belong to the Tiberian age, from AD 22 onwards, and also on Tacitus' aforementioned words (above p. 5), Landwehr concludes that the example from *Caesarea Mauretaniae* is the oldest known monumental Oriental figure in coloured marble. However, a contrasting school of thought (Schneider, Bitterer etc.) view it as a later creation

[22] Landwehr 2000, 74-83. The head, neck, left shoulder, legs, feet and the lower part of the mantle are missing. Cherchel, Archaeological Museum.

[23] Landwehr 2000, 79.

[24] Landwehr 2000, 80 and n. 72.

inspired by the sculpture in the Forum, which certainly had a considerable diffusion and gave rise to numerous imitations.

Regardless, this work would have expressed the power and wealth of the Numidian royal house: it was sculpted in a particularly representative context, probably constructed or renovated in connection to the city's new role as the kingdoms' capital. This event took place under Juba II, a friend and ally of Rome, put on the throne of Mauretania in 25 BC by Augustus.

The inclusion of the pillar can be better understood in the eastern/Greek area by Corinth's white marble sculptures of "The Terrace of the *Captivi*", which belong to the end of the 2nd century A.D. Here, at least four Attis-type statues with folded arms replace the columns[25]. Similarly, at Ephesos on "Domitian's terrace" we find a white-marble Oriental male figure, dating to the late Antonine age, sculpted in high relief on a second-order column[26]. However, both these examples refer to different figurative schemes and/or chronological ranges.

The addition of the pillar, which, on a formal level, seems to support an overhead architectural element, makes the Terracina statue the first appearance of a new compositional type, at least in the Italic peninsula, perhaps preceded by the example from Cherchel (Fig.10).

Despite the missing fragments, our sculpture, untampered-with and of known origin, constitutes a vital testimony to this statuary series, both on account of its imposing dimensions, its precious material, its chronology, and also its discovery in a known public context. This makes our statue a vital element of comparison for future studies and adds to our understanding of the reception of significant urban models, acting as a testimony to the widespread trend of imitating the Urbs, even in a provincial city such as *Tarracina.*

However, it remains to be said that the original location of the statue is uncertain. We can imagine that, paired with another statue (significant evidence points to its existence), it may have decorated the *scaenae frons*[27], or perhaps have stood near the *valva regia,* framing an entrance, or in the large *porticus post scaenam*[28].

Regardless of its exact position, the Oriental statue must have been highly visible. The presence of this work in a public space also raises questions about the client, public or private, who commissioned it. Mining activities in the giallo antico deposits of imperial properties in *Africa Proconsularis* took place under the careful control of *procuratores* and its supply was by no means guaranteed.

In addition, the costs involved in employing specialized workers and transporting the stone would have been added to the (already significant) cost of the precious material. This leads us to assume a private act of euergetism by an elite and influential figure in celebration of a particular occasion, rather then a venture by the local government[29]. Unfortunately, we are unable to identify the benefactor, since information regarding prosopography in the mid-Julio-Claudian city is still quite scarce.

The sculpture reflects its state of conservation at the time of discovery: the restoration undertaken involved assembling the fragments of the arm and the base in a traditional way

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[25] Schneider 1986, 129, pl. 37,2; I nstead, Strocka (2010, 29-55) proposes a Neronian dating for the "prisoners" on the basis of stylistic and typological observations. He claims that the monumental context, the decorations and the sculptures can all be attributed to a single constructive intervention, perhaps connected with the Emperor's visit to Greece (AD 66-67) and his stay in Corinth, as described by the literary sources. The author therefore suggests we see the Orientals' mournful poses as Neronian propaganda for the victory over the Parthians in Armenia.

[26] Schneider 1986, 125-128, pl. 35, 2/4.

[27]A similar location is also suggested for Rome by Lipps (2016, 235-237), who views richly-adorned architectural prospects in permanent theatres as one of most appropriate settings for large Oriental figures.

[28] Interesting debates abound, see Pensabene 2007, 7-10; 47-50.

[29] Pensabene 1994, 281-283.

and joining the trunk to the lower part of the body without the use of pins, simply by juxtaposing the fragments in order to safeguard the work's integrity. A self-supporting steel structure was created for the restored statue which allows it to be taken apart, displayed in museums and handled[30].

Figure 10: **a**. The torso of an Oriental from Cherchel (courtesy of Photo: R.M. Schneider); **b**. Oriental statue from Terracina with a posterior pillar (Photo: T. Böhm).

The support design and construction were carried out on the basis of 3D scanning and virtual reconstruction (Fig. 11). This had already highlighted that the contact surface between the two blocks was so small that any solution assembling them by means of pins or traditional systems would have been impossible. Based on the studies carried out with the 3D modelling software a 1 : 1 scale model was created in lightweight materials, since the weight and size of the original pieces did not allow for concrete checks. The support consists of a wide base, on which the lower part of the statue rests, and a vertical strut, fixed on to the back and equipped with a sturdy shelf that sustains a section of the torso; in this way the upper part does not rest its considerable weight on the lower part.

[30] Ministry of Cultural Heritage and Activities. Restoration 2016-2017. Scientific direction: Nicoletta Cassieri. C. Bart Consortium- Technical Director: Thomas Böhm; LS survey and 3D model: Soc. Azimut by Luca Fabiani & Co; design and realization of the support: Soc. Equilibrarte, Carlo Serino.

The structure is equipped with adjustment systems that allow for small corrections in position while the fragments are already in place, whereby they can be tilted, rotated and altered in height. The assembly of the fragments is reversible, exclusively mechanical and didn’t require the creation of new holes: the brackets used the existing ones in order to maintain the integrity of the marble as much as possible. Finally, shock-absorbing materials were arranged between the stone material and the support in order to preserve the surfaces.

Figure 11: 3D reconstruction of the Oriental statue from Terracina (Photo: Azimut s.r.l.).

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SANDSTONE AS BUILDING AND DECORATIVE STONE AT BOLSKAN-OSCA-WASQUA-HUESCA (NORTHEAST SPAIN)

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Abstract

The paper presents a first survey of the most used natural stone for centuries in the city of Bolskan-Osca-Wasqua-Huesca (northeast Spain). The rock, a continental Miocene sandstone from the Ebro Valley (Sariñena Formation) outcrops in palaeo-channels of decametric transversal area and horizontal tabular strata of lesser thickness but greater lateral continuity. This rock, abundant and cheap, was mainly used for building purposes, such as military fortifications, monuments and normal houses, from ancient times until the 16th century. Decorative elements have also been carved in this soft material. A brief summary of its historical use, the geological characteristics of this natural stone and a first survey about the old quarries near Huesca is presented.

Keywords: Huesca, Miocene sandstone.

Introduction

Sandstone is a detrital sedimentary rock, continental or marine, composed of sand-size grains. The spaces between the grains may be partially filled by a much finer sediment called the matrix. Grains and matrix are held together by a cement that is usually limestone or silica. The relationships between the three components can vary even at short distances, resulting in great heterogeneity. Sandstone is usually easily eroded by differential erosion, which gives rise to occasional spectacular outcrops that have been used in emblematic monuments, such as Abu Simbel or Petra. Sandstone has also been used in Roman monuments in Hispania (Casas, Febo, Parcerisa 2020), Britannia (Hunter *et al*. 2002) and in the amphitheatre of Thysdrus, today El Jem (Tunisia).

The present work presents a first look at the historical use of sandstone in the city of Huesca, located in the Ebro River valley, in northeast Spain

Historical background

A small inselberg at the foot of the Pyrenees, near the Isuela River, once housed the Iron Age city of Bolskan, which minted bronze coins. Annexed by Rome around 200 BC, probably by the army of Cato the Elder, the city took the name of Osca, under which it coined a large number of bronze and silver coins until the beginning of the Imperial period. The city played a minor role during the Roman civil wars of Marius and Sulla, as it was a key place during the Sertorian rebellion. Quintus Sertorius established his capital in Osca and was killed there (72 BC). Years later, the city supplied the army of Julius Caesar during the battle of Ilerda (49 BC). Very little remains of the Roman Osca, which was built almost entirely of sandstone. It is known from archaeological excavations that several large buildings, including a Theatre, were raised during this period (Asensio, Justes 2018). Figure 1 shows the remains of an unidentified building currently in the basement of the administrative headquarters of the province of Huesca. At an uncertain date, possibly in the 3rd century BC, a casemate wall was erected around the urban hill. Due to the generally poor quality of the rock and the multi-saecular recycling, almost no pieces of carved Roman sandstone have been preserved. A beautiful exception is the capital shown in figure 2. The use of other building stone in the Roman period seems to have been practically exceptional. In fact, very few remains of ornamental marble have been found (Lapuente *et al*. 2012, 2015; Royo *et al*. 2015). There is speculation about its use to make lime for construction during the Middle Ages.

Figure 1: Roman ashlars in the basement of the administrative headquartersof the Province of Huesca (Photo: J.A. Cuchi).

Figure 2: Roman Capital from Osca (Photo: J.A. Cuchi).

There is very little information about the Late Roman and Visigothic periods, except for the expansion of Christianity. The city was taken by a Muslim army around 720 (98 Anno Hegirae). The Muslim chronicles point to a surrender by agreement after a seven-year siege. With the surrounding territory deeply Islamized, the name changed to Wasqa during the next four centuries. Included in the Upper Islamic March, the city was involved in almost permanent, sometimes simultaneous, conflicts with the neighbouring Islamic cities, the Umayyad Caliphate of Córdoba, the Taifa of Saraqusta, the Carolingian Empire and the Christian territories that gave rise in the 11^{th} century AD to the Kingdom of Aragon. As an example, the city suffered at least four sieges by Carolingian armies alone. In 874-875 (242-3 AH), a new sandstone wall was erected by Amrus ibn Muhamad by order of Muhammad I of Córdoba. A detail of the wall is presented in figure 3. The Islamic fortification, built in a distinctive header bond style, was 2 km long, nearly 2 m wide, 15 m high and was strengthened by 90 towers (Naval 1997; Sénac 2000; Zueco 2012, 330).

After the collapse of the Caliphate of Cordoba, in the subsequent period of Muslim weakness, the surrounding territory was conquered by the Christian kingdom of Aragon. In 1085, King Sancho Ramírez of Aragon erected the nearby castle of Montearagón to harass Wasqa. Eleven years later his successor, Pedro I, took the city by force of arms and renamed it Huesca. The defence wall was repaired several times during the following centuries until the unification of Spain ended its military role. It is estimated that the volume of rock used in the medieval wall exceeds 90,000 m^3 (Cuchi *et al*. 2005, 163).

During the Christian Middle Ages, several Romanesque and Gothic-style churches were built on sandstone in and around Huesca. The main building is the cathedral erected between 1294 and 1511 (Durán 1991; Garcés 2014). The plan of the building is a Latin cross of 48.5 by 41.2 m. The maximum height of the vault is 25.6 m, and it has a massive tower of

37 m. The “libro de fábrica” (workbook) of the cathedral documents the purchase of numerous loads of stone transported in carts. The price was conscientiously recorded but unfortunately the quarry of origin remains unspecified. After the 16th century, with some exceptions, the use of sandstone in public buildings in Huesca was generally replaced by fired brick, except for noble elements such as door lintels.

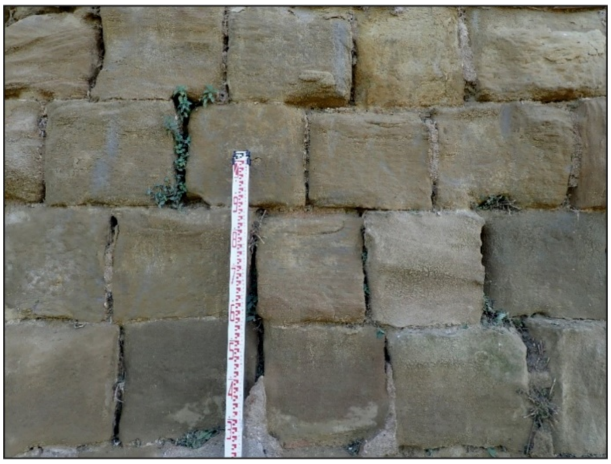

Figure 3: Detail of the Islamic wall of Wasqa. Ashlars (0.3 x 0.3 x 0.9 m) in header bond style wall. (Photo: J.A. Cuchí).

The alteration of the sandstone is very evident in the monuments of Huesca. Problems with sandstone are detectable through the hydrolysis of plagioclases associated with the capillary ascent of water, facilitated by the high porosity of the rock. For this reason, the cathedral, other historic buildings and the medieval wall were partially restored during the 20th century. Initially, until 1970, local sandstone was used for replacement purposes. Later, sandstone from some distant quarries (Ayerbe, Murillo de Gállego, Uncastillo, Floresta) was employed. Today there are no active quarries around Huesca.

In order to understand the problems of the local sandstone and to look for possible solutions, a geological study of the rock has been carried out and an inventory of nearby historical quarries has been initiated.

Geology

The geological context that surrounds the city of Huesca belongs to the Sariñena Formation of the continental Miocene of the current Ebro Valley, in the past a large endorheic basin. Until the middle Miocene, a large fluvial fan (the Huesca fan) of a lost river from the nearby Pyrenean Mountain range contributed to filling the depression with an important volume of classified sediments. Around the modern city of Huesca, the geologic materials were composed of sandstone and finer materials (silt and clay) in strata of metric thickness organized in subhorizontal beds. Locally, the sandstone-filled palaeochannels that may reach a thickness of 10 m (Hirst 1983, Arenas *et al.* 2001, Fisher *et al.* 2007, Nichols, Fisher 2007, Donselaar, Overeem 2008). Fig. 4 presents an excerpt of the geological map of Spain.

