

**T.C.**  
**DOKUZ EYLÜL UNIVERSITY**  
**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**SCALING AND CORROSION PROBLEMS  
IN DENİZLİ-ÇÜRÜKSU RIGHT SIDE PLAINS  
AND HYDROGEOLOGICAL ASPECTS**

38536

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**In Partial Fulfillment of the Requirements  
for Master Degree in Geological Engineering**

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İZMİR**

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## ***MAPS***

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**Map 3. Yukarı Çürüksu Plain sampling location.**





## ÖZET

İnceleme alanı, İç Ege Bölgesinde Denizli il merkezine 15 km uzaklıkta yaklaşık 250 km<sup>2</sup> alanı kapsar.

Araştırmanın amacı, bölgenin hidrolojik, hidrojeolojik ve hidrokimyasal özelliklerini ortaya koymak ve birbirleri ile oran ilişkilerini saptamaktır.

İnceleme alanında alttan üste Paleozoyik yaşlı şistler ve mermerler, Alt Pliyosen yaşlı gölssel ve Pliyo-Kuvaterner yaşlı karasal çökeller ile traverten, alüvyon ve yamaç molozu birimleri ayırtlanmıştır.

Hazne kayalar üstten alta traverten, Pliyosen kireçtaşları, Paleozoyik yaşlı mermerler ve olası gnayslardır. Örtü kayalar ise Alt Pliyosen birimin killi ve siltli seviyeleridir. Beslenme, yağış suları, Çivril-Baklan Ovası ve Acıgöl Havzası'ndan gelen yeraltı suları tarafından sağlanır. Yeraltı suları sıcaklık ve debileri kararlı bir sistemi gösterirler. Yeraltı sularının sıcaklığı orta kesimlerden güney ve kuzeydeki fay zonlarına doğru bir yükselme gösterir.

İzotop analizleri sonuçları ovanın kuzey ve güneyi arasındaki ilişkiyi ortaya koymuştur ve sadece kuzeyden güney batıya bir akım gözlenebilmiştir. Elde edilen sonuçlar yeraltısuyu rezervuarının kümülatif yağışların etkisinde olduğunu ve pompalamanın çok az bir etkisinin olabileceğini göstermiştir.

Çürüksu sağ sahil sulaması için eksik su miktarı 2388 lt/s'dir. Gökpınar Barajından Temmuz ve Ağustos aylarında Çürüksu sağ sahil sulamsına 2400 lt/s verilerek eksik sulama suyu gereksiniminin karşılanması planlanmıştır

## **INTRODUCTION**

### **1.1 The Location of the Investigation Area**

Investigation area is located on the 15 km north-east of the Denizli, Turkey. The area is placed M<sub>22</sub>-b<sub>3</sub>, M<sub>22</sub>-b<sub>4</sub> Denizli topographic map and occupy approximately 250 km<sup>2</sup> area (Fig.1).

### **1.2. The Aim of the Investigation**

This report has been prepared as M-SC Thesis to present to the Applied Geology Department of Science Institute of Dokuz Eylül University, İzmir.

The aim of this project is investigate the karst system and the hydrological and hydrogeological relationships between Çivril-Baklan plain and Acıgöl basin in the study area. In addition to this hydrogeological and hydrochemical properties of ground waters are determined.

### **1.3. Geography**

Morphology of investigation area is connected with graben tectonic. Approximate extension of Çürüksu plain is from east to west and altitude variation from east to west is 300 m.

The most important altitudes of the study area are Büyükçökelez H. (1840 m.), Küçükçökelez H. (1733 m.), Bereket H.(1570 m.), Mal H.(1275 m.) , Kıranyol H.(1210 m.) and Kara H.(1063).

Principal stream of the working area is Çürüksu stream which is flow east to west. Çürüksu Stream is fed by several streams and mix to Menderes stream 6 km east of Sarayköy. Stream net of the investigation area and nearby place have been given in figure 2.

The rivers which are run in only rainy season are Yeldere, Çakallı Stream, Gelinteli Stream, Karacakaz Stream, Uzunpınar Stream, Kocahasan Stream, Cutakayası Stream, Gökdere, Cindere, Kadı Stream, Acidere and Sarıkız Stream .

Investigation area is effected by Aegean, Mediterranean and Interior Anatolia climate zones. For that reason there is no linear relation between altitude and precipitation portion.

Natural plants of investigation area are around oaks, pines and junipers. Cotton, wheat, tobacco, sugar beet, corn are culture plants which is grown in the investigation area.

Settlement points of working area are Kaklık, Alikurt, Kocabaş and Acidere.

Denizli-İzmir, Denizli-Ankara, Denizli-Acıpayam highways are the highway's of the working area. Every roads are open to the transportation in each month of the year and also all of the road are stabilized in the working area.

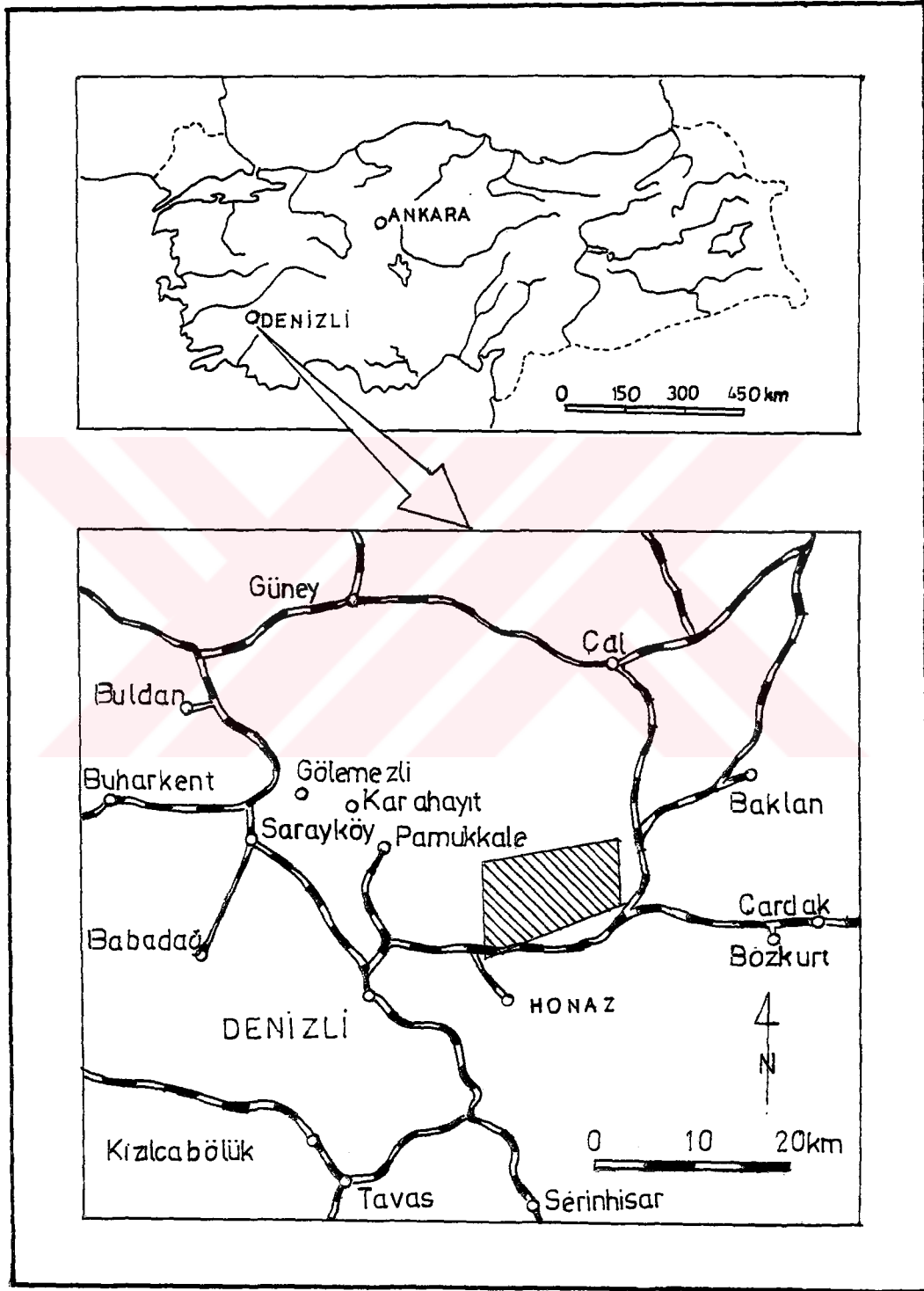


Figure 1. The Location map of study area.

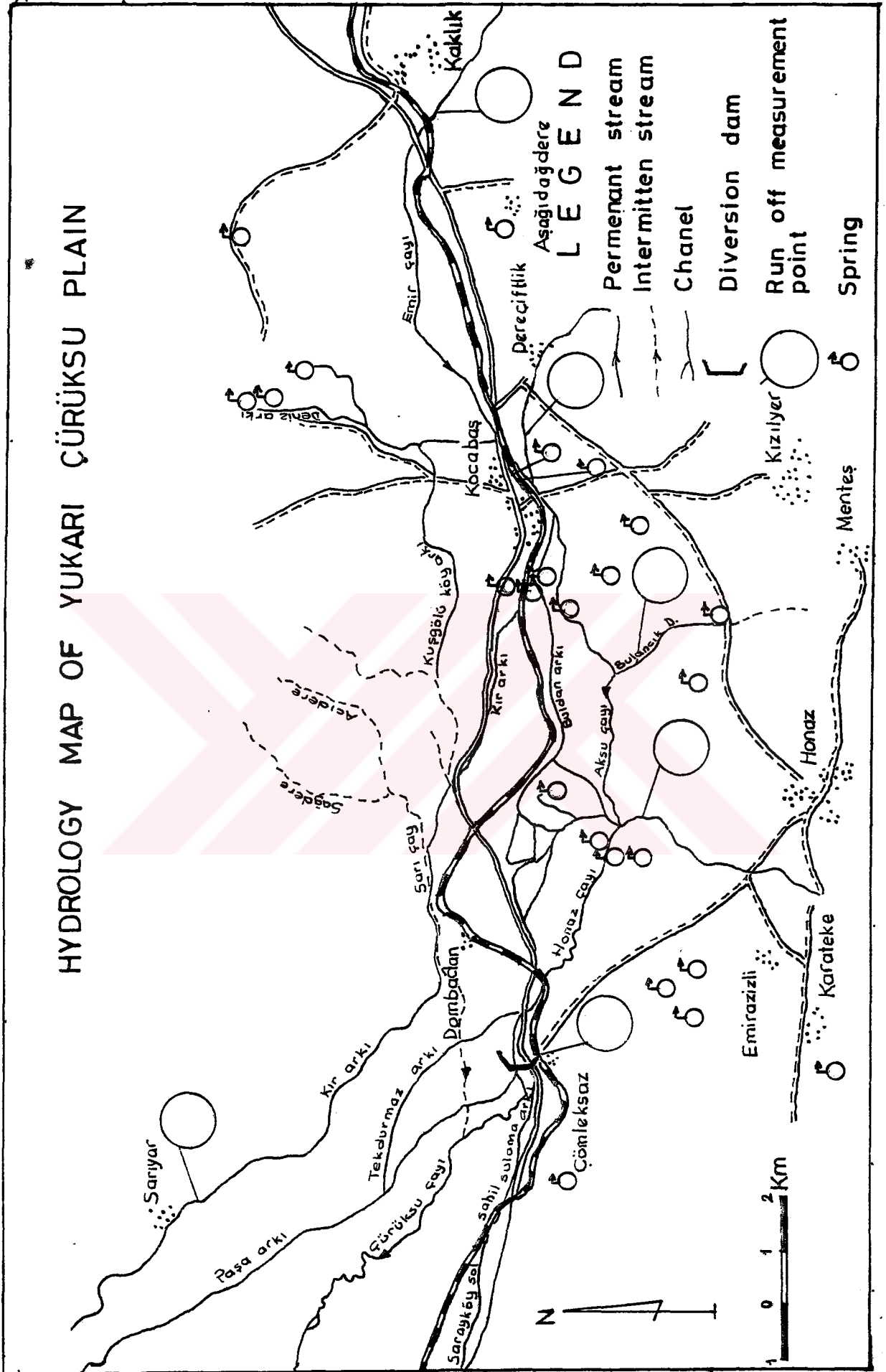


Figure 2. Stream map of investigation area.

## **2.PREVIOUS STUDIES**

First investigation have been realized by stricland (1841) and Hamilton (1842) in Pamukkale travertine's. The other investigations have been summarized as bellow.

ERENTÖZ (1956), Reported that brecciated Units of the Denizli district were a product of the branch of the see which is come over Burdur and Acıgöl.

NEBERT (1958), Studied Pliocene aged sediments of Denizli-Sarayköy-Pamukkale district and reported that bottom of the Pliocene consist of Meotian-Pontian aged marine-brachia. Dacian-Levantinian aged lagustrine sediments are rest uncomformably on the bottom.

TEZCAN (1967), measured gravity and resistivity around of Buharkent-Sarayköy-Buldan and reported that thickness of Neogene were changeable.

EKİNGEN (1970), According to gravity measurements results of Denizli-Pamukkale-Denizler-Dereköy-Honaz region reported that around of Kurudere and Dereköy would be possible geothermal potential.

GÖKALP (1971), Studied the regional geology of Yenice-Gölemezli -Karahayıt hot springs and reported that source of Pamukkale and Karahayıt hot springs were crystalline massive. In addition determined that while ground waters reach to surface were mixed with cold waters so its yield and calcium amount were increased but it's heat were decreased.

KASTELLİ (1971), As a result of geological investigation around of Tavas, Babadağ and Honaz reported that study area was not a possible geothermal area.

ERENTÖZ (1974), Prepared the geological map of the Denizli sector of 1/500000 scale and pointed the Menderes massive metamorphics and Mezosoic sediments .

ŞİMŞEK (1977), Studied the sulfur ore around of Gölemezli and Tekke hot spring and determined that sulfur ores which is non economic, sourced from H<sub>2</sub>S gas coming from depth.

FİLİZ(1982), Studied important geothermal fields of Aegean region and applied O<sup>18</sup> isotopes for determine recharge area and source of springs, O<sup>18</sup>-H<sup>2</sup> to found water reservoir rock relation and heat of reservoir, H<sup>3</sup> to denoted relative age and velocity of geothermal water in the system, C<sup>18</sup> to found the source of CO<sub>2</sub> gases.

ÖZPINAR(1989), studied west of Denizli -Acıpayam region and separated sedimental rocks and pointed that ophiolitic series were placed as tectonic in Lutetium or Lutetium - Oligocene period.

OKAY(1989), studied around of Honaz H. and explained that five mean tectonic units were take in region which are consist of Göbeciktepe unit, Honaz shale,

Menderes Massive, Sandak unit and Honaz ophiolite. Author have separated three mean deformation phase in region.

EŞDER and YILMAZER(1991), Reported that Gölemezli and Yenice hot spring's waters were source from high heat reservoir but Pamukkale and Karahayıt waters which are related with each other source from low heat reservoir.

FİLİZ and others(1992), All geothermal waters of the Büyük Menderes and Gediz graben have been classified geochemically and origin of these waters determined as meteoric. In addition reported that chemical composition of the Gediz Graben waters were changed by time and pointed that geothermal potential o Büyük Menderes Graben were higher than Gediz Graben.

GÖKGÖZ(1994), Investigated the occurrence of hydrothermal waters of the hydrothermal karst system situated between Kaklık and Kızıldere and hydrological and hydrogeological relationships between Çivril-Baklan plain and Acıgöl basin.



### **3. GEOLOGY**

Geological investigation of the area have been done by Hakyemez (1989), Okay (1989), Sözbilir (1994). Their results are as below (Map 1).

#### **3.1. Stratigraphy**

##### **3.1.1. Paleozoic**

###### **3.1.1.1. Honaz Shale**

Honaz Shale which is taken form nucleus of the Honaz Mount, consists of massive, dark bluish-green colored, abundant fractured and folded, slightly methamorph shale and silt stone. Honaz Shale is underlain the Yılanlı formation with a tectonic contact. This formation has been pushed through to Göbeciktepe unit at the east side of the Honaz Mount.

##### **3.1.2. Mesozoic**

###### **3.1.2.1 Gereme Formation**

Gereme formation is observed south east of the Mentеше Village and Mal Mount. Formation starts with dark gray colored, massive-thick bedded dolomites and includes chert limestone's through to top. Gereme Formation indicates a faulty contact with Middle-Upper Eocene aged Göbeciktepe formation.

###### **3.1.2.2. Yılanlı Formation**

Yılanlı formation is expose west and east sides of the Honaz Mount. Formation is constructed from bottom to top gray colored, thick bedded, massive recrystalized limestone, pelagic limestone; cherty limestone and light green colored shale. Yılanlı formation Mezosoic-Lower Tertiary in age.

###### **3.1.2.3. Honaz Ophiolite**

Honaz Ophiolite is crop out east of the Mentеше Village and composed of dark green colored, partly serphantinized periotides. Honaz Ophiolite settle down on the Gereme formation with tectonic contact at southeast of the Mentеше Village.



#### ***3.1.2.4. Kelkaya Formation***

Kelkaya formation crops out at Kelkaya Mounth. Formation is consist of light gray colored, micritic limestone, brecciated limestone and Globotruncana bearing limestone. Kelkaya formation rests uncomformably on the Late Paleocene-Eocene aged Faralya formation.

#### ***3.1.2.5. Faralya Formation***

Faralya formation which is crop out south of the Kelkaya Mount is placed on the Kelkaya formation and set in with basal conglomerate and through to top colored mud stone and turbiditic sandstone-shale intercalation. Faralya formation is overlain by Oligocene aged Karadere formation with discomformity.

#### ***3.1.2.6. Göbeciktepe Formation***

Göbeciktepe formation expose south of the Mentşe Village. Bottom of the formation consist of middle-thick bedded, black colored, micritic limestone with radiolaria, yellowish colored, thin bedded, sandy limestone, red colored, green shale with rich nummulith, fragmented limestone and claret red colored, thin bedded limestone. Upper side of the formation composed of quartz, chert, serpantinite, volcanic and carbonate grained, green colored sandstone, coarse sandstone, conglomerata and shale.

#### ***3.1.2.7. Karadere Formation***

Karadere formation is crop out north and east sides of the study area. Formation built up commonly by ruddy-brow-claret red colored conglomerates. Sandstone and mud stone are observed through to top. Karadere formation is overlain by Pliocene aged Kızılburun Formation with uncomformity.

#### ***3.1.2.8. Kızılburun Formation***

The Kızılburun formation cover large area in study area. Formation begin with polymict conglomerate inter bedded with limestone and toward to up contains sandstone and mud stone.

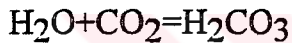


### **3.1.3. Quaternary**

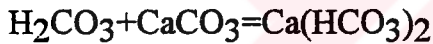
#### **3.1.3.1. Travertine**

There are thick travertine occurrence around Çömleksaz, Kocabaş and Dereköy. Thickness of travertine is approximately 110 m. in south of Kocabaş. Recent travertine are observed around Haydarbaba sinkhole. Direction of travertine strata is related with direction of the flowing water. Travertine is include sandy and gravely levels some place. Former travertine have hard texture and high resistance toward to broken.

There are close relation between solved carbon dioxide in water and travertine occurrence. Because dissolved CO<sub>2</sub> gas is formed carbonic acid.



Carbonic acid is attack to carbonate rocks and reaction with calcium carbonate is occurred calcium bicarbonate.



When this water which is enriched by calcium bicarbonate reached to surface CO<sub>2</sub> gas release from water to atmosphere because of the decrease of presure. Reaction is below.



All travertine are show excessive karstification and abundant fractured.

Travertine rests uncomformably on the all underlying units. Altunel (1993), determined Pamukkale and Karahayıt travertine age are much than 400.000 years depending on Th/U method.

#### **3.1.3.2. Alluvium**

Alluvium is show wide spread at left and right sides of Çürüksu stream. Thickness of alluvium which is contain untidy, coarse-middle sized gravel, sand, silt have been determined as 130 m around Çürüksu stream.

### ***3.2. Structural Geology and Geological Evaluation***

Study area and nearby environment were under the sea in Paleozoic. Gravel and sandstone deposits of this sea have been occurred gneisses as a result of metamorphism. Gneisses uplifted by Caledonian orogene and alteration phase began. Result of the Hercynian orogene they became under sea again and siltstone, claystone and limestone sediments of this sea overlaid the gneisses and a result of the metamorphism of these units cover metamorphic of Menderes massif consisting schist and marble have been occurred. Mesozoic limestones is show that the environment was under the sea in Mesozoic. Limestones observing in Büyükökelemez H., Küçükökelemez H., and Mal H., are belong to this sea, and thrust to the other units by Alpine orogene. Environment was terrestrial along Paleocene time. In Eocene time there are transition to shallow situation, and conglomerates, bioclastic limestone and sandstone, shale sequence have been deposited which is observed around of Kelkaya H. Regression which is being effective at the end of the Eocene caused erosion in units at terrestrial condition. The Investigation area was shallow in Oligocene time after the Oligocene there was transition to terrestrial condition Authors have been reported different models relation with graben tectonic which is improve in West Anatolia in Neotectonic period.

All formations in the basin effected by Alpine orogene. However except phish this is not observed as anticline and synclinal.

Investigation area have been effected from tectonism and direction of tectonism is northeast southwest. Mean faults have been bounded by Baklan-Çivril and Acıgöl plains. According to the geophysical investigation at east-west direction of Yukarı Çürüksu plain extends a graben. This graben has been filled by new sediments.

#### **4.HYDROLOGY**

In this section, water balance of the study area have been done by using meteorological data of the Denizli city center belonging the years between 1931-1991 and the years between 1992-1993.

Variation of annual mean of Etp belong the years between 1931-1991 and the years between 1992-1993 have been given.

##### **4.1.Precipitation**

Mean data between 1931-1990 years taken from Denizli meteorology station is give a general knowledge about meteorological elements belong city center (Table1)

|  |        |
|--|--------|
| Mean air pressure(Mill bare).                    | 964.73 |
| Mean vapor pressure                              | 10.93  |
| Mean of relative moisture(%)                     | 61.47  |
| Mean evaporation(mm)                             | 4.91   |
| The number of stormy days (1.72 m/sec<)          | 7.95   |
| The number of strong windy days (10.8-17.1m/sec) | 23.36  |
| The mean of cloudy days                          | 3.64   |
| The number of bright days                        | 146.08 |
| The number of close days                         | 165.64 |
| The number of rainy days                         | 49.68  |
| The number of snowy days                         | 93.63  |
| The number of days covering with snow            | 4.52   |
| The mean of highest snow thickness(cm)           | 3.80   |
| The number of misty days                         | 24.10  |
| The number of hails days                         | 3.01   |
| The number of raw days                           | 1.29   |
| The number of frostily days                      | 36.90  |
| The mean of precipitation (mm)                   | 557.42 |
| The mean of heat ( <sup>0</sup> C)               | 15.75  |

Table 1. The mean meteorological data between 1931-1990 year of Denizli city center.

Rose diagram have been drawn(Gökgöz,1994) according to the number of blowing of wind, direction respectively south,north-west, west,north and south-west directions. Nearly there is no wind at east direction.

Annual mean of total precipitation is 556.14 mm. Lowest precipitation is 6.78 mm at august and highest precipitation is 97.81 mm at January(5.64 <sup>0</sup>C). Around the study time the mean of annual heat was 15.63 <sup>0</sup>C and the mean of annual precipitation was 453.40 mm.

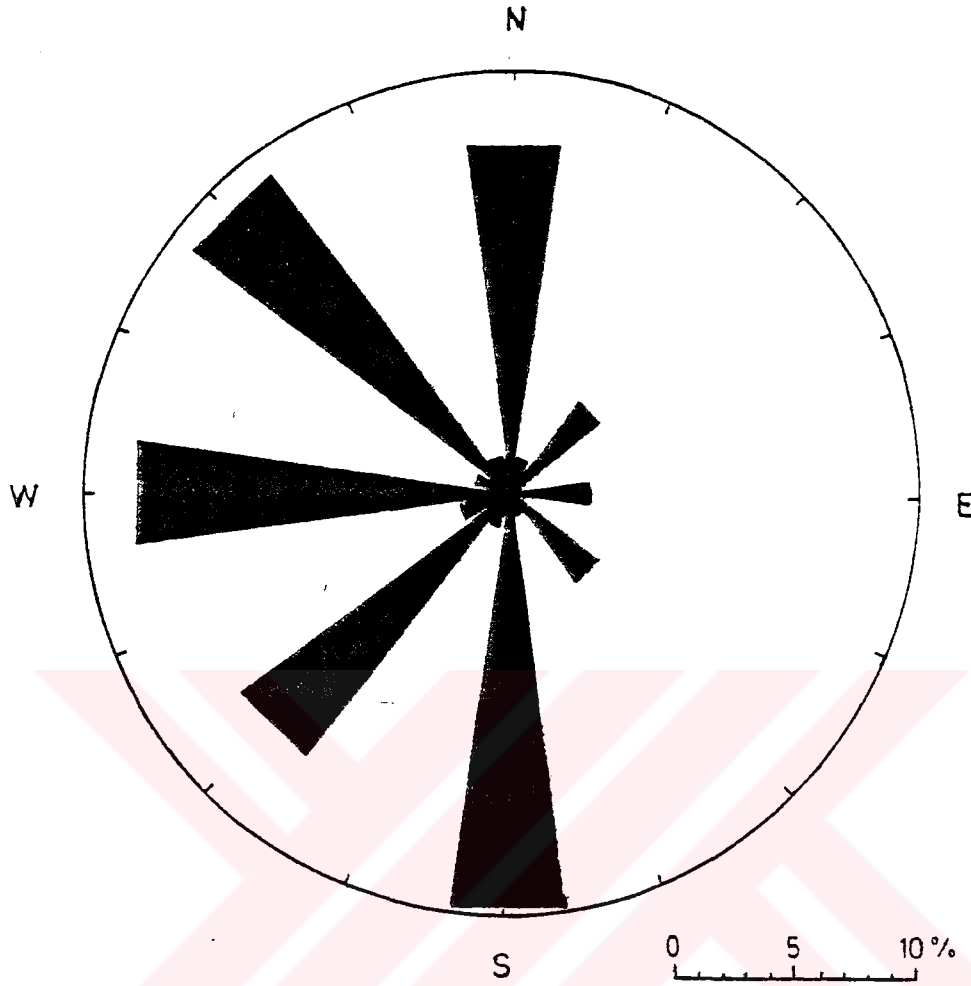


Figure 3. Rose diagram of density of wind and wind direction of Denizli. (Gökgöz, 1994)

Mean annual heat and mean annual total precipitation years between 1931-1991 and years between 1992-1993 have been compared in figure 4. It is understood that dry and rainy period is continue 8 or 9 years so we can say that dry period which is continue since 1988 will be effective several years.

#### ***4.2. Evaporation***

Evaporation - transpiration values of Denizli belong years between 1931-1991 and 1992-1993 have been counted with Thornthwaite method.

##### ***4.2.1 Thornthwaite***

Annual evapo-transpiration (Etp) have been found 857.90 mm and annual real evopo-transpiration (Etr) 404.87 mm (Table 2)

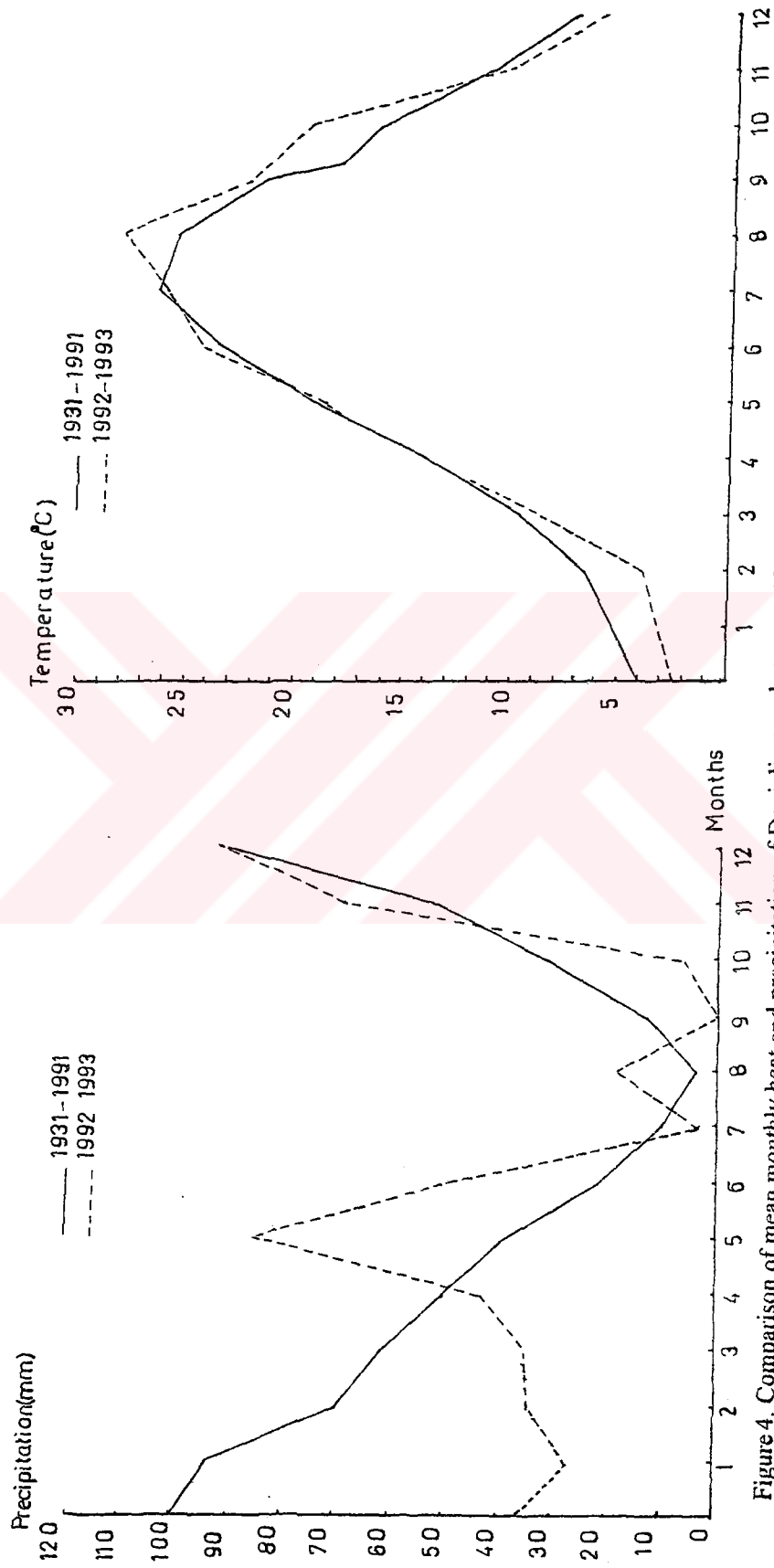


Figure 4. Comparison of mean monthly heat and precipitation of Denizli years between 1931-1991 and 1992-1993.

| Thornthwaite Evapo-Transpiration Table of Denizli Years Between 1931-1991. |         |          |        |       |        |        |        |        |           |         |          |          |        |
|--|---------|----------|--------|-------|--------|--------|--------|--------|-----------|---------|----------|----------|--------|
| Months   | January | February | March  | April | May    | June   | July   | August | September | October | November | December | Annual |
| Mean monthly temperature( C)   | 5.63    | 6.72     | 9.89   | 14.36 | 19.22  | 23.91  | 26.67  | 25.96  | 21.76     | 16.25   | 11.13    | 7.58     | 15.76  |
| Monthly index  | 1.20    | 1.56     | 2.81   | 4.94  | 7.68   | 10.69  | 12.61  | 12.11  | 9.27      | 5.96    | 3.36     | 1.88     | 74.07  |
| Etp(mm)  | 10.12   | 13.60    | 25.94  | 48.37 | 78.72  | 113.39 | 136.10 | 130.10 | 96.87     | 59.47   | 31.60    | 16.63    |        |
| Correction coef.   | 0.85    | 0.84     | 1.03   | 1.10  | 1.23   | 1.24   | 1.25   | 1.17   | 1.04      | 0.96    | 0.84     | 0.83     |        |
| Corrected Etp(mm)  | 8.60    | 11.42    | 26.72  | 53.21 | 96.83  | 140.60 | 170.13 | 152.22 | 100.74    | 57.09   | 26.54    | 13.80    | 857.90 |
| Rainfall (p) mm  | 96.90   | 69.86    | 62.21  | 50.19 | 39.04  | 22.54  | 11.67  | 6.68   | 15.09     | 33.39   | 55.64    | 92.93    | 556.14 |
| Soil reserve change (mm)   | 0       | 0        | 0      | -3.02 | -57.79 | -39.19 | 0      | 0      | 0         | 0       | 0        | 0        |        |
| Soil reserve   | 100.00  | 100.00   | 100.00 | 96.98 | 39.19  | 0      | 0      | 0      | 0         | 0       | 29.10    | 100      |        |
| Real evaporation Etr (mm)  | 8.60    | 11.42    | 26.72  | 53.21 | 136.02 | 61.73  | 11.67  | 6.68   | 15.09     | 33.39   | 26.54    | 13.80    | 404.87 |
| Water deficiency(mm)   | 0       | 0        | 0      | 0     | 0      | 78.87  | 158.46 | 145.54 | 85.65     | 23.70   | 0        | 0        | 492.22 |
| Monthly moisture content P-Etp/Etp (mm)                                    | 88.3    | 58.44    | 35.49  | 0     | 0      | 0      | 0      | 0      | 0         | 0       | 0        | 8.23     | 190.46 |

Table 2.Thornthwaite Evapo-transpiration table of Denizli years between 1931- 1991.

| Months                                  | January | February | March  | April  | May   | June   | July   | August | September | October | November | December | Annual |
|---|---------|----------|--------|--------|-------|--------|--------|--------|-----------|---------|----------|----------|--------|
| Mean monthly temperature( C)            | 3.35    | 3.95     | 8.75   | 14.65  | 18.62 | 24.40  | 26.70  | 28.10  | 22.55     | 19.85   | 10.10    | 6.55     | 15.63  |
| Monthly index                           | 0.55    | 0.70     | 2.33   | 5.09   | 7.31  | 11.02  | 12.63  | 13.65  | 9.28      | 8.06    | 2.90     | 1.88     | 75.53  |
| Etp(mm)                                 | 4.03    | 5.33     | 20.54  | 49.24  | 73.84 | 117.03 | 136.36 | 148.71 | 102.37    | 82.45   | 26.20    | 16.63    |        |
| Correction coef.                        | 0.85    | 0.84     | 1.03   | 1.10   | 1.23  | 1.24   | 1.25   | 1.17   | 1.04      | 0.96    | 0.84     | 0.83     |        |
| Corrected Etp(mm)                       | 3.43    | 4.48     | 21.16  | 54.16  | 90.82 | 145.12 | 170.45 | 173.99 | 106.46    | 79.15   | 22.00    | 13.80    | 881.64 |
| Rainfall (p) mm                         | 26.95   | 34.10    | 34.95  | 43.75  | 85.30 | 53.00  | 3.90   | 18.50  | ---       | 5.50    | 67.05    | 92.93    | 453.40 |
| Soil reserve change (mm)                | 0       | 0        | 0      | -10.41 | -5.52 | -04.07 | 0      | 0      | 0         | 0       | 0        | 0        |        |
| Soil reserve                            | 100.00  | 100.00   | 100.00 | 89.59  | 84.07 | 0      | 0      | 0      | 0         | 0       | 45.05    | 100      |        |
| Real evaporation Etr (mm)               | 3.43    | 4.48     | 21.16  | 54.16  | 90.82 | 137.97 | 3.90   | 18.50  | 0         | 5.50    | 22.00    | 13.80    | 371.44 |
| Water deficiency(mm)                    | 0       | 0        | 0      | 0      | 0     | 61.05  | 166.55 | 155.49 | 106.46    | 73.65   | 0        | 0        | 563.20 |
| Monthly moisture content P-Etp/Etp (mm) | 23.52   | 29.62    | 13.79  | 0      | 0     | 0      | 0      | 0      | 0         | 0       | 0        | 8.23     | 81.96  |

Table 3.Thornthwaite Evapo-transpiration table of Denizli years between 1992- 1993.

Table 3.Thornthwaite Evapo-transpiration table of Denizli years between 1992-1993.

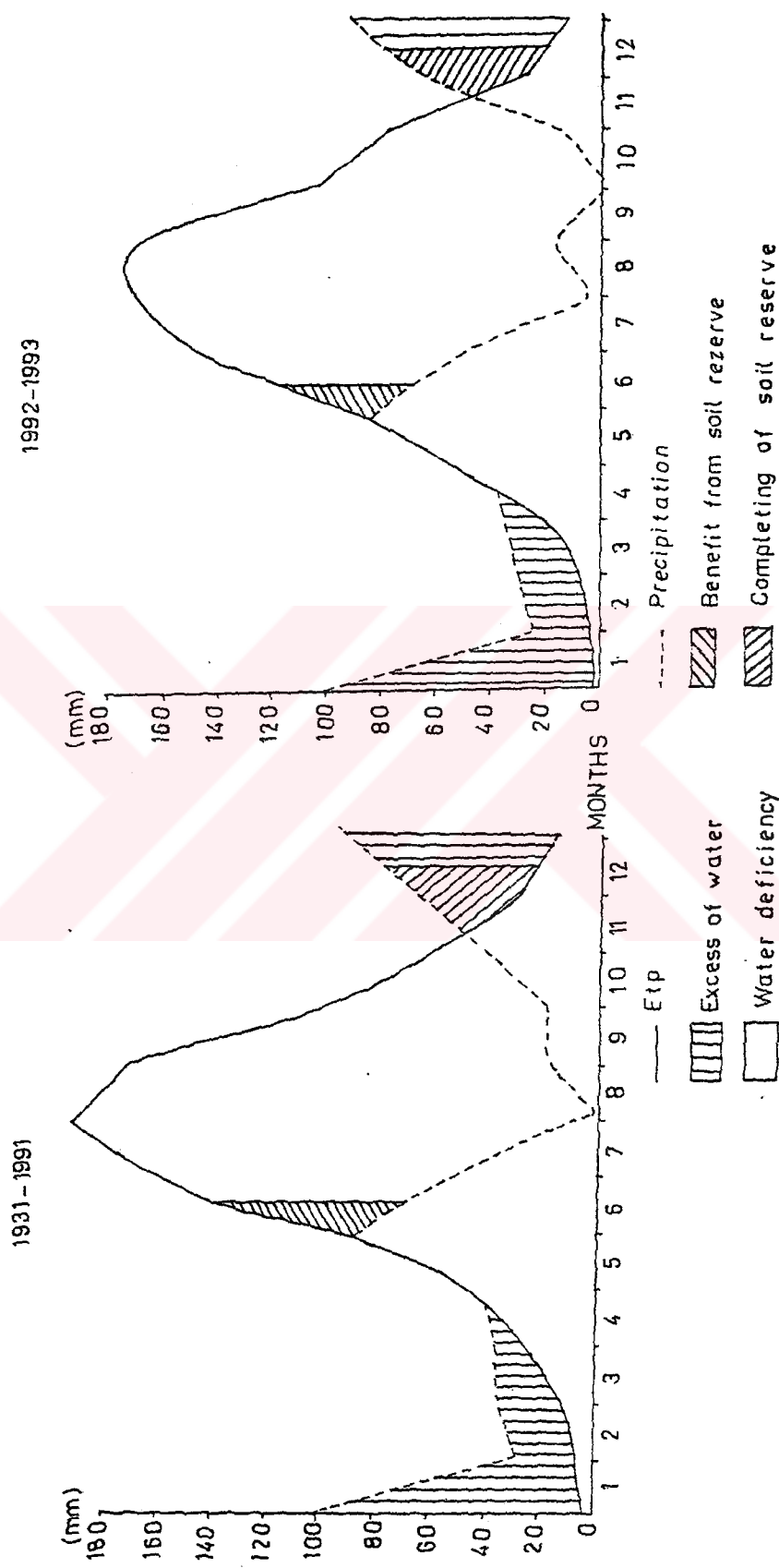


Figure 5. Monthly variation of precipitation and Etp of Denizli years between 1931-1991 and 1992-1993.



Since at the middle of the April precipitation is more than Etp. For that reason Etp is equal to Etr. Excess of precipitation is 190.46 mm A part of precipitation infiltrates to the ground water table and a part flows from overland.

From middle of the April to middle of the June the soil reserve change which is accepted theory 100 mm.

From middle of the June to middle of the November there are water deficiency. In dry period Etp is equal to 717.61 mm and precipitation equal to 128.41 mm so deficiency of water is  $717.61 - (128.41 + 100) = 489.2$  mm.

At middle of the November precipitation exceeds Etp. At the middle of the December excess of precipitation completes soil reserve. 72 percent of the precipitation (404.87 mm) is return to atmosphere by evapo-transpiration. Excess of precipitation corresponds 34.25 percent of the total precipitation.

Annual Etp is 881.64 mm excess in precipitation along middle of the may. At middle of the June all of the soil reserve have been used up. Along first half of the November there are water deficiency.

In dry period Etp is equal to 865.99 mm and precipitation is 166.2 mm so water deficiency is found as follow.

$865.99 - (166.2 + 100) = 499.79$  mm.

At middle of the November precipitation exceeds. Etp and completes soil reserve at December. According to this method 82 percent of the total precipitation returns to atmosphere. Excess of precipitation is 18 percent of the total precipitation.



Photograph 1. DSI well using for irrigation

#### **4.3. Irrigation of Right Sides of the Yukarı Çürüksu Plain**

Right side of the Yukarı Çürüksu plain bounded by Kaklık at east, Eski Pamukkale way at west, mountains at north and Çürüksu river at south. 6620 hectare of the 7000 hectare have been classified as irrigatable.

Since years 1987 irrigation trenches which are irrigate approximately 6000 hectare and collect approximately 4 m<sup>3</sup>/sec water were Kuşgölü canal, Kır canal, Bolden canal, Tekdurmaz canal and Koca canal.

For irrigate of Çürüksu right side plain "Improvement plan of Çürüksu plain and right side planning report" have been prepared by planning department of D.S.I. at 1982. According to this report irrigation water necessity of the plain have accounted as 14.42 m<sup>3</sup>/s., 6.24 m<sup>3</sup>/s of this value would be provided from present waters and wells, 8.18 m<sup>3</sup>/s from B. Menderes.

Çürüksu right side irrigation

Total irrigation area is 9346 hectare.

Irrigation of Kaklık-Kocabaş plain

:3952 hectare

Module

:1.13 l/s./hectare

Necessity of irrigation water

:3952x0.97x1.13=4333 l/s.

Irrigation area of right canal

: 3894 hectare

Module

:1.13l/s./hectare

Necessity of irrigation water

:3894x0.97x1.13=4268 l/s.

Irrigation area under the Gölmezli mean canal

: 1500 hectare

Module

: 1.15 l/s./hectare

Necessity of irrigation water

:1500x0.864x1.15=1459 l/s.

Total

: 10059 l/s.

Water taken from springs

Aşağıdere wells

:2500 l/s.

Kelkaya springs

: 130 l/s.

Haydarbaba springs

:563 l/s.

Kokarsu springs

: 844 l/s.

Halkabaşı springs

: 130 l/s.

Domuzdüşen springs

:74 l/s.

Akpınar springs

:120 l/s.

Kızlarpınarı springs

:206 l/s.

Çamurlu springs

:97 l/s.

Kaynarca springs

:760 l/s.

Total

:5424 l/s.

|   |                          |
|---|--------------------------|
| Water taken from Halkabaşı                        |                          |
| Halkabaşı springs                                 | : 1063 l/s.              |
| Çayırılı springs                                  | :209 l/s.                |
| Çıbanpınar springs                                | : 438 l/s.               |
|   | Total :1710 l/s.         |
|   | General Total :7134 l/s. |
| Corresponding ratio of necessity irrigation water | : %71                    |
| Çürüksu plain total irrigation area               | :16376 hectare           |
| Çürüksu plain net irrigation area                 | :1506 hectare            |
| Total water necessity                             | :16439 l/s.              |
| Total water resource                              | :11206 l/s.              |

Corresponding ratio of necessity irrigation water :%68

Because of insufficiency of water source, corresponding of necessity water is not possible. To provide new source investigations have been done by planning Branch Management of D.S.I.

1200 l/s. of the water would given out of net and 5934 l/s. of 7134 l/s. have been taken into account. 4224 l/s. of this water will be used up at Kocabaş-Kaklık plain and 1710 l/s. will be used up at Halkabaşı regulator and Çürüksu right side plain. Water which will be used up at Çürüksu right side is plain found 1880 l/s. receiving 170 l/s. will returning water.

Water deficiency for Çürüksu right side plain is below.

$$4268-1880=2388 \text{ l/s.}$$

According to the "Çürüksu-Gökpınar Project. Gökpınar Dam Planning Report" deficiency of irrigation water would be provided from Gökpınar dam(2400 l/s.).

| Table 4. Present situation of Yukarı Çürüksu Right Side Plain        |            |                |                            |                       |                        |   |  |
|--|------------|----------------|----------------------------|-----------------------|------------------------|---|--|
| Name of Irrigation   | Area (hec) | Net area (hec) | Irrigation module (l/s/ha) | Water Necessity (l/s) | Water at Present (l/s) | Water Source (l/s)                          | Corresponding Ratio of Necessity Water |
|  | 1500       | 1269           | 1.15                       | 1459                  |                        |   |  |
|  | 3894       | 3777           | 1.13                       | 4268                  |                        |   |  |
|  | 3952       | 3833           | 1.13                       | 4332                  |                        |   |  |
|  | 9346       | 8819           |                            | 10059                 | 7134                   | Spring + Wells                              | 71.0                                   |
| Table 5. Situation of Yukarı Çürüksu Right Side Plain in the future. |            |                |                            |                       |                        |   |  |
| Name of Irrigation   | Area (hec) | Net area (hec) | Irrigation module (l/s/ha) | Water Necessity (l/s) | Water at Present (l/s) | Water Source (l/s)                          | Corresponding Ratio of Necessity Water |
| Right Side irrigation  | 3894       | 3777           | 1.13                       | 4268                  |                        | Springs(1880 l/s) + Gökpınar Dam (2388 l/s) | 100                                    |
| Kaklık - Kocabaş irrigation  | 3952       | 3833           | 1.13                       | 4332                  |                        | Springs+Wells (4224 l/s)                    | 98                                     |
| Total  | 7846       | 7610           |                            | 8600                  |                        | Springs+Wells+Gökpınar Dam (8492 l/s)       | 99                                     |
| Akhan irrigation   | 698        | 677            | 1.17                       | 790                   |                        | Gökpınar Dam (790 l/s)                      | 100                                    |

## **5. HYDROGEOLOGY**

### **5.1 Hydrogeologic Units**

Units in the investigation are separated as permeable, semipermeable and impermeable taking into account of their lithologic and stratigraphic features.

