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THE REPUBLIC OF TURKEY

MINERAL RESEARCH AND EXPLORATION INSTITUTE

REPORT ON

KOPDAĞ AND TUNCELİ AREA, TURKEY

PHASE 2

GEOLOGICAL SURVEY AND GEOCHEMICAL SURVEY OF TUNCELİ

FEBRUARY 1979

METAL MINING AGENCY OF JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Turkey, decided to conduct cooperative mineral exploration project in Tunceli and Kopdağ areas in eastern Turkey and entrusted its execution to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The project started in 1977 under close collaboration with Maden Tetkik ve Arama Enstitusu (MTA) of the Republic of Turkey. The intention of the project is to study potentiality of copper and chrome deposits in the areas.

Between 23 June and 27 November, 1978, the Metal Mining Agency of Japan dispatched a survey team headed by Mr. Hisashi Mizumoto to conduct geological survey and geochemical prospects of the Phase II of the project.

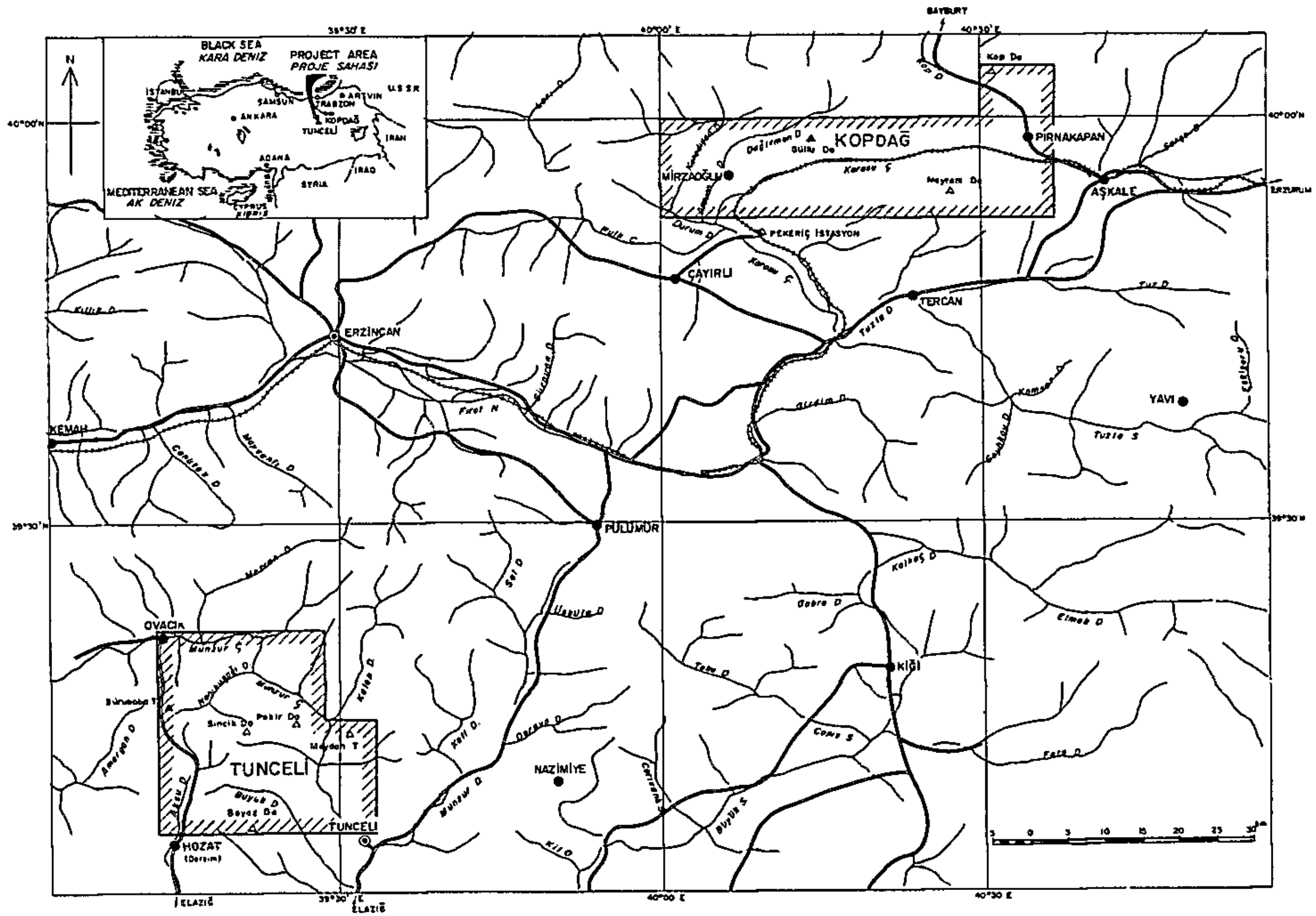
This report is a compilation of the basic survey findings of the Phase II. At the completion of the project consolidated report will be submitted to be Government of the Republic of Turkey.

We wish to express our appreciation to all of the organizations and members who bore the responsibility for the project; the Government of the Republic of Turkey, Maden Tetkik ve Arama Enstitüsü, and other authorities and the Embassy of Japan in Turkey.

February 1979

Shinsaku Hogen
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan



LEGEND Preliminary photogeological survy area
Lejand *Fotojeolojik ön çalişmalarıistenen saha*

City *Şehir* · Town *Kaza* · Stream and river *Dere suyu, cavi nehir* · Road *Karayolu* · Rail road *Demiryolu*

ABBREVIATION T Hill *Type* · Da Mountain *Dağ* · D Stream *Dere* · S River *Suyu* · Ç River *Çayl* · N River *Nehir*
Kısaltma

Fig. 1 INDEX MAP FOR TUNCELİ AREA

LOKASYON HARİTASI

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SUMMARY

This report summarises a geological investigation of the Tunceli area, undertaken as part of a cooperative program between Turkey and Japan, with the aim of conducting mineral exploration in the Tunceli and the Kopdağ areas in eastern Turkey.

In the fiscal year 1977, photogeological analysis was carried out. It clarified the outline of geology and selected the mineralization - alteration zones.

Based on the above-mentioned information, geological investigation and geochemical prospecting was done in fiscal year 1978.

Geological investigation was carried out in an area of 760 km^2. In the Sin and the Mamlis areas where noteworthy mineralized indications were found detailed geological investigation on a scale of 1 : 2,000 was carried out and mineralization was clarified. Both areas are in the size range of 5 km^2. Because a widespread altered zone had been recognized from the Siliç to the Mamlis areas, the geological investigation was carried out on a scale of 1 : 10,000 and geochemical soil samples were obtained by the Ridge and Spur method. The samples were collected in a span of 100 m in the Mamlis, the Sin and the Siliç areas, and collected in an interval of 300 m in the other area. The above-mentioned area is 115 km^2 and the sampling density was 13 samples per km^2.

On the other hand, the reconnaissance geological investigation was carried out on a scale of 1 : 25,000 in an area of 640 km^2, and geochemical samples of stream sediments were collected in areas of 220 km^2 along and to the east of the Munzur river. Sampling density was 1 sample per km^2.

The result of geological investigation is as follows:

The Tunceli area is comprised of the Munzur Formation correlated to the Paleozoic, the Atadoğdu, the Bentepe, and the Kamışlık Formations correlated to the Eocene, the Düzpelit, the Tırnas, the Cevizlik, and the Savular Formations correlated to the Miocene, and the Göktepe Formation correlated to the Pliocene.

The Paleozoic Formation which was subjected to the low grade regional metamorphism consists of pelitic schist, green schist, and crystalline limestone. Sediments of the Eocene are mainly composed of (calcareous) mudstone, and rocks of the Miocene consist of submarine pyroclastic rocks, predominantly of dacitic composition. Most intrusive rocks form stocks of dacite, quartz-diorite, and diorite intruded during Miocene, and porphyry, porphyrite, and andesite, which form small dikes or stocks.

Serpentinite occurs only in the northern area, and is correlated to the Jurassic or the Cretaceous system.

The remarkable mineralizations in this area include copper and zinc disseminated deposits related to the intrusion of the Sin dacite, stockwork deposits with zinc (and copper) developed in the Düzpelit Formation around the Bulanık quartz diorite (Mamlis mine), and vein-type deposits with copper (and zinc) in both the Bentepe and the Kamışlık Formations around the Bulanık quartz diorite (Kört mine).

Chapter 1 Introduction

1-1 Survey history

This project is the second phase of the Turkish-Japanese Collaboration with the Development of Mineral Resources in Turkey. First one was completed during the interval of 1973 - 1975 around Trabzon area. Early stage of this project has already been mentioned in the "Report on Geological Survey of Tunceli and Kopdağ Area, Eastern Turkey, Phase 1, Photogeological Survey", written by Metal Mining Agency of Japan, June 1978.

On the basis of the recommendation of this report, this project was started on July 10th, 1978. Following members took part in this project.

Turkish Team (M.T.A.)

Yılmaz ALTUN	(Project Coordinator)
Mithat KAYAALP	(Project Manager)
Torun YILMAZ	(Mining Geologist)
Hayati YAVUZ	(Mining Geologist)

Geochemical prospecting Team (M.T.A.)

Sinan ORBAY	(Geologist)
Refik ÖNALI	(Prospector)
Haluk DİKMEN	(Prospector)

Japanese Team (M.M.A.J.)

Hisashi MIZUMOTO	(Leader of Japanese Team)
Yoshihiro WATANABE	(Mining Geologist)
Masaharu MARUTANI	(Mining Geologist)
Hideo SUZUKI	(Mining Geologist)

1-2 Purpose of the survey

First and main aim of the survey was to find out the mining potential of the area with respect to Cu-Pb-Zn and to evaluate the existing mineral occurrences. In the beginning, this project was started to find a new porphyry copper deposit. However, the mineralizations of this area consist of Cu-Pb-Zn ore deposits, and are related to dacite - granodiorite of submarine igneous activity in the Tertiary. The type of ore deposits are dissemination, stockwork, and vein. This project was based mainly on geological mapping and geochemical sampling.

During the survey, general geological mapping of 640 km^2 on a scale of 1 : 25,000, detailed prospecting of 105 km2 on a scale of 1 : 10,000, and detailed prospecting of 10 km^2 on a scale of 1 : 2,000 in Sin and Mamlis areas, were completed and a total of 1986 geochemical samples were collected, of which 1961 samples were collected from the 115 km^2 of detailed prospecting area (soil), and 225 samples from the 220 km^2 inside the general geological mapping area (stream sediments).

1-3 Location of the area (Fig. 2)

The location of the survey area is as follows:

(A) General geological mapping area

	North latitude	East longitude
A	39°21'30"	39°11'26"
B	39°07'30"	39°11'27"
C	39°07'30"	39°34'00"
D	39°15'08"	39°34'04"
E	39°15'10"	39°29'12"

	North latitude	East longitude
F	39°21'23"	39°29'15"

Total area: 760 km^2

(B) The area where soil samples were collected.

	Latitude	Longitude
G	$^{43}45^{700}$	$^{5}18^{570}$
H	$^{43}41^{430}$	$^{5}17^{080}$
I	$^{43}32^{440}$	$^{5}42^{450}$
J	$^{43}36^{700}$	$^{5}43^{950}$

(on 1 : 25,000 scale maps; ERZINCAN J43- c_1, c_3, c_4, d_2, d_3, J43-a_4)

Total area: 120 km^2

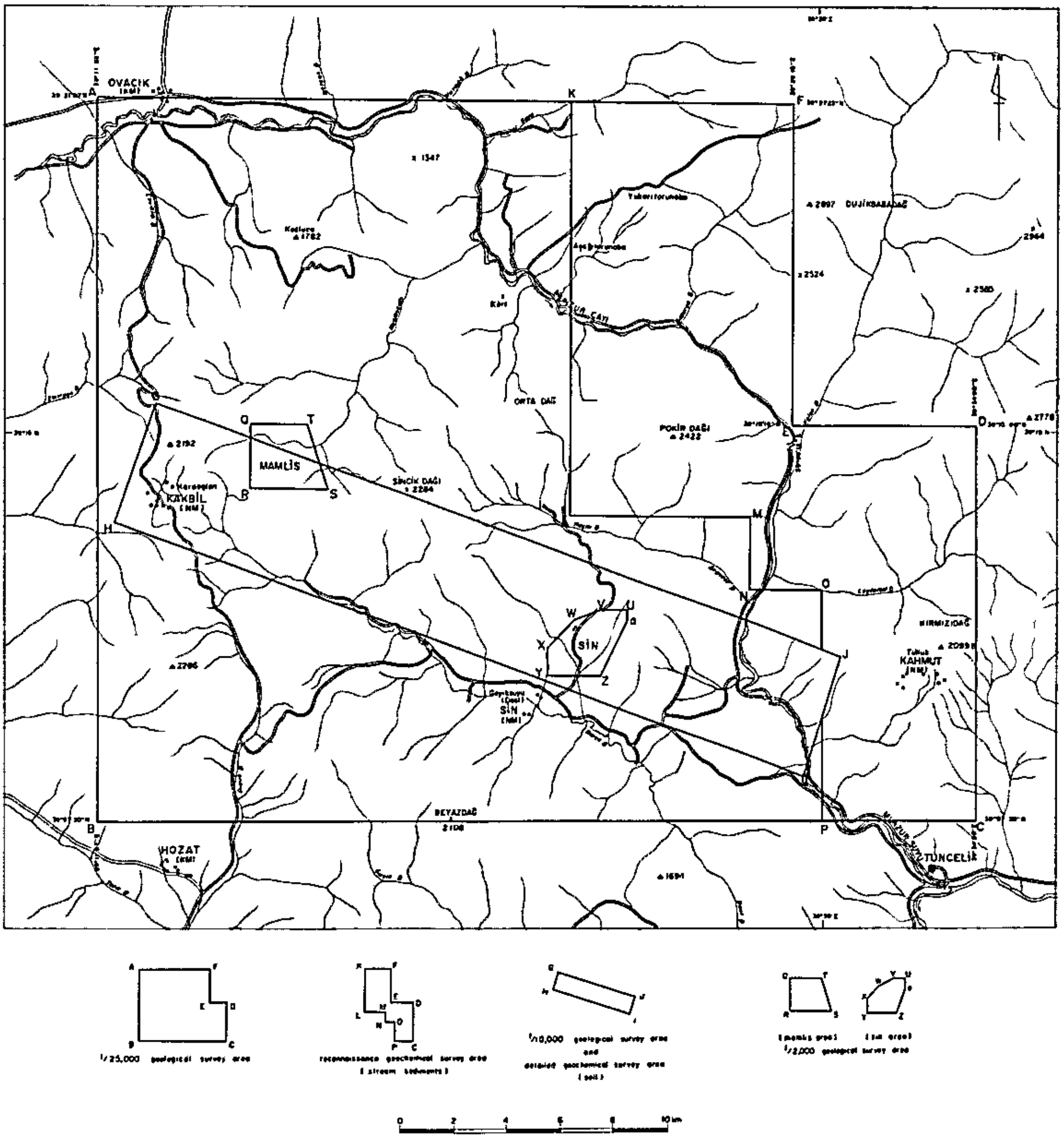
(C) The area where stream sediment samples were collected.

	Latitude	Longitude
K	$^{43}56^{525}$	$^{5}33^{800}$
L	$^{39}41^{700}$	$^{5}33^{800}$
M	$^{39}41^{700}$	$^{5}40^{600}$
N	$^{43}39^{100}$	$^{5}40^{600}$
O	$^{43}39^{100}$	$^{5}43^{205}$
P	$^{43}30^{850}$	$^{5}43^{205}$
C	$^{43}30^{875}$	$^{5}49^{000}$
D	$^{43}45^{000}$	$^{5}49^{000}$
E	$^{43}45^{000}$	$^{5}42^{000}$
F	$^{43}56^{525}$	$^{5}42^{000}$

(on 1 : 25,000 scale maps; ERZINCAN J42-b_3, c_1, J43-a_4, d_1)

Total area: 220 km^2

FIG 2 LOCATION MAP OF THE FIEID WORK IN 1978



(D) Mamlis area

	Latitude	Longitude
Q	$^{43}45^{000}$	$^{5}22^{000}$
R	$^{43}42^{700}$	$^{5}22^{000}$
S	$^{43}42^{700}$	$^{5}24^{900}$
T	$^{43}45^{000}$	$^{5}24^{900}$

(on 1 : 25,000 scale map; ERZINCAN J42-c_1)

Total area: 5.8 km^2

(E) Sin area

	Latitude	Longitude
U	$^{43}38^{400}$	$^{5}36^{000}$
V	$^{43}38^{400}$	$^{5}35^{000}$
W	$^{43}38^{000}$	$^{5}34^{000}$
X	$^{43}37^{000}$	$^{5}33^{000}$
Y	$^{43}36^{000}$	$^{5}33^{000}$
Z	$^{43}36^{000}$	$^{5}35^{000}$
a	$^{43}38^{000}$	$^{5}36^{000}$

(on 1 : 25,000 scale map; ERZINCAN J42-c_1)

Total area: 5.1 km^2

1-4 Topographical maps

The following maps were used in the district during the survey.

1 : 500,000	ERZURUM (TRABZON)
1 : 25,000	ERZINCAN J42, J43
1 : 25,000	ERZINCAN J42-a_3; b_3, b_4, c_1, c_2, d_2 J43-a_4; d_2

1-5 Previous work

Tunceli area is one of the poorly explored areas of Turkey in terms of geology. Very few geologists have previously worked in this area. KRAEFF, A. (1964) worked in the Kört mine area and found outcrop of a Cu-Pb-Zn vein. AFSHAR, F.A. (1965) reported on the stratigraphy and geological structure in the Tunceli area.

Private Bilfer Cooperation did a limited geochemical survey covering Mamlis, Sin, and Silic area. Geochemical team of M.T.A. completed some limited geochemical prospecting different from Bilfer Co. in 1977. Photogeological map of the area, done by Turkish and Japanese photogeologists, was available for this work.

1-6 Acknowledgements

We wish to express our sincere gratitude to Dr. Sadrettin ALPAN, the former General Director of M.T.A. and to Prof. Dr. Nezihi CANITEZ, the present General Director of M.T.A. for their help, permission to use M.T.A. facilities.

We would like to thank Dr. Orhan ÖZKOÇAK, the Deputy Director of M.T.A., Mr. Recai KUTLU, the former Director of the Mineral Exploration Branch, Dr. Tandoğan ENGIN, Director of the Mineral Exploration Branch and other members of M.T.A. for their great help, and encouragements. Thanks go also to our workers for their continuous work.

Chapter 2 Geography, climate and traffic

The investigated area occupies the northwestern part of the Tunceli city. Topography with the exception of one or two plains, is very rugged. The Munzur river makes a wide enough Ovacık Basin from its source and runs through the investigated area a in the NW-SE direction and makes a quite deep V shaped valley. There are no other big rivers except some creeks.

Mt. Duzikbaba is the highest mountain of the area, reaching the height of 2,897 m. The other mountains are Mt. Pokir (2,422 m), Mt. Sarısaltık (2,286 m), Mt. Sincik (2,284 m), Mt. Hallac (2,044 m), Mt. Kıran (2,128 m) and Mt. Büyükkur (2,105 m).

Road conditions in the area are poor. Tunceli-Ovacık road (56 km), which runs along the Munzur valley, is in a good condition. Tunceli-Sin road and Hozat-Ovacık road are important. There are also some secondary roads which connect villages to each other.

Climatic conditions of the area resemble very much the continental climatic patterns, summer season is very hot (the average temperature; 35°C), winter season is very cold. Temperature suddenly falls down to about 10°C right after September and it is very difficult and even impossible to work in the field after 15th of October.

Vegetation of the area is fairly poor. Some scattered pine trees and oaks can be seen in the area. Rest of the vegetation consists of small trees and grass. Barren land occupies a wide stretches of land. Ovacık Basin is the most important plain in the district.

Population density is very low, about one person per square kilometer. Villages, located mainly near the river, have ten houses at the most. City of Tunceli, Ovacık, Hozat, and Sin are the major population centers of the district.