The opening of the endorheic depression to the Mediterranean Sea, which began in the middle Miocene, organized the current fluvial network of the Ebro River and started a great erosion process, still active, that today has given rise to a typical semi-arid landscape with areas of bare sandstone and an irregular coverage of Quaternary fluvial materials. In the surroundings of Huesca, besides several small inselbergs, a dominant feature of its current landscape is a long escarpment of about 100 m high and more than 40 km long that near the city is dominated by the massive castle of the abbey of Montearagon. The escarpment and inselbergs are devoid of natural vegetation after centuries of uncontrolled fires, firewood collection and sheep grazing in open ranch conditions. The alternation of sandstone layers and the fine material of the slopes has a different resistance to erosion, so that the sandstone layers are in positive relief, prone to break and fall rolling down the slope helped by a family of vertical decompression-type diaclases parallel to the cliffs of decompression origin. As a result, many sandstone blocks have been produced that partially cover the slopes.

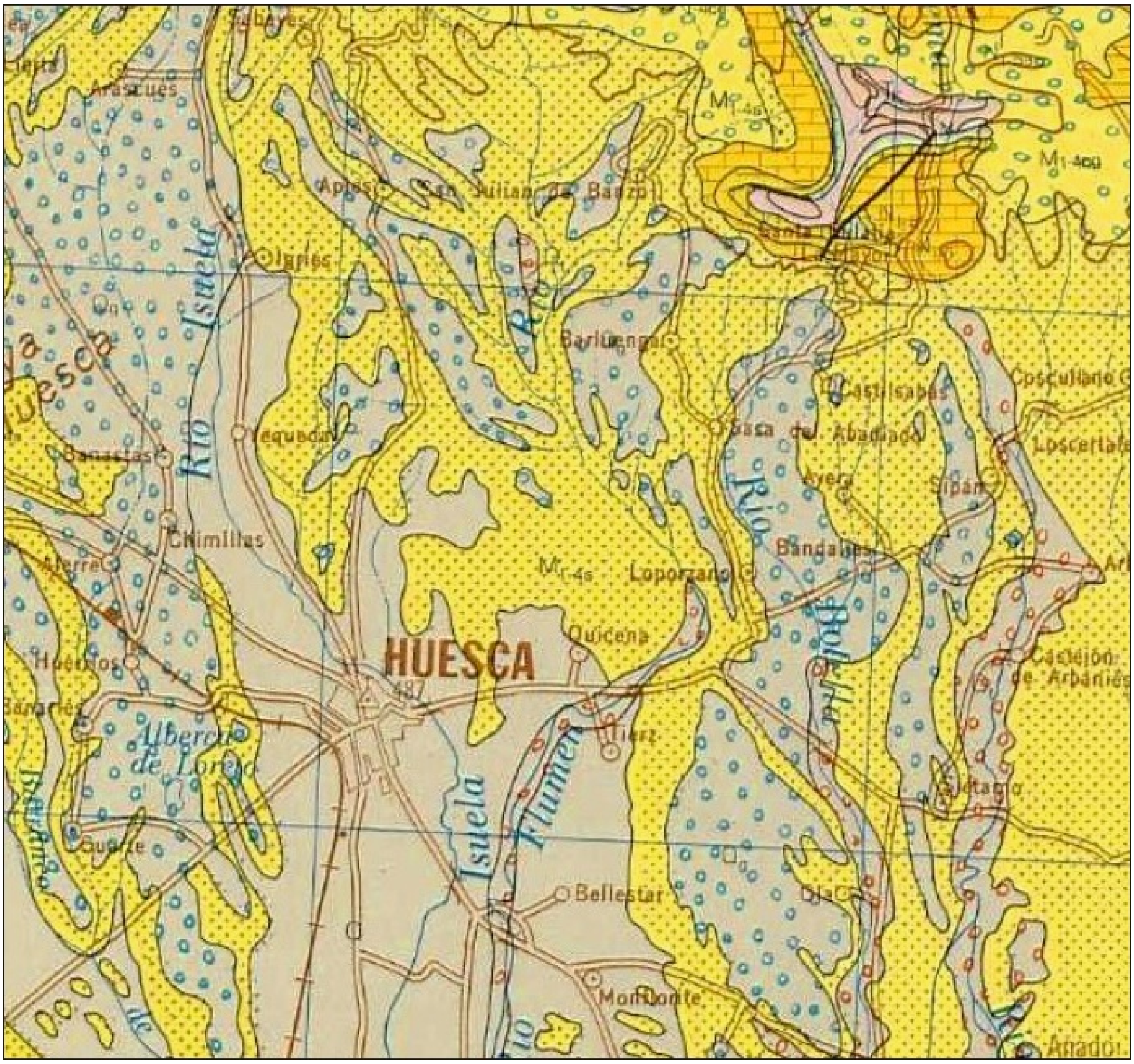

Figure 4: Geological map (IGME-Geological Survey of Spain) of the surroundings of Huesca. Legend. $M_{1\text{-}4s}$ (yellow) Miocene sandstones and marls. Q (grey): Quaternary.

Petrographically, sandstone is a calcareous litharenite, with grain support, generally of fine-to-medium sand that is not very rounded (< 0.5 mm, and average size close to 0.2 mm) and well classified. Compositionally, it shows 55-60% of rock fragments with a predominance of carbonate fragments composed of limestone and skeletal grains of varied bioclasts, but also marls, lutites, metamorphic rocks and silexites, 15-30% of quartz, 5-8% of feldspar and plagioclase, 5-10% of mica (biotite, muscovite). 8-12% as phyllosilicate matrix, mainly illite and variable amounts of dispersed iron oxides. Carbonate cement (5-15%) is composed of sparite-type calcite that sometimes presents syntactic overgrowths in the echinoderm plates. The cements partially fills the interparticular voids, leaving an important open porosity (15-20%). Figure 5 shows some petrographic images of the sandstone at different scales.

Generally the rock is very friable. This facilitates its use for ashlars and sculpture, but also causes the development of several pathologies. Physical arenization and the formation of honeycombs and taffonis are general in the natural sandstone outcrops and exposed ashlars of buildings. The formation of external 1 cm thick plates is also quite common in ashlars. In the presence of water, plagioclases are hydrolyzed releasing salts that contribute to the erosion of the rock.

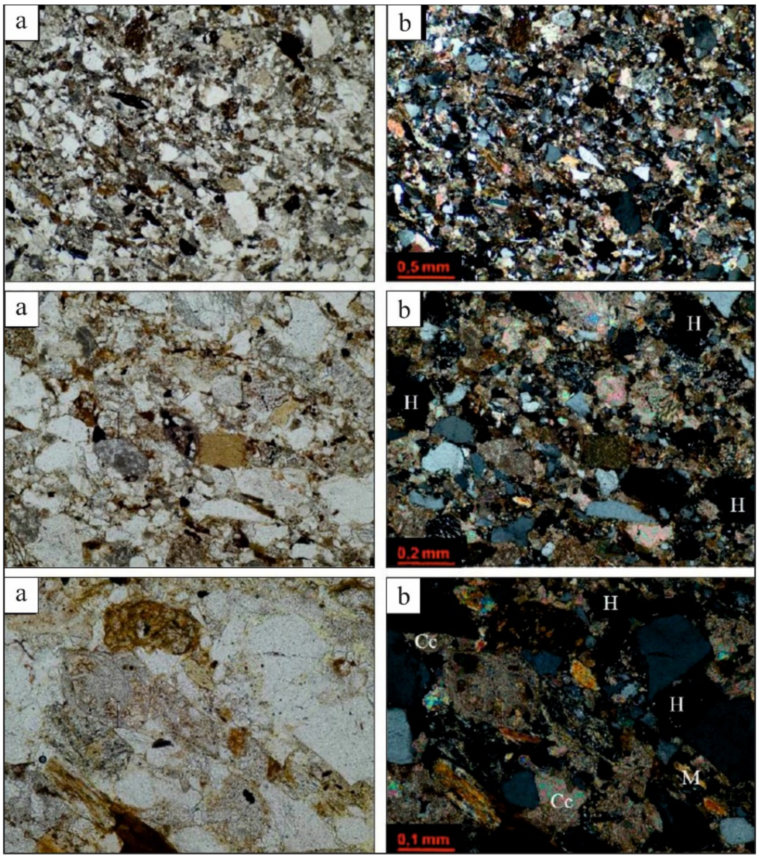

Figure 5: Thin sections micrographs of the local sandstone, calcareous litharenite, at different scales. **a**. Under polarized light, parallel nicols; **b**. Under polarized and analyzed light, crossed nicols. Legend: H = voids, porosity; Cc = calcite; M = marls.

Quarries

In search of the quarries of origin of the abundant use of the sandstone in Huesca, and looking for possible alternatives for replacement rock, a first inventory of the quarries of the surroundings of Huesca has been made, trying to define the different systems of extraction. The southern side of the aforementioned escarpment and many small inselbergs have sandstone outcrops where the presence of vertical diaclases on a metric scale facilitates the extraction of stone and which are very suitable for quarrying, all at a distance of less than five kilometers of Huesca. The inventory of quarries has been achieved through field surveys, supported by archive data, place names and aerial photographs. On the terrain, the presence of extraction traces has been noted, including small cutting trenches and notches for wedges, as well as the presence of discarded pieces. Further, it has been observed that many slopes naturally present blocks of sandstone, which have been removed by surface erosion and are easily available for use. These are abundant in distant outcrops but are not observed on slopes near Huesca, suggesting intentional extraction. It should also be noted that some of the quarries were used as trenches during the battle of Huesca in the Spanish Civil War of 1936-1939.

A non-exhaustive inventory is shown in Figure 6. A relatively high number of quarries has been located and the information is presented by Cuchí and Lapuente (2016). Most of them are very small, just a few square metres, but some cover over ten hectares. The volume of rock extracted, not always capable of estimation, is also variable, but seems to be only a few cubic metres in many places. The quarries closest to Huesca are exhausted and the land recycled for crops since the remains of sandstone in the rubble are very friable. The most important quarries are located at the foot of the escarpment which also acts as a boundary for rock transport.

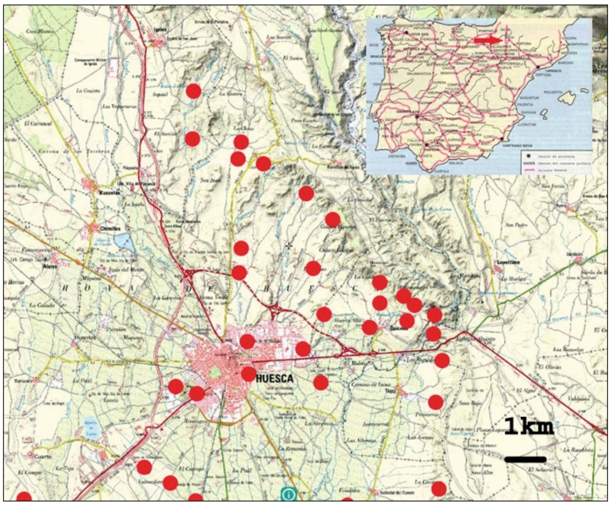

Figure 6: Location of quarries around Huesca, and its location in the NE of Spain

Two different types of extraction have been detected. In quarries that appear to be older, ashlars are defined by narrow trenches made with a pickaxe (Fig. 7). In the rest, only raw blocks were extracted, using diaclases, to be carved away from the quarries. There are very few signs of expansive wedges. Some depressions have been found of adequate size for machine supports. No marks or graffiti of the quarrymen have been found. There are also almost no archaeological findings *in situ*, such as pottery, that could be related to the quarries. The oldest written references are from 1290. Therefore, it is not possible to date the quarries properly, especially since some have been reused throughout history.

Figure 7: Precut ashlars in a quarry by the system of narrow trench (Photo: J.A. Cuchí).

Figure 8: Very small quarry of possible Roman date (Photo: J. A. Cuchí).

Given the reuse of the quarries over the centuries and natural erosion it is not easy to assign dates to them. By analogy with the Roman ashlars in figure 1 and casual finds in a nearby old but unexcavated dump, the quarry in figure 8 appears to be from the Roman period. The rest of the quarry in figure 9, which seems to have supported a watchtower, could be from the Islamic period. It seems clear that the quarries near the castle-abbey of Montearagón are ascribable to the Christian Middle Ages (Fig. 9).

Figure 9: An old sandstone quarry near Huesca. Most of it has been repurposed as an agricultural field. The rest of the rock was probably used during the Islamic period as the foundations for a watchtower (Photo: J.A. Cuchí).

Figure 10: Small quarry, probably of the Middle Ages, near the abbey-castle of Montearagón (Photo: J.A. Cuchí).

Conclusion

Miocene sandstone has been used from the Iron Age to the 16th century as a basic construction and decoration material in the current city of Huesca. It is a calcareous lithoarenite, porous and poor in cement, susceptible to various pathologies. There are clear needs for restoration in various buildings. There is an evident need to increase studies related to the conservation of buildings in sandstone, especially sculptural elements.

A first programme of work has been carried out to locate the historical quarries, many of them little-known at present. The inventory of quarries indicates an interesting historical heritage that should be properly valued and preserved.

This work should be considered as a first approach to the study and conservation of architectural and sculptural elements in the city of Huesca.

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PIGMENTS AND PAINTINGS ON MARBLE

THE PAINTED REPRODUCTION OF PORFIDO ROSSO AND PORFIDO SERPENTINO (14th-15th CENTURIES)

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Abstract

The reproduction of coloured marbles in painting was a common practice in Italy and abroad. Different marbles were imitated, carefully depicting colours, textures, veins, spots etc. for floor tiles, shafts, piers, slabs or decorative elements placed in a painted scene. In particular, the presence of the two most valuable "marbles" is noticeable, both alone and paired: porfido rosso antico (Eastern Egyptian Desert) and porfido serpentino (Lakonia, Southern Greece). The porphyries were represented by the different Italian schools (Giotto, Foppa, Piero, Mantegna, Botticelli, Cima, Montagna, Luini, Palmezzano etc.) and by the Flemish primitives (D. Bouts, Christus, van Eyck, Memling, van der Weyden etc.). A list of paintings, coming from first-hand observations on Museums and catalogues, is provided together with the specific location of porphyries in each painting.