#### **5.1.1. Permeable Units**

The oldest permeable units of investigation area are Paleozoic aged marbles. As a result of dense tectonic movement marbles have gained jointed structure. At the surface of bedding plane and joints there is loose karstification. Units have gained their secondary permeability by these structural features and faults placed in the units. So marbles are good reservoir for water.

Travertines are second pervious unit in region. Thickness of travertine is approximately 110 m around Yukarı Çürüksu basin. It is possible to see joints and faults which are a result of dense tectonism. Haydarbaba sinkhole, caves, Gemili spring and concaves are karstic formation observed in the region. This high permeable unit is good reservoir for water. Direction of flowing water at wells in the travertine and Haydarbaba Sinkhole shows that unit recharges from Çivril-Baklan plain and Acıgöl basin where placed at high altitudes.

Last permeable unit consists of alluvium and talus. Units have wide separation and approximately 130 m thickness and carries ground water.

#### **5.1.2. Semipermeable Unit**

This unit consists of claystone, siltstone, limestone levels and Plio-Quaternary aged conglomerate, sandstone, and conglomerate levels of siltstone unit.

Secondary permeability and karstification make it possible for unit to be reservoir for ground water. But it can be said that due to the claystone and siltstone it can not yield the water in high performance.

#### **5.1.3. Impermeable Unit**

Unit consists of Paleozoic aged schist and Quartzites which are consecutive with micaschist, quartzschist, calcschist is not a aquifer because of its fine grain in spite of its hardness and breakable and secondary permeability. Schists hold ground water which are in the marbles. In addition they are very good a cover rock for reservoir consists of gneisses.

Second impervious unit consist of consecutive with lower Pliocene aged conglomerate sandstone, claystone, siltstone and sandstone, claystone, clayey limestone. Conglomerate, sandstone, claystone, siltstone consecutive is cover rock of marbles. Sandstone, claystone, clayey limestone consecutive is cover rock of Pliocene limestones.

## **5.2. Water Points**

### **5.2.1. Wells**

62 well samples have been collected from Çürüksu right side plain periodically along working time. All of these wells are provide irrigation water to Yukarı Çürüksu plain. Depth of wells is change between 30 and 300 m. Well data have been shown that thickness of travertine reaches 110 m. Ground water is taken from travertine around investigation area. East of the basin is taken it's ground water from Pliocene aged sandstone, conglomerate, and limestone. Alluvium is the other important aquifer in the region.

Circulation losses which are observing in well data have been determined karstification of travertine. Well numbers, D.S.I. 33277, D.S.I. 33278, D.S.I. 33276 which are placed south of cement factory and number D.S.I 34553 are artesian wells. First third of these wells have approximately 300 l/s. total yields. Artesian wells data are show that thickness of clay and marl (50-90 m) are much than other wells source of other artesian wells is semi pressured aquifer. Total yield of well have been showed that the recharge area of Çürüksu basin is Çivril-Baklan Plain and a part of Acıgöl Basin. Filiz (1982), have been determined recharge area of Çürüksu basin at more high altitude depending on isotopic investigation. Well pipes of Yukarı Çürüksu Plain are not show scaling problem. But typical scent of H<sub>2</sub>S gas is indicate existence of H<sub>2</sub>S gas in the ground water. The H<sub>2</sub>S gas is induce corrosion in pipes.

### **5.2.2. Springs**

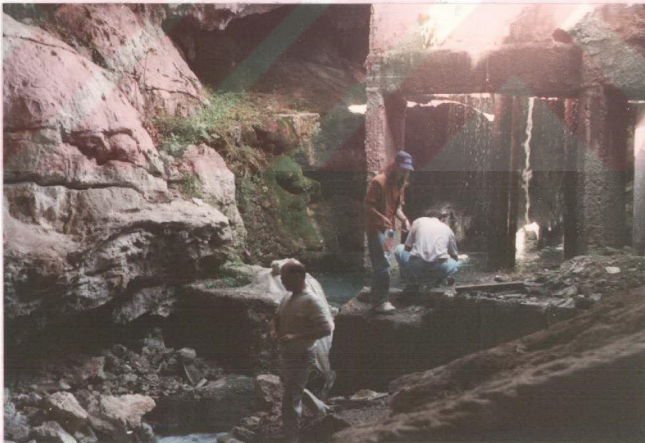
**Gemili Spring:**Placed 250 m. north of Münir Kuyumcu's farm. Depth of the spring approximately 27 m. and have high yield. South of the Gemili springs there are two little springs.

**Haydarbaba Sinkhole:** Settled southeast of the basin. Karstification have been resulted at 30 m. length, 7-8 m. height cave in travertine. Water in the cave recharge from around of Mal H. and it's yield is change depending on water taken from other wells. Water and mud of sinkhole are used for itching and rheumatism by villager.





Photograph 2.DSI well



Photograph 3. Haydarbaba Sinkhole

| Number | Explanation                |        | Chemical analysis | Log |
|--------|----------------------------|--------|-------------------|-----|
| 1      | D.S.I. well number         | 37127  | +                 | +   |
| 2      | "                          | 37128  | +                 | +   |
| 3      | "                          | 39388  | +                 | -   |
| 4      | "                          | 39340B | +                 | -   |
| 5      | "                          | 39337  | +                 | -   |
| 6      | "                          | 39336A | +                 | -   |
| 7      | "                          | 39339B | +                 | -   |
| 8      | "                          | 39335  | +                 | -   |
| 9      | "                          | 37126  | +                 | +   |
| 10     | "                          | 39335  | +                 | -   |
| 11     | "                          | 37125  | +                 | +   |
| 12     | "                          | 34555  | +                 | -   |
| 13     | "                          | 25570  | +                 | +   |
| 14     | "                          | 25568  | +                 | +   |
| 15     | "                          | 33278  | +                 | +   |
| 16     | "                          | 33277  | +                 | +   |
| 17     | "                          | 33276  | +                 | +   |
| 18     | "                          | 27204  | +                 | +   |
| 19     | Haydarbaba sinkhole        |        | +                 | -   |
| 20     |                            | 34553  | +                 | +   |
| 21     |                            | 25569  | +                 | +   |
| 22     |                            | 34291  | +                 | +   |
| 23     |                            | 43530  | +                 | -   |
| 24     | Cimento fabrikası          |        | +                 | -   |
| 25     | D.S.I. well number         | 34220  | +                 | +   |
| 26     |                            | 34554  | +                 | +   |
| 27     |                            | 33279  | +                 | +   |
| 28     | Near D.S.I. well number    | 33279  | +                 | -   |
| 29     | Kaklık drinking water      |        | +                 | -   |
| 30     | Kocabas                    |        | +                 | -   |
| 31     |                            | 37124  | +                 | +   |
| 32     | Gemili spring              |        | +                 | -   |
| 33     | Concave near Gemili spring |        | +                 | -   |

Table 6. Sample data of investigation area



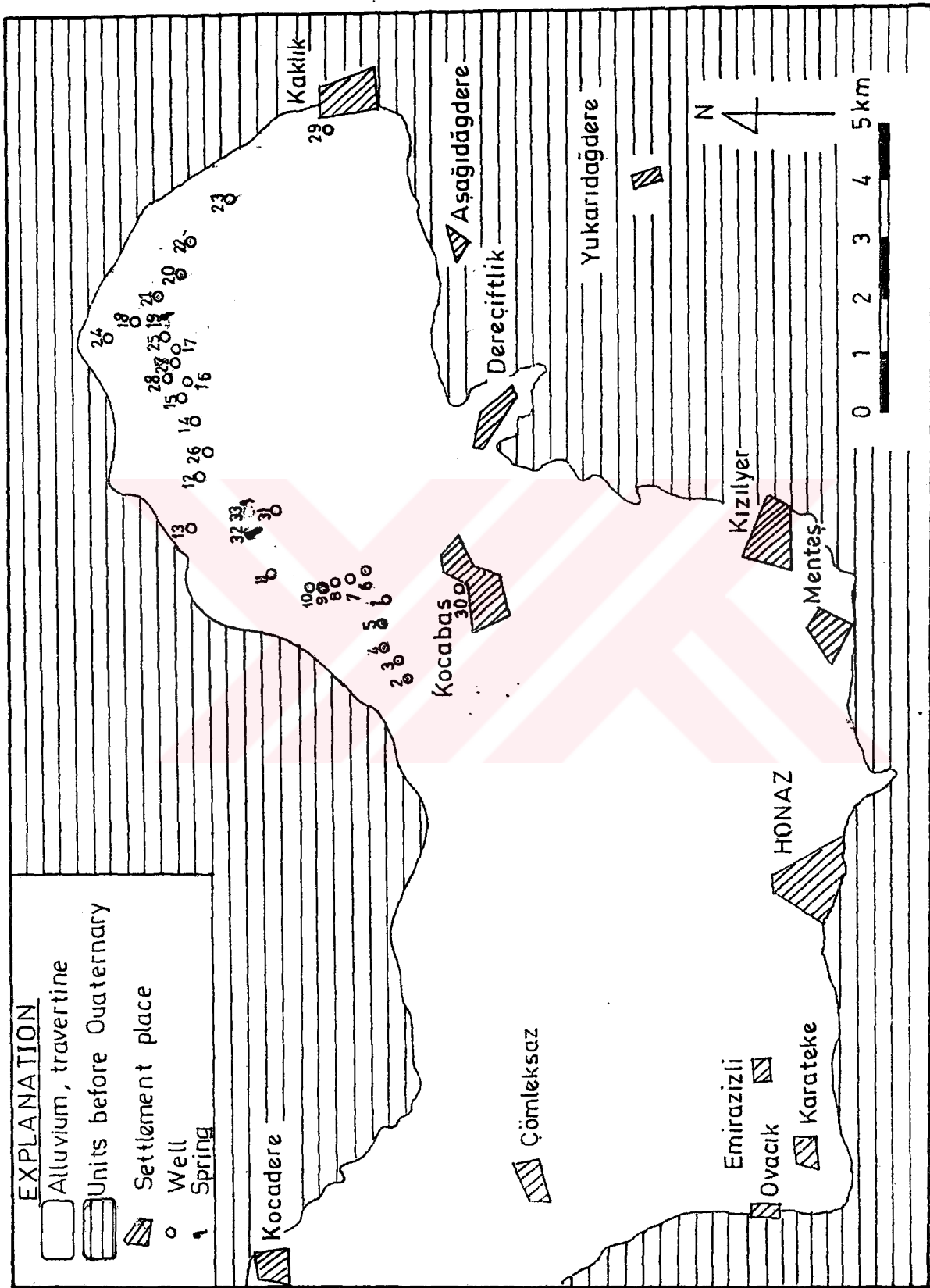


Figure 6. Location of the water points in the investigation area.

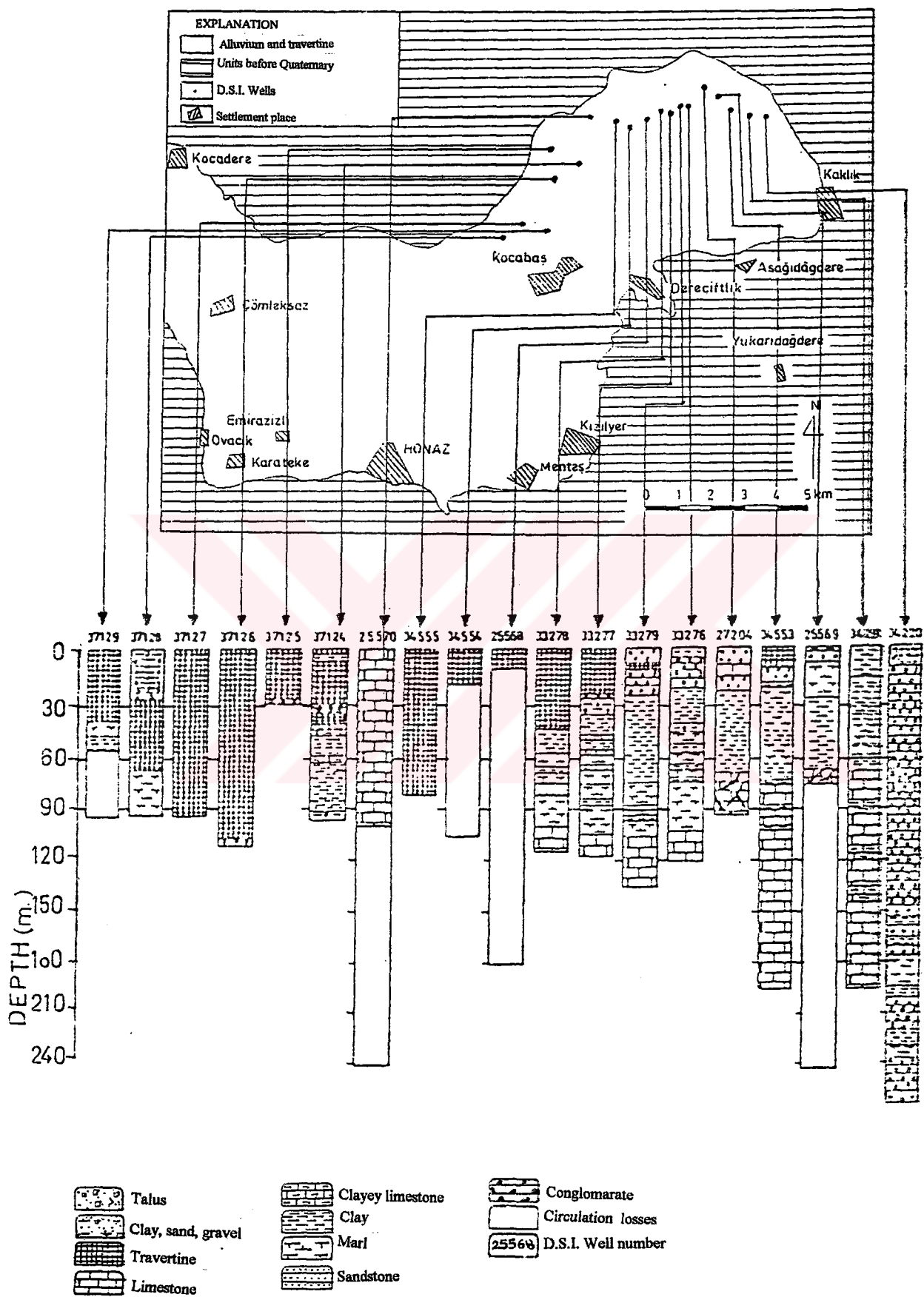


Figure 7. Data of wells in the investigation area.

Approximately 20 m west of Haydarbaba sinkhole there are "Küçük Düden". It's diameter approximately 20 m. and depth not much. This sinkhole is dry in summers.

### **5.2.3. Streams**

Çürüksu stream is the most important surface flow in the investigation area. Çürüksu stream named at north of Çömleksaz as Sarıçay and Acidere around of Gürlek. It's flow is from north to west. The other stream is Emirçay which is flowing east-west direction and mix to Çürüksu stream 1,5 km. northwest of Çömleksaz. Emirçay is named Aksu stream and Honaz stream is mix to B. Menderes river at 6 km east of Sarayköy. Other streams are seasonal streams.



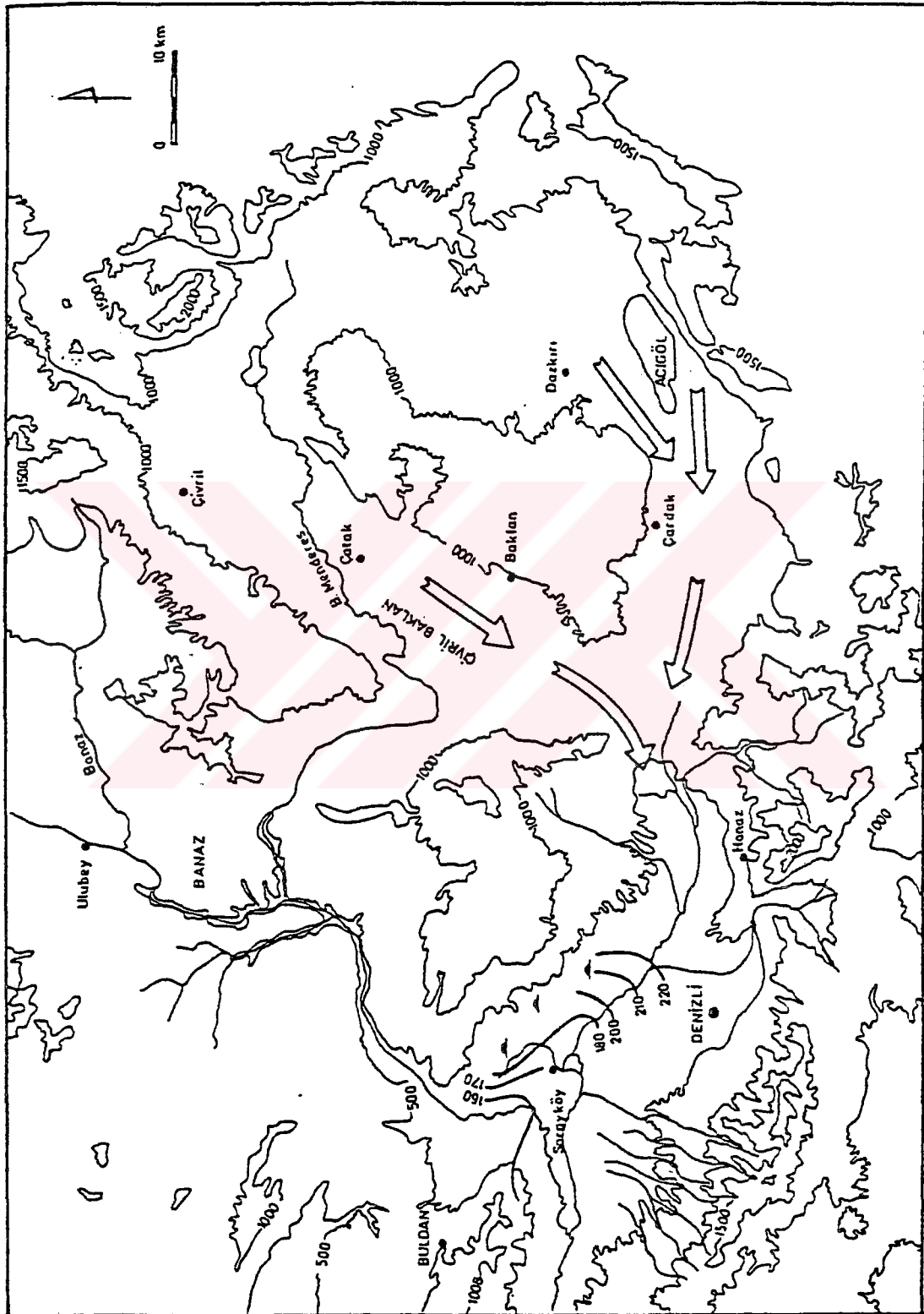


Figure 8. Recharge area of karst system in the investigation area.

### 5.3. WATER CHEMISTRY

The relatively slow movement of water percolating through the ground affords intimate and long contact of the water with the minerals that make up earth's crust. These minerals are soluble to a greater or less degree, so ground water increases in mineral content as it moves along until a combined equilibrium or balance of the dissolved substances is reached. Many variables in the chemical character of ground water, even within small regions, are encountered.

The dissolved minerals in ground water affect its usefulness for various purposes. If one or more of the minerals are in excess of the amount that can be tolerated for a given use, some type of treatment may be applied to change or remove the undesirable mineral, so that the water will serve the intended purpose.

In this section, chemical properties of Çürüksu right side ground water have been evaluated in view of drinking water standards, industrial water criteria, irrigation water criteria. For that reason ground water anion and cation dissociation, ionic strength, chemical activity, calcite-dolomite-sulfate saturation indices and partial CO<sub>2</sub> gas pressure have been calculated. Besides that ground waters have been classified according to the Piper, Schoeller, Wilcox, U.S. Salinity laboratory and calcium equilibrium diagrams so chemical properties, usefulness and similarity of origin have been investigated.

#### 5.3.1. Chemical Properties of Ground Waters

62 samples have been collected from 2 springs and 30 wells. Samples have been taken periodically date between 7.27.1993 - 11.10.1993.

Chemical analyses of samples which is taken from study area have been encountered in Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>++</sup>, Mg<sup>++</sup>, Cl<sup>-</sup>, HCO<sub>3</sub><sup>-</sup> amounts for all samples and Si<sup>+4</sup>, Sr<sup>++</sup> amounts except September samples.

Concentration of the common ions found in ground water have been reported by weight mg/l, r (miliequivalent/l=meq/l), mol/l and %meq/l values.

Investigation areas ground waters pH, electrical conductivity (EC, micromhos/cm) values and chemical analyses result %Na, sodium adsorption ratio (SAR), hardness values have been given table 7-69.

#### 5.3.2. Anions and Cations

Dissolved minerals in the ground water have been investigated as following.

**Sodium :** Sodium content of ground water around 20-40 mg/l (Figure 9). Source of sodium is metamorphic rocks especially feldspar content of gneiss in the

Table 7 Chemical analyses results of ground waters.

| SAMPLE NAME : HAYDARBABA DUDENI |      |       |         | LAB NO : D1          |                |        |        |       |
|---------------------------------|------|-------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING : JULY 1993    |      |       |         | TEMPERATURE(°C) : 23 |                |        |        |       |
| IONS                            | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                             | 31   | 1.35  | 0.00135 | 0.00135              | 0.0007         | 0.0011 | 0.83   | 5.91  |
| K+                              | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.83   | 0.45  |
| Ca++                            | 283  | 14.12 | 0.00706 | 0.02824              | 0.0141         | 0.0033 | 0.47   | 61.91 |
| Mg++                            | 88   | 7.24  | 0.00362 | 0.01447              | 0.0072         | 0.0017 | 0.47   | 31.73 |
| Cl-                             | 32   | 0.90  | 0.00090 | 0.00090              | 0.0005         | 0.0007 | 0.83   | 3.48  |
| HCO3                            | 537  | 8.30  | 0.00880 | 0.00880              | 0.0044         | 0.0073 | 0.83   | 33.99 |
| SO4=                            | 778  | 16.20 | 0.00810 | 0.03239              | 0.0162         | 0.0038 | 0.47   | 62.53 |
| TOTAL CATION AMOUNT (meq/l) :   |      |       |         | 22.81                | PH :           |        | 6.48   |       |
| TOTAL ANION AMOUNT (meq/l) :    |      |       |         | 25.90                | EC(mmho/cm) :  |        | 2510   |       |
| TOTAL ION AMOUNT (meq/l) :      |      |       |         | 48.71                | Si(mg/l) :     |        | 10.000 |       |
| IONIC STRENGTH :                |      |       |         | 0.043                | Sr++(mg/l) :   |        | 5.78   |       |
| SAR (SODIUM AD.RATIO) :         |      |       |         | 0.41                 | HARDNESS(FR) : |        | 106.79 |       |
| Cl/(SO4+HCO3) :                 |      |       |         | 0.04                 | Ca/Mg :        |        | 1.95   |       |

Table 8.

| SAMPLE NAME : DSI 34553       |      |       |         | LAB NO : D2          |                |        |        |       |
|-------------------------------|------|-------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING : JULY 1993  |      |       |         | TEMPERATURE(°C) : 23 |                |        |        |       |
| IONS                          | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 28   | 1.22  | 0.00122 | 0.00122              | 0.0006         | 0.0010 | 0.82   | 5.37  |
| K+                            | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.45  |
| Ca++                          | 283  | 14.12 | 0.00706 | 0.02824              | 0.0141         | 0.0031 | 0.44   | 62.27 |
| Mg++                          | 88   | 7.24  | 0.00362 | 0.01447              | 0.0072         | 0.0016 | 0.44   | 31.91 |
| Cl-                           | 27   | 0.76  | 0.00076 | 0.00076              | 0.0004         | 0.0006 | 0.82   | 2.16  |
| HCO3                          | 586  | 9.61  | 0.00961 | 0.00961              | 0.0048         | 0.0078 | 0.82   | 27.27 |
| SO4=                          | 1194 | 24.86 | 0.01243 | 0.04972              | 0.0249         | 0.0055 | 0.44   | 70.57 |
| TOTAL CATION AMOUNT (meq/l) : |      |       |         | 22.68                | PH :           |        | 5.49   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |       |         | 35.23                | EC(mmho/cm) :  |        | 2860   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |       |         | 57.90                | Si(mg/l) :     |        | 10.000 |       |
| IONIC STRENGTH :              |      |       |         | 0.052                | Sr++(mg/l) :   |        | 6.57   |       |
| SAR (SODIUM AD.RATIO) :       |      |       |         | 0.37                 | HARDNESS(FR) : |        | 106.79 |       |
| Cl/(SO4+HCO3) :               |      |       |         | 0.02                 | Ca/Mg :        |        | 1.95   |       |



Table 9.

| SAMPLE NAME : DSI SONDAJ            |      |       |         | LAB NO : D3           |        |        |      |       |
|-------------------------------------|------|-------|---------|-----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 23  |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                   | .5CZ2  | AC     | F    | %     |
| Na+                                 | 29   | 1.26  | 0.00126 | 0.00126               | 0.0006 | 0.0010 | 0.80 | 3.88  |
| K+                                  | 4    | 0.10  | 0.00010 | 0.00010               | 0.0001 | 0.0001 | 0.80 | 0.32  |
| Ca++                                | 423  | 21.11 | 0.01055 | 0.04222               | 0.0211 | 0.0044 | 0.42 | 64.94 |
| Mg++                                | 122  | 10.03 | 0.00502 | 0.02007               | 0.0100 | 0.0021 | 0.42 | 30.87 |
| Cl-                                 | 26   | 0.73  | 0.00073 | 0.00073               | 0.0004 | 0.0006 | 0.80 | 2.02  |
| HCO3                                | 610  | 10.00 | 0.01000 | 0.01000               | 0.0050 | 0.0080 | 0.80 | 27.56 |
| SO4=                                | 1227 | 25.54 | 0.01277 | 0.05109               | 0.0255 | 0.0053 | 0.42 | 70.41 |
| TOTAL CATION AMOUNT (meq/l) : 32.50 |      |       |         | PH : 6.42             |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 36.28  |      |       |         | EC(mmho/cm) : 3000    |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 68.78    |      |       |         | Si(mg/l) : 11.000     |        |        |      |       |
| IONIC STRENGTH : 0.063              |      |       |         | Sr++(mg/l) : 7.06     |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.32        |      |       |         | HARDNESS(FR) : 155.70 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.02                |      |       |         | Ca/Mg : 2.10          |        |        |      |       |

Table 10

| SAMPLE NAME : DSI 33278             |      |       |         | LAB NO : D4           |        |        |      |       |
|-------------------------------------|------|-------|---------|-----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 24  |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                   | .5CZ2  | AC     | F    | %     |
| Na+                                 | 29   | 1.26  | 0.00126 | 0.00126               | 0.0006 | 0.0010 | 0.80 | 3.96  |
| K+                                  | 4    | 0.10  | 0.00010 | 0.00010               | 0.0001 | 0.0001 | 0.80 | 0.32  |
| Ca++                                | 412  | 20.56 | 0.01028 | 0.04112               | 0.0206 | 0.0043 | 0.42 | 64.50 |
| Mg++                                | 121  | 9.95  | 0.00498 | 0.01990               | 0.0100 | 0.0021 | 0.42 | 31.22 |
| Cl-                                 | 29   | 0.82  | 0.00082 | 0.00082               | 0.0004 | 0.0007 | 0.80 | 2.25  |
| HCO3                                | 647  | 10.61 | 0.01061 | 0.01061               | 0.0053 | 0.0085 | 0.80 | 29.23 |
| SO4=                                | 1194 | 24.86 | 0.01243 | 0.04972               | 0.0249 | 0.0052 | 0.42 | 68.51 |
| TOTAL CATION AMOUNT (meq/l) : 31.87 |      |       |         | PH : 6.48             |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 36.28  |      |       |         | EC(mmho/cm) : 3110    |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 68.16    |      |       |         | Si(mg/l) : 11.000     |        |        |      |       |
| IONIC STRENGTH : 0.062              |      |       |         | Sr++(mg/l) : 7.22     |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.32        |      |       |         | HARDNESS(FR) : 152.55 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.02                |      |       |         | Ca/Mg : 2.07          |        |        |      |       |

Table 11

| SAMPLE NAME                   |      | : DSI 34554 |         | LAB NO :D5 |                | TEMPERATURE(°C) : 21 |        |       |
|-------------------------------|------|-------------|---------|------------|----------------|----------------------|--------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         |            |                |                      |        |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2        | .5CZ2          | AC                   | F      | %     |
| Na+                           | 24   | 1.04        | 0.00104 | 0.00104    | 0.0005         | 0.0008               | 0.80   | 3.22  |
| K+                            | 3    | 0.08        | 0.00008 | 0.00008    | 0.0000         | 0.0001               | 0.80   | 0.24  |
| Ca++                          | 421  | 21.01       | 0.01050 | 0.04202    | 0.0210         | 0.0043               | 0.41   | 64.82 |
| Mg++                          | 125  | 10.28       | 0.00514 | 0.02056    | 0.0103         | 0.0021               | 0.41   | 31.72 |
| Cl-                           | 21   | 0.59        | 0.00059 | 0.00059    | 0.0003         | 0.0005               | 0.80   | 1.53  |
| HCO3                          | 647  | 10.61       | 0.01061 | 0.01061    | 0.0053         | 0.0085               | 0.80   | 27.35 |
| SO4=                          | 1325 | 27.59       | 0.01379 | 0.05517    | 0.0276         | 0.0057               | 0.41   | 71.13 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 32.41      | PH :           |                      | 6.42   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 38.78      | EC(mmho/cm) :  |                      | 3180   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 71.19      | Si(mg/l) :     |                      | 11.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.065      | Sr++(mg/l) :   |                      | 7.43   |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.26       | HARDNESS(FR) : |                      | 156.44 |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.02       | Ca/Mg :        |                      | 2.04   |       |

Table 12

| SAMPLE NAME                   |      | : DSI 25568 |         | LAB NO :D6 |                | TEMPERATURE(°C) : 21 |        |       |
|-------------------------------|------|-------------|---------|------------|----------------|----------------------|--------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         |            |                |                      |        |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2        | .5CZ2          | AC                   | F      | %     |
| Na+                           | 25   | 1.09        | 0.00109 | 0.00109    | 0.0005         | 0.0009               | 0.80   | 3.11  |
| K+                            | 3    | 0.08        | 0.00008 | 0.00008    | 0.0000         | 0.0001               | 0.80   | 0.22  |
| Ca++                          | 458  | 22.85       | 0.01143 | 0.04571    | 0.0229         | 0.0047               | 0.41   | 65.38 |
| Mg++                          | 133  | 10.94       | 0.00547 | 0.02188    | 0.0109         | 0.0022               | 0.41   | 31.29 |
| Cl-                           | 32   | 0.90        | 0.00090 | 0.00090    | 0.0005         | 0.0007               | 0.80   | 2.45  |
| HCO3                          | 647  | 10.61       | 0.01061 | 0.01061    | 0.0053         | 0.0085               | 0.80   | 28.85 |
| SO4=                          | 1213 | 25.25       | 0.01263 | 0.05051    | 0.0253         | 0.0052               | 0.41   | 68.69 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 34.96      | PH :           |                      | 6.44   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 36.76      | EC(mmho/cm) :  |                      | 3260   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 71.72      | Si(mg/l) :     |                      | 11.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.065      | Sr++(mg/l) :   |                      | 7.46   |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.26       | HARDNESS(FR) : |                      | 168.96 |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.03       | Ca/Mg :        |                      | 2.09   |       |



Table 13

| SAMPLE NAME                   |      | : DSI 33279 |         | LAB NO :D7A          |              |        |         |       |
|-------------------------------|------|-------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         | TEMPERATURE(°C) : 21 |              |        |         |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 30   | 1.30        | 0.00130 | 0.00130              | 0.0007       | 0.0011 | 0.81    | 3.84  |
| K+                            | 4    | 0.10        | 0.00010 | 0.00010              | 0.0001       | 0.0001 | 0.81    | 0.30  |
| Ca++                          | 452  | 22.55       | 0.01128 | 0.04511              | 0.0226       | 0.0049 | 0.43    | 66.35 |
| Mg++                          | 122  | 10.03       | 0.00502 | 0.02007              | 0.0100       | 0.0022 | 0.43    | 29.51 |
| Cl-                           | 30   | 0.85        | 0.00085 | 0.00085              | 0.0004       | 0.0007 | 0.81    | 3.00  |
| HCO3                          | 610  | 10.00       | 0.01000 | 0.01000              | 0.0050       | 0.0081 | 0.81    | 35.50 |
| SO4=                          | 832  | 17.32       | 0.00866 | 0.03464              | 0.0173       | 0.0037 | 0.43    | 61.49 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 34.00                | PH           |        | : 6.41  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 28.17                | EC(mmho/cm)  |        | : 3000  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 62.16                | Si(mg/l)     |        | :11.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.056                | Sr++(mg/l)   |        | : 6.97  |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.32                 | HARDNESS(FR) |        | :162.94 |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.03                 | Ca/Mg        |        | : 2.25  |       |

Table 14

| SAMPLE NAME                   |      | : DSI 33279 YANI |         | LAB NO :D7B         |              |        |         |       |
|-------------------------------|------|------------------|---------|---------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : JULY 1993      |         | TEMPERATURE(°C) : 0 |              |        |         |       |
| IONS                          | mg/l | meq/l            | mol/l   | CZ2                 | .5CZ2        | AC     | F       | %     |
| Na+                           | 30   | 1.30             | 0.00130 | 0.00130             | 0.0007       | 0.0010 | 0.79    | 3.80  |
| K+                            | 4    | 0.10             | 0.00010 | 0.00010             | 0.0001       | 0.0001 | 0.79    | 0.30  |
| Ca++                          | 465  | 23.20            | 0.01160 | 0.04641             | 0.0232       | 0.0046 | 0.40    | 67.62 |
| Mg++                          | 118  | 9.70             | 0.00485 | 0.01941             | 0.0097       | 0.0019 | 0.40    | 28.28 |
| Cl-                           | 28   | 0.79             | 0.00079 | 0.00079             | 0.0004       | 0.0006 | 0.79    | 1.81  |
| HCO3                          | 598  | 9.80             | 0.00980 | 0.00980             | 0.0049       | 0.0078 | 0.79    | 22.43 |
| SO4=                          | 1591 | 33.12            | 0.01656 | 0.06625             | 0.0331       | 0.0066 | 0.40    | 75.77 |
| TOTAL CATION AMOUNT (meq/l) : |      |                  |         | 34.32               | PH           |        | : 6.47  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                  |         | 43.72               | EC(mmho/cm)  |        | : 2990  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                  |         | 78.03               | Si(mg/l)     |        | :11.000 |       |
| IONIC STRENGTH :              |      |                  |         | 0.072               | Sr++(mg/l)   |        | : 6.97  |       |
| SAR (SODIUM AD.RATIO) :       |      |                  |         | 0.32                | HARDNESS(FR) |        | :164.54 |       |
| Cl/(SO4+HCO3) :               |      |                  |         | 0.02                | Ca/Mg        |        | : 2.39  |       |

Table 15

| SAMPLE NAME                   |      | : CIMENTO FABRIKASI |         |         |                | LAB NO : D8       |        |       |
|-------------------------------|------|---------------------|---------|---------|----------------|-------------------|--------|-------|
| DATE OF SAMPLING              |      | : JULY 1993         |         |         |                | TEMPERATURE(°C) : |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2     | .5CZ2          | AC                | F      | %     |
| Na+                           | 31   | 1.35                | 0.00135 | 0.00135 | 0.0007         | 0.0012            | 0.86   | 13.88 |
| K+                            | 1    | 0.03                | 0.00003 | 0.00003 | 0.0000         | 0.0000            | 0.86   | 0.26  |
| Ca++                          | 37   | 1.85                | 0.00092 | 0.00369 | 0.0018         | 0.0005            | 0.54   | 19.00 |
| Mg++                          | 79   | 6.50                | 0.00325 | 0.01299 | 0.0065         | 0.0018            | 0.54   | 66.86 |
| Cl-                           | 25   | 0.70                | 0.00070 | 0.00070 | 0.0004         | 0.0006            | 0.86   | 3.58  |
| HCO3                          | 378  | 6.20                | 0.00620 | 0.00620 | 0.0031         | 0.0053            | 0.86   | 31.48 |
| SO4=                          | 614  | 12.78               | 0.00639 | 0.02557 | 0.0128         | 0.0035            | 0.54   | 64.94 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 9.72    | PH :           |                   | 7.81   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 19.68   | EC(mmho/cm) :  |                   | 1160   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 29.40   | Si(mg/l) :     |                   | 25.000 |       |
| IONIC STRENGTH :              |      |                     |         | 0.025   | Sr++(mg/l) :   |                   | 0.00   |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.66    | HARDNESS(FR) : |                   | 41.72  |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.04    | Ca/Mg :        |                   | 0.28   |       |

Table 16.

| SAMPLE NAME                   |      | : DSI 25569 |         |         |                | LAB NO : D9          |        |       |
|-------------------------------|------|-------------|---------|---------|----------------|----------------------|--------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         |         |                | TEMPERATURE(°C) : 23 |        |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2     | .5CZ2          | AC                   | F      | %     |
| Na+                           | 30   | 1.30        | 0.00130 | 0.00130 | 0.0007         | 0.0011               | 0.82   | 5.29  |
| K+                            | 4    | 0.10        | 0.00010 | 0.00010 | 0.0001         | 0.0001               | 0.82   | 0.42  |
| Ca++                          | 308  | 15.37       | 0.00768 | 0.03074 | 0.0154         | 0.0035               | 0.45   | 62.30 |
| Mg++                          | 96   | 7.89        | 0.00395 | 0.01579 | 0.0079         | 0.0018               | 0.45   | 32.00 |
| Cl-                           | 29   | 0.82        | 0.00082 | 0.00082 | 0.0004         | 0.0007               | 0.82   | 2.80  |
| HCO3                          | 525  | 8.61        | 0.00861 | 0.00861 | 0.0043         | 0.0071               | 0.82   | 29.45 |
| SO4=                          | 951  | 19.80       | 0.00990 | 0.03960 | 0.0198         | 0.0045               | 0.45   | 67.75 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 24.67   | PH :           |                      | 6.50   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 29.22   | EC(mmho/cm) :  |                      | 2460   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 53.89   | Si(mg/l) :     |                      | 11.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.048   | Sr++(mg/l) :   |                      | 5.56   |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.38    | HARDNESS(FR) : |                      | 116.32 |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.03    | Ca/Mg :        |                      | 1.95   |       |

Table 17.

| SAMPLE NAME : DSI 34291             |      |       |         | LAB NO : D10          |        |        |      |       |
|-------------------------------------|------|-------|---------|-----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 21  |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                   | .5CZ2  | AC     | F    | %     |
| Na+                                 | 20   | 0.87  | 0.00087 | 0.00087               | 0.0004 | 0.0007 | 0.81 | 2.73  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008               | 0.0000 | 0.0001 | 0.81 | 0.24  |
| Ca++                                | 410  | 20.46 | 0.01023 | 0.04092               | 0.0205 | 0.0044 | 0.43 | 64.24 |
| Mg++                                | 127  | 10.44 | 0.00522 | 0.02089               | 0.0104 | 0.0022 | 0.43 | 32.79 |
| Cl-                                 | 8    | 0.23  | 0.00023 | 0.00023               | 0.0001 | 0.0002 | 0.81 | 0.71  |
| HCO3                                | 696  | 11.41 | 0.01141 | 0.01141               | 0.0057 | 0.0092 | 0.81 | 35.71 |
| SO4=                                | 976  | 20.32 | 0.01016 | 0.04064               | 0.0203 | 0.0043 | 0.43 | 63.59 |
| TOTAL CATION AMOUNT (meq/l) : 31.85 |      |       |         | PH : 6.22             |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 31.95  |      |       |         | EC(mmho/cm) : 3060    |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 63.80    |      |       |         | Si(mg/l) : 11.000     |        |        |      |       |
| IONIC STRENGTH : 0.058              |      |       |         | Sr++(mg/l) : 7.08     |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.22        |      |       |         | HARINESS(FR) : 154.52 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.01                |      |       |         | Ca/Mg : 1.96          |        |        |      |       |

Table 18.

| SAMPLE NAME : DSI 43530             |      |       |         | LAB NO : D11         |        |        |      |       |
|-------------------------------------|------|-------|---------|----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 18 |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC     | F    | %     |
| Na+                                 | 39   | 1.70  | 0.00170 | 0.00170              | 0.0008 | 0.0014 | 0.85 | 11.77 |
| K+                                  | 1    | 0.03  | 0.00003 | 0.00003              | 0.0000 | 0.0000 | 0.85 | 0.18  |
| Ca++                                | 68   | 3.39  | 0.00170 | 0.00679              | 0.0034 | 0.0009 | 0.52 | 23.55 |
| Mg++                                | 113  | 9.29  | 0.00465 | 0.01859              | 0.0093 | 0.0024 | 0.52 | 64.50 |
| Cl-                                 | 26   | 0.73  | 0.00073 | 0.00073              | 0.0004 | 0.0006 | 0.85 | 3.62  |
| HCO3                                | 561  | 9.20  | 0.00920 | 0.00920              | 0.0046 | 0.0078 | 0.85 | 45.40 |
| SO4=                                | 496  | 10.33 | 0.00516 | 0.02065              | 0.0103 | 0.0027 | 0.52 | 50.98 |
| TOTAL CATION AMOUNT (meq/l) : 14.41 |      |       |         | PH : 7.57            |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 20.26  |      |       |         | EC(mmho/cm) : 1380   |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 34.66    |      |       |         | Si(mg/l) : 20.000    |        |        |      |       |
| IONIC STRENGTH : 0.029              |      |       |         | Sr++(mg/l) : 0.60    |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.67        |      |       |         | HARDNESS(FR) : 63.43 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.04                |      |       |         | Ca/Mg : 0.37         |        |        |      |       |

Table 19

| SAMPLE NAME                   |      | : DSI 34291 |         | LAB NO :D10          |              |        |          |       |
|-------------------------------|------|-------------|---------|----------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         | TEMPERATURE(°C) : 21 |              |        |          |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2                  | .5CZ2        | AC     | F        | %     |
| Na+                           | 20   | 0.87        | 0.00087 | 0.00087              | 0.0004       | 0.0007 | 0.81     | 2.73  |
| K+                            | 3    | 0.08        | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.81     | 0.24  |
| Ca++                          | 410  | 20.46       | 0.01023 | 0.04092              | 0.0205       | 0.0044 | 0.43     | 64.24 |
| Mg++                          | 127  | 10.44       | 0.00522 | 0.02089              | 0.0104       | 0.0022 | 0.43     | 32.79 |
| Cl-                           | 8    | 0.23        | 0.00023 | 0.00023              | 0.0001       | 0.0002 | 0.81     | 0.71  |
| HCO3                          | 696  | 11.41       | 0.01141 | 0.01141              | 0.0057       | 0.0092 | 0.81     | 35.71 |
| SO4=                          | 976  | 20.32       | 0.01016 | 0.04064              | 0.0203       | 0.0043 | 0.43     | 63.59 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 31.85                | PH           |        | : 6.22   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 31.95                | EC(mmho/cm)  |        | : 3060   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 63.80                | Si(mg/l)     |        | : 11.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.058                | Sr++(mg/l)   |        | : 7.08   |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.22                 | HARDNESS(FR) |        | : 154.52 |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.01                 | Ca/Mg        |        | : 1.96   |       |

Table 20

| SAMPLE NAME                   |      | : DSI 43530 |         | LAB NO :D11          |              |        |          |       |
|-------------------------------|------|-------------|---------|----------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : JULY 1993 |         | TEMPERATURE(°C) : 18 |              |        |          |       |
| IONS                          | mg/l | meq/l       | mol/l   | CZ2                  | .5CZ2        | AC     | F        | %     |
| Na+                           | 39   | 1.70        | 0.00170 | 0.00170              | 0.0008       | 0.0014 | 0.85     | 11.77 |
| K+                            | 1    | 0.03        | 0.00003 | 0.00003              | 0.0000       | 0.0000 | 0.85     | 0.18  |
| Ca++                          | 68   | 3.39        | 0.00170 | 0.00679              | 0.0034       | 0.0009 | 0.52     | 23.55 |
| Mg++                          | 113  | 9.29        | 0.00465 | 0.01859              | 0.0093       | 0.0024 | 0.52     | 64.50 |
| Cl-                           | 26   | 0.73        | 0.00073 | 0.00073              | 0.0004       | 0.0006 | 0.85     | 3.62  |
| HCO3                          | 561  | 9.20        | 0.00920 | 0.00920              | 0.0046       | 0.0078 | 0.85     | 45.40 |
| SO4=                          | 496  | 10.33       | 0.00516 | 0.02065              | 0.0103       | 0.0027 | 0.52     | 50.98 |
| TOTAL CATION AMOUNT (meq/l) : |      |             |         | 14.41                | PH           |        | : 7.57   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |             |         | 20.26                | EC(mmho/cm)  |        | : 1380   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |             |         | 34.66                | Si(mg/l)     |        | : 20.000 |       |
| IONIC STRENGTH :              |      |             |         | 0.029                | Sr++(mg/l)   |        | : 0.60   |       |
| SAR (SODIUM AD.RATIO) :       |      |             |         | 0.67                 | HARDNESS(FR) |        | : 63.43  |       |
| Cl/(SO4+HCO3) :               |      |             |         | 0.04                 | Ca/Mg        |        | : 0.37   |       |