Tunceli is the biggest and most accessible city from the base camp. It is connected by a 150 km highway to Elazığ, where the nearest airport is. This highway is at the same time the only direct highway which connects the southern and northern parts of Turkey.

Chapter 3 Geology and mineral deposits

3-1 Outline of geology

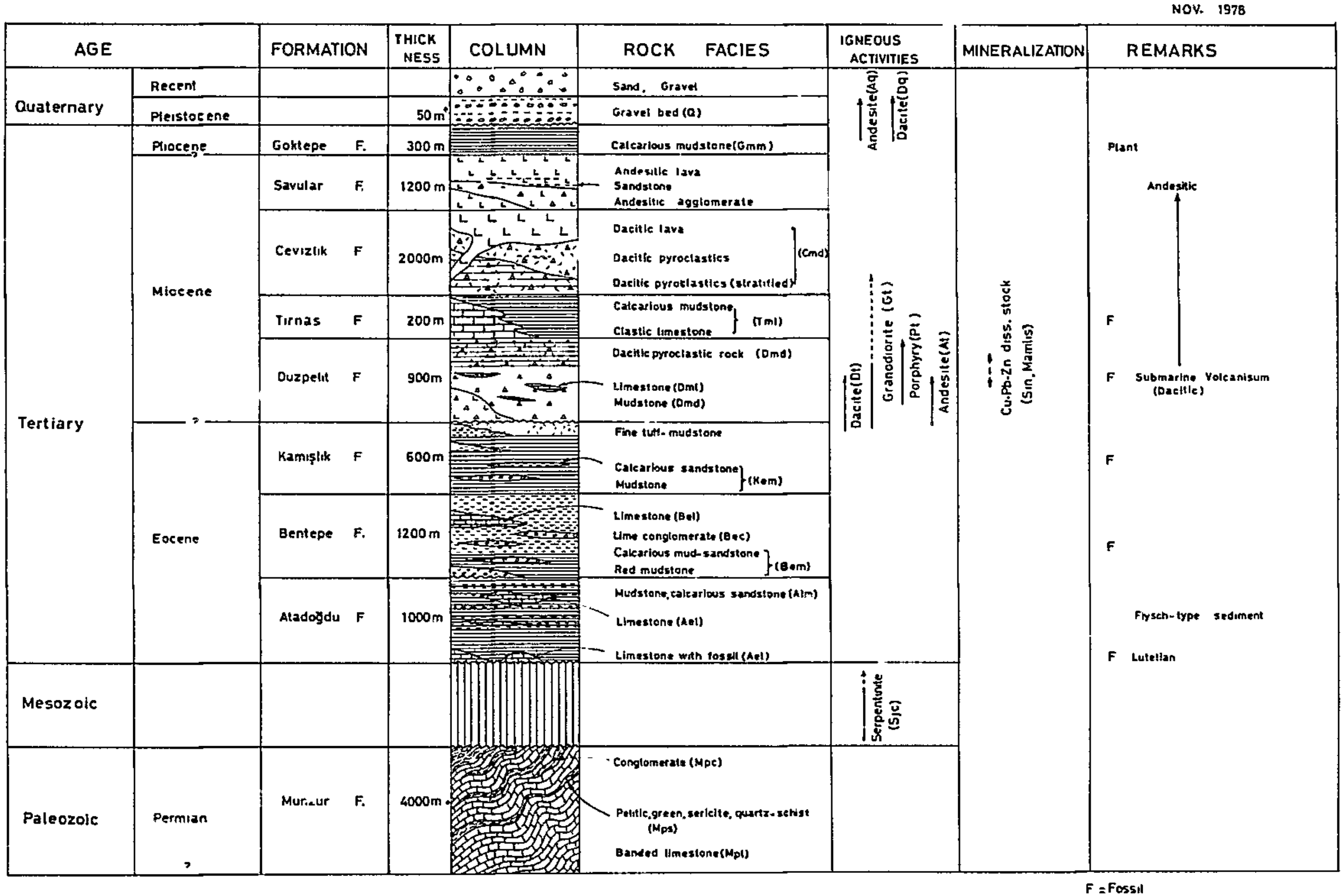
In the Tunceli area, the Munzur Paleozoic Formation is the lowermost formation, and the Eocene Series comprised of the Atadoğdu, the Bentepe and the Kamışlık Formations overlie the Paleozoic Formation unconformably. They are overlain by the Miocene Series, which is composed of the Düzpelit, the Tırnas, the Cevizlik, the Savular, and the Goktepe Formations deposited conformably on one another.

The Munzur Formation, the basement of this area, is considered to be correlated with the Permian System, and consists mainly of metamorphosed crystalline limestone, pelitic schist, and green schist, and is widespread along the Munzur river and to the east of it.

The Mesozoic Erathem is absent, and the Atadoğdu Formation comprised of the lowermost Eocene Series overlies the Munzur Paleozoic Formation unconformably. The sediment of the Atadoğdu, the Bentepe, and Kamışlık Formations indicate stable sedimentation, and appear to have been deposited in a deep marine environment control by the paleotopograph, which was influenced by structure of the Paleozoic Formation.

During the Miocene Series, early submarine volcanic activity resulted in the deposition of the Düzpelit Formation. The Tırnas Formation was formed during a pause in volcanic activity. The Cevizlik and the Savular Formations accumulated as a result of widespread repeated volcanic activity. After the termination of the volcanism the Göktepe Formation was deposited. Each formation is described as follows:

Fig. 3 Geological succession of the Tunceli area



3-1-1 Munzur Formation

Type locality: The road along Munzur river between the Siliç and the Zımayık hamlets.

Thickness: 4,000 m

The Munzur Formation forms the basement of the Tunceli area, and is widely distributed to the north of Tunceli city. The formation consists mainly of bluish-gray to black crystalline limestone, pelitic schist, greenschist, and conglomerate. Outcrops of the formation are divided into roughly five blocks, they are northwestern, the northern, the central, the eastern, and the southern blocks.

The northwestern block

This block crops out from the Yaylagunu to the Kandilli hamlets. The formation consists of crystalline limestone, pelitic schist, and greenschist. Pelitic schist is predominant in the southern part of the block and greenschist in the northern part, respectively. Crystalline limestone is bluish gray to black, and shows banded or massive structure.

Pelitic schist is dark green to grayish-black and greenschist is light green to dark green. In both schists schistosity, microfolding and segregation film of calcite are developed. Both pelitic schist and greenschist gradually grade into each other. Crystalline limestone occurs in schists, forming lenses. Massive green rock occurs near Mt. Görrek (1673). This rock is compact and dark green in color. Crystals of amphibole can be observed with a naked eye. The basic rocks of the Paleozoic era are metamorphosed. Distribution of the meta-basic rock is correlated with the eastern prolongation of greenschist zone.

The structure of the block is monoclinal, striking N60° - 70°E and dipping 30° - 40° north. The northern end of the block is in contact with basic to ultrabasic rocks (mainly - composed of serpentinite) along the Ösik fault.

The southern part is in contact with the strata of Neogene along the Yaylagünü fault.

The northern block

The block is composed of gray to bluish gray massive crystalline limestone, forming a steep mountains, Mt. Duzikbaba (2897), which is the highest mountain in the block. East of the Dumantepe hamlet, conglomerate occurs between the crystalline limestone and mudstone of the Paleogene. It is massive and compact, composed mainly of subangular or subrounded grains of black, gray, and red crystalline limestone.

The structure of the block couldn't be observed in detail owing to the massive nature of the limestone, but an anticlinal axis may be on the western slope of the Duzik dağı. The block was uplifted up by movement of the Duzik fault. In the northern block, the lower part of the Munzur Formation could be observed, judging from the rock facies.

The central block

The central block is the type locality of the Munzur Formation. It consist of black to bluish black banded crystalline limestone, gray massive crystalline limestone, pelitic schist, greenschist, and conglomerate. Limestone and schists are in units of 10 meters. Crystalline limestone is composed of calcite and shows compact texture. Undulose extinction of calcite crystals suggests metamorphic deformation. Pelitic schist is composed of albite, muscovite, chlorite, quartz, and biotite, and accompanied with calcite and hematite. Garnet couldn't be recognized. But these metamorphic rocks belong to epidote - amphibolite facies. The greenschist metamorphism is equivalent to a range from greenschist to epidote - amphibolite facies. The greenschist facies are composed of albite, chlorite, epidote actinolite, and calbite, and the epidote - amphibolite facies of hornblend, albite, and chlorite.

The Venk fault runs NE-SW and divides the block into the northern and southern parts. The structure of the northern part of the block consist of a gentle anticline the axis of which runs along the Munzur river and plunges to the north. From the lower to the upper part, the rock facies could be observed to vary from conglomerate, banded limestone, massive limestone, and banded limestone to conglomerate. The gravel of conglomerate is subangular, and consists of crystalline limestone, pelitic schist, and quartzite.

In the southern part, of the block, anticlinal structures lie along the Munzur river, the Avgasor, and the Laç valley, they plunge dip to the north. In this area banded limestone, massive limestone, pelitic schist, and greenschist could be observed, there is alternation of limestones and schists. Judging from the rock facies, the northern part of the block is equivalent to the upper part, and the southern part is the lower part of the Munzur Formation, respectively. At the southern most part of the block, it is in contact with the Bentepe Formation along the Balık fault.

The eastern block

The rock of the eastern block is distributed around Mt. Meydan (2,284 m). It consists of bluish black to gray banded crystalline limestone and pelitic schist. A part of this schist gradually changes into quartz-sericite schist or greenschist. The structure of the block is an anticline running along the Katran valley.

The southern block

Rocks of this block crop out in the southeast of the Babaocağı hamlet. They consist mainly of bluish banded crystalline limestone and pelitic schist. Along the western side of the Munzur river, a gentle anticlinal structure plunges to the south.

The most northern part of the block is in contact with the Atadoğdu Foundation along the Dolubaba fault.

Although fossils were not found in the Munzur formation during the geological survey, AFSHAR, T.A. (1965) discovered "Neoschwagerina carticulifera" in crystalline limestone, which crops about 20 km to the west of the Tunceli area. Based on this evidence, the Munzur Formation is correlated with the Permian System.

3-1-2 Atadoğdu Formation

Type locality : Around the Atadoğdu hamlet on the Büyük river.

Thickness : 1,000 m

The Agadoğdu Formation overlies the basement of the Munzur Paleozoic Formation unconformably. This formation is the lowermost formation of the Paleogene. It is overlain by the Bentepe Formation conformably. It is distributed around the blocks of the Paleozoic formation and in a wide belt along the Büyük river.

The formation consists mainly of mudstone, accompanied with sandstone and limestone. According to the rock facies, it is divided into three members : the lower member consists of limestone with fossils, the middle one consists of a clastic limestone, calcareous sandstone and mudstone, and the upper one is rhythmical alternation between calcareous mudstone and sandstone.

The lower member is characterized by limestone, sandstone, and mudstone containing Nummulities. Fossil bearing rocks occur here and there. Limestone containing Nummulites is brownish-black to bluish-black in color, massive, and compact. Weathering over long period results in splendid reliefs of Nummulites. The fossiliferous sandstones are composed of carbonates, quarts, and feldspar. The fossiliferous mudstone is vandyke brown in color and has good fissility.

	Point found fossil	Rock name	Sample number
1	1 km east of Güneykanak hamlet	limestone, mudstone sandstone	
2	2 km northeast of Mt. Pokir	mudstone	TWR 054
3	2 km west of Venk hamlet	limestone	TMR 275
4	2 km southwest of Mt. Pokir	limestone	
5	1.5 km southwest of Mt. Meydan	limestone	TMR 197
6	1 km north of Mt. Meydan	limestone, sandstone	
7	1 km east of Mt. Meydan	limestone, sandstone	
8	0.7 km north of Aşağibor hamlet	limestone, mudstone	
9	0.5 km south of Aşağibor hamlet	limestone	TSR 236
10	2.5 km southwest of Tülük hamlet	mudstone	TSR 217
11	1 km southwest of Babaocağı	mudstone	
12	1 km south of Sin hamlet	mudstone	TAR 038

The lower limestone in the Atadoğdu Formation overlies directly limestones of the Paleozoic Formation, but the former can be distinguished from the latter by the following features.

1 - Abundant Nummulites

2 - Non-crystalline and heterogeneous

3 - No banded structure

4 - Reddish brown in color

The middle member occurs in three areas, that is, from Mt. Meydan to the Çıralı hamlet, from the Zımayık hamlet to the Munzur river, and about 3 km to the south of the Tüllük hamlet. This member is characterized by non-fossiliferous clastic limestone, accompanied by alternations of calcareous mudstone and sandstone.

The upper member overlies the above-mentioned middle member, and is distributed widely along the Büyük river. It is formed by rhythmical alteration of mudstones and sandstones.

Distribution of the Atadoğdu Formation is influenced by the structure of the basement. The sediments of the formation are characterized by rhythmical alternation between calcareous mudstone and sandstone, except the lower member. Although the strata vary in strike and dip near intrusive rocks, they are stable around the type locality. This indicates that the facies of the formation are flysh type deposits.

Fossils of Lutetian were found in the Atadoğdu Formation as follows :

Sample number	Fossil	Period
TWR 054	Nummlites sp.	Lutetian
	Discocyclina sp.	
	Assilina sp	
	Operculina sp.	
	Rotaliidae	
TMR 275	Assilina spira (de Roissy)	Lutetian
	Assilina exponens (Sowerby)	
	Nummulites spp.	
	Discocyclina spp.	
	Aktinocyclina sp.	
	Gypsina sp.	
	Rotaliidae	
TMR 197	Nummulites sp.	Lutetian
	Assilina sp.	

	Discocyclina sp.	
	Rotaliidae	
TSR 236	Nummulites sp.	Lutetian
	Assilina sp. (iri formlar)	
	Sphaerogypsina sp.	
	Operculina sp.	
	Acervulinidae	
	Rotaliidae	
TSR 217	Nummulites sp.	They are not clean, but are assumed lower or middle Eocene.
TAR 038	Rotaliidae	

3-1-3 Bentepe Formation

Type locality : Along the car road between the Bentepe and Geyiksuyu hamlets

Thickness : 1,200 m

This formation is widely distributed throughout the investigated area. It overlies the Atadogdu Formation conformably and is overlain conformably by the Kamışlık Formation. This formation is composed mainly of alternation of conglomerate and sandstone, and partly calcareous mudstone and limestone. The fine sandstone of the lower part of this formation, generally characterized by red tinge, is called "Reddish sandstone" or "Reddish mudstone". The reddish parts are composed of mudstone, sandstone, and partly conglomerate.

Under the microscope, mudstone and fine sandstone are composed mainly of quartz, feldspar, calcite, muscovite, and chromite. The matrix consists of clay with micrite. The grains are almost round, partly sub-angular. Facies of this formation vary laterally, so that, the distribution of this formation is divided into the following portions :

(1) Bentepe portion lies in the southern part of the investigated area, extending from the east to the west.

(2) Center portion extends from Dikenlitarla hamlet northwards to Kort hamlet. It shows influence of the paleo-topography of the Paleozoic formation.

(3) Northern portion extends in a NE direction in the north of the survey area. It is composed mainly of limestone.

Bentepe portion

This area is the type locality of Bentepe Formation, and a continuous outcrop can be observed from the lower part of the Atadoğdu Formation to the upper part of the Kamışlık Formation. It has monoclinic structure dipping 5° - 10° to the south. In this area, it is composed mainly of coarse reddish sandstone overlying the Atadoğdu Formation conformably, and partly of conglomerate and reddish sandstone alternating with mudstone in the lower part. The middle part consists of calcareous mudstone, the upper part is composed of calcareous conglomerate and sandstone.

The top of the formation consists of calcareous mudstone with lamina of mudstone and sandstone. Calcareous mudstone is widely distributed in the area, but it is thin, about 5 - 10 m on the average. The sandstone contains gradually increasing amount of calcareous material from east to west, and is intercalated with limestone. The dip of the formation changes to 40° - 60° near Mirco tepe and Büyükcadde tepe, where the formation has been cut off by intrusion of the Çet Dacite.

There is anticlinal axis plunging at low angle around Yüceldi hamlet and the dip of the formation gradually changes to the north. In this area, the Kamışlık Formation is missing, and the Bentepe Formation is unconformably overlain by the

Düzpelit Formation.

Central portion

This portion is distributed around Karşılar, Siliç, Bakocağı and Tüllük hamlets. In the north, this formation directly overlies the Munzur Paleozoic Formation along the Balık fault, the Atadoğdu Formation is absent. In the central and western part in the Sin mah and Siliç hamlet, an alteration zone was formed under the influence of the Sin dacite. Althouth the Sin dacite and the Karşılar diorite extend to the west, for a distance of about 3 km, from İstiran hamlet to Bentepe area, alteration zone does not continue, due to the absence of the Bentepe Formation.

This formation is composed of conglomerate and sandstone. It is present only on the NE side of the İstiran fault, on the SW side it was probably eroded away, due to characteristic coarse grain size and thick bedding, which resemble the rock facies of the Bentepe area, it is easy to trace this formation. However, wide variation in dips and strikes of these rocks which is a result of the intrusion of dacite and quartz diorite, complicate the tracing. Calcareous mudstone is dominant around the Geriş tepe, forms hills here and there on the west side of Pagan hamlet. Floats of gypsum have been found west of Pagan hamlet, but outcrop has not been observed.

The Sin dacite is accompanied by alteration and silicification, pyritization and some mineral dissemination, and mudstone of Bentepe Formation near the Sin dacite is argillaceous and siliceous. The formation is overlain by the Düzpelit Formation, with the Kamışlık Formation missing, from Sin to Mehmet hamlet. Strong alteration to limonite gossan was observed around Mehmet hamlet.

Alteration and mineralization near this hamlet are considered to accompany the intrusion of Bulanık quartz diorite. The same is true for the alteration and mineralization around the Kört mine, and around the area from Aynalıpozvenk to Leşkan hamlet.

Northern portion

This formation lies around Sin, Dikenlitarla, Kört, and Ağaçpınar hamlets, following the outline of the Munzur Paleozoic Formation, and changes strike from NW to NE, and to NW again, dipping at 30° - 50° to the west.

Conglomerates are predominant in the lowest part of the formation, in the lower part reddish sandstone alternates with conglomerate and sandstone between the Sin and Kört hamlets. In the upper part alternation of calcareous sandstone and conglomerate is also found, but gradually sandstone becomes predominant. The Sin dacite is conspicuous around the Sin hamlet.

The formation is composed of clastic limestone and muddy limestone in the area from the Kört to Ağaçpınar hamlet and gradually changes from calcareous mudstone and limestone into clastic limestone and muddy limestone. Those limestones are thicker than those in the Bentepe area, and partially compacted, massive crystalline and pale brown in color. The lower part of clastic limestone and calcareous mudstone contains many fossils.

Gypsum deposits found around the Yukarıtorunoba, Ibrahim, and Kömleri hamlets and east of Gölçen tepe, occur in reddish sandstone, and are approximately 100 - 300 m in length and 30 - 50 m in width. The color is white to gray, and in general, they are banded and coarse grained. They occur in the form of small lenses.

This formation is intruded by the Miricik dacite from the Kört to Ağaçpınar hamlet, but no alteration was observed. In the north, this formation has contact with the Munzur Paleozoic Formation along the Yaylagünü fault.

The Bentepe Formation surrounds and partially covers the dome like structures of the Paleozoic Formation along the Munzur river and the Laç stream. It was removed by erosion on the south-west side of the İstiran fault. It reappears in Bentepe area and continues west, forming a south dipping monocline. The limestone of this formation is thick in the north, but thins southwards.

Alteration due to the intrusion of the Sin dacite are exposed near the Siliç and Sin hamlets. It is very difficult to identify the original rock around the Siliç hamlet, around the intrusive rock, it is white due to argillization (sericite, kaolinite). Limonite and weak pyrite dissemination are observed in the alteration zone.

The Bentepe Formation contains a very strong silicified zone and argillaceous zone around Sin mine, but pyrite dissemination is weak. The dacite is also partially altered, and forms a silicified and argillaceous zone. Because relicts of the texture of the original rocks are present in Sin area, it is easy to recognise the texture of sandstone and mudstone.