Keywords: Porfido rosso antico, porfido serpentino, Old Masters painting.

Introduction

Italian and Flemish painters often reproduced coloured marbles in their paintings; painted scenes, both of religious and secular character, contain imitations of different coloured or white marbles, carefully depicting colours, textures, veins, spots etc. of floor tiles, slabs of veneer, columns, piers or decorative elements (Bugini, Folli 2015).

The imitation depicted the surface morphology of each marble with great precision, so the identification is very easy: we see granito rosso (Aswan red granite), porfido rosso antico (Egyptian red porphyry), porfido serpentino (Greek green porphyry), rosso antico (Greek red marble) and giallo antico (Tunisian yellow limestone). This kind of painting seems to start in the 14th century and lasts until the first decades of the 16th century; then in the second half of the 16th century the marbles disappear almost suddenly from paintings, following new rules of the representation of religious or secular scenes.

In particular, it is worth noting the widely-diffused representation, both singly and paired, of two of the most valuable "marbles": porfido rosso antico (Eastern Egyptian Desert) (Brown, Harrell 1995; Malgouyres 2003) and porfido serpentino (Lakonia, Southern Greece) (Lazzarini 2007,).

Methods and techniques

A general survey, wide but obviously partial, was made by first-hand observations in European and North American Museums of Fine Arts and by examinations of the on-line archives of museums and of the catalogues of exhibitions of painting. The survey permitted the selection of dozens of paintings where the red and green porphyry were paired almost always in alternating positions (i.e. as decorations of the throne of the Virgin or as floor tiles); in other paintings only one of the two porphyries is reported. The porphyries feature a dark ground speckled with small light green or pink geometric spots; so the imitation was made by laying-out a uniform deep red or green ground with superimposed rectangular, squared or circular spots of a lighter colour. The supports were very different including: wood, canvas, plaster, stained glass etc.

Survey of paintings representing red and/or green porphyry.

The porphyries were represented by the painters of many Italian schools: from Tuscany (Botticelli, Andrea del Castagno, Giotto, Piero) to Lombardy (Butinone, Foppa, Luini), from Venice (Vivarini, Mantegna, Fra Carnevale, Crivelli, Cima, Montagna, Palmezzano etc) to Naples (Colantonio). The "peak" of this kind of picture was in the last decades of the 15th century.

On the other side of Europe, primarily in the 15th century, the Flemish primitives (D. Bouts, Christus, van Eyck, Memling, van der Weyden etc) also depicted porphyries in their paintings.

The painters are listed in alphabetical order following a chronological sequence. For each painter is reported the title (in the language of the museum) and the date of the painting; the town and the museum including the inventory number identifying the painting (in brackets).

The text leaves out illustrations to avoid Copyright violations; images of each painting are easily available on the websites.

Easel Painting on Wood and on Canvas

14th century

- Giotto, Polittico Santa Reparata, about 1310 - Firenze, Opera Duomo:
  Red porphyry: strips on the rear of the side panels.

First half of 15th century

- Alemagna Giovanni - Storie di Sant'Apollonia, 1435/40 - Bergamo, Acc. Carrara:
  Red porphyry: panels on the architectures of the background.
  Green porphyry: panels on the architectures of the background.
- Campin R. (workshop), The Merode Altarpiece (The Annunciation), 1427/32 - New York, The Met Cloisters (56.70a-c):
  Red porphyry: octagonal floor tiles.
  Green porphyry: square floor tiles.
- Campin R. (workshop), The Virgin and Child in an interior, about 1432, London, Nat. Gallery (6514):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles.
- Campin R. (follower), The Virgin and Child before a firescreen, London, Nat. Gallery (2609):
  Red porphyry: octagonal and triangular floor tiles.
  Green porphyry: square floor tiles.
- Colantonio, San Francesco consegna la regola, 1445 - Napoli, Capodimonte (Q21):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with maiolica.
- Eyck Jan van, Madonna with Canonic J. van del Paele, 1436 - Bruges, Groeninge (0161.I):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with blue and white ceramic tiles.
- Eyck Jan van, The annunciation, 1436 - Washington, Nat. Gallery (Mellon 19371.39):
  Red porphyry: column shafts in the two levels of the church.
- Eyck Jan van, The Triptych of the Virgin, 1437 - Dresden, Gem. Galerie (799):
  Red porphyry: column shafts in the nave of the church.
- Masaccio, Coat of arms of the cardinal Antonio Casini (rear of Madonna del Solletico), 1430 - Firenze, Uffizi (9929):
  Green porphyry: ground.

- Maître de Flémalle, L'Annonciation, 1415/25 - Bruxelles, Musée Beaux Arts (3937):
  Red porphyry: geometric floor tile.
  Green porphyry: square floor tiles together with white marble square tiles.
- Maître de Flémalle, La messe de saint Grégoire, 1430?- Bruxelles, Musée Beaux Arts:
  Red porphyry: two column shafts of the chapel.
  Green porphyry: two column shafts of the chapel.
- Vivarini A., Ambrogio battezza Agostino, 1435/40 - Bergamo, Acc. Carrara (Lochis 1856):
  Green porphyry: square floor tiles.
- Weyden Rogier van, Saint Luke drawing the Virgin, 1435/40 - Boston, Museum Fine Arts (93.153):
  Red porphyry: square and triangular floor tiles together with white ones.

Third quarter of 15th century

- d'Antonio da Bolognola Giovanni Angelo, about 1465, Polittico di Gualdo Tadino - Milano, Brera (760):
  Red porphyry: rectangular panel of the throne of the Virgin.
  Green porphyry: rectangular panel of the throne of the Virgin.
- Baldovinetti A., Santo Vescovo, 1470 - Firenze, Santa Trinita, left nave, fifth chapel:
  Red porphyry: rectangular panels.
  Green porphyry: ground of the portrait of the Saint.
- Baldovinetti A., Annunciazione, 1470 - Firenze, Gall. Uffizi (483):
  Red porphyry: column shafts of Virgin house; rectangular panels on the background.
  Green porphyry: rectangular panels on the background.
- Boccati G. di Piermatteo, Madonna con Bambino. 1455/60 - Perugia, Gall. Nazionale (147-32):
  Red porphyry: panels in the base (white marble) of the throne of the Virgin.
  Green porphyry: panels in the base of the throne of the Virgin.
- Boldrini L., Madonna tra i santi, after1450 - Venezia, Correr (C l.I. 25):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with Cipollino Rosso.
- Botticelli S., Madonna e Santi, 1470 - Firenze, Uffizi (1890 1609):
  Red porphyry: rounded floor tiles.
  Green porphyry: rounded floor tiles.
- Botticini F., The resurrection, 1465/70 - New York, Frick coll. (1939.1.143):
  Red porphyry: disc on the Holy Sepuchre.
- Bouts D. (workshop), The Virgin and Chid with Saints, about 1460 - London, Nat. Gallery (774):
  Green porphyry: octagonal floor tiles; sides of the throne of the Virgin.
- Bouts D., Het Laaste Avondmal, 1464/68 - Leuwen, St. Pieters:
  Red porphyry: square floor tiles disposed in a cross-shape; porch, shaft on the right.
  Green porphyry: square floor tiles, in cross-shaped disposition; together with white or grey tiles.
- Bouts D., La justice de l'empereur Otton: l'épreuve du feu - Bruxelles, Beaux Arts (1447-48):
  Red porphyry: octagonal floor tiles.
  Green porphyry: octagonal floor tiles together with other white and coloured marbles.
- Fra Carnevale, Alcova di Federico da Montefeltro, 1459/60 - Urbino, Gall. Nazionale:
  Red porphyry: pilasters on the walls.
  Green porphyry: panels on the base.

- Fra Carnevale, Birth of Virgin, 1467 - New York, Metropolitan (35.121):
  Red porphyry: spandrels in the arches of the building in the background.
  Green porphyry: spandrels in the arches of the building in the background.
- Castagno A., L'Ultima cena, about 1447 - Firenze, Sant'Apollonia:
  Red porphyry: square panel on the rear wall.
  Green porphyry: square panel on the rear wall together with other coloured marbles.
- Caylina il Vecchio P., Madonna in trono col Bambino, 1458 - Torino, Gall. Sabauda (34):
  Green porphyry: small square slabs on the throne of Virgin.
- Christus P., Annunciation, 1452 - Brugge, Groeninge (0019.I):
  Red porphyry: octagonal and pentagonal floor tiles.
  Green porphyry: octagonal and pentagonal floor tiles.
- Christus P., Portrai of Young Man, 1450/60 - London , Nat. Gallery (2593):
  Red porphyry: small slabs decorating the door of the left.
  Green porphyry: small slabs decorating the door of the left.
- Cossa Francesco, San Giovanni Battista / San Pietro, 1472/73 - Milano, Brera (449/449bis):
  Green porphyry: frieze of the entablature of the construction behind the Saint.
- Crivelli C., Polittico, 1473 - Ascoli, Duomo, chapel of Crocefisso:
  Green porphyry: panel on the back of the throne of the Virgin.
- David G., The Virgin and child with Saints, about 1460 - London, Nat. Gallery (774):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with other coloured marbles.
- Eyck Jan (workshop), Fonte della Grazia, 1455/59 - Madrid, Prado (1511):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with white marble.
- Foppa V., Tre crocifissi, 1450 - Bergamo, Acc. Carrara (796):
  Green porphyry: two panels in the base of the arch around the crosses.
- Isenmann G., Retable de Saint Martin (Flagellation of Christ), 1465 - Colmar, Unterlinden (88 RP 303):
  Red porphyry: one shaft.
  Green porphyry: one shaft.
- Leonardo Da Vinci, wreath of Laurel, Palm and Juniper with a scroll (rear of Ginevra de' Benci portrait), 1474/1478 - Washington, National Gallery of Art (Mellon 1967.6.1.b):
  Red porphyry: ground.
- Liberatore N. called L'Alunno, Polittico di Cagli, 1461 - Milano, Brera (152 etc):
  Red porphyry: squared floor tiles above the throne of the Virgin.
  Green porphyry: squared floor tiles above the throne of the Virgin.
- Mantegna A., San Sebastiano, 1459 - Wien, Kunsthistorisches (inv. 301):
  Green porphyry: square floor tiles together with white and black tiles.
- Mantegna A. (scholar), San Bernardino, 1469 - Milano, Brera (inv.163):
  Red porphyry: disc on chancel screen behind the figure of the Saint.
- Martini F. di Giorgio, Annunciazione, 1470 - Siena, Pinacoteca (437):
  Red porphyry: round floor tiles.
  Green porphyry: squared floor tiles in a frame of white marble.
- Piero della Francesca, Polittico di Sant'Antonio, 1459 - Perugia, Gall. Nazionale (69):
  Red porphyry: slab in front of the throne of the Virgin.
- Piero della Francesca, La Madonna col figlio, angeli e Santi, 1472/74 - Milano, Brera (510):
  Red porphyry: rectangular panels on the architecture behind the figures.
  Green porphyry: rectangular panels on the architecture behind the figures together with other coloured marbles.

- Pollaiolo P., Speranza, 1470 - Firenze, Uffizi (1890 - 495):
  Red porphyry: panels on the base.
- Pollaiolo P. and A., S.Vincenzo, S.Giacomo and S.Eustachio, 1466/67 - Firenze, Uffizi (1617):
  Red porphyry: disc in the floor.
  Green porphyry: disc in the floor together with Occhio di Pavone.
- Rimini Giovan Francesco, Trittico, 1464-70 - Perugia, Gall. Nazionale (73):
  Red porphyry: square panels on the base of the white throne of the Virgin.
  Green porphyry: square panels on the throne of the Virgin.
- Čulinovič G. called Schiavone, Madonna col Bambino, about 1456 - Torino, Gall. Sabauda (192):
  Red porphyry: a quarter of a disc on the arch over the Virgin.
  Green porphyry: a quarter of a disc on the arch over the Virgin.
- Netherlandish Master (Hugo van der Goes ?), Virgin and child with Saints, 1472 - New York, Metropolitan (L.1999.45):
  Red porphyry: floor tiles.
- San Severino Master - S. Severino in trono e Santi, 1472 - Napoli, Capodimonte:
  Red porphyry: square floor tiles; square panels on the throne of the Saint.
  Green porphyry: square floor tiles.
- Spanish Master (Rois de Corella?), S. Ferdinando, about 1450 - Napoli, Capodimonte:
  Red porphyry: square tiles on the floor.
  Green porphyry: square tiles on the floor together with white marble.
- Stratonikea Master, Annunciazione, 1470/90 - Firenze, S.Giovanni dei Cavalieri, right nave:
  Red porphyry: panel below the window.
  Green porphyry: panel below the window.

Fourth quarter of 15th century

- d’Alba Macrino, Madonna col Bambino in Gloria, 1498 - Torino, Gall. Sabauda (246):
  Red porphyry: rectangular floor tiles.
  Green porphyry: square floor tiles together with white marble.
- Botticelli S., Annunciazione (fresco), 1481 - Firenze, Uffizi (Depositi 201):
  Red porphyry: disc-shaped floor tiles.
- Botticelli S., Madonna con bambino, Santi e Angeli, 1487/88 - Firenze, Uffizi (1890 - 8361/8300-8393):
  Red porphyry: polygonal floor tiles.
  Green porphyry: polygonal floor tiles.
- Bouts A., Jésus chez Simon le pharisien, about 1490 - Bruxelles, Beaux Arts (2580):
  Red porphyry: square tile of the floor together with white and blue tiles.
- Braccesco C., Annonciation et Saints, 1490/1500 - Paris, Louvre (1410):
  Red porphyry: square floor tiles.
  Green porphyry: square floor tiles together with white marble.
- Butinone B., Circoncisione di Gesù Cristo, 1475 - Bergamo, Acc. Carrara (Carrara 1796):
  Green porphyry: panels in the lower parts of the aediculae.
- Caporali B. (probably), The Virgin and Child and Saints, 1475-80, London, Nat. Gallery (1103.1):
  Red porphyry: frieze of the throne of the Virgin.
- Crivelli C., Trittico di San Domenico, 1482/83 - Milano, Brera (155-350-351):
  Red porphyry: frieze on the base covered with skulls, fruits and vegetables.
- Crivelli C., Incoronazione della Vergine Milano, 1493 - Brera (737,738):
  Red porphyry: panel below the throne of the Virgin and Jesus.