Table 21

| SAMPLE NAME : KAKLIK ÇEŞME SUYU     |      |       |         | LAB NO :D12          |        |          |      |       |
|-------------------------------------|------|-------|---------|----------------------|--------|----------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 20 |        |          |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC       | F    | %     |
| Na+                                 | 14   | 0.61  | 0.00061 | 0.00061              | 0.0003 | 0.0005   | 0.87 | 5.76  |
| K+                                  | 1    | 0.03  | 0.00003 | 0.00003              | 0.0000 | 0.0000   | 0.87 | 0.24  |
| Ca++                                | 79   | 3.94  | 0.00197 | 0.00788              | 0.0039 | 0.0011   | 0.57 | 37.26 |
| Mg++                                | 73   | 6.00  | 0.00300 | 0.01201              | 0.0060 | 0.0017   | 0.57 | 56.74 |
| Cl-                                 | 25   | 0.70  | 0.00070 | 0.00070              | 0.0004 | 0.0006   | 0.87 | 5.35  |
| HCO3                                | 378  | 6.20  | 0.00620 | 0.00620              | 0.0031 | 0.0054   | 0.87 | 47.06 |
| SO4=                                | 301  | 6.27  | 0.00313 | 0.01253              | 0.0063 | 0.0018   | 0.57 | 47.59 |
| TOTAL CATION AMOUNT (meq/l) : 10.58 |      |       |         | PH                   |        | : 7.61   |      |       |
| TOTAL ANION AMOUNT (meq/l) : 13.17  |      |       |         | EC(mmho/cm)          |        | : 1000   |      |       |
| TOTAL ION AMOUNT (meq/l) : 23.75    |      |       |         | Si(mg/l)             |        | : 27.000 |      |       |
| IONIC STRENGTH : 0.020              |      |       |         | Sr++(mg/l)           |        | :        |      |       |
| SAR (SODIUM AD.RATIO) : 0.27        |      |       |         | HARDNESS(FR)         |        | : 49.73  |      |       |
| Cl/(SO4+HCO3) : 0.06                |      |       |         | Ca/Mg                |        | : 0.66   |      |       |

Table 22

| SAMPLE NAME : DEI 37430             |      |       |         | LAB NO :D13          |        |          |      |       |
|-------------------------------------|------|-------|---------|----------------------|--------|----------|------|-------|
| DATE OF SAMPLING : JULY 1993        |      |       |         | TEMPERATURE(°C) : 19 |        |          |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC       | F    | %     |
| Na+                                 | 10   | 0.43  | 0.00043 | 0.00043              | 0.0002 | 0.0004   | 0.81 | 1.34  |
| K+                                  | 2    | 0.05  | 0.00005 | 0.00005              | 0.0000 | 0.0000   | 0.81 | 0.16  |
| Ca++                                | 441  | 22.01 | 0.01100 | 0.04401              | 0.0220 | 0.0047   | 0.43 | 67.83 |
| Mg++                                | 121  | 9.95  | 0.00498 | 0.01990              | 0.0100 | 0.0021   | 0.43 | 30.67 |
| Cl-                                 | 2    | 0.06  | 0.00006 | 0.00006              | 0.0000 | 0.0000   | 0.81 | 0.19  |
| HCO3                                | 635  | 10.41 | 0.01041 | 0.01041              | 0.0052 | 0.0084   | 0.81 | 34.83 |
| SO4=                                | 933  | 19.42 | 0.00971 | 0.03885              | 0.0194 | 0.0042   | 0.43 | 64.98 |
| TOTAL CATION AMOUNT (meq/l) : 32.44 |      |       |         | PH                   |        | : 6.30   |      |       |
| TOTAL ANION AMOUNT (meq/l) : 29.89  |      |       |         | EC(mmho/cm)          |        | : 2630   |      |       |
| TOTAL ION AMOUNT (meq/l) : 62.33    |      |       |         | Si(mg/l)             |        | : 10.000 |      |       |
| IONIC STRENGTH : 0.057              |      |       |         | Sr++(mg/l)           |        | : 5.78   |      |       |
| SAR (SODIUM AD.RATIO) : 0.11        |      |       |         | HARDNESS(FR)         |        | : 159.78 |      |       |
| Cl/(SO4+HCO3) : 0.00                |      |       |         | Ca/Mg                |        | : 2.21   |      |       |



Table 23

| SAMPLE NAME : DSI KOCABAŞ SONDAJ    |      |       |         | LAB NO : D1          |        |                    |      |       |
|-------------------------------------|------|-------|---------|----------------------|--------|--------------------|------|-------|
| DATE OF SAMPLING : 8 JULY 1993      |      |       |         | TEMPERATURE(°C) : 20 |        |                    |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC                 | F    | %     |
| Na+                                 | 28   | 1.22  | 0.00122 | 0.00122              | 0.0006 | 0.0010             | 0.82 | 6.22  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008              | 0.0000 | 0.0001             | 0.82 | 0.39  |
| Ca++                                | 205  | 10.23 | 0.00511 | 0.02046              | 0.0102 | 0.0024             | 0.46 | 52.24 |
| Mg++                                | 98   | 8.06  | 0.00403 | 0.01612              | 0.0081 | 0.0019             | 0.46 | 41.15 |
| Cl-                                 | 24   | 0.68  | 0.00068 | 0.00068              | 0.0003 | 0.0006             | 0.82 | 2.23  |
| HCO3                                | 561  | 9.20  | 0.00920 | 0.00920              | 0.0046 | 0.0076             | 0.82 | 30.31 |
| SO4=                                | 983  | 20.47 | 0.01023 | 0.04093              | 0.0205 | 0.0047             | 0.46 | 67.46 |
| TOTAL CATION AMOUNT (meq/l) : 19.58 |      |       |         | PH : 6.93            |        | EC(mmho/cm) : 3120 |      |       |
| TOTAL ANION AMOUNT (meq/l) : 30.34  |      |       |         | Si(mg/l) : 12.000    |        | Sr++(mg/l) : 5.80  |      |       |
| TOTAL ION AMOUNT (meq/l) : 49.92    |      |       |         | HARDNESS(FR) : 91.44 |        | Ca/Mg : 1.27       |      |       |
| IONIC STRENGTH : 0.044              |      |       |         |                      |        |                    |      |       |
| SAR (SODIUM AD.RATIO) : 0.40        |      |       |         |                      |        |                    |      |       |
| Cl/(SO4+HCO3) : 0.02                |      |       |         |                      |        |                    |      |       |

Table 24

| SAMPLE NAME : DSI 39339 B           |      |       |         | LAB NO : D2           |        |                    |      |       |
|-------------------------------------|------|-------|---------|-----------------------|--------|--------------------|------|-------|
| DATE OF SAMPLING : 8 JULY 1993      |      |       |         | TEMPERATURE(°C) : 20  |        |                    |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                   | .5CZ2  | AC                 | F    | %     |
| Na+                                 | 28   | 1.22  | 0.00122 | 0.00122               | 0.0006 | 0.0010             | 0.82 | 5.63  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008               | 0.0000 | 0.0001             | 0.82 | 0.36  |
| Ca++                                | 228  | 11.38 | 0.00569 | 0.02275               | 0.0114 | 0.0026             | 0.45 | 52.59 |
| Mg++                                | 109  | 8.96  | 0.00448 | 0.01793               | 0.0090 | 0.0020             | 0.45 | 41.43 |
| Cl-                                 | 26   | 0.73  | 0.00073 | 0.00073               | 0.0004 | 0.0006             | 0.82 | 2.29  |
| HCO3                                | 574  | 9.41  | 0.00941 | 0.00941               | 0.0047 | 0.0077             | 0.82 | 29.42 |
| SO4=                                | 1049 | 21.84 | 0.01092 | 0.04368               | 0.0218 | 0.0049             | 0.45 | 68.29 |
| TOTAL CATION AMOUNT (meq/l) : 21.64 |      |       |         | PH : 6.93             |        | EC(mmho/cm) : 3310 |      |       |
| TOTAL ANION AMOUNT (meq/l) : 31.98  |      |       |         | Si(mg/l) : 12.000     |        | Sr++(mg/l) : 5.90  |      |       |
| TOTAL ION AMOUNT (meq/l) : 53.62    |      |       |         | HARDNESS(FR) : 101.71 |        | Ca/Mg : 1.27       |      |       |
| IONIC STRENGTH : 0.048              |      |       |         |                       |        |                    |      |       |
| SAR (SODIUM AD.RATIO) : 0.38        |      |       |         |                       |        |                    |      |       |
| Cl/(SO4+HCO3) : 0.02                |      |       |         |                       |        |                    |      |       |

Table 25

| SAMPLE NAME                   |      | : DSI 39336 A |         | LAB NO :D3           |              |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 8 JULY 1993 |         | TEMPERATURE(°C) : 20 |              |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2        | AC     | F        | %     |
| Na+                           | 28   | 1.22          | 0.00122 | 0.00122              | 0.0006       | 0.0010 | 0.82     | 5.96  |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.82     | 0.38  |
| Ca++                          | 219  | 10.93         | 0.00546 | 0.02186              | 0.0109       | 0.0025 | 0.46     | 53.45 |
| Mg++                          | 100  | 8.22          | 0.00411 | 0.01645              | 0.0082       | 0.0019 | 0.46     | 40.22 |
| Cl-                           | 24   | 0.68          | 0.00068 | 0.00068              | 0.0003       | 0.0006 | 0.82     | 2.13  |
| HCO3                          | 586  | 9.61          | 0.00961 | 0.00961              | 0.0048       | 0.0079 | 0.82     | 30.22 |
| SO4=                          | 1033 | 21.51         | 0.01075 | 0.04301              | 0.0215       | 0.0049 | 0.46     | 67.65 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 20.45                | PH           |        | : 6.73   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 31.79                | EC(mmho/cm)  |        | : 3160   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 52.24                | Si(mg/l)     |        | : 12.000 |       |
| IONIC STRENGTH :              |      |               |         | 0.046                | Sr++(mg/l)   |        | : 5.97   |       |
| SAR (SODIUM AD.RATIO) :       |      |               |         | 0.39                 | HARDNESS(FR) |        | : 95.76  |       |
| Cl/(SO4+HCO3) :               |      |               |         | 0.02                 | Ca/Mg        |        | : 1.33   |       |

Table 26

| SAMPLE NAME                   |      | : DSI 37126   |         | LAB NO :D4           |              |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 8 JULY 1993 |         | TEMPERATURE(°C) : 20 |              |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2        | AC     | F        | %     |
| Na+                           | 28   | 1.22          | 0.00122 | 0.00122              | 0.0006       | 0.0010 | 0.82     | 5.32  |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.82     | 0.34  |
| Ca++                          | 250  | 12.48         | 0.00624 | 0.02495              | 0.0125       | 0.0028 | 0.45     | 54.48 |
| Mg++                          | 111  | 9.13          | 0.00456 | 0.01826              | 0.0091       | 0.0021 | 0.45     | 39.86 |
| Cl-                           | 27   | 0.76          | 0.00076 | 0.00076              | 0.0004       | 0.0006 | 0.82     | 2.46  |
| HCO3                          | 561  | 9.20          | 0.00920 | 0.00920              | 0.0046       | 0.0075 | 0.82     | 29.72 |
| SO4=                          | 1008 | 20.99         | 0.01049 | 0.04197              | 0.0210       | 0.0047 | 0.45     | 67.82 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 22.90                | PH           |        | : 6.86   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 30.94                | EC(mmho/cm)  |        | : 3200   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 53.84                | Si(mg/l)     |        | : 13.000 |       |
| IONIC STRENGTH :              |      |               |         | 0.048                | Sr++(mg/l)   |        | : 6.26   |       |
| SAR (SODIUM AD.RATIO) :       |      |               |         | 0.37                 | HARDNESS(FR) |        | : 108.02 |       |
| Cl/(SO4+HCO3) :               |      |               |         | 0.03                 | Ca/Mg        |        | : 1.37   |       |



Table 27

| SAMPLE NAME : DSI 29334             |      |       |         |         | LAB NO : D5           |        |      |       |
|-------------------------------------|------|-------|---------|---------|-----------------------|--------|------|-------|
| DATE OF SAMPLING : 8 JULY 1993      |      |       |         |         | TEMPERATURE(°C) : 20  |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2     | .5CZ2                 | AC     | F    | %     |
| Na+                                 | 29   | 1.26  | 0.00126 | 0.00126 | 0.0006                | 0.0010 | 0.82 | 5.77  |
| K+                                  | 4    | 0.10  | 0.00010 | 0.00010 | 0.0001                | 0.0001 | 0.82 | 0.47  |
| Ca++                                | 228  | 11.38 | 0.00569 | 0.02275 | 0.0114                | 0.0025 | 0.45 | 52.02 |
| Mg++                                | 111  | 9.13  | 0.00456 | 0.01826 | 0.0091                | 0.0020 | 0.45 | 41.74 |
| Cl-                                 | 29   | 0.82  | 0.00082 | 0.00082 | 0.0004                | 0.0007 | 0.82 | 2.44  |
| HCO3                                | 513  | 8.41  | 0.00841 | 0.00841 | 0.0042                | 0.0069 | 0.82 | 25.07 |
| SO4=                                | 1168 | 24.32 | 0.01216 | 0.04863 | 0.0243                | 0.0054 | 0.45 | 72.49 |
| TOTAL CATION AMOUNT (meq/l) : 21.87 |      |       |         |         | PH : 6.88             |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 33.54  |      |       |         |         | EC(mmho/cm) : 3430    |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 55.41    |      |       |         |         | Si(mg/l) : 17.000     |        |      |       |
| IONIC STRENGTH : 0.050              |      |       |         |         | Sr++(mg/l) : 6.58     |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.39        |      |       |         |         | HARINESS(FR) : 102.53 |        |      |       |
| Cl/(SO4+HCO3) : 0.02                |      |       |         |         | Ca/Mg : 1.25          |        |      |       |

Table 28

| SAMPLE NAME : DSI 37125             |      |       |         |         | LAB NO : D6           |        |      |       |
|-------------------------------------|------|-------|---------|---------|-----------------------|--------|------|-------|
| DATE OF SAMPLING : 8 JULY 1993      |      |       |         |         | TEMPERATURE(°C) : 18  |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2     | .5CZ2                 | AC     | F    | %     |
| Na+                                 | 33   | 1.44  | 0.00144 | 0.00144 | 0.0007                | 0.0012 | 0.81 | 5.80  |
| K+                                  | 4    | 0.10  | 0.00010 | 0.00010 | 0.0001                | 0.0001 | 0.81 | 0.41  |
| Ca++                                | 234  | 11.68 | 0.00584 | 0.02335 | 0.0117                | 0.0025 | 0.43 | 47.22 |
| Mg++                                | 140  | 11.51 | 0.00576 | 0.02303 | 0.0115                | 0.0025 | 0.43 | 46.56 |
| Cl-                                 | 34   | 0.96  | 0.00096 | 0.00096 | 0.0005                | 0.0008 | 0.81 | 2.75  |
| HCO3                                | 403  | 6.61  | 0.00661 | 0.00661 | 0.0033                | 0.0054 | 0.81 | 18.93 |
| SO4=                                | 1313 | 27.34 | 0.01367 | 0.05467 | 0.0273                | 0.0059 | 0.43 | 78.32 |
| TOTAL CATION AMOUNT (meq/l) : 24.73 |      |       |         |         | PH : 7.03             |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 34.90  |      |       |         |         | EC(mmho/cm) : 3400    |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 59.63    |      |       |         |         | Si(mg/l) : 22.000     |        |      |       |
| IONIC STRENGTH : 0.055              |      |       |         |         | Sr++(mg/l) : 7.08     |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.42        |      |       |         |         | HARINESS(FR) : 115.95 |        |      |       |
| Cl/(SO4+HCO3) : 0.03                |      |       |         |         | Ca/Mg : 1.01          |        |      |       |

Table 29

| SAMPLE NAME                   |      | : DSI 37124   |         | LAB NO :D7           |               |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|---------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 8 JULY 1993 |         | TEMPERATURE(°C) : 22 |               |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2         | AC     | F        | %     |
| Na+                           | 25   | 1.09          | 0.00109 | 0.00109              | 0.0005        | 0.0009 | 0.82     | 5.30  |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000        | 0.0001 | 0.82     | 0.37  |
| Ca++                          | 228  | 11.38         | 0.00569 | 0.02275              | 0.0114        | 0.0026 | 0.45     | 55.45 |
| Mg++                          | 97   | 7.98          | 0.00399 | 0.01595              | 0.0080        | 0.0018 | 0.45     | 38.88 |
| Cl-                           | 25   | 0.70          | 0.00070 | 0.00070              | 0.0004        | 0.0006 | 0.82     | 2.12  |
| HCO3                          | 622  | 10.20         | 0.01020 | 0.01020              | 0.0051        | 0.0084 | 0.82     | 30.66 |
| SO4=                          | 1074 | 22.36         | 0.01118 | 0.04472              | 0.0224        | 0.0051 | 0.45     | 67.22 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 20.52                | PH            |        | : 6.80   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 33.26                | EC(mmho/cm)   |        | : 3540   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 53.78                | Si(mg/l)      |        | : 12.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.048              | Sr++(mg/l)    |        | : 6.14   |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.35               | HARINNESS(FR) |        | : 96.77  |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.02               | Ca/Mg         |        | : 1.43   |       |

Table 30

| SAMPLE NAME                   |      | : DSI 45600   |         | LAB NO :D8           |               |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|---------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 8 JULY 1993 |         | TEMPERATURE(°C) : 25 |               |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2         | AC     | F        | %     |
| Na+                           | 14   | 0.61          | 0.00061 | 0.00061              | 0.0003        | 0.0005 | 0.89     | 9.67  |
| K+                            | 1    | 0.03          | 0.00003 | 0.00003              | 0.0000        | 0.0000 | 0.89     | 0.41  |
| Ca++                          | 13   | 0.65          | 0.00032 | 0.00130              | 0.0006        | 0.0002 | 0.62     | 10.30 |
| Mg++                          | 61   | 5.02          | 0.00251 | 0.01003              | 0.0050        | 0.0016 | 0.62     | 79.63 |
| Cl-                           | 23   | 0.65          | 0.00065 | 0.00065              | 0.0003        | 0.0006 | 0.89     | 5.67  |
| HCO3                          | 415  | 6.80          | 0.00680 | 0.00680              | 0.0034        | 0.0060 | 0.89     | 59.53 |
| SO4=                          | 191  | 3.98          | 0.00199 | 0.00795              | 0.0040        | 0.0012 | 0.62     | 34.80 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 6.30                 | PH            |        | : 7.60   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 11.43                | EC(mmho/cm)   |        | : 1250   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 17.73                | Si(mg/l)      |        | : 28.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.014              | Sr++(mg/l)    |        | : 0.42   |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.36               | HARINNESS(FR) |        | : 28.33  |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.06               | Ca/Mg         |        | : 0.13   |       |

Table 31

| SAMPLE NAME                   |      | : DSI 33278   |         | LAB NO : D1          |               |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|---------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : 25 |               |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2         | AC     | F        | %     |
| Na+                           | 29   | 1.26          | 0.00126 | 0.00126              | 0.0006        | 0.0011 | 0.84     | 11.99 |
| K+                            | 4    | 0.10          | 0.00010 | 0.00010              | 0.0001        | 0.0001 | 0.84     | 0.97  |
| Ca++                          | 116  | 5.79          | 0.00289 | 0.01158              | 0.0058        | 0.0015 | 0.50     | 55.00 |
| Mg++                          | 41   | 3.37          | 0.00169 | 0.00674              | 0.0034        | 0.0008 | 0.50     | 32.04 |
| Cl-                           | 9    | 0.25          | 0.00025 | 0.00025              | 0.0001        | 0.0002 | 0.84     | 0.90  |
| HCO3                          | 598  | 9.80          | 0.00980 | 0.00980              | 0.0049        | 0.0083 | 0.84     | 34.80 |
| SO4=                          | 870  | 18.11         | 0.00906 | 0.03623              | 0.0181        | 0.0046 | 0.50     | 64.30 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.52                | PH            |        | : 8.35   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 28.17                | EC(mmho/cm)   |        | : 2550   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 38.69                | Si(mg/l)      |        | : 12.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.033              | Sr++(mg/l)    |        | : 14.04  |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.59               | HARINNESS(FR) |        | : 45.80  |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.01               | Ca/Mg         |        | : 1.72   |       |

Table 32

| SAMPLE NAME                   |      | : DSI 33277   |         | LAB NO : D2          |               |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|---------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : 25 |               |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2         | AC     | F        | %     |
| Na+                           | 28   | 1.22          | 0.00122 | 0.00122              | 0.0006        | 0.0010 | 0.84     | 12.08 |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000        | 0.0001 | 0.84     | 0.76  |
| Ca++                          | 102  | 5.09          | 0.00254 | 0.01018              | 0.0051        | 0.0013 | 0.51     | 50.47 |
| Mg++                          | 45   | 3.70          | 0.00185 | 0.00740              | 0.0037        | 0.0009 | 0.51     | 36.69 |
| Cl-                           | 23   | 0.65          | 0.00065 | 0.00065              | 0.0003        | 0.0005 | 0.84     | 2.34  |
| HCO3                          | 598  | 9.80          | 0.00980 | 0.00980              | 0.0049        | 0.0083 | 0.84     | 35.43 |
| SO4=                          | 827  | 17.22         | 0.00861 | 0.03443              | 0.0172        | 0.0044 | 0.51     | 62.23 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.09                | PH            |        | : 8.38   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 27.67                | EC(mmho/cm)   |        | : 2540   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 37.75                | Si(mg/l)      |        | : 12.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.032              | Sr++(mg/l)    |        | : 13.90  |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.58               | HARINNESS(FR) |        | : 43.95  |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.02               | Ca/Mg         |        | : 1.38   |       |

Table 33

| SAMPLE NAME                   |      | : DSI 33279   |         | LAB NO :D3           |              |        |         |       |
|-------------------------------|------|---------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : 25 |              |        |         |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 30   | 1.30          | 0.00130 | 0.00130              | 0.0007       | 0.0011 | 0.84    | 12.29 |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.84    | 0.72  |
| Ca++                          | 111  | 5.54          | 0.00277 | 0.01108              | 0.0055       | 0.0014 | 0.51    | 52.15 |
| Mg++                          | 45   | 3.70          | 0.00185 | 0.00740              | 0.0037       | 0.0009 | 0.51    | 34.84 |
| Cl-                           | 19   | 0.54          | 0.00054 | 0.00054              | 0.0003       | 0.0005 | 0.84    | 1.93  |
| HCO3                          | 586  | 9.61          | 0.00961 | 0.00961              | 0.0048       | 0.0081 | 0.84    | 34.69 |
| SO4=                          | 843  | 17.55         | 0.00878 | 0.03510              | 0.0176       | 0.0044 | 0.51    | 63.38 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.62                | PH           |        | : 8.40  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 27.69                | EC(mmho/cm)  |        | : 2640  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 38.31                | Si(mg/l )    |        | :12.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.033              | Sr++(mg/l)   |        | : 13.65 |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.61               | HARDNESS(FR) |        | : 46.20 |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.02               | Ca/Mg        |        | : 1.50  |       |

Table 34

| SAMPLE NAME                   |      | : DSI 33276   |         | LAB NO :D4           |              |        |         |       |
|-------------------------------|------|---------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : 25 |              |        |         |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 30   | 1.30          | 0.00130 | 0.00130              | 0.0007       | 0.0011 | 0.84    | 12.34 |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.84    | 0.73  |
| Ca++                          | 110  | 5.49          | 0.00274 | 0.01098              | 0.0055       | 0.0013 | 0.49    | 51.92 |
| Mg++                          | 45   | 3.70          | 0.00185 | 0.00740              | 0.0037       | 0.0009 | 0.49    | 35.01 |
| Cl-                           | 20   | 0.56          | 0.00056 | 0.00056              | 0.0003       | 0.0005 | 0.84    | 1.84  |
| HCO3                          | 496  | 8.13          | 0.00813 | 0.00813              | 0.0041       | 0.0068 | 0.84    | 26.58 |
| SO4=                          | 1052 | 21.90         | 0.01095 | 0.04380              | 0.0219       | 0.0054 | 0.49    | 71.58 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.57                | PH           |        | : 8.70  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 30.60                | EC(mmho/cm)  |        | : 2610  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 41.17                | Si(mg/l )    |        | :12.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.036              | Sr++(mg/l)   |        | : 13.39 |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.61               | HARDNESS(FR) |        | : 45.95 |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.02               | Ca/Mg        |        | : 1.48  |       |

Table 35

| SAMPLE NAME                   |      | : HAYDARABAD DUDENI |         |         |              | LAB NO :D5           |          |       |
|-------------------------------|------|---------------------|---------|---------|--------------|----------------------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993       |         |         |              | TEMPERATURE(°C) : 25 |          |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2     | .5CZ2        | AC                   | F        | %     |
| Na+                           | 30   | 1.30                | 0.00130 | 0.00130 | 0.0007       | 0.0011               | 0.86     | 15.21 |
| K+                            | 3    | 0.08                | 0.00008 | 0.00008 | 0.0000       | 0.0001               | 0.86     | 0.90  |
| Ca++                          | 80   | 3.99                | 0.00200 | 0.00798 | 0.0040       | 0.0011               | 0.55     | 46.52 |
| Mg++                          | 39   | 3.21                | 0.00160 | 0.00641 | 0.0032       | 0.0009               | 0.55     | 37.38 |
| Cl-                           | 22   | 0.62                | 0.00062 | 0.00062 | 0.0003       | 0.0005               | 0.86     | 3.19  |
| HCO3                          | 403  | 6.61                | 0.00661 | 0.00661 | 0.0033       | 0.0057               | 0.86     | 33.97 |
| SO4=                          | 587  | 12.22               | 0.00611 | 0.02444 | 0.0122       | 0.0034               | 0.55     | 62.84 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 8.58    | PH           |                      | : 7.99   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 19.45   | EC(mmho/cm)  |                      | : 2150   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 28.03   | Si(mg/l)     |                      | : 11.000 |       |
| IONIC STRENGTH                |      |                     |         | : 0.024 | Sr++(mg/l)   |                      | : 10.33  |       |
| SAR (SODIUM AD.RATIO)         |      |                     |         | : 0.69  | HARDNESS(FR) |                      | : 36.00  |       |
| Cl/(SO4+HCO3)                 |      |                     |         | : 0.03  | Ca/Mg        |                      | : 1.24   |       |

Table 36

| SAMPLE NAME                   |      | : DSI 34553   |         |         |              | LAB NO :D6           |          |       |
|-------------------------------|------|---------------|---------|---------|--------------|----------------------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         |         |              | TEMPERATURE(°C) : 24 |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2     | .5CZ2        | AC                   | F        | %     |
| Na+                           | 28   | 1.22          | 0.00122 | 0.00122 | 0.0006       | 0.0010               | 0.85     | 12.08 |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008 | 0.0000       | 0.0001               | 0.85     | 0.76  |
| Ca++                          | 102  | 5.09          | 0.00254 | 0.01018 | 0.0051       | 0.0013               | 0.52     | 50.47 |
| Mg++                          | 45   | 3.70          | 0.00185 | 0.00740 | 0.0037       | 0.0010               | 0.52     | 36.69 |
| Cl-                           | 22   | 0.62          | 0.00062 | 0.00062 | 0.0003       | 0.0005               | 0.85     | 2.42  |
| HCO3                          | 574  | 9.41          | 0.00941 | 0.00941 | 0.0047       | 0.0080               | 0.85     | 36.69 |
| SO4=                          | 750  | 15.61         | 0.00781 | 0.03123 | 0.0156       | 0.0040               | 0.52     | 60.89 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.09   | PH           |                      | : 8.00   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 25.64   | EC(mmho/cm)  |                      | : 2490   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 35.73   | Si(mg/l)     |                      | : 11.000 |       |
| IONIC STRENGTH                |      |               |         | : 0.030 | Sr++(mg/l)   |                      | : 12.24  |       |
| SAR (SODIUM AD.RATIO)         |      |               |         | : 0.58  | HARDNESS(FR) |                      | : 43.95  |       |
| Cl/(SO4+HCO3)                 |      |               |         | : 0.02  | Ca/Mg        |                      | : 1.38   |       |



Table 37

| SAMPLE NAME                   |      | : DSI 25569   |         | LAB NO :D7           |              |        |          |       |
|-------------------------------|------|---------------|---------|----------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : 24 |              |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2                  | .5CZ2        | AC     | F        | %     |
| Na+                           | 29   | 1.26          | 0.00126 | 0.00126              | 0.0006       | 0.0011 | 0.86     | 16.51 |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008              | 0.0000       | 0.0001 | 0.86     | 1.01  |
| Ca++                          | 67   | 3.34          | 0.00167 | 0.00669              | 0.0033       | 0.0009 | 0.54     | 43.75 |
| Mg++                          | 36   | 2.96          | 0.00148 | 0.00592              | 0.0030       | 0.0008 | 0.54     | 38.74 |
| Cl-                           | 21   | 0.59          | 0.00059 | 0.00059              | 0.0003       | 0.0005 | 0.86     | 2.37  |
| HCO3                          | 696  | 11.41         | 0.01141 | 0.01141              | 0.0057       | 0.0098 | 0.86     | 45.61 |
| SO4=                          | 625  | 13.01         | 0.00651 | 0.02602              | 0.0130       | 0.0035 | 0.54     | 52.02 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 7.64                 | PH           |        | : 7.93   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 25.01                | EC(mmho/cm)  |        | : 2130   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 32.66                | Si(mg/l)     |        | : 11.000 |       |
| IONIC STRENGTH :              |      |               |         | 0.026                | Sr++(mg/l)   |        | : 9.74   |       |
| SAR (SODIUM AD.RATIO) :       |      |               |         | 0.71                 | HARDNESS(FR) |        | : 31.52  |       |
| Cl/(SO4+HCO3) :               |      |               |         | 0.02                 | Ca/Mg        |        | : 1.13   |       |

Table 38

| SAMPLE NAME                   |      | : DSI 34291   |         | LAB NO :D8        |              |        |          |       |
|-------------------------------|------|---------------|---------|-------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : AUGUST 1993 |         | TEMPERATURE(°C) : |              |        |          |       |
| IONS                          | mg/l | meq/l         | mol/l   | CZ2               | .5CZ2        | AC     | F        | %     |
| Na+                           | 19   | 0.83          | 0.00083 | 0.00083           | 0.0004       | 0.0007 | 0.84     | 7.79  |
| K+                            | 3    | 0.08          | 0.00008 | 0.00008           | 0.0000       | 0.0001 | 0.84     | 0.73  |
| Ca++                          | 112  | 5.59          | 0.00279 | 0.01118           | 0.0056       | 0.0014 | 0.50     | 52.70 |
| Mg++                          | 50   | 4.11          | 0.00206 | 0.00822           | 0.0041       | 0.0010 | 0.50     | 38.78 |
| Cl-                           | 14   | 0.39          | 0.00039 | 0.00039           | 0.0002       | 0.0003 | 0.84     | 1.39  |
| HCO3                          | 647  | 10.61         | 0.01061 | 0.01061           | 0.0053       | 0.0089 | 0.84     | 37.23 |
| SO4=                          | 840  | 17.49         | 0.00874 | 0.03498           | 0.0175       | 0.0044 | 0.50     | 61.38 |
| TOTAL CATION AMOUNT (meq/l) : |      |               |         | 10.60             | PH           |        | : 7.75   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |               |         | 28.49             | EC(mmho/cm)  |        | :        |       |
| TOTAL ION AMOUNT (meq/l) :    |      |               |         | 39.09             | Si(mg/l)     |        | : 11.000 |       |
| IONIC STRENGTH :              |      |               |         | 0.033             | Sr++(mg/l)   |        | : 22.00  |       |
| SAR (SODIUM AD.RATIO) :       |      |               |         | 0.38              | HARDNESS(FR) |        | : 48.50  |       |
| Cl/(SO4+HCO3) :               |      |               |         | 0.01              | Ca/Mg        |        | : 1.36   |       |

Table 39

| SAMPLE NAME : DSI 43530        |      |       |         | LAB NO : D9       |              |        |        |       |
|--------------------------------|------|-------|---------|-------------------|--------------|--------|--------|-------|
| DATE OF SAMPLING : AUGUST 1993 |      |       |         | TEMPERATURE(°C) : |              |        |        |       |
| IONS                           | mg/l | meq/l | mol/l   | CZ2               | .5CZ2        | AC     | F      | %     |
| Na+                            | 30   | 1.30  | 0.00130 | 0.00130           | 0.0007       | 0.0012 | 0.89   | 25.82 |
| K+                             | 1    | 0.03  | 0.00003 | 0.00003           | 0.0000       | 0.0000 | 0.89   | 0.51  |
| Ca++                           | 12   | 0.60  | 0.00030 | 0.00120           | 0.0006       | 0.0002 | 0.64   | 11.85 |
| Mg++                           | 38   | 3.13  | 0.00156 | 0.00625           | 0.0031       | 0.0010 | 0.64   | 61.83 |
| Cl-                            | 18   | 0.51  | 0.00051 | 0.00051           | 0.0003       | 0.0005 | 0.89   | 4.55  |
| HCO3                           | 415  | 6.80  | 0.00680 | 0.00680           | 0.0034       | 0.0061 | 0.89   | 61.06 |
| SO4=                           | 184  | 3.83  | 0.00192 | 0.00766           | 0.0038       | 0.0012 | 0.64   | 34.38 |
| TOTAL CATION AMOUNT (meq/l) :  |      |       |         | 5.05              | PH           |        | 8.80   |       |
| TOTAL ANION AMOUNT (meq/l) :   |      |       |         | 11.14             | EC(mmho/cm)  |        | 1320   |       |
| TOTAL ION AMOUNT (meq/l) :     |      |       |         | 16.20             | Si(mg/l)     |        | 20.000 |       |
| IONIC STRENGTH :               |      |       |         | 0.012             | Sr++(mg/l)   |        | 1.52   |       |
| SAR (SODIUM AD.RATIO) :        |      |       |         | 0.96              | HARDNESS(FR) |        | 18.62  |       |
| Cl/(SO4+HCO3) :                |      |       |         | 0.05              | Ca/Mg        |        | 0.19   |       |

Table 40

| SAMPLE NAME : DSI 37430        |      |       |         | LAB NO : D10         |              |        |        |       |
|--------------------------------|------|-------|---------|----------------------|--------------|--------|--------|-------|
| DATE OF SAMPLING : AUGUST 1993 |      |       |         | TEMPERATURE(°C) : 20 |              |        |        |       |
| IONS                           | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2        | AC     | F      | %     |
| Na+                            | 10   | 0.43  | 0.00043 | 0.00043              | 0.0002       | 0.0004 | 0.85   | 5.19  |
| K+                             | 2    | 0.05  | 0.00005 | 0.00005              | 0.0000       | 0.0000 | 0.85   | 0.61  |
| Ca++                           | 89   | 4.44  | 0.00222 | 0.00888              | 0.0044       | 0.0012 | 0.53   | 52.99 |
| Mg++                           | 42   | 3.45  | 0.00173 | 0.00691              | 0.0035       | 0.0009 | 0.53   | 41.21 |
| Cl-                            | 2    | 0.06  | 0.00006 | 0.00006              | 0.0000       | 0.0000 | 0.85   | 0.23  |
| HCO3                           | 635  | 10.41 | 0.01041 | 0.01041              | 0.0052       | 0.0089 | 0.85   | 42.21 |
| SO4=                           | 682  | 14.20 | 0.00710 | 0.02840              | 0.0142       | 0.0037 | 0.53   | 57.57 |
| TOTAL CATION AMOUNT (meq/l) :  |      |       |         | 8.38                 | PH           |        | 7.95   |       |
| TOTAL ANION AMOUNT (meq/l) :   |      |       |         | 24.66                | EC(mmho/cm)  |        | 2480   |       |
| TOTAL ION AMOUNT (meq/l) :     |      |       |         | 33.05                | Si(mg/l)     |        | 10.000 |       |
| IONIC STRENGTH :               |      |       |         | 0.028                | Sr++(mg/l)   |        | 10.97  |       |
| SAR (SODIUM AD.RATIO) :        |      |       |         | 0.22                 | HARDNESS(FR) |        | 39.48  |       |
| Cl/(SO4+HCO3) :                |      |       |         | 0.00                 | Ca/Mg        |        | 1.29   |       |



Table 41

| SAMPLE NAME                   |      | : DSI 37127         |         | LAB NO :D1           |              |        |         |       |
|-------------------------------|------|---------------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 22 |              |        |         |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 23   | 1.00                | 0.00100 | 0.00100              | 0.0005       | 0.0008 | 0.82    | 4.87  |
| K+                            | 5    | 0.13                | 0.00013 | 0.00013              | 0.0001       | 0.0001 | 0.82    | 0.62  |
| Ca++                          | 223  | 11.13               | 0.00556 | 0.02226              | 0.0111       | 0.0026 | 0.46    | 54.12 |
| Mg++                          | 101  | 8.31                | 0.00415 | 0.01661              | 0.0083       | 0.0019 | 0.46    | 40.39 |
| Cl-                           | 30   | 0.85                | 0.00085 | 0.00085              | 0.0004       | 0.0007 | 0.82    | 2.82  |
| HCO3                          | 561  | 9.20                | 0.00920 | 0.00920              | 0.0046       | 0.0076 | 0.82    | 30.65 |
| SO4=                          | 959  | 19.97               | 0.00998 | 0.03993              | 0.0200       | 0.0046 | 0.46    | 66.53 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 20.56                | PH           |        | : 8.54  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 30.01                | EC(mmho/cm)  |        | : 2960  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 50.57                | Si(mg/l)     |        | :       |       |
| IONIC STRENGTH                |      |                     |         | : 0.045              | Sr++(mg/l)   |        | :       |       |
| SAR (SODIUM AD.RATIO)         |      |                     |         | : 0.32               | HARDNESS(FR) |        | : 97.17 |       |
| Cl/(SO4+HCO3)                 |      |                     |         | : 0.03               | Ca/Mg        |        | : 1.34  |       |

Table 42

| SAMPLE NAME                   |      | : DSI 37128         |         | LAB NO :D2           |              |        |         |       |
|-------------------------------|------|---------------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 22 |              |        |         |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 22   | 0.96                | 0.00096 | 0.00096              | 0.0005       | 0.0008 | 0.82    | 4.75  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001       | 0.0001 | 0.82    | 0.51  |
| Ca++                          | 221  | 11.03               | 0.00551 | 0.02206              | 0.0110       | 0.0025 | 0.46    | 54.74 |
| Mg++                          | 98   | 8.06                | 0.00403 | 0.01612              | 0.0081       | 0.0019 | 0.46    | 40.00 |
| Cl-                           | 27   | 0.76                | 0.00076 | 0.00076              | 0.0004       | 0.0006 | 0.82    | 2.51  |
| HCO3                          | 549  | 9.00                | 0.00900 | 0.00900              | 0.0045       | 0.0074 | 0.82    | 29.71 |
| SO4=                          | 986  | 20.53               | 0.01026 | 0.04106              | 0.0205       | 0.0047 | 0.46    | 67.77 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 20.15                | PH           |        | : 8.20  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 30.29                | EC(mmho/cm)  |        | : 3010  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 50.44                | Si(mg/l)     |        | :       |       |
| IONIC STRENGTH                |      |                     |         | : 0.045              | Sr++(mg/l)   |        | :       |       |
| SAR (SODIUM AD.RATIO)         |      |                     |         | : 0.31               | HARDNESS(FR) |        | : 95.44 |       |
| Cl/(SO4+HCO3)                 |      |                     |         | : 0.03               | Ca/Mg        |        | : 1.37  |       |

Table 43

| SAMPLE NAME : DEI 39338              |      |       |         | LAB NO : D3          |        |                    |      |       |
|--------------------------------------|------|-------|---------|----------------------|--------|--------------------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 22 |        |                    |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC                 | F    | %     |
| Na+                                  | 25   | 1.09  | 0.00109 | 0.00109              | 0.0005 | 0.0009             | 0.82 | 5.30  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001 | 0.0001             | 0.82 | 0.50  |
| Ca++                                 | 226  | 11.28 | 0.00564 | 0.02255              | 0.0113 | 0.0026             | 0.46 | 54.94 |
| Mg++                                 | 98   | 8.06  | 0.00403 | 0.01612              | 0.0081 | 0.0018             | 0.46 | 39.26 |
| Cl-                                  | 26   | 0.73  | 0.00073 | 0.00073              | 0.0004 | 0.0006             | 0.82 | 2.36  |
| HCO3                                 | 586  | 9.61  | 0.00961 | 0.00961              | 0.0048 | 0.0079             | 0.82 | 30.89 |
| SO4=                                 | 997  | 20.76 | 0.01038 | 0.04151              | 0.0208 | 0.0048             | 0.46 | 66.75 |
| TOTAL CATION AMOUNT (meq/l) : 20.53  |      |       |         | PH : 8.10            |        | EC(mmho/cm) : 3040 |      |       |
| TOTAL ANION AMOUNT (meq/l) : 31.10   |      |       |         | Si(mg/l) :           |        | Sr++(mg/l) :       |      |       |
| TOTAL ION AMOUNT (meq/l) : 51.62     |      |       |         | HARDNESS(FR) : 96.68 |        | Ca/Mg : 1.40       |      |       |
| IONIC STRENGTH : 0.046               |      |       |         |                      |        |                    |      |       |
| SAR (SODIUM AD.RATIO) : 0.35         |      |       |         |                      |        |                    |      |       |
| Cl/(SO4+HCO3) : 0.02                 |      |       |         |                      |        |                    |      |       |

Table 44

| SAMPLE NAME : DSI 39340 B            |      |       |         | LAB NO : D4          |        |                    |      |       |
|--------------------------------------|------|-------|---------|----------------------|--------|--------------------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 22 |        |                    |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC                 | F    | %     |
| Na+                                  | 25   | 1.09  | 0.00109 | 0.00109              | 0.0005 | 0.0009             | 0.82 | 5.34  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001 | 0.0001             | 0.82 | 0.50  |
| Ca++                                 | 226  | 11.28 | 0.00564 | 0.02255              | 0.0113 | 0.0026             | 0.46 | 55.38 |
| Mg++                                 | 96   | 7.89  | 0.00395 | 0.01579              | 0.0079 | 0.0018             | 0.46 | 38.77 |
| Cl-                                  | 23   | 0.65  | 0.00065 | 0.00065              | 0.0003 | 0.0005             | 0.82 | 2.09  |
| HCO3                                 | 561  | 9.20  | 0.00920 | 0.00920              | 0.0046 | 0.0076             | 0.82 | 29.59 |
| SO4=                                 | 1020 | 21.24 | 0.01062 | 0.04247              | 0.0212 | 0.0049             | 0.46 | 68.32 |
| TOTAL CATION AMOUNT (meq/l) : 20.36  |      |       |         | PH : 8.20            |        | EC(mmho/cm) : 3020 |      |       |
| TOTAL ANION AMOUNT (meq/l) : 31.08   |      |       |         | Si(mg/l) :           |        | Sr++(mg/l) :       |      |       |
| TOTAL ION AMOUNT (meq/l) : 51.44     |      |       |         | HARDNESS(FR) : 95.86 |        | Ca/Mg : 1.43       |      |       |
| IONIC STRENGTH : 0.046               |      |       |         |                      |        |                    |      |       |
| SAR (SODIUM AD.RATIO) : 0.35         |      |       |         |                      |        |                    |      |       |
| Cl/(SO4+HCO3) : 0.02                 |      |       |         |                      |        |                    |      |       |

Table 45

| SAMPLE NAME                   |      | : DSI 39337         |         | LAB NO :D5           |                |        |       |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|-------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 22 |                |        |       |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F     | %     |
| Na+                           | 25   | 1.09                | 0.00109 | 0.00109              | 0.0005         | 0.0009 | 0.82  | 5.30  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82  | 0.50  |
| Ca++                          | 229  | 11.43               | 0.00571 | 0.02285              | 0.0114         | 0.0026 | 0.46  | 55.71 |
| Mg++                          | 96   | 7.89                | 0.00395 | 0.01579              | 0.0079         | 0.0018 | 0.46  | 38.49 |
| Cl-                           | 26   | 0.73                | 0.00073 | 0.00073              | 0.0004         | 0.0006 | 0.82  | 2.33  |
| HCO3                          | 586  | 9.61                | 0.00961 | 0.00961              | 0.0048         | 0.0079 | 0.82  | 30.48 |
| SO4=                          | 1017 | 21.17               | 0.01059 | 0.04235              | 0.0212         | 0.0048 | 0.46  | 67.19 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 20.51                | PH :           |        | 8.45  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 31.51                | EC(mmho/cm) :  |        | 3070  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 52.02                | Si(mg/l) :     |        |       |       |
| IONIC STRENGTH :              |      |                     |         | 0.046                | Sr++(mg/l) :   |        |       |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.35                 | HARDNESS(FR) : |        | 96.61 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.02                 | Ca/Mg :        |        | 1.45  |       |

Table 46

| SAMPLE NAME                   |      | : DSI 39339 B       |         | LAB NO :D6           |                |        |       |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|-------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 23 |                |        |       |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F     | %     |
| Na+                           | 25   | 1.09                | 0.00109 | 0.00109              | 0.0005         | 0.0009 | 0.82  | 5.38  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82  | 0.51  |
| Ca++                          | 223  | 11.13               | 0.00556 | 0.02226              | 0.0111         | 0.0026 | 0.46  | 55.05 |
| Mg++                          | 96   | 7.89                | 0.00395 | 0.01579              | 0.0079         | 0.0018 | 0.46  | 39.06 |
| Cl-                           | 24   | 0.68                | 0.00068 | 0.00068              | 0.0003         | 0.0006 | 0.82  | 2.18  |
| HCO3                          | 598  | 9.80                | 0.00980 | 0.00980              | 0.0049         | 0.0081 | 0.82  | 31.55 |
| SO4=                          | 989  | 20.59               | 0.01030 | 0.04118              | 0.0206         | 0.0047 | 0.46  | 66.27 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 20.21                | PH :           |        | 8.60  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 31.07                | EC(mmho/cm) :  |        | 3040  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 51.28                | Si(mg/l) :     |        |       |       |
| IONIC STRENGTH :              |      |                     |         | 0.045                | Sr++(mg/l) :   |        |       |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.35                 | HARDNESS(FR) : |        | 95.11 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.02                 | Ca/Mg :        |        | 1.41  |       |

