NO.

REPORT ON THE MINERAL EXPLORATION
IN
THE HOPA AREA,
THE REPUBLIC OF TURKEY
PHASE III

MARCH 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN OIL, GAS AND METALS NATIONAL CORPORATION

ED
JR
05-024

PREFACE

The Japanese Government decided to conduct a mineral exploration program consisting of geological and geochemical surveys in the Hopa area, in response to the request from the Government of the Republic of Turkey. The purpose of the program is to estimate its potential for mineral deposits. The Japanese Government entrusted the implementation of this plan to the Japan International Cooperation Agency (JICA), and JICA entrusted the enforcement of the program to the Japan Oil, Gas and Metals National Corporation (JOGMEC) due to the specialty of the program.

JOGMEC (MMAJ) started the survey program in the fiscal year of 2002 and dispatched a five members survey team to Turkey from September 28 to November 2, 2004.

The field survey program in the area has completed as scheduled in cooperation with the General Directorate of Mineral Research and Exploration (MADEN TETKİK ve ARAMA GENEL MÜDÜRLÜGÜ) and the concerned governmental organizations of Turkey.

Finally, we would like to express a deep appreciation for the cooperation of the concerned governmental organizations of Turkey and Japan.

February 2005

Tadashi Izawa
Vice President
Japan International Cooperation Agency

Hidejiro Ohsawa
President
Japan Oil, Gas and Metals National Corporation

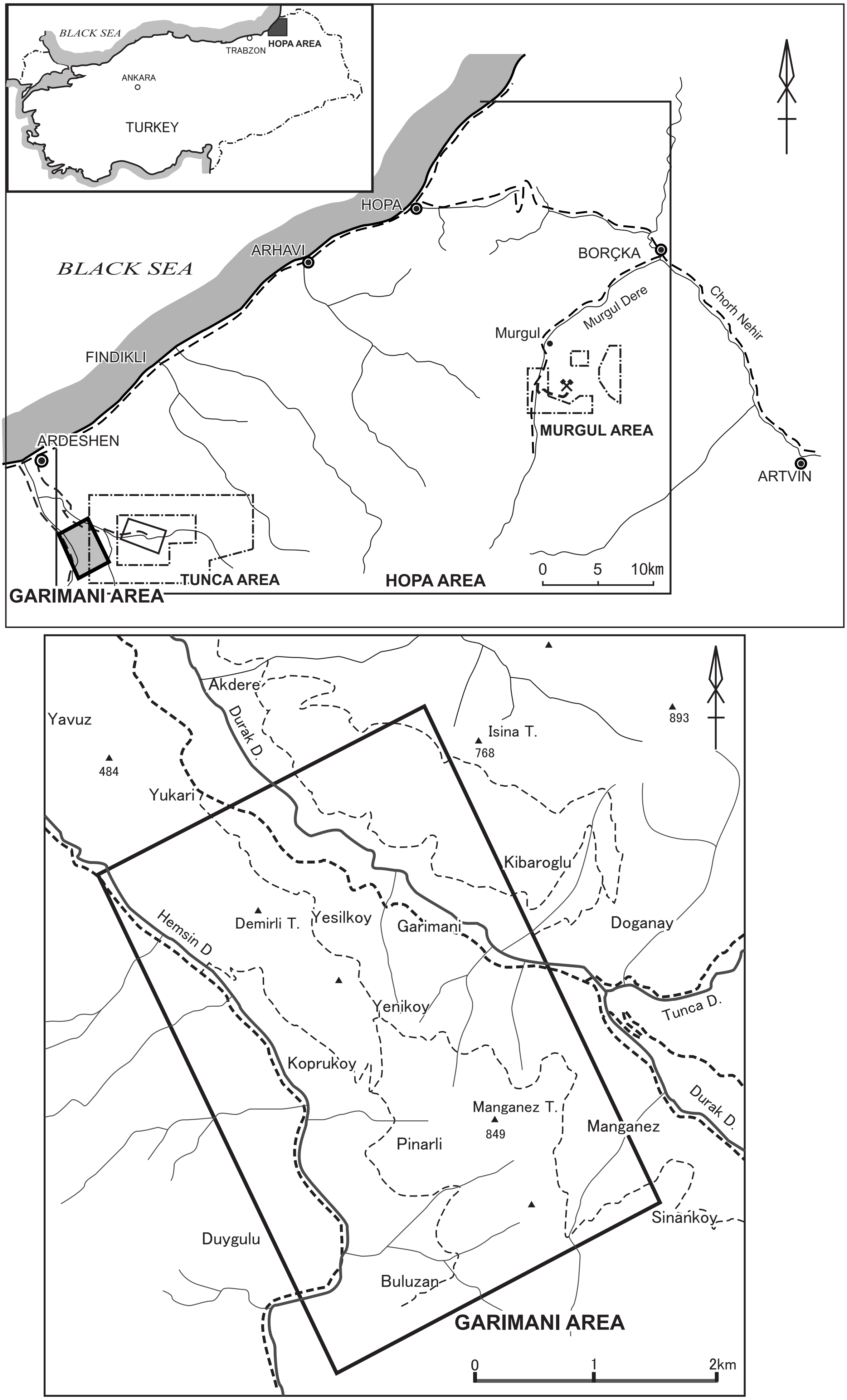


Fig.1 Location Map of the Survey Area

Summary

The survey has been performed to extract potential zones for gold, silver, copper, lead, and zinc ore deposits, e.g. the volcanogenic massive sulphide ore deposit, by means of investigation and interpretation of the geological setting and state of ore deposits in the Hopa area of the Republic of Turkey. Transfer of the exploration technique to the relevant counterpart organizations is also another object in the program.

This year's detailed geological survey has been performed for the Garimani area, after the selection based on the second year's survey program.

The Garimani area is underlain by the Alemağaç, Çağlayan, and Sivrikaya Formations of the upper Cretaceous, and the Hamidiya Formation of the Tertiary, having been intruded by dacite and granitic rocks. The Alemağaç Formation is divided into two members, the lower member composed of the aphyric dacite (Adcu), dacitic lava (Adcl), and dacitic pyroclastic rocks (Atf), and the upper member composed of the purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Attf). The tectonic structure extending northeast to southwest is dominant in the area, and it affects the trend of the fault system, intrusive rocks, and mineralized zones in the area. The formations generally strike the same trend, northeast to southwest.

The mineralized zones of Garimani, Yeşilköy West, Köpruköy, and Duygulu exist in the area. The Garimani Mineralized Zone has been formed by the volcanogenic massive sulphide mineralization, and the Yeşilköy West and Köpruköy Mineralized Zones have been formed by the vein-type mineralization, before the deposition of the upper member of the Alemağaç Formation of the late Cretaceous. On the other hand, the Duygulu Mineralized Zone has been formed associated with the intrusion of the granitic rocks of the Eocene.

The mineralized zones confirmed by the survey are mainly composed of pyrite dissemination zones, being scarcely accompanied by chalcopyrite and sphalerite. It is judged that the development of these mineralized zones is economically impossible in future.

The ore horizon of the Çayeli Ore Deposit continues to the areas around the area, therefore it is important to expand survey areas to the surrounding area of the area.

CONTENTS

Part Ⅱ Details of the Surveys

Part Ⅲ Conclusion and Recommendation

List of Figures

List of Tables

Part Ⅰ

General Remark

Part I General Remark

Chapter 1 Introduction

1-1 Background and Object of the Survey

The coastal area of the Black Sea in Turkey is one of a high potential area for massive sulphide ore deposits similar to the Japanese Kuroko deposits containing multi-metal elements. The head office of MTA, "MADEN TETKİK ve ARAMA GENEL MÜDÜRLÜGÜ: Mineral Research and Exploration Institute" has aggressively conducted many mineral exploration programs. The government of the Republic of Turkey has planned to conduct a new exploration program for metallic minerals in the Hopa area in the eastern part of the coastal area, and requested the cooperation from the Japanese government. In response to the request, the Japanese government has decided to conduct a survey program for the area, to extract potential areas for gold, silver, copper, lead, zinc etc. by means of surveys and interpretations for the geological environment and the status of ore deposits in the area. Another purpose of the program is to transfer the technology for mineral exploration to the Turkish counterpart.

1-2 Conclusion and Proposal of the Second Year

1-2-1 Conclusion of the Second Year

The survey was composed of geological survey and drilling survey in the Tunca district and geological survey in the Murgul area. Conclusion from these surveys are described as follows,

(1) Tunca District

(a) Geology

The rocks in the survey district are of the upper Cretaceous Alemağaç, Çağlayan, and Sivrikaya Formations, and Tertiary Hamidiya Formation from the bottom, and the intrusive rocks such as dacite and dolerite.

The Alemağaç Formation is composed of the dacite lava (Adcl), dacitic pyroclastic rocks (Atf), purple dacite (Adcp), green dacite (Adcg), green dacitic pyroclastic rocks (Attf), dacitic tuff-breccia (Adlh), and dacitic tuff-breccia (Adlf). The dacite lava (Adcl) forms lava domes centering Muskale Mountain to the south of the district. The dacitic pyroclastic rocks (Atf) has been formed by the phreatic explosion occurred on the flank of the lava dome. The purple dacite (Adcp), green dacite (Adcp), and its pyroclastic rocks (Attf) are of essentially same source, showing different facies, and extensively distributed specially in the south. The dacitic tuff-breccia (Adlh) and dacitic tuff-breccia (Adlf) have been captured by the drilling survey, and is situated subsurface of the north.

(b) Mineralization

The volcanogenic massive sulphide ore deposits in the district have been formed by the hydrothermal activity associated with the phreatic explosion on the flank of the dacite lava dome (Adcl) of the Alemağaç Formation. In the decaying stage of the hydrothermal activity right after the phreatic explosion stopped, the purple dacite intruded. Then, it is presumed that the mineralization occurred in the green dacitic pyroclastic rocks (Attf). Accordingly, the ore horizon ranges from the upper part of the dacitic pyroclastic rocks (Aft) to below the reddish calcareous mudstone of the lowermost bed of the Çağlayan Formation.

Regarding the mineralization in the district, it is thought that the mineralization itself has been weak or the district has been situated far from principal mineralization center. Considering the location of the purple dacite, the geological state of the drill hole MJTH-2, and the ore formation process of the Tunca Deposit, it is presumed that the postulated mineral center should be to the northeast to east of the Tunca Deposit.

(2) Murgul Area

(a) Geology

The rocks in the survey area are of the lower Cretaceous Kabaca Formation, and upper Cretaceous Murgul, Ardiç, and Küre Formations, and intrusive rocks such as dacite, andesite, and granitic rocks. The Kabaca Formation is the lowermost formation in the area, consisting of andesite and andesitic sedimentary rocks. The Murgul Formation is divided into two members, the Lower Member having been undergone volcanogenic massive sulphide mineralization and overlying Upper Member. The lower Member is extensively distributed in the area, consisting of dacite lava and dacitic pyroclastic rocks (Mdcl). The Upper Member is composed of pumice tuff, and fine-grained tuff. The Ardiç Formation is characterized by basic volcanism represented by basalt and andesite lava. It is divided into several members by intercalated sedimentary layers. The Küre Formation is distributed to the north of the area, being composed of sedimentary rocks. The Karatepe Dacite intrudes into the Murgul and Ardiç Formations, and overlies the lowers basic volcanic rocks of the Ardiç Formation as pyroclastic rocks. The granitic rocks are distributed in the watershed of the Kokolet River as stocks.

(b) Mineralization

The volcanogenic massive sulphide mineralization zones exist in the area, being hosted in the Lower Member of the Murgul Formation. The alteration mineral zoning associated with the mineralization, the distribution of the strong alteration intensity zones, and the arrangement of the mineralized zones extend northeast to southwest through the Murgul Deposit swarm. It is thought that the volcanogenic massive sulphide mineralization has occurred along this zone.

The ore horizon of the southwest side of the Murgul Deposit has been already eroded out, exposing the Lower Member of the Murgul Formation. However, the mountain block from the Ardiç district to Kokolet district in the northeast side of the Murgul Deposit is composed of the basic volcanic rocks of the Ardiç Formation. It means that the Upper Member of the Murgul Formation possibly exists underneath the mountain block. Therefore it is possible to judge that there is some potential for large-scale volcanogenic massive sulphide ore.

1-2-2 Recommendation for the Third Year's Program

The second year's survey program has concluded that the center of the volcanogenic massive sulphide mineralization possibly would be to the northeast of the Tunca Deposit, and the mountain block in between the Ardiç district and Kokolet district in the Murgul area would be a high potential area for the volcanogenic massive sulphide ore deposit.

In the third year's survey program, following surveys are recommended to perform.

(1) Tunca District

(a) East of the Beyazsu area

* Drilling Survey

To confirm the potential for the center of the volcanic massive sulphide mineralization, to the east of the mineralized part captured in drill hole MJTH-3.

(b) Around the Maganez Area

* Detailed Geological Survey

* Drilling Survey

To obtain more detailed knowledge of the occurrence to judge its potential for mineralization in the dacite of the Alemağaç Formation in the western corner of the Tunca area.

(2) Murgul Area

(a) Eastern Mountain Area in the Ardiç district .

* Drilling Survey

To confirm the potential for the volcanogenic massive sulphide ore deposit extending from the Murgul Deposit swarm.

(3) Another Area

(a) Around the Peronit, Kutunit and Syvrikaya Area.

* Detailed Geological Survey

* Drilling Survey

To obtain more detailed knowledge of the occurrence to judge its potential for mineralization that is extracted from MTA's reconnaissance survey.

1-3 Outline of the Third Year's Survey

1-3-1 Survey Area

The survey area was established in the area concluded to the hopeful by Phase Ⅱ Survey. That is the Garimani area, from the Garimani Occurrence to Manganez.

1-3-2 Purpose of the Survey

The purpose of geological survey in the Garimani area was to establish stratigraphy around the survey area and investigate the possibility of new volcanogenic massive sulphide deposits.

1-3-3 Method and Content of the Survey

Geological survey has been carried out in the Garimani area. Contents and amounts of field work, laboratory test are shown Table Ⅰ-1-1 and Table Ⅰ-1-2.

Table Ⅰ-1-1 Contents and Amounts of Field Survey

Method and Contents	Amount of Survey
Geological Survey	
Garimani area	
Survey area	$14km^2$
Survey routes	70km

Table I -1-2 Contents and Amounts of Laboratory Test

Contents of Laboratory Test	Amounts
Geological Survey（Garimani area）	
① Thin Section	39
② Polished Section	12
③ Ore assay (Au, Ag, Cu, Pb, Zn, Ba, S, Ga, Ge, In, As)	23
④ X-ray diffraction	48
⑤ Whole Rock Analysis（28elements）	77
(Au, Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn,	
Mo, Na, Ni, P, Pb, S, Sb, Sr , Ti, V, W, Zn)	
⑥ K-Ar Age Determination	3

1-3-4 Survey Team

Members participating in this survey are as follows,

Japanese side

Koichi Hisatani	Geotechnos Company Limited (Geotechnos)
Shigehisa Fujiwara	Geotechnos
Seiju Ikeda	Geotechnos
Hiroyuki Nakado	Geotechnos
Hirohisa Shingu	Geotechnos

Turkish side

Şenol Karslı	Maden Tetkik ve AramaGenel Müdürlügü (MTA)
Mustafa Özkan	MTA
İskender Kurt	MTA
Turgut Çolak	MTA
Mustafa Kemal Revan	MTA

Supervisor in Turkey

Kouji Yamamoto	Japan Oil, Gas and Metals National Corporation (JOGMEC)

1-3-5 Tears of the Survey

Field survey was carried as follows.

Geological Survey in the Garimani area

September 28th, 2004～ November 2nd, 2004

Chapter 2 Geography in the Survey Area

2-1 Location and Access

Figure 1 shows the location of the survey area. The Hopa area is situated in the northeastern part of the Turkey, near the boundary with the Republic of Georgia, ranging around 41 degrees 10 minutes to 41 degrees 30 minutes north in latitude, and 41 degrees 10 minutes to 41 degrees 45 minutes east in longitude. The northern edge faces to the Black Sea, and the Eastern Black Sea Mountains are situated to the south, extending northeast to southwest.

The Garimani area, this year's survey area, is in southwestern end of the Hopa area.

Arhavi Town is situated to the northeast of the Hopa area, facing to the Black Sea, and the survey team has set up its base camp there.

Trabzon City can be reached from the capital city of Ankara by air in one hour. The paved highway connects Trabzon City and Arhavi Town along the Black Sea coast, and it takes about three hours by car.

It takes about one hour from Arhavi to the Garimani area.

2-2 Topography and Drainage System

Within this survey area belonging to the Black Sea coast part, a fold mountain range having been formed in the early Alpine Orogeny stage, called as the East Black Sea Mountain Ranges falls sharply into the vicinity of the coast, and there is little flat land. For this reason, the Hopa area is steep and rich in undulations.

The Garimani area is in basin of the Hemsin River and Durak River, which are branches of the Fırtına River flowing into the Black Sea. The area is from 100 meters to 850 meters high above the sea level. The drainage patterns are well developing in the area.

2-3 Climate and Vegetation

The wet wind from the Black Sea is blocked off by the Black Sea Mountains, therefore the Hopa area have much rain falls through a year. The climate of the area is of so-called " Black Sea type", recording highest rain and snow falls in Turkey (Metal Mining Agency of Japan, 1970). The vegetation in the area is very thick. The precipitation from September to March is especially much, showing average monthly precipitation of 300mm. The rain changes to snow from November. The highest temperature in the summer reaches to 35°C, and lowest to 5°C below zero.

The vegetation is similar to that of Japan, consisting of thick conifers and broadleaf trees, and also grasses. Tea trees are planted on southern flanks of mountain ranges, even on steep slopes in the Garimani area.

2-4 Infrastructures

Arhavi Town has the population of about 10,000, facing the Black Sea, belonging to Artvin Prefecture. The base camp of the survey team has been set up in this town. The town is spread around the mouth of the Kabisre River. The Route 20 runs along the Black Sea coast, connecting principal cities, and some long distance bus services connecting to Ankara, Trabzon, and Artvin are available. Banks, post offices, hotels, and other infrastructure are well equipped, and tea processing is one of its principal industries here.

Chapter 3 General Geology

3-1 Outline of Turkish Geology

Figure I-3-1 shows the tectonic zones of Anatoria. The Anatolia Peninsular constitutes a part of the Alpine-Himalaya-Indonesia Mountains, and four tectonic belts extending east to west, the Pontides, Anatolides, Taurides, and Border Folds, align from the north to south. The Arabian and African Plates have surged from the south to the Eurasia Plate, and the Arabian Plate is in fault contacts with the Eurasia Plate by the Zagros Fault. The African Plate submerges underneath of the Aegean Volcanic Arc. The southern terrane of the North Anatoria Fault is pushed out due to the collision with the Arabian Plate, therefore the Anatoria Fault is the first class right-lateral active fault at present.

These plate activities have caused the Alpine Orogeny since the early Jurassic, and especially it has become very regional since the Paleogene. As the result of such activities, the area has uplifted as a mobile belt associated with igneous activity from the marine basin of the Tethys Sea in late Paleozoic time.

The Anatolides is situated in the central axis zone, and the terrane is composed of basement rocks and overlying ophiolite. The Taurides situated in the front-arc side of the Anatolides is mainly composed of Mesozoic limestone deposited in the Tethys Sea. The Pontides is of the jointed terrane of the Anatolides and Taurides due to the contraction of the Tethys Sea, and its basement rocks are composed of Devonian to Carboniferous metamorphic rocks and intrusive rocks such as granitoid. In the back-arc side of the Anatolides, the black Sea was expanded in the late Cretaceous, and the Mesozoic flysh-type sedimentary rocks have been deposited in the back-arc basin, and finally some marine volcanic rocks have been erupted. Associated

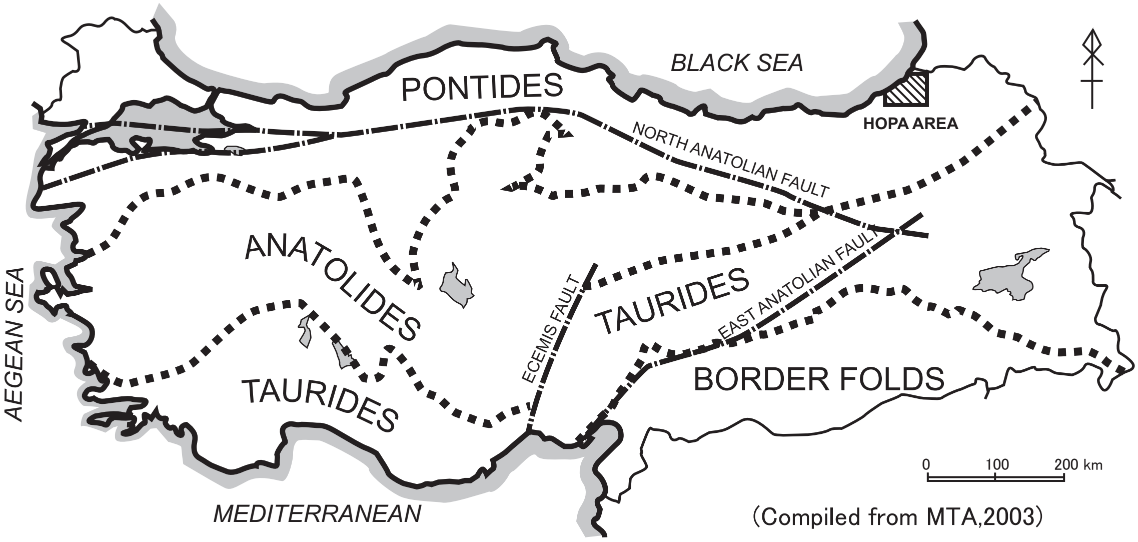


Fig. I -3-1 Tectonic Zones of Anatolia

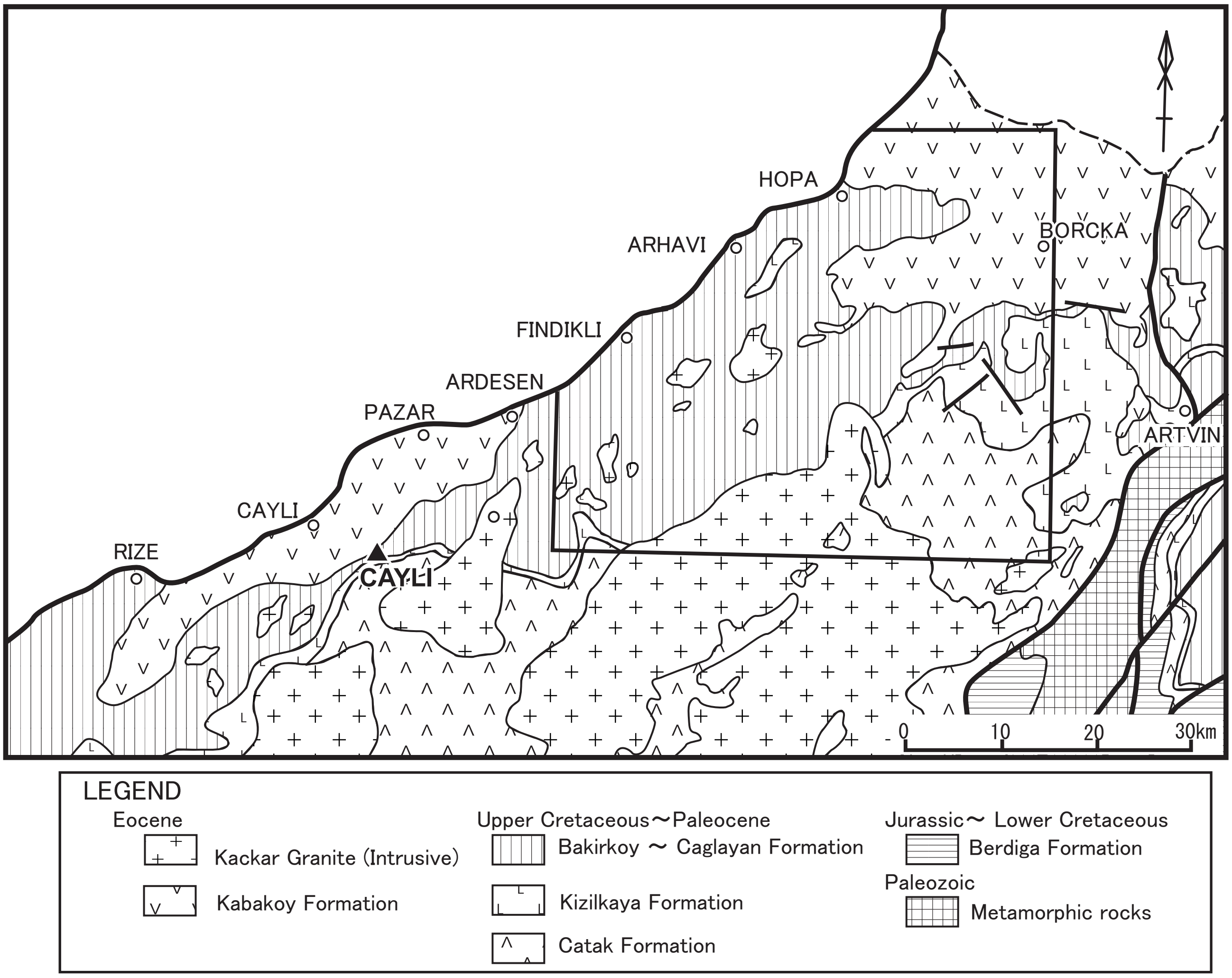


Fig. I -3-2 Geological Map of the Northeastern part of the Pontides with this volcanic activity, some volcanogenic massive sulphide deposits have been formed along the Black Sea coast.

3-2 Outline of Geology in the Survey Area

Figure I-3-2 shows the geological map of the northeastern Pontedes and Figure I-3-3 shows the stratigraphic units of the northeastern Pontides. The survey area is situated in the coastal area of the Black Sea, and geologically in the northeastern part of the Pontides. The basement rocks of the Pontides consist of Devonian to Carboniferous metamorphic rocks such as gneiss and schist, and Paleozoic intrusive granitic rocks. Six stratigraphic unites overlie the basement rocks, upper Carboniferous to lower Cretaceous, upper Cretaceous to lower Eocene, middle to upper Eocene, Oligocene to Miocene, and Pliocene to Quaternary from the bottom.

The coastal area of the eastern Black Sea is underlain by the upper Cretaceous to the lower Paleocene volcanic rocks, which are accompanied by volcanogenic massive sulphide deposits such as Murgul, Çayeli, and Cerattepe etc.

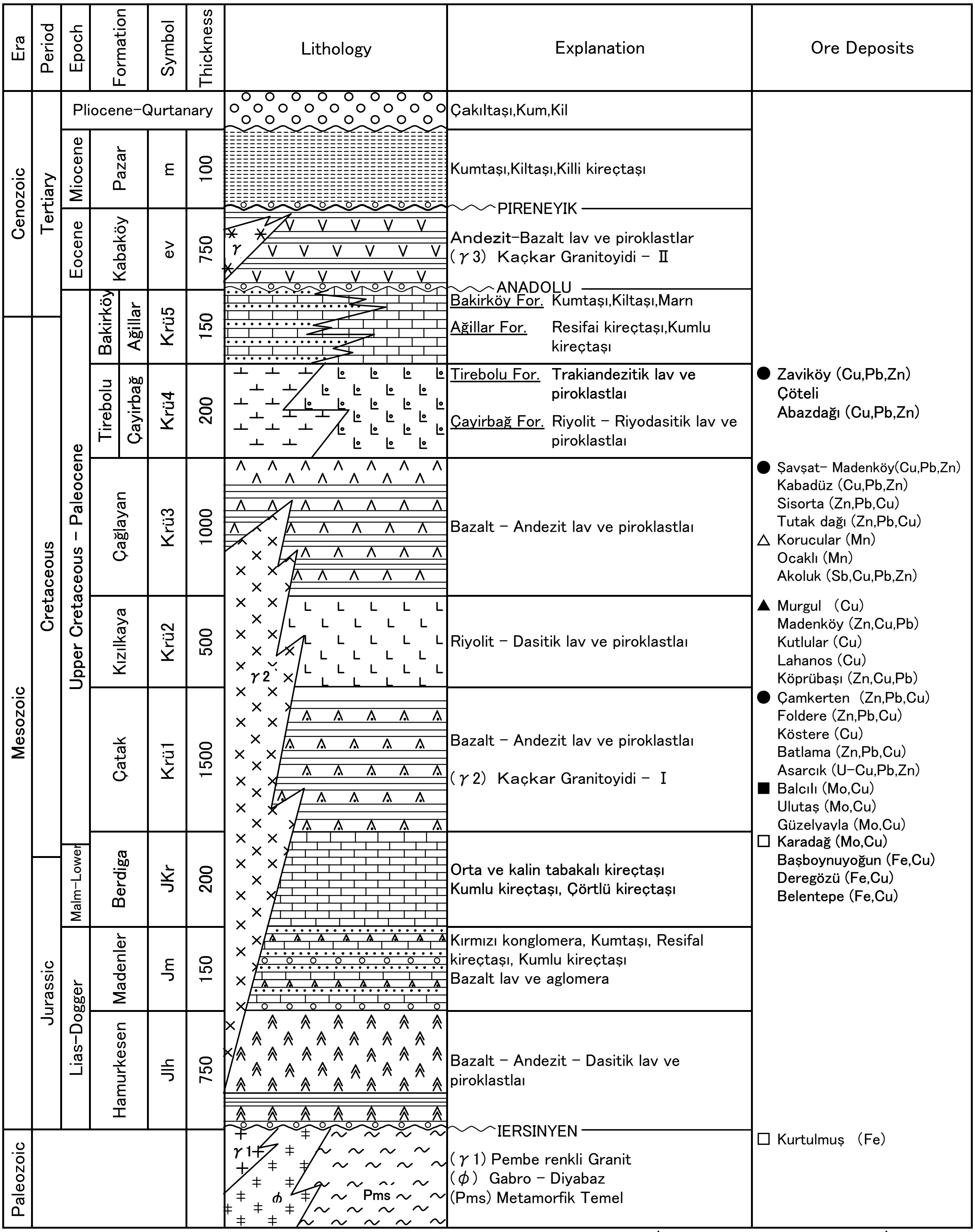
Güven et al (1992) classified the upper Cretaceous to the lower Paleocene into the Çatak Formation mainly composed of andesitic-basaltic volcanics, and Kızılkaya Formation mainly composed of dacitic volcanics, and Çağlayan Formation composed of andesite-basaltic lava, pyroclastics, and part of dacitic volcanics in ascending order.

The Kızılkaya and Çağlayan Formations are correlated with the Alemağaç and Çağlayan Formations in the Tunca area respectively.

The Kaçkar granitic rocks are distributed in the south of the Hopa area.

3-3 Geological Structure

Figure I-3-4 shows the extracted lineaments from LANDSAT TM images and MTA's extraction result using the same images (MTA, 2002). From the figure, the northeast to southwest, northwest to southeast, and north-northwest to south-southeast systems are recognized in the Hopa area, and the former two systems are dominant. Circular structures are seen in many places, and that of seen in the Tunca area is several kilometers in diameter. Regarding these structures, MMAJ (2001) reported that the northwest to southeast system reflects this area's geological structure, i.e. the boundary between the Pontides and Anatolides, and the northwest to southeast system are extensively seen in the upper Cretaceous volcanic rocks distributed in the Black Sea coast area. The distribution of the circular structures are concentrated in the upper Cretaceous volcanic rocks as same as the northwest to southeast lineaments.



(Compiled from MTA, 1994)

Fig. I–3–3 Stratigraphic Units of the Eastern Pontides

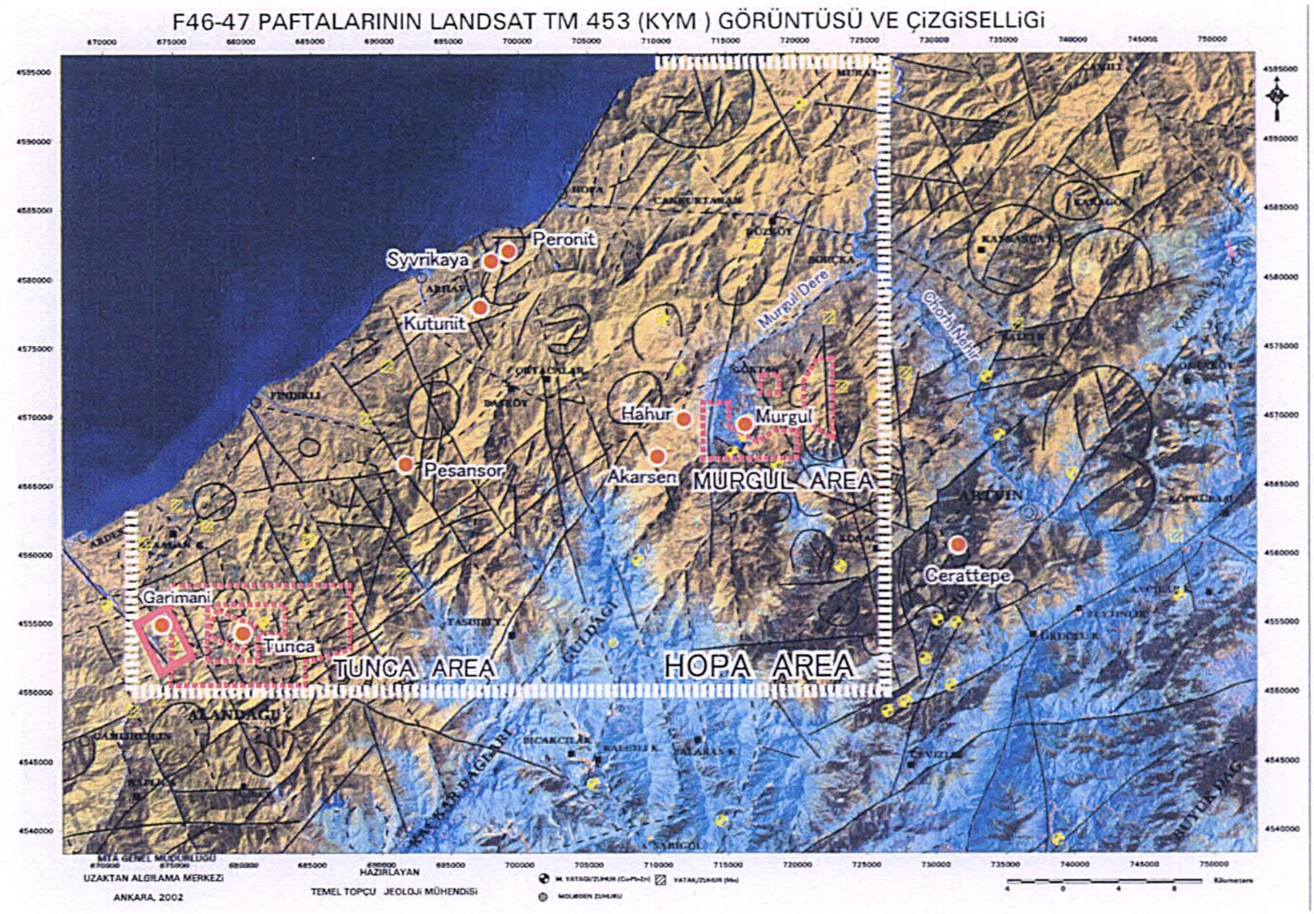


Fig. I -3-4 Photogeological Interpretation Map and LANDSAT TM Image of the Hopa Area

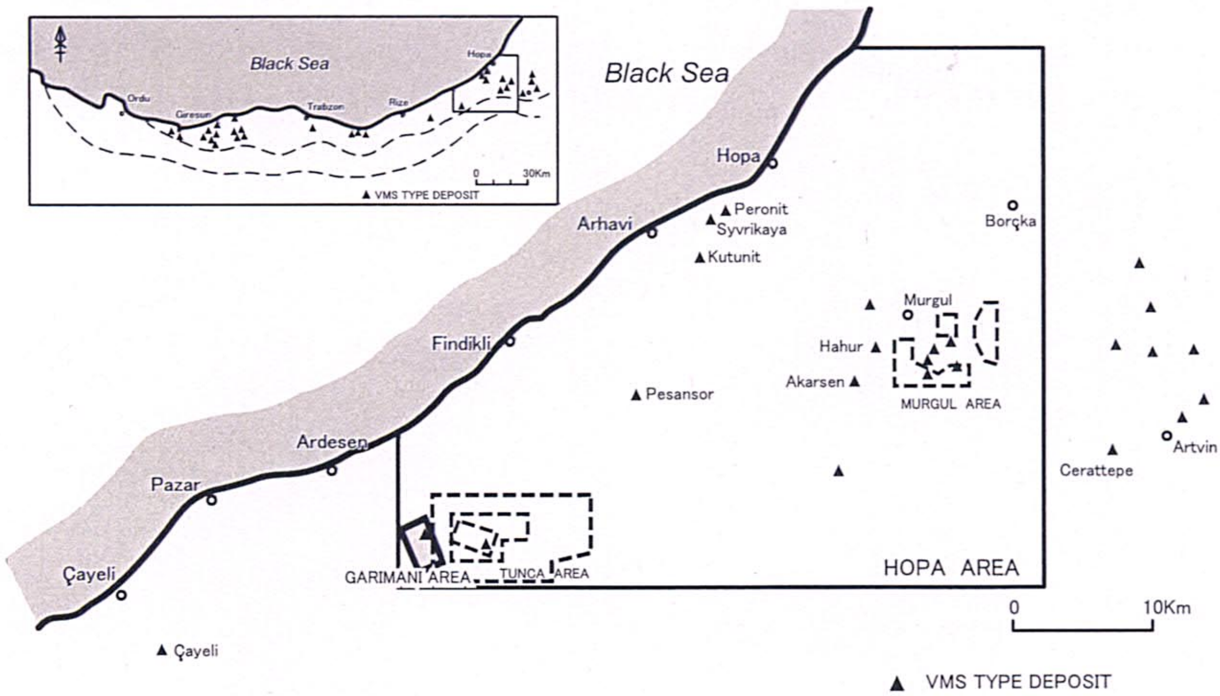


Fig. I -3-5 VMS Type Deposits Around the Hopa Area

Regarding relationship between the Japanese Kuroko-ore deposits and geological structure, many investigators have pointed out that Japanese Kuroko-ore deposits are distributed being accompanied with some depression structure. In Turkey, Japan National Oil Corporation (1998) has conducted an investigation program for the geological structure of the Black Sea coast in the northeastern Turkey using Satellite image data. The company has clarified that the volcanogenic massive sulphide deposits are distributed around some circular structures in some specific stratigraphic horizon, and emphasized that the study of geological structure is the very important tool for the exploration of massive sulphide deposits.

3-4 Mineralization and Alteration

As shown in Figure I-3-5, many volcanogenic massive sulphide deposits such as the Murgul, Cerattepe, Çayeli, Peronit, and Kutunit Deposits are distributed in the Hopa and surrounding areas, and the Tunca Deposit is in the Tunca area. These ore deposits are in the upper part of the upper Cretaceous Kızılkaya Formation, same as the Alemağaç Formation in the Tunca area, and some stockwork and disseminated sulphide ore deposits exist in the lower part. The Sivrikaya Deposit is of only lower stockwork and disseminated ores, lacking massive ore. The calcareous mudstone and basalt lava of the Cağlayan Formation overlies these deposits.

It is thought by some investigators that the massive sulphide deposits in the eastern Pontides have been formed by duplicated mineralization, and the associated igneous rocks and genetic time of the Peronit and Kutunit Deposits are different from those of the Tunca, Murgul, and Cerattepe Deposits.

Kaolinization, sericitization, and chloritization are recognized in the surrounding areas of the Murgul Deposit. An alteration zone of smectite, chlorite, kaolinite, mixed layers clay, smectite, illite, naclite, and siderite surrounds the Çayeli Deposit (Çağatay, 1993).

Chapter 4 Integrated Discussion on Survey Results

4-1 Characteristics of Geological Structure and Mineralization

4-1-1 Geology and Geological Structure

The area is underlain by the Alemağaç, Çağlayan, and Sivrikaya Formations of the upper Cretaceous, and the Hamidiya Formation of the Tertiary from the bottom. The Alemağaç Formation is the bottom one in the area, being correlated to the Kızılkaya Formation, which is the host formation for the volcanogenic massive sulphide deposits in the eastern Pontides. The formation is divided into two members, the lower member consisting of the aphyric dacite (Adcu), dacite lava (Adcl), and dacitic pyroclastic rocks (Atf), and the upper member consisting of the purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Attf). The aphyric dacite (Adcu) is distributed along the Hemsin River, mainly consisting of hyaloclastite. The dacite lava (Adcl) and dacitic pyroclastic rocks (Atf) are distributed along the Durak River. The purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Attf) are of essentially same rock body, but its intrusive facies, lava facies, and pyroclastic facies correspond to the purple dacite, green dacite, and the dacitic pyroclastic rocks respectively.

The Çağlayan Formation is characterized by the dominant basic activities, and the basaltic rocks (Cbs) is divided into three members, the lower, middle, and upper from the bottom by its intercalated sedimentary layers. The Sivrikaya Formation is composed of the dominant acidic tuffaceous rocks (Stf) and mudstone (Smd), and the Hamidiya Formation consists of the poorly consolidated sedimentary rocks. The intrusive rocks exist in many places in the area. The dolerite intrusive bodies are dominant in the area, and the granitic rocks are correlated with the Kaçkar Granitic rocks of the Eocene.

The area is geologically separated into two parts, being bounded by the Garimani Fault. The northern side of the fault is underlain by the lower member of the Alemağaç Formation, together with various intrusive bodies. On the other hand, the southern side of the fault is broadly underlain by the Çağlayan Formation, and some mineralized zones are emplaced in the lower member of the Alemağaç Formation centering to the watershed of the Hemsin River. The northeast to southwest tectonic system is dominant in the area, reflecting to the trend of the fault system, intrusive bodies, and mineralized zones. The formations in the area also strike the same northeast to southwest direction.

4-1-2 Mineralization

The Garimani, Yeşilköy West, Köpruköy, and Duygulu Mineralized Zones, and the Yukarı Mineral Occurrence exist in the area, being emplaced in the dacitic rocks (Adcu, Adcl, and Atf) of the lower member of the Alemağaç Formation. These mineralized zones and occurrences have been formed by the volcanic massive sulphide mineralization, vein-type mineralization, and the mineralization related to the granodiorite intrusion.

The mineralized zones except the Duygulu Mineralized Zone extend northeast to southwest, and the green dacite (Adcg) and purple dacite (Adcp) of the upper member of the Alemağaç Formation have not undergone alteration related to the mineralization. Therefore, it is thought that these mineralized zones had been formed before the deposition of the upper member of the Alemağaç Formation. The Garimani Mineralized Zone presumably has been formed by the volcanogenic massive sulphide mineralization, due to the existence of the silicified dacite lave (Adcl) and the quartz - potassium feldspar - sericite zone in the center of the mineralized zone, as well as the Tunca Deposit.

On the other hand, it is thought that the Yeşilköy and Köpruköy West Mineralized Zones have been formed by the vein-type mineralization controlled by the tectonic movement. The K-Ar age determination result for sericite indicates 83.1±2.1 Ma for the Garimani Zone, 82.0±1.6 Ma for the Tunca Deposit, and 83.2±2.1 Ma for the Köpruköy Zone, being correlated with the Santonian stage, 86.6 to 83.0 Ma, to the Campanian stage, 83.0 to 74.0 Ma, of the late Cretaceous.

The alteration zones related to the mineralization are in large-scale in the area, but consisting mainly of pyrite dissemination, and the grade of copper is low, ranging from <0.01 to 0.54 %.

(1) Alteration Mineral

The mineralized zones show the alteration mineral zones from the center as follows: 1) quartz-sericite-chlorite zone, 2) quartz - (sericite) - (chlorite) - sericite/ smectite mixed-layer mineral zone. The Garimani Mineralized Zone is present quartz - potassium feldspar - sericite zone inside of the 1) quartz - sericite chlorite zone as well as the Tunca Ore Deposit.

(2) Alteration Index

The strong alteration zones showing over 90 percent alteration Index (AI) are seen in the Garimani, Yeşilköy West, Köpruköy, and Duygulu Mineralized Zones, and the Yukarı Occurrence. The strong alteration zones in the area except the Duygulu

Zone, extends northeast to southwest, reflecting the geological structure.

(3) Geochemical Survey

The geochemical anomalies detected in the area are as follows: Au, Cu, Zn, Cd, and S in the Duygulu Zone, Au, Ag, As, and S in the Yeşilköy West Zone, Pb, As, and S in the Köpruköy Zone, Pb in the Garimani Zone, and Au, Pb, Cd, and Ba in the Yukarı Zone. These anomalies have been detected from the specimens of the aphyric dacite (Adcu).

4-2 Potential for New Ore Deposit

The volcanogenic massive sulphide mineralization, vein-type mineralization and mineralization related to the granodiorite intrusion are recognized in the area. The former two mineralization have occurred before the formation of the upper member of the Alemağaç Formation, i.e. in late Cretaceous time, and the third mineralization has occurred in Eocene time. The volcanogenic massive sulphide mineralization is represented by that of the Garimani Mineralized Zone, abundant copper and zinc compared with other zones. The Yeşilköy West and Köpruköy Mineralized Zones have been formed by the vein-type mineralization, extending northeast to southwest. The Duygulu Mineralized Zone has been formed by the mineralization related to the granodiorite intrusion, correlated with the Kaçkar Granitic Rocks, being expanded around the granodiorite.

Each mineralized zone in the area is characterized by following points, even it has different type and timing of the mineralization.

* The sulphide is mainly composed of pyrite dissemination, being scarcely accompanied by chalcopyrite and sphalerite.
* The assay value of the ore minerals is generally low, lower than 0.2 percent for copper and zinc, except a few specimens.
* No significant lateral and vertical change is seen in the mineralized zones.

Accordingly, it is low for economical potential in the mineralized zones confirmed in the Garimani area.

Chapter 5 Conclusion and Recommendation

5-1 Conclusion

5-1-1 Geology

The area is underlain by the Alemağaç, Çağlayan, and Sivrikaya Formations of the upper Cretaceous, and the Hamidiya Formation of the Tertiary from the bottom, having been intruded by dacite, granitic rocks, and dolerite intrusive bodies. The Alemağaç Formation is divided into two members, lower member composed of the aphyric dacite (Adcu), dacite lava (Adcl), and dacitic pyroclastic rocks (Atf), and the upper member composed of the purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Attf). The lower member is distributed along the Hemsin and Durak Rivers, having undergone alteration related to the mineralization. The purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Adcg) are different rock facies from the same body, and the granitic rock is correlated with the Kaçkar Granitic Rocks situated to the south of the area. The northeast to southwest structure system is dominant in the area, reflecting to the trend of the fault system, intrusive bodies, and mineralized zones.

5-1-2 Mineralization

Three types of mineralization are recognized in the area, the volcanogenic massive sulphide mineralization and vein-type mineralization, having occurred before the formation of the upper member of the Alemağaç Formation, and the mineralization associated with the Eocene granitic intrusive rock. The mineralized zones other than the Duygulu Zone are controlled by the geological structure, extending northeast to southwest. The mineralized zones are composed of pyrite dissemination zones, and the grade for copper and zinc is low. The mineralized zones do not change their state vertically and laterally. Accordingly, it is judged that the economic potential for the minerals is low in the area.

5-2 Recommendation for Future

The third year's survey has revealed that the economic potential of the mineralized zones confirmed in the Garimani area is low for development in future.

However, the high grade Çayeli Deposit, 3.6 % Cu and 5.7 % Zn, and 16 million tons of ore reserve, is situated about 25 kilometers to the southwest of the area, and its ore horizon extends to the area. It is judged that the potential for economic ores is high in the surrounding area of the area.

It is important to expand prospecting areas to the surrounding area in future.

Part Ⅱ

Details of the Surveys

Part Ⅱ Details of the Surveys

Chapter 1 Geological Survey

1-1 Survey Area

Fig. 1 shows the location of the survey area. The Hopa area is situated in the northeast of the Turkey, near the border with the Republic of Georgia. For fiscal 2004, The Garimani was selected for the survey. The Garimani area is situated in the southwestern end of the Hopa area.

1-2 Survey Method

(1) Field Survey

The geological survey in the field has been performed along route lines set up for the survey, after study of existing geological data. Topographic maps scaled 1: 5,000 was enlarged from existing maps scaled 1: 25,000 have been provided for the field survey. GPS has been utilized for the field survey. Specimens for all typical rocks and rock facies have been taken with sufficient cares.

(2) Specimens and Laboratory Tests

The laboratory tests included thin section observation, polished section observation, whole rock analysis, X-ray diffraction, ore grade analysis and K-Ar age detarmonation.

1-3 Survey Results

1-3-1 Geology

The area is underlain by the Upper Cretaceous Alemağaç, Çağlayan, and Sivrikaya Formations, and the Tertiary Hamidiya Formation, having been intruded by granite and dolerite intrusive rocks. Figure Ⅱ-1-1 shows the geological map, Figure Ⅱ-1-1-2 shows the geological cross section, and Figure Ⅱ-1-1-3 shows the stratigraphic columnar section.

(1) Alemağaç Formation

The Alemağaç Formation is the lowermost one in the area, consisting of dacitic lavas and dacitic pyroclastic rocks, and partly preceding small-scale basaltic lavas.

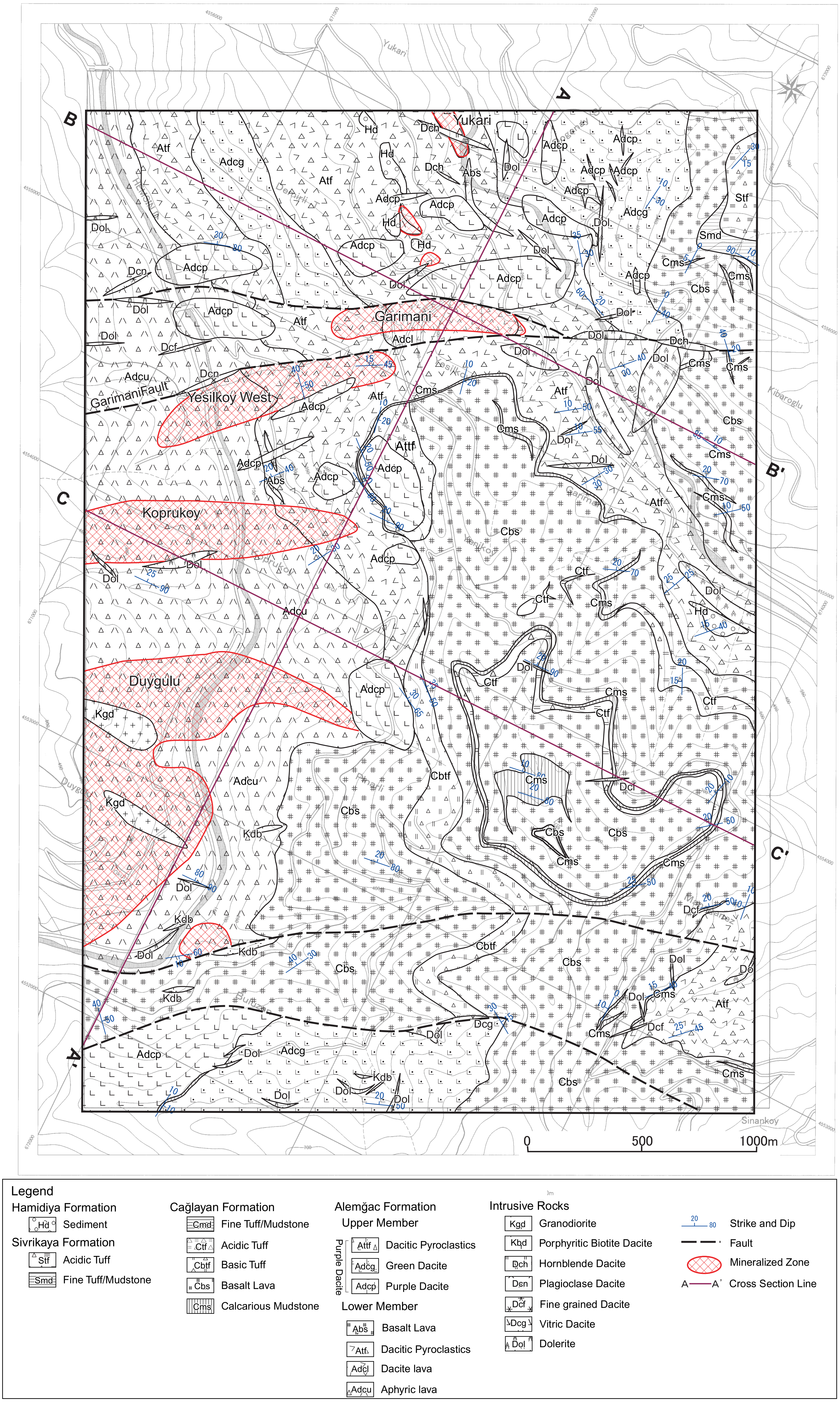


Fig. II-1-1 Geological Map of the Garimani Area

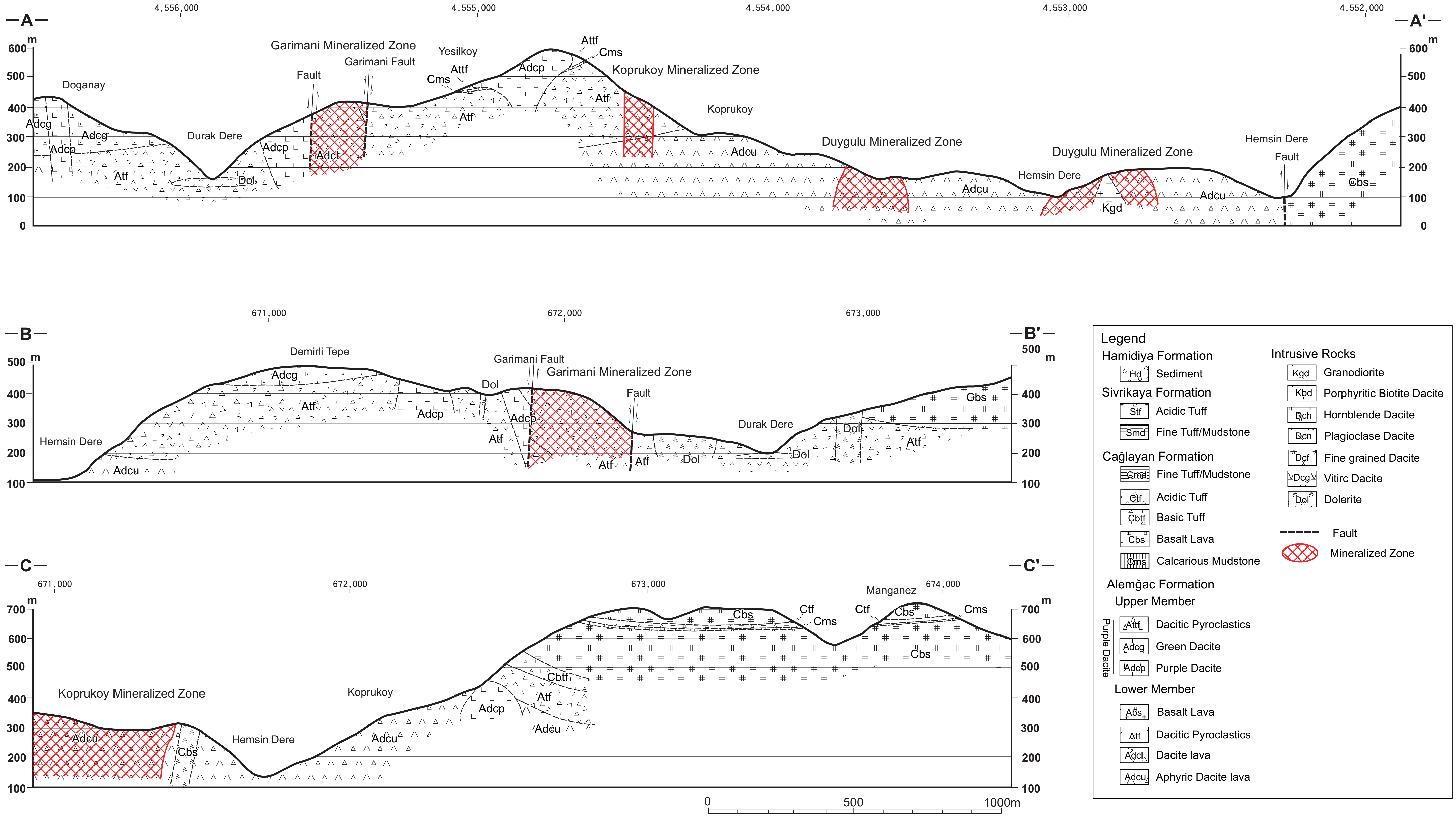


Fig. II-1-2 Geological Cross Section of the Garimani Area

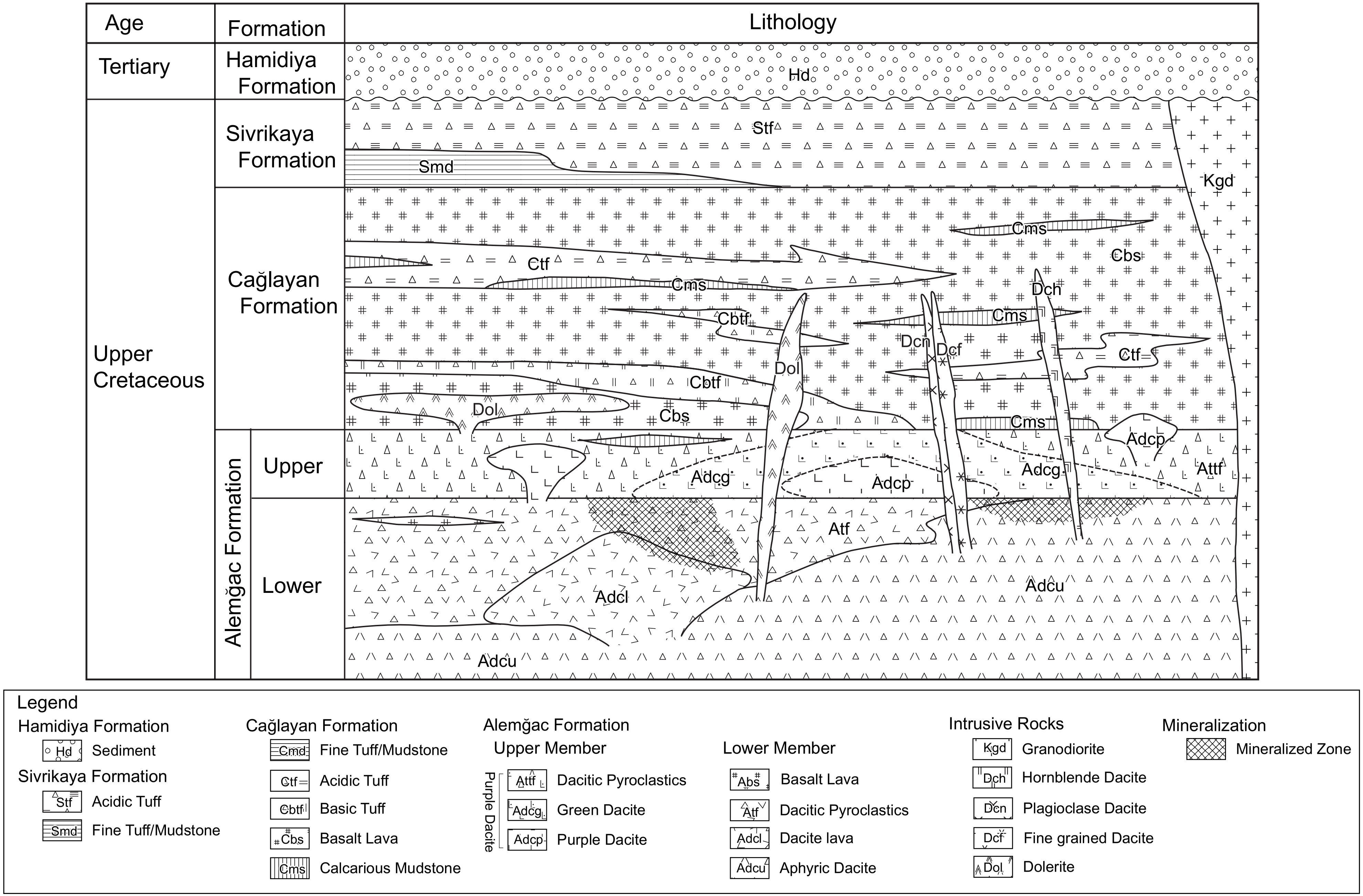


Fig. II-1-3 Schematic Stratigraphic Column of the Garimani Area

The Alemağaç Formation has been treated as one formation until now, but the formation has been classified into the lower member having undergone the volcanogenic massive sulphide mineralization and the upper member in this report.

(a) Lower Member of the Alemağaç Formation

The lower Member is composed of lower aphyric dacite (Adcu) and overlain dacitic lave (Adcl), and dacitic pyroclastic rocks (Atf), distributing along the Hemsin and Durak Rivers.

The aphyric dacite (Adcu) is broadly distributed in the western area, centering the Hemsin River watershed. The dacite is green aphyric vitric rock, mainly consisting of hyaloclastite showing autobrecciated structure. Around Duygulu, the rock contains a small-amount of silicified accidental fragments. The rock shows intrusive facies to the west of Köprukӧy and around Duygulu, showing columnar joints. The Duygulu, Köprukӧy, and Yeşilkӧy West mineralized zones are emplaced in the dacite, being accompanied with pyrite dissemination, silicification, and argillization zones.

The dacite lava (Adcl) and dacitic pyroclastic rocks (Atf) are distributed along the Durak River and around Yeşilkӧy and Manganez. The dacite lava (Adcl) is present around Garimani Mineralized zone as a small body, and is in fault contact with dacitic pyroclastic rocks (Atf) in the southeastern side and with purple dacite (Adcp) in the northwestern side. The dacite lava (Adcl) is pale gray to pale green, aphyric rock, rarely containing small-amounts of quartz and plagioclase phenocrysts.

The dacitic pyroclastic rocks (Atf) consist of tuff breccia and lapilli tuff mainly composed of the fragments derived from the underlain dacitic lava (Adcl), partly containing black siliceous fragments. The rock is pale yellowish brown to pale greenish gray, and its matrix consists of dacitic coarse and loose tuff, in some cases containing green vitric flakes. In the east side of the Durak River, the pyroclastic rocks are mainly composed of lapilli-tuff and fine-grained tuff, showing bedding and intercalating thin layers of reddish calcareous mudstone.

Along the Durak River in the northern area, a small-scale basalt (Abs) and basaltic tuff are distributed.

[Microscopic Observation]

Aphyric dacite (Adcu): Containing small-amounts of plagioclase, and shows vitric texture. Quartz, calcite, chlorite, and clay minerals appear as the alteration minerals.

Dacite lava (Adcl): A small amount of plagioclase as phenocrysts. Groundmass shows vitric texture, probably colorless glass in origin. It has undergone mineralization/ alteration, appearing quartz, sericite, pyrite, and sphalerite.

Dacitic lapilli tuff (Atf): Mainly consists of dacitic fragments, together with small amounts of plagioclase crystals. Quartz, sericite, chlorite, calcite, and hydroxide iron minerals as alteration minerals.

(b) Upper Member of the Alemağaç Formation

The upper member is composed of the purple dacite (Adcp), green dacite (Adcg), and green dacitic pyroclastic rocks (Attf). The purple dacite (Adcp) is of intrusive facies showing pale purple, dominantly distributing northern side of the Garimani Fault, and partly in Yeşilköy and Bülüzan. The rock has intruded in the lower member of the Alemağaç Formation and the green dacite, forming small stocks and dykes. The rock is aphyric as well as the dacite lava (Adcl) of the lower member of the Alemağaç Formation, rarely containing small-amounts of quartz and plagioclase phenocrysts. The rock distributed in Demirli Tepe and Bülüzan is vitric.

The green dacite (Adcg) and green dacitic pyroclastic rocks (Attf) are distributed in Doğanay, Yeşilköy, Demirli Tepe, and Bülüzan. These rocks are of green to pale green lava facies, showing dark green bands, and containing small amounts of quartz and plagioclase phenocrysts. The rocks grade into pyroclastic facies to the edges of the flows. The rocks contain some fragments of the purple dacite in many places, transforming volcanic breccia or tuff-breccia containing large-amounts of vitric purple dacite fragments.

Followings are some phenomena observed in the purple dacite and green dacite.

* The purple dacite fragments are included in the green dacite in many places.
* The purple dacite has intruded into the green dacite.
* Both rocks are distributed closely associated each other. The boundary between them is unclear, changing gradually.

From the above-mentioned phenomena, it is judged that both rocks are essentially same rock, and the purple dacite fragments in the green dacite are the crushed parts of the autobrecciated lava. The relation between them is that the green dacite is presumably a part of the purple dacite flowed out on the sea floor, and the purple dacite probably has intruded into the consolidated rock body itself repeatedly. It is thought that the activity stage of the rocks is just right after the sedimentation of the dacitic rocks (Adcl and Atf) of the lower member of the Alemağaç Formation, however the rock body to the south of Yeşilköy overlies the reddish calcareous mudstone (Cms) of the lower part of the Çağlayan Formation. It is presumed, therefore, that some part of the rock body has been still active after it intrusion into the Çağlayan Formation.

[Microscopic Observation]

Purple dacite (Adcp): Including small-amounts of quartz and plagioclase phenocrysts. Groundmass shows cryptocrystalline felsic texture, consisting of microlite of quartz and feldspar and colorless glass. Having undergone weak alteration, producing microcrystalline quartz.

Green dacite (Adcg): Scattering small-phenocrysts of quartz and plagioclase, showing porphyritic texture. Groundmass shows cryptocrystalline felsic texture, consisting of microlite of quartz and feldspar and glass. Showing weak alteration, producing small-amounts of quartz, calcite, chlorite, and clay minerals.

Green dacitic lapilli-tuff (Attf): Consisting of dacitic lapilli to coarse-grained volcanic ash with dacitic fine-grained volcanic ash filling. Lapilli and volcanic ash contain small-amounts of quartz and plagioclase. Producing quartz, chlorite, clay minerals, and hydroxide iron as alteration minerals.

(2) Çağlayan Formation

The Çağlayan Formation is distributed in the southern side of the Garimani Fault and to the east of the Durak River, consisting of basalt lava (Cbs), basaltic tuffs (Cbtf), calcareous mudstone (Cms), and acidic tuffs (Ctf), being characterized by dominant basic volcanic activity.

The basic volcanic rocks are mainly composed of dark green to blackish brown basalt lava, being accompanied by basic tuffs. The basalt shows aphyric to porphyritic texture, containing some phenocrysts of colored minerals. It is supposed that the basalt has erupted from multiple vents intermittently for a long period, however to distinguish each activity product is impossible. The basalt flows are divided in the upper, middle, and lower units by the intercalating reddish calcareous mudstone and tuffs.

The lower basalt lava is distributed from Pınarlı to Bülüzan in the southern area, showing fresh-compact and massive appearance. In some places, the flow shows agglomerate-like to tuff breccia-like feature with amygdaloidal texture. A large-scale dolerite sheet characterized by coarse-grained pyroxene phenocrysts seemingly exists along the forest roads from Pınarlı to Bülüzan, but it is difficult to distinguish it from the basalt lava. The lower basalt flow does not intercalate calcareous mudstone or acidic tuffs.

On the other hand, the middle and upper basalt lavas intercalate many thin layers of the reddish calcareous mudstone and acidic tuffs, and a thick acidic tuff bed exists to the southeast of Garimani. The amygdaloidal texture and pillow lava are very common in the middle and lower basalt lavas, being filed by calcite or zeolite in their spaces. On the east bank of the Durak River, basaltic agglomerate and tuff breccia is dominant, and some mud-balls contained calcareous mudstone are seen.

The upper basalt lava is distributed around Manganez Mountain, bounded by the reddish calcareous mudstone and acidic tuffs, about 20 meters thick, with the middle basalt lava. This sedimentary layer is distributed along the forest road from Yeniköy to Manganez, extending northeast to southwest, to east to west, dipping 10 to 20 degrees to the north. The acidic sedimentary rocks are bluish green compact fine–grained, pale green containing fine-fragments of dacite, and others.

The reddish calcareous mudstone appears as thin layers in the basalt lava, or lenticular bodies. On the west bank of the Durak River, the reddish calcareous mudstone exists on the boundary between the Alemağaç and Çağlayan Formations, traceable about 2 kilometers long from Garimani to Yeniköy repeating swelling and shrinking.

The basic tuff (Cbtf) is composed of lapilli-tuff and tuff containing fine-grained basalt fragments. In the west side of the Manganez Mountain, a thick basic tuff layer overlies the lower basalt lava, and the upper and middle basalt lavas intercalate thin basic tuff layers together with calcareous mudstone.

[Microscopic Observation]

Basalt (Cbs): Augite and plagioclase, and small-amounts of olivine as phenocrysts. Gas cavities filled by calcite, chlorite, and zeolite. Groundmass is intersertal, consisting of glass, plagioclase, augite, and oxidized iron. Alteration grade is low, producing calcite, chlorite, zeolite, and clay minerals.

Basaltic coarse-grained tuff (Cbtf): Consisting of breccia-like basaltic coarse-grained volcanic ash. Basalt contains plagioclase phenocrysts, and porous. Plagioclase and chlorite as alteration minerals together with quartz and hydroxide iron.

Acidic lapilli-tuff (Ctf): Secondary deposited sediment consisting of rounded dacite, andesite, and basalt lapilli and volcanic ash. Quartz, sericite, and smectite as alteration minerals.

Reddish calcareous mudstone (Cms): Consisting of foraminifer fossil and mud. Mud contains hematite together with oxide manganese in some places.

(3) Sivrikaya Formation

The Sivrikaya Formation is distributed in the northeastern area, consisting of gray to brown mudstone (Smd) in the lower, and acidic tuffs (Stf) in the upper. The tuffs are greenish gray, containing fine-grained fragments of dacite and basalt. In the matrix, dark green band texture is seen.

The formation strikes east to west, and dips north in the southern part, but strikes north-northeast to south-southwest, and dips east in the northern part.

[Microscopic Observation]

Acidic coarse-grained tuff (Stf): Consisting of rounded fragments of dacite, andesite, and basalt, coarse volcanic ash size. Fragments of andesite and dacitic rocks are dominant. Secondary deposited sediment, showing low-grade alteration. Quartz, sericite, chlorite, and epidote exist as alteration minerals.

(4) Hamidiya Formation

The Hamidiya Formation is the uppermost unit of the area, unconformably overlies the lower formations. The formation is distributed to the southeast of Yukarı and to the east of Garimani, along the Durak River. The formation is composed of grayish white unconsolidated sediment, containing fragments of dacite, basalt, and mudstone. The stage of the deposition is unclear, but presumably the Miocene.

(5) Intrusive Rocks

Intrusive rocks of dacite (Dch, Dcn, Def, Dcg), granite (Kgd, Kdb), and dolerite (Dol) exist in many places in the area.

(a) Hornblende Dacite (Dch)

The hornblende dacite is distributed in Kibaroglu, on the river floor of the Durak River near Yukarı, and in the north of the Hemsin River, intruding in the aphyric dacite (Adcu) and dacitic pyroclastic rocks (Atf) of the Alemağaç Formation, trending east to west and northeast to southwest. The rock is gray to purple gray, containing large phenocrysts of quartz and plagioclase. Under the microscope, quartz, plagioclase, biotite, augite, and iron minerals are seen as phenocryst, are the groundmass is composed of quartz, feldspar, biotite, and glass.

(b) Plagioclase Dacite (Dcn)

The plagioclase dacite is distributed along the Hemsin River, intruding into the dacitic rocks (Adcu, Atf) of the Alemağaç Formation as small-scale dykes. Under the microscope, small-amounts of plagioclase phenocrysts are seen. The groundmass shows intersertal texture, consisting of quartz, feldspar, oxide-iron microlite. The rock is relatively fresh, containing small-amounts of chlorite and calcite.

(c) Fine-grained Dacite (Dcf)

The fine-grained dacite is distributed near Manganez, intruding into the basalt of the Çağlayan Formation as a dyke several meters in width. The rock is gray to grayish green, fine-grained compact, containing small phenocrysts of quartz.

(d) Vitric Dacite (Dcg)

The vitric dacite is distributed the upper stream of the Bülüzan River, as a small-scale dyke in the basalt of the Çağlayan Formation. The rock is vitric with chocolate color, and containing abundant large-scale plagioclase phenocrysts. Under the microscope, plagioclase phenocrysts