3-1-4 Kamışlık Formation

Type locality : Around Kamışlık hamlet in the south of the investigated area.

Thickness : 600 m

This formation is correlated with the upper Eocene, overlies the Bentepe Formation, and is overlain unconformably by the Düzpelit Formation. The formation is composed mainly of sandstone and mudstone, lower part is mudstone and upper part is calcareous sandstone and tuffaceous sandstone. This formation extends from the north of Dikenli hamlet to Çayüstü hamlets as a sinuous belt, following the outline of the dome like structures of the Munzur Paleozoic Formation along the Munzur river and Laç stream, south-west of the İstiran fault, it forms an east-west belt dipping gently to the south.

Type locality is around the Kamışlık hamlet in the southern area. This area is composed mainly of mudstone, which gradually changes from mudstone to tuffaceous mudstone westward. This formation changes strike to north-east, forms an anticlinal structure, and disappears near Mt. Bayır (1,854 m). Near Sacak hamlet, it is composed of alternation of sandstone and lapilli tuff. The mudstone is black or gray in color and has bedding.

The lower part of the formation shows alternation of conglomerate and mudstone in the south, but gradually changes to bedded mudstone forming the base of the formation in the north. The upper part of the formation is composed of mudstone and sandstone in the south, but in the north, it gradually changes to tuffaceous sandstone with intercalations of calcareous mudstone and sandstone. Fossils occur in sandstone and mudstone.

An alteration and mineralization zone was observed from Leşkan to Aynalıpozvenk hamlet and around the Bulanık quartz diorite in the north of Yenisögüt hamlet. It consists of white argillization, silicification, pyritization and malachite stains. Because there is some limonite, and magnetite floats were also found around this area, it should receive further alteration.

The Kört mine is located in this formation and the Bentepe Formation. The dacitic intrusive rocks occur around Mt. Miricik (1,927 m) and Mt. Dalık (1,740 m) in the north of Kört mine, but no alteration zone was observed in the rocks. In the north, the contact between this formation and the Munzur Paleozoic Formation runs along Yaylagünü fault.

3-1-5 Düzpelit Formation

Type locality : Around Düzpelit hamlet in the south of the investigated area

Thickness : 900 m

The Düzpelit Formation is developed in the mountain area from Mt. Kortan (1,321 m) to Mt. Sürübaba (2,182 m) in the central part of the investigated area, and extends to Mt. Gelin in the north, with a little change in rock facies. In the south part, this formation is developed widely on the west side of Duzpelit hamlet, which is mentioned above as a type locality. This formation is mainly composed of dacitic pyroclastic rocks which are partly intercalated with muddy-sandy sedimentary rocks and limestones.

This formation overlies the Kamışlık Formation unconformably, and is overlain by the Tırnas Formation conformably. On the north side of the Boztepe fault, the Duzpelit Formation is overlain by the Cevizlik Formation unconformably. Based on the distribution and the nature of rock facies, this formation can be divided into three areas, as follows, the southern part, the central part, and the northern part.

The southern part

The Düzpelit Formation is developed widely on the west side of Düzpelit hamlet. The area around this hamlet belongs to Büyük drainage system and is formed by comparatively flat topography, although there are mountains with flat summits and very steep slopes. From the south side to the west side of Düzpelit hamlet on the steep slopes, it's very easy to observe the nature of this formation and the conformable contact between the Düzpelit Formation and the Kamışlık Formation. The lower part of the formation consists of non-bedded dacitic tuff breccia - volcanic breccia, and is also accompanied by autobrecciated lava. The amount and the size of lithic fragments decrease gradually in upwards. Due to this vertical change, the Duzpelit Formation becomes intercalated with sandy beds, and sedimentary structures can be observed. Near the boundary between this formation and the Tırnas Formation, the sandy beds become predominant and constitute alternation of lapilli tuff and tuffaceous sand. Generally this formation strikes NW-SE and dips gently to the south.

The central part

The central part is located in the northern part of the uplifted belt which extends from SEE to NWW in the south of the investigated area. This uplifted belt has been intruded by intermediate to felsic igneous rocks called Karataş quartz diorite, Sin-dacite, and Çet dacite, etc.

In this area, the Atadoğdu Formation, the Bentepe Formation, and the Kamışlık Formation had been eroded out before these igneous rocks were intruded, and the Düzpelit Formation overlies the Atadoğdu Formation and the Bentepe Formation unconformably. Dacitic tuff breccia and lapilli tuff which the lower part of this formation is composed, are also the main constituents in this area, where they are intercalated with muddy tuff and show sedimentary structures. Autobrecciated dacite lavas, and limestone lenses also occur.

This formation was subjected to intense argillization and silicification, seems to have been subjected to mineralization and alteration related to the intrusion of the Sin dacite and the Bulanık quartz-diorite, in Sin area, Mamlis area, etc. The lower part of this formation develops widely in the central part, but shows unstable dip and strike due to the effect of the intrusive rocks.

Northern part

The upper part of the formation occurs from the north of Mamlis mine to the Gelin. The main constituent rocks in this area are composed of dacitic tuff breccia partly intercalated with limestone lenses, lapilli tuff, and tuffaceous sandstone, and often show clear sedimentary structures. The amount of sandy - muddy part increases near the Tırnas Formation. The Düzpelit Formation is pinched out on the north side of Mt. Gelin and overlies the Kamışlık Formation unconformably in the northeast area, where dacitic tuff breccia, characteristic of the lower part of the Düzpelit Formation, is present.

Fossils of the lower Miocene were found in the Düzpelit Formation as follows:

Sample number	TBR 011
Fossil	Miogypsina sp.
	Lepidocyclina sp.
	Amphistegina sp.
	Rotaliidae, Miliolidae, Textularidae
Sample number	TBR 057
Fossil	Lepidocyclina sp.
	Miogypsina sp.
	Gypsina sp.
	Amphistegina sp.
	Globigerina sp.
	Miliolidae, Bryozoa, Ostracoda

Rock facies

The Düzpelit Formation is composed mainly of dacitic pyroclastic rock which is pale grey to pale purple-grey in color. The matrix is greenish-grey to pale-grey in color and includes large amount of plagioclose (ø0.5 - 2 cm) and small amount of hornblende (ø0.3 - 1 cm), volcanic glass is rare.

Under microscope

The matrix is composed mainly of fragments of plagioclase, hornblende, and quartz. Sorting is very bad. The main constituents of fragments are greenish-grey dacite including large amount of plagioclase (ø0.3 - 1 cm), grey hornblende-dacite including hornblende and plagioclase, dark-grey glassy dacite and reddish-purple andesitic rock.

Generally, greenish-grey porpyritic dacite including large amount of plagioclase is considered to be essential. Fragment have characteristic distribution, reddish-purple andesitic rocks are observed commonly in the lower part rather than the upper part. From the above data indicate that, the Düzpelit Formation has the character of shallow submarine pyroclastic rocks, and the central area where the lower part is predominant, was the center of the volcanic activity. It is intercalated with sandy-muddy rocks towards the north and the south.

3-1-6 Tırnas Formation

Type locality : Around the south side of Mt. Tırnas (1,392 m) in the northwest of the investigated area.

Thickness : 200 m

This formation is situated between Mt. Tırnas and Reşo hamlet which are 10 km apart, in the northwest of the investigated area, and between Beyaz Dağ (2,102 m) at the edge of the southern part of the investigated area and Mt. Hızandağı

(2,102 m) at the edge of the southwestern part. Though the thickness is in the order of a few hundred meters, due to its continuity it can play the role of the key bed which clarifies geological structure.

The Tırnas Formation consists mainly of calcareous sedimentary rocks which include fossil shells and corals. In the area between Mt. Tırnas and Reşo hamlet, this formation is composed of limestone (containing shells) interbedded with calcareous mudstone, slaty calcareous mudstone and mudstone and alternation of clastic limestone, impure limestone and calcareous mudstone, and also with partly tuffaceous mudstone. Towards the east, the thickness of this formation decreases and the rock-facies gradually change to alternations of muddy limestone - clastic limestone, calcareous sand - mudstone, tuff, etc.

This formation is dislocated a little by a few faults between Mt. Tırnas and Reşo hamlet and it is pinched out by the Boztepe fault in the north of Reşo hamlet. Generally, the strike is EW - NE and dip 20 - 40° to the north. In the southwest area, this formation is located around a high elevation area which exceeds 2,000 m on the south side of Mt. Beyaz and forms table land inclined gently to the south.

This formation is also seen at the top of Mt. Sarısaltık (2,286 m) and Mt. Sivri (2,121 m) in the southwest area. In these areas, calcareous part is more abundant than in the northern area.

Generally, the lower part consists of clastic limestone and the upper part is composed of calcareous sandstone and mudstone. Large number of fossils (shells and corals) are found in the limestone. It strikes NW-SE and dips gently to the south.

Fossils of the Miocene were found in the Tırnas Formation as follows :

Sample number	TWR 058
Fossil	Heterostegina sp.
	Globigerina sp.
	Gypsina sp.
	Ataxophragmidae, Rotaliidae, Alg, Bryozoa
Sample number	TWR 084
Fossil	Gypsina sp.
	Miogypsina?
	Globigerina sp.
	Rotaliidae, Alg, Bryozoa,
Sample number	TAR 042 TAR 043
Fossil	Gavellinella sp.
	Rotaliidae, Miliolidae, Opthalimididae,
	Textularidae, Polipiye, Alg, Ostracoda,
	Bryozoa

From the geological evidence mentioned above, the environment of deposition seems to have been shallow sea; the north side of Reşo hamlet was above sea level.

3-1-7 Cevizlik Formation

Type locality : Along the Cevizlik creek south of Ovacık

Thickness : 2,000 m

The Cevizlik Formation is located on the north side of Mt. Tırnas in the north-west of the investigated area and extends from here to Çayüstü hamlet crossing the Munzur river in the north-east area. In the north-west area the formation overlies the Tırnas Formation conformably and is overlain by the Savular Formation.

In the east the formation overlies both the Düzpelit and the Kamışlık Formations unconformably north of the Boztepe fault and in the northeast the formation has a contact with the Munzur Formation along the Yaylagünü fault.

Based on the rock facies, the formation is divided into three parts; lower, middle, and upper part.

Lower part

The lower part extends from Dagyayla in the west end to Reşo hamlet and pinches out north of Reşo hamlet. This part consists of the same kind of pyroclastic rocks as the upper part of the Düzpelit Formation. This dacitic pyroclastic rock has greenish-gray ~ purple-grey color. Matrix is greenish grey, and includes large amount of plagioclase and small amount of hornblende.

The main constituents consist of fragments of purple-gray dacite with abundant plagioclase and dark-grey glassy dacite.

Middle part

The middle part crops out between Gol Mah hamlet north of Mt. Tırnas and the Çayüstü hamlet beyond the Munzur river. This part is composed of dacitic pyroclastic rocks which are more acidic than those in the lower part.

The pyroclastic rocks consist of tuff breccia and lapilli tuff, partly intercalated with tuff - muddy tuff. This matrix is pale-green ~ pale-purple grey and sometimes contains pale-green ~ white pumice. The main lithic fragments are white ~ pale-grey dacite and grey-glassy dacite.

Upper part

The upper part is located between Göl hamlet and the lower Cevizlik creek. Dacitic lava is predominant and is partly intercalated with lapilli tuff. This lava is considered to be of the same composition as the rocks in the middle part and is the composite rocks composed of intrusive part and lava part. The intrusive part in which, phenocrysts of plagioclase (1 - 5 mm, 5 - 10%), hornblende (1 - 3 mm, 1 - 10%) and quartz (2 - 3 mm, 1 - 5%) are observed, has well developed columnar joints. The lava part is aphyrtic and shows clear flow texture.

3-1-8 Savular Formation

Type locality : Around Savular hamlet

Thickness : 1,200 m

The Savular Formation is distributed from the Oveçler hamlet to Sorsivenk mine in the northwestern part of the survey area. It overlies the Cevizlik Formation conformably, and is overlain by the Göktepe Formation conformably. It is correlated with the upper formation of Miocene.

The formation consists mainly of porphyritic andesite lavas in which auto-brecciated texture is partly observed. There are occurrences of agglomerate in the south of the Savular hamlet, and of coarse to fine sand in the western part. Andesite is composed mostly of phenocrysts of plagioclase, quartz and magnetite were observed. It is characterized by the fact that phenocrysts of hornblende are locally predominant, and that andesite gradually changes to dacite in the western part, due to increasing number of quartz phenocrysts.

The structure of the formation is monoclinal dipping to the north. At the northern periphery, it is overlain by the Göktepe Formation and Quaternary sediments, and partly in contact with the Munzur Paleozoic Formation along the Yaylagünü fault. On the other hand there isn't a clear boundary between this formation and the Cevizlik Formation at the southern periphery. It is possible that the differentiation of andesite and dacite did not take place at that time.

3-1-9 Goktepe Formation

Type locality : Around Mt. Göktepe east of the Ovacık town.

Thickness : 300 m

The Goktepe Formation is distributed around Mt. Göktepe. Its range is very small, this is 3 km in the E-W and 1 km in the N-S direction. It overlies the Savular Formation conformably in the south, and it is in contact with the limestone and the calcareous mudstones of the Bentepe Formation along the Ösik fault in the north. The formation consists of calcareous mudstones, it is white or pale brown in color, and contains fossil plant.

The formation has monoclinal structure, striking E-W and dipping gently to the north. It may be correlated with the Pliocene, because it indicates submarine sedimentation, following volcanic activities.

3-1-10 Quarternary

Andesite

Andesite lavas are distributed from Mt. Belbaba (2,142 m) to Mt. Kantar (1,736 m) in the northwestern part of the investigated area, and overlie the Duzpelit Formation. Andesitic rocks are divided into a lava flow and autobrecciated lava or volcanic breccia, the former is predominant the east of Mt. Kantar, the latter is dominant around Mt. Barıkan (2,184 m). Lava is compact, dark brown in color, and develops joints. Autobrecciated parts are purplish gray to violet in color and are associated with a network and amygdales of limonite.

Dacite

Dacite lavas are distributed around Mt. Karakaya east of Çaytaşı hamlet. They are whitish gray, and composed dominantly of phenocrysts of plagioclase, biotite, and hornblende, and a matrix of quartz associated with magnetite. They have porphyritic texture.

The Tırnas Formation is intruded by dacite at Mt. Karakaya (2,100 m) and Mt. Kale (2,086 m), and lava flows overlie the gentle southern slopes of the Tırnas, and the Cevizlik Formation around the Çaytaşı hamlet.

Conglomerate

Conglomerate is distributed widely enough to form terrace deposits in the Ovacık area. It is assumed that conglomerate resulted from tektonic movement along a Yaylagünü fault.

Talus deposits are distributed locally in the following areas;

east of the Karşılar hamlet

Dedeağaç hamlet

east of the Tüllük hamlet

In the investigated area, with the exception of the above talus deposits conglomerate is considered to from the terrace deposits.

3-2 Outline of intrusive rocks

The intrusive rocks which are located in the investigated area, were intruded during the Miocene epoch, particularly along the uplifted zone which has a trend of NWW-SEE in the south of the investigated area. Dacitic intrusive rocks, partially including porphyry, are predominant. Though the main intrusive rocks are dacitic, quartz diorite - diorite stocks and a few porphyries, andesite dykes, which were intruded subsequently are also observed.

The facies of dacitic and dioritic rocks are different, according to the distribution, as follows ;

Dacitic rocks

Karataş dacite, Sin dacite, Çet dacite, Miricik dacite, Tüllük porphyry.

Dioritic rocks.

Karşılar quartz diorite, Bulanık quartz diorite, Dalören diorite, Pokir quartz diorite, Dirik quartz diorite.

Ultrabasic rocks are observed in the north of the investigated area.

3-2-1 Serpentinite

Serpentinite is distributed around the north side of Çolaklar hamlet in the north of the investigated area. It covers 5 km^2 in the above area, but this rock also extends widely to the north, covering an area of 200 km (in the east-west direction) by 30 km (in the north-south direction) on the Erzrum geological map (scale of 1/500,000) where this rock is described as an ophiolite of Jurasic-Cretaceous age.

This rock does not weather easily because of the presence of serpentine, and as a result the grass does not grow well on its surface, and the soil is reddish brown - brownish red. In the south from Anakomu hamlet to the Munzur river, serpentinite is in contact with the Munzur Formation along the Armutlu fault, and is overlain by the Bentepe Formation unconformably in the west of Ösik hamlet. Though this rock is almost serpentinized, gabbro and pyroxinite are partially observed in the float. A weak mineralization of chromite is known in this ophiolite.

3-2-2 Dacitic rocks

Karataş dacite

The rock is located between Seyhömerler mezraası (east of Sin hamlet) and the south side of Tüllük hamlet. The western part is a composite rock of brecciated lava and intrusive rock, the central part shows partly hypabyssal rock facies, and the eastern part consists of volcanics.

Rock facies :

Hand specimen

(1) Intrusive rocks (in the west and east of distribution area)

Pale greenish-grey to grey porphyritic rock

Hornblende : prismatic, ø 1 - 5 mm (partly ø 7 - 8 mm) 5 - 15%

Plagioclase : rectangular (partly prismatic) ø 1 - 5 mm, 20 - 30%

Ground mass : aphanitic, partly glassy.

Autobrecciated dacitic dykes which include less phenocryst than countryrock were also observed.

(2) Brecciated lava

Purple-grey fragments are monolithic and tuffbreccia size.

Matrix is homogeneous.

(3) Hypabyssal rocks (Central part)

Smoky-green porphyritic rock, almost holocrystalline,

Hornblende : prismatic 1 - 3 mm, 30 - 40%

Plagioclase : rectangular, partly prismatic, 1 -4 mm, 50 - 60%

Under microscope

(1), (2) Intrusive rocks and lava (in the west and east of distribution area,

Sample No. TAR 128. 131, TWR 190, TMR 210, TSR 215, TYR 042)

Texture : porphyritic

phenocrysts : euhedral

ground mass : intersertal texture

Phenocrysts : (ø 0.3 - 2.0 mm)

plagioclase, hornblende, quartz, augite

Ground mass : (0.02 - 0.1 mm)

plagioclase, quartz

(3) Hypabyssal rocks (Sample No. TMR 268, TSR 313)

Texture : porphyritic

phenocrysts : euhedral

ground mass : intersertal - granitic texture

Mineralization, Alteration

Hand specimen

In the eastern part and the western part, mineralization and alteration were not observed, however in the central part, chloritization, weak silicification, and pyritization were observed, especially around the marginal part.

Under microscope

(1), (2) Intrusive rock and lava

Plagioclase : partly replaced by calcite, epidote, and sericite

Hornblende : partly altered to chlorite and calcite

Generally, alteration is not strong, however it is stronger in the western part.

(3) Hypabyssal rocks (Central part)

Plagioclase : partly replaced by calcite

Hornblende : almost altered to chlorite and calcite

Alteration of hornblende seems to be stronger than in other areas.

Sin dacite

Sin dacite extends from the east side of Sepertek, through Sin, to Siliç hamlets. This dacite forms stock - dome like shape, cutting the Atadoğdu Formation, the Bentepe Formation and the Düzpelit Formation. It has sheet-like structure. Autobrecciated structure which is limited to a small portion dacite, is sometimes observed.

Rock facies :

Hand specimen

Pale green to greenish-gray porphyritic rock.

Hornblende : prismatic, ø 1 - 4 mm, 10 - 15%

Plagioclase : rectangular, ø 1 - 4 mm, 10 - 30%

quartz phenocrysts are not clear

Ground mass : aphanitic, partly glassy

Under microscope

Sample No. TAR 110, 112, 113. TSR 184, 185, 186, 200.

TWR 141, 143, TYR 156.

Texture : porphyritic

phenocrysts : euhedral

ground mass : intersertal - granitic texture

Phenocrysts : (0.3 - 3.4 mm)

plagioclase, hornblende, quartz.