Table 47

| SAMPLE NAME                   |      | : DSI 39336    |         | LAB NO :D7           |                |        |       |       |
|-------------------------------|------|----------------|---------|----------------------|----------------|--------|-------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER |         | TEMPERATURE(°C) : 22 |                |        |       |       |
| IONS                          | mg/l | meq/l          | mol/l   | CZ2                  | .5CZ2          | AC     | F     | %     |
| Na+                           | 23   | 1.00           | 0.00100 | 0.00100              | 0.0005         | 0.0008 | 0.82  | 4.87  |
| K+                            | 4    | 0.10           | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82  | 0.50  |
| Ca++                          | 236  | 11.78          | 0.00589 | 0.02355              | 0.0118         | 0.0027 | 0.46  | 57.37 |
| Mg++                          | 93   | 7.65           | 0.00382 | 0.01530              | 0.0076         | 0.0018 | 0.46  | 37.26 |
| Cl-                           | 26   | 0.73           | 0.00073 | 0.00073              | 0.0004         | 0.0006 | 0.82  | 2.36  |
| HCO3                          | 574  | 9.41           | 0.00941 | 0.00941              | 0.0047         | 0.0077 | 0.82  | 30.29 |
| SO4=                          | 1005 | 20.92          | 0.01046 | 0.04185              | 0.0209         | 0.0048 | 0.46  | 67.35 |
| TOTAL CATION AMOUNT (meq/l) : |      |                |         | 20.53                | PH :           |        | 8.48  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                |         | 31.07                | EC(mmho/cm) :  |        | 3050  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                |         | 51.59                | Si(mg/l) :     |        |       |       |
| IONIC STRENGTH :              |      |                |         | 0.046                | Sr++(mg/l) :   |        |       |       |
| SAR (SODIUM AD.RATIO) :       |      |                |         | 0.32                 | HARDNESS(FR) : |        | 97.12 |       |
| Cl/(SO4+HCO3) :               |      |                |         | 0.02                 | Ca/Mg :        |        | 1.54  |       |

Table 48

| SAMPLE NAME                   |      | : DSI 39335         |         | LAB NO :D8           |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 22 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 25   | 1.09                | 0.00109 | 0.00109              | 0.0005         | 0.0009 | 0.82   | 5.04  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.48  |
| Ca++                          | 242  | 12.08               | 0.00604 | 0.02415              | 0.0121         | 0.0027 | 0.45   | 55.98 |
| Mg++                          | 101  | 8.31                | 0.00415 | 0.01661              | 0.0083         | 0.0019 | 0.45   | 38.50 |
| Cl-                           | 27   | 0.76                | 0.00076 | 0.00076              | 0.0004         | 0.0006 | 0.82   | 2.36  |
| HCO3                          | 549  | 9.00                | 0.00900 | 0.00900              | 0.0045         | 0.0074 | 0.82   | 27.86 |
| SO4=                          | 1083 | 22.55               | 0.01127 | 0.04509              | 0.0225         | 0.0051 | 0.45   | 69.79 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 21.57                | PH :           |        | 8.40   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 32.31                | EC(mmho/cm) :  |        | 3120   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 53.88                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.048                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.34                 | HARDNESS(FR) : |        | 101.91 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.02                 | Ca/Mg :        |        | 1.45   |       |

Table 49

| SAMPLE NAME                   |      | : DSI 37126         |         | LAB NO :D9           |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 22 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 24   | 1.04                | 0.00104 | 0.00104              | 0.0005         | 0.0009 | 0.82   | 4.85  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.48  |
| Ca++                          | 247  | 12.33               | 0.00616 | 0.02465              | 0.0123         | 0.0028 | 0.45   | 57.24 |
| Mg++                          | 98   | 8.06                | 0.00403 | 0.01612              | 0.0081         | 0.0018 | 0.45   | 37.43 |
| Cl-                           | 27   | 0.76                | 0.00076 | 0.00076              | 0.0004         | 0.0006 | 0.82   | 2.32  |
| HCO3                          | 610  | 10.00               | 0.01000 | 0.01000              | 0.0050         | 0.0082 | 0.82   | 30.52 |
| SO4=                          | 1057 | 22.01               | 0.01100 | 0.04401              | 0.0220         | 0.0050 | 0.45   | 67.16 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 21.53                | PH :           |        | 8.70   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 32.77                | EC(mmho/cm) :  |        | 3140   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 54.30                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.048                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.33                 | HARDNESS(FR) : |        | 101.92 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.02                 | Ca/Mg :        |        | 1.53   |       |

Table 50

| SAMPLE NAME                   |      | : DSI 39334         |         | LAB NO :D10          |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 21 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 25   | 1.09                | 0.00109 | 0.00109              | 0.0005         | 0.0009 | 0.82   | 4.56  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.43  |
| Ca++                          | 268  | 13.37               | 0.00669 | 0.02675              | 0.0134         | 0.0030 | 0.44   | 56.06 |
| Mg++                          | 113  | 9.29                | 0.00465 | 0.01859              | 0.0093         | 0.0021 | 0.44   | 38.95 |
| Cl-                           | 30   | 0.85                | 0.00085 | 0.00085              | 0.0004         | 0.0007 | 0.82   | 2.52  |
| HCO3                          | 549  | 9.00                | 0.00900 | 0.00900              | 0.0045         | 0.0073 | 0.82   | 26.82 |
| SO4=                          | 1139 | 23.71               | 0.01186 | 0.04743              | 0.0237         | 0.0052 | 0.44   | 70.66 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 23.86                | PH :           |        | 8.40   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 33.56                | EC(mmho/cm) :  |        | 3200   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 57.41                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.052                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.32                 | HARDNESS(FR) : |        | 113.33 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.03                 | Ca/Mg :        |        | 1.44   |       |



Table 51

| SAMPLE NAME                   |      | : DSI 37125         |         | LAB NO :D11          |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 19 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 29   | 1.26                | 0.00126 | 0.00126              | 0.0006         | 0.0010 | 0.81   | 4.61  |
| K+                            | 5    | 0.13                | 0.00013 | 0.00013              | 0.0001         | 0.0001 | 0.81   | 0.47  |
| Ca++                          | 292  | 14.57               | 0.00729 | 0.02914              | 0.0146         | 0.0031 | 0.43   | 53.20 |
| Mg++                          | 139  | 11.43               | 0.00572 | 0.02286              | 0.0114         | 0.0024 | 0.43   | 41.73 |
| Cl-                           | 33   | 0.93                | 0.00093 | 0.00093              | 0.0005         | 0.0008 | 0.81   | 2.69  |
| HCO3                          | 403  | 6.61                | 0.00661 | 0.00661              | 0.0033         | 0.0053 | 0.81   | 19.10 |
| SO4=                          | 1299 | 27.04               | 0.01352 | 0.05409              | 0.0270         | 0.0058 | 0.43   | 78.20 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 27.39                | PH :           |        | 8.76   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 34.58                | EC(mmho/cm) :  |        | 3270   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 61.97                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.058                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.35                 | HARDNESS(FR) : |        | 130.01 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.03                 | Ca/Mg :        |        | 1.27   |       |

Table 52

| SAMPLE NAME                   |      | : DSI 34555         |         | LAB NO :D12          |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 24 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 22   | 0.96                | 0.00096 | 0.00096              | 0.0005         | 0.0008 | 0.82   | 4.53  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.49  |
| Ca++                          | 244  | 12.18               | 0.00609 | 0.02435              | 0.0122         | 0.0028 | 0.45   | 57.62 |
| Mg++                          | 96   | 7.89                | 0.00395 | 0.01579              | 0.0079         | 0.0018 | 0.45   | 37.36 |
| Cl-                           | 22   | 0.62                | 0.00062 | 0.00062              | 0.0003         | 0.0005 | 0.82   | 1.93  |
| HCO3                          | 598  | 9.80                | 0.00980 | 0.00980              | 0.0049         | 0.0080 | 0.82   | 30.50 |
| SO4=                          | 1043 | 21.71               | 0.01086 | 0.04343              | 0.0217         | 0.0049 | 0.45   | 67.57 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 21.13                | PH :           |        | 8.40   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 32.14                | EC(mmho/cm) :  |        | 3090   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 53.27                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.048                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.30                 | HARDNESS(FR) : |        | 100.35 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.02                 | Ca/Mg :        |        | 1.54   |       |

Table 53

| SAMPLE NAME : DSI 25570              |      |       |         | LAB NO : D13         |        |         |      |       |
|--------------------------------------|------|-------|---------|----------------------|--------|---------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 23 |        |         |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC      | F    | %     |
| Na+                                  | 22   | 0.96  | 0.00096 | 0.00096              | 0.0005 | 0.0008  | 0.82 | 4.62  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001 | 0.0001  | 0.82 | 0.50  |
| Ca++                                 | 244  | 12.18 | 0.00609 | 0.02435              | 0.0122 | 0.0028  | 0.46 | 58.77 |
| Mg++                                 | 91   | 7.48  | 0.00374 | 0.01497              | 0.0075 | 0.0017  | 0.46 | 36.12 |
| Cl-                                  | 24   | 0.68  | 0.00068 | 0.00068              | 0.0003 | 0.0006  | 0.82 | 2.10  |
| HCO3                                 | 622  | 10.20 | 0.01020 | 0.01020              | 0.0051 | 0.0084  | 0.82 | 31.63 |
| SO4=                                 | 1026 | 21.36 | 0.01068 | 0.04272              | 0.0214 | 0.0049  | 0.46 | 66.27 |
| TOTAL CATION AMOUNT (meq/l) : 20.72  |      |       |         | PH                   |        | : 7.81  |      |       |
| TOTAL ANION AMOUNT (meq/l) : 32.23   |      |       |         | EC(mmho/cm)          |        | : 3120  |      |       |
| TOTAL ION AMOUNT (meq/l) : 52.95     |      |       |         | Si(mg/l)             |        | :       |      |       |
| IONIC STRENGTH : 0.047               |      |       |         | Sr++(mg/l)           |        | :       |      |       |
| SAR (SODIUM AD.RATIO) : 0.31         |      |       |         | HARDNESS(FR)         |        | : 98.30 |      |       |
| Cl/(SO4+HCO3) : 0.02                 |      |       |         | Ca/Mg                |        | : 1.63  |      |       |

Table 54

| SAMPLE NAME : DSI 25568              |      |       |         | LAB NO : D14         |        |         |      |       |
|--------------------------------------|------|-------|---------|----------------------|--------|---------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 24 |        |         |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC      | F    | %     |
| Na+                                  | 23   | 1.00  | 0.00100 | 0.00100              | 0.0005 | 0.0008  | 0.82 | 4.88  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010              | 0.0001 | 0.0001  | 0.82 | 0.50  |
| Ca++                                 | 239  | 11.93 | 0.00596 | 0.02385              | 0.0119 | 0.0027  | 0.45 | 58.14 |
| Mg++                                 | 91   | 7.48  | 0.00374 | 0.01497              | 0.0075 | 0.0017  | 0.45 | 36.48 |
| Cl-                                  | 30   | 0.85  | 0.00085 | 0.00085              | 0.0004 | 0.0007  | 0.82 | 2.55  |
| HCO3                                 | 647  | 10.61 | 0.01061 | 0.01061              | 0.0053 | 0.0087  | 0.82 | 32.02 |
| SO4=                                 | 1041 | 21.67 | 0.01084 | 0.04335              | 0.0217 | 0.0049  | 0.45 | 65.43 |
| TOTAL CATION AMOUNT (meq/l) : 20.51  |      |       |         | PH                   |        | : 8.40  |      |       |
| TOTAL ANION AMOUNT (meq/l) : 33.12   |      |       |         | EC(mmho/cm)          |        | : 3190  |      |       |
| TOTAL ION AMOUNT (meq/l) : 53.64     |      |       |         | Si(mg/l)             |        | :       |      |       |
| IONIC STRENGTH : 0.047               |      |       |         | Sr++(mg/l)           |        | :       |      |       |
| SAR (SODIUM AD.RATIO) : 0.32         |      |       |         | HARDNESS(FR)         |        | : 97.05 |      |       |
| Cl/(SO4+HCO3) : 0.03                 |      |       |         | Ca/Mg                |        | : 1.59  |      |       |



Table 55

| SAMPLE NAME                   |      | : DSI 33278         |         | LAB NO :D15          |              |        |         |       |
|-------------------------------|------|---------------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 24 |              |        |         |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 27   | 1.17                | 0.00117 | 0.00117              | 0.0006       | 0.0010 | 0.83    | 6.09  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001       | 0.0001 | 0.83    | 0.53  |
| Ca++                          | 221  | 11.03               | 0.00551 | 0.02206              | 0.0110       | 0.0026 | 0.46    | 57.15 |
| Mg++                          | 85   | 6.99                | 0.00350 | 0.01398              | 0.0070       | 0.0016 | 0.46    | 36.23 |
| Cl-                           | 27   | 0.76                | 0.00076 | 0.00076              | 0.0004       | 0.0006 | 0.83    | 2.47  |
| HCO3                          | 622  | 10.20               | 0.01020 | 0.01020              | 0.0051       | 0.0084 | 0.83    | 33.13 |
| SO4=                          | 952  | 19.82               | 0.00991 | 0.03964              | 0.0198       | 0.0046 | 0.46    | 64.40 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 19.30                | PH           |        | : 8.21  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 30.78                | EC(mmho/cm)  |        | : 3090  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 50.07                | Si(mg/l)     |        | :       |       |
| IONIC STRENGTH                |      |                     |         | : 0.044              | Sr++(mg/l)   |        | :       |       |
| SAR (SODIUM AD.RATIO)         |      |                     |         | : 0.39               | HARDNESS(FR) |        | : 90.09 |       |
| Cl/(SO4+HCO3)                 |      |                     |         | : 0.03               | Ca/Mg        |        | : 1.58  |       |

Table 56

| SAMPLE NAME                   |      | : DSI 33277         |         | LAB NO :D16          |              |        |         |       |
|-------------------------------|------|---------------------|---------|----------------------|--------------|--------|---------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 24 |              |        |         |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2        | AC     | F       | %     |
| Na+                           | 27   | 1.17                | 0.00117 | 0.00117              | 0.0006       | 0.0010 | 0.82    | 5.60  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001       | 0.0001 | 0.82    | 0.49  |
| Ca++                          | 250  | 12.48               | 0.00624 | 0.02495              | 0.0125       | 0.0029 | 0.46    | 59.44 |
| Mg++                          | 88   | 7.24                | 0.00362 | 0.01447              | 0.0072       | 0.0017 | 0.46    | 34.48 |
| Cl-                           | 34   | 0.96                | 0.00096 | 0.00096              | 0.0005       | 0.0008 | 0.82    | 3.17  |
| HCO3                          | 598  | 9.80                | 0.00980 | 0.00980              | 0.0049       | 0.0081 | 0.82    | 32.41 |
| SO4=                          | 936  | 19.49               | 0.00974 | 0.03897              | 0.0195       | 0.0045 | 0.46    | 64.42 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 20.99                | PH           |        | : 8.05  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 30.25                | EC(mmho/cm)  |        | : 3030  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 51.24                | Si(mg/l)     |        | :       |       |
| IONIC STRENGTH                |      |                     |         | : 0.045              | Sr++(mg/l)   |        | :       |       |
| SAR (SODIUM AD.RATIO)         |      |                     |         | : 0.37               | HARDNESS(FR) |        | : 98.56 |       |
| Cl/(SO4+HCO3)                 |      |                     |         | : 0.03               | Ca/Mg        |        | : 1.72  |       |

Table 57

| SAMPLE NAME                   |      | : DSI 33276         |         | LAB NO :D17          |                |        |        |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 25 |                |        |        |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F      | %     |
| Na+                           | 27   | 1.17                | 0.00117 | 0.00117              | 0.0006         | 0.0010 | 0.82   | 5.47  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.82   | 0.48  |
| Ca++                          | 260  | 12.97               | 0.00649 | 0.02595              | 0.0130         | 0.0030 | 0.46   | 60.38 |
| Mg++                          | 88   | 7.24                | 0.00362 | 0.01447              | 0.0072         | 0.0017 | 0.46   | 33.68 |
| Cl-                           | 31   | 0.87                | 0.00087 | 0.00087              | 0.0004         | 0.0007 | 0.82   | 3.05  |
| HCO3                          | 586  | 9.61                | 0.00961 | 0.00961              | 0.0048         | 0.0079 | 0.82   | 33.48 |
| SO4=                          | 875  | 18.22               | 0.00911 | 0.03643              | 0.0182         | 0.0042 | 0.46   | 63.48 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 21.49                | PH :           |        | 8.55   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 28.70                | EC(mmho/cm) :  |        | 2960   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 50.19                | Si(mg/l) :     |        |        |       |
| IONIC STRENGTH :              |      |                     |         | 0.044                | Sr++(mg/l) :   |        |        |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.37                 | HARDNESS(FR) : |        | 101.05 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.03                 | Ca/Mg :        |        | 1.79   |       |

Table 58

| SAMPLE NAME                   |      | : DSI 27204         |         | LAB NO :D18          |                |        |       |       |
|-------------------------------|------|---------------------|---------|----------------------|----------------|--------|-------|-------|
| DATE OF SAMPLING              |      | : 19 SEPTEMBER 1993 |         | TEMPERATURE(°C) : 25 |                |        |       |       |
| IONS                          | mg/l | meq/l               | mol/l   | CZ2                  | .5CZ2          | AC     | F     | %     |
| Na+                           | 29   | 1.26                | 0.00126 | 0.00126              | 0.0006         | 0.0010 | 0.83  | 6.85  |
| K+                            | 4    | 0.10                | 0.00010 | 0.00010              | 0.0001         | 0.0001 | 0.83  | 0.56  |
| Ca++                          | 205  | 10.23               | 0.00511 | 0.02046              | 0.0102         | 0.0024 | 0.47  | 55.54 |
| Mg++                          | 83   | 6.83                | 0.00341 | 0.01365              | 0.0068         | 0.0016 | 0.47  | 37.06 |
| Cl-                           | 33   | 0.93                | 0.00093 | 0.00093              | 0.0005         | 0.0008 | 0.83  | 3.22  |
| HCO3                          | 586  | 9.61                | 0.00961 | 0.00961              | 0.0048         | 0.0080 | 0.83  | 33.22 |
| SO4=                          | 883  | 18.38               | 0.00919 | 0.03677              | 0.0184         | 0.0043 | 0.47  | 63.57 |
| TOTAL CATION AMOUNT (meq/l) : |      |                     |         | 18.42                | PH :           |        | 8.20  |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                     |         | 28.92                | EC(mmho/cm) :  |        | 2930  |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                     |         | 47.34                | Si(mg/l) :     |        |       |       |
| IONIC STRENGTH :              |      |                     |         | 0.041                | Sr++(mg/l) :   |        |       |       |
| SAR (SODIUM AD.RATIO) :       |      |                     |         | 0.43                 | HARDNESS(FR) : |        | 85.28 |       |
| Cl/(SO4+HCO3) :               |      |                     |         | 0.03                 | Ca/Mg :        |        | 1.50  |       |

Table 59

| SAMPLE NAME : HAYDARBABA DUDENI      |      |       |         | LAB NO : D19           |        |                      |      |       |
|--------------------------------------|------|-------|---------|------------------------|--------|----------------------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 24   |        |                      |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                    | .5CZ2  | AC                   | F    | %     |
| Na+                                  | 29   | 1.26  | 0.00126 | 0.00126                | 0.0006 | 0.0011               | 0.84 | 7.51  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010                | 0.0001 | 0.0001               | 0.84 | 0.61  |
| Ca++                                 | 194  | 9.68  | 0.00484 | 0.01936                | 0.0097 | 0.0024               | 0.51 | 57.62 |
| Mg++                                 | 70   | 5.76  | 0.00288 | 0.01151                | 0.0058 | 0.0015               | 0.51 | 34.26 |
| Cl-                                  | 31   | 0.87  | 0.00087 | 0.00087                | 0.0004 | 0.0007               | 0.84 | 4.64  |
| HCO3                                 | 260  | 4.26  | 0.00426 | 0.00426                | 0.0021 | 0.0036               | 0.84 | 22.63 |
| SO4=                                 | 658  | 13.70 | 0.00685 | 0.02740                | 0.0137 | 0.0035               | 0.51 | 72.73 |
| TOTAL CATION AMOUNT (meq/l) : 16.80  |      |       |         | PH : 7.80              |        | EC(nmho/cm) : 2500   |      |       |
| TOTAL ANION AMOUNT (meq/l) : 18.84   |      |       |         | Si(mg/l) :             |        | Sr++(mg/l) :         |      |       |
| TOTAL ION AMOUNT (meq/l) : 35.64     |      |       |         | IONIC STRENGTH : 0.032 |        | HARDNESS(FR) : 77.19 |      |       |
| SAR (SODIUM AD.RATIO) : 0.45         |      |       |         | Ca/Mg : 1.68           |        |                      |      |       |
| Cl/(SO4+HCO3) : 0.05                 |      |       |         |                        |        |                      |      |       |

Table 60

| SAMPLE NAME : DSI 34553              |      |       |         | LAB NO : D20           |        |                      |      |       |
|--------------------------------------|------|-------|---------|------------------------|--------|----------------------|------|-------|
| DATE OF SAMPLING : 19 SEPTEMBER 1993 |      |       |         | TEMPERATURE(°C) : 23   |        |                      |      |       |
| IONS                                 | mg/l | meq/l | mol/l   | CZ2                    | .5CZ2  | AC                   | F    | %     |
| Na+                                  | 26   | 1.13  | 0.00113 | 0.00113                | 0.0006 | 0.0009               | 0.83 | 5.62  |
| K+                                   | 4    | 0.10  | 0.00010 | 0.00010                | 0.0001 | 0.0001               | 0.83 | 0.51  |
| Ca++                                 | 247  | 12.33 | 0.00616 | 0.02465                | 0.0123 | 0.0029               | 0.47 | 61.21 |
| Mg++                                 | 80   | 6.58  | 0.00329 | 0.01316                | 0.0066 | 0.0015               | 0.47 | 32.67 |
| Cl-                                  | 30   | 0.85  | 0.00085 | 0.00085                | 0.0004 | 0.0007               | 0.83 | 2.98  |
| HCO3                                 | 610  | 10.00 | 0.01000 | 0.01000                | 0.0050 | 0.0083               | 0.83 | 35.19 |
| SO4=                                 | 844  | 17.57 | 0.00879 | 0.03514                | 0.0176 | 0.0041               | 0.47 | 61.83 |
| TOTAL CATION AMOUNT (meq/l) : 20.14  |      |       |         | PH : 6.52              |        | EC(nmho/cm) : 2510   |      |       |
| TOTAL ANION AMOUNT (meq/l) : 28.42   |      |       |         | Si(mg/l) :             |        | Sr++(mg/l) :         |      |       |
| TOTAL ION AMOUNT (meq/l) : 48.55     |      |       |         | IONIC STRENGTH : 0.043 |        | HARDNESS(FR) : 94.52 |      |       |
| SAR (SODIUM AD.RATIO) : 0.37         |      |       |         | Ca/Mg : 1.87           |        |                      |      |       |
| Cl/(SO4+HCO3) : 0.03                 |      |       |         |                        |        |                      |      |       |

Table 61

| SAMPLE NAME                   |      | : GEMILI SPRING    |         | LAB NO :D1        |              |        |          |       |
|-------------------------------|------|--------------------|---------|-------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 13 NOVEMBER 1993 |         | TEMPERATURE(°C) : |              |        |          |       |
| IONS                          | mg/l | meq/l              | mol/l   | CZ2               | .5CZ2        | AC     | F        | %     |
| Na+                           | 25   | 1.09               | 0.00109 | 0.00109           | 0.0005       | 0.0009 | 0.83     | 4.73  |
| K+                            | 4    | 0.10               | 0.00010 | 0.00010           | 0.0001       | 0.0001 | 0.83     | 0.45  |
| Ca++                          | 241  | 12.03              | 0.00601 | 0.02405           | 0.0120       | 0.0028 | 0.47     | 52.28 |
| Mg++                          | 119  | 9.79               | 0.00489 | 0.01957           | 0.0098       | 0.0023 | 0.47     | 42.54 |
| Cl-                           | 12   | 0.34               | 0.00034 | 0.00034           | 0.0002       | 0.0003 | 0.83     | 1.54  |
| HCO3                          | 86   | 1.41               | 0.00141 | 0.00141           | 0.0007       | 0.0012 | 0.83     | 6.44  |
| SO4=                          | 968  | 20.15              | 0.01008 | 0.04031           | 0.0202       | 0.0047 | 0.47     | 92.02 |
| TOTAL CATION AMOUNT (meq/l) : |      |                    |         | 23.00             | PH           |        | : 6.54   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                    |         | 21.90             | EC(mmho/cm)  |        | : 2490   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                    |         | 44.90             | Si(mg/l)     |        | : 10.000 |       |
| IONIC STRENGTH :              |      |                    |         | 0.043             | Sr++(mg/l)   |        | : 7.15   |       |
| SAR (SODIUM AD.RATIO) :       |      |                    |         | 0.33              | HARDNESS(FR) |        | : 109.06 |       |
| Cl/(SO4+HCO3) :               |      |                    |         | 0.02              | Ca/Mg        |        | : 1.23   |       |

Table 62

| SAMPLE NAME                   |      | : CONCAVE          |         | LAB NO :D2        |              |        |          |       |
|-------------------------------|------|--------------------|---------|-------------------|--------------|--------|----------|-------|
| DATE OF SAMPLING              |      | : 13 NOVEMBER 1993 |         | TEMPERATURE(°C) : |              |        |          |       |
| IONS                          | mg/l | meq/l              | mol/l   | CZ2               | .5CZ2        | AC     | F        | %     |
| Na+                           | 22   | 0.96               | 0.00096 | 0.00096           | 0.0005       | 0.0008 | 0.82     | 4.16  |
| K+                            | 3    | 0.08               | 0.00008 | 0.00008           | 0.0000       | 0.0001 | 0.82     | 0.33  |
| Ca++                          | 234  | 11.68              | 0.00584 | 0.02335           | 0.0117       | 0.0027 | 0.45     | 50.79 |
| Mg++                          | 125  | 10.28              | 0.00514 | 0.02056           | 0.0103       | 0.0023 | 0.45     | 44.71 |
| Cl-                           | 20   | 0.56               | 0.00056 | 0.00056           | 0.0003       | 0.0005 | 0.82     | 1.88  |
| HCO3                          | 598  | 9.80               | 0.00980 | 0.00980           | 0.0049       | 0.0080 | 0.82     | 32.70 |
| SO4=                          | 942  | 19.61              | 0.00981 | 0.03922           | 0.0196       | 0.0045 | 0.45     | 65.42 |
| TOTAL CATION AMOUNT (meq/l) : |      |                    |         | 22.99             | PH           |        | : 6.45   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                    |         | 29.98             | EC(mmho/cm)  |        | : 2580   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                    |         | 52.97             | Si(mg/l)     |        | : 10.000 |       |
| IONIC STRENGTH :              |      |                    |         | 0.047             | Sr++(mg/l)   |        | : 7.11   |       |
| SAR (SODIUM AD.RATIO) :       |      |                    |         | 0.29              | HARDNESS(FR) |        | : 109.78 |       |
| Cl/(SO4+HCO3) :               |      |                    |         | 0.02              | Ca/Mg        |        | : 1.14   |       |

Table 63

| SAMPLE NAME : DSI 34555             |      |       |         | LAB NO : D3          |        |        |      |       |
|-------------------------------------|------|-------|---------|----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : 13 NOVEMBER 1993 |      |       |         | TEMPERATURE(°C) :    |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                  | .5CZ2  | AC     | F    | %     |
| Na+                                 | 27   | 1.17  | 0.00117 | 0.00117              | 0.0006 | 0.0010 | 0.83 | 5.86  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008              | 0.0000 | 0.0001 | 0.83 | 0.38  |
| Ca++                                | 192  | 9.58  | 0.00479 | 0.01916              | 0.0096 | 0.0022 | 0.46 | 47.80 |
| Mg++                                | 112  | 9.21  | 0.00461 | 0.01842              | 0.0092 | 0.0021 | 0.46 | 45.95 |
| Cl-                                 | 29   | 0.82  | 0.00082 | 0.00082              | 0.0004 | 0.0007 | 0.83 | 2.73  |
| HCO3                                | 598  | 9.80  | 0.00980 | 0.00980              | 0.0049 | 0.0081 | 0.83 | 32.70 |
| SO4=                                | 930  | 19.36 | 0.00968 | 0.03872              | 0.0194 | 0.0045 | 0.46 | 64.58 |
| TOTAL CATION AMOUNT (meq/l) : 20.04 |      |       |         | PH : 6.52            |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 29.98  |      |       |         | EC(mmho/cm) : 2410   |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 50.03    |      |       |         | Si(mg/l) : 11.000    |        |        |      |       |
| IONIC STRENGTH : 0.044              |      |       |         | Sr++(mg/l) : 7.03    |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.38        |      |       |         | HARDNESS(FR) : 93.96 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.03                |      |       |         | Ca/Mg : 1.04         |        |        |      |       |

Table 64

| SAMPLE NAME : DSI 34554             |      |       |         | LAB NO : D4           |        |        |      |       |
|-------------------------------------|------|-------|---------|-----------------------|--------|--------|------|-------|
| DATE OF SAMPLING : 13 NOVEMBER 1993 |      |       |         | TEMPERATURE(°C) :     |        |        |      |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2                   | .5CZ2  | AC     | F    | %     |
| Na+                                 | 26   | 1.13  | 0.00113 | 0.00113               | 0.0006 | 0.0009 | 0.82 | 5.21  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008               | 0.0000 | 0.0001 | 0.82 | 0.35  |
| Ca++                                | 220  | 10.98 | 0.00549 | 0.02196               | 0.0110 | 0.0025 | 0.46 | 50.53 |
| Mg++                                | 116  | 9.54  | 0.00477 | 0.01908               | 0.0095 | 0.0022 | 0.46 | 43.91 |
| Cl-                                 | 29   | 0.82  | 0.00082 | 0.00082               | 0.0004 | 0.0007 | 0.82 | 2.75  |
| HCO3                                | 598  | 9.80  | 0.00980 | 0.00980               | 0.0049 | 0.0081 | 0.82 | 32.97 |
| SO4=                                | 918  | 19.11 | 0.00956 | 0.03822               | 0.0191 | 0.0044 | 0.46 | 64.28 |
| TOTAL CATION AMOUNT (meq/l) : 21.73 |      |       |         | PH : 6.52             |        |        |      |       |
| TOTAL ANION AMOUNT (meq/l) : 29.73  |      |       |         | EC(mmho/cm) : 2410    |        |        |      |       |
| TOTAL ION AMOUNT (meq/l) : 51.46    |      |       |         | Si(mg/l) : 11.000     |        |        |      |       |
| IONIC STRENGTH : 0.046              |      |       |         | Sr++(mg/l) : 7.03     |        |        |      |       |
| SAR (SODIUM AD.RATIO) : 0.35        |      |       |         | HARDNESS(FR) : 102.59 |        |        |      |       |
| Cl/(SO4+HCO3) : 0.03                |      |       |         | Ca/Mg : 1.15          |        |        |      |       |



Table 65

| SAMPLE NAME                   |      | : DSI 25568        |         | LAB NO :D5        |                |        |        |       |
|-------------------------------|------|--------------------|---------|-------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 13 NOVEMBER 1993 |         | TEMPERATURE(°C) : |                |        |        |       |
| IONS                          | mg/l | meq/l              | mol/l   | CZ2               | .5CZ2          | AC     | F      | %     |
| Na+                           | 29   | 1.26               | 0.00126 | 0.00126           | 0.0006         | 0.0010 | 0.82   | 5.88  |
| K+                            | 3    | 0.08               | 0.00008 | 0.00008           | 0.0000         | 0.0001 | 0.82   | 0.36  |
| Ca++                          | 220  | 10.98              | 0.00549 | 0.02196           | 0.0110         | 0.0025 | 0.46   | 51.19 |
| Mg++                          | 111  | 9.13               | 0.00456 | 0.01826           | 0.0091         | 0.0021 | 0.46   | 42.57 |
| Cl-                           | 29   | 0.82               | 0.00082 | 0.00082           | 0.0004         | 0.0007 | 0.82   | 2.83  |
| HCO3                          | 586  | 9.61               | 0.00961 | 0.00961           | 0.0048         | 0.0079 | 0.82   | 33.23 |
| SO4=                          | 888  | 18.49              | 0.00924 | 0.03697           | 0.0185         | 0.0043 | 0.46   | 63.94 |
| TOTAL CATION AMOUNT (meq/l) : |      |                    |         | 21.44             | PH :           |        | 6.64   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                    |         | 28.91             | EC(mmho/cm) :  |        | 2360   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                    |         | 50.36             | Si(mg/l) :     |        | 11.000 |       |
| IONIC STRENGTH :              |      |                    |         | 0.044             | Sr++(mg/l) :   |        | 6.74   |       |
| SAR (SODIUM AD.RATIO) :       |      |                    |         | 0.40              | HARDNESS(FR) : |        | 100.53 |       |
| Cl/(SO4+HCO3) :               |      |                    |         | 0.03              | Ca/Mg :        |        | 1.20   |       |

Table 66

| SAMPLE NAME                   |      | : DSI 34553        |         | LAB NO :D6        |                |        |        |       |
|-------------------------------|------|--------------------|---------|-------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING              |      | : 13 NOVEMBER 1993 |         | TEMPERATURE(°C) : |                |        |        |       |
| IONS                          | mg/l | meq/l              | mol/l   | CZ2               | .5CZ2          | AC     | F      | %     |
| Na+                           | 28   | 1.22               | 0.00122 | 0.00122           | 0.0006         | 0.0010 | 0.83   | 6.70  |
| K+                            | 3    | 0.08               | 0.00008 | 0.00008           | 0.0000         | 0.0001 | 0.83   | 0.42  |
| Ca++                          | 170  | 8.48               | 0.00424 | 0.01697           | 0.0085         | 0.0020 | 0.48   | 46.70 |
| Mg++                          | 102  | 8.39               | 0.00419 | 0.01678           | 0.0084         | 0.0020 | 0.48   | 46.17 |
| Cl-                           | 28   | 0.79               | 0.00079 | 0.00079           | 0.0004         | 0.0007 | 0.83   | 2.99  |
| HCO3                          | 574  | 9.41               | 0.00941 | 0.00941           | 0.0047         | 0.0078 | 0.83   | 35.65 |
| SO4=                          | 778  | 16.20              | 0.00810 | 0.03239           | 0.0162         | 0.0039 | 0.48   | 61.36 |
| TOTAL CATION AMOUNT (meq/l) : |      |                    |         | 18.17             | PH :           |        | 6.51   |       |
| TOTAL ANION AMOUNT (meq/l) :  |      |                    |         | 26.40             | EC(mmho/cm) :  |        | 2160   |       |
| TOTAL ION AMOUNT (meq/l) :    |      |                    |         | 44.56             | Si(mg/l) :     |        | 11.000 |       |
| IONIC STRENGTH :              |      |                    |         | 0.039             | Sr++(mg/l) :   |        | 6.16   |       |
| SAR (SODIUM AD.RATIO) :       |      |                    |         | 0.42              | HARDNESS(FR) : |        | 84.36  |       |
| Cl/(SO4+HCO3) :               |      |                    |         | 0.03              | Ca/Mg :        |        | 1.01   |       |

Table 67

| SAMPLE NAME : HAYDARBABA SINKHOLE   |      |       |         | LAB NO : D7       |                |        |        |       |
|-------------------------------------|------|-------|---------|-------------------|----------------|--------|--------|-------|
| DATE OF SAMPLING : 13 NOVEMBER 1993 |      |       |         | TEMPERATURE(°C) : |                |        |        |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2               | .5CZ2          | AC     | F      | %     |
| Na+                                 | 30   | 1.30  | 0.00130 | 0.00130           | 0.0007         | 0.0011 | 0.82   | 4.49  |
| K+                                  | 3    | 0.08  | 0.00008 | 0.00008           | 0.0000         | 0.0001 | 0.82   | 0.26  |
| Ca++                                | 405  | 20.21 | 0.01010 | 0.04042           | 0.0202         | 0.0046 | 0.46   | 69.51 |
| Mg++                                | 91   | 7.48  | 0.00374 | 0.01497           | 0.0075         | 0.0017 | 0.46   | 25.74 |
| Cl-                                 | 33   | 0.93  | 0.00093 | 0.00093           | 0.0005         | 0.0008 | 0.82   | 4.19  |
| HCO3                                | 513  | 8.41  | 0.00841 | 0.00841           | 0.0042         | 0.0069 | 0.82   | 37.84 |
| SO4=                                | 619  | 12.89 | 0.00644 | 0.02577           | 0.0129         | 0.0030 | 0.46   | 57.98 |
| TOTAL CATION AMOUNT (meq/l) :       |      |       |         | 29.07             | PH :           |        | 6.60   |       |
| TOTAL ANION AMOUNT (meq/l) :        |      |       |         | 22.23             | EC(mmho/cm) :  |        | 1930   |       |
| TOTAL ION AMOUNT (meq/l) :          |      |       |         | 51.30             | Si(mg/l) :     |        | 11.000 |       |
| IONIC STRENGTH :                    |      |       |         | 0.046             | Sr++(mg/l) :   |        | 5.34   |       |
| SAR (SODIUM AD.RATIO) :             |      |       |         | 0.35              | HARDNESS(FR) : |        | 138.47 |       |
| Cl/(SO4+HCO3) :                     |      |       |         | 0.04              | Ca/Mg :        |        | 2.70   |       |

Table 68

| SAMPLE NAME : KELKAYA SINKHOLE      |      |       |         | LAB NO : D8       |                |        |       |       |
|-------------------------------------|------|-------|---------|-------------------|----------------|--------|-------|-------|
| DATE OF SAMPLING : 13 NOVEMBER 1993 |      |       |         | TEMPERATURE(°C) : |                |        |       |       |
| IONS                                | mg/l | meq/l | mol/l   | CZ2               | .5CZ2          | AC     | F     | %     |
| Na+                                 | 10   | 0.43  | 0.00043 | 0.00043           | 0.0002         | 0.0004 | 0.84  | 2.46  |
| K+                                  | 2    | 0.05  | 0.00005 | 0.00005           | 0.0000         | 0.0000 | 0.84  | 0.29  |
| Ca++                                | 177  | 8.83  | 0.00442 | 0.01766           | 0.0088         | 0.0022 | 0.50  | 49.88 |
| Mg++                                | 102  | 8.39  | 0.00419 | 0.01678           | 0.0084         | 0.0021 | 0.50  | 47.37 |
| Cl-                                 | 9    | 0.25  | 0.00025 | 0.00025           | 0.0001         | 0.0002 | 0.84  | 1.25  |
| HCO3                                | 329  | 5.39  | 0.00539 | 0.00539           | 0.0027         | 0.0045 | 0.84  | 26.54 |
| SO4=                                | 705  | 14.68 | 0.00734 | 0.02935           | 0.0147         | 0.0036 | 0.50  | 72.22 |
| TOTAL CATION AMOUNT (meq/l) :       |      |       |         | 17.71             | PH :           |        | 7.67  |       |
| TOTAL ANION AMOUNT (meq/l) :        |      |       |         | 20.32             | EC(mmho/cm) :  |        | 2060  |       |
| TOTAL ION AMOUNT (meq/l) :          |      |       |         | 38.03             | Si(mg/l) :     |        | 9.000 |       |
| IONIC STRENGTH :                    |      |       |         | 0.035             | Sr++(mg/l) :   |        | 5.28  |       |
| SAR (SODIUM AD.RATIO) :             |      |       |         | 0.15              | HARDNESS(FR) : |        | 86.10 |       |
| Cl/(SO4+HCO3) :                     |      |       |         | 0.01              | Ca/Mg :        |        | 1.05  |       |



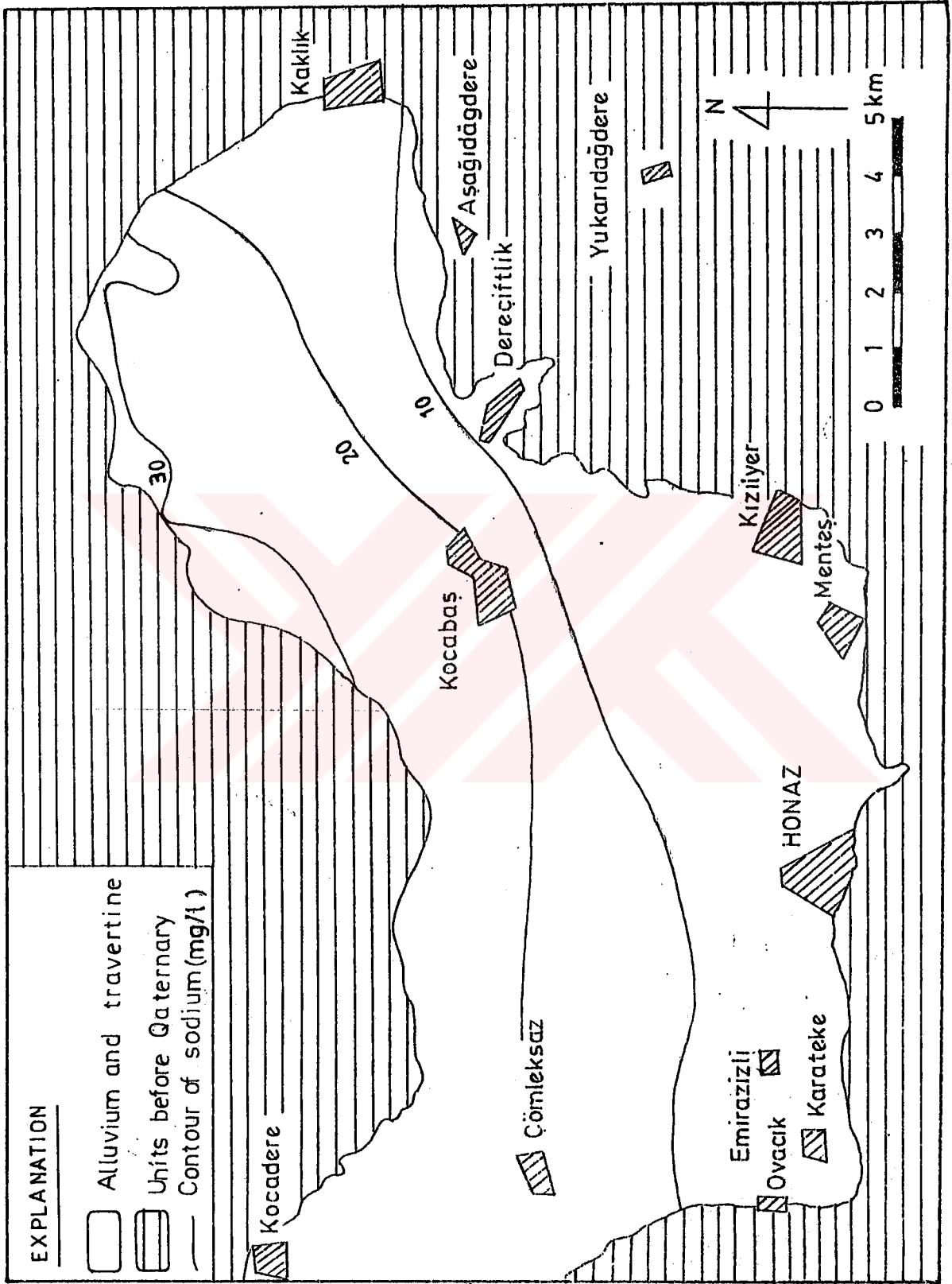


Figure 9. Contour map of sodium content

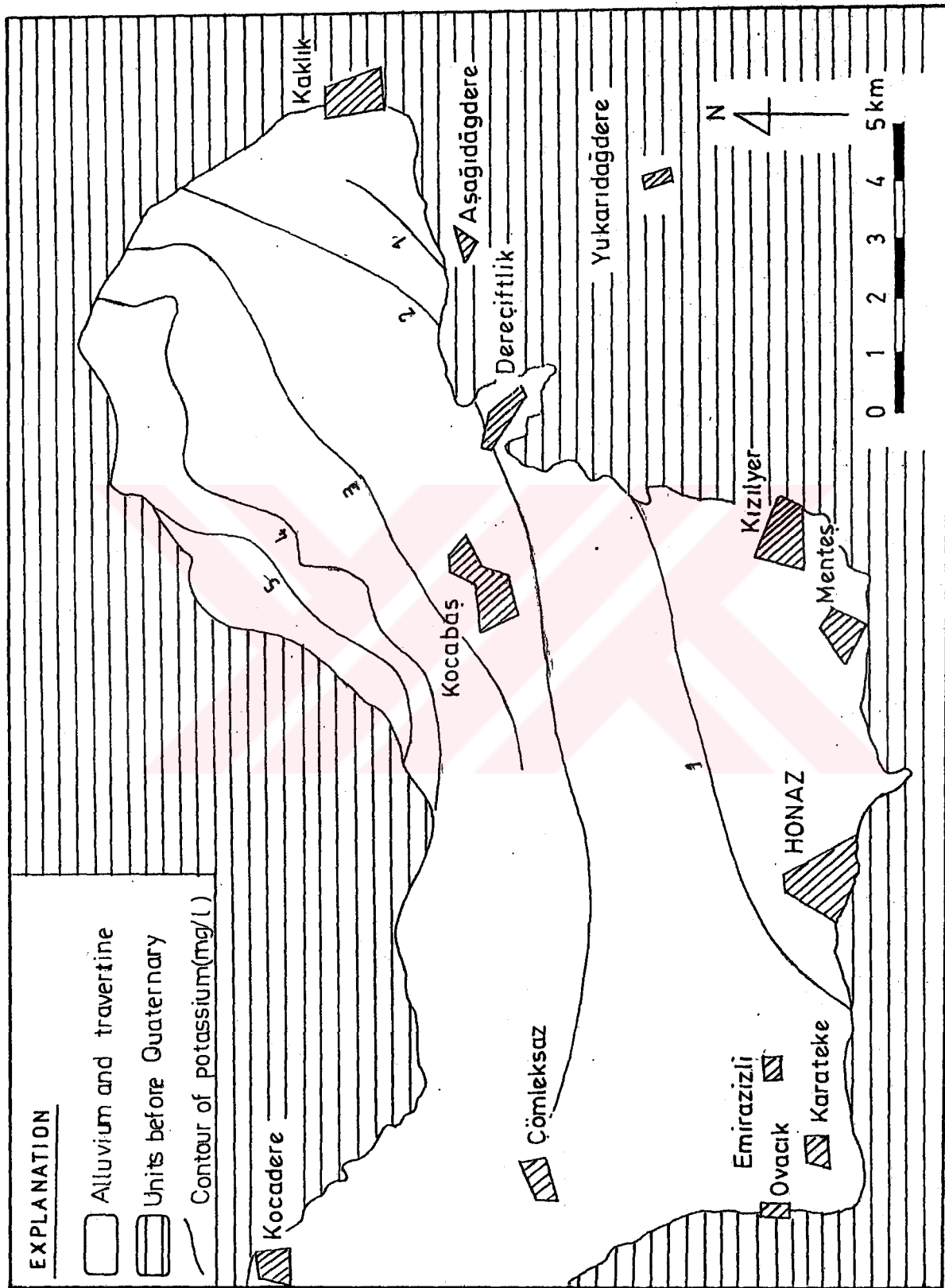


Figure 10. Contour map of potassium content

investigation area. Solubility of sodium is increase with temperature and ionic exchange sodium amount of water is effected.