- Di Giovanni M., Strage degli innocenti, 1481/88 - Napoli, Capodimonte (Q38):
    Red porphyry: square floor tiles.
    Green porphyry: square floor tiles.
- Landi Neroccio, San Benedetto in preghiera, 1480 - Firenze, Uffizi (1890 #1602):
    Red porphyry: round floor tiles, shafts of the hexagonal aedicule.
    Green porphyry: round floor tiles.
- Foppa V., Pala della Rovere, 1490 - Savona, Santa Maria di Castello:
    Green porphyry: rhomboid floor tiles.
- Montagna B., Madonna col Bambino in trono e Santi, 1483 - Bergamo, Acc. Carrara (Lochis 1886):
    Red porphyry: discs on the base-board of the throne of the Virgin.
- Montagna B., Madonna con Bambino in trono e Santi, about 1488 - Milano, Brera (165):
    Red porphyry: triangular elements above the arches.
    Green porphyry: triangular floor tiles, triangular elements above the arches.
- Palmezzano M., Madonna col figlio, 1493 - Milano, Brera (471):
    Red porphyry: triangular tiles together with green porphyry and other marbles.
- Spanzotti G. M., Madonna in trono col Bambino, 1480/85 - Torino, Gall. Sabauda (225):
    Green porphyry: slabs on the base-board of the white throne of the Virgin.
- Di Zanobi D., Madonna del Soccorso, about 1485 - Firenze, S. Spirito, Velluti chapel:
    Red porphyry: panels within a cornice of white marble.
- Pala Muratori Master, Madonna in trono e Santi, 1476 - Bologna, Pinacoteca (784):
    Red porphyry: panels on the pillars of the throne of the Virgin.
    Green porphyry: panels on the pillars of the throne.

16th century

- Bellini Gentile and Giovanni, Predica di San Marco, 1504/07 - Milano, Brera:
    Red porphyry: square on a cubic element; small geometric tiles of a staircase.
    Green porphyry: disc on a cubic element; small geometric slabs of a staircase.
- Bianchi Ferrari F. and Scacceri G. A., Annunciazione, early 16th c. - Modena, Gall. Estense (476):
    Red porphyry: panels on the walls.
    Green porphyry: panels on the walls.
- Botticelli S., Story of Lucretia, 1500/1501 - Boston, Stewart Gardner Museum:
    Red porphyry: central coloumn.
    Green porphyry: veneer of the column base.
- Botticelli S., Storia di Virginia romana, 1500/10 - Bergamo, Acc. Carrara (Morelli 1891):
    Green porphyry: veneer of the wall with two doors.
- Brea L., Retable de St Nicholas, 1500 - Monaco, Cathédrale:
    Red porphyry: square floor tiles.
    Green porphyry: square floor tiles together with white marble.
- Campaña P., The Conversion of Mary Magdalene, 1562, London, Nat. Gallery (1241):
    Green porphyry: disc in the floor.
- Carpaccio V., Disputa di Santo Stefano, 1514 - Milano, Brera (170):
    Red porphyry: disc of a frieze on the front of a building in the background.
    Green porphyry: rectangular panels around the disc of Red porphyry.
- Ferrari G., S. Giovanni Battista, 1519/20 - Torino, Gall. Sabauda (566):
    Red porphyry: square floor tiles.
    Green porphyry: square floor tiles together with white rectangles.
- Foppa V., Polittico delle Grazie, 1500/1510 - Milano, Brera (307):
    Green porphyry: square tiles on the floor together with white marble.

- Giovenone G., Madonna in trono col Bambino, 1514 - Torino, Gall. Sabauda (231):
  Red porphyry: triangles in the floor.
  Green porphyry: triangles in the floor together with white marbles.
- Gossaert J, The Adoration of the Kings, 1510-15 - London, Nat. Gallery (2790):
  Green porphyry: square tiles with a specific layout and with tiles of various colours.
- Holbein H. the Younger, The Ambassadors, 1533, London, Nat. Gallery (1314):
  Red porphyry: geometric floor tiles.
  Green porphyry: geometric floor tiles together with white marble.
- Marziale M., The Circumcision, 1500 - London, Nat. Gallery (803):
  Green porphyry: friezes of the entablature of the chapel.
- Ventura Almerico (workshop), Annunciazione, 1522 - Roma, Vaticani (40272.0.0):
  Red porphyry: square floor tiles.
  Green porphyry: round floor tiles in an orthogonal frame of white marble.
- Verona Michele da, Crocefissione, 1501 - Milano, Brera (160 - 1138):
  Green porphyry: discs on the pillars on the sides of the figures.
- Legend of St Lucy Master, Retable de St Nicholas, 1505 - Brugge, Groeninge (0676.I):
  Red porphyry: two shafts supporting the vault above the Saint.

Note: one of the last paintings reproducing coloured marbles is P. Batoni's "Madonna col Bambino e Santi", made in 1740 (Milano, Pinacoteca di Brera, cat. 564): discs of red porphyry in the floor together with square tiles of Verde antico.

Fresco - Imitation of a Marble Cladding or Veneer

14th century

- Giotto, Decorative dividing panels between the separate story panels, 1304/06 - Padova, Scrovegni chapel:
  Red porphyry: rectangular cornices.
  Green porphyry: rectangular cornices.
- Martini S., S. Maria Maddalena e S. Caterina on the intrados of the arch, 1320/30 - Assisi, lower church of S. Francesco, S. Martino chapel:
  Red porphyry: hexagonal tiles on the spandrels of the arches painted above the Saints.
  Green porphyry: hexagonal tiles on the spandrels and triangles of white marble.

15th century

- Baldovinetti A., Edicola Rucellai inner walls, 1467 - Firenze, S. Pancrazio:
  Red porphyry: rectangular panels and discs.
  Green porphyry: rectangular panels and discs.

16th century

- Luini B., Church walls, 1522/24 - Milano, S. Maurizio:
  Red porphyry: discs on the base near the high altar.
  Green porphyry: tabernacle on the right side of the high altar.
- Pinturicchio, Annunciazione, 1501 - Spello, Santa Maria Maggiore, Baglioni chapel:
  Red porphyry: square slabs on the intrados; triangular slab in the floor.
  Green porphyry: triangular slabs on the intrados; triangular slab of the floor together with white stone slabs. In this fresco the porphyries pertain to the painted scene.

Finally, reproductions of the porphyries are reported in the window glass of the Duomo of Milan (last quarter of 15th century) and on the illuminations of manuscripts (Bandera 2014).

Quotations in old authors

The reproduction of coloured marbles and, in particular, the reproduction of porphyries, seems to be neglected by old authors writing about paintings and pigments.

Authors of the Italian Renaissance and later totally ignored the theme, from either technical or symbolic points of view: Cennini (Cennini 1958) in the early 15th century, Alberti (Alberti 1950) in the mid 15th century, Leonardo (Da Vinci 1859) in the mid 16th century, Borghini (Borghini 1584) and Lomazzo (Lomazzo 1584) in the late 16th century.

Giorgio Vasari (Vasari 1568) mentioned the painting of coloured marbles only for the decoration of building fronts: "(…) Artists have been accustomed to decorate (…) the façades of palaces and houses giving these a semblance other than reality and making them appear to be built of marble or stone (…) or indeed they may imitate particular kinds of marble, porphyry, green stone, red and grey granite or bronze and other stones, according to their taste, arranging them in many divisions; and this style is much in use now-a-days for the front of houses and palaces in Rome and throughout Italy." (Maclehose 1907, Introduction chapter 25).

On the side of poetry and other literary texts, the description of coloured marbles was very scarce and the coupling of red and green porphyry was not mentioned. Dante's Divina Commedia (first decades of the 14th century), reports only once the red porphyry, describing three steps (white marble, dark stone, red porphyry) approaching the gate of Purgatory: "The third [step], resting above more massively, / appeared to me to be of porphyry, / as flaming red as blood that spurts from veins" (Dante 1867). A few other Authors of the 14th century (Niccolò da Correggio, Sacchetti, Uberti) and some of the 15th - 16th centuries (Aretino, Ariosto, Bandello, Bembo, Franco V., Piccolomini) wrote about the porphyries both for their colour or hardness and their use in buildings. Boccaccio, in the mid 14th century, reported the porphyry shafts near the main portal of the S. Giovanni Baptistry in Florence Boccaccio 1950). Later on, Vasari reported the obstacles to making the surface of porphyry smooth and shiny (Vasari 1568, Introduction, chap. 1). F. Colonna, in the late 15th century, seems to be the sole "connoisseur" of porphyries and coloured marbles. His poem on "The strife of love in a dream" (Colonna 1998) reported plenty of coloured marbles employed in a fabolous scenario of palaces, temples, baths, towers, arches, obelisks, triumphal wagons etc. In particular were reported the following: "rubente porphyro" (red porphyry) or "terso porphyrite" (bright red porphyry) and "petra lacedaemonia verdeggiante" (green stone of Lacedaemonia) or "petra durissima laconica" (very hard stone of Lakonia). The porphyries are often complementary in the decoration of these breathtaking buildings.

Conclusion

The imitation of coloured marbles by the painters is enhanced together with the option to represent the red and green porphyries set together. From the list reported above, the presence of porphyries in painted scenes is mainly reserved to the floor: polygonal tiles made of two porphyries are always trodden by the figures. Another use concerns the throne of the Virgin Mary: the porphyries are present as coloured decoration on a white (white marble) throne. Besides the porphyries are also present as shafts linked to the throne or to the architecture in the background. Finally, they were painted on the rear of portraits, both for religious or secular purposes, as the ground of coats of arms or as a ground of botanical trophies.

To understand the iconographic maeaning of the porphyries in painting, a different awareness than the petrography is needed. In general terms, it is possible to consider, in the Middle Ages, the constant coupling of red and green porphyries as related both to the religious and the imperial figures (birth and burial). Examples are the geometric patterns of byzantine decorations (Justinian's Hagia Sophia, İstanbul); the decorations of "ambones" and "cathedrae" (San Lorenzo extramuros Basilica, Rome; Palatine chapel, Palermo); Cosmati work, both inlays of tombs (pope Adriano V, St. Francesco church, Viterbo) or tiles for floor spread in the churches of central and southern Italy (i.e. Santa Maria Aracoeli, Rome; Cathedral, Anagni; Duomo, Salerno) or abroad (i.e. Westminster Abbey, London). During the Renaissance, on the contrary, the nobility and prestige of the porphyries were linked to a fascination with Antiquity: the painted reproductions had reference to the evocation of the ancient world and the painters, probably, acquired a source of inspiration in the decorative patterns of the local contemporary architecture, as in Venice (i.e. façades of Ca' Dario, Scuole of San Rocco and of San Marco, Santa Maria dei Miracoli etc.) or in Florence (i.e. Cappella dei Magi at palazzo Medici-Riccardi, S. Miniato chapel of cardinal of Portugal) or in Rome (i.e. floor of Sistine chapel, floor of Raphael's rooms in Vatican etc.).

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CELADONITE FROM SMYRNA (İZMİR-TÜRKİYE): DID VITRUVIUS GET RIGHT?

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Abstract

Green earth pigments were widely used in the ancient Mediterranean area during the Roman period. Two green pigments were mentioned by Roman authors: the *creta viridis* and *appianum*. The former was cited by Vitruvius who indicated that it was coming from Smyrna (current Izmir) and it has been speculated that it could correspond to the green earth of Cyprus, with Smyrna only being the transfer port; the other pigment was cited by Pliny and thought to originate in Monte Baldo in Northern Italy. However, neither author mentions the important green earth deposit in Cyprus. As celadonite has been widely detected in wall paintings from all over the empire, most analysts attributed it to Cyprus deposit. In this paper, the geological and historical occurrence of celadonite green earth in Izmir (Smyrna) area is being investigated. Celadonite bearing green colored volcanic blocks and columns have been found in some historical building in Izmir. The material would have most probably quarried from a location 1.5 km south of Smyrna Agora. The green powder that appeared during stone processing may have been used as a green pigment. However, the green pigment is yet to be investigated in excavation studies of Roman wall painting from the area of Smyrna. It is presented here the existence of celadonite formation in Smyrna by petrographic, XRD, SEM studies of green volcanic rock and compared with celadonite materials from Cyprus and Monte Baldo. The data confirm the occurrence of celadonite in the area and that it has close similarity with Cyprian celadonite.

Keywords: Green pigments, volcanic rocks, Cyprus, Smyrna Agora, *creta viridis.*

Introduction

Green pigments detected in Roman wall paintings are green earths or copper-based. Although green copper-based pigments like verdigris and malachite are sometimes detected (Singer *et al.* 1954; Augusti 1967; Delamare *et al*. 1990; Bearat 1997a, b; Eastaugh *et al*. 2004), green earth: celadonite, glauconite and chlorite remains the basic pigments and still being used (Grissom, 1986; Bearat 1997a; Bearat 1997b; Grygar *et al*. 2003; Hradil *et al*. 2003). The latter were mentioned by Vitruvius and Pliny the Elder under the names of *creta viridis* and *appianium*.