Ground mass : (0.1 - 0.2 mm)

plagioclase, quartz, hornblende

Mineralization, Alteration

A large part of Sin dacite was subjected to alteration, intensity of which was varied, and which also altered the country rocks. The alteration is divided into four types as follows ;

Color	Alteration	Mineralization
Greenish gray	Silicification, chloritization	Pyrite dissemination,
Gray	Silicification	Pyrite dissemination, malachite stains
White	Silicification, argillization	Limonite stains
White	Argillization	Limonite stains

Generally, silicification and mineralization is observed especially in the marginal parts of the dacite intrusive body. Plagioclase is pervasively replaced by calcite and epidote, and sericite as altered a mineral is also observed.

Remark

In the Sin dacite which looks fresh, epidote and chlorite were found through detailed observation.

Çet dacite

Çet dacite is located between the west margin of the investigated area and Sepertek in the central part of the area. This intrusive rock forming stock - dome, cuts the Düzpelit Formation. Because autobrecciated parts are sometimes observed and the composition of this rock changes from dacite to andesite, Çet dacite is considered to be a composite rock, the activity of which continued for a long time.

Rock facies :

As the composition of this rock varies, it is possible to divide it into three rock facies as follows : dacitic rock, dacitic-andestic rock, and andestic rock.

Hand specimen

(1) Dacitic rock : Pale greenish-gray~ pale purple-gray porphyritic rock. Almost holocrystalline.

Hornblende : prismatic, partly rectangular, ø 1 - 5 mm, 25 - 30%

Plagioclase : rectangular, ø 1 - 4 mm, 40 - 60%

Hypocrystalline rock :

Hornblende : rectangular - prismatic ø 1 - 4 mm, 10 - 20%

Plagioclase : rectangular, partly prismatic ø 1 - 3 mm, 25 - 35%

Ground mass : aphanitic, microcrystalline like

(2) Dacitic - Andesitic rock : green - dark green, porphyritic rock

Hornblende : prismatic, ø 1 - 5 mm, 5 - 7%

Plagioclase : rectangular, ø 1 - 3 mm, 5 - 10%

Ground mass : glassy

(3) Andesitic rock : gray - dark gray, porphyritic, fluidal texture is observed.

Hornblende : prismatic, ø 1 - 2 mm, 5 - 10%

Plagioclase : rectangular - prismatic, ø 1 - 2 mm, 40 - 50%

Judging from the fluidal texture, this rock seems to have been close to extrusive condition.

Under microscope

(1) Dacitic rock (Sample No. TAR 052, TAR 099, TBR 040, TSR 132)

Texture : porphyritic texture

phenocrysts : euhedral

ground mass : intersertal - granitic texture

Phenocrysts : (0.3 - 3.1 mm)

plagioclase, hornblende, quartz, alkali feldspar.

Ground mass : plagioclase, quartz

(2) Dacitic - Andesitic rock (Sample No. TBR 054)

Texture : porphyritic texture

phenocrysts : euhedral

ground mass : intersertal texture

Phenocrysts : (0.3 - 3.1 mm)

plagioclase, hornblende

Ground mass : (0.05 - 0.3 mm)

plagioclase, quartz

The amount of quartz is small.

(3) Andesitic rock (Sample No. TBR 026)

Texture : pilotaxitic texture

Phenocryst : (0.3 - 2.0 mm)

plagioclase, augite, arthopyroxene

Ground mass : (0.05 - 0.2 mm)

plagioclase

Alteration, Mineralization

Hand specimen :

The marginal parts of Çet dacite intrusion are partly argillized and silicified

Under microscope :

(1) Dacitic rock : Plagioclase was subjected to strong saussuritization and was replaced by sericite and epidote. Hornblende is partly altered to chlorite and epidote. In the alkali feldspar, string perthite is altered to sericite.

(2) Dacitic - Andesitic rock : Plagioclase is replaced by calcite, epidote, and chlorite.

Hornblende is almost replaced by secondary quartz and sericite and partly includes calcite and chlorite.

Remark

The alteration is considered to have accompanied the intrusion of the dacitic rock and dacitic-andesitic rock. The time gap between dacite, dacitic-andesitic rock and andesitic rock intrusion seems to have been long.

Tüllük porphyry - porphyrite

This rock is widely scattered southeast and north of Tüllük hamlet. This rock whose composition varies from dacitic to andesitic, intrudes as a dome and dyke, cutting the Munzur Formation, the Atadoğdu Formation and the Bentepe Formation.

This rock shows different facies in the south part and in the north part, and andesitic rock is observed in the marginal part. Based on this geological evidence this rock is divided into three rock facies as follows : dacitic rock of the southern part, dacitic rock of the northern part, and andesitic rock.

Rock facies :

Dacitic rock of the southern part intrudes as a dome. This rock shows porphyritic texture in the central part and dacitic texture in the marginal part.

Hand specimen

(1) Dacitic part : Gray porphyritic texture

Hornblende : prismatic, ø 1 - 3 mm, 3 - 5%, part glomero-porphyritic.

Plagioclase : rectangular, ø 1 - 3 mm, 15 - 20%

Ground mass : aphanitic

(2) Andesitic rock : Dark brownish gray

Hornblende : prismatic, ø 1 - 8 mm, 3 - 5%

Plagioclase : rectangular, ø 1 - 2 mm, 5 - 10%

(3) Dacitic rock of the northern part

Dacite dome : grey - pale greenish grey, part glomeroporphyritic

Hornblende : prismatic, ø 1 - 10 mm, 30 - 35%

Plagioclase : rectangular, ø 1 - 14 mm, 30 - 35%

Ground mass : glassy - aphanitic

(4) Dacite dyke : greenish grey, glomeroporphyritic

Plagioclase : rectangular, ø 4 - 10 mm, 15 - 25%

Ground mass : glassy

Under microscope

(1) Southern part (porphyry rock, Sample No. TSR 220)

Texture : porphyritic texture

phenocrysts : euhedral

ground mass : granitic texture

Phenocrysts : (0.5 - 1.8 mm)

plagioclase, hornblende

Ground mass : (0.01 - 0.03 mm)

plagioclase, quartz

(2) Porphyrite (Sample No. TAR 138, TYR 071)

Texture : pilotaxitic - intersertal (ø 0.1 - 0.8 mm)

plagioclase, hornblende

(3) Northern part (Sample No. TAR 145, TMR 227)

Texture : porphyritic texture

phenocrysts : euhedral

ground mass : intersertal texture

Phenocrysts : (0.5 - 1.6 mm)

plagioclase, biotite, hornblende

Ground mass : (0.01 - 0.05 mm)

plagioclase, quartz

Alteration, Mineralization

Alteration is not visible to the naked eye.

Under microscope

(1) Southern part : Plagioclase is partly replaced by calcite and sericite.

Hornblende is almost completely altered to calcite and chlorite.

(2) Andesitic rock : Plagioclase is partly replaced by epidote and chlorite.

(3) Northern part : Plagioclase was sassuritized.

Hornblende is completely altered to clay minerals, calcite, and epidote.

Biotite is partly changed to vermiculite and chlorite, and also partly replaced by calcite.

Miricik dacite

This rock is located around Mt. Miricik. It forms a dome like intrusion cutting the Bentepe Formation, the Kamışlık Formation, and the Cevizlik Formation.

Rock facies :

Hand specimen

Pale brownish gray

Hornblende : prismatic, ø 1 - 2 mm, 10 - 15%

Plagioclase : rectangular, partly prismatic, ø 1 - 3 mm, 25 - 30%

Ground mass : aphanitic, microcrystalline-like

Remark

Hornblende is partly oxidized and shows reddish brown color.

3-2-3 Granodioritic rocks

Karşılar quartz diorite

This rock is distributed between Mt. Maden and Mt. Ahmet in the south part of the central area. This rock intruded as a dome, penetrating the Atadogdu Formation and the Bentepe Formation. The marginal part of this rock is chilled and the country rock shows effects of thermal metamorphism and argillization to depth of a few meters.

Rock facies :

Hand specimen

Pale greenish-gray, porphyritic rock

Hornblende :	prismatic, partly rectangular, ø 1 - 3 mm, 5 - 15%
Plagioclase :	rectangular, ø 1 - 3 mm, 25 - 35%
Ground mass :	aphanitic

Under microscope (Sample No. TYR 098)

Texture :	porphyritic
	phenocrysts : euhedral
	ground mass : granitic texture
Phenocrysts :	(0.8 - 1.8 mm)
	plagioclase, hornblende
Ground mass :	(0.02 - 0.05 mm)
	quartz, plagioclase

Alteration, Mineralization

Chlorite and epidote are partly observed as altered minerals.

Under microscope : Plagioclase was subjected to saussuritization and replaced by epidote and sericite. Hornblende was completely altered to chlorite.

Remark

Because geological evidence indicates that the country rock was not subjected to strong deformation and thermal effects, the emplacement of this rock does not seem to have been a violent event.

Bulanık quertz diorite

This rock is located between Mamlis area and Mt. Kula in the central area and Yenisöğüt hamlet in the north area. This rock intrudes dacitic pyroclastic rocks and dacitic intrusive rocks, and seems to form a batholith like mountain chain in the central area.

Rock facies :

Hand specimen

Two kinds of rock facies which show granitic texture and porphyritic texture, are observed.

(1) Granitic texture

Hornblende : ϕ 1 - 3 mm, 30 - 40% (felsic part, ϕ 1 - 3 mm, 5 - 10%)

Plagioclase : ϕ 1 - 3 mm, 60 - 70% (felsic part, ϕ 1 - 3 mm, 80 - 90%)

Biotite : ϕ 1 mm ± 1 - 5%

Quartz phenocrysts are present

(2) Porphyritic texture

Hornblende : prismatic ϕ 1 - 5 mm, 2 - 5%

Plagioclase : rectangular ϕ 1 - 5 mm, 20 - 30%

Ground mass : aphanitic

Under microscope (Sample No. TAR 098)

Texture : subhedral granular texture (0.2 - 2 mm)

plagioclase, alkali feldspar, hornblende, quartz, biotite, augite

Alteration, Mineralization

Alteration and mineralization are observed especially in the marginal parts of the intrusive body. The alteration is mainly argillization and silicification, and dissemination or veinlets of lead, zinc and copper are principal types of mineralization.

Under microscope : Hornblende is partly altered to chlorite. In the alkali feldspar, string perthite is altered to sericite. Biotite is partly changed to vermiculite. Small amount of augite is replaced by aggregations of tremolite.

Dalören diorite

Dalören diorite located around Mt. Sultanseyit (2,173 m) in the southwest area, has a dome structure, which intrudes the Düzpelit Formation and Tırnas Formation.

Rock facies :

Hand specimen

Dark-green equigranular rock.

Hornblende : partly ø 1 - 2 mm prismatic crystals are observed.

Plagioclase : ø 1 - 2 mm rectangular crystals are observed, but not common.

Under microscope (Sample No. TAR 045)

Texture : subhedral granular (ø 1 - 3 mm)

plagioclase, alkali feldspar, biotite, augite

Alteration, Mineralization

Biotite is partly changed to vermiculite and chlorite.

Pokir quartz diorite

This rock extends from the east side of Bulanık quartz diorite through Mt. Pokir to the east. It seems to be dome-like body intruding the Atadoğdu Formation.

Rock facies :

Hand specimen

Pale greenish gray - gray, holocrystalline, porphyritic.

Hornblende :	prismatic, ø 1 - 10 mm, 10 - 20%, the size of hornblende is variable.
Plagioclase :	rectangular, ø 1 - 3 mm, 40 - 50%
Ground mass :	aphanitic

Under microscope (Sample No. TMR 277)

Texture :	porphyritic
	phenocrysts : subhedral - euhedral
	ground mass : granitic texture
Phenocrysts :	(0.2 - 1.3 mm)
	plagioclase, hornblende, quartz (anhedral)
Ground mass :	(0.05 - 0.1 mm)
	quartz, plagioclase, hornblende

Alteration, Mineralization

Alteration is not observed on the hand specimen scale.

Under microscope : Plagioclase was subjected to saussuritization and replaced by epidote. Hornblende was partly altered to chlorite.

Remark

Most of the country rocks are not disturbed and some boundaries between the Pokir quartz diorite and the country rock show a weak thermal effect. This geological evidence shows that the Pokir quartz diorite intruded gradually into the Atadogdu Formation during a long time interval.

Dirik quartz diorite

This intrusive rock has a dome like shape, and intrudes dacitic pyroclastic rocks, which are located around Mt. Dirik in the southwest area.

Rock facies :

Hand specimen

Gray holocrystalline granitic

Hornblende : ø 1 mm, partly rectangular ø 1 - 2 mm included.

Plagioclase : ø 1 mm ±

Under microscope (Sample No. TMR 076)

Texture : subhedral granular (ø 0.03 - 0.8 mm)

Mineral : plagioclase, hornblende, quartz, biotite, augite.

Alteration, Mineralization

Not observed.

3-2-4 Porphyry

Most porphyritic rocks are located in the same area as the Çet dacite. These rocks, which are usually small scale, about 100 m in width, have N-S, NW-SE and NE-SW trends, and almost vertical dips, they intrude the Düzpelit Formation. These rocks show the same facies as the porphyritic part of the Çet dacite, which are dark gray - greenish gray in color and have noticeable phenocrysts of plagioclase and hornblende. Alteration was not observed.

This geological evidence indicates that the porphyry rocks are closely related to the Çet dacite. In the Mamlis area, small amount of porphyry rocks intruding Bulanık quartz, diorite and Düzpelit Formation were observed. These rocks, having conspicuous phenocrysts of plagioclase and green ground mass, extend NE-SW and dip almost vertically, and are called feldspar porphyry. The distribution area of this feldspar porphyry limited to the Mamlis area, is smaller than that of the porphyry rocks mentioned above.

In the area, 2 km west of Uzundal hamlet, porphyry rocks having N-S trend, were observed. These rocks have the same composition as the above-mentioned porphyry rocks around Çet hamlet.

3-2-5 Andesite dyke

Andesite dyke with nearly N-S trend and 100 m in width was observed on the west side of the Dalören diorite. This rock is dark-gray, compact, and intrudes the Düzpelit Formation. This rock is limited to the area around the Dalören diorite, and seems to be related to the Dalören diorite.

3-3 Geological structure

The basement of the Tunceli area is formed by the Munzur Paleozoic Formation, distributed widely along the Munzur river and throughout the eastern area. The metomorphic grade is equivalent to a low grade of epidote amphibolite facies, that is occurrence of biotite in pelitic schist, and epidote and common hornblende in green schist. It is assumed that the metamorphism may have been regional metamorphism, which took place after the deposition of the Munzur Paleozoic Formation, which is correlated with the Permian.

Prior to the Eocene epoch, the metamorphosed Munzur Paleozoic Formation was divided into blocks by faults resulting from tectonic movements. Five blocks crop out in the Tunceli area. The lower member of the formation is occurs in two areas : one of the two areas is located in the area between the Venk and the Balık faults and the other is north of the Duzik fault. Crystalline limestone is predominant in both areas.

In the Tunceli area, Mesozoic sediments were not observed except for serpentinite distributed in the north. The serpentinite forming ophiolite intruded at the later stage of the Alpine orogeny.

During the Eocene epoch Flysh-Type sediments were deposited and resulted in forming of the Atadoğdu, the Bentepe and the Kamışlık Formations.
The rock facies of these formations indicate the typical flysh sedimentation. The Atadoğdu Formation, composed of mainly calcareous mudstone, may represent the stable deep-sea sediments. The Bentepe Formation, formed by alternating conglomerate, limestone, and calcareous mudstone may be considered to be shallow sea sediments. The Kamışlık Formation may represent deep-sea sediments, but volcanic fragments have been observed in the upper part. The sediments of the Eocene Series assume undulated structure dipping to the south along the Büyük river and to the south of it. In the central and northern parts of the area, these sediments form a half-dome structure, surrounding the Paleozoic Formation. In the investigated area marine regression took place during the interval form the late Eocene to Miocene epochs. At that time, the area from the Kakbil hamlet to Mt. Karataş, was lifted up, forming the leading structure resulting from igneous activities in the Miocene. After extensive erosion, the Kakbil-Karataş lift zone was submerged and submarine volcanic activity took place. The Düzpelit Formation was formed by this activity.

At the Düzpelit stage, Sin dacite, Çet dacite and other dacites intruded along the Kakbil-Karataş lift zone, and granite rocks followed around the perimeter of the zone. The volcanic cycle was terminated by intrusion of porphyry. At the end of the stage, the area became a sedimentary environment. Mainly limestone and calcareous mudstone were deposited and formed the Tırnas Formation to the north and the south of the lift zone.

Submarine volcanic activities took place again at the Cevizlik stage. Violent activity resulted in deposition of dacitic pyroclastics of the Cevizlik Formation. Composition of pyroclastic rocks changed into andesitic one at the Savular stage. Both the Cevizlik and Savular Formations are distributed in the northern area.

3-4 Mineral deposits and alteration zone

3-4-1 Sin mine

The Sin mine is located at a distance of about 1 km, southeast of Sin hamlet, which is at a distance of about 20 km from Tunceli city. It takes about 1 hour by car from Tunceli city to Sin hamlet, and about 20 minutes to the mine on foot. The mine lies at a distance of about 200 m along a right branch of the Hasruk stream. There remain traces of an open pit (9 x 10 x 6 m) and a tank (6 x 1 x 1 m) for extracting cement copper, and some ore piled up near the Sin mine. It is said that the cement copper (150 t) was made by Mr. Asim Usta, who lived in Elazığ city in 1968.
The Sin mine is located at about 1,350 m above sea level. The highest hill, 1,436 m in the hight at northeast of mine, has comparatively steep topography.

The rocks of this area, consist mainly of the Atadoğdu Formation, Bentepe Formation and Düzpelit Formation. These formations are intruded by the Sin dacite, and this fact complicates the geology. The Sin dacite is distributed from the

Sepertek to Siliç hamlets with about 12 km east-westward extension (about 4 km wide). The silicification, argillization, and pyritization were observed in the neighborhood of the Sin dacite.

The alteration is especially strong around Sin and Siliç hamlets. Geochemical anomaly was found by Bilfer coorporation in the Sin area, and therefore soil samples were collected at an interval of 100 m and a detailed geological investigation on a scale of 1 : 2,000 was carried out in the Sin area.

The Sin dacite is characterized by phenocrysts of hornblende. Phenocrysts of plagioclase and hornblende and are replaced by epidote and sericite in some cases. The matrix consists of plagioclase and quartz, and is replaced by sericite, chlorite, epidote, and pyrite. Silicification is conspicuous in the Sin dacite.

The following mineralization occurs in the Sin decite: the disseminated zone was found to consist of pyrite, sphalerite, and bornite and to be accompanied by epidote and chlorite. The mineralization which was observed to occur along a shard zone of NEE or EW trend, contains disseminated Cu-Zn-pyrite ore. Malachite stains was often observed in the shard zone (E-W) of the Sin dacite near the Sin mine, and also a network of sphalerite, weak quartz veins, malachite, and secondary azurite were found in the strong silicification zone. The silicification zone extends from the Sin mine to Sin hamlet. It covers an area of about 500 by 300 m around the Sin mine, and changes to weak argillization and weak limonitization around the central hill midway to Sin hamlet, but becomes strong in the southwest of Mt. Nişan and Sin hamlet again.

The malachite stains are composed of two types, one occurs along joints and is weak, but the other forms a network and is conspicuous. The mineralization mentioned above is predominant between the Sin mine and Mt. Nişan. The another mineralization in this area, was found to occur in mudstone of the Atadoğdu Formation near the Sin dacite. It is a Cu-Zn-quartz vein with silicification. It is different from the Sin mine placed in the dacite.

The veins are strike N40°E and dip at 70° - 80° to the west. The width is less than 1 m, and so the mineralization is a small scale one. Though the alteration observed in the Sin area is white argillization, characterized by chlorite (and probably sericite), the mineralization is weak in the strong argillization zone, and predominant in the silicification zone.