**Potassium :** Properties of potassium is similar with sodium. Ground water potassium content is around 4 mg/l (Figure 10). Source of potassium is mica and potassium feldspar which is contained by metamorphic rocks. Rate of potassium is low than sodium Besides that potassium is adsorbed by clay minerals and plants.

**Calcium :** Ground waters calcium content in the investigation area is around 250-400 mg/l (Figure 11). Ground waters are enriched in view of calcium amount while passing from limestones and travertines. Besides that there are gypsum levels in Pliocene aged sequence. As solubility of gypsum very high they may be a source for calcium. Wide travertine deposits which are observing south of Kocabaş and around should have been occurred by mixing of ground water enriched by calcium and bicarbonate coming from gypsum deposits enriched by calcium and sulfate. Solubility of calcium depends on both temperature and pressure of CO<sub>2</sub> gas. When ground waters are reached to surface because of decreasing of CO<sub>2</sub> gas pressure cause high pH and calcium carbonate precipitation is occurred.

**Magnesium :** Magnesium content of Çürüksu right side plains ground water is around 80-120 mg/l (Figure 12). Source of magnesium is dissolved magnesium salts in the Pliocene aged sequence.

**Bicarbonate :** Bicarbonate content of investigation area is between 550-700 mg/l (Figure 13). Source and solubility of bicarbonate shows similarity with calcium.

**Chloride:** Chloride content of investigation area's ground waters is approximately 25 mg/l (Figure 14). Source of chloride is dissolved chloride salts.

**Sulfate:** Sulfate shows similarity with calcium. Sulfate is reach high values as a result of dissolution of gypsum deposits (Figure 15). Sulfate from east to west shows sulfate enrichment which is gained from gypsum levels of Pliocene aged sequence. The gas of hydrogen sulfur is recognized with it's characteristic scent. Existence of H<sub>2</sub>S gas shows magmatic contribution with faults.

**Silicium :** Dissolution of silisium depends on temperature an pH value of water. High value of pH and temperature are increased the silisium solubility. Silisium content of investigation is changes between 10-20 mg/l. Source of silisium is minerals of metamorphic rocks.

**Strontium :** Strontium which is chemically similar with calcium is replaced calcium in bonds. Strontium content of Çürüksu plain's ground water between 5,5-7 mg/l . As calcium and strontium sulfate's solubility are similar selestite(SrSO<sub>4</sub>) precipitate with gypsum.

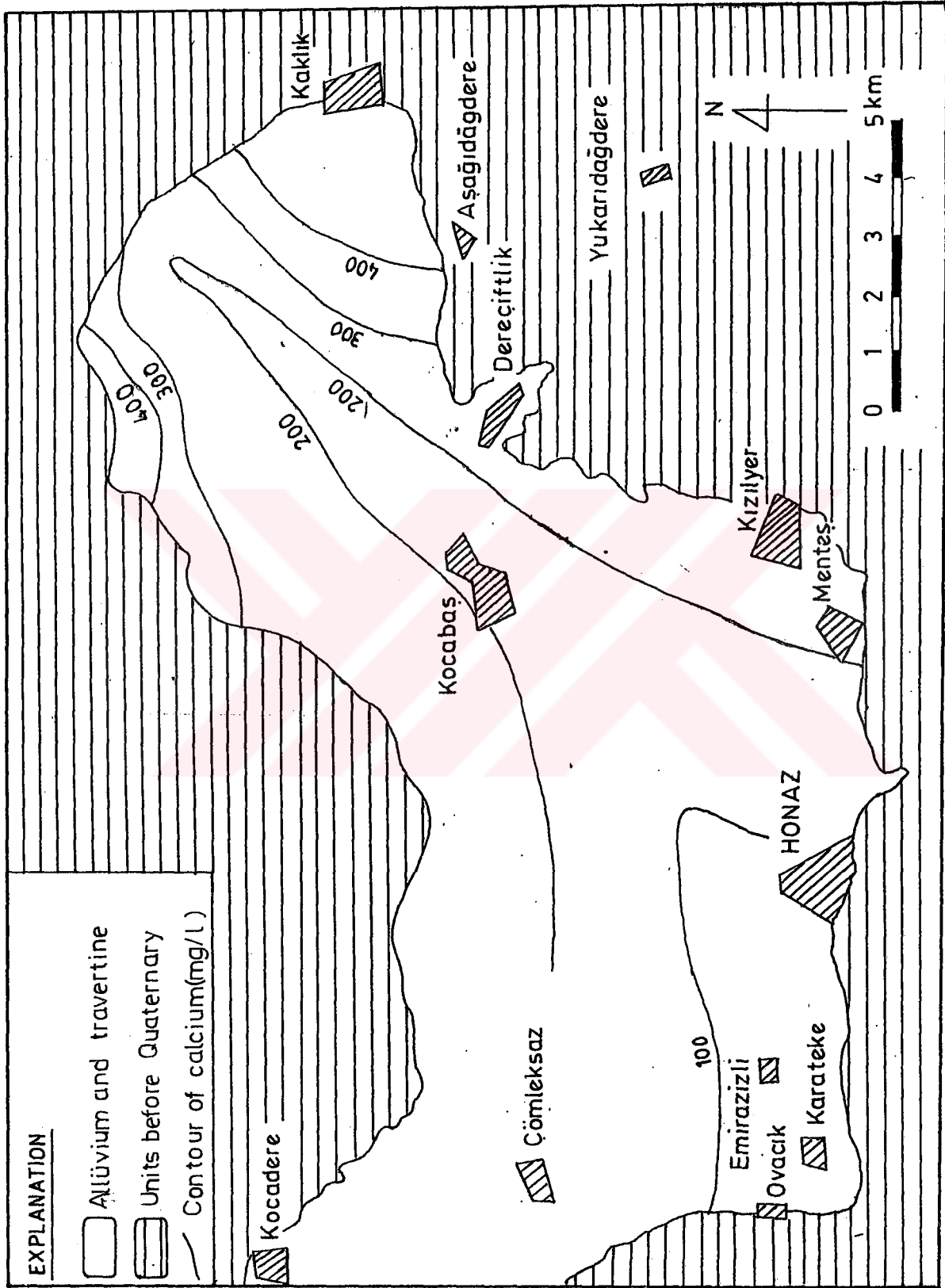


Figure 11. Contour map of calcium content

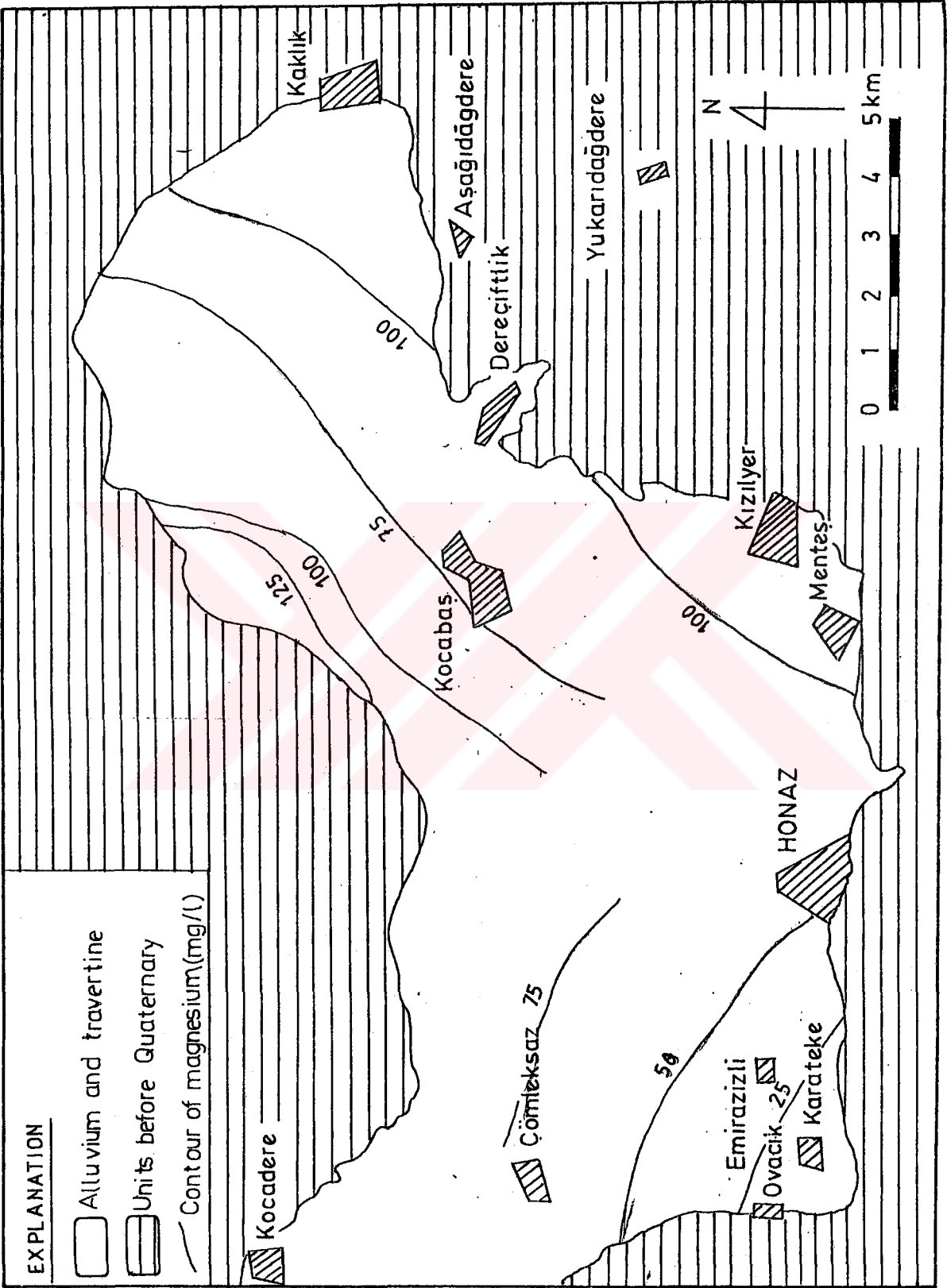


Figure 12. Contour map of magnesium content

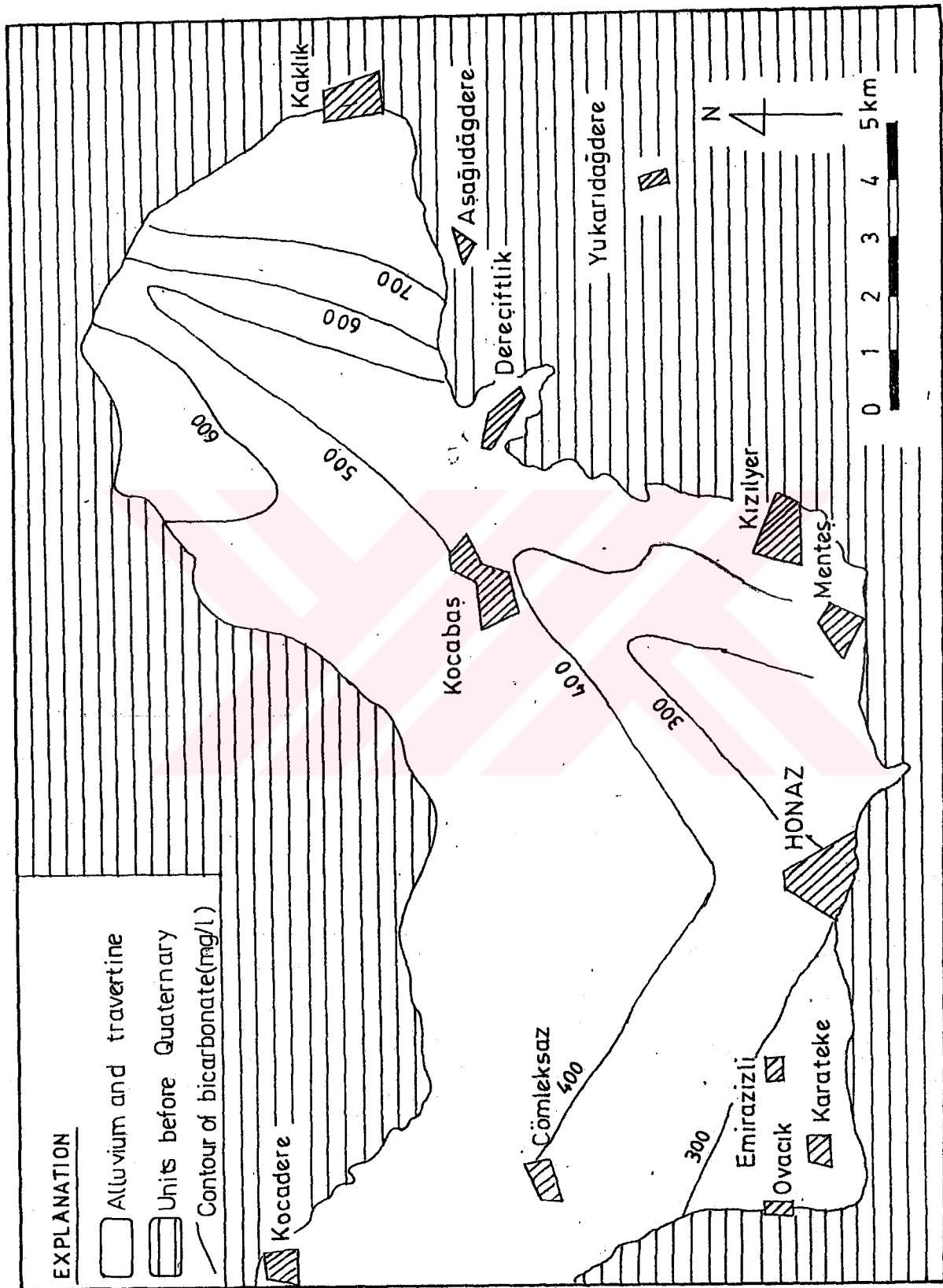


Figure 13. Contour map of bicarbonate content



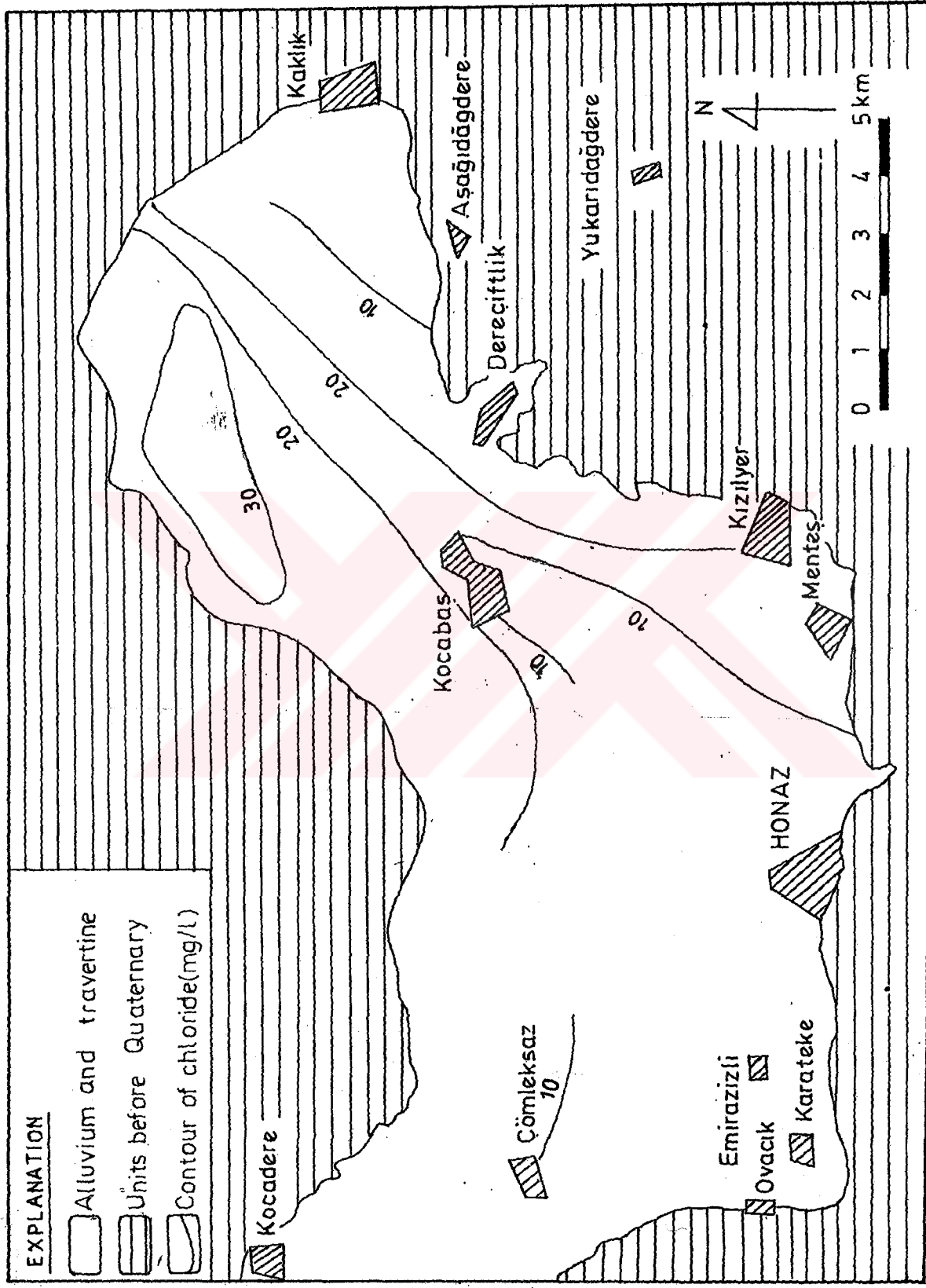


Figure 14. Contour map of chloride content

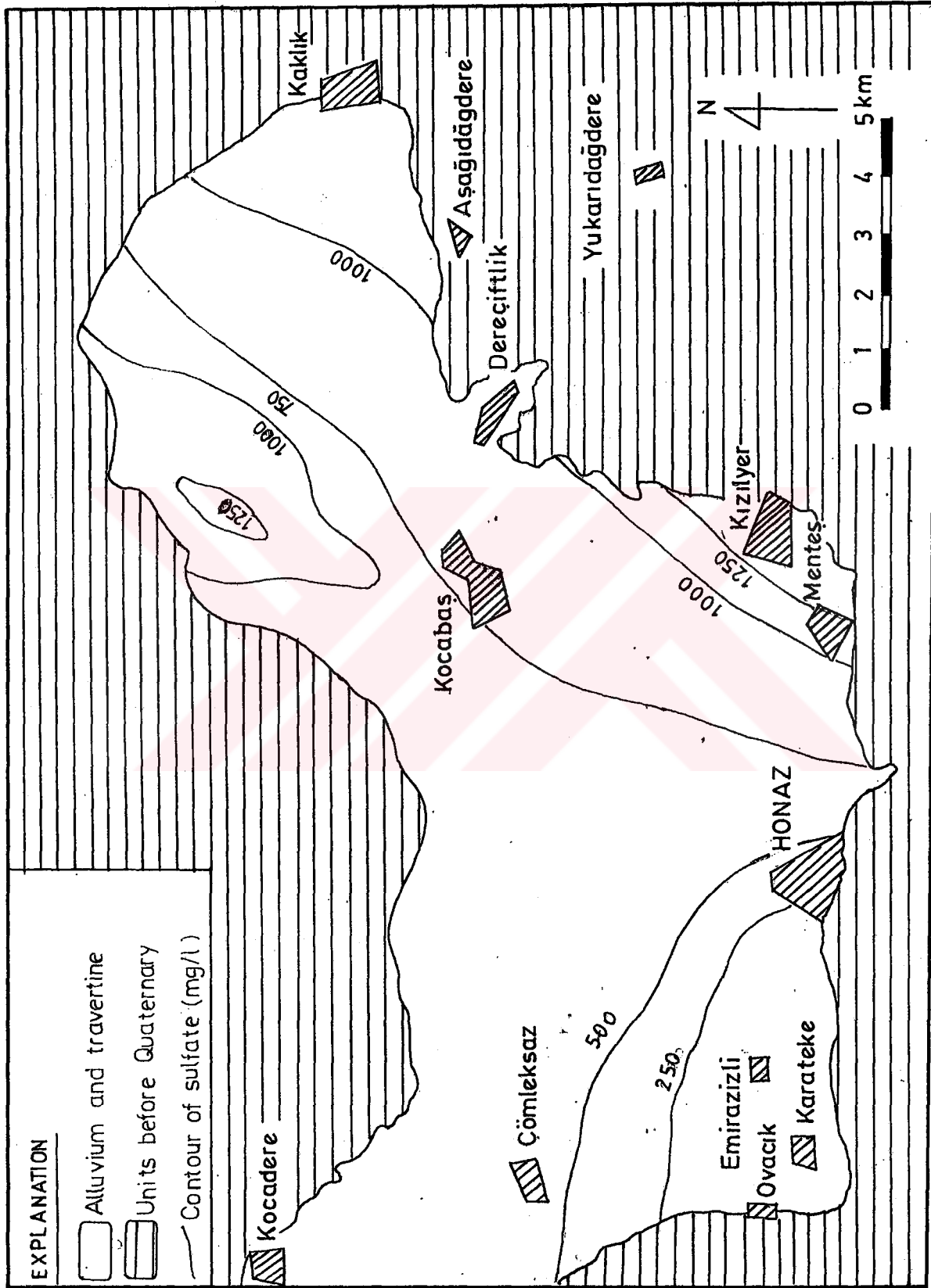


Figure 15. Contour map of sulfate content

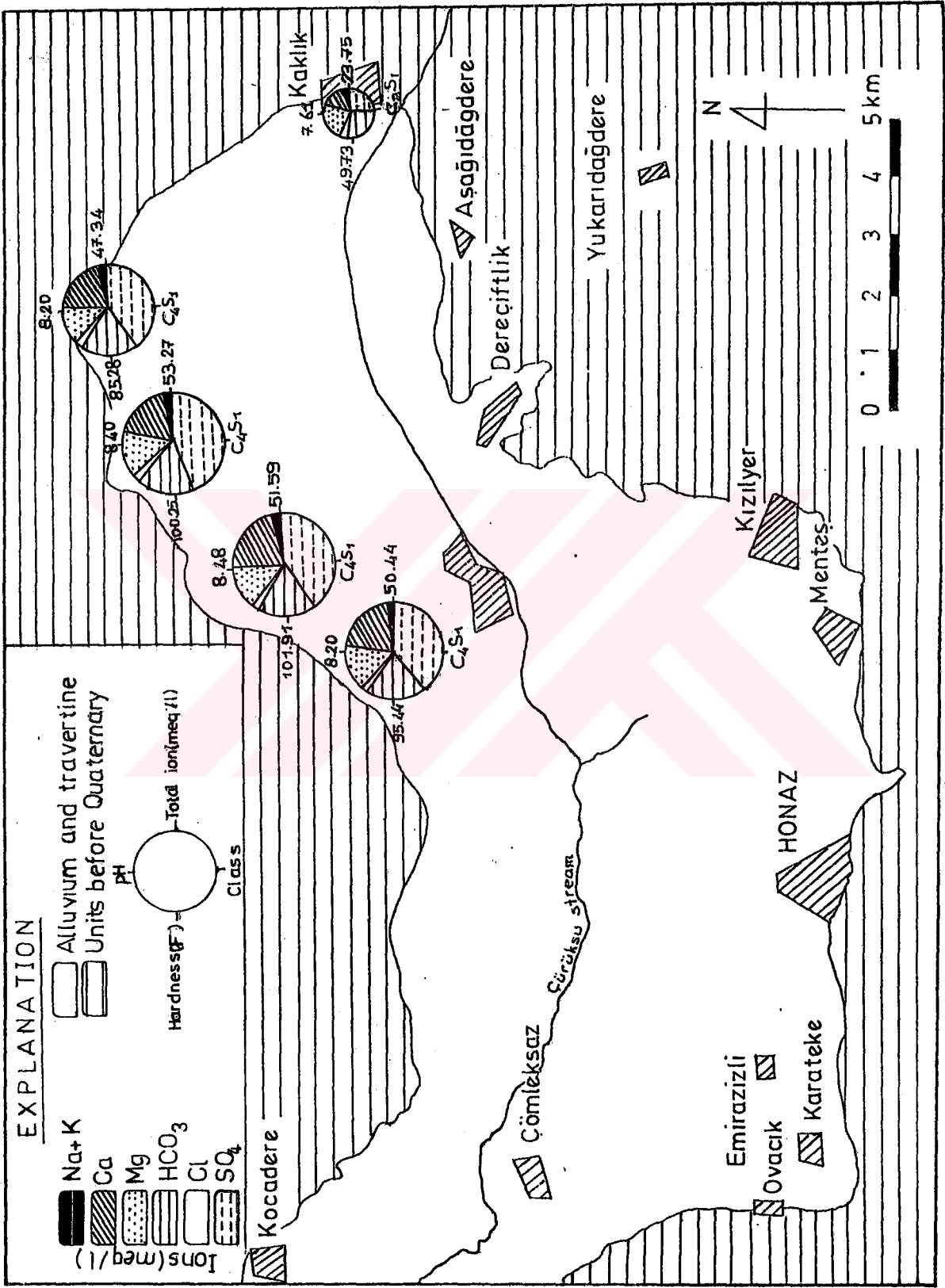


Figure 16. Chemical properties of Yukarı Çürüksu Right side Plain's Ground Water

Ground water's of investigation area is classified as carbonated water. Cation's distribution is express generally.

$$rCa^{++} > rMg^{++} > rNa^{++}K^{+}$$

But well number D.S.I. 43530, Kocabaş and Kaklık drinking water's shows distribution as below.

$$rMg^{++} > rCa^{++} > rNa^{+} + rK^{+}$$

Increases of  $Mg^{++}$  may be because of dolomitic levels of limestones.

Anions distribution is generated as following

$$rSO_4^{-} > rHCO_3^{-} > rCl^{-}$$

### 5.3.1.2. Electrical Conductivity of Water

Chemically pure water has very low electrical conductance meaning that it is a good insulator. However, only a very small amount of dissolved mineral renders the water conductive.

This occurs when the dissolved material separates into ions carrying their negative and positive charges. Conductance is a function of water temperature, hence a standard temperature, is 25 °C, water with relatively high specific conductance, can cause corrosion.

Figure 17 shows the relation between total dissolved solids and specific conductance for samples of water taken from Çürüksu right side plain.

The equation of the line which is given in figure 17 be expressed as.

$$y = a + bx$$

Whose y is electrical conductivity, x the total ions amount (mg/l)

$$a = \frac{\sum y \sum x^2 - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$$

$$b = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$$

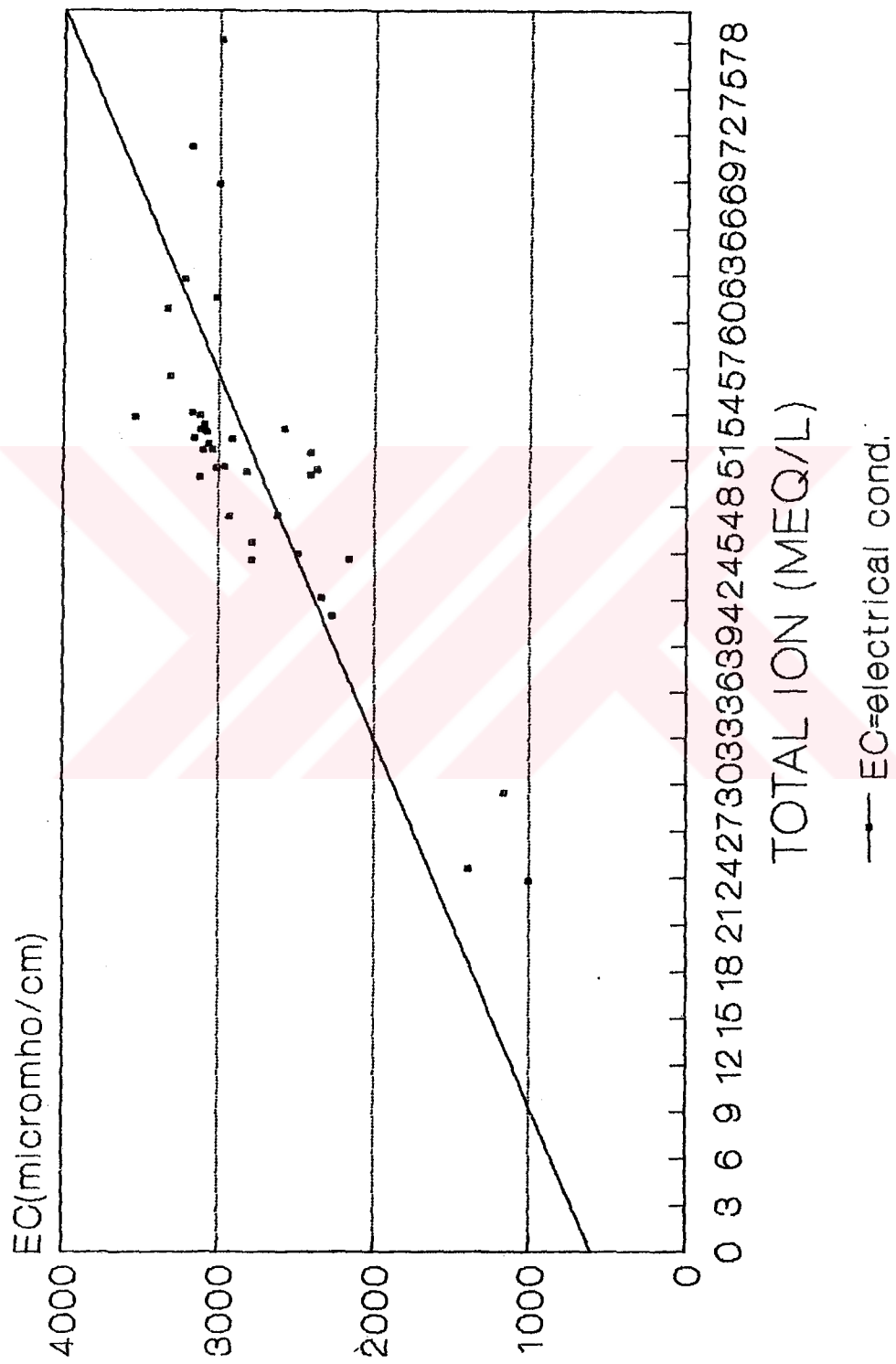


Figure 17. Linear relation between total ions-EC values of ground waters in the investigation area.

equations gives a and b coefficients

Correlation coefficient(r) of water is

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n \sum x^2 - (\sum x)^2] [n \sum y^2 - (\sum y)^2]}}$$

where n is total sample amount

Standard deviation (Syx)

$$S_{yx} = \frac{\sum y^2 - b \sum xy}{n - 2}$$

From this equations, correlation coefficient between EC and total ion amount of investigation area found as

$$r = 0.783$$

regression equation as

$$y = 496.08 + 1.185x$$

and standard deviation as

$$S_{yx} = 570.42$$

### ***5.3.1.3. Hardness of Ground water***

Calcium and magnesium cause almost all the hardness of water. The sources of calcium and magnesium ions that are present in the water may be of the following mineral salts.

Calcium and magnesium bicarbonates

Calcium and magnesium sulfates

Calcium and magnesium chlorides

Calcium and magnesium nitrates.

Hardness map which is made according to the French hardness belong investigation area have been given in figure 18.



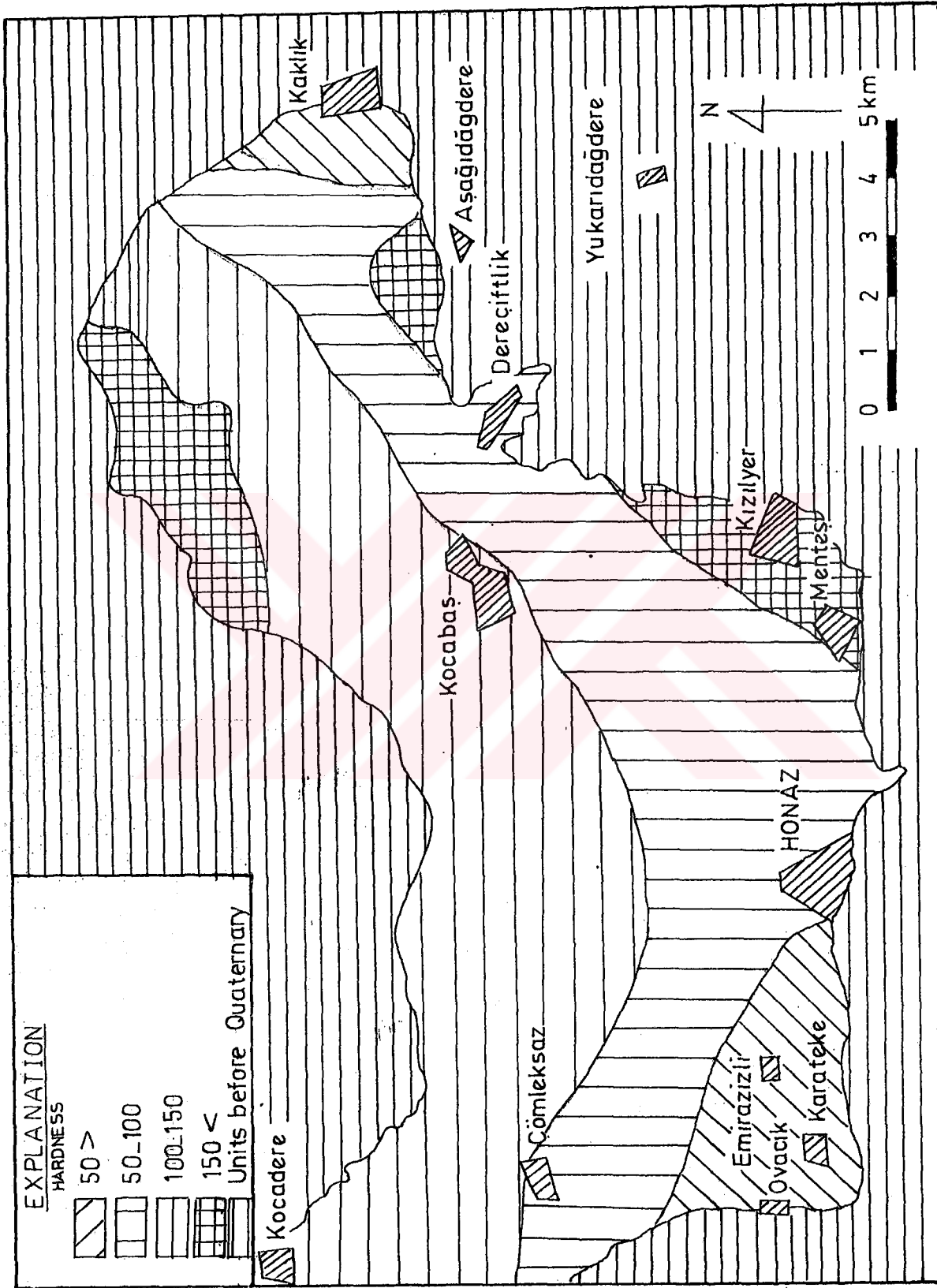


Figure 18. Hardness map of ground waters in the investigation area

A values at different temperatures have been given below.

| T, °C | A       | T, °C | A       |
|-------|---------|-------|---------|
| 0     | 0.49135 | 30    | 0.51570 |
| 5     | 0.49480 | 35    | 0.52206 |
| 10    | 0.49850 | 40    | 0.52580 |
| 20    | 0.50240 | 50    | 0.53690 |
| 25    | 0.51110 |       |         |

chemical activity( $a_i$ ),

$$a_i = f_i c_i$$

or

$$\log a_i = \log f_i + \log c_i$$

where  $a_i$  is the chemical activity and  $c_i$  is the analytical concentration. Activity and concentration have the same units so the activity coefficient ( $f_i$ ) is dimensionless.

Equilibrium which is used for saturation indexes are below.

$$K_1 = (a_{H^+})(a_{HCO_3^-}) / (a_{H_2CO_3}) = 10^{-6.35}$$

$$K_2 = (a_{H^+})(a_{CO_3^{2-}}) / (a_{HCO_3^-}) = 10^{-10.33}$$

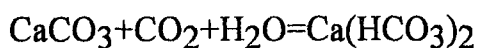
$$K_c = (a_{Ca^{++}})(a_{CO_3^{2-}}) / (a_{CaCO_3}) = 10^{-8.41}$$

$$K_d = \sqrt{(a_{Ca^{++}})(a_{Mg^{++}})}(a_{CO_3^{2-}}) / (a_{CaMg(CO_3)_2}) = 10^{-17}$$

$$K_{CaSO_4} = (a_{Ca^{++}})(a_{SO_4^{2-}}) / (a_{CaSO_4}) = 10^{-2.31}$$

$$K_{CO_2} = (a_{H_2CO_3}) / P_{CO_2} = 10^{-1.46}$$

Although  $CaCO_3$  have high solubility in water, existence of  $CO_2$  gases is increased the  $CaCO_3$  solubility.



#### 5.3.1.4.1. Calcite Saturation Index ( $S_c$ )

Calcite saturation index ( $S_c$ ) is below

$$S_c = \log(I_{APC}/K_c)$$

$$I_{APC} = (a_{Ca^{++}})(a_{HCO_3^-}) K_2 / 10^{-pH}$$

$$S_c = \log(a_{Ca^{++}}) + \log(a_{HCO_3^-}) + \log K_2 - \log 10^{-pH} - \log K_c$$

$I_{APC}$  = chemical activity product of calcite.

$10^{-pH}$  = water's pH

$a$  = chemical activity

$K_2$  and  $K_c$  = equilibrium constants.

Interpretation of  $S_c$

If  $S_c > 0$  There are  $CaCO_3$  precipitation in water

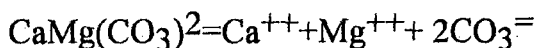
If  $S_c = 0$  Water is saturate  $CaCO_3$

If  $S_c < 0$  Water is dissolve  $CaCO_3$

$S_c = \pm 0.1$  values is accepted as undetermined saturation area.

#### 5.3.1.4.2. Dolomite Saturation Index ( $S_d$ )

Dissolution of dolomite depends on dissolved  $CO_2$  gases in water like  $CaCO_3$ .



Dolomite saturation index ( $S_d$ ),

$$S_d = \log(I_{APd}/K_d)^{1/2}$$

$$I_{APd} = (a_{Ca^{++}})(a_{Mg^{++}})(a_{HCO_3^-})^2 (K_2)^2 / 10^{-2pH}$$

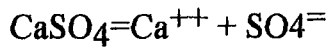
$$S_d = 0,5 [\log(a_{Ca^{++}}) + \log(a_{Mg^{++}}) + 2\log(a_{HCO_3^-}) + 2\log K_2 - \log 10^{-2pH} - \log K_d]$$

Where,  $I_{APd}$  is the chemical activity product of dolomite,  $K_2$  and  $K_d$ , equilibrium constant .

Interpretation of dolomite saturation index is like calcite saturation indices.

#### 5.3.1.4.3. Sulfate Saturation Indices ( $S_s$ )

Sulfate ions generally in a balance with calcium ions in ground water. Dissolubility of  $\text{CaSO}_4$  in water



According to this equilibrium sulfate saturation index shown as below.

$$S_s = \log[(a\text{Ca}^{++})(a\text{SO}_4^{=}) / K_{\text{CaSO}_4}]$$

$$S_s = \log(a\text{Ca}^{++}) + \log(a\text{SO}_4^{=}) - \log K_{\text{CaSO}_4}$$

$K_{\text{CaSO}_4}$  = Equilibrium constant

Interpretation of sulfate saturation similar with calcite saturation index.

#### 5.3.1.4.4. Partial $\text{CO}_2$ Gas Pressure Dissolved in Water.

Partial  $\text{CO}_2$  gas pressure dissolved in water found in equation given below.

$$P_{\text{CO}_2}(\text{atm}) = (a\text{H}^+)(a\text{HCO}_3^-) / K_1 K_{\text{CO}_2}$$

Where  $(a\text{H}^+)$  describes pH of water. Partial pressure value of  $\text{CO}_2$  gases in the atmosphere of  $\text{CO}_2$  gases value solved in water much than value of atmosphere a part of them pass to atmosphere from water to provide the balance with atmosphere so carbonate precipitation occurs.

Saturation indexes and partial  $\text{CO}_2$  gases pressure of investigation area have been given in table 70.

According to this value, Çürüksu right side plain's all water are precipitate calcite and dolomite, dissolve sulfate and partial  $\text{CO}_2$  gases pressure higher than atmosphere.

In addition the result which is obtaining from calcite and dolomite equilibrium pH showed that all waters are precipitate calcite and dolomite.

Calcite equilibrium pH ( $p_{\text{Hc}}$ ) of water. Theoretically water's pH which arrive to saturation in view of  $\text{CaCO}_3$  described as equilibrium pH ( $p_{\text{Hc}}$ ) and expressed as below.

$$p_{\text{Hc}} = -\log[K_2(a\text{Ca}^{++})(a\text{HCO}_3^-) / K_c]$$

and interpretation in that manner,

| Number | Sc      | Sd      | Ss       | PCO2     | Phc   | Phd   |
|--------|---------|---------|----------|----------|-------|-------|
| 1      | 2.30579 | 1.29268 | -2.63227 | -2.87919 | 6.694 | 4.588 |
| 2      | 1.56717 | 1.47258 | -2.63996 | -2.55077 | 6.723 | 4.597 |
| 3      | 1.42260 | 1.38094 | -2.61379 | -2.43919 | 6.677 | 6.702 |
| 4      | 1.50579 | 1.49775 | -2.60483 | -2.53919 | 6.694 | 7.322 |
| 5      | 1.77260 | 1.74775 | -2.61379 | -2.77237 | 6.677 | 6.702 |
| 6      | 1.09260 | 1.07949 | -2.61379 | -2.09237 | 6.677 | 5.330 |
| 7      | 0.91706 | 0.89816 | -2.60928 | -1.92792 | 6.683 | 6.702 |
| 8      | 3.84136 | 1.68929 | -2.57107 | -2.75077 | 6.689 | 6.711 |
| 9      | 1.13203 | 1.10847 | -2.57710 | -2.10513 | 6.857 | 6.672 |
| 10     | 1.11728 | 1.09199 | -2.55466 | -2.13205 | 6.673 | 6.698 |
| 11     | 1.08551 | 1.11151 | -2.49569 | -2.39165 | 6.814 | 6.788 |
| 12     | 3.92716 | 1.82430 | -2.55265 | -2.09691 | 6.783 | 6.576 |
| 13     | 1.02735 | 1.24308 | -2.55265 | -2.30980 | 6.549 | 6.567 |
| 14     | 1.00270 | 0.95362 | -2.43851 | -2.67550 | 6.487 | 6.466 |
| 15     | 1.13144 | 1.08591 | -2.56160 | -1.97572 | 6.549 | 6.594 |
| 16     | 1.51603 | 1.50189 | -2.70978 | -2.47619 | 6.684 | 6.698 |
| 17     | 1.74872 | 1.72948 | -2.73431 | -2.79371 | 6.721 | 6.741 |
| 18     | 1.56330 | 1.56526 | -2.67632 | -2.48691 | 6.637 | 6.634 |
| 19     | 0.52200 | 0.46526 | -2.69734 | -1.64284 | 6.698 | 6.755 |
| 20     | 0.36330 | 0.32017 | -2.65658 | -1.28691 | 6.637 | 6.755 |
| 21     | 0.04904 | 0.16804 | -3.20145 | -1.38709 | 6.961 | 6.842 |
| 22     | 0.00953 | 0.15491 | -2.59526 | -0.73096 | 6.560 | 6.625 |
| 23     | 0.51070 | 0.89124 | -3.73136 | -2.30749 | 6.409 | 6.996 |
| 24     | 0.24325 | 0.57640 | -2.65769 | -2.30572 | 6.567 | 7.234 |
| 25     | 0.04654 | 0.02408 | -2.32227 | -0.70691 | 6.373 | 6.444 |
| 26     | 0.00711 | 0.10773 | -2.32066 | -0.71058 | 6.427 | 6.528 |
| 27     | 0.89680 | 0.94927 | -2.58423 | -1.69151 | 6.513 | 6.461 |
| 28     | 0.10485 | 0.00285 | -2.20770 | -0.76791 | 6.365 | 6.467 |
| 29     | 0.39379 | 0.54332 | -3.41333 | -2.09761 | 6.226 | 7.067 |
| 30     | 0.20102 | 0.20530 | -2.65769 | -1.26919 | 6.729 | 6.725 |
| 31     | 0.13925 | 0.17940 | -2.58746 | -1.09572 | 6.651 | 6.676 |

Table 70. Sc, Sd, Ss, PCO2, Phc, Phd values of ground waters.

If water's  $pH > pH_c$  there are precipitation of  $CaCO_3$

If water's  $pH = pH_c$  there are saturation of  $CaCO_3$

If water's  $pH < pH_c$  water is corrosive and solved  $CaCO_3$ .

### ***5.3.2. Chemical Classification of Waters***

#### ***5.3.2.1. Schoeller Classification***

Schoeller has been classified the waters according to chloride, sulfate and bicarbonate quantity.

All waters in the investigation area have normal chloride ( $rCl < 15$  meq/l) content. View point of sulfate concentration water are classified as sulfated water ( $rSO_4 = 24-58$  meq/l) and oligosulfated water ( $rSO_4 = 6-24$  meq/l). Carbonate and bicarbonate concentration of water's are classified as hipocarbonated waters ( $rHCO_3^- + rCO_3^{2-} > 7$  meq/l) and drinking water are in carbonated waters ( $rHCO_3^- + rCO_3^{2-} > 2-7$  meq/l) group.

#### ***5.3.2.2. Piper Classification***

Waters have been classified with triangular diagrams by Piper. According to this classification it is possible to determine chemical properties of anion and cation at each triangle. Investigation area ground water's ions exaluated, as % meq/l at Piper diagrams, result given at figure 20.

### ***5.3.3. Usefulness of Ground water***

The main classes of use are (1) domestic or household purposes, (2) agricultural purposes; and (3) industrial purposes.

The dissolved minerals in ground water affect its usefulness for various purposes. If one or more of the minerals are in excess of the amount that can be tolerated for given use, some type of treatment may be applied to change or remove the undesirable mineral, so that the water will serve the intended purpose.

#### ***5.3.3.1. Water Quality for Drinking Water***

Determiration of drinking water properties is depends on the climate condition and potential of the water which is changes from one country to another.