There have been many important studies on the use of green pigments in Rome, Pompeii and other Roman sites across the empire (Varone, Bearat 1997; Mazzocchin *et al*. 2003; Aliatis *et al*. 2009; Duran *et al*. 2011; Piovesan *et al*. 2011). It is, in most cases, celadonite (Nöll *et al.* 1972; Kriens, Wessicken 1981; Delamare 1987; Delamare *et al*. 1990; Bearat 1997b), glauconite (Giovanoli 1969; Delamare 1987; Jaro 1987; Delamare *et al*. 1990; Klemenz 1990; Bearat 1997b), or chlorite (Bearat 1997b). Mixtures of these minerals have been detected in many cases: celadonite and glauconite (Delamare *et al*. 1990; Bearat 1997b), mixture of celadonite and chlorite, which can be natural (Delamare 1990) or artificial (Bearat 1997b). The attribution of a pigment like celadonite to one or the other of the deposits likely to have been exploited by the Romans has been proposed by some authors (Delamare *et al*. 1990; Bearat 1996; Bearat 1997a, b). It is obvious that the determination of the origin of a pigment is indeed only an advanced phase of the characterization of this pigment. This question of provenance of the celadonite is dealt with by Bearat, Pradell (1997) and dealt with in more depth by Bearat (1996). Two varieties of celadonite are also presented. The first, more common, is bluish green, tender and very fine floury appearance. It is associated with a zeolite, clinoptilolite and resembles the celadonite of Cyprus. The second, less common, is a dark yellowish green and a grainy appearance. It is almost pure and rather resembles that of Monte Baldo. It has been found only in western Swiss sites (Avenches, Bösingen and especially in Vallon where it seems to be the only green pigment used). Previously, in Switzerland, celadonite was detected in *Vindonissa* (Aargau) by Kriens and Wessicken (1981) and in Geneva, Sait-Antoine, by Rinuy (Ramjoue *et al.* 1995). The combination of different analytical techniques allowed distinction between the celadonite deposits of Monte Baldo and those of Cyprus as well as to attach certain pigments to one or the other of these deposits. The dominant green pigment in Switzerland is celadonite rather like that of Cyprus. Celadonite attributable to Monte Baldo has been observed at three sites in western Switzerland.

Smyrna's confusion

Smyrna is being confused with Cyprus with respect to Roman Green earth. The source of confusion is bifacetted. On one hand, the Western Anatolian region surrounding Smyrna (currently Izmir) has not been known as a source of green earth (celadonite) that could supply substantial amount of the pigment to a global market. On the other, massive celadonite occurence in the Troodos Massif, Cyprus has a long exploitation history and it is less likely that it went unseen by the Romans. However, had it been known and largely exploited by the Romans, why would Vitruvius cite Smyrna instead? A few decades later, Pliny has not mentioned Cyprus as a source of green earth (*creta veridis*), but cited a new source for it under the appelation of Appianum (Pliny, NH, XXXV, 29). The latter was interpreted as a pigment coming from Valley *Appiana* near Verona in Northern Italy that has been interpreted as the well-known terra verde de Verona or Monte Baldo green earth. Meanwile, Pliny was well aware of the "Cyprian verdigris" another green pigment (Pliny, NH, XXXIV, 26) as well as Cyprian bronze used as a starting material for its manufacture. One can argue that the Cyprian celadonite deposit had not been discovered yet by the Romans in Vitruvius' an Pliny's lifetimes. However, recent research provides evidence for its use (at the least) on the Island of Cyprus (Radpour *et al.* 2019). Another puzzle coming from Cyprus is the fact that celadonite continued to be used for painting on the island from the Helenistic through the Roman period (Radpour *et al.* 2019).

The rock units where these three localities Monte Baldo, Cyprus and Smyrna, which are specified as celadonite sources, are volcanic. There are differences when looking at the ages of these volcanics. Odin *et al.* (1988) states that the celadonite is in Eocene (56-33.9 Ma) volcanics on Monte Baldo region. According to Gallahan *et al.* (1994) celadonites from the Troodos ophiolite is $\geq$ 40 m.y. for the duration of low-temperature hydrothermal alteration within this ancient oceanic crust is proposed. The age of the Troodos igneous rocks is around 91-92 Ma. Seghedi *et al.* (2015) reveals the age of Smyrna (Yamanlar) volcanics as between ~17.48-14.94 Ma. Only the age of Cyprus celadonite is known. No data are available on the ages of other celadonites. The celadonite formation ages must be the same age as the volcanics in which it is found or younger.

In the lack of geological and archaeological evidence on the occurrence of celadonite in Smyrna's area led some authors (Delamare *et al.* 1990) to exclude the occurrence of celadonite in the area and suggested Smyrna as a transition port for the green earth coming from Cyprus. Therefore, the detection of this mineral as a pigment in ancient painting in western Anatolia and/or its geological occurrence in the surrounding area would help settle this case. In this paper is presented such geological evidence on its natural occurrence in Smyrna's area as well as on it use in form of building stones.

The green volcanic quarry of Smyrna and ıt's uses

The most common types of rocks used in the construction of these historical buildings are the pink and grey andesitic rocks. These were the most commonly produced rocks in the region from the Miocene volcanic activity. Unlike the other parts of Izmir (Smyrna), in one of the districts of Izmir province, locally known as Buca, the majority of the historical constructions were completed using the rare green, attractive colored and massive appearance andesites.

The quarry of green volcanic rock deposit is situated 1.5 km south of Smyrna Agora near Buca (Fig. 1). The quarries are located in an area covered with houses and it is not possible to see the trace of ancient period.

Figure 1: View by Google Earth showing the locations of of green rock quarry and Smyrna Agora.

The quarries had been in use from the Roman Period (Agora Basilica basement walls) (Fig. 2) to the 1970s, (blocks in use in Levantine, Greek houses and in modern buildings) (Fig. 3). The green volcanic rock probably used only locally. Green earth formations are also seen on the volcanic blocks used in Agora (Fig. 4). This formation turned into dust during the processing of the stones and has reached to puddles by rain in the quarry. The green dust could be reached to the stream called as Green Stream (Meles stream), and deposited in suitable environments.

Figure 2: Green stones used in the arch structures and in the wall blocks in the Smyrna Basilica basement, pen size is 16.5 cm (Photo: B. Yolaçan).

Figure 3: Green rock used in the historical buildings in Alsancak-İzmir (Photo: M Çolak).

Geological setting

The green altered volcanic belong to the Yamanlar volcanics of the Early to Middle Miocene age; composed of several lavas, pyroclastic rocks, dykes and domes of dacitic, andesitic, rhyolitic and basaltic compositions (Fig. 5). Yamanlar volcanic are wide spread in the studied area and covered the Neogene aged sedimentary rocks (gravel stone, marl and limestone) as concordantly. The NE-SW- trending faults, which are Seferihisar, and Orhanlı Fault Zone are operative in these regions (Uzel *et al.* 2012). Orhanlı Fault Zone could be effective in the formation of green colored volcanic rocks indicated as celadonite zone (Fig. 5). Plio-Pleistocene and Holocene occurrences cover these units as unconformable.

Figure 4: Green earth formation in the volcanic block in Smyrna Agora (Photo: M. Çolak).

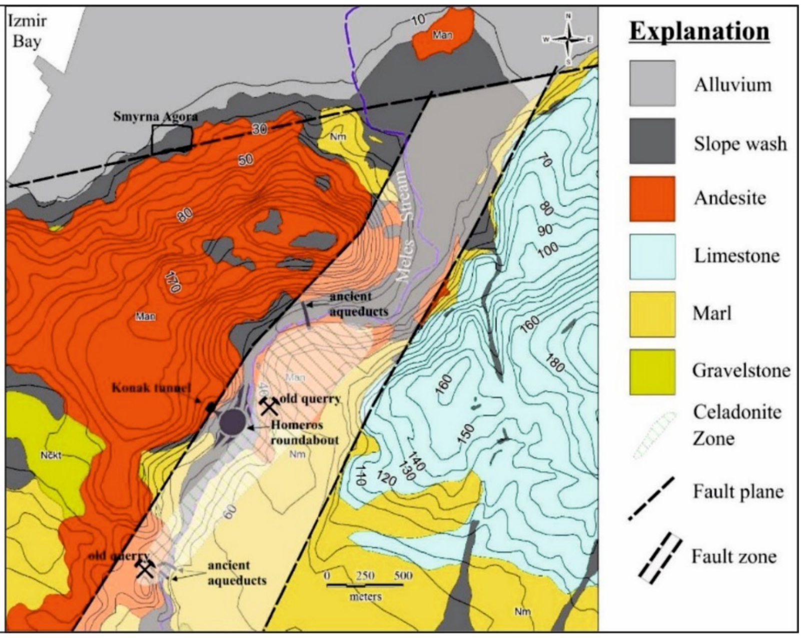

Figure 5: Geology map of studied area (Map: modified after Kıncal, 2004).

Scientific characterization: results and discussion

The green colored volcanic rocks were studied petrographically in thin sections under a polarizing microscope, and whole rock and clay fraction mineralogy were analyzed by X-Ray diffraction (CuKα at 40kV, 20mA). The microscopic study of the green coloured hypocrystalline textured rock contain euhedral plagioclase, biotite, pyroxene, amphibole minerals and glassy matrix (Fig. 6a). In thin section studies which were made in green andesites, secondary alteration minerals which greenish clay type cryptocrystalline were detected predominantly in amphibole group minerals and glassy matrix texture with the effect of hydrothermal alteration, offering dark green, bluish green, brownish green and pinkish green pleochroism. These minerals most likely present differences in composition. In many examples, green secondary minerals alternate the matrix texture in places (Fig. 6a). Pyroxene and amphibole minerals decomposed, turning into the green pleochroism minerals, and often it is seen that green colored formation has been filtrated into surrounding groundmass (Fig. 6b). This green formation is sometimes settled in mineral cracks, and covered the other minerals and makes it appear as green (Fig. 6b). New green mineral formation in the cavities infiltrates through cracks in the main mass and sometimes overlays transparent minerals such as quartz. (Fig. 6 c and d). This green mineral has been identified as chlorite due to green pleochroism by previous studies. Among the altered andesite samples, secondary mineral formations of fibrous zeolite type mostly located in the cavities, were identified (Fig. 6e).

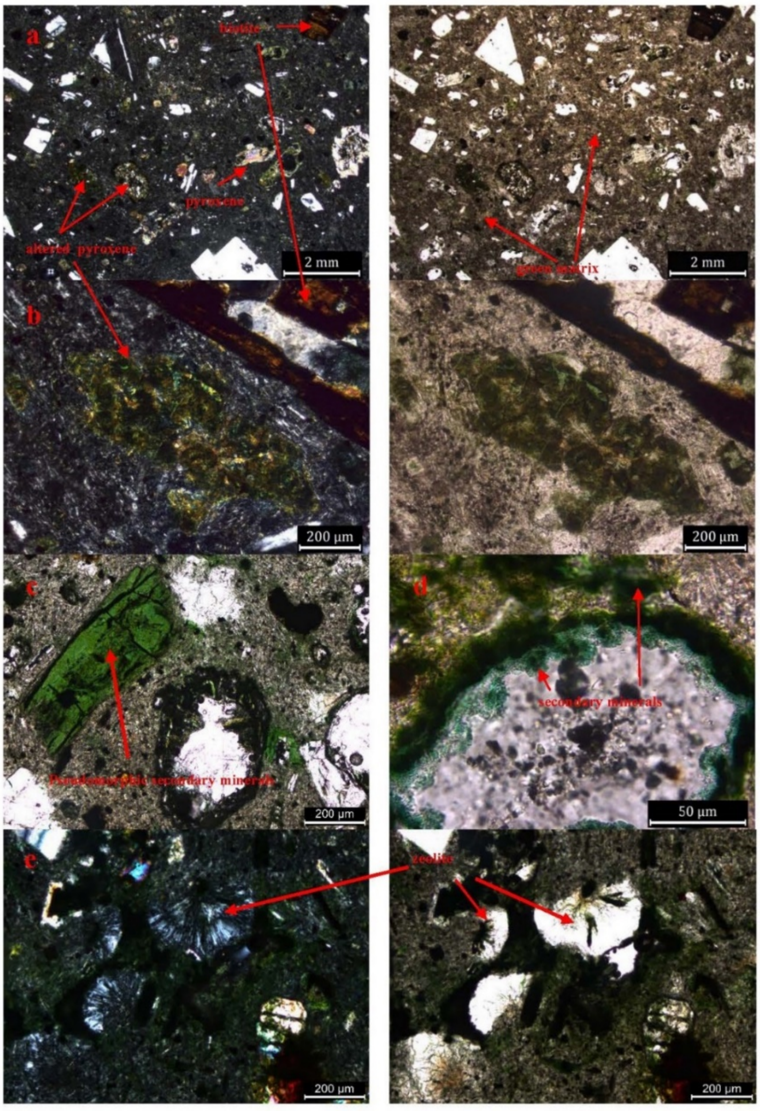

Figure 6: **a**. Microscopic view of green colored volcanic rocks (left side: cross-polarized light, right side: plane-polarized light); **b**. (left side: cross-polarized light, right side: plane-polarized light) **c**. and **d**. secondary minerals altered pyroxene/amphibole and its altered products and filtration (plane-polarized light); **c**. new mineral formation in cavities and green mineral intrusion to the groundmass, sometimes cover also transparent minerals (plane-polarized light); **e**. fibrous zeolite mineral formations in the altered green andesite (left side: cross-polarized light, right side: plane-polarized light).

X-Ray diffraction studies of total rock mineralogy of green volcanic rock shows mica, K-feldspar, quartz, cristobalite, plagioclase and pyroxene (Fig .7). The mineral defined as chlorite in the polarizing microscope studies could not be identified in the XRD studies. Therefore, clay fraction separation studies were done. Clay fraction (<2 micron) studies of green mineral show that there is no chlorite mineral in (Fig. 7- normal, glycolated and fired patterns). Illite and smectite were observed in clay fraction of the green mineral. Illite is the dominant clay mineral. The probability of illite being celadonite, which is a type of illite rich in Fe, is quite high. In order to reach this conclusion, EDS chemical analysis should be performed in SEM (Scanning Electron Microscope) on illite samples.