3-4-2 Mamlis mine

Mamlis mine is situated in the west part of the investigated area, and is located about 5 km west of Mt. Sincik (2,384 m). It takes two hours to the Kakbil hamlet from Tunceli City by jeep, via Ovacık town, and one hour to the Çeper hamlet on foot. The mine is situated at about 1,300 m distance to the south of the Çeper hamlet. Mt. Haydar (2,028 m) and Mt. Sivri Kaya (2,017 m) form steep topography and the mine is surrounded by them. Ağtaş creek flows from west to east.

The rocks of Mamlis area are composed of dacitic pyroclastic rocks of the Düzpelit Formation and Bulanık quartz diorite intruded into the formation. Bulanık quartz diorite is distributed along the Ağtaş creek, along the Maden stream from the Çeper hamlet to Mt. Gözerek (1,930 m), and to the east of the Sorik stream. Dacitic pyroclastic rocks around the quartz diorite are strongly altered and it is difficult to clarify the original structures and textures. However, the pyroclastic rocks about 1.5 km to the north of the Çeper hamlet were not subjected to the alteration and generally have bedding dipping to the north.

Dacitic pyroclastic rocks in the area of 1 km (north-south) by 1.4 km (east-west) centering around Mt. Sivri Kaya, are remarkably altered, that is silicification, white argillization and limonitization (the last originated from sulfide minerals). Especially strongly silicified zones trend N-S on the northern slope of Mt. Sivri Kaya and in the eastern part of Mt. Haydar (along the upper part of the Gezik creek). The silicified zones range from 5 m to 10 m in width and are over 100 m in length. Topographically, these zones form protruded ridges.

To the north of the Ağtaş creek, pyroclastic rocks are altered and from a chloritized zone ranging 100 m to 400 m in width in the north to south direction. The textures of the original rocks are preserved clearly in the chloritized zone. The weakly altered zone also occurs about 1 km south of Mt. Haydar. The Mamlis altered zone forms a wide belt extending over 11 km in E-W and the altered area around the Garipuşağı hamlet corresponds to the eastern part of this zone. In the Mamlis area, some dykes of plagioclase porohyry occur their width ranges from 10 to 20 m, and they trend N40° - 60°E.

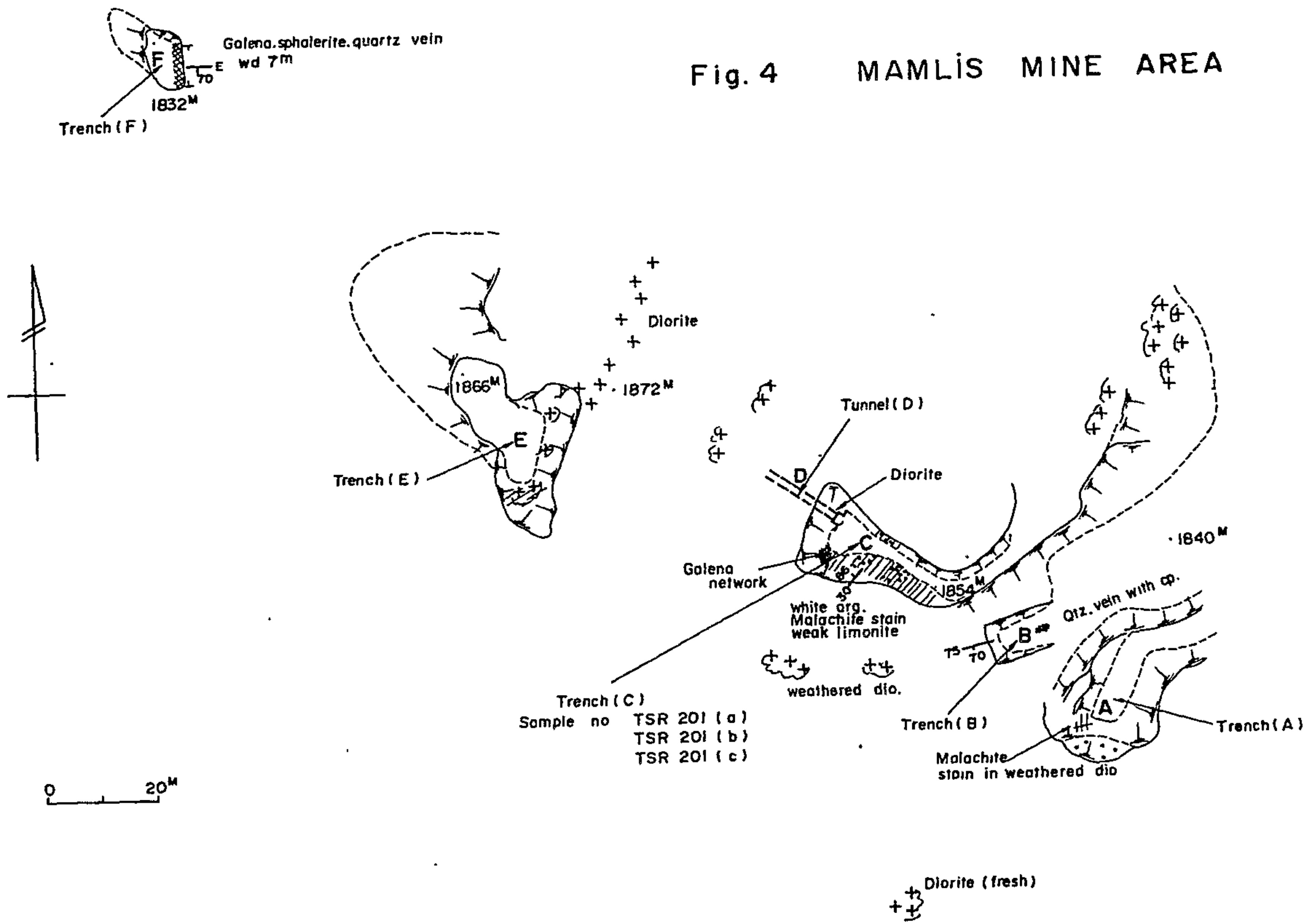
The Mamlis mine is situated about 1,850 m above sea level, along a branch of the Maden stream between Mt. Gözerek and Mt. Haydar, to the south of the Çeper hamlet. Wastes lie on the slope and slags were found here and there. It is said that the mine was operated for 10 years since 1964, and produced 10 - 100 tons of crude ore per month. It was sold via Tunceli city. During the most prosperous period 150 miners worked in the mine.

Main mine trenches are as follows :

Trench (A) ; 15 x 3 x 6 m. Secondary copper ore occurs in weathered quartz diorite.

Trench (B) ; 10 x 3 x 1 m. Chalcopyrite, sphalerite, and quartz vein

Fig. 4 MAMLİS MINE AREA



striking N75°E, dipping 70°S, and 15 cm in width. Secondary copper ore occurs in quartz diorite.

Trench (C) ; 25 x 4 x 3 m. Quartz diorite associated with oxide copper ore. Strong sericitization with galena and quartz vein. Main quartz vein strikes toward N30°E and occurs as a network.

Tunnel (D) ; 15 m? unknown in detail.

Trench (E) ; 30 x 10 x 6 m. Weathered quartz diorite altered to argillaceous zone and limonite accompanied by secondary copper ore.

Trench (F) ; 7 x 3 x 3 m. Galena and quartz vein in quartz diorite, striking E-W and dipping 70°S.

The mineralization is composed of vein and stockwork type, the former is a chalcopyrite-quartz vein, the latter is a stockwork with galena and sphalerite around the peripheries of quartz diorite intrusions. Quartz diorite associated with mineralization is altered into a prominent argillaceous zone and has whitish color. However, because the altered zone is very narrow, large part of quartz diorite is not altered.

Mineralization is found not only in Mamlis mine, but also in a wide area from the east to the northeast of the mine. Numerous limonite-quartz veins were observed in a region from the north side of Mt. Haydar to the branches of the Gezik creek.

They occur in white argillaceous quartz diorite, and strike mainly N30°W and dip 80°E. Maximum width is 1 m and the lengths of outcrops range from 30 m to 60 m. Five or six outcrops of gossan containing much limonite were found on the western and the eastern ridges of Mt. Haydar, and on the eastern ridge of the Peak

1,947 m. These gossan strike N60° - 80°E and are about 10 m in width. Gossans are predominant in limonite, in the strongly silicified zones of both Mt. Sivri Kaya and the Peak 1,947 m.

Floats of silicified rock containing sphalerite were found along the Gezik creek, and in this region geochemical anomalies were obtained by the Bilfer Co. from stream sediments, with Zn as the indicator element.

Weak mineralization was observed near the boundaries between the pyroclastic rocks and quartz diorite about 200 m to the north of the Çeper hamlet. It is formed by a quartz network, striking N40° - 50°E associated with sphalerite and malachite stain.

Consequently, two types of mineralization are recognized in the Mamlis area. One is zinc and copper (and lead) vein type mineralization in or around quartz diorite, and the other is zinc and copper (and lead) stockwork mineralization in dacitic pyroclastic rocks. The former is observed in outcrops, but is small in comparison with the alteration zone.

It occurs along the peripheries and the weak zones of the stocks of quartz diorite. Some veins of this type were also found in the Mamlis hamlet and about 1 km southeast of the Varsekli hamlet. They occur in quartz diorite striking N-S.

The latter are completely altered into limonite in the Mamlis area due to strong oxidation. It is assumed that oxide minerals change into primary minerals with increasing depth, because floats containing sulfide minerals (sphalerite etc.) were found in the Gezik creek.

It is considered that the Bulanık quartz diorite lies deeply under the east slopes of both Mt. Sivri Kaya and Mt. Haydar, where ore bodies may be buried. The presence of large quantitties of gossans suggests that large scale orebodies may be found by further prospecting.

3-4-3 Kört mine

Kört mine is located about 700 m southeast of Kört hamlet, which lies at about 1,300 - 1,350 m above sea level. There are two galleries in Kört mine.

One (we call it No. 1 gallery provisionally) is about 200 m southwest of Mt. Nişan (1,397 m) and its elevation is 1,350 m. The other (No. 2 gallery) is about 100 m to the west from No. 1 gallery, elevation of which is 1,300 m. This mine was explored in late 1960's, and No. 1 gallery is connected with No. 2 gallery underground. The ores which were produced are stocked around No. 1 and No. 2 galleries, and also around the suspension bridge across the Munzur river at the foot of Mt. Değirmen. Total ores produced are estimated at over 300 tons. The country rocks are composed of silicious conglomerate of the Bentepe Formation and tuffaceous mudstone of the Kamışlık Formation.

Ore bodies are composed of quartz veins accompanied Cu-Pb-Zn minerals. Ore minerals are sphalerite, bornite, and chalcopyrite, secondary azurite and chrysocolla were also observed. It is assumed that an outcrop had been discovered and excavated, forming No. 1 gallery, No. 2 gallery was excavated later and connected to gallery No. 1. Now it is impossible to enter these galleries. Secondary copper minerals accompanying quartz-pyrite vein and malachite stain in the altered country rock, were observed at an outcrop near No. 1 gallery.

The ores which are stocked, are mostly secondary minerals and only small amounts of primary minerals (chalcopyrite and sphalerite) were found. This is considered to indicate that the prospecting was located in the oxide zone of ore bodies. The country rocks are almost brecciated, and mineralization and alteration is developed along shear zones. Judging from this geological evidence, Kört mine seems to be a small scale vein type ore deposit composed mainly of copper minerals.

The Kamışlık Formation along the Bulanık quartz diorite in the southe of Kort mine was subjected to strong alteration, and in this area, many floats of stained malachite and magnetite which are also observed at Yayla creek, were found. The area extending from Aynalıpozvenk to Leşkan hamlet is also strongly altered.

In this area, the geochemical exploration of Bilfer company was done, and its results show a Zn-Cu anomaly around this area. The alterations and mineralizations mentioned above are considered to have accompanied the intrusion of the Bulanık quartz diorite.

3-4-4 Sorsivenk mine

The Sorsivenk mine is located about 300 m northeast of Sorsivenk hamlet, in the northwestern part of the investigated area.

The ore is a barite-calcite-quartz vein with azurite and malachite.

This vein occurs in a calcareous siliceous rock.

Calcareous rock is of the Paleozoic Formation.

The vein is thin and was observed in the hanging wall of a colapsed gellery. The Munzur Formation in this area is composed of whitish green, banded limestone, pelitic schist, and massive green schist. It is exposed along the Munzur river. The Savular Formation composed of mainly porphyritic andesite, overlies Munzur Paleozoic Fromation south and east of Sorsivenk hamlet. There is an acidic dyke of about N80°E near the suspension bridge across the Munzur river in the east of Sorsivenk hamlet. This acidic dyke intruded the Savular Formation and the Cevizlik Formation. It is partially altered and silicified and contains weak pyritization. The Sorsivenk ore is considered to be related to the intrusion of the acidic dyke.

The dacite is distributed in the southeast of Sorsivenk hamlet; it intrudes the Cevizlik Formation, but it is fresh and no alteration was observed. It is said that there is some mineralization south of the hamlet and near the adit of the mine, but they were not found during the investigation.

The Sorsivenk ore body is of the vein type, and is related to acidic volcanic rocks. It is not important because alteration is too weak and the scale of mineralization too small.

3-4-5 Maden tepe mine

The old adit is situated about 1.3 km to the north-northeast of the Karşılar hamlet, and about 400 m to the southeast of Mt. Maden which is 1,640 meters above sea level. The rocks around the mine area are composed of green schist and crystalline limestone. Green schist has gentle folds, striking N30°E, and dipping 10° to the west. Crystalline limestone is banded bluish black in color.

A open pit was found, it is 10 m x 15 m, and is filled with slag and waste. There is a waste dump 5 m in height. Ore body occurs along the boundary between crystalline limestone and green schist, where the former corresponds to a foot wall and the latter to a hanging wall.

Gossan which crops out is compact and massive, and composed of limestone and hematite. The skarn minerals of diopside and epidote form the gangue. Magnetite and sulfide minerals of lead and zinc were not observed with a naked eye. The mine had been operated to produce iron, but nobody knows about this mine in detail.

Karşılar quartz diorite intrudes into the Atadoğdu Formation about 400 m to the west of the mine, and is partly altered into chloritized zone and pyrite dissemination. The ore body is assumed to be an iron deposit of skarn type which replaced crystalline limestone and green schist of the Munzur Paleozoic Formation, as a result of the intrusion of acidic igneous rock. Judging from the fact that skarn minerals occur only around the ore body and that the structure of the Paleozoic Formation is stable, the ore body may not be large and may be a pocket-like concentration. It is considered that the ore deposit may have formed during the Miocene epoch, provided that the intrusion of Karşılar quartz diorite is related to the formation of the ore deposit.

3-4-6 Venk mine

The Venk mine, which is situated 500 m southwest of the Venk hamlet, is located at 1,450 m above sea level.

The ore body occurs in pelitic schist intercalated with green schist. The structure of schist strikes N50°W and dips 30° to the north. Wastes were found here and there around the mine. A prospecting tunnel of 2 m x 7 m x 2 m, along the strike remains.

Ore is porous and massive. Limonite, hydrous iron and quartz were observed with naked eye. They form shell structures. Galena (0.5 x 1 cm) is rare and fragments of schist are sometimes found in the ore, and are altered to brownish clay minerals.

Igneous rocks, presumed to be related to the mineralization, were not found around the mine. Though Pokir quartz diorite crops out about 2 km to the west, doesn't show alterations.

The Munzur Paleozoic Formation is steadily stable and gossan doesn't occur except around the mine. It is considered that the ore deposit may be an ore pocket resulting from small dykes of igneous rock intruded into the Paleozoic Formation, the formation of the ore deposit took place during the Miocene epoch.

3-4-7 Garipuşağı mineralized zone

The Garipuşağı hamlet where this mineralized area occurs, is situated about 3 km to the northeast of the Mamlis mineralized area. In this area, it consists of dacitic pyroclastic rocks of the Düzpelit Formation. The pyroclastic rocks are predominantly composed of plagioclase and hornblende crystals. Matrix is microcrystalline and pale purple to pale greenish gray. It is compact and massive, and the stratified structure has not been observed in the neighbourhood of the hamlet. At 1 km both to the north and the west of the hamlet, obvious sedimentary structure, striking 30° to the west, was recognized.

Bulanık quartz diorite crops out 1 km to the south of the Garipuşağı hamlet, and intrudes into the Düzpelit Formation.

An alteration zone, which is about 2.5 km wide in the E-W direction and 1 km in the N-S direction is distributed from about 300 m to the west of the hamlet, to the east of Mt. Büyüktepeler. The alteration is mainly comprised of white argillization accompanied by silicification and chloritization. Generally, the alteration is so weak that unaltered pyroclastic rocks remain. Some of solfataric alterations were observed along the Garip creek.

Mineralization may be classified into four types, that is,

(1) fissure filling type hematite ore

(2) disseminated zinc and hematite ore

(3) banded magnetite ore (float)

(4) network zinc ore

Type (1) is formed by micaceous hematite (specularite) along fissures in wall rocks near a solfataric alteration 100 m west of the hamlet, the texture of the wall rocks (dacitic pyroclastic rocks) remains and shows effects of silicification and chloritization. Trends of fissures filled with hematite are irregular.

Type (2) was formed in white argillaceous zone, 1 m in width, at a distance of 30 m from the solfataric alteration. It is composed of disseminated sphalerite and hematite, in patches of at maximum 5 mm. Wall rocks are slightly porous.

Type (3) is a float on the slope, 200 m north of the hamelt. It has a banded form and is composed of magnetite and some galena. It is considered to be skarn ore because of the formation of diopside, hedenbergite and pink garnet. No outcrops were found.

Type (4) was found on the ridge between the Garipuşağı and the Varsekli hamlet. Wall rock was subjected to white argillization and silicification and is slightly porous. The region between this ridge and the southern mountains composed of quartz diorite, is occupied by farms. At the farms, white argillaceous and silicified gossans have been found in large quantities.

It is a most noticeable that the alterations are similar to Mamlis mineralized area.

3-4-8 Siliç alteration zone

The alteration developing around Siliç hamlet area is accompanied by the Sin dacite. This alteration zone is mainly composed of white argillized part (may be sericite) containing weak pyrite dissemination. The earth surface around this area is pained reddish brown according due to oxidation of pyrite. This alteration zone is not large and is limited only to the Sin dacite and the country rock (calcareous mudstone of the Bentepe Formation).

Fortunately a new car road connecting Siliç hamlet with the main road along the Munzur river, was finished at the time of the survey. Through detailed observation of this new outcrop, it became to clear that the intensity of alteration and mineralization decreases abruptly with depth.

The mineralization which could be seen with naked eyes was only weak pyrite dissemination in the Sin dacite and the country rock. Judging from the above-mentioned geological evidence the Siliç area was considerably eroded out.

A Cu-Zn-Mo anomaly was found by Bilfer Company. However, due to the reason mentioned above, a detailed investigation was not undertaken, and this area is considered to have low potential.

3-4-9 Mehmet alteration zone

The alteration was observed around Mehmet hamlet, which is located in the center of the investigated area. The alteration area is narrow. The north side is limited by the Bulanık quartz diorite and the south side is also limited by the unaltered Düzpelit Formation. The country rock is the Bentepe Formation composed of calcareous mudstone, limestones, etc.

At Çirtik creek located north of Mehmet hamlet, quartz diorite float which is rich in quartz-tourmaline and includes a few sulfide minerals (silver mineral? Sample No. TAR 097B) was observed. This alteration zone looks similar to the zones which extend from Kört mine to Leşkan hamlet and also extend from Kört mine southward. Both of them occur around the Bulanık quartz diorite.

Chapter 4 Geochemical survey

4-1 Collection and treatment of samples

Geochemical survey of stream sediments in phase two was performed in an area which covered 220 km^2 and detailed geochemical survey of soil in an area of 115 km^2. Because porphyry copper type ore deposits were expected in this area, and then copper, lead, zinc and molybdenum were chosen as indicator elements.

The collected samples consisted of 244 samples of stream sediments and 1561 samples of soil. Stream sediments were collected at a dencity of one sample per 1 km2, and 8 soil samples were collected per 1 km^2.

As a result, many geochemical anomaly areas were found and they revealed that the relation between the mineralization - alteration zone and geochemical anomaly areas are extremely close.