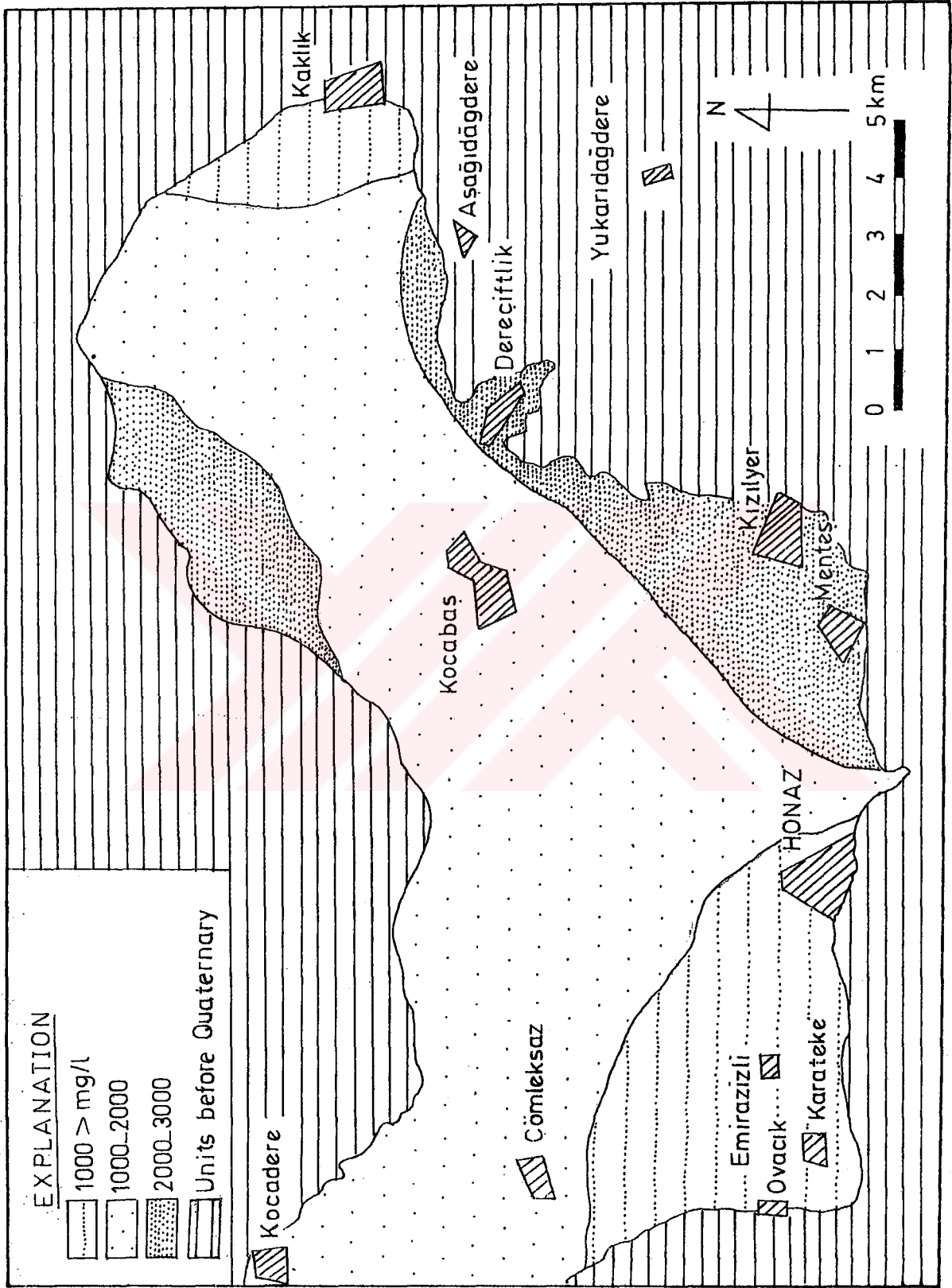


Figure 19. Dispersion of total ion amount of Investigation area.

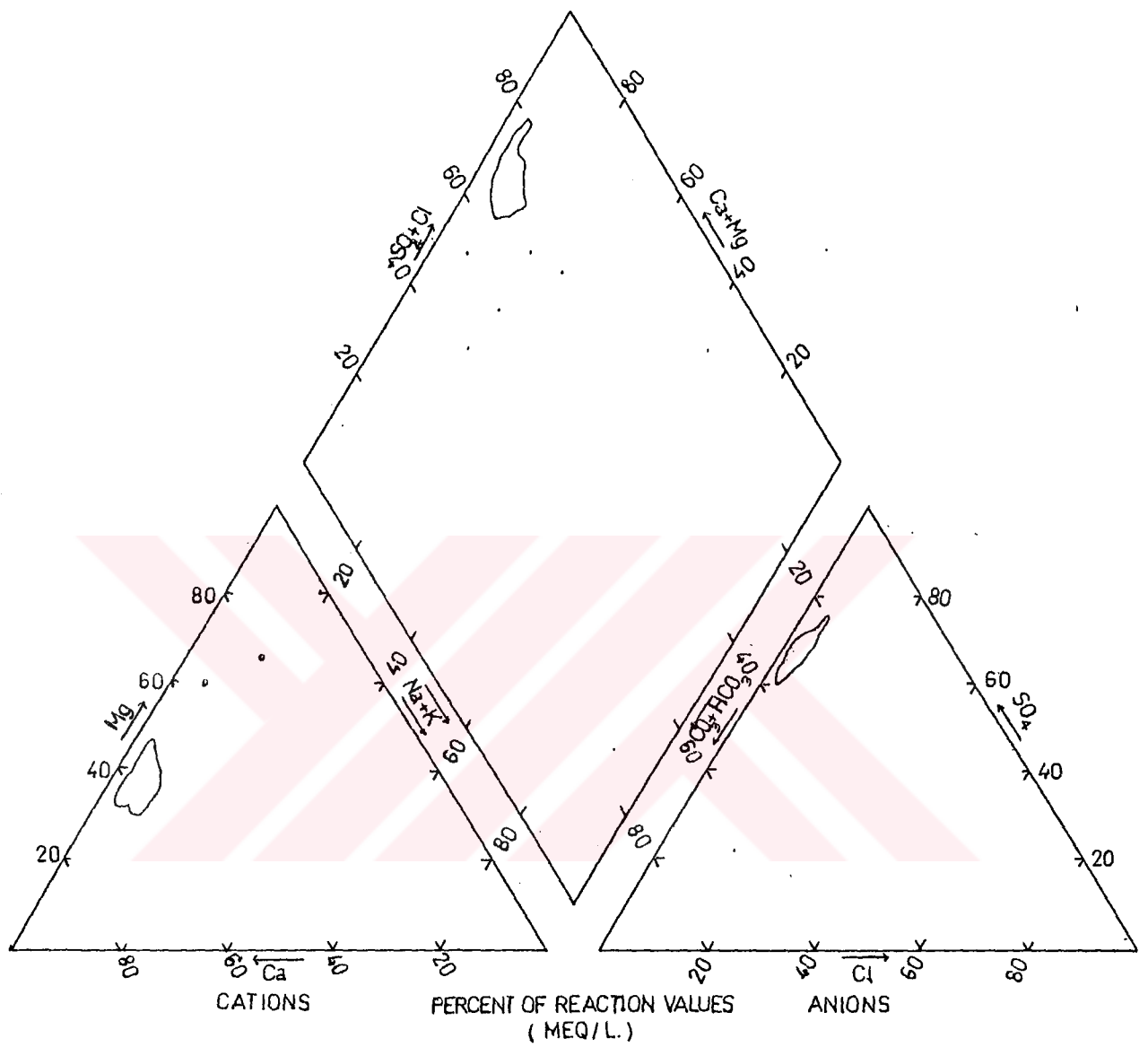


Figure 20. Piper diagram of ground waters

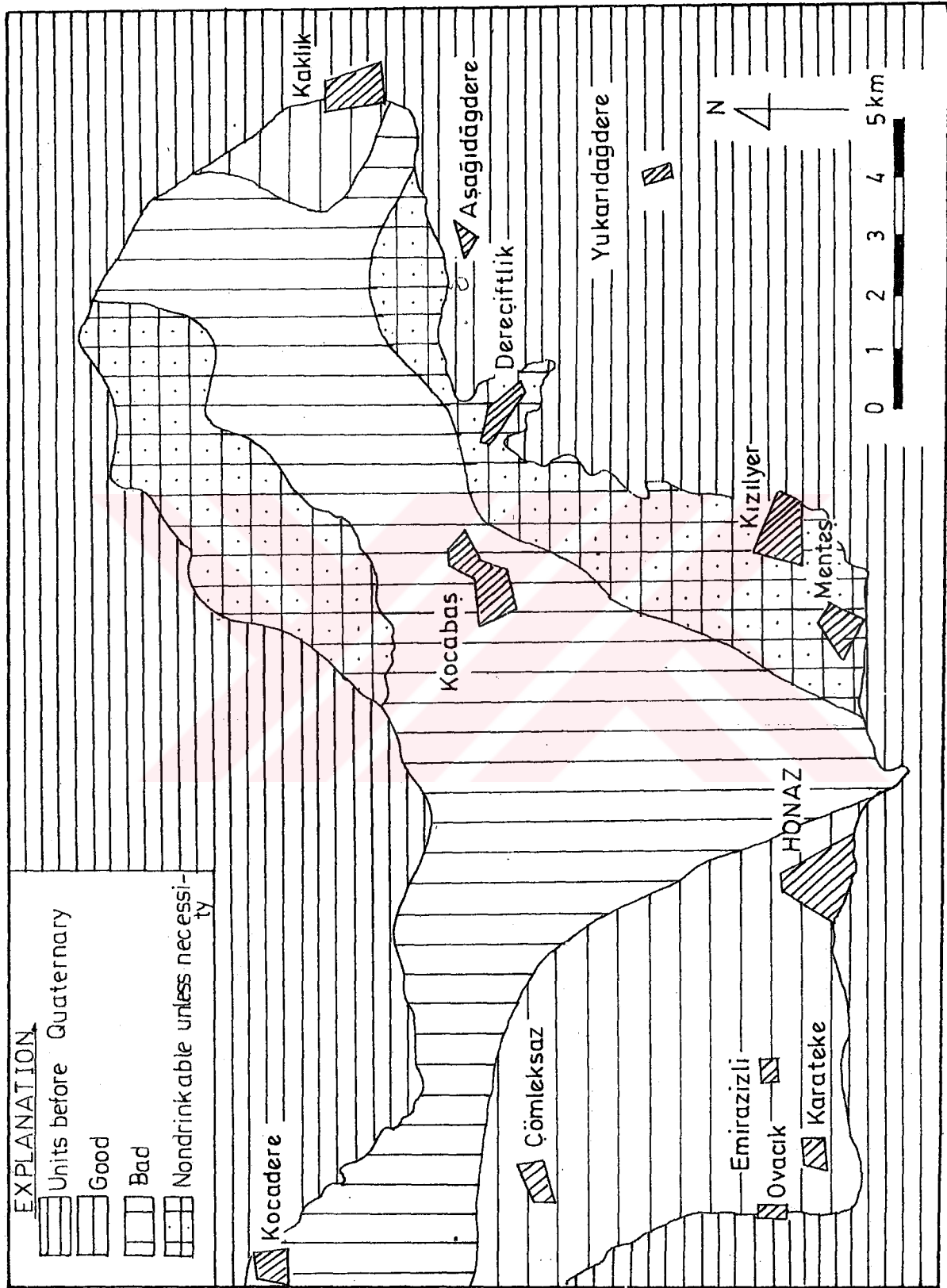
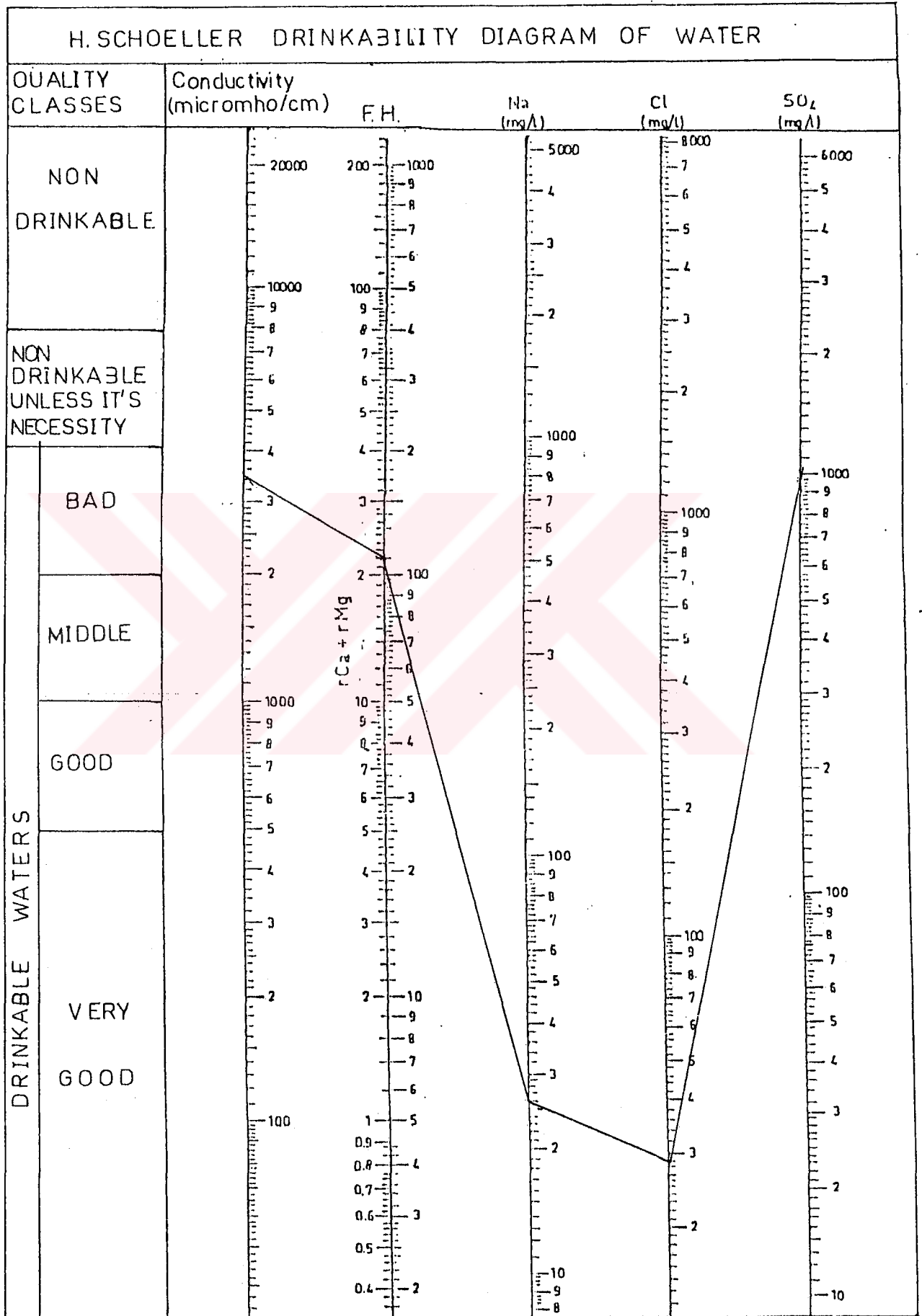


Figure 21. Drinking water map of ground waters.

Figure 22. Schoeller diagram of ground waters.



Whether the ground water suitable for drinking have been interpreted with Schoeller's drinking water diagram (Figure 22).

All of ground water which is take place in investigation area have been classified as bad quality.

### 5.3.3.2. Irrigation Water Criteria

The suitability of a ground water for irrigation is contingent upon the effects of the mineral constituents of the water through modification of osmotic processes, or chemically by metabolic reactions such as caused by toxin constituents. Effects of salts on soil, causing changes in soil structure, permeability and of aeration, indirectly affect plant grow the. For determination whether the ground water suitable for irrigation "SAR", "U.S. Salinity Laboratory" and "Wilcox" diagram" have been used.

#### 5.3.3.2.1. Sodium Adsorption Ratio(SAR)

Sodium amount takes an important place in irrigation water. Clay that carries a good excess of calcium or magnesium ions tills easily and has good permeability. If the same clay takes up sodium it becomes sticky and slick when dry into hard clods which are difficult to break.

Sodium adsorption ratio(SAR) is defined by

$$SAR = \frac{Na^+}{\sqrt{(Ca^{++} + Mg^{++})/2}}$$

Where the concentration of the constituents are expressed in milliequivalents per liter. Recommended water classifications for SAR follow.

| SAR   | Water Class |
|-------|-------------|
| <10   | Excellent   |
| 10-18 | Good        |
| 18-26 | Fair        |
| 26    | Poor        |

As none of the water in investigation area exceeds 10 SAR value ground waters classified as excellent water for irrigation. Water ,SAR values have been given table 7-69.

### 5.3.3.2.2. Chloride Risk

If chloride amount exceeds 5 meq/l absorbed chloride is resulted burning of leafs. Investigation area's waters are not contain enough chloride to affect plants negatively.

### 5.3.3.2.3. Wilcox Diagram

The suitability is judged on measurement of electrical conductivity (expressing total dissolved solids), sodium content reported as percent sodium. It is defined by

| <u>Water class</u> | <u>Percent sodium</u> | <u>ECx10<sup>6</sup> at 25 °C</u> |
|--------------------|-----------------------|-----------------------------------|
| Excellent          | <20                   | <250                              |
| Good               | 20-40                 | 250-750                           |
| Permissible        | 40-60                 | 750-2000                          |
| Doubtful           | 60-80                 | 2000-3000                         |
| Unsuitable         | >80                   | >3000                             |

$$\%Na^+ = \frac{rNa^+}{rCa^{++} + rMg^{++} + rNa^+ + rK^+}$$

Where all ionic concentrations are expressed in miliequivalents per liter. Ground water's EC sodium percent investigation are have been shown in table 7-69. Place of ground water in Wilcox diagram have been shown in figure 23.

According to this diagram waters number 5,6,7,8,9,10,13,14,30 and 31 unsuitable, 23,24, and 29 good to permissible others doubtful to unsuitable for irrigation.

### 5.3.3.2.4. U.S. Salinity Laboratory

Water have been separate in U.S. Salinity Laboratory into 16 class according to SAR and EC values.

Çürüksu right side plain's ground water are in C<sub>4</sub>-S<sub>1</sub> class and can be used in well-drained soil. Kocabaş, Kaklık drinking water and D.S.I. number 43530 well water



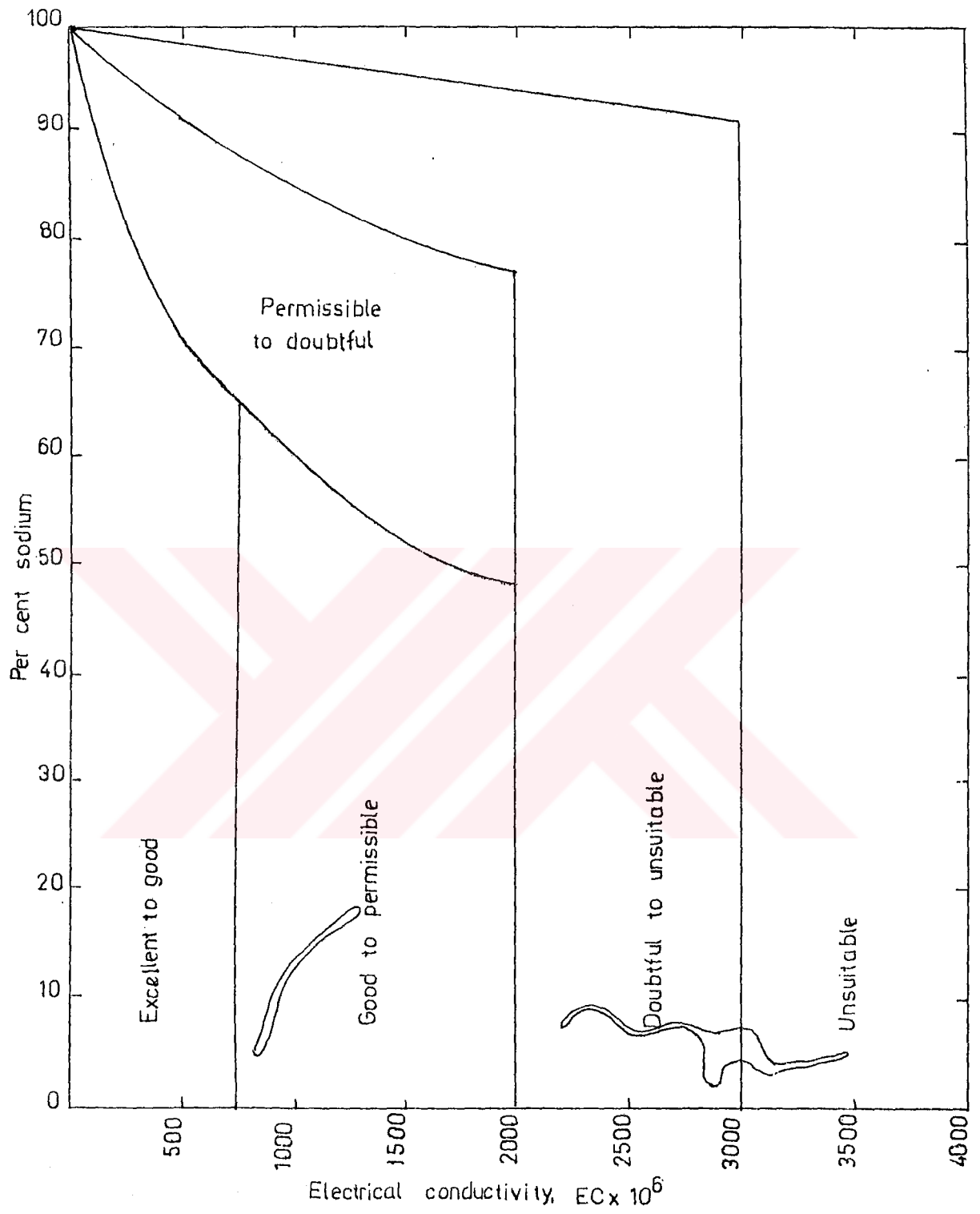


Figure 23. Wilcox diagram of ground waters.

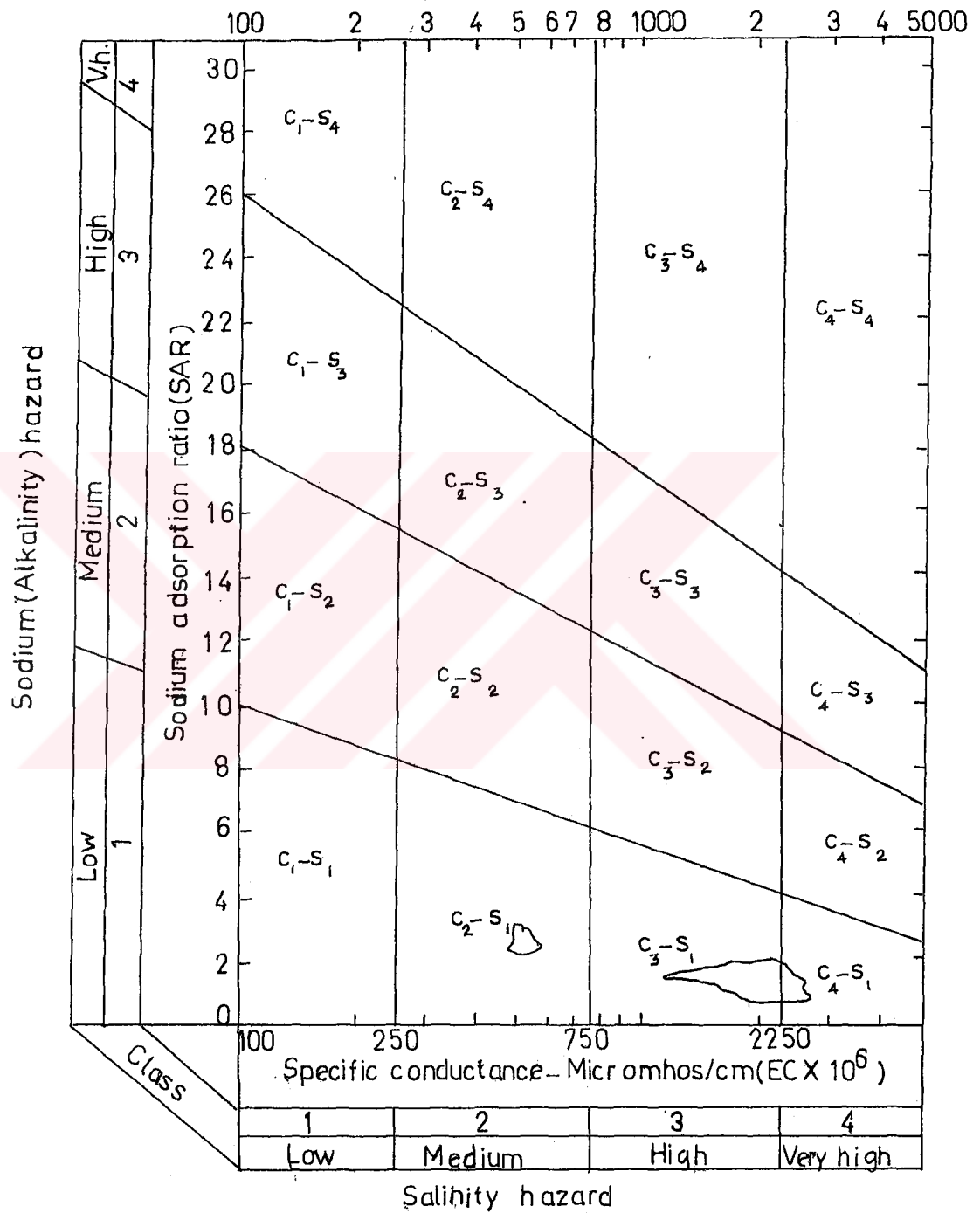


Figure 24. U.S. Salinity laboratory of ground water

are in C<sub>3</sub>-S<sub>1</sub> class although this water is not create a problem salt amount should be observed (Figure 24).

#### 5.3.3.2.5. *Synthesis of Irrigation water classifications.*

Result of U.S. Salinity Laboratory and Wilcox diagram shows differences. For prevent of this differences classification have been repeated according to the %Na, Cl,SO<sub>4</sub> and EC values(Şahinci 1986-b)

| Water class | % Na  | rCl   | rSO <sub>4</sub> | EC        |
|-------------|-------|-------|------------------|-----------|
| Excellent   | <20   | <4    | <4               | <250      |
| Good        | 20-40 | 4-7   | 4-7              | 250-750   |
| Permissible | 40-60 | 7-12  | 7-12             | 750-2000  |
| Doubtful    | 60-80 | 12-20 | 12-20            | 2000-3000 |
| Unsuitable  | >80   | >20   | >20              | >3000     |

For investigation area water %Na and chloride is not a problem but EC and SO<sub>4</sub> values makes the water doubtful and unsuitable.

#### 5.3.3.3. *Usefulness of Ground water as Industrial Water*

The quality requirements of waters used in different industrial processes vary widely. Thus, make-up water for high pressure boilers must meet extremely exacting criteria whereas water of as low a quality as sea water can be satisfactorily employed for cooling of condensers. Even within each industry, criteria cannot be established; instead, only recommended limiting values or ranges can be stated.

##### 5.3.3.3.1. *Lathering properties of water while boil.*

Lathering of water while boil because of the sodium and potassium salt accumulating on the water. Water spurts improving as a result of this event effects cauldron systems and evaporation .Lathering is account as below

$$F=62rNa+78rk$$

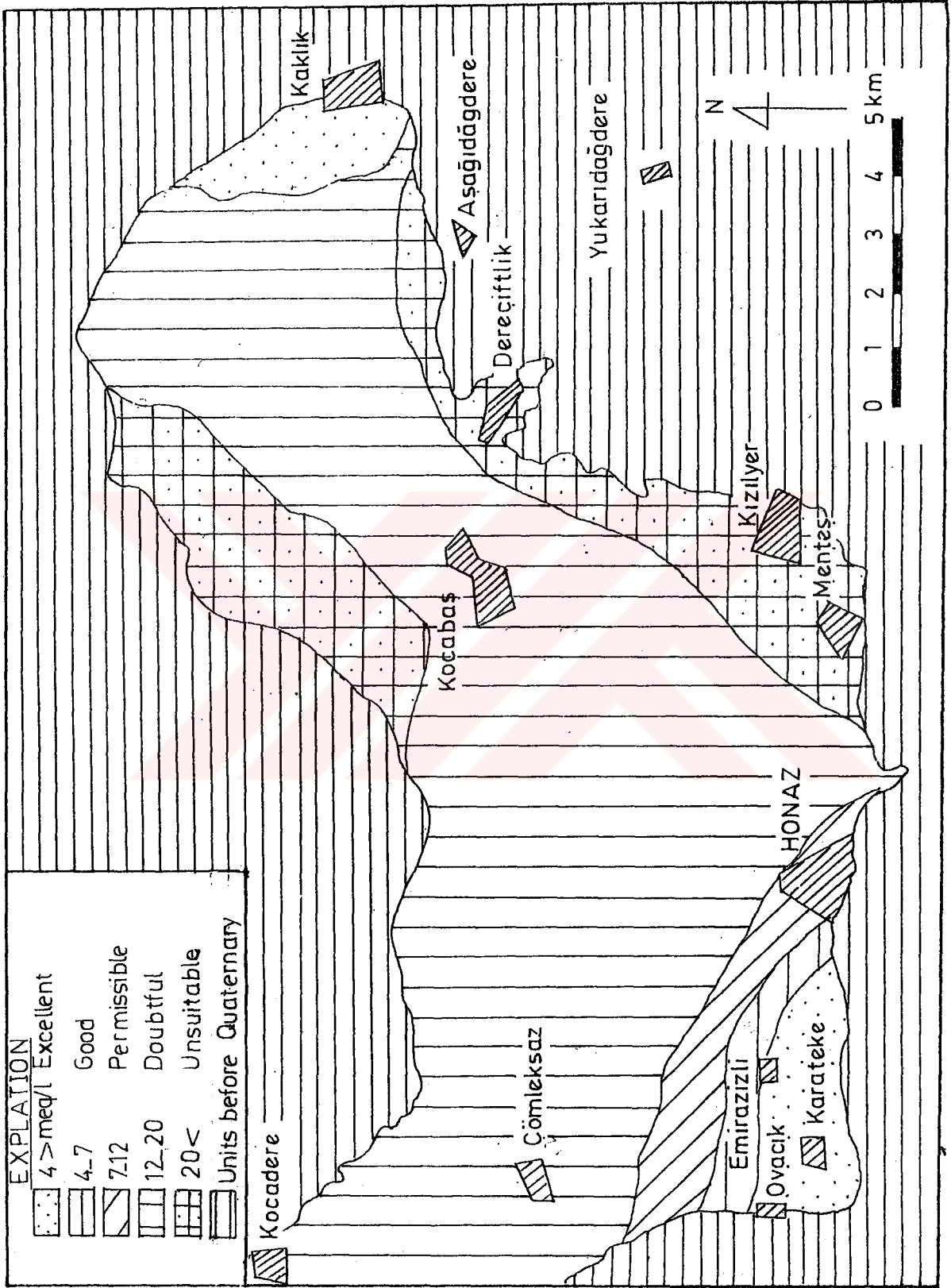


Figure 25. Usefulness map of ground water according to the SO<sub>4</sub> values

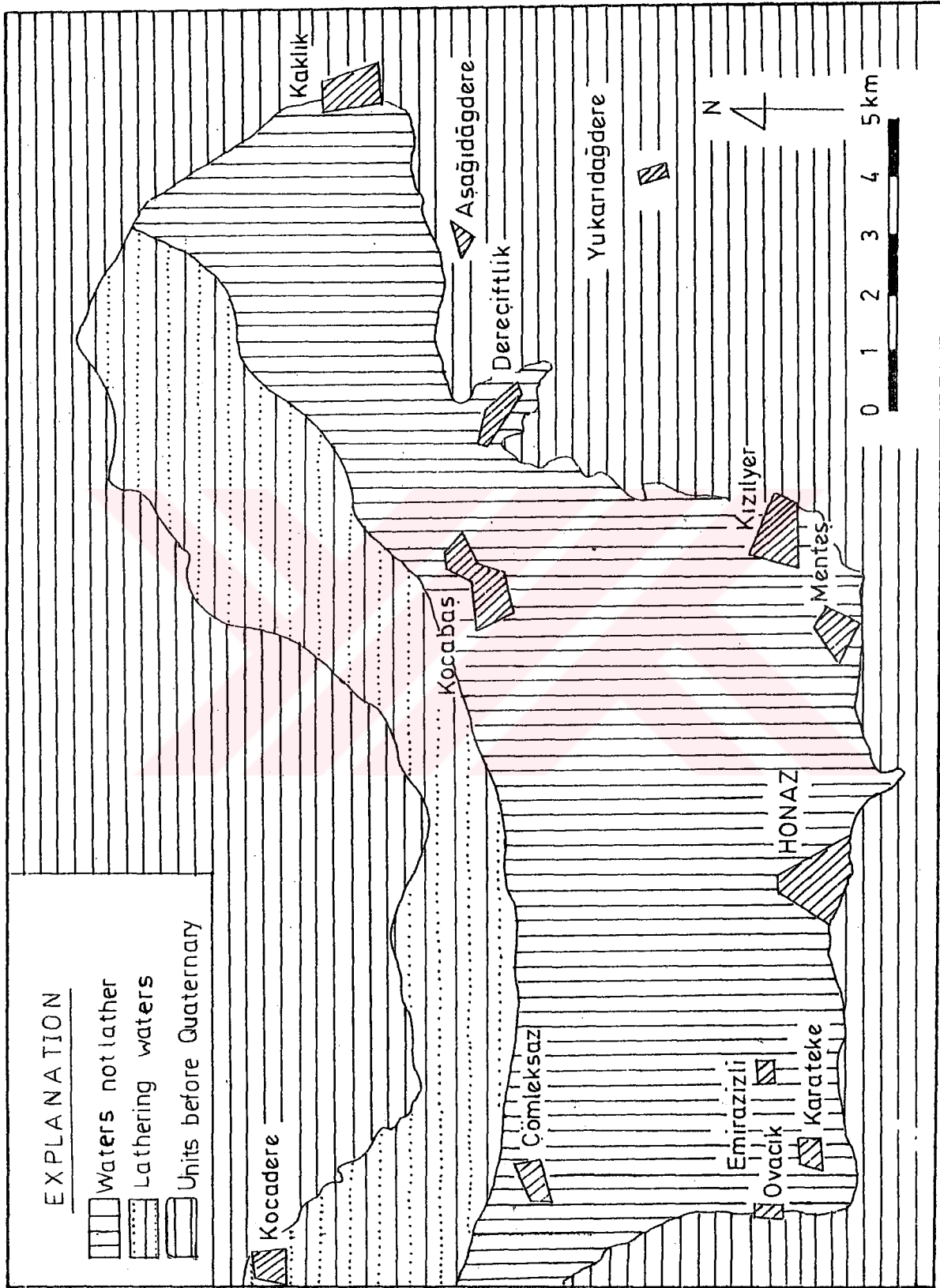


Figure 26. Usefulness map of ground water as Industrial water

### Classification of water according to the lathering properties

- F<600 Waters not lather while boil
- 60<F<200 Waters lathering while boil
- F>200 Waters very lathering while boil.

Ground waters of investigation area have been classified as "Water Lathering while boil and water very lathering while boil". Using of this water resulted effects mentioned above figure 26.

#### 5.3.3.3.2. Effect of water on concrete.

Harmful effects of ground water while using as mixing water and water effects to basement of the buildings have been investigated in this section. Limit value of effectiveness have been given by T.S. 3440 as below:

|                 | Harmful effectiveness degree |          |             |
|-----------------|------------------------------|----------|-------------|
|                 | Weak                         | Strong   | Very Strong |
| pH              | 6,5-5,5                      | 5,5-4,5  | <4,5        |
| Magnesium(mg/l) | 100-300                      | 300-1500 | >1500       |
| Sulfate(mg/l)   | 200-600                      | 600-3000 | >3000       |

Validity of this values for stagnant or slow flowing wares and water mixing to concrete. Increasing of pressure and heat of water is increased harmful effect of waters.

Effect of water into concrete is by two ways. First effect occurs when the water use as mixing water. If pH low than 6,5 dissolved CO<sub>2</sub> in water forms carbonic acid then calcium carbonate forms and cause deformation of concrete. Sulfated waters which are use producing of concrete when react with cement cause increase of valume.

Although harmful of magnesium show similarity with sulfate effects more great than sulfate. Second effect of ground water concrete harmfuluş which is given to basement of builts.

Using sulfate value of investigation area effectiveness contour map have been doen (Figure 27).

Çürüksu Plain's ground water have been used for mixing water to concrete. If portland cement is use for concrete harmful effects have been shown. But as CaSO<sub>4</sub> is not effects alumined because reaction produce of water. Cement is sulfaaluminate crystals which is increase the resistant of concrete. To prevent harmful effect of water into basement of built alumined cement should be used.



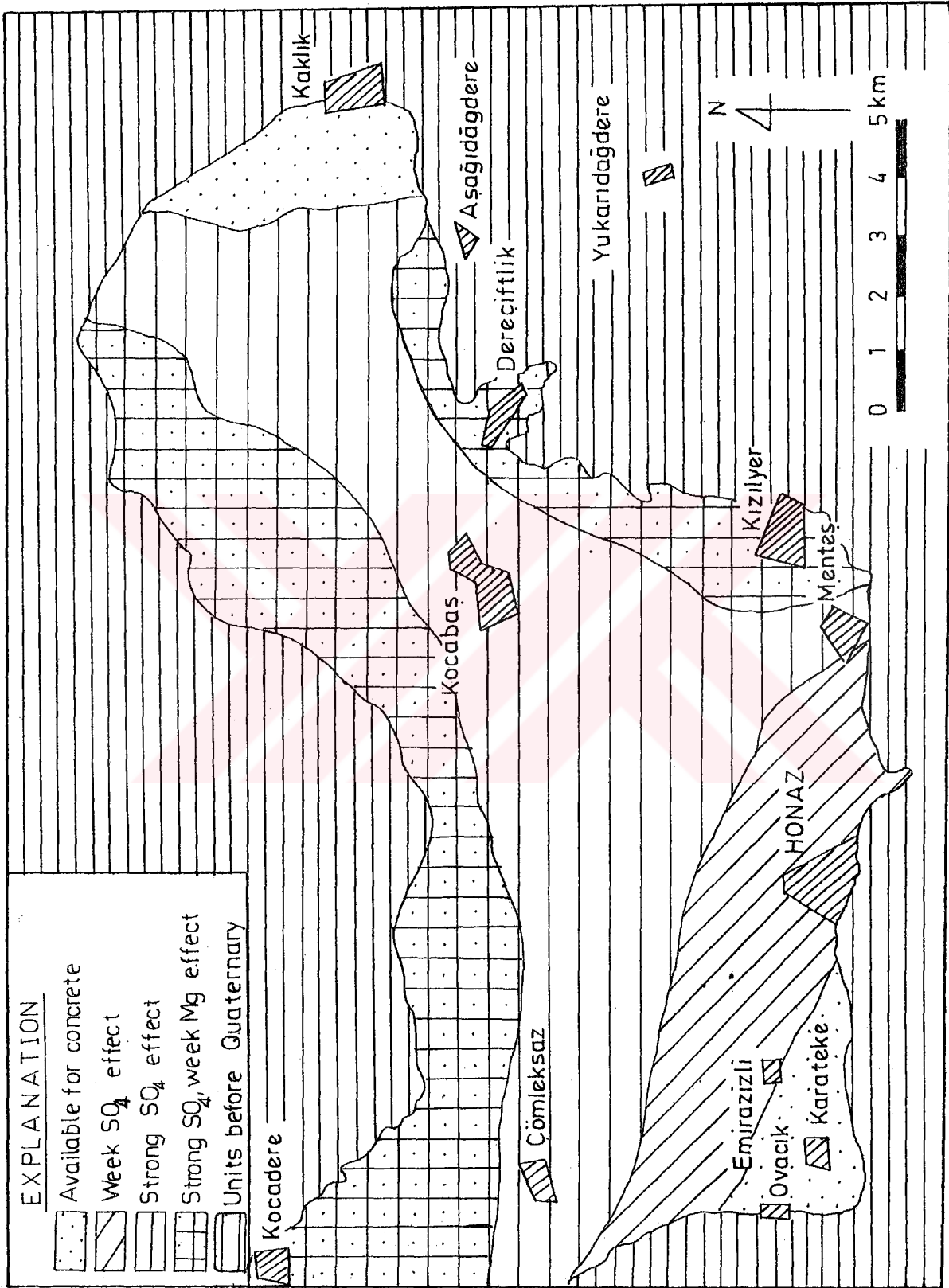


Figure 27. Favor ability map of ground water for concrete

### 5.3.3.3.3. *Scaling Problems of Ground Waters*

Ground waters depending on their temperature, pressure, pH, dissolved partial CO<sub>2</sub> pressure and chemical properties cause precipitation.

In general the scaling consist of carbonates, silicates, sulfates, chlorides and silicium dioxide, either alone or in combination.

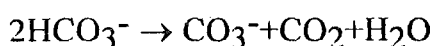
In principle, scaling and corrosion properties of water are examined according to Langier diagram dependent on the comparison of the theoretical pH and measured values of water. Langelier's saturation index (sat ind)

$$\text{Sat Ind} = \text{pH} - \text{pH}_s$$

It's possible for saturation index of examined water to be over or below zero. If saturation index of the water exceeds zero, the water tends to make calcite deposition in casing or at the surface equipment. Result of saturation index have been given table 70.

#### 5.3.3.3.3.1. *The Mechanism of CaCO<sub>3</sub> Deposition*

As the water flows up the well cause the pressure decrease because of velocity and heat losses. A point where the pressure is equal to the partial pressure of CO<sub>2</sub> in the solution is called the gas "bubble point" because CO<sub>2</sub> gas begin to release from the solution above this point. Releasing of CO<sub>2</sub> gas causes a shift in chemical equilibrium from bicarbonate to insoluble carbonate according to this reaction.



The insoluble carbonate ion formed, reacts with calcium in the fluid and formed calcium carbonate or other form of carbonates (MgCO<sub>3</sub>, SrCO<sub>3</sub> etc).

As it given section ground water's have dolomite and calcite saturation and precipitation properties but not reached saturation point so we should expect CaCO<sub>3</sub>.

Scaling in water pipes. There is not encrustation problem in investigation area's well (Conversation with Salim Yüzereroğlu). Since the capacity of water to hold carbon dioxide in solution varies with the pressure the higher pressure, the more carbon dioxide will be held, but when water is pumped from a well because of the reduction in pressure and carbon dioxide releasing from the water occurs, the water is unable to carry in solution its full load of calcium carbonate then precipitation occurs, in irrigation channels.

Carbonate scale control can be achieved by: a) acting on carbonate-bicarbonate equilibria (pH and CO<sub>2</sub> partial pressure control); b) Making use of scale inhibiting products, and c) Periodic cleaning (chemical or mechanical). The addition of acid to the brine, CO<sub>2</sub> injection into the well and the use of downhole pumps are the methods utilized for chemical equilibria control.

For reduce or prevent the scaling in investigation area aeration builds have been constructed. The aim of this is provide to releasing of CO<sub>2</sub> gas from the water so pH value is increase and CaCO<sub>3</sub> is precipitate, by this way Ca and HCO<sub>3</sub> ions are decrease and cause minimum rate of CaCO<sub>3</sub> precipitation.

Aeration, the process of exposing water to air, produces two results. The water can dissolve a maximum of oxygen, and it may release other gases that are in solution. With the exception of water hardness, one or both of these can assist removal of some undesirable substances.

Methods of aeration include spraying water into the air, allowing it to cascade over steps, trickling it through beds of coarse coke or stone, and bubbled into water in a open tank or in a closed system under pressure.

Aeration in the atmosphere can remove dissolved gasses such as hydrogen sulfide, methane (from decay of organic matter), carbon dioxide and chlorine.

Except for carbon dioxide, the removal of the other gasses by aeration improve the taste and odor at the water. Removal of carbon dioxide and hydrogen sulfide by aeration can reduce the corrosiveness of water containing these gases. This benefit may be partly offset, however, by the increased Oxygen content of the aerated water which also plays a part in corrosion.

#### **5.3.3.3.4 Corrosion**

The rate at which corrosion takes place depends on several factors such as acidity of solution, presence or absence of oxidizing agents, movement of solutions over areas being corroded, electrolytic effect, formation of films or protective deposits and temperature of the corrosive reactions.

Most natural waters are either corrosive or scaling . The difference between the corrosiveness and scaling effect of various waters is entirely a matter of degree and nature. The two effects can occur to gather, but a combined action of corrosion and erosion tends to prevent accumulation of encrusting materials, whereas a coating of encrusting materials tends to protect or insulate the screen against the action of corrosion.

Corrosion is defined as chemical action on materials exerted by outside factors, which action causes eating away or destruction of the material. It is often difficult



Photograph 4. Ground water precipitates calcium carbonate.



Photograph 5. Corrosion effect of ground water.



to predict the rate of corrosion even when the character of the water and the metal are known because of other obscure variables that may be involved.

Elements in the water that speed up corrosion are dissolved carbon dioxide, dissolved oxygen, dissolved hydrogen sulfide and high total dissolved solids that increase the electrical conductivity of the water. Hard waters are usually thought of as non corrosive but if the electrical conductivity of the water is also high due to chlorides and sulfates they can corrode iron and steel rapidly.

Water velocity influences corrosion rate primarily because of its effect upon other factors involved in corrosion occurrence. Movement over the metal surfaces in a well screen supplies the corrosive at a greater rate than if the water were quiet. Low velocity can be favorable, however, in that it tends to make corrosion uniform and prevents concentrated local attack that often occurs in still water. But the general rule is that corrosion increases with velocity. Too great velocity can sweep away protective films that may otherwise form on the metal surface. This increases the corrosion rate. The forms of corrosion, as commonly identified, include:

General rusting or other uniform loss of metal with occasional perforation in some areas.

Dezincification or loss of one element of an alloy leaving a weakened residue.

Bi-metallic corrosion near the juncture of two different metals.

Highly localized pitting and perforation, with little loss of metal outside the pitted areas.

Stress-corrosion cracking induced at highly stressed areas.

Corrosion in crevices, in sockets, and under gaskets or washers.

All these forms of corrosion proceed by electrochemical action.

The first-named form of corrosion in the above list is recognized as uniform, even destruction of the surface of the metal. When a well screen is corroded in this manner, the slot openings may become several times larger than the original width of the openings. Usually this allows sand or gravel to enter with the water being pumped. The strength of the screen is reduced to the extent that the corrosive action may have reduced the thickness of the metal.