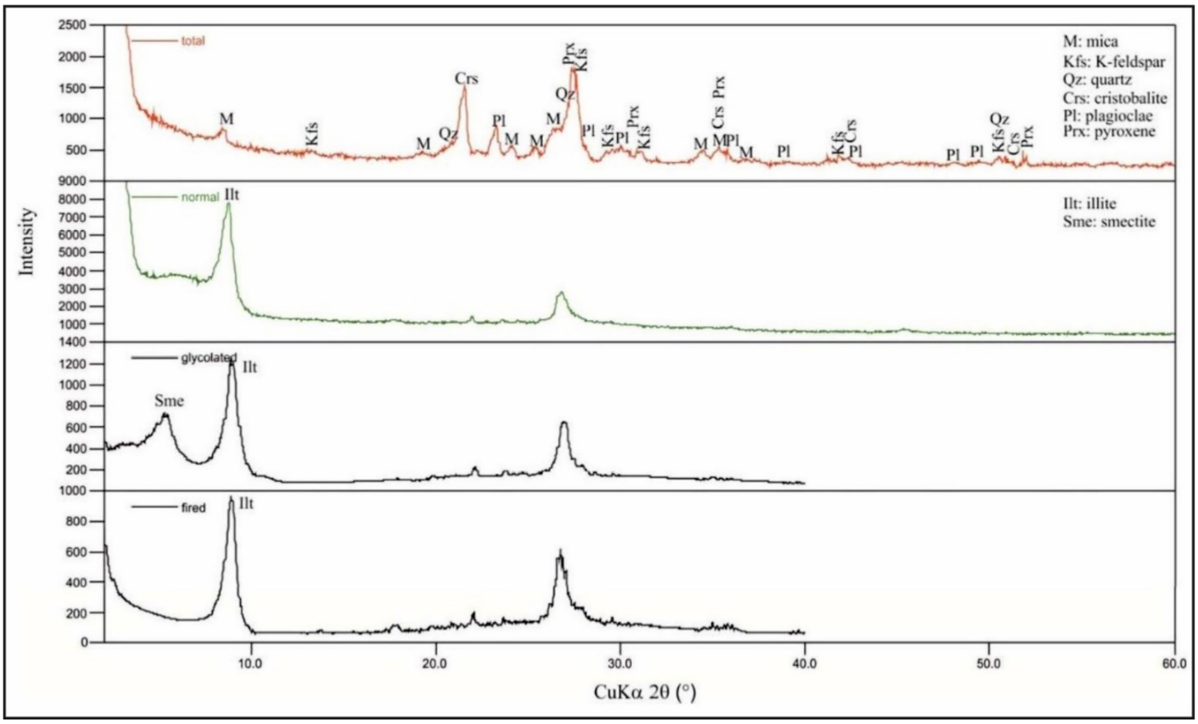

Figure 7: Total rock and clay fraction (below 2 micron) studies of green andesite.

The SEM image shows the green mineral to be fine-grained and cover the other minerals. It is accompanied by cristobalite (Fig. 8a-b). EDS studies show that green minerals are rich in iron. Illite is mostly iron-rich illite type mica. According to the EDS values, this formation could be celadonite. Secondary minerals consist of celadonite-type clay minerals with predominantly variable chemical compositions. Although the general chemical compositions of celadonites are: $K(Mg,Fe)(Fe,Al)[Si_4O_{10}](OH)$, aluminousceladonite: $KAl(Mg,Fe)Si_4O_{10}(OH)_2$, ferroaluminousceladonite: $K_2Fe_2Al_2Si_8O_{20}(OH)_4$ and ferrousceladonite: $K_2FeFeSi_8O_{20}(OH)_4$ type minerals were also analyzed. While celadonitic clays mostly develop through decomposition of amphiboles, celadonitizations have been detected in matrix and pyroxenes. Due to several alteration in green andesite, all primary minerals, except apatite and ilmenite, are disintegrated and replaced by secondary minerals (Fig. 8c). In pink colored andesites, clinoptilolite $(Ca,Na,K)_23Al_3(Al,Si)_2Si_{13}O_{36}.12(H_2O)$ type zeolite minerals predominate (Fig. 8f) and these minerals are accompanied by radial chalcedony and nodular opal formations.

Green colored volcanic sample (round) chemical analysis results were compared with pink (triangle) and green-pink mixed (plus) volcanics. TAS diagram of Le Maitre (2002) is used in Fig. 9. In this diagram, it is observed that the samples fall between basaltic andesite, andesite and dacite and their trachytic equivalents. Due to the increase of K_2O due to celadonite, the samples shift to the area of trachy-andesite. As mentioned in mineralogy-petrography section, green volcanics have undergone low alteration in the form of celadonitisation. With celadonitisation and cristobalite formations are also observed in the sample cavities (Yavuz *et al*. 2017). Accordingly, in the green volcanic samples, especially when the SiO_2 values are assumed lower, the rocks should be located in the andesite area.

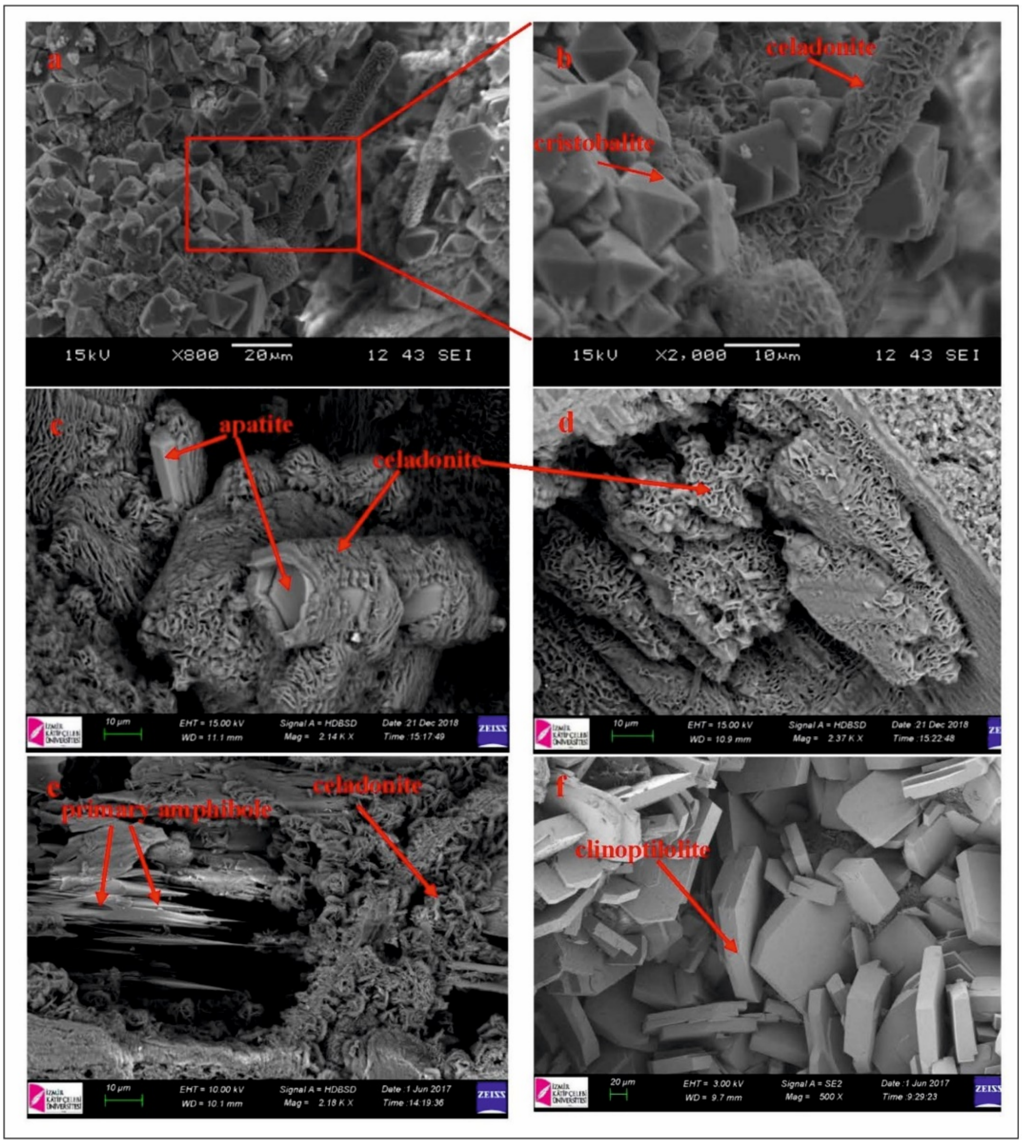

Figure 8: SEM images of **a**., **b**. celadonite $K(Mg,Fe)(Fe,Al)[Si_4O_{10}](OH)$ covered prismatic mineral and cristobalite formed at the same time with celadonite; **c**. apatite $Ca_5(PO_4)_3(OH)$ mineral covered by celadonite. Alterations and rounding caused by alteration are observed in apatite crystal corners; **d**. celadonite in cavities covered the other minerals; **e**. celadonite formed by replacing an euhedral primary amphibole mineral with the effect of hydrothermal alteration of green andesite; **f**. clinoptilolite $(Ca,Na,K)_23Al_3(Al,Si)_2Si_{13}O_{36}.12(H_2O)$ formed due to hydrothermal alteration in pink andesite.

The triangular correlation diagram shows that it is possible to clearly differentiate three sources of celadonite and to establish two distinct reference groups, that of Cyprus and that of Monte Baldo (Fig. 10). Smyrna celadonites below 2 micron is plotted in Cyprus celadonite area. Total rock analysis of green andesite differs from the reference samples and Smyrna celadonite below 2 micron.

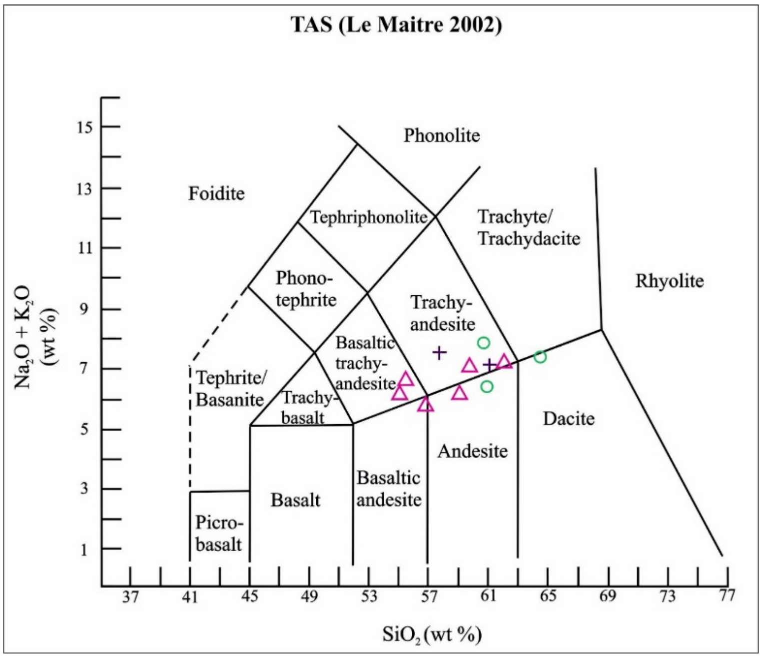

Figure 9: Le Maitre (2002) total alkali silica (TAS) diagram, (Red triangle: pink colored volcanics, plus sign: green-pink mixed volcanics, green circles: green volcanics).

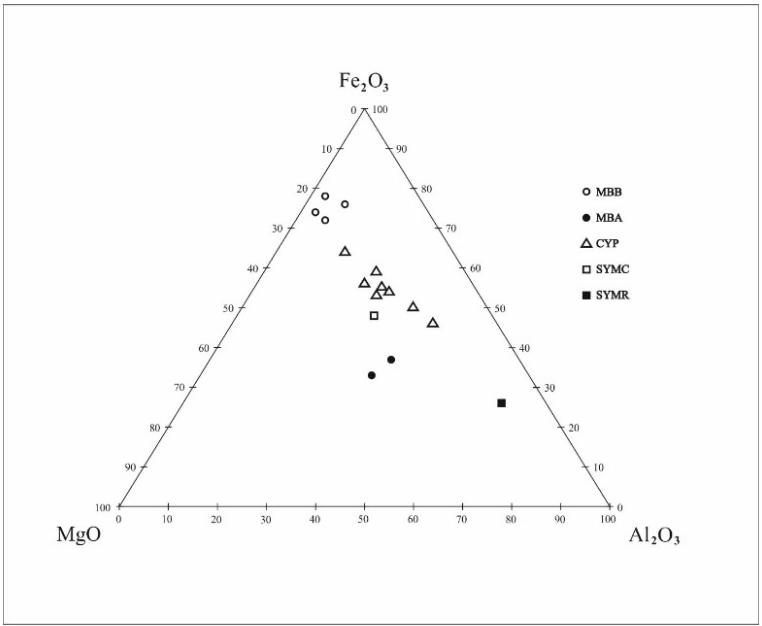

Figure 10: Fe_2O_3-MgO-Al_2O_3 correlation diagram from analyzes of reference celadonite samples (Bearat, 1996) with Smyrna celadonite. (SYMR: Smyrna green andesite total rock, SYMC: Smyrna celadonite-< 2 micron, MBA: celadonite from Monte Baldo A, MBB: celadonite from Monte Baldo B, CYP: celadonite from Cyprus).

Conclusion

In this study, as Vitrivius wrote, the occurrence of celadonite in Smyrna-İzmir region has been examined. As other researchers have claimed, celadonite may have come from Cyprus to Smyrna for commercial purposes, and transported to Rome from Smyrna. Although many Roman deposits have been reported, it is also puzzling that such an important deposit in

Cyprus has not been mentioned by Vitruvius and Pliny the Elder. The fact that the green andesite blocks used in the construction of the Smyrna Agora came from the quarries close to here and show that there was stone processing here. The powder that appears during this stone processing is colored green and creates green mud in the puddles, indicating that this powder could have been used as green earth pigment. However, mineralogical and chemical analysis results show that this celadonite samples are similar ones from Cyprus. If K/Ar age analysis can be made on the green pigment obtained from the Pompeii excavation, it will show where the celadonite came from in Pompeii.