Samples for geochemical survey were collected on the route of geological field survey. Most soil samples were collected by the prospectors of MTA who also took small rock chips at the collection point and recorded rock name on a topography map on a scale of 1 : 10,000.

The samples were collected from most main streams in the surveyed area at a density of one sample per square kilometer, but in case of inaccessibility, due to steep cliffs of Paleozoic limestone, they were collected from adjacent locations, and therefore the density of samples is not constant. Geochemical data collected by Bilfer Co., were added to data obtained in this survey.

Soil samples were collected by ridge and spur method. They were collected at constant intervals, whenever possible, aiming to attain sample density of 8/km^2. In the strong alteration areas of Mamlis, Sin and Siliç, samples were taken at

100 m intervals over $30/km^2$, in order to cover the ore deposit or mineralized zone in detail. The samples were sieved through 80 mesh in the field, except in case of wet stream sediments.

Topographical maps on 1 : 25,000 scale were used for positioning of stream sediment samples and drainage maps on the same scale were prepared for the final plotting of sample locations. Topographical maps on 1 : 10,000 scale were used for positioning of soil samples.

4-2 Chemical analysis

Crushing and chemical analysis of the samples were performed at the Diyarbakır branch of MTA. Samples were analyzed for Cu, Pb, Zn and Mo using atomic absorption spectroscopic method. Because the method of sample treatment and apparatus for analysis are the same as those used up to now, they are not going to be described here. Results of chemical analysis are shown in appendix 3, 4.

4-3 Treatment of geochemical data

4-3-1 Stream sediments

In evaluation of data obtained by analysis of unit anomaly areas which were selected by four indicator elements, geological conditions of drainage basins were taken into consideration.

4-3-2 Soil samples

Because the soil in this surveyed area is not a humus soil, soil samples of the area are considered to indicate the composition of the weathered parent material. In the treatment of data obtained by analysis, it is necessary to define the back ground value. Therefore the geochemical data were classified into five groups as follows :

a. Granitic rocks (Bulanık quartz diorite, Karşılar quartz diorite)

b. Dacite (Karataş dacite, Sin dacite, Çet dacite)

c. Düzupelit series (pyroclastic rocks, mudstone, limestone)

d. Kamışrık - Atadoğdu series (conglomerate, mudstone, limestone)

e. Munzur Paloeozoic Formation (conglomerate, mudstone, limestone)

Anomaly maps of the geochemical prospect were compiled, based on the above-mentioned lithofacies classification (PL. 23, 24, 25). The granitic rocks consists of Bulanık quartz diorite and Karşılar quartz diorite. Anomaly in the Bulanık quartz diorite is higher than that in the Karşılar quartz diorite (Fig. 15). This evidence coincides with the present state of alteration in the field. Although the background of Karşılar quartz diorite has low value, anomalies are indicated in or around quartz diorite (Fig. 8). Karataş dacite is distinguished from Sin Dacite and Çet Dacite (Fig. 7), by it comparatively low background.

Field investigation showed that Karataş dacite is not altered, and its anomaly area is small and the value of the anomaly is lower than that of Sin dacite and Çet dacite. Tüllük porphyry and Miricik dacite are also not altered and analysed value is low, but there is an anomaly area located in and around Karataş dacite (Fig. 16). The division of lithofacies into pyroclastic rocks, sedimentary rocks, and intrusive rocks in the unit of stratigraphic classification in the Miocene, Eocene and Permian, are necessary for analysis of data. Anomalies of each geological unit are shown in Fig. 17, 18, 19.

4-4 Statistical treatment

The statistical treatment of geochemical data followed the method of LEPELTIER C. (1969). Data on the four indicator elements from the stream sediments and the five units of soil samples mentioned above were treated statistically. Cumulative frequency distribution for copper, lead, zinc, and molybdenum in each geological unit are shown in Fig. 12 - 18. Dispersion patterns which were obtained from the diagrams are shown in Table 1, background, deviation, and threshold value in Table 2, and coefficient of correlation of the four elements in Table 3.

4-4-1 Stream sediments

Dispersion (Frequency distribution)

(1) The frequency distribution curve of the four elements shows negative skewness (excess of low value).

(2) The value of standard deviation is low for copper, lead and zinc, but for molybdenum unit is very large.

Correlation

Correlation between the four indicator elements is shown in Table 3, correlation chart in Fig. 12. The coefficient of correlation between copper and zinc is large. Copper and lead, lead and zinc are shown positive, but other are given the negative. They are no correlation.

4-4-2 Soil samples

Dispersion (Frequency distribution)

"Cu"

(1) The frequency distribution curve of copper is generally positivery

skewed (excess of high value). The dispersion pattern of dacites, the Eocene Series, and the Munzur Paleozoic Formation show binomial distribution of values.

(2) Standard deviation is generally high, due mainly to the presence of the low value Munzur Formation.

"Pb"

(1) The frequency distribution curve of lead shows mainly binomial distribution. The Eocene Series and porphyry group are almost lognormal.

(2) Standard deviation is low for the dacite. It is high for the Miocene Series.

"Zn"

(1) Zinc shows binomial frequency distribution, the dispersion pattern of zinc is shown almost lognormal.

(2) Standard deviation is small for the porphyry. It is moderate for the other groups.

"Mo"

(1) The number of soil samples, molybdenum content of which is lower than the determined limit, is very large, therefore the reliability of the pattern is less than for other elements.

(2) The frequency distribution curve is negatively skewed.

(3) Standard deviation is always large.

Corrleation

Correlation between the four indicator elements for each geological unit are shown in Table 3, correlation chart in Fig. 13. As shown in Table 3, the coefficient of correlation between copper and lead, copper and zinc, and lead and zinc is positive in each geological unit except for porphyry. It is particularly large for quartz diorite.

Correlation between copper and molybdenum of quartz diorite and porphyry is large. But in other groups there is no correlation. There is no correlation between lead and molybdenum, zinc and molybdenum. In this case, the lack of correlation between molybdenum and other elements is due to extremely low contents of molybdenum, because most soil samples contained less molybdenum than the limit of determination.

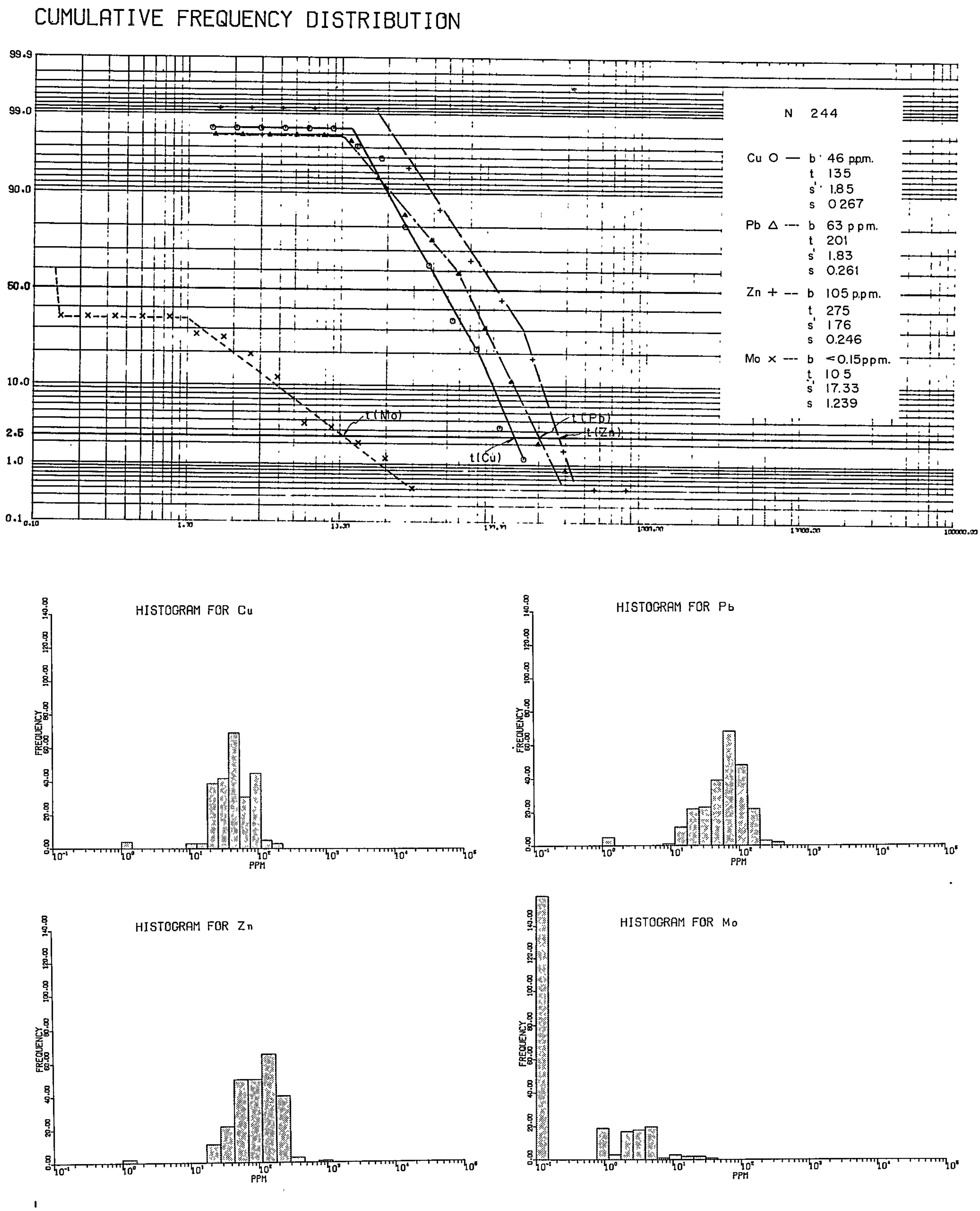
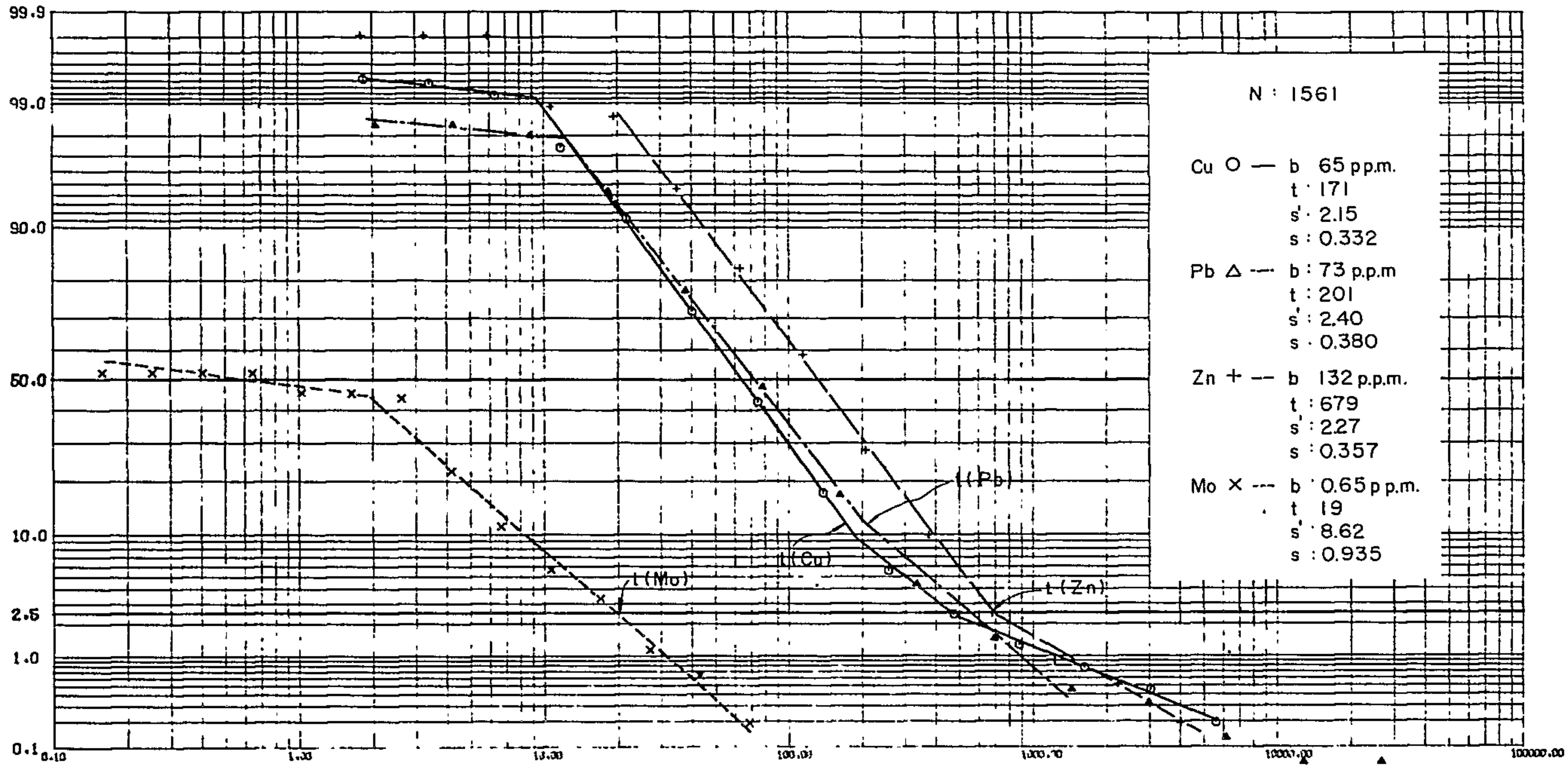


Fig. 5 Cumulative frequency distribution and histogram for the stream sediment samples