Dezincification, the second-named form, is sometimes called selective corrosion. The effect upon a brass alloy is to separate the zinc from the alloy leaving the copper in a porous form. The shape and dimension of the affected portion may be the same as the original piece, but the strength of the metal is greatly reduced. Sudden failure can occur even though the material may appear to be sound. Low zinc content and addition of a small amount of an inhibiting element to the alloy make a brass resistant to dezincification.

Bi-metallic corrosion results when two different metals are connected and immersed in water. This situation sets up a galvanic cell. Corrosion occurs as electrochemical action of the cell proceeds. A well screen made of two different

metals, such as mild steel is readily damaged as the result of galvanic corrosion of the mild steel.

The term electrochemical action means chemical change that is accompanied by the flow of an electric current. The action can be easily demonstrated by immersing pieces of two different metals in tap water and connecting the two metal externally with a good electrical conductor such as a copper wire. Under these conditions, as shown in figure 28 chemically

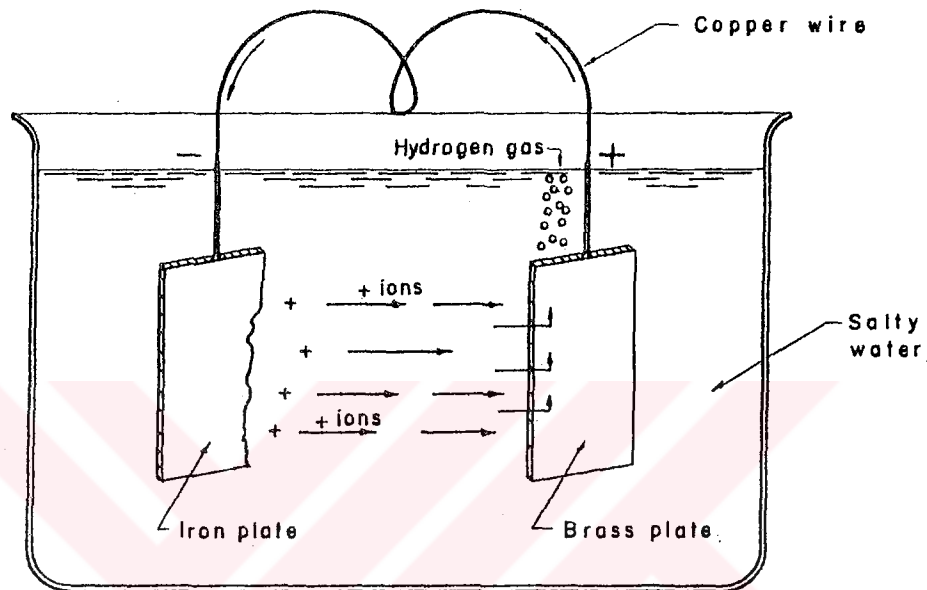


Figure 28. Chemical action causes the corrosion current to flow, where the current leaves the metal, corrosion occurs.

created electrical current flows in the closed circuit that is set up. A little salt adds to the water speeds up the action.

If one metal plate is iron and other brass, current automatically flows from the iron through the salty water to the brass, then through the copper wire back to the iron. The iron is corroded as the result of this electrochemical action. The corrosive attack produces iron rust, some of which will stick to the iron, some will drop off in flakes.

Another chemical change that occurs at the same time is release of some hydrogen at the surface of the brass plate and produce hydrogen gas. Some hydrogen clings to the brass and the rest escapes as bubbles of gas.

Electrical conductivity of the water in contact with a metal is an important factor in the rate of corrosion. Dissolved minerals in ground water increase its electrical conductivity. There fore the chances of corrosion damage to the well structure will be greater where the ground water carries large amounts of minerals in solution.

The electrochemical action displaces hydrogen from the electrolyte. This occurs because positively charged hydrogen ion in the water move to the cathode.



A thin film of hydrogen is deposited on the surface of the cathode. If it remains on the surface of the cathode, a thin film of hydrogen acts as an insulator and tends to stop the flow of current. This, in turn, tends to stop corrosion of the anode. Such an occurrence and its effect are called polarization of the cathode.

When corrosion occurs because of two dissimilar metals in a structure such as a bi-metallic well screen, it is known as galvanic cell. Figure 28 illustrates a galvanic cell. The current that flows because of the difference in electrical potential of the dissimilar metals is called a galvanic current.

Different areas on the same metal can also exhibit differences in electrical potential. These result from variations in composition, in surface finish, or in hardness of the metals. If wetted we have elements of galvanic cell.

Two areas on the surface of a steel pipe can correspond to the dissimilar metals, water is the electrolyte and the pipe wall corresponds to the wire that completes the electrical circuit. Where the current leaves the pipe, the anode area, the pipe is corroded. Where it returns to the pipe, the cathode area, a thin film of hydrogen is deposited on the surface of the pipe and this area is protected.

Where corrosion occurs because of differences in electrical potential from point to point on a single metal as indicated in figure 29, it is called local action.

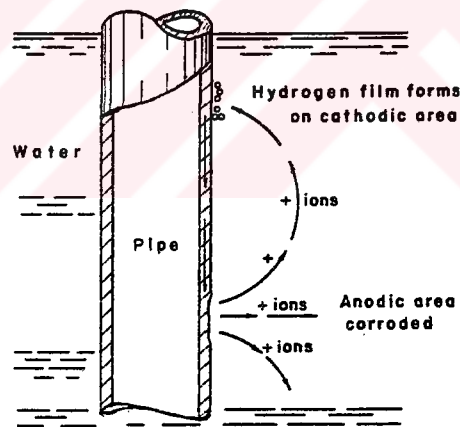


Figure 29. Anode and cathode can develop in nearby areas on a single metal surface, resulting in corrosion by local action.

Note that both local action and galvanic action are electrochemical in nature. They are named by these terms only to distinguish bi-metallic corrosion from corrosion occurring on the surface of a single metal.

Figure 30 is a close-up of the anodic area on the pipe surface of figure... and shows how the chemical action proceeds. Iron ions leave the metal surface in solution in the water. These combine with other chemicals in the water and with hydroxyl ions (OH ions) of the water itself to form iron hydroxide. Some of the iron hydroxide is oxidized to iron oxide or rust by dissolved oxygen in the water. Both iron hydroxide and iron oxide are insoluble in water. They come out of

solution as they are formed and are deposited on the metal surface at the anodic or corroded area.

The formation of iron hydroxide frees one atom of hydrogen (H) from each molecule of water (H<sub>2</sub>O) that reacts with the positively - charged iron. This is like the iron ion released from the metal, so moves toward the cathode under the influence of the electric current flow through the electrolyte. Hydrogen formation and polarization of the cathode and release of hydrogen gas are the result.

This corrosion process leaves the iron behind as a rusty tubercle around the pit area. The pit continues to deepen until the wall of the pipe is perforated. Sometimes, however, the barnacle-like scab of rust will seal off the pit to the extent that it stops the flow of ions and current. The cell then becomes inactive so long as the barnacle is not disturbed. Another cell or local action may begin, however, at another nearby point.

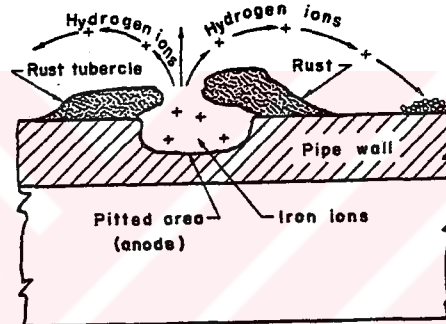


Figure 30. Tight rust coating can seal the pitted area and stop flow of current from this point .

In a simplified way, this explains why the rate of corrosion of iron or steel in water may slow up as time goes on. The formation of a tight layer of rust decreases the flow of current in the local cell and can stop the corrosive action completely. Polarization can also help arrest the action at the same time.

Conditions that prevent a tightly adhering film of rust, such as erosion by turbulent flow or chemical combinations of iron that produce a porous layer, permit corrosion to proceed without interruption. Such differences in the action due to small differences in two sets of conditions often account for what appear to be contradictions in occurrence of metal corrosion.

When a section of pipe in a underground line is replaced with new pipe, the new piece often corrodes faster than the old. What causes the corrosion of the new pipe is that galvanic cells develop because the new steel and the rust on the surface of the old pipe are like two dissimilar metals. Current flows as indicated by the arrows in figure 31. The new pipe starts to corrode where the current leaves it and the old pipe is protected against further damage where the current enters it.

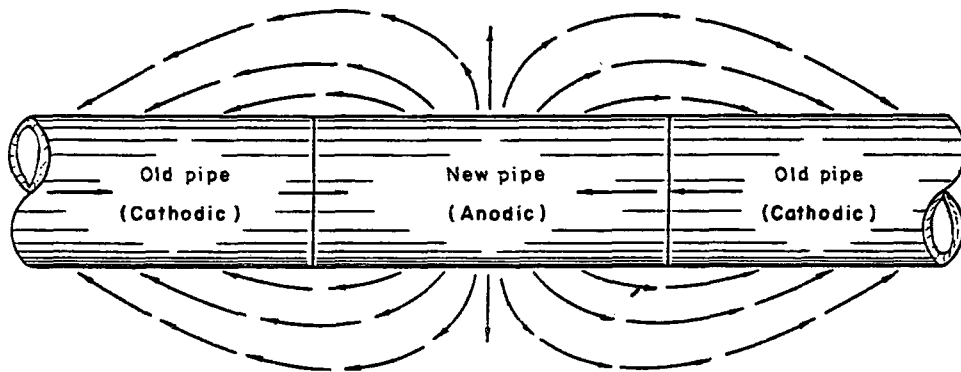


Figure 31. New pipe replacing a section in an older pipe line often is anodic and Corrodes faster than the older pipe.

Protection of the old is had at the expense of the new.

Bad pits often develop at the shallow threads exposed just outside any threaded pipe fitting. This happens because the freshly cut surface of the steel in the threads becomes the anode of a galvanic cell. The nearby uncut surface of the pipe with its mill varnish, mill scale and some rust provides a greatly dissimilar surface condition. Current flows as shown in figure 32. In such a case, the anode area is small in relation to the cathode area, and this situation accelerates metal removal at the anode.

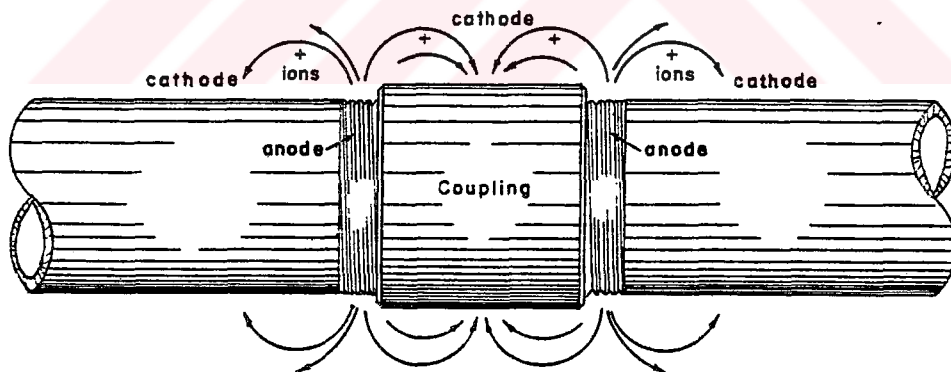


Figure 32. Cut surface of steel exposed in threads at a pipe joints suffers corrosion

Galvanizing of steel pipe takes advantage of the electrochemical principle to protect the steel from corrosion, particularly when the pipe is under water.

In the metal plates in the cell in figure 28 were zinc and iron, zinc would be anode and would suffer corrosion. The galvanic current would flow from the zinc to the iron through the water and the iron would be protected since it becomes the cathode in this situation.

Corroded end

Magnesium

Magnesium Alloys

Zinc

0

Aluminum 25

0

Cadmium

0

Aluminum 17 st

0

Steel, iron, cast iron

0

Chromium - iron (active)

0

Ni-Resist

0

18-8 stainless steel(active)

0

Lead, tin, lead-tin solders

0

Nickel, Inconel(active)

0

Brass, copper

Bronze, Monel

0

Silver solder

0

Nickel, Inconel(passive)

0

Chromium-iron(passive)

18-8 stainless steel(passive.)

0

Silver

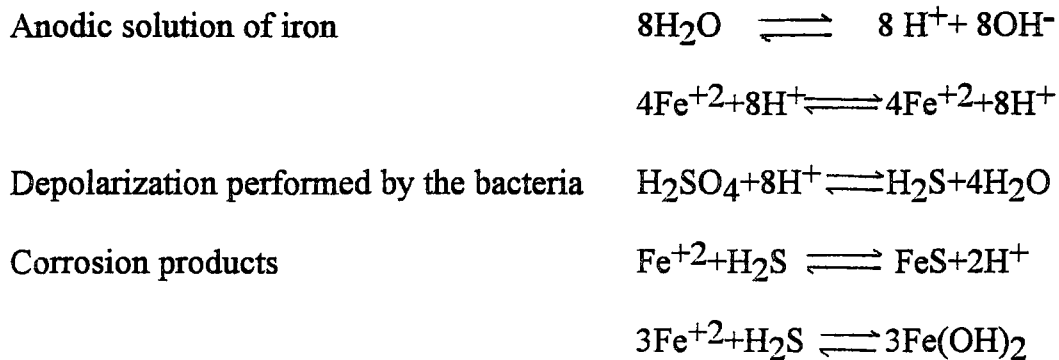
0

Gold, platinum

Protected end.

Table 71. Galvanic Series(As listed by The International Nickel Co.,Inc., New York.)

In investigation area corrosion occurs depending on high sulfate concentration. Corrosion of iron is the result of the following reactions.

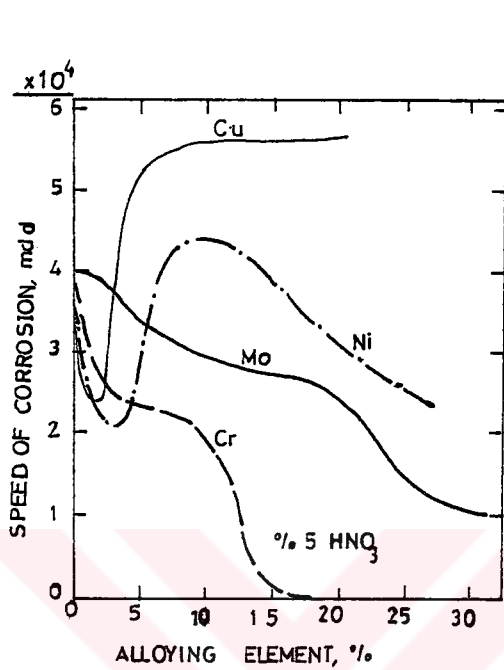


The principal products of corrosion are iron sulfide(black) and ferrous hydroxide. The result is intensified, localized corrosion.

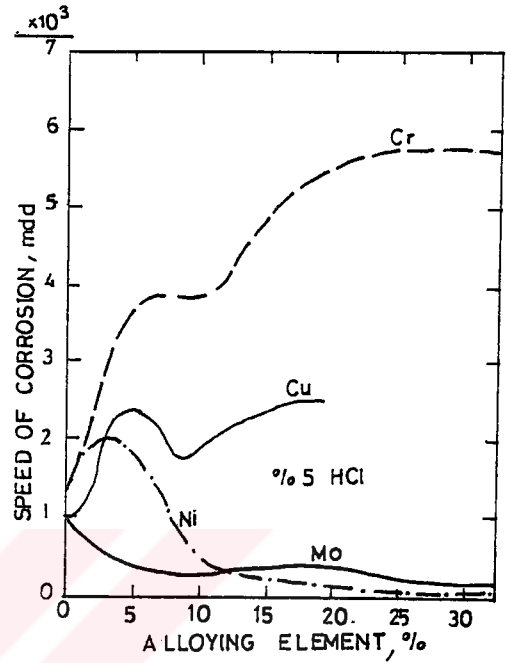
The most important species of the sulfate-reducing bacteria is sporoubria desulfuricans. These bacteria can grow only under anaerobic conditions, and they are responsible for the anaerobic corrosion of iron and steel. In addition, they require for their nourishment adequate amounts of sulfates, as well asher special nutrients. Other conditions favorable to their growth are suitable temperature and pH of the environment. The optimum temperature has been found to be from 25 to 30 °C, the optimum pH from 5 to 9.

All these conditions and results have been observed in investigation area.

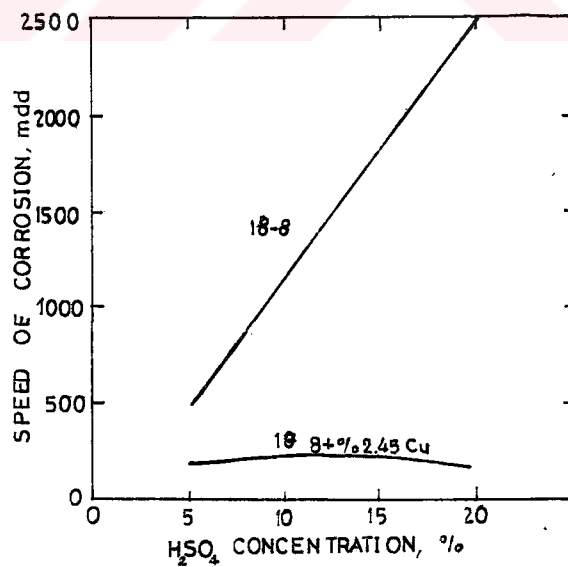
These other way to prevent corrosion is alloying of metals. If chloride is not present in ground water effective way to reducing of corrosion provided by chromate(Figure a). Although is chloride is present, best reducing of corrosion is provided by using of nickel(Figure b). In steel pipes, while the corrosion rate of carbon steel increase with  $\text{H}_2\text{SO}_4$  concentration, the corrosion rate of steel containing %2,45 copper has been very low (Figure c).



a) At chlorided condition



b) At non-chlorided condition



c) At H<sub>2</sub>SO<sub>4</sub> condition

Figure 33. Effect of alloying element on corrosion speed.



## ***6.ISOTOPIC INVESTIGATION of the YUKARI ÇÜRÜKSU PLAIN***

Geochemistry aims to provide on understanding of the principal chemical controls on element distribution in nature. The recent advance of quantitative mass analysis has allowed geochemists to measure the ratios of stable isotope abundance in various substances and subsequently to explain how natural processes cause isotopic fractionation.

Isotopes can be divided into stable and unstable (radioactive) species. The term stable is relative, depending on the detection limits of radioactive decay times. In the range of atomic numbers from 1(H) to 83(Bi) stable nuclides of all masses except 5 and 8 are known.

For most geochemical purposes, stable ratios are reported in  $\delta$  values in part per thousand(termed per mil and noted as ‰) enrichment (or depletion if negative) relative to a standard. The standard used for hydrogen and oxygen in natural waters is a standard mean ocean water (Smow), defined by Craig(1961).

D.S.I. have made a isotopic investigation to find the origin and recharge area of Yukarı Çürüksu Plain's ground waters years between 1986-1988. So oxygen ( $\delta^{18}\text{O}$ ), hydrogen( $\delta\text{D}$ ) stable isotopes and hydrogen's ( $\text{H}^3$ -tritium) radioactive isotopes and Carbon( $\text{C}^{14}$ ) isotopes of the environment have been researched.

Tritium and stable isotope analysis have been done by D.S.I. laboratory but  $\text{C}^{14}$  analyses have been done by Hacettepe University. Result have been given below.

### ***6.1.Evaluation of Isotopic Results***

#### ***6.1.1Tritium in the Precipitation***

While evaluate the concentration of tritium in the precipitation, decreasing of tritium concentration at all over the world has been taken into account. Precipitation samples have been taken from Honaz and Yeşiloba meteorology stations.

The samples which are taken in rainy months, analyzed in view of tritium and results pointed at figure 34. The value of Yeşiloba station have been taken a base and for determination of unexist points Honaz and Ankara precipitation values have been used. As it show at figure 34 highest tritium value is 22 T.U. and lowest 4 T.U years between 1986-1988. There is not precipitation in study area at summers. For Yeşiloba observation station weighted mean of tritium is 11 T.U. at 1987.

As it is shown at figure 35 there are similarity between Ankara and Yeşiloba rainfalls. Since 1952 tritium concentration is show great fluctuation and still it is decreased through low values. This variations and low values are show great difficulties while account of recharge function. Tritium content of rainfall in the previous periods which is observation station so recharge function has been tried to guess (Figure 35).

### *6.1.2. Oxygen end Hydrogens stable isotopes.*

The study of the characteristics and origin of ground water has been among the most successful areas of application of stable isotope measurements . To a large extent this is due to the conservative nature of the stable is topic composition of water in a aquifer, as a result of which it is possible to characterize the origin of water.

Ground water maintain the isotopic composition of the origin over long periods, of the order of 10000 years, provided that they are not exposed to temperatures above 60 to 80 °C. In many case, the isotopic composition of meteoric ground water is found to match the mean composition of precipitation over the recharge area to a fair approximation. Ground waters are derive directly from precipitation a from fresh surface waters, usually by recharge through on unsaturated soil zone. The composition fluctuations of individual rainfalls are smoothed out by transition of the water through the unsaturated soil zone to extent that the seasonal fluctuation seems to have disappeared completely. Ground waters therefore, may represent mean precipitation with reasonable fidelity.

The variation in the isotopic composition of ground waters from one area to the next is foremost a reflection of the area geographic variation of the isotopic content of the precipitation is the most commonly encountered factor. The magnitude of the altitude effect depends on the local climate and topography gradients of -0.15 to -0.5 permil/10 m (for  $\delta^{18}\text{O}$ ) and about -1 to -4 permil/100 m ( $\delta\text{D}$ ) have been encountered.

This isotopic techniques are applied to Yukarı Çürüksu Plain, oxygen -18 is used o find the recharge area and the origin of the waters, tritium is used to find the relative age of water end circulation velocity.

Although it is possible to determine with piston flow model the yearly contribution to ground water reservoir, it has been considered that mixing model will be much more fidelity (Figure 33). Data taken from LAEA/WMO and the values which are obtained from Government Meteorology General Directorate make it possible to determine a correlation between Ankara and Yeşiloba station for the years between 1986-1987.

As it shown at figure 34 old waters which are contain much more tritium may be mixed of fresh waters. Station numbers 32,33,34 values in the years 1987

determines two different charge-recharge period which is take 18 years or much than 18 years.

### 6.1.3.1. $\delta^{18}\text{O}$ and $\delta\text{D}$ Values of Precipitation.

The isotope contains which are given in table 73 shows rainy day's results only. Months between November and may are rainy months of investigation area. This period's isotopic result's which is given in table 73 have been pointed in figure 37-38. Limit's of isotopic contents is below.

|          |                       | Maximum | Minimum |
|----------|-----------------------|---------|---------|
| Honaz    | $\delta^{18}\text{O}$ | -7.68   | +6.80   |
|          | $\delta\text{D}$      | -54.65  | +21.85  |
| Yeşiloba | $\delta^{18}\text{O}$ | -9.83   | -6.98   |
|          | $\delta\text{D}$      | -53.11  | -46.90  |

Isotopic values of Yeşiloba and Honaz station have been given in table 3. According to the monthly rainfalls of Yeşiloba station weighted mean as following.

$$\delta^{18}\text{O} = -6.91 \qquad \delta\text{D} = -44.53$$

Weighted mean values of Honaz station could not accounted because of insufficient isotopic data.

Isotopic values without take into account evaporated samples and precipitation amount are below.

|          |                               |                           |
|----------|-------------------------------|---------------------------|
| Honaz    | $\delta^{18}\text{O} = -7.47$ | $\delta\text{D} = -52.32$ |
| Yeşiloba | $\delta^{18}\text{O} = -8.19$ | $\delta\text{D} = -51.40$ |

As a result we can said that Yeşiloba precipitation values much more reliable than Honaz precipitation values.

### 6.1.2.2. $\delta\text{D}$ and $\delta^{18}\text{O}$ Values of Ground Water

Locations of samples have been shown in map 3. Results (Table 73) have been evaluated with histograms, curves and various pointed method.

$\delta^{18}\text{O}$ - $\delta\text{D}$  pointed in two graphics. One of them has been represented Yukarı Çürüksu Plain (figure 37) and the other represented neighbors basins of investigation area.

Figure 37 and 38 regression lines represents continental rainfalls ( $\delta\text{D}=8\delta^{18}\text{O}+10$ ); East Mediterranean rainfalls ( $\delta\text{D}=8\delta^{18}\text{O}+22$ ), Antalya rainfalls ( $\delta\text{D}=8\delta^{18}\text{O}+22$ ), Antalya rainfalls ( $\delta\text{D}=8\delta^{18}\text{O}+16.69$ ); Lakes Region rainfalls ( $\delta\text{D}=8\delta^{18}\text{O}+14.6$ ).

High altitude rainfalls have -9.00% or much  $\delta^{18}\text{O}$  content. Only the springs numbers 3 and 31/B and well number 31 have high isotopic values. Station number 44 placed in northwest takes it's water from travertines and have high  $\delta^{18}\text{O}$  value. Other high  $\delta^{18}\text{O}$  values are belong station numbers 18,27,32,33,34 and 22,23,24 which are placed north and northwest direction high altitude recharge area. All these areas are out of Yukarı Çürüksu Plain.

Station number 34 placed northwest of Çürüksu Plain and station number 44 at north are fit with regression line which is represent East Mediterranean precipitation.

Station numbers 20,37 and 30 represents continental precipitation.

Other samples have been dispersed between Antalya ( $\delta\text{D}=8\delta^{18}\text{O}+14,6$ ) and East Mediterranean ( $\delta\text{D}=8\delta^{18}\text{O}+22$ ) regression lines.

According to the  $\delta^{18}\text{O}$  histogram,  $\delta^{18}\text{O}$  values generally have been gathered between -8,6 and - 9.00 % and comprise all region cumulative probability distribution curve (Figure 39) have been prepared for all points (Figure 40-41) and only Yukarı Çürüksu Plain area (Figure 41). Results which is taken from these curves have been evaluated as below.

a. Station numbers 9,48 and 50 Station number 9 is a spring which have 1100 l/s yield and station numbers 48 and 50 are wells which are taken it's waters from travertine.

b. Station numbers 2,5,6,7,8,10,11,14,15,16,47,51,52,53 and 54 Except station numbers 2 and 11 all stations placed north of investigation area. Station numbers 5,6,7,8,10,13,14 and 15 are karstic springs and others are well. Water point have spread towards to middle and north of Plain. As it shown in figure 5 lots of the points have been found middle of figure. Although station numbers 51,52,53 and 54 close to Mediterranean precipitation others close to Antalya precipitation.

c. Station numbers 1,12,41,43,45,49 and 55 Except station numbers 1 and 12 placed south part of the plain and station number 41 which is a spring, all wells placed north of the plain other wells are take theirs water from travertine. So  $\delta\text{D}$  values show increase through to regression line (figure 5).

d. Station numbers 4 and 31 These stations are placed at south and represent precipitation which is became dense at high altitude.

e. Station numbers 3,31/B and 44 Station 44 placed at northeast of the plain and takes it's water from travertine. Station number 31/B is only a little spring and placed near station number 3.

Although it is possible to evaluate last two groups together station number 44 placed on Mediterranean line others are placed on Antalya regression line.

Using station numbers 20,22,23,24,25,30 and 37 isotopic values regression line may be drawn shown in figure 5

$$\delta D=3,72 \delta^{18}O-26,18 \quad r^2=0,86 \quad \text{and} \quad r=0,93$$

and using station numbers 22,23 and 25

$$\delta D=2,51 \delta^{18}O-36,41 \quad r^2=0,99 \quad \text{and} \quad r=1$$

These lines are show effect of thermal water. Nevertheless although some of the water points have high heat and high  $\text{HCO}_3^-$ ,  $\text{SO}_4^{=}$  values effect of thermal water could not observed at  $\delta D-\delta^{18}O$  pointation. In addition station numbers 22,23,24,25 and 30 placed on the fault zone is extent along northeast-southwest direction.

Regression line drawn by taken into account station numbers 2,3 and 4

$$\delta D=2,95 \delta^{18}O-28,69 \quad r^2=0,78 \quad \text{and} \quad r=0,9$$

This is at same parallel with thermal waters.

Station numbers 13,14,15 and 16 construct regression line as following.

$$\delta D=8,21 \delta^{18}O+15,15 \quad r^2=0,73$$

Station 38 and 39 placed at Acıpayam plain. Station number 38 values close to the terrestrial precipitation line and station number 39 values close the Lakes Region precipitation line.

Station numbers 27,32,33 and 34 placed south of region represent low altitude precipitation. Station numbers 28 and 29 which are on the evaporation line represent regional precipitation.

### **6.1.2.3. Tritium in the Ground Water**

Tritium values which are taken from region rather low. Tritium values which are between 0-2 T.U. is not show effect of nuclear precipitation and renewing time much than 50 years. However tritium increase in the fall rainfalls which shown in station numbers 2 and 8 may be with the effect of the new rainfalls.

High tritium content in the station 26 is explain that discharged water from Eocene limestone is a new charge.

Station number 25 have low tritium value in November and high spring and summer values together with evaporated isotope values is indicate that there are contribution of Akgöl water by karstic canals of the Mesozoic aged limestone. However it's heat decrease from 34 °C to 19,5 °C at recharge period in spring. Tritium values are high in spring (9 T.U.), low in fall (3T.U.) and mixing 7T.U. discharge.

Station numbers 22 and 23 tritium values are 9 and 9 T.U. respectively. Tritium values of samples which are taken from south well of the Acıgöl are between 0 and 9 T.U.

Tritium values station numbers 18,27,32,33 and 34 increase to 44 T.U. and a result of precipitation in the 1800-2000 m. As they are discharge of high mounts near the Işıklı lake their transitional period is rather short.

Station numbers 20 and 37 have tritium values between 0 and 2 T.U. and represent water which have transition time much than 50 years.

Station numbers 35 and 36 have high tritium values (28-19 T.U.) and effected by new precipitation under the 1500 m altitude. Geological condition show that there are 2-3 years delay in recharge.

Station number 28 tritium value is show 6 years transition time and compose of stable isotope is show of regional precipitation filtered.

Station numbers 38 and 39 placed north of the investigation area show similarity with in the north's and have tritium value between 0-3 T.U. which are determine transition time much than 50 years.

Tritium values in the Düzova changes between 0-5 T.U. As a conclusion, dense of rainfall at north determined by Yeşiloba observation station and south by Honaz observation station.

If recharge is effective it is possible variation in compose of water which have high  $\text{HCO}_3^-$  and  $\text{SO}_4^{2-}$  content. In addition recharge considering from B. Menderes have not observed.



#### 6.1.2.4. C-14 in the Ground Water

Tritium values is not sufficient for explain the flowing of ground water. For that reason C-14 samples taken at April 1988 analyzed at Ankara Hacettepe University.

Results have been given below.

| Station Number | CO <sub>2</sub> amount (mg/l) | Age                 |
|----------------|-------------------------------|---------------------|
| 1              | 31,0                          | Low CO <sub>2</sub> |
| 11             | 54,0                          | "                   |
| 13             | 200,0                         | 5945+-196           |
| 15             | 97,0                          | 4091+-198           |
| 16             | 161,0                         | 9681+-189           |

#### Stable isotope results

| Station Number | $\delta^{18}O\text{‰}$ | $\delta D\text{‰}$ |
|----------------|------------------------|--------------------|
| 1              | -8.91                  | -54.82             |
| 11             | -8.74                  | -55.48             |
| 13             | -8.67                  | -56.46             |
| 15             | 8.78                   | 56.52              |
| 16             | 8.79                   | 57.32              |

The List Of The Springs And The Yields

| <u>Site No.</u> | <u>Date Of Measurement</u> | <u>Yield l/s</u> |
|-----------------|----------------------------|------------------|
| 1               | Sept - 1988                | 77               |
| 2               | Sept - 1988                | 287              |
| 3               | Sept - 1988                | 1169             |
| 5               | Sept - 1988                | 94               |
| 6               | Sept - 1988                | 104              |
| 7               | Sept - 1988                | 202              |
| 8               | Sept - 1988                | 160              |
| 9               | Oct - 1988                 | 1211             |
| 10              | Oct - 1988                 | 94               |
| 11              | Oct - 1988                 | 96               |
| 14              | Oct - 1988                 | 114              |
| 15              | Oct - 1988                 | 236              |
| 21              | Oct - 1989                 | 301              |
| 22              | Sept - 1989                | 17               |
| 40              | Sept - 1989                | 907              |
| 41              | Oct - 1989                 | 41               |
| 42              | Oct - 1989                 | 645              |

Table 72. The list of the springs and the yields.

Results On The Isotopic Data of Precipitation  
( YEŞİLOBA AND HONAZ OBSERVATION STATIONS)

| Months | Year | YEŞİLOBA            |                 | T.U. | HONAZ               |                 | T.U. |
|--------|------|---------------------|-----------------|------|---------------------|-----------------|------|
|        |      | $\delta^{18}O$<br>‰ | $\delta D$<br>‰ |      | $\delta^{18}O$<br>‰ | $\delta D$<br>‰ |      |
| Dec.   | 1986 | -7.67               | -49.03          | 5    | -7.68               | -50.03          | 7    |
| Jan.   | 1987 | -8.72               | -53.11          | 6    |                     |                 | 6    |
| Feb.   | 1987 |                     |                 | 22   |                     |                 | 13   |
| March  | 1987 | -6.83               | -51.30          | 13   | -3.87               |                 | 14   |
| Apr.   | 1987 |                     |                 |      | -7.17               | -54.65          | 16   |
| May    | 1987 | -8.98               | -52.15          |      | -3.65               | -52.30          | 20   |
| June   | 1987 |                     |                 |      | -4.41               | +21.85          | 30   |
| July   | 1987 |                     |                 |      | +6.80               | + 2.40          | 21   |
| Oct.   | 1987 | -6.89               | -46.90          | 5    |                     |                 |      |
| Nov.   | 1987 |                     |                 |      |                     |                 |      |
| Dec.   | 1987 |                     |                 | 7    |                     |                 |      |
| Jan.   | 1988 |                     | -52.78          | 11   |                     |                 |      |
| Feb.   | 1988 |                     |                 |      |                     |                 |      |
| Mar.   | 1988 | -9.83               | -67.53          | 8    |                     |                 |      |
| Sept.  | 1988 |                     |                 | 11   |                     |                 |      |
| Oct.   | 1988 |                     |                 | 7    |                     |                 |      |
| Nov.   | 1988 |                     |                 | 6    |                     |                 |      |
| Dec.   | 1988 |                     |                 | 4    |                     |                 |      |

Table 73. Results on the isotopic data of precipitation.

Results On The Isotopic Analyses For  
Sampled Sites

| SITE<br>No<br>TYPE | DATE<br>OF<br>SAMPLING | $\delta^{18}O$<br>‰ | SD<br>‰ | T.U. | C-14<br>Years | $C^0$ | $\delta^{18}O$ | $\delta^2D$ |
|--------------------|------------------------|---------------------|---------|------|---------------|-------|----------------|-------------|
| 1                  | 3/1986                 | -8.99               | -54.83  | 0    |               | 17.0  |                |             |
| SP                 | 4/1987                 | -8.90               | -56.40  | 0    |               | 17.0  |                |             |
|                    | 8/1987                 | -8.78               | -53.50  |      |               | 17.5  | -8.91          | -54.82      |
|                    | 4/1988                 | -8.95               | -53.71  | 0    |               |       |                |             |
|                    | 3/1988                 | -8.93               | -54.55  |      |               |       |                |             |
| 2                  | 9/1986                 | -8.85               | -55.70  | 11   |               | 17.0  |                |             |
| SP                 | 4/1987                 | -8.83               | -54.50  | 5    |               | 16.5  | -8.73          | -54.46      |
|                    | 8/1987                 | -8.67               | -54.20  |      |               | 18.0  |                |             |
| 3                  | 9/1986                 | -9.26               | -59.12  | 4    |               | 18.5  |                |             |
| SP                 | 4/1987                 | -9.22               | -54.90  | 2    |               | 18.0  | -9.11          | -56.00      |
|                    | 8/1987                 | -8.87               | -54.00  |      |               | 19.5  |                |             |
| 4                  | 9/1986                 | -9.23               | -57.23  | 5    |               | 20.5  |                |             |
| DW                 | 4/1987                 | -8.89               | -53.20  |      |               | 20.0  | -8.93          | -55.12      |
|                    | 8/1987                 | -8.85               | -54.95  |      |               | 20.0  |                |             |
|                    | 4/1988                 | -8.95               |         |      |               |       |                |             |
| 5                  | 9/1986                 | -8.73               | -55.23  | 2    |               | 20.0  |                |             |
| SP                 | 4/1987                 | -8.75               | -57.55  | 1    |               | 18.5  | -8.70          | -57.31      |
|                    | 8/1987                 | -8.44               | -59.15  |      |               | 20.0  |                |             |
|                    | 4/1988                 | -8.88               |         |      |               |       |                |             |
| 6                  | 3/1986                 | -8.80               | -56.75  | 1    |               | 21.0  |                |             |
| SP                 | 4/1987                 | -8.77               | -54.50  |      |               | 20.0  | -8.72          | -55.15      |
|                    | 8/1987                 | -8.55               | -54.20  |      |               | 20.5  |                |             |
|                    | 10/1988                | -8.77               |         |      |               |       |                |             |

Table 74. Results on the isotopic analyses for sampled sites.

|    |         |       |        |    |      |       |        |
|----|---------|-------|--------|----|------|-------|--------|
| 7  | 3/1986  | -8.78 | -54.58 | 1  | 21.0 |       |        |
| SP | 4/1987  | -8.68 | -54.00 |    | 20.5 | -8.68 | -54.38 |
|    | 8/1987  | -8.56 | -54.55 |    | 21.0 |       |        |
|    | 10/1988 | -8.72 | -54.39 |    |      |       |        |
| 8  | 9/1986  | -8.94 | -55.36 | 10 | 16.5 |       |        |
| SP | 4/1987  | -8.68 | -52.45 | 7  | 16.5 | -8.69 | -53.92 |
|    | 8/1987  | -8.47 | -53.95 |    | 17.0 |       |        |
| 9  | 3/1986  | -8.44 | -54.13 | 1  | 19.2 |       |        |
| SP | 4/1987  | -8.53 | -54.00 |    | 19.0 | -8.55 | -54.51 |
|    | 8/1987  | -8.39 | -55.40 |    | 20.5 |       |        |
|    | 10/1988 | -8.74 |        |    |      |       |        |
|    | 3/1989  | -8.63 | -50.04 |    |      |       |        |
| 10 | 3/1986  | -8.91 | -55.27 | 0  | 22.0 |       |        |
| SP | 4/1987  | -8.56 | -56.30 |    | 22.0 |       |        |
|    | 8/1987  | -8.65 | -54.65 |    | 22.0 | -8.73 | -55.73 |
|    | 10/1987 | -8.81 | -56.70 |    |      |       |        |
| 11 | 9/1986  | -8.75 | -56.30 | 2  | 19.0 |       |        |
| SP | 4/1987  | -8.59 | -55.45 | 0  | 19.0 |       |        |
|    | 8/1987  | -8.69 | -52.75 |    | 19.0 | -8.74 | -55.48 |
|    | 4/1988  | -8.88 |        | 0  |      |       |        |
|    | 10/1988 | -8.88 |        |    |      |       |        |
|    | 3/1989  | -8.86 | -57.44 |    |      |       |        |
| 12 | 9/1986  | -8.94 | -54.09 | 1  | 20.0 |       |        |
| DW | 11/1986 | -8.84 | -57.68 | 1  | 19.5 |       |        |
|    | 2/1987  | -9.17 | -48.20 |    |      | -8.88 | -54.43 |
|    | 3/1987  | -8.91 | -53.00 |    |      |       |        |
|    | 4/1987  | -9.08 | -53.75 |    | 19.5 |       |        |
|    | 5/1987  | -8.60 | -55.85 |    | 20.0 |       |        |
|    | 6/1987  | -8.84 | -54.00 |    | 20.0 |       |        |
|    | 7/1987  | -8.74 | -54.15 |    | 20.0 |       |        |
|    | 8/1987  | -8.81 | -52.95 |    | 20.0 |       |        |

|    |         |       |        |    |      |       |        |
|----|---------|-------|--------|----|------|-------|--------|
| 13 | 9/1986  | -8.78 | -57.31 | 1  | 23.0 |       |        |
| DW | 11/1986 | -8.61 | -59.78 |    | 23.0 |       |        |
|    | 2/1987  | -8.97 | -55.40 |    |      |       |        |
|    | 3/1987  | -8.81 | -55.80 |    | 23.0 |       |        |
|    | 4/1987  | -8.30 | -55.25 | 5  | 23.0 |       |        |
|    | 5/1987  | -8.70 | -55.25 |    | 22.0 |       |        |
|    | 6/1987  | -8.70 | -57.20 |    |      | -8.67 | -56.46 |
|    | 7/1987  | -8.62 | -57.00 |    | 23.0 |       |        |
|    | 8/1987  | -8.12 | -56.55 |    | 23.0 |       |        |
|    | 4/1988  | -8.84 | -56.61 | 0  | 5945 |       |        |
|    | 10/1988 | -8.77 | -54.80 |    |      |       |        |
|    | 3/1989  | -8.88 | -56.74 |    |      |       |        |
| 14 | 3/1986  | -8.59 | -57.03 | 0  | 23.0 |       |        |
| SP | 4/1987  | -8.54 | -56.20 | 0  | 23.0 | -8.66 | -55.54 |
|    | 8/1987  | -8.80 | -50.35 |    | 23.5 |       |        |
|    | 10/1988 | -8.71 | -58.59 |    |      |       |        |
| 15 | 9/1986  | -8.81 | -57.38 | 3  | 23.5 |       |        |
| SP | 4/1987  | -8.29 | -55.85 | 0  | 21.0 |       |        |
|    | 8/1987  | -8.79 | -57.15 |    | 23.5 | -8.73 | -56.52 |
|    | 4/1988  | -9.00 | -55.10 | 0  | 4091 |       |        |
|    | 10/1988 | -8.88 |        |    |      |       |        |
|    | 3/1989  | -8.94 | -55.73 |    |      |       |        |
| 16 | 9/1986  | -8.88 | -57.79 | 0  | 23.5 |       |        |
| DW | 4/1987  | -8.82 | -57.25 |    | 23.0 |       |        |
|    | 8/1987  | -8.70 | -60.10 |    | 24.0 |       |        |
|    | 4/1988  | -8.78 |        | 0  | 9631 | -8.73 | -57.32 |
|    | 10/1988 | -8.77 | -58.00 |    |      |       |        |
|    | 3/1989  | -8.84 | -51.48 |    |      |       |        |
| 17 | 3/1986  | -4.34 | -39.14 | 13 | 23.0 |       |        |
| R  | 4/1987  | -7.87 | -53.55 | 11 |      |       |        |
|    | 8/1987  | -5.15 | -48.30 | 11 | 22.0 |       |        |



|     |         |       |        |    |      |       |        |
|-----|---------|-------|--------|----|------|-------|--------|
| 18  | 9/1986  | -9.84 | -65.13 | 10 | 17.0 |       |        |
| SP  | 4/1987  | -9.50 | -59.55 |    | 14.5 | -5.56 | -62.51 |
|     | 8/1987  | -9.36 | -62.35 |    | 16.5 |       |        |
| 19  | 9/1986  | -4.19 | -34.71 | 18 | 23.0 |       |        |
| R   | 4/1987  | -7.87 | -51.90 | 11 | 12.5 |       |        |
|     | 8/1987  | -4.90 | -45.65 |    | 21.0 |       |        |
| 20  | 11/1986 | -8.08 | -60.65 | 2  | 34.0 |       |        |
| TSP | 4/1987  | -8.91 | -57.40 |    | 34.5 | -8.73 | -58.10 |
|     | 8/1987  | -9.20 | -56.25 |    | 34.5 |       |        |
| 21  | 11/1986 | -8.34 | -60.95 | 5  | 19.0 |       |        |
| SP  | 4/1987  | -8.14 | -56.80 | 2  | 19.5 | -8.32 | -58.16 |
|     | 8/1987  | -8.48 | -56.75 |    | 19.0 |       |        |
| 22  | 11/1986 | -9.29 | -61.48 |    | 19.0 |       |        |
| SP  | 4/1987  | -8.73 | -58.35 | 9  | 19.0 | -9.04 | -58.56 |
|     | 8/1987  | -9.12 | -56.75 |    | 19.5 |       |        |
| 23  | 11/1986 | -9.36 | -62.23 | 4  | 21.5 |       |        |
| SP  | 4/1987  | -9.04 | -57.60 |    | 23.0 | -9.20 | -59.66 |
|     | 8/1987  | -9.20 | -59.15 |    | 20.3 |       |        |
| 24  | 11/1986 | -9.47 | -61.69 |    | 20.0 |       |        |
| SP  | 4/1987  | -8.84 | -62.15 |    | 22.0 | -9.13 | -62.01 |
|     | 8/1987  | -9.23 | -62.20 |    | 24.5 |       |        |
| 25  | 11/1986 | -8.14 | -57.82 | 3  | 34.0 |       |        |
| TSP | 4/1987  | -5.87 | -49.75 |    | 19.5 | -8.01 | -56.62 |
|     | 8/1987  | -7.89 | -55.20 |    | 34.5 |       |        |
| 26  | 11/1986 | -8.40 | -57.15 | 13 | 13.5 |       |        |
| SP  | 4/1987  | -8.63 | -56.15 |    | 13.5 | -8.57 | -56.61 |
|     | 8/1987  | -8.93 | -55.95 |    | 14.0 |       |        |

|         |         |       |        |    |      |       |        |
|---------|---------|-------|--------|----|------|-------|--------|
| 27-SP   | 11/1986 | -9.75 | -63.38 | 28 | 12.0 |       |        |
|         | 4/1987  | -9.48 | -62.25 | 29 | 12.0 | -9.49 | -60.57 |
|         | 8/1987  | -9.24 | -56.10 |    |      |       |        |
| 28-SP   | 11/1986 | -7.24 | -55.52 | 41 | 12.5 |       |        |
|         | 4/1987  | -7.18 | -50.30 | 37 | 12.5 | -7.17 | -54.14 |
|         | 8/1987  | -7.09 | -56.60 | 11 | 19.0 |       |        |
| 29-SP   | 11/1986 | -7.16 | -53.69 | 1  | 18.0 |       |        |
|         | 4/1987  | -8.88 | -59.30 | 0  | 17.0 | -7.74 | -54.51 |
|         | 8/1987  | -7.20 | -50.55 | 6  | 17.0 |       |        |
| 30-SP   | 6/1987  | -8.32 | -56.30 | 0  | 27.0 |       |        |
| 31-DW   | 6/1987  | -9.16 | -55.50 | 5  | 26.0 | -9.03 | -56.45 |
|         | 12/1987 | -8.68 | -57.40 | 0  |      |       |        |
|         | 11/1988 | -9.26 |        |    |      |       |        |
| 31/B/SP | 12/1987 | -9.18 | -54.65 | 4  | 21.0 | -9.16 | -54.65 |
|         | 11/1988 | -9.14 |        |    |      |       |        |
| 32-SP   | 6/1987  | -9.23 | -55.35 | 40 | 17.0 |       |        |
| 33-SP   | 6/1987  | -9.87 | -61.90 | 44 | 13.0 |       |        |
| 34-SP   | 6/1987  | -9.95 | -57.85 | 16 | 17.0 |       |        |
| 35-SP   | 6/1987  | -8.80 | -55.10 | 28 | 14.0 |       |        |
| 36-SP   | 6/1987  | -8.79 | -57.65 | 19 | 17.0 |       |        |
| 37-TSP  | 12/1987 | -8.62 | -58.80 | 0  | 65.0 |       |        |
| 38-DW   | 12/1987 | -8.75 | -60.15 | 0  | 19.0 |       |        |
| 39-DW   | 12/1987 | -8.65 | -56.95 | 2  | 19.0 |       |        |
| 40-SP   | 11/1988 | -8.88 | -53.72 | 2  |      |       |        |
| 41-SP   | 10/1988 | -8.92 | -59.46 | 0  |      |       |        |
| 42-SP   | 10/1988 | -8.85 | -56.70 | 0  |      |       |        |
| 43-DW   | 10/1988 | -8.93 | -59.11 |    |      |       |        |

|       |         |       |        |   |       |
|-------|---------|-------|--------|---|-------|
| 44-DW | 10/1988 | -9.10 | -50.15 |   |       |
| 45-DW | 10/1988 | -8.89 | -53.57 |   |       |
| 46-DW | 10/1988 | -8.74 | -53.52 |   |       |
| 47-DW | 10/1988 | -8.63 | -51.51 |   |       |
| 48-DW | 10/1988 | -8.52 | -55.10 |   |       |
| 49-DW | 10/1988 | -8.90 | -49.69 |   |       |
| 50-DW | 10/1988 | -8.42 | -50.69 |   |       |
| 51-DW | 10/1988 | -8.93 | -49.47 |   |       |
| 52-DW | 10/1988 | -8.74 | -50.67 |   |       |
| 53-DW | 10/1988 | -8.78 | -45.80 |   |       |
| 54-DW | 10/1988 | -8.81 | -51.44 |   |       |
| 55-DW | 10/1988 | -8.91 | -52.93 |   |       |
| 56-DW | 10/1988 | -8.76 | -53.30 |   |       |
| TS    | 6/1987  | -5.53 | -57.95 | 2 | 147.0 |
|       | 12/1987 | -7.42 | -67.60 | 0 | 147.0 |

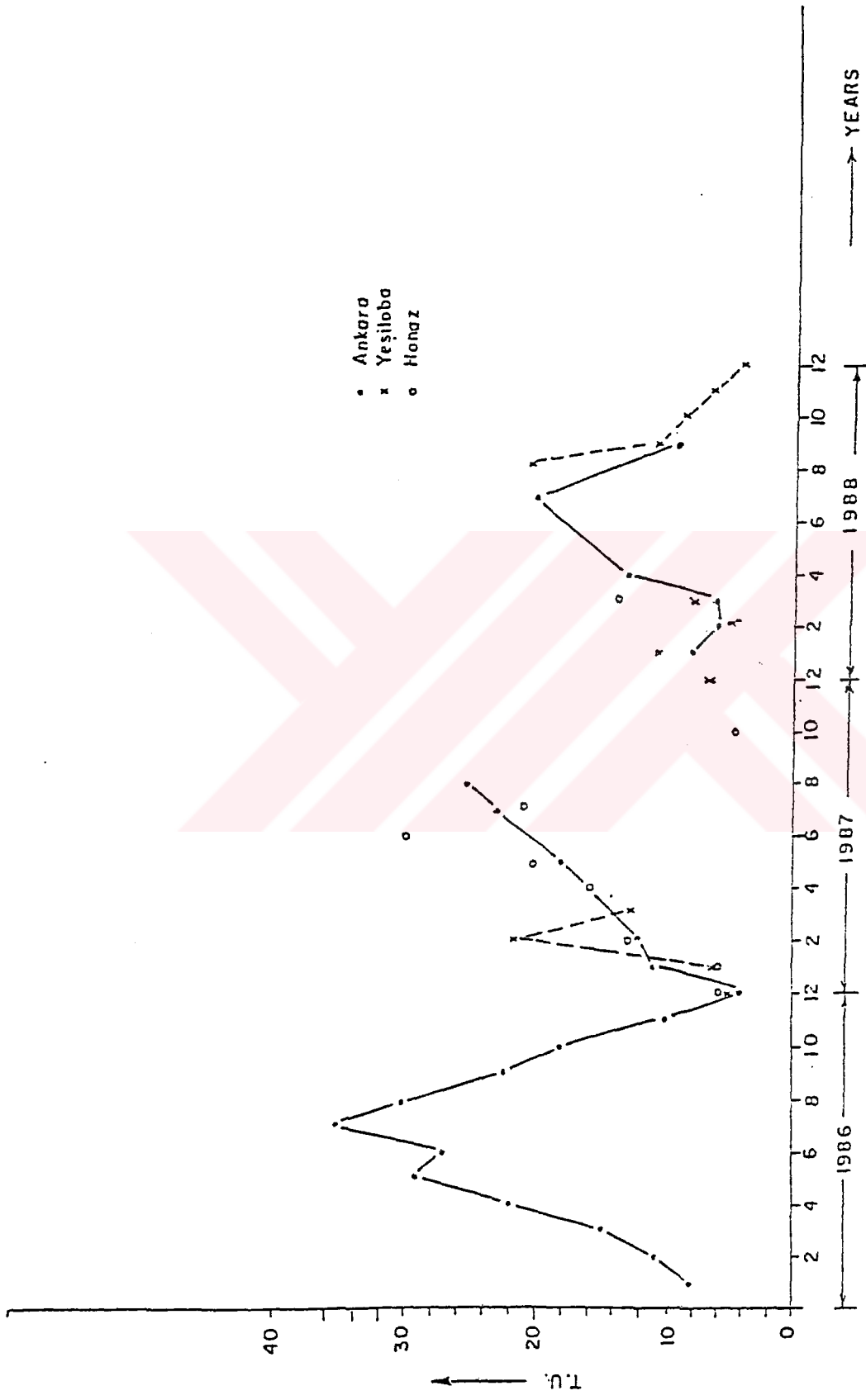


Figure 34. Monthly variations of tritium concentrations in precipitation.