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ASPECTS OF GILDING IN ROMAN MARBLE SARCOPHAGI

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Abstract

This work aims to improve our knowledge of polychrome Roman sarcophagi by offering the first observations about the gilding techniques detected and the characterization of a purplish substance often co-present with gold. Those new elements came to light by combining archaeological-historical research with the results of scientific analyses, and the evidence obtained from direct visual observation of sarcophagi preserved in the collections of the Vatican Museums, the National Roman Museum, and the Capitoline Museums. Among the eighty sarcophagi with colour examined in the Catalogue, only twelve (or perhaps fifteen) preserve traces of gilding that may or may not be associated with a purplish substance. Furthermore, the gilding is mainly visible on sarcophagi dating to the 3rd century AD, unrelated to the iconographic theme. Despite the difficulties encountered in establishing the findings, two different techniques are used to apply the gold. In the most frequently-attested method, the gold leaf was applied on a ground layer of colour; in the other technique, the gold leaf was applied directly onto the marble surface or more probably on top of a thin ground layer of kaolin.

Keywords: Gold, application techniques, purple substance.

Introduction

With a renewal of scientific interest in ancient polychromy, a methodological and multidisciplinary approach to the study of preserved traces of colour and gilding on Roman marble sarcophagi today allows us to retrieve valuable information to understand better this class of artefact (Siotto 2013; 2017). Following this trend, I identified and catalogued eighty Roman sarcophagi – including many unpublished examples – made in Rome from the beginning of the 2nd century AD to the end of the 4th century AD that shows traces of colour and gilding. These marble sarcophagi are to be found in the collections of the Vatican Museums, the National Roman Museum, and the Capitoline Museums (Siotto 2017). They were all investigated with the naked eye or through a stereomicroscope. Some of the sarcophagi conserved in the Vatican Museums and the National Roman Museum were selected as case studies and submitted for further detailed scientific investigation. The technical examination was based on the application of multispectral imaging, and spectroscopic and elemental analysis. However, for the central issue of the overlapped layers of colour, the gilding and its application techniques, micro-invasive techniques remain the most effective tools for their characterization (Siotto 2017; 2019). The final step consisted of polychrome surface acquisition by colour-calibrated 2D images and, in some selected cases, 3D digitalization of the artefact (Siotto *et al*. 2015).

Main problems

The study of gilding on Roman marble sarcophagi is much more problematic than the study of their polychromy. This is both because the gilding has been preserved in a relatively minor number of sarcophagi and due to some technical aspects. The gold fragments are visible in the form of small flakes with a thickness of a few ten-thousandths of a millimetre on top of the colour layers with a sub-millimetric thickness. The main difficulties in characterizing the technique used to apply the gold leaf on the marble surface are, on the one hand, the justified hesitation in taking micro-samples to perform micro-invasive diagnostic analysis, which is mainly based on optical petrographic microscopy (OPM) and scanning electron microscopy (SEM). On the other, the lack of knowledge on the topic which is limited to a few isolated artefacts (Cagiano De Azevedo 1957; Bourgeoise, Jockey 2004-2005; Liverani 2010; Sargent 2011; Powers *et al.* 2018). Indeed, until now, studies of polychromy on Roman marble sarcophagi amounted to fewer than ten over a century (more details in Siotto 2017). Moreover, attention to the gilding characterization was often given lower consideration and was generally mentioned only in connection with symbolic or stylistic topics (Swoboda 1889; Pietrogrande 1932; Gütschow 1938; Reuterswärd 1960; Philippot 1980; Lange, Sörries 1990).

Gilding sarcophagi

Table 1 shows those Roman marble sarcophagi with gilding or purple substance, or both, identified with direct visual inspection or thanks optical petrographic microscopy in the Vatican Museums, the National Roman Museum, and the Capitoline Museums collections. In particular, the careful examination of their surfaces has underlined that among eighty polychrome sarcophagi investigated, including many unpublished examples, only twelve (or perhaps fifteen) preserve traces of original gilding with may or may not be associated with a purplish substance.

Figure 1: Rome, National Roman Museum and Capitoline Museums. Roman marble sarcophagi, general view of some sarcophagi analysed in Tab. 1, Siotto 2017, cat. Ref. 51 (**a**), 12 (**b**), 6 (**c**), 75 (**d**), 24 (**e**), 41 (**f**), 64 (**g**), 34 (**h**), 21 (**i**), 36 (**j**), 18 (**k**), made in Rome and representing different iconographic themes, which preserved a significant amount of gilding or purplish substance, or both (Photo: E. Siotto).

In a case study among these sarcophagi, the gold leaf has been identified only thanks to a micro-sampling performed to recognise the techniques used to apply the colour (Siotto 2017, cat. ref. 21; Siotto 2019). This fortunate discovery reinforces the hope of detecting new traces of gilding on other sarcophagi with a more in-depth investigation in progress (Siotto 2017). In figure 1, this sarcophagus is highlighted by a dotted yellow outline. A red shape marks the sarcophagi chosen as a case study that underwent a detailed diagnostic investigation. The dotted lines indicate the unpublished sarcophagi; the presence of colour was also unknown in the well-known ‘Acilia sarcophagus’ (Siotto 2017). Violet outlines the sarcophagi or fragments of sarcophagi with only the purple substance, which in origin were probably (painted and) gilded. The sarcophagi with traces of gilding mentioned in academic literature but now not visible through direct visual inspection supported by stereomicroscope are indicated in green.

Aspects of gilding

The examined sarcophagi with gilding or purplish substance cover a period from the beginning to the end of the 3rd century AD and with no relation to a specific subject or iconographic theme.

Gilding is visible on the historical, mythological and Dionysian sarcophagi, and again on the sarcophagi with Muses, marine subjects, Victories and Cupids holding a shield or clypeus, scenes of private life, and also on the pastoral, bucolic and Christological sarcophagi (see Tab. 1 and Fig. 1).

The preserved gilding is mainly discernible on the protruding areas of curls, beards, the hair of animals, the rolled volumes or scrolls (*volumina*), the backs of garment folds, and the background drapes (*parapètasma*). Here and on the clothing and the *volumina*, gold was applied uniformly with a linear shape; the width of the gilded strip and the thickness of the substrate are variable (Fig. 2). On the other hand, gold appears to have been applied in a non-uniform manner, as a sort of hatching aimed at creating a “light vibration” effect, on the curls of hair, beards, torch flames, altars and censers (*thymiatèria*), manes and tails of lions and horses, sheep and goat fleeces, and sea waves (Fig. 3).

Figure 2: Rome, National Roman Museum and Capitoline Museums. Roman marble sarcophagi, details where the gold was applied uniformly with a linear shape; the width of the gilded strip and the thickness of the substrate are variable (Photo: E. Siotto).

Figure 3: Rome, National Roman Museum and Capitoline Museums. Roman marble sarcophagi, details where gold appears to have been applied in a non-uniform manner, as a sort of hatching aimed at creating a "light vibration" effect (Photo: E. Siotto).

Technical application of gold leaf: method and results in brief

Among these twelves sarcophagi identified, three golden sarcophagi have been chosen as case studies to perform a comparative survey between the results of scientific analyses and archaeological information in order to characterize the techniques used to apply the gold leaf onto the marble surface. Specifically, the so-called 'Annona sarcophagus' (Fig. 4) and the sarcophagus with the myth of Phaedra and Hippolytus (Fig. 5) represent those sarcophagi where the gold leaf seems applied on top of a dark yellow tending towards brown-reddish layer. While the so-called 'Acilia sarcophagus' (Fig. 6) stands for the sarcophagi where the gilding seems applied directly onto the marble surface or on top of a thin kaolin coat (see Tab. 2).

Figure 4: ‘Annona sarcophagus’, MNR inv. no. 40799. Detail of hair with gilding at the back left of the Annona head where we have taken a 40799-C micro-sample (Photo: E. Siotto).

Figure 5: Sarcophagus with Phaedra and Hippolytus, MNR inv. no. 122444. Detail of a projecting area of Theseus’ hair lock with gilding where we have taken a 122444-2 micro-sample (Photo: E. Siotto).

The first selected case study is the sarcophagus with *dextrarum iunctio* and personification, better known as ‘Annona sarcophagus’ (National Roman Museum in Palazzo Massimo inv. no. 40799). This rectangular sarcophagus without lid (Fig. 4) is decorated only in the frontal part with allegorical characters: *Portus*, *Annona*, *Concordia* (behind a married couple making a *dextrarum iunctio*), *Genius Senatus*, *Abundantia*, and *Africa*, from the right to the left of the sarcophagus. The sarcophagus was discovered with its fragmented lid in a modest tomb in the via Latina in Rome some years before 1877 (Aquari 1877; Siotto 2017, Cat. Ref. 51), and it is dated at the last third of the 3rd century, *c.* AD 270-280. This sarcophagus presents a significant amount of polychromy and gilding cited but not analysed in the academic literature (Aquari 1877; Musso, Friggeri 1985).

The second case study is the sarcophagus with the myth of Phaedra and Hippolytus (National Roman Museum – Baths of Diocletian inv. no. 112444). The sarcophagus (Fig. 5), in a rectangular chest with gable lid covered by rosette-shaped ending tiles and chunky acroteria corner on the front, was carved in Rome by artists from Asia Minor at the end of the third century, *c.* AD 290 (Musso 1985). The sarcophagus is decorated in high relief and only on the front; Phaedra and Hippolytus have unfinished portrait heads. It was found in via Muzio Attendolo near Largo Preneste, Rome in 1931 (Musso 1985). It presents a significant amount of red and gilding traces on the relief and on the acroterial corner masks of the lid (Siotto 2017, Cat. Ref. 12). Up to now it has been neglected in academic studies (Musso 1985 with the previous bibliography; Liverani 2007; Zanker, Ewald 2012 with selected bibliography).

Figure 6: 'Acilia sarcophagus', MNR inv. no. 126372. Detail of the figure with toga identified as Gordian III (Bianchi 1954) with abundant traces of gilding and purplish substance where we have performed the micro-samplings, 126372-F, 126372-A, and 126372-E (Photo: E. Siotto).

The third case study is the famous 'Acilia sarcophagus' (National Roman Museum in Palazzo Massimo inv. no. 126372) with *processus consularis* (Fig. 6). It was discovered in Acilia, near Rome, and is generally dated to the second quarter of the 3rd century AD (Bianchi 954; Sapelli 1983) or, more recently, to the last quarter of the 3rd century AD (Reinsberg 2006). It presents a considerable amount of gilding and a purple substance generally interpreted until now as 'bole' or mordant to fix the gold leaf on the marble surface. Before my study, the presence of the colour (red ochre, rose madder lake, and Egyptian blue) was unknown (Siotto 2017).

In the 'Annona sarcophagus' in particular, traces of original gilding are discernible on the upper surface of the *parapètasma* and clothes, and on the protruding areas of the curls of hair and beard, the flame of the *thymiaterion* and in some attributes of the personifications. Gold is visible on top of the red and blue of the *parapètasma* and clothes; while on the beard and hair, it seems applied on a dark yellow to reddish ground coat. On the *parapètasma* and clothing, gold was applied uniformly with a linear shape; on the other hand, gold appears to have been applied in a non-uniform manner, as a sort of hatching aimed at creating a 'light vibration' effect, on the curls of hair, beard and flame of the *thymiatèria* (Siotto 2017, Cat. Ref. 51). A purple-colour substance is also visible in association with the gold on the hair of the *Annona* personification similar to the 'Acilia sarcophagus'. In this case, gilding is co-present with a purple substance which has penetrated into the marble surface and blue powdered material, which has never been mentioned in the academic literature (more details in Siotto, 2017; 2019). Gilding is discernible on the upper surface of the togas and their *sinus* in a uniform appearance and linear shape approx. 0.5 cm wide. On the other hand, gold appears to have been applied in a non-uniform manner, as a sort of hatching aimed at creating a 'light vibration' effect on the protruding areas of the curls of hair and beards of the figures (Siotto 2017, cat. ref. 6). In the sarcophagus of Phaedra and Hippolytus, finally, gilding is preserved on the hair of the acroterial masks, on the protruding areas of the figures' hair and beard, the hooves of the horse and, again, on the button of the coat and the eagle head of Hippolytus' sword and the Cupid wings (Siotto 2017, cat. ref. 12). Similar to the 'Annona sarcophagus', the gold leaf appears to have been applied, especially on the hair and beard, on top of a dark yellow tending towards brown-reddish coat. This sarcophagus was also selected as a case study to understand the nature of a purple substance co-present with the gilding (Siotto 2019).

The first preliminary action to detect the different techniques used to apply the gilding was the historical and iconographic research on one hand, and on the other by a careful examination by fixed magnification (2×) Olympus VMF stereomicroscope mounted on a tripod. Moreover, we have performed some non-invasive analysis (e.g. VIL-Visible Induced IR Luminescence and UVL-Ultraviolet Luminescence multispectral imaging) followed by micro-invasive investigations, namely optical petrographic microscopy (OPM) and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM–EDS), in order to acquire information on the techniques used to apply the gold leaf onto the marble surface. To this end, three small and representative micro-samples, namely 40799-C, 122444-2, and 126372-F samples (Figs. 4-6), were chosen to respect the criteria of minimum invasiveness in collaboration with the Museum's restorers (Siotto 2019).