CUMULATIVE FREQUENCY DISTRIBUTION



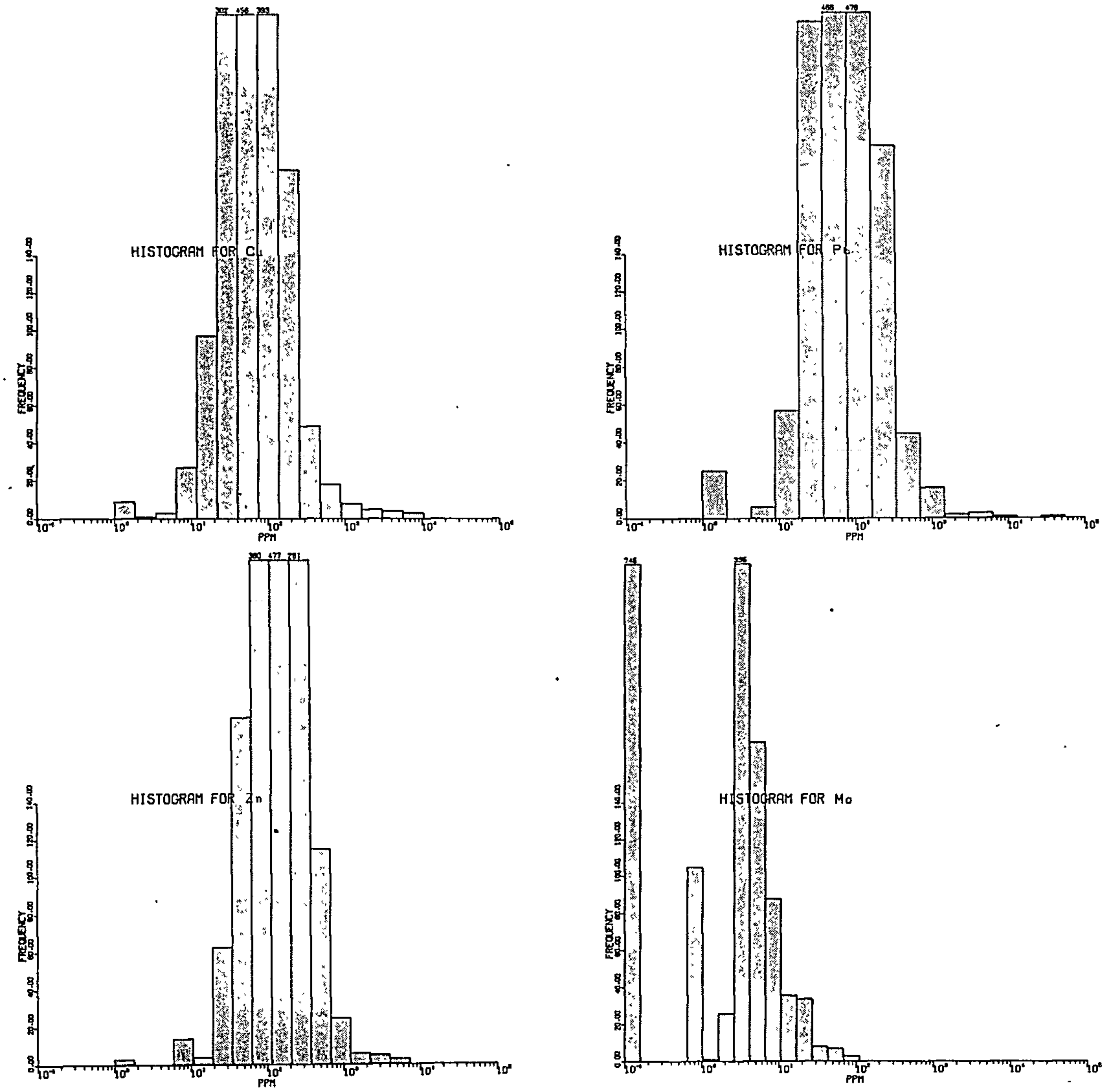


Fig. 6 Cumulative frequency distribution and histogram for the soil samples

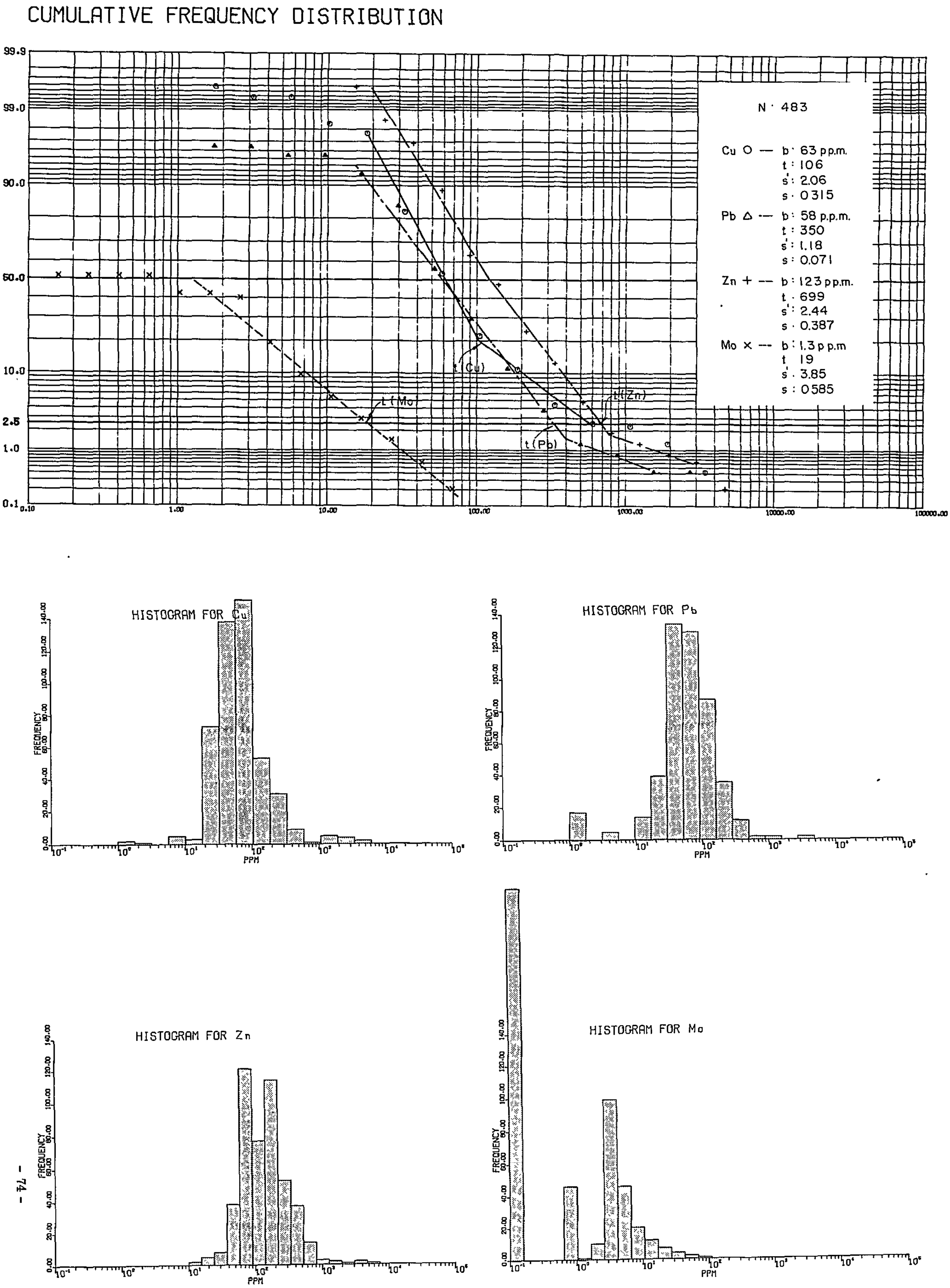


Fig. 7 Cumulative frequency distribution and histogram for dacite

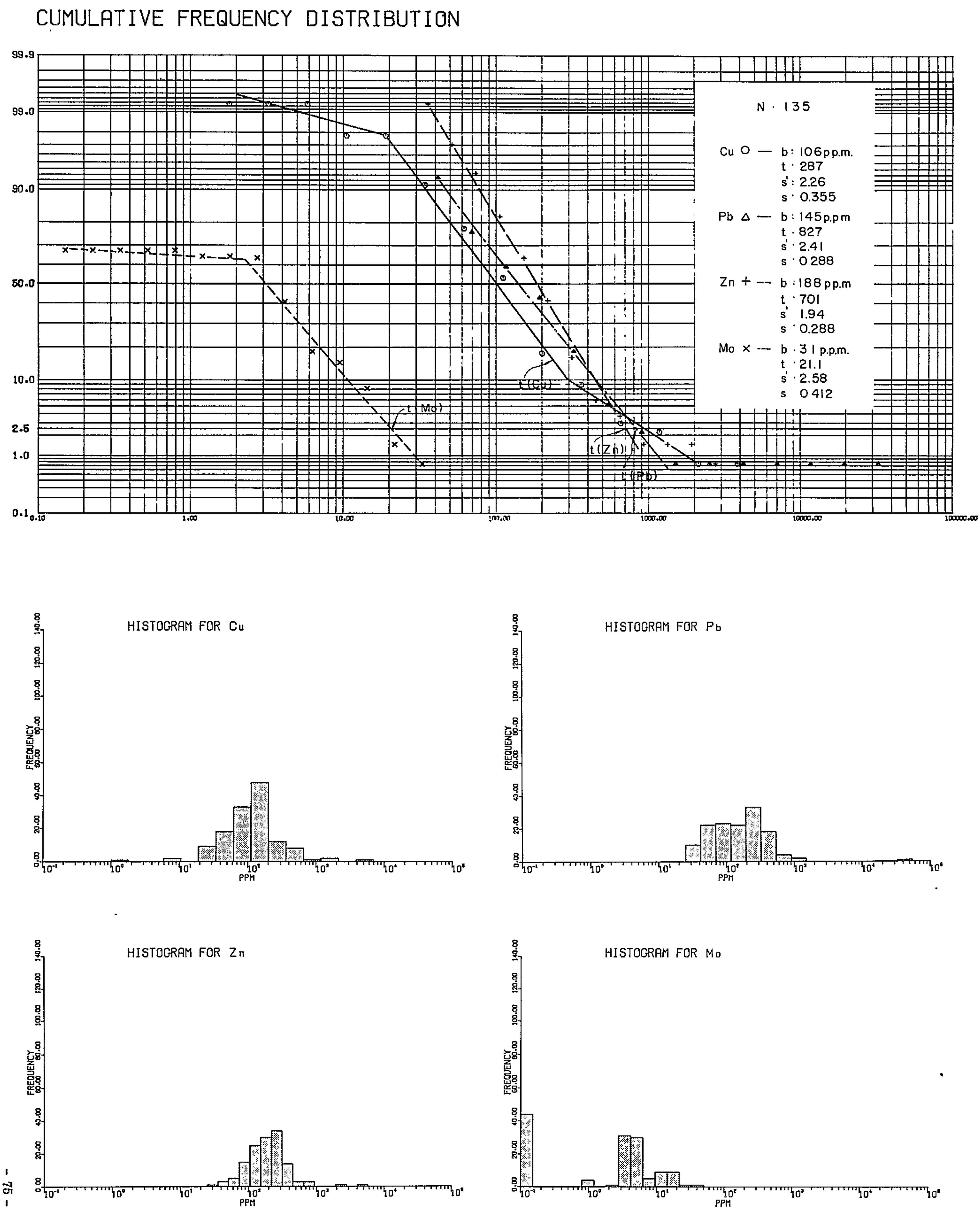


Fig. 8 Cumulative frequency distribution and histogram for quartz diorite

CUMULATIVE FREQUENCY DISTRIBUTION

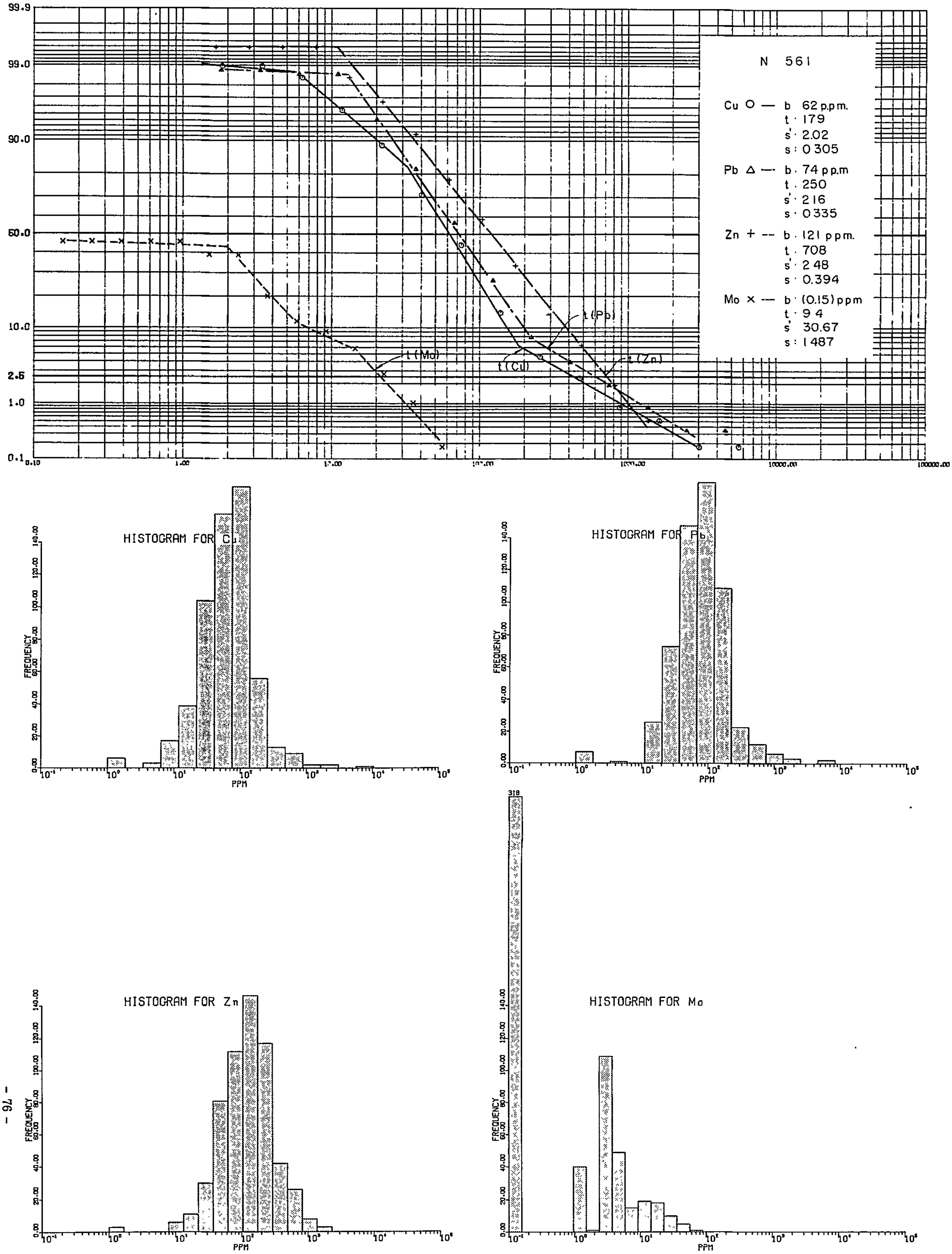


Fig. 9 Cumulative frequency distribution and histogram for Miocene

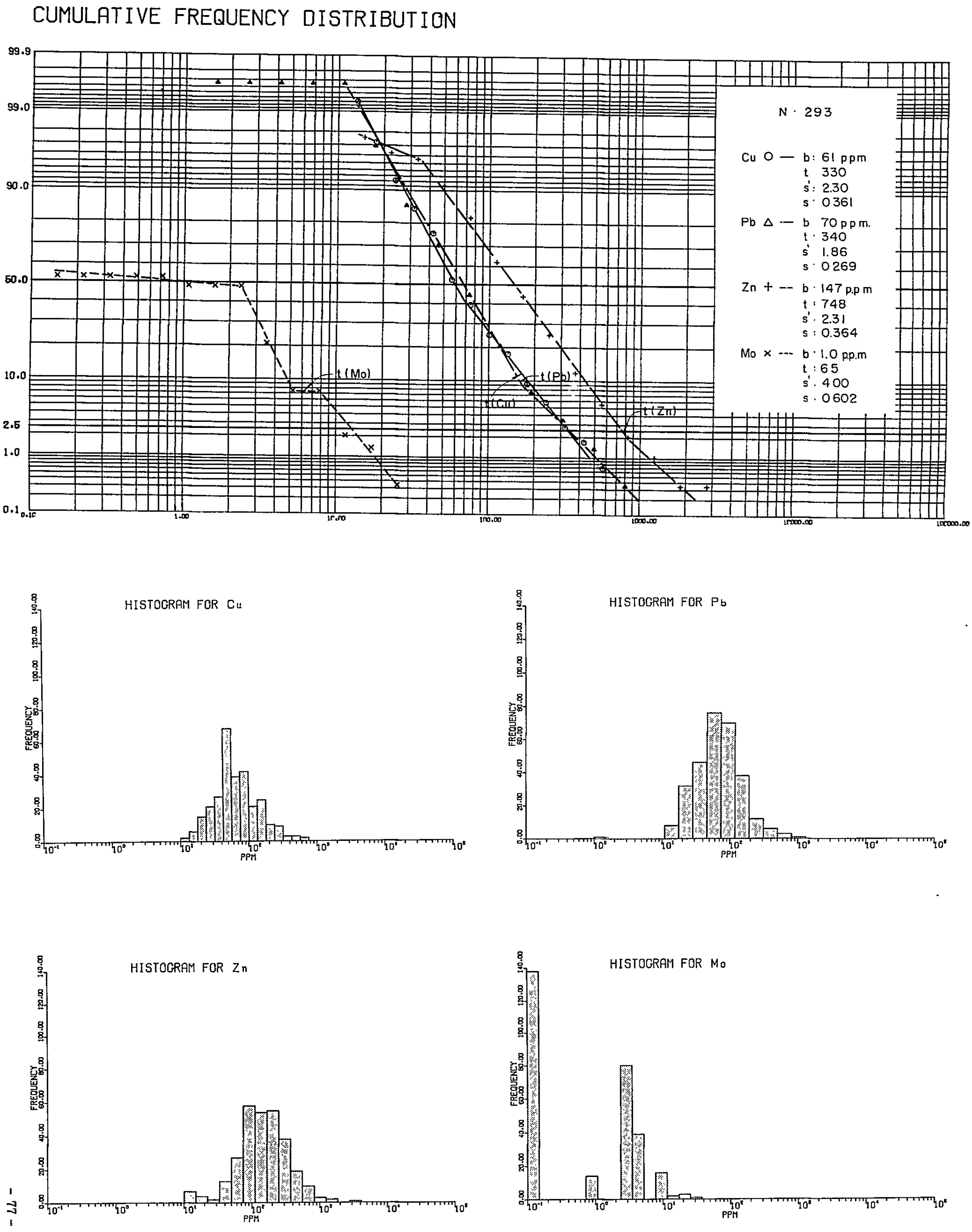
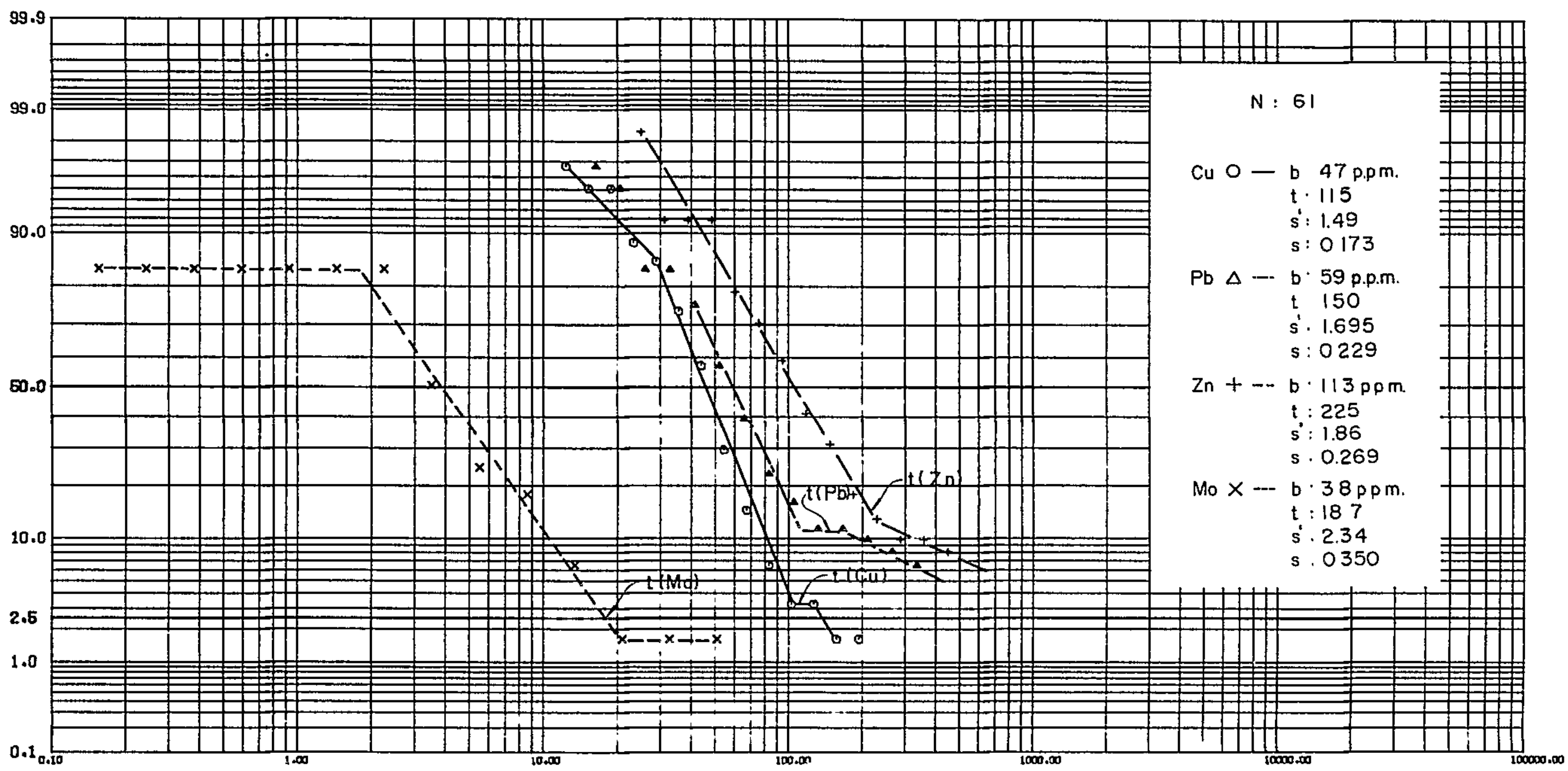
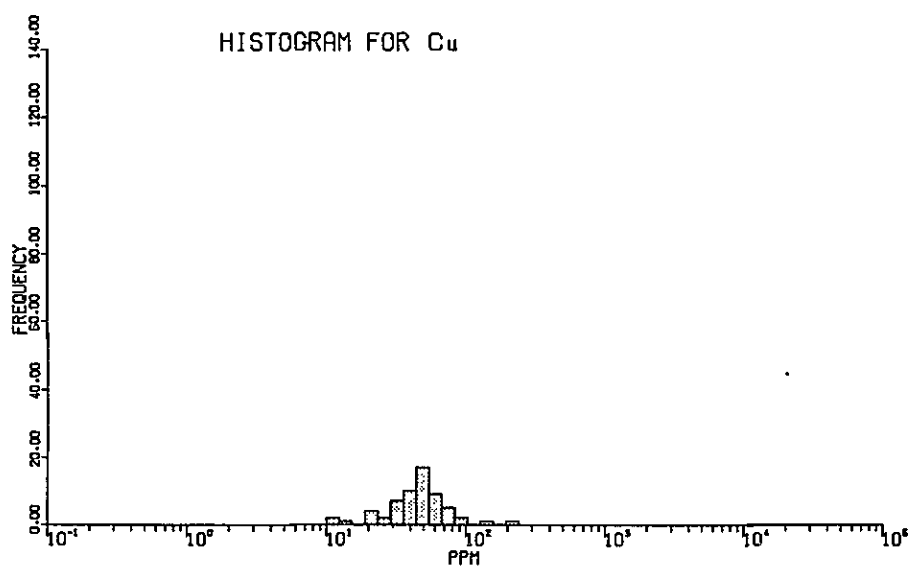
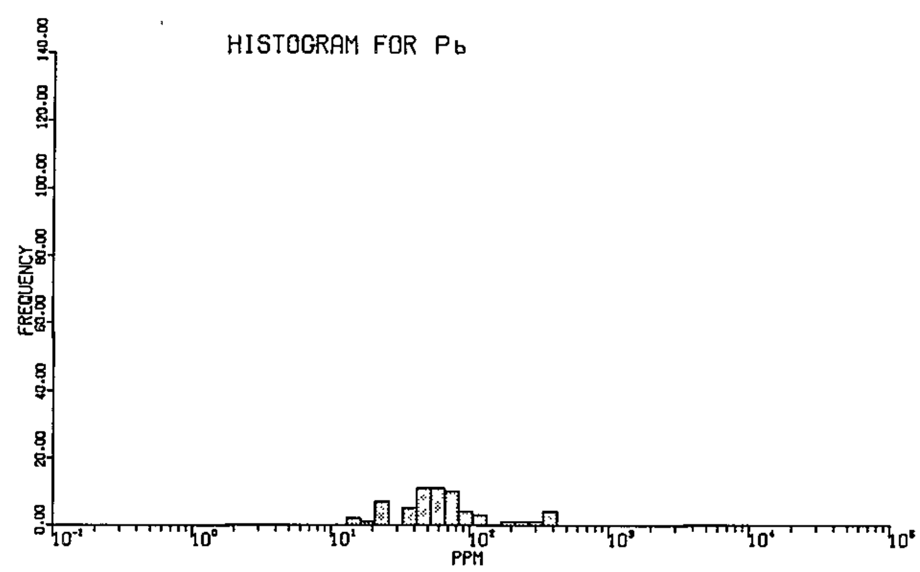


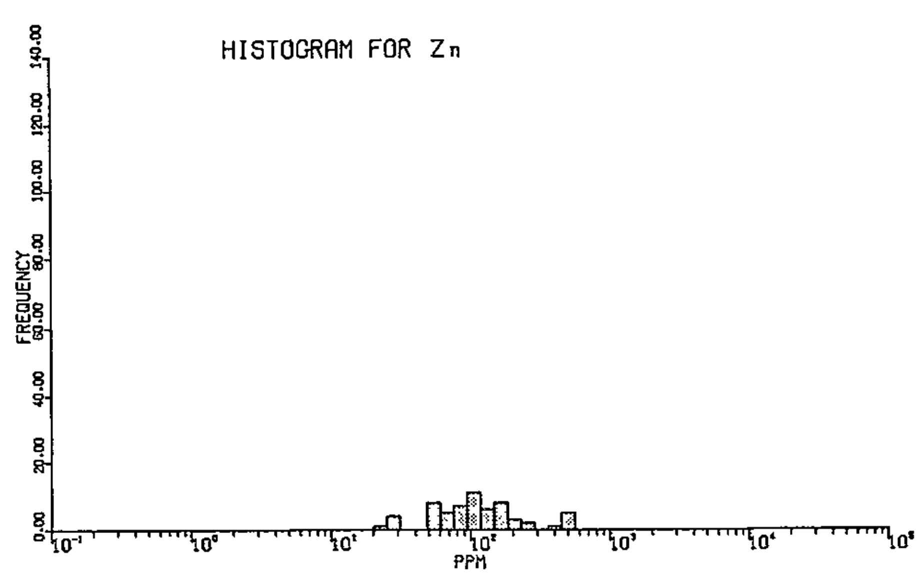
Fig. 10 Cumulative frequency distribution and histogram for Eocene

CUMULATIVE FREQUENCY DISTRIBUTION









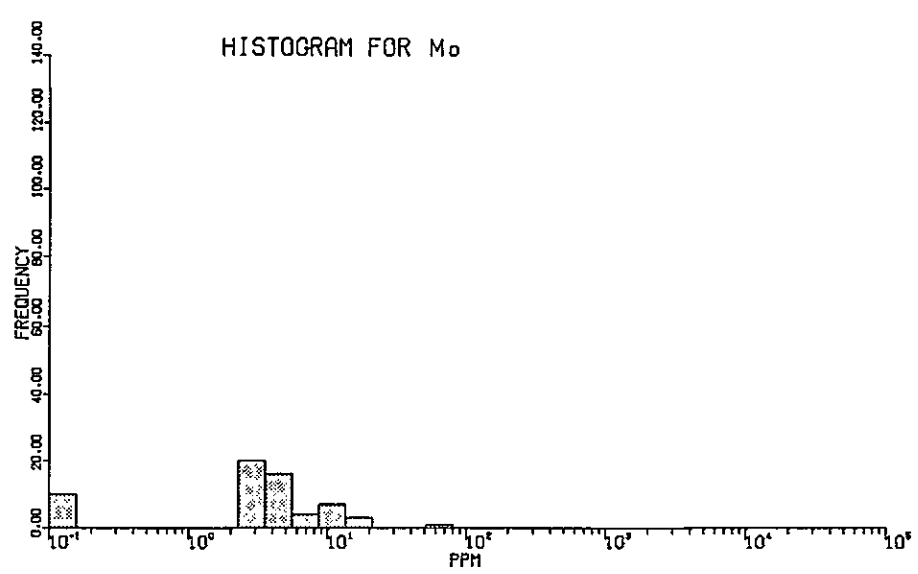


Fig. 11 Cumulative frequency distribution and histogram for Permian

Table 1 Pattern of Dispersion

Geological Unit	Cu		Pb		Zn		Mo	
	Deviation	Pattern	Deviation	Pattern	Deviation	Pattern	Deviation	Pattern
Stream Sediment	M	excess of low value	M	excess of low value	M	excess of low value	V.H.	excess of low value (almost log normal)
Soil, (in all)	L	excess of low value (almost log normal)	H	excess of low value (almost log normal)	H	excess of low value	V.H.	excess of low value (almost log normal)(zig zag)
Soil, Karataş Dacite	M	excess of high value	M	excess of low value	M	excess of low value (almost log normal)	L	excess of low value
Soil, Sin Dacite	H	excess of high value	H	two groups mixture	H	excess of high value	H	excess of low value (almost log normal)
Soil, Çet Dacite	H	excess of low value	M	excess of low value	M	two groups mixture (almost log normal)	V.H.	almost log normal
Soil, Dacite in all	H	two groups mixture	L	two groups mixture	H	two groups mixture (almost log normal)	H	excess of low value
Soil, Karşılar Quartz diorite	H	excess of low value	L	log normal	H	two groups mixture	M	excess of low value
Soil, Bulanık Quartz diorite	H	excess of high value	H	two groups mixture	M	excess of high value	H	excess of low value (almost log normal)
Soil, Quartz diorite in all	H	excess of high value	H	two groups mixture	M	two groups mixture	H	excess of low value
Soil, Upper part of Düzpelit F.	H	two groups mixture	H	two groups mixture	H	excess of low value (almost log normal)	V.H.	excess of low value
Soil, Atadoğdu F. Kamışlık F.	H	log normal	M	excess of low value (almost log normal)	H	two groups mixture (almost log normal)	H	excess of low value
Soil, Munzur F.	L	two groups mixture	M	two groups mixture	M	two groups mixture	H	excess of low value
Soil, Porphyry	H	excess of high value	M	log normal	L	excess of high value	V.H.	excess of low value

Table 2 Background deviation and threshold value

Cu

Geological Unit	(N) Population	(b) Background value	(S') Standard deviation	(S) Standard deviation	(t) Threshold value	Supplementary Threshold value		Remarks
		p.p.m.			p.p.m.	*4(t')p.p.m.	(2t) p.p.m.	
Stream Sediment	244	46	1.85	0.267	135	93	270	
Soil, (in all)	1,561*1	65	2.15	0.332	171	140	342	
Soil, Karataş Dacite	92	39.3	1.44	0.157	140	60	128	
Soil, Sin Dacite	212	83	2.59	0.413	175	140	350	
Soil, Çet Dacite	179	57	1.76	0.246	182	110	364	
Soil, Dacite (in all)	483*2	63	2.06	0.315	106	86	212	
Soil, Karşılar Quartz diorite	24	34	2.61	0.417	170	85	340	
Soil, Bulanık Quartz diorite	111	137	2.19	0.340	254	200	508	
Soil, Quartz diorite (in all)	135*3	106	2.26	0.355	287	240	574	
Soil, Upper part of Düzpelit F.	561	62	2.02	0.305	179	125	358	
Soil, Atadoğdu F. Kamislik F.	293	61	2.30	0.361	330	160	660	
Soil, Munzur F.	61	47	1.49	0.173	115	74	130	
Soil, Porphyry	28	64	2.34	0.370	140	94	280	

Background deviation and threshold value

Pb

Geological	(N) Population	(b) Background Value	(S') Standard deviation	(S) Standard deviation	(t) Threshold Value	Supplementary Threshold Value		Remarks
		p.p.m.			p.p.m.	*4(t')p.p.m.	(2t) p.p.m.	
Stream Sediment		63	1.83	0.261	201	130	402	
Soil, (in all)		73	2.40	0.380	201	175	402	
Soil, Karataş Dacite		33.4	1.61	0.206	88	65	176	
Soil, Sin Dacite		65	2.69	0.430	468	210	934	
Soil, Çet Dacite		83	1.75	0.243	255	160	510	
Soil, Dacite(in all)		58	1.18	0.071	350	170	700	
Soil, Karşılar Quartz diorite		56	1.56	0.195	138	95	276	
Soil, Bulanık Quartz diorite		180	2.50	0.399	827	440	1,654	
Soil, Quartz diorite		145	2.41	0.383	827	400	1,654	
Soil, Upper part of Düzpelit F.		74	2.16	0.335	250	160	500	
Soil, Atadoğdu F. Kamışlık F.		70	1.86	0.269	340	150	680	
Soil, Munzur F.		59	1.695	0.229	150	110	300	
Soil, Porphyry		71	1.97	0.295	250	155	500	

Background deviation and threshold value

Zn

Geological	(N) Population	(b) Background value	(S') Standard deviation	(S) Standard deviation	(t) Threshold value	Supplementary Threshold value		Reamrks
		p.p.m.			p.p.m.	*4(t')p.p.m.	(2t) p.p.m.	
Stream Sediment		105	1.76	0.246	275	200	550	
Soil, (in all)		132	2.27	0.357	679	350	1,358	
Soil, Karataş Dacite		75	1.64	0.215	95	88	190	
Soil, Sin Dacite		151	2.45	0.389	898	430	1,796	
Soil, Cet Dacite		148	1.79	0.253	434	300	866	
Soil, Dacite(in all)		123	2.44	0.387	699	330	1,398	
Soil, Karsılar Quartz diorite		98	2.40	0.380	233	185	466	
Soil, Bulanık Quartz diorite		211	1.84	0.264	652	400	1,302	
Soil, Quartz diorite		188	1.94	0.288	701	400	1,402	
Soil, Upper part of Düzpelit F.		121	2.48	0.394	708	340	1,416	
Soil, Atadoğdu F. Kamışlık F.		147	2.31	0.364	748	380	1,496	
Soil, Munzur F.		113	1.86	0.269	225	210	450	
Soil, Porphyry		151	1.45	0.161	294	220	588	

Mo

Background deviation and threshold value

Geological	(N) Population	(b) Background value	(S') Standard deviation	(S) Standard deviation	(t) Threshold value	Supplementary Threshold value		Ramrks
		p.p.m.			p.p.m.	*4(t')p.p.m.	(2t) p.p.m.	
Stream Sediment		0.15	17.33	1.239	10.5	3.3	21.0	
Soil, (in all)		0.65	8.62	0.935	19.0	7.0	38.0	
Soil, Karataş Dacite		3.0	1.33	0.125	5.3	4.2	10.6	
Soil, Sin Dacite		3.2	2.44	0.387	5.0	4.0	10.0	
Soil, Çet Dacite		0.15	6.33	0.802	1.6	0.95	3.2	
Soil, Dacite(in all)		1.3	3.85	0.585	19.0	6.2	38.0	
Soil, Karşılar Quartz diorite		0.19	1.88	0.274	10.0	3.0	20.0	
Soil, Bulanık Quartz diorite		3.75	2.59	0.413	22.9	11.5	45.8	
Soil, Quartz diorite		3.1	2.58	0.412	21.0	9.4	42.0	
Soil, Upper part of Düzpelit F.		0.15	30.67	1.487	9.4	4.6	18.8	
Soil, Atadoğdu F. Kamışlık F.		1.0	4.00	0.602	6.5	4.0	13.0	
Soil, Munzur F.		3.8	2.34	0.350	18.7	9.6	37.4	
Soil, Porphyry		0.15	21.33	1.329	4.0	3.3	8.0	

Note

* 1 ; Total number of specimens (1561)

* 2 ; Total number of dacite

* 3 ; Total number of quartz diorite

* 4(t'); The value either t - 10% of total number or the value 16% of total number less in a Population than the highest, if it is smaller than t, t' is cancelled.

Table 3 Coefficient of Colleration (ρ)

Geological Unit	ρCu-Pb	ρCu-Zn	ρCu-Mo	ρPb-Zn	ρPb-Mo	ρZn-Mo
Stream Sediment	0.2831	0.6117	▲0.1525	0.2449	▲0.1946	▲0.1068
Soil Sample (in all)	0.3582	0.3971	0.2456	0.4000	0.0484	▲0.0991
Karataş Dacite	0.1912	0.2065	0.1889	0.3541	▲0.1399	0.0505
Sin Dacite	0.3525	0.5536	0.2118	0.4272	0.0279	▲0.0932
Çet Dacite	0.1285	0.1867	0.0685	0.0987	▲0.1388	▲0.2342
Miocene	0.3029	0.2637	0.3448	0.3181	0.1025	▲0.1257
Eocene	0.4471	0.5779	▲0.1711	0.6814	▲0.1507	▲0.2017
Permian	0.1366	0.2607	0.2094	0.6560	0.0801	▲0.0570
Porphyrite	▲0.0016	0.0478	0.4649	0.2692	▲0.2064	▲0.2386
Dacite (in all)	0.2897	0.4223	0.2421	0.3381	▲0.0372	▲0.1141
Quartz diorite	0.6028	0.5482	0.5188	0.5015	0.2972	0.1442

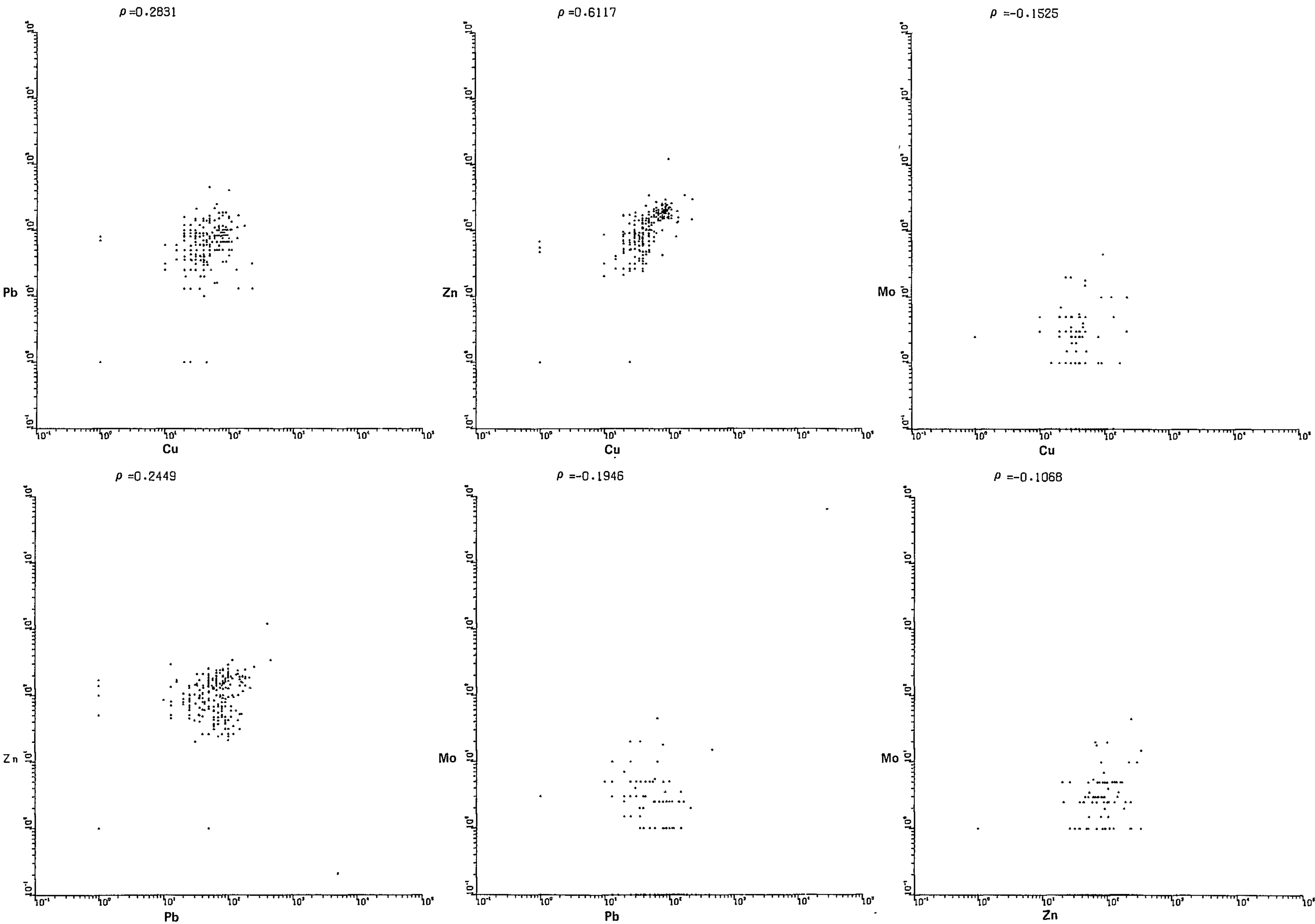


Fig. 12 Coefficient of correlation of the stream sediments

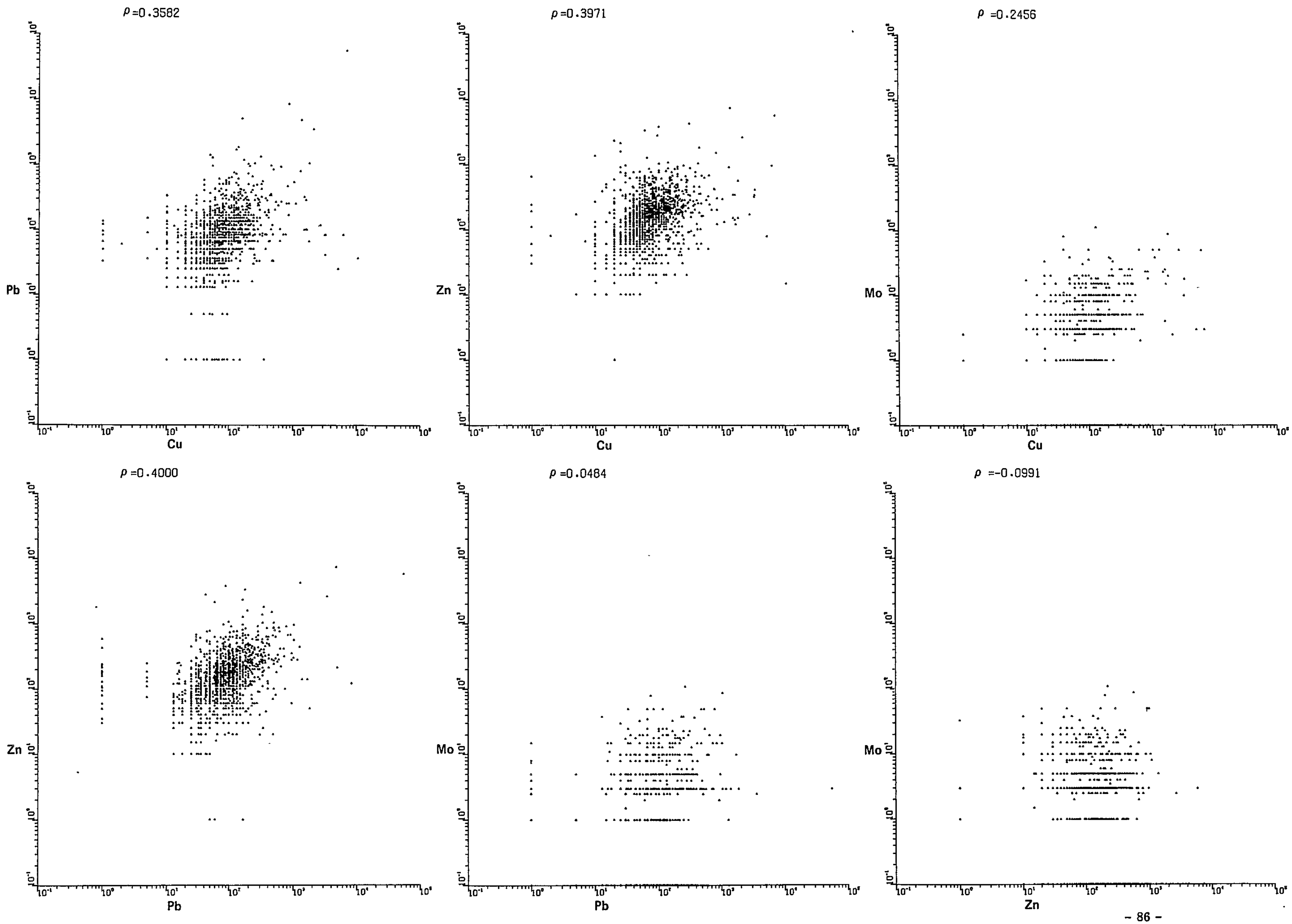


Fig. 13 Coefficient of correlation of the soil samples