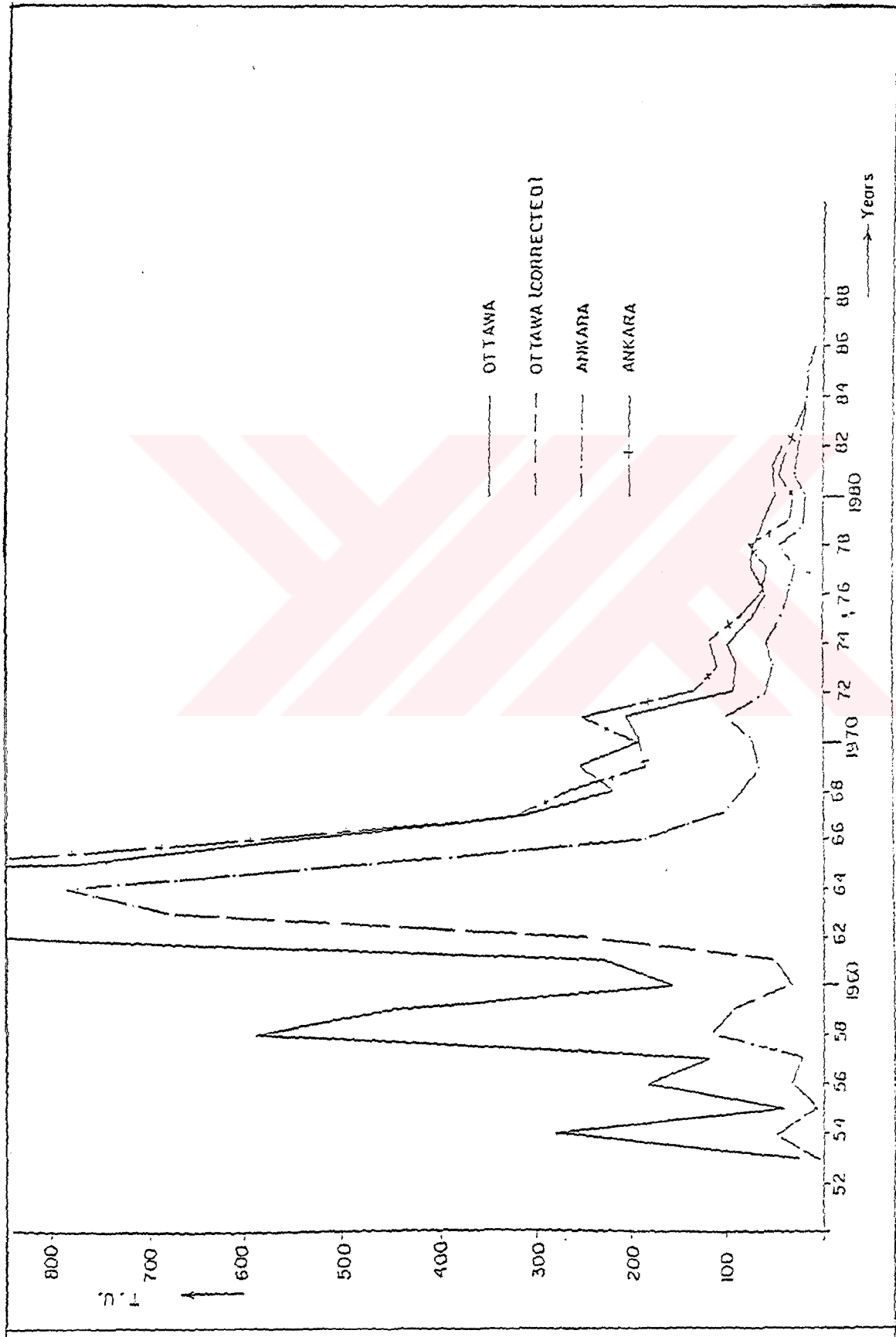
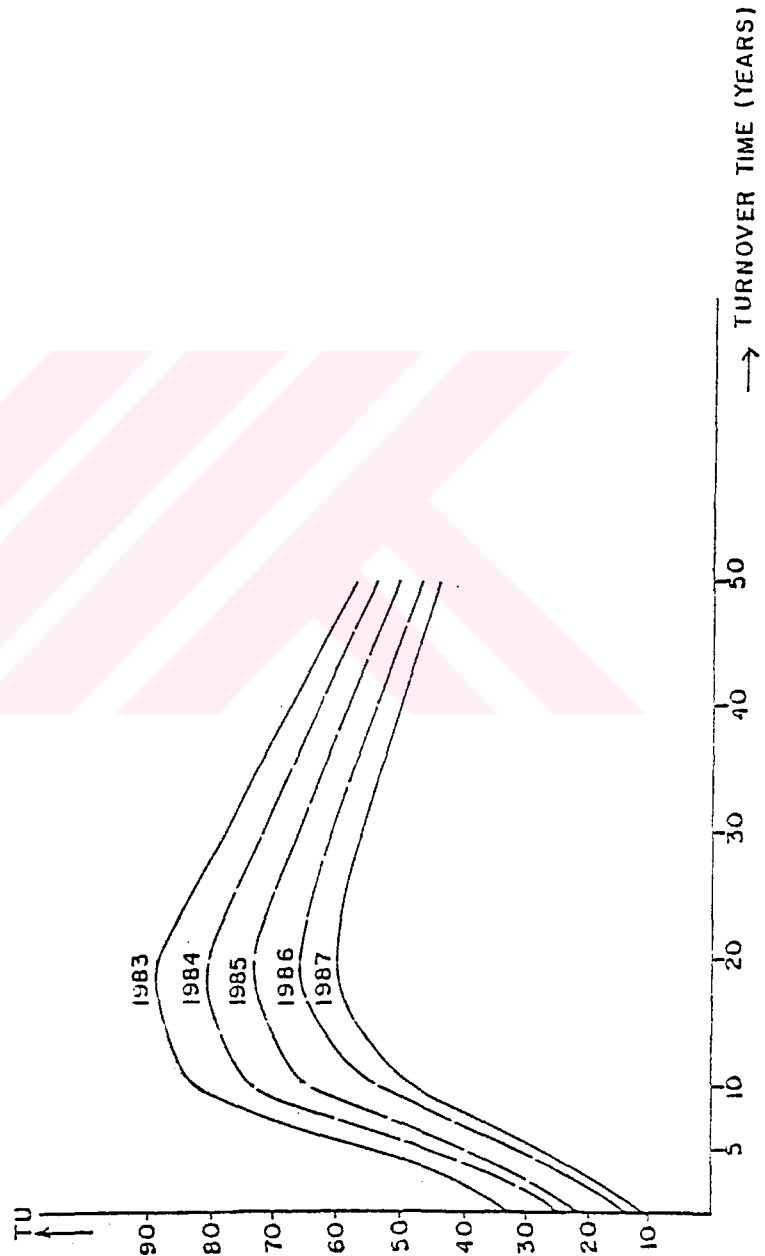


Figure 35. Yearly weighted tritium means of Ottawa and Ankara precipitation's and calculated decay values according to 1987.

Figure 36. Completely mixed model for T values (from Ottawa and Ankara precipitation for 1963-1985 and adapted to Yeşiloba for 1986-1987)



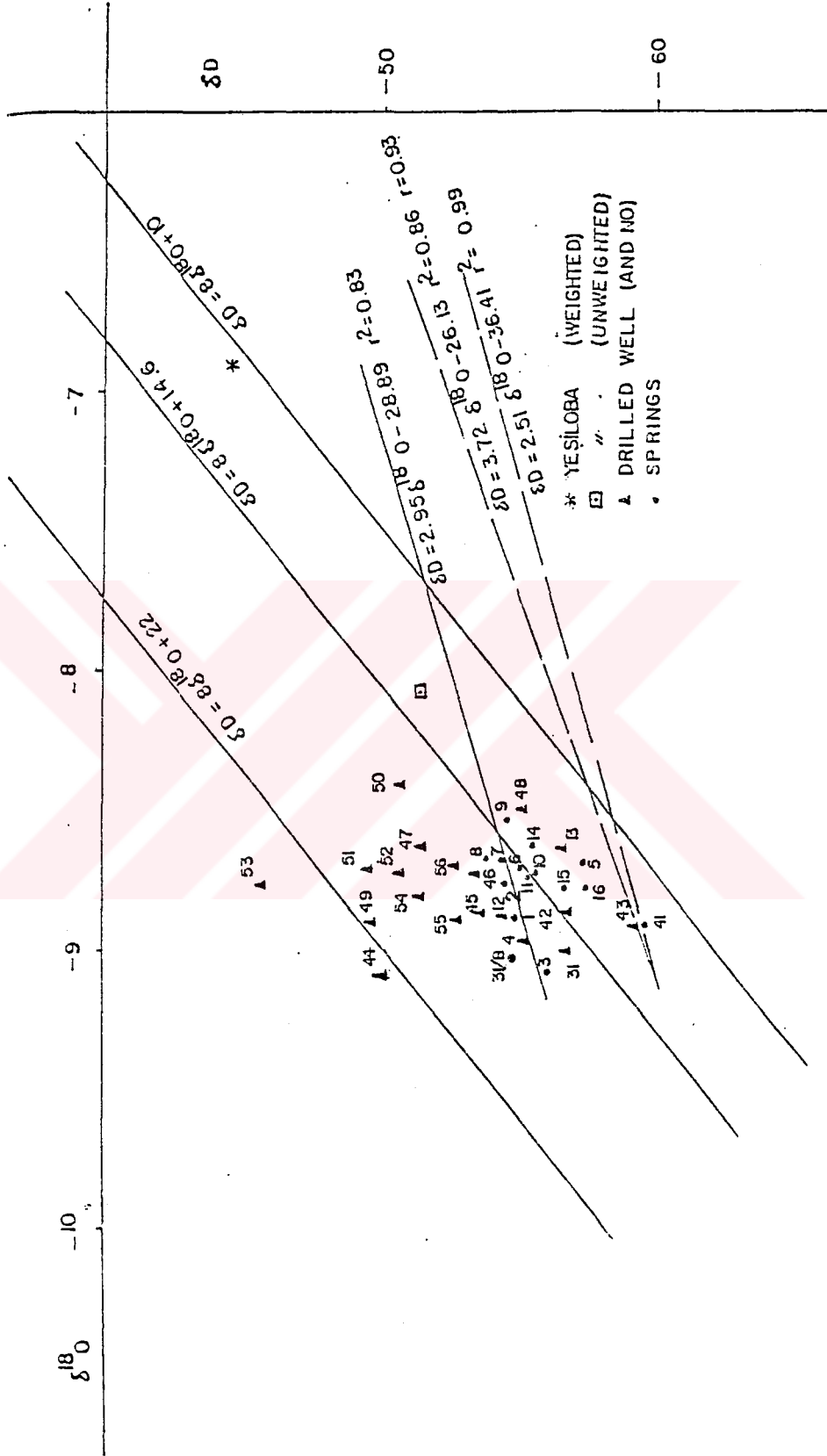
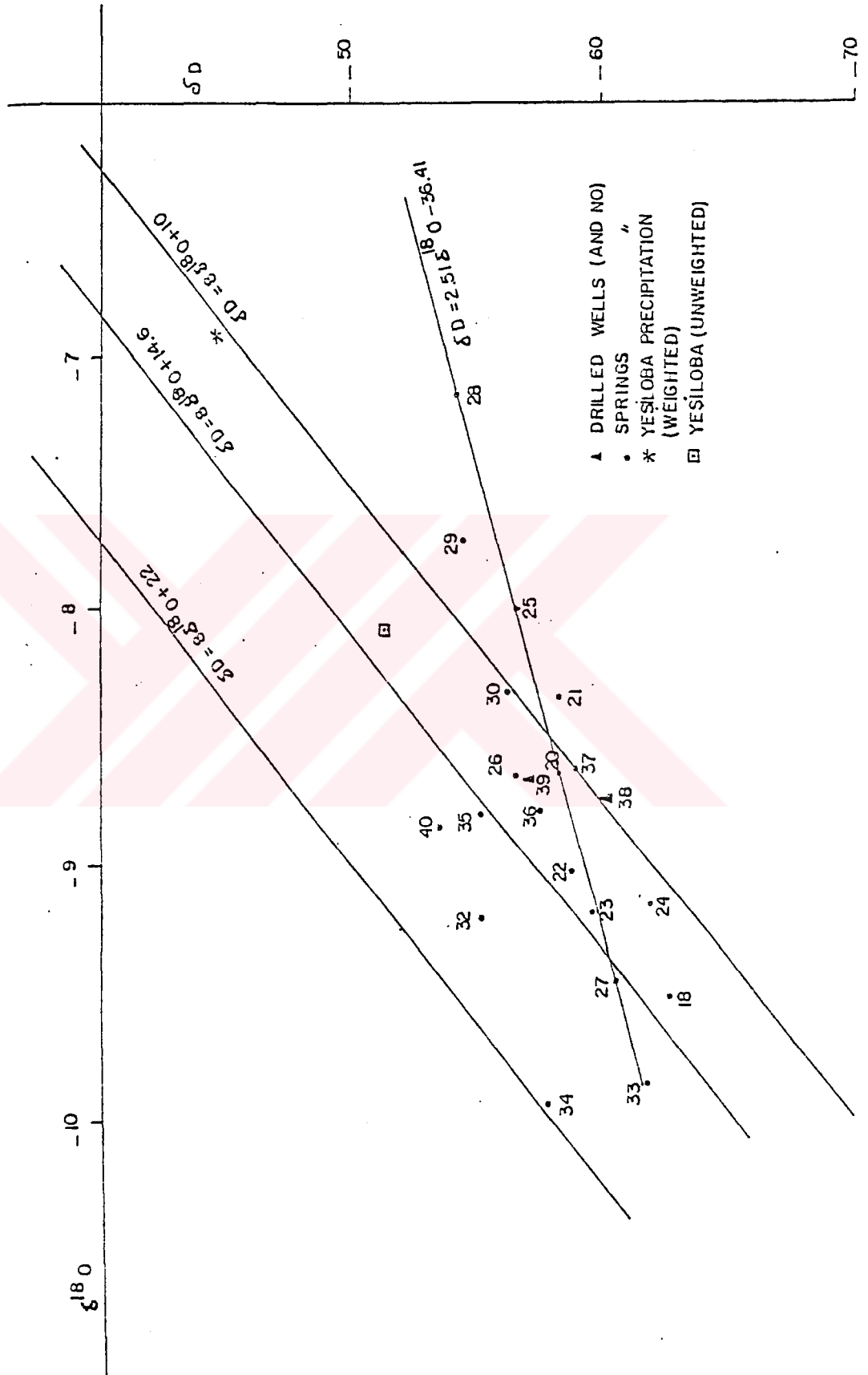


Figure 37.  $\delta^{18}O$  versus  $\delta D$  plot of Yukarı Çürüksu Plain area samples



Figure 38.  $\delta^{18}O$  versus  $\delta D$  plot of samples out of plain area.



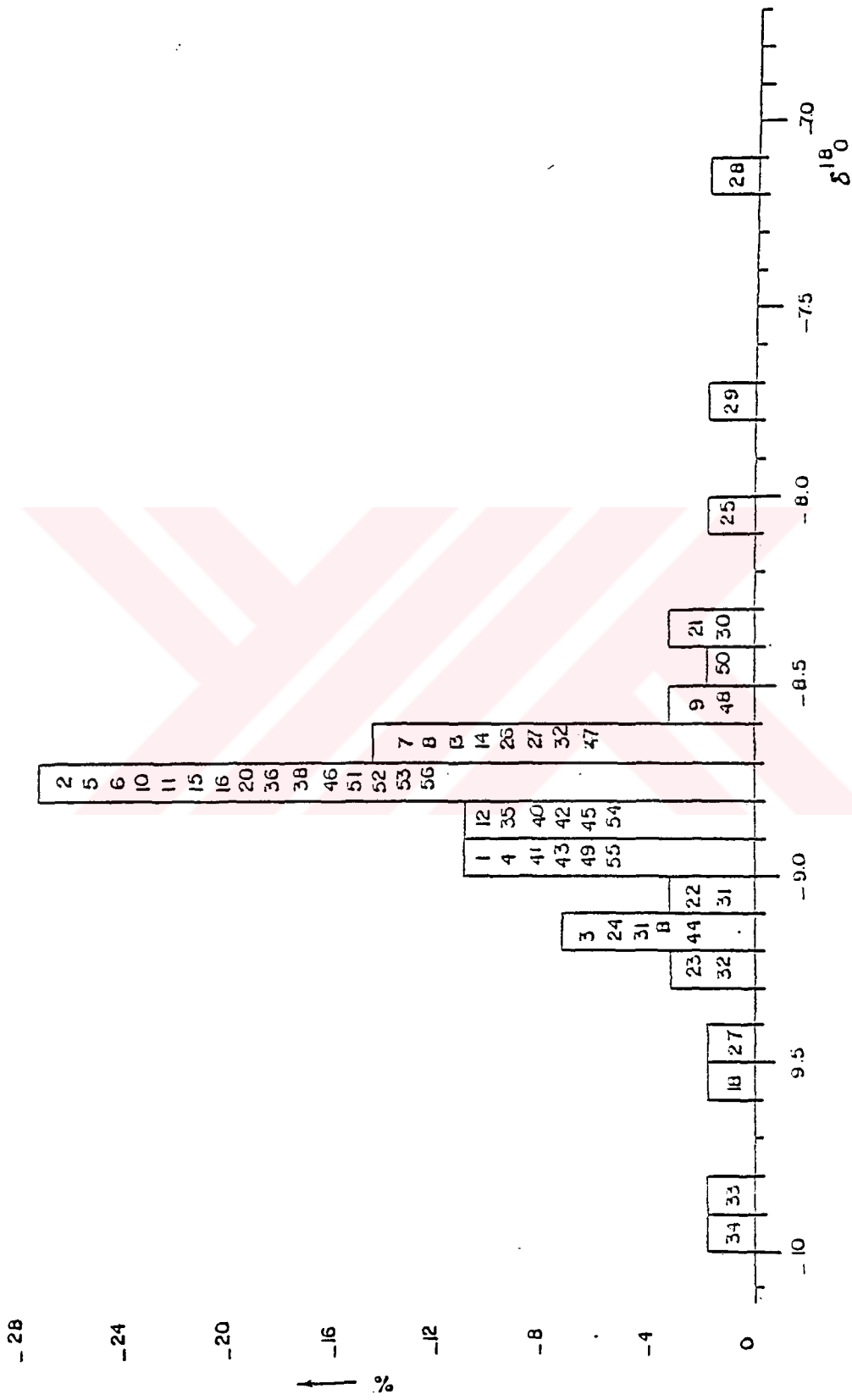


Figure 39. Distribution histogram

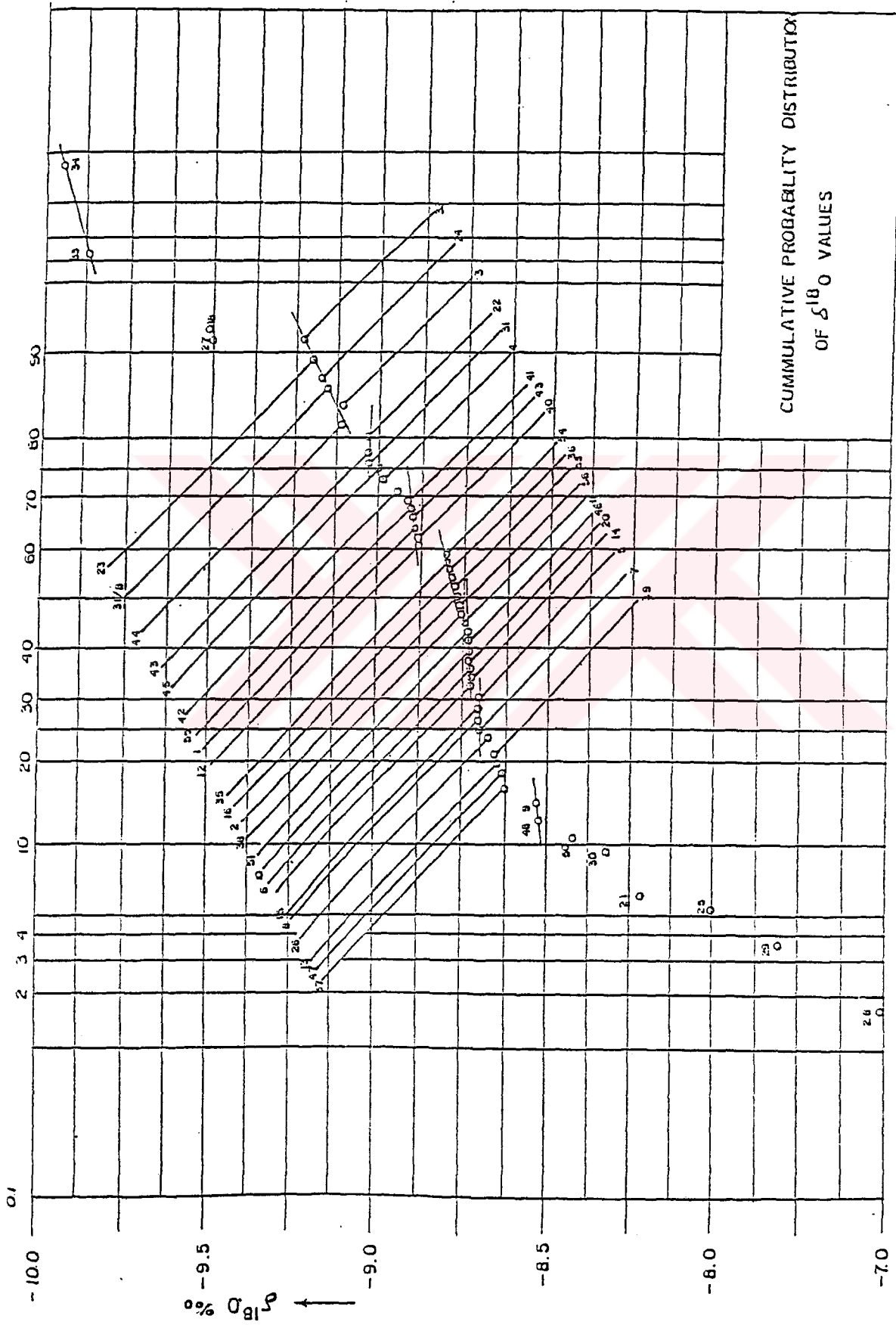


Figure 40. Cumulative probability distribution of  $\delta^{18}\text{O}$  values

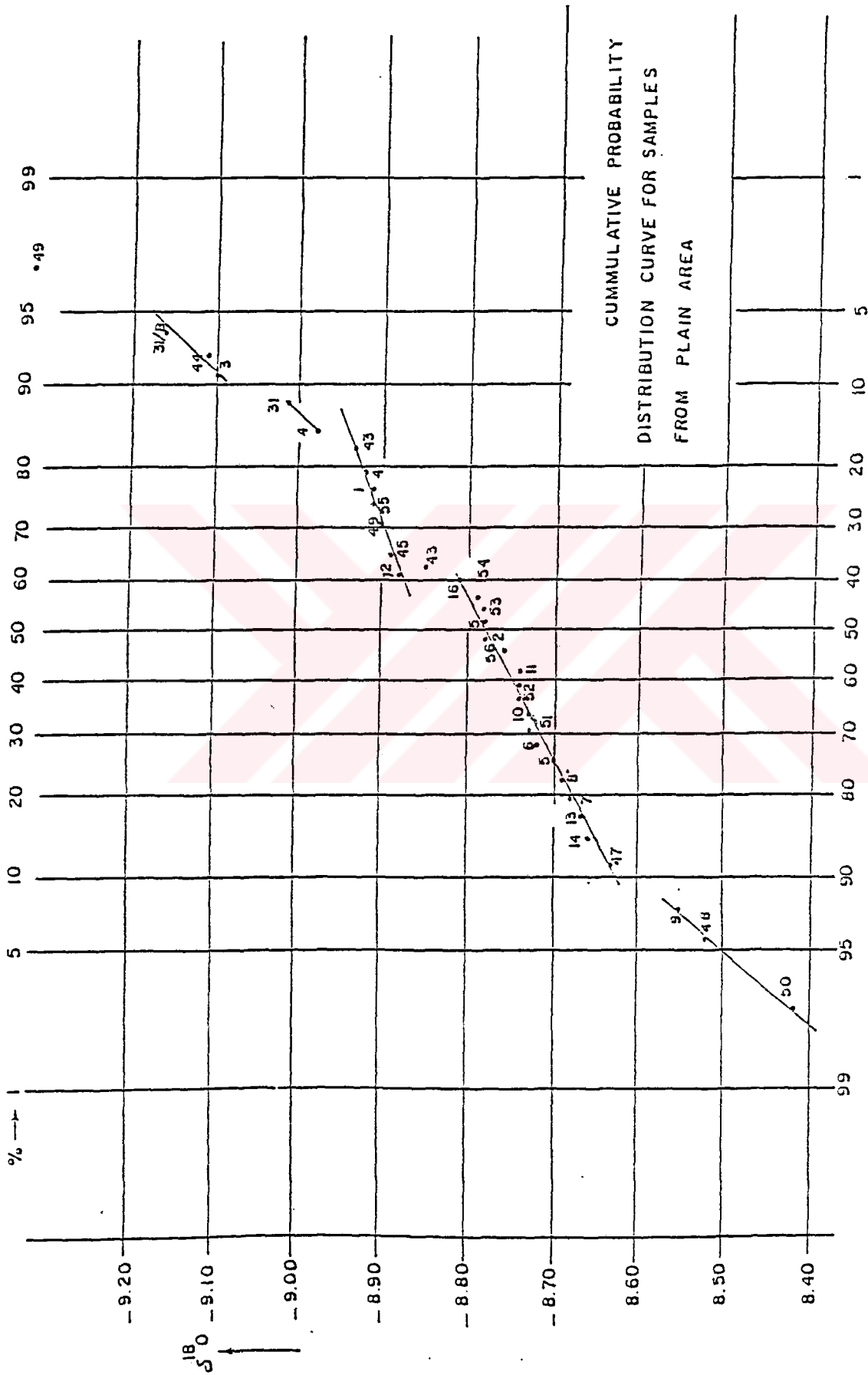


Figure 41. Cumulative probability distribution curve for samples from plain area

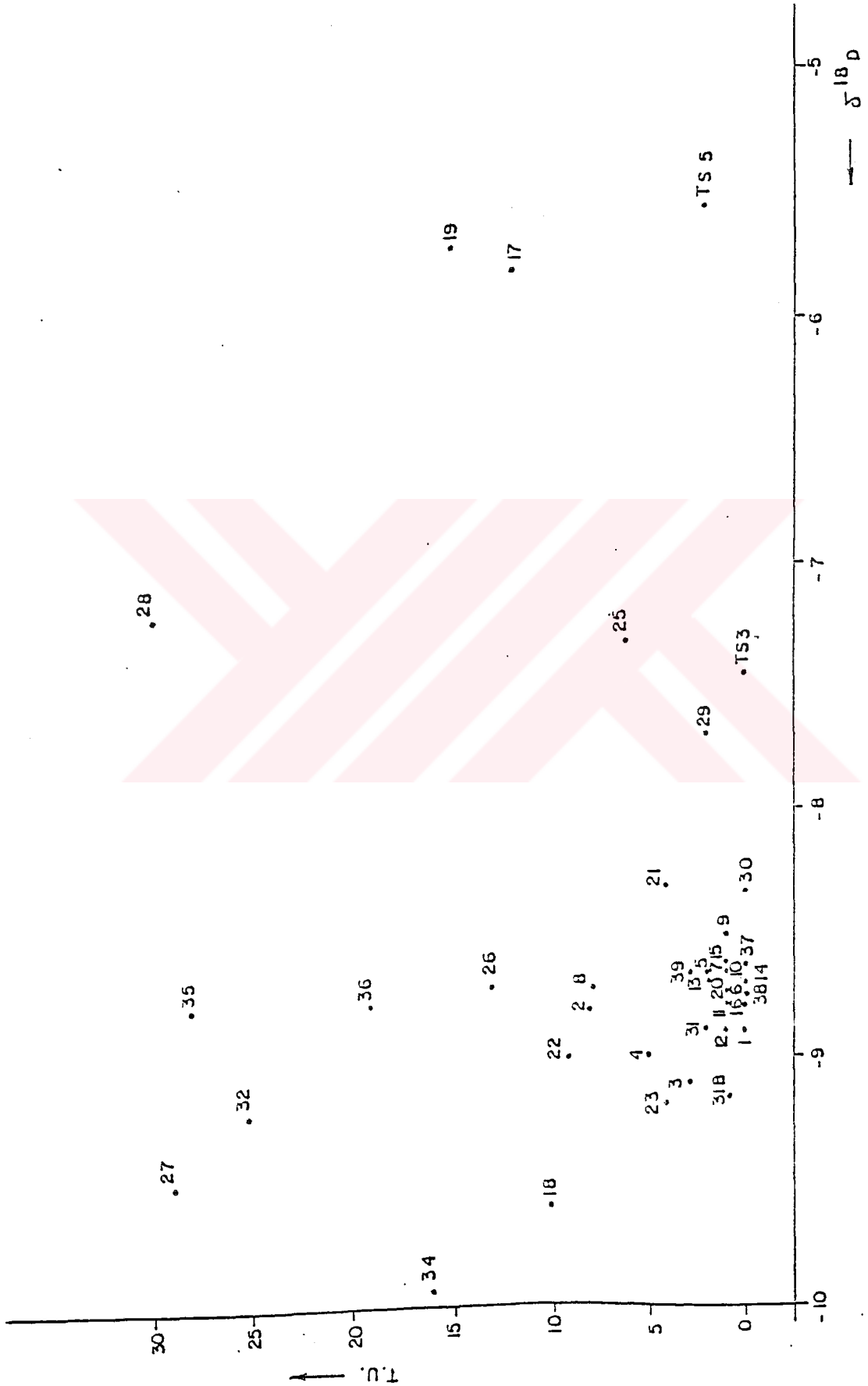


Figure 42. T versus δ<sup>18</sup>O plot

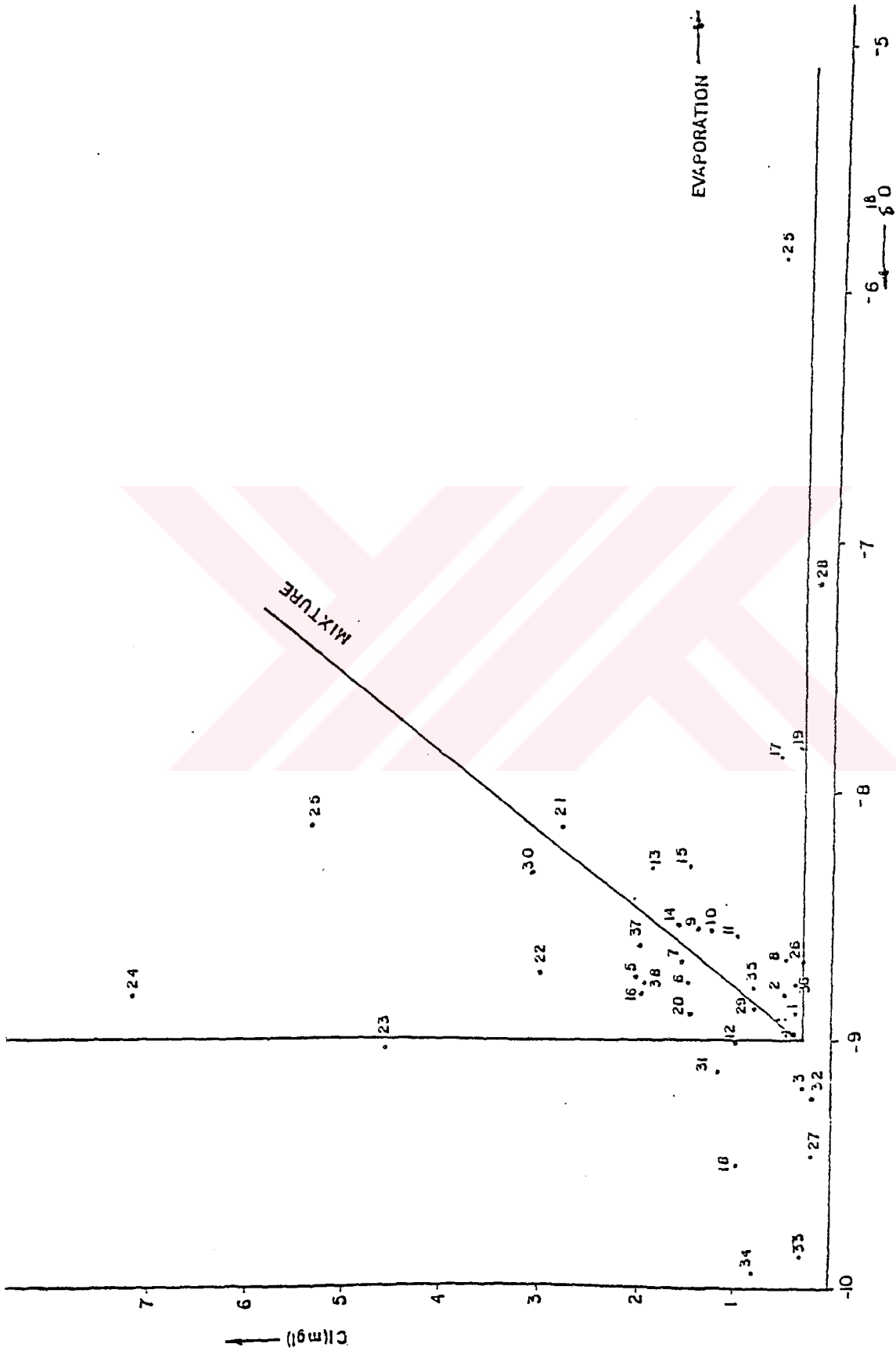


Figure 43.  $\delta^{18}O$  versus Cl plot

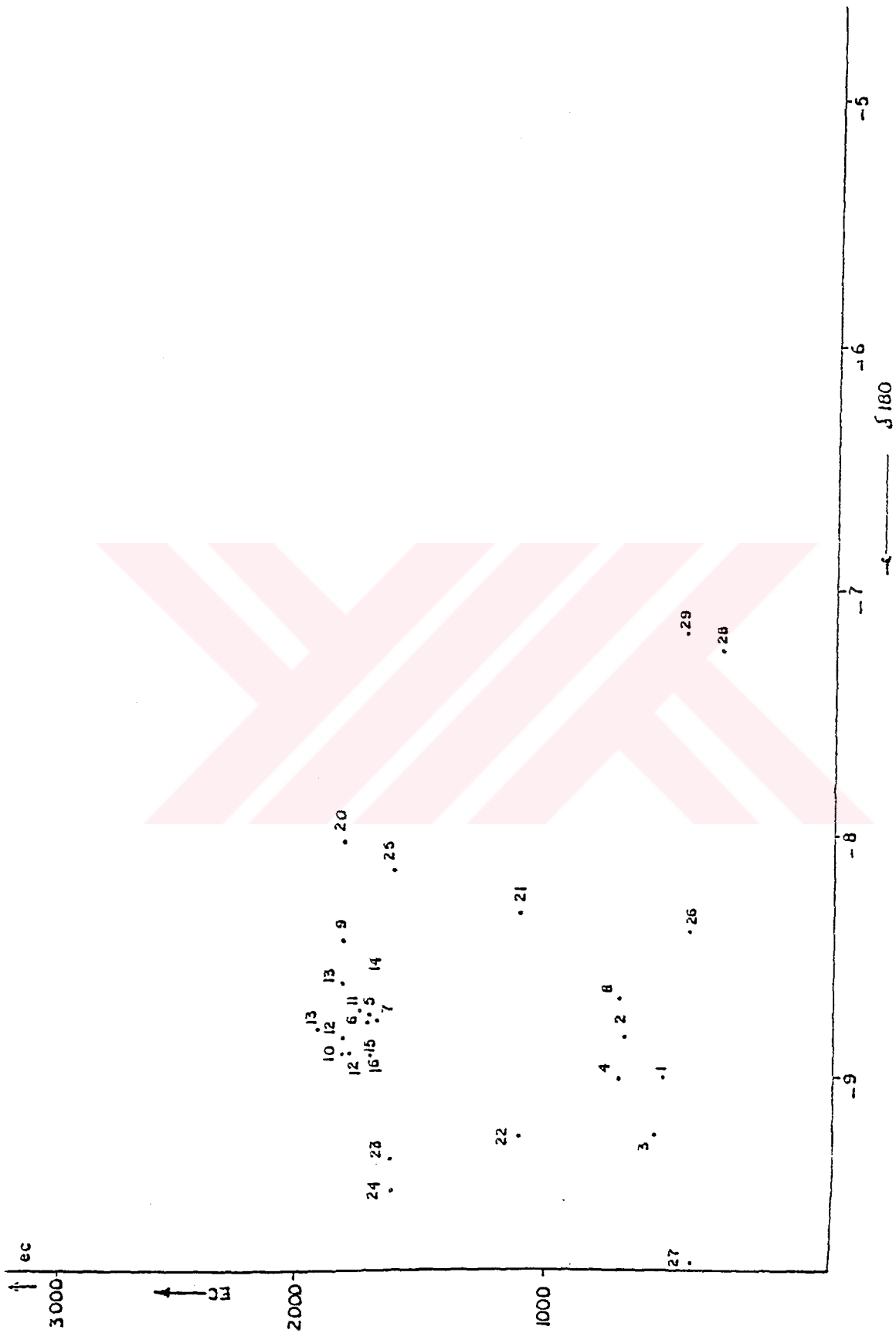


Figure 44. EC versus δ<sup>18</sup>O plot



## **7. CONCLUSIONS and RECOMMENDATION**

1. Geological map of investigation area have been prepared scaled 1/100.000
2. Lower Pliocene aged lagunal and Plio-Quaternary aged terrestrial sediments, and travertine, alluvium, talus units have been determined
3. % 82 of the precipitation have been determined as Etr % 18 of precipitation have been determined as excess of water along working time.
4. Haydarbaba and Gemili karst springs are discharge from travertine.
5. First reservoir of investigation area is travertine, second is Pliocene aged limestones and third is marbles and quartz schist, quartzite levels in the marbles.
6. Recharge is provided by precipitation, Çivril-Baklan Plain and Acıgöl basin's ground waters.
7. Chemical properties of ground waters commonly shows similarity and gain their chemical properties in basin.
8. According to H. Schoeller drinkable water diagram all waters of investigation area at bad quality water class. U.S. Salinity laboratory have been determined ground water as  $C_4-S_1$  and  $C_3-S_1$  class. According to the Wilcox diagram waters have been classified as "doubtful to permissible" and "unsuitable" waters. Waters of investigation area generally non-industrial, harmful in concrete and limited in use of irrigation .
9. Çürüksu right side plain's all ground waters precipitates calcite and dolomite, dissolves sulfate and partial  $CO_2$  gas pressure higher than atmosphere.
10. Total water necessity of Yukarı Çürüksu Right Side Plain is have been 16439 l/sec. and only % 68 of the necessity irrigation waters are corresponded by present source. Water deficiency of Çürüksu Right Side Plain is 2388 l/sec. and it has been planed to provide by Gökpınar Dam which is planning to construct.
11. As it is too difficult to determine charge - recharge relation, isotopic investigation should continue. Every year amount to discharging water should be determined and seasonal hydrological relations should be observed.
12. Pumping equipment should be kept out of use except irrigation season because all waters in corrosive properties.
13. Detailed corrosion investigation must be done and well and irrigation equipment should be chosen by taking into account of galvanic series and alloying element properties.

14. For reduce of harmful effect of ground water into concrete aluminized cement should be used.

15. Gemili Spring should be use for irrigation.

16. Mechanical cleaning of scaling product will be suitable for investigation area. Aeration system may be available to reduce of scaling.



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