In detail, we have taken a 40799-C micro-sample from a lock of hair at the back left of the Annona head in the 'Annona sarcophagus' (Fig. 4). The dark yellow, almost brown, micro-sample appears as small flakes. It seems to correspond to a very similar substance visible on the 122444-2 micro-sample took from a projecting area of Theseus hair lock in the sarcophagus with the myth of Phaedra and Hippolytus (Fig. 5). In this case, the dark yellow, almost brown, micro-sample is composed of few granules. Finally, we have performed a micro-sampling from the 'Acilia sarcophagus' (Fig. 6). This was performed in a hidden area near the sinus of the figure with toga (identified as Gordian III by Bianchi 1954) in order to understand the gilding application techniques and the nature of purplish substance often visible along with the gilding or where it was. Two other similar micro-samples (126372-A and 126372-E) were taken later from the toga for more in-depth examination, and a micro-sample (126372-G) was taken later, in 2016, to clarify the origin of the violet substance.

Figure 7: 'Annona sarcophagus', MNR inv. no. 40799. Detail of the *parapètasma* where the gold leaf appears applied to a ground layer of colour made of Egyptian blue (Photo: E. Siotto).

Figure 8: Sarcophagus with Phaedra and Hippolytus, MNR inv. no. 122444. Detail of the Cupid wing where the gold leaf appears applied to a ground layer of colour made of red and/or yellow ochre (Photo: E. Siotto).

In brief, despite the difficulties encountered in establishing the findings, two different techniques are used to apply the gold leaf. In the most-attested method, the gold leaf was applied to on top of a coloured layer made of iron oxides and hydroxides used separately or mixed together or of Egyptian blue or, again, of madder rose lake mixed with other pigments. That is attested in the scientific results obtained from the 'Annona sarcophagus' (Fig. 7) and the sarcophagus with Phaedra and Hippolytus (Fig. 8). In the other technique, the gold leaf was applied directly onto the marble surface or more probably on top of a thin ground layer of kaolin (Fig. 9). That seems to be confirmed by the evidence from the 'Acilia sarcophagus' (Siotto 2017; 2019).

Figure 9: 'Acilia sarcophagus', MNR inv. no. 126372. Detail of the toga that shows the gold leaf applied directly onto the marble surface or more probably on top of a thin ground layer of kaolin. It also shows the purplish substance, ranging from violet to dark purple, attributable to the gold that has been transformed into colloidal gold particles (Photo: E. Siotto).

Purple substance (colloidal gold)

The initial investigations and evidence also show that the nature of the purplish substance, which ranges from violet to dark purple and is often visible in combination with gilding (or found where the gilding was), is attributable to gold that has been transformed into colloidal gold particles. In this regard, the 'Acilia sarcophagus' (Figs. 6, 9) was selected for a more in-depth investigation in order to clarify the nature of the purplish substance but also its origin. The sarcophagus has been known to scholars since 1950 – the year of its discovery – due to the abundant presence of this purplish substance commonly interpreted as a 'bole' or 'mordant' for gilding (Pietrogrande 1932; Bianchi 1954; Pesce 1957; Sapelli 1983; 2002).

Optical petrographic analysis and SEM-EDS results show that the purplish substance is attributable to gold that had been transformed into colloidal gold particles. Therefore, the purple colour substance is colloidal gold and not a 'bole' or mordant substance to fix the gold leaf as usually considered in academic literature even recently. Additionally, colloidal gold is also visible in some Hellenistic, Roman and Medieval marble sculptures and in some Roman sarcophagi re-painted and gilded (or re-gilded) in medieval times when they have been reused, as, for example, those exposed in the Camposanto Monumentale of Pisa. The process has likely been triggered by a microbiological attack when the sarcophagus was still underground and ongoing analysis will allow us to confirm or refute this hypothesis (Siotto 2017; 2019).

Conclusions

The present work has imparted an improved understanding of some aspects of gilding in Roman marble sarcophagi (Tab. 1) and confirms the complexity of this topic (Tab. 2). It is an area which requires a combined approach involving data integration obtained through various analytical techniques to obtain solutions. However, the method designed and tested has allowed us to get exciting results from these Roman polychrome and gilded sarcophagi. In particular, it allowed us to ascertain that the gilding is preserved mainly in the sarcophagi of the 3rd century AD, and its stylistic and technical aspect is unrelated to the iconographic theme represented. The integration of macroscopic and microscopic examinations results on the one hand, and archaeological and historical information, on the other, enabled the identification of the two methods used to apply the gold leaf. I also noted a preliminary result regarding the characterization of the purple substance, which is gold mutated in colloidal gold and not colouring or a restoration material or, finally, a 'bole' or mordant to fix the gold leaf as usually characterised in academic literature. Additionally, the process is very likely to have been triggered by a microbiological attack when the sarcophagus was still underground. The study of this particular aspect is being investigated in collaboration with Adelaide University, Australia.

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Chest and lid type	Iconographic theme	Colours (pigments and dyes)	Purplish substance	Gilding	Dating	Discovery	Museum inv. no.	Siotto 2017 Cat. Ref.
'Acilia sarcophagus'; *lenòs* without lid	*Processus consolaris*	Red (haematite, pink madder lake); VIL shows Egyptian blue	A significant amount of purplish substance has penetrated into the marble surface and coexists with gold	A considerable amount of gold is visible on the marble surface and it coexists with purplish substance	Second quarter of the 3rd cent. (AD 230-240)	1950 – Acilia (Rome)	MNR-PM 126372	6
Parallelepiped chest with gable lid and chunky acroteria corner	Phaedra and Hippolytus	Red made of iron oxides and hydroxides	Few traces of purplish substance are visible in combination with gold leaf on the hair of Theseus and the left handmaid	A great amount of gilding is visible on top of dark yellow to brown layer by DVI	End of the 3rd cent. (*c.* AD 290)	1931 – via Muzio Attendolo in Rome	MNR-TD 122444	12
'*Plotinus*'s sarcophagus'	Muses and Philosophers	Red and black probably attributable to red ochre and carbon black	A considerable amount of purplish substance is visible on the figures' hair and beard. It appears to be penetrated into the marble surface	DVI has not detected gilding traces	Third quarter of the 3rd cent. (AD 260-270)	1808 – from the Canova's excavation: *Servilii* tomb on the via Appia, Rome	MV 9504	13
Parallelepiped chest without lid	Woman portrait among Cupids of seasons, shepherds and Muses	Red and blue: presumable red ochre and Egyptian blue	DVI has not detected purplish substance traces	A possible gold trace has been identified on the left Cupid's chlamys by DVI	End of the 3rd cent. (*c.* AD 300)	unknown	MV 31465	16
Parallelepiped chest with lid and acroteria corner	Dionysiac procession	Red and yellow presumable ochres	DVI has not detected purplish substance traces	Gilding traces were mentioned by Pietrogrande (1932). At present we have not detected any traces by DVI	Third quarter of the 2nd cent. (AD 160-170)	1930 – near the Rome-Pisa railway bridge	MC 1378	18
Parallelepiped chest with lid and acroteria corner	Dionysus and Ariadne	Red and yellow ochres, gypsum, Egyptian blue, and possible pink madder lake and carbon black	DVI has not detected purplish substance traces	Some gold traces are occasionally identified by OPM analysis	End of the 2nd cent. (*c.* AD 200)	1936 – via Labicana, Rome	MNR-TD 124682	21
Lenòs sarcophagus without lid	Clypeus portrait among marine creatures	Red, red tending towards cyclamen, dark yellow and blue colours probably attributable to red and yellow ochres, pink madder lake, and Egyptian blue	DVI has not detected purplish substance traces	A significant amount of gilding is visible on top of a clear layer by DVI	Last quarter of the 3rd cent. (*c.* AD 280)	1937 – Villa Borghese, Rome	MC 2403	24
Parallelepiped chest with lid	Victories holding a clypeus and sacrifice Cupids	Red, red tending towards cyclamen, dark yellow and blue colours probably attributable to red and yellow ochres, pink madder lake, and Egyptian blue. Presence also of white and black	DVI has not detected purplish substance traces	A substantial amount of gilding is visible on top of a dark yellow to brown layer by DVI	Mid-3rd cent. AD	1904 – Lungotevere near the Farnesina, Rome	MNR-TD 23894	34
Parallelepiped chest with slab lid	Cupids holding a clypeus; *Oceanus* and *Tellus*; Chiron and Achilles	Red ochre and probably red cinnabar; Egyptian blue and black-based carbon	DVI has not detected purplish substance traces	Gilding traces were mentioned by SAPELLI (1981). At present we have not detected any traces by DVI	Third quarter of the 3rd cent. (*c.* AD 260)	1946 – via Casilina Loc. Torraccia, Rome	MNR-TD 124735	36
Two unmatched fragments of parallelepiped chest	Cupid seasons	Possible red ochre	Vanish traces of purplish material are visible into the marble surface	DVI has not detected gilding traces	Second half of the 3rd cent. AD	Unknown	MNR storages 115723, 115724	41
'Annona sarcophagus'; parallelepiped chest without lid	*Dextrarum iunctio* and personifications	Red ochre, red ochre mixed with possible pink madder lake, Egyptian blue and white lime	Few traces of purplish substance are visible together with gold leaf on the *Annona* hair	A significant amount of gilding is visible on top of a dark yellow to brown layer on the hair and on top of colours on the *parapètasma*	Last third of the 3rd cent. (270-280 AD)	1877 – (few years before) via Latina, Rome	MNR-PM 40799	51
Fragment of lid	Figure on biga (a two-horse chariot)	DVI has not detected colour traces	Purplish traces are visible into the marble surface	DVI has not detected gilding traces	End of the 3rd century AD	1935 – from Wilpert collection	MV 31591	58
'Lateranense no. 150 sarcophagus'; parallelepiped chest and lid	Bucolic scenes (chest) Hunting hare and portrait (lid)	Red and yellow ochres, Egyptian blue	Dark purple substance visible over and under gold leaf by OPM are identified as varnish of vegetable resin (Liverani 2010)	The pure gold leaf was applied on top of a kaolin layer through albumin binder; in some areas it is on top of the red or blue layers (Liverani 2010)	End of the 3rd cent. (*c.* AD 300)	1818 – Tor Sapienza, Rome	MV 31485	60
'*Iulius Achilleus*'s sarcophagus'; *lenòs* and lid	Bucolic and pastoral scenes (*lenòs*)Cupids on chariots (lid)	Red and yellow ochres, Egyptian blue and probably bright pink madder lake	Few traces of purplish substance coexist with gilding	A great amount of gilding is visible on top of red-based ochre and Egyptian blue	Last third of the 3rd century (AD 270-275)	1939 – Via Imperiale, Loc. Vigna Casali, Rome	MNR-TD 125802	64
'Polychrome slab'	Christological scenes of the New Testament	Yellow-ochre and red-hematite; green was blue probably attributable to Egyptian blue; white still non identified		A significant amount of gilding is visible on top of colours (dark red and green/blue)	Towards the end of the 3rd or the beginning of the 4th century (*c.* AD 290-310)	1860 – from Kircker Museum	MNR-PM 67606, 67607	75

Table 1: List of Roman polychrome sarcophagi with gilding and/or purple substance identified with direct visual inspection (DVI) or optical petrographic microscopy (OPM) in the Vatican Museums (MV), the National Roman Museum (MNR), and the Capitoline Museums (MC) collections. Grey highlights sarcophagi chosen as a case study that underwent in-depth diagnostic investigation.

Analytical Techniques	Investigated Issues	Samples or Measure Points	Additional Information	Examined Sarcophagus
OPM	Materials composition Gold leaf characterization Nature of purple substance Degradation processes Stratigraphy	The micro-sample no. *40799-C* was taken from a lock of hair at the back left of the *Annona* head. It appears as small flakes	Direct inspection with naked eyes and through portable stereoscope has showed that (i) gold leaf appears applied over a dark yellow to reddish ground coat on the upper surface of the *parapètasma* and clothes, and on the protruding areas of the curls of hair and beard, the flame of the *thymiatèrion* and in some attributes of the personifications; (ii) purple substance is also discernible in association with the gold; (iii) gilding is visible either on the top of red and blue colours, or over a dark yellow to reddish ground coat.	Annona sarcophagus (MNR-PM inv. no. 40799)
Raman	Materials composition	*Ibidem*		
VIL	Egyptian Blue mapping	Performed on all the relief surface		
UVL	Materials composition	Performed only on selected areas		
OPM	Materials composition Gold leaf characterization Degradation processes Stratigraphy	The micro-sample no. *112444-2* was taken from a projecting area of Theseus hair lock; it is composed of few granules	Direct inspection with naked eyes or through magnifying glass has showed that (i) gold leaf appears applied over a dark yellow to reddish ground coat on the hair of the acroterial masks, on the protruding areas of the hair and beard of the figures, the hooves of the horse and, again, on the button of the coat and the eagle head of Hippolytus' sword and the Cupid wings; (ii) a purple substance is also discernible in association with the gold.	Sarcophagus of Phaedra and Hippolytus (MNR-TD inv. no. 112444)
Raman	Materials composition	*Ibidem*		
OPM	Materials composition Purple substance nature Gold leaf characterization Degradation processes Stratigraphy	The micro-sample no. *126372-F* was taken from a hidden area of the *sinus* of the figure with toga. It is powdery material mixed with marble	Direct inspection with naked eyes and through portable stereoscope has showed on the top of supposed stratigraphy a spread white substance, under it a bright blue substance, and under it the gilding appears always co-present with the purple substance. They seem directly applied on the marble surface.	Acilia sarcophagus (MNR-PM inv. no. 126372)
Raman	Materials composition	*Ibidem*		
VIL	Materials composition Nature of purple substance	Performed on all the relief surface *Ibidem*		
UVL	Materials composition Nature of purple substance	Performed only on selected areas *Ibidem*		
SEM-EDS	Compositional and textural aspects Gold leaf characterization Degradation processes Purple substance nature Stratigraphy	The micro-sample no. *126372-F* is powdery material mixed with marble, which was taken from a hidden area of the *sinus* of the figure with toga		

Table 2: The table shows an overview of the analytical techniques used to resolve the issues investigated and, on the other hand, the micro-samples and data detected by direct visual inspection of selected Roman marble sarcophagi to identify the gilding techniques used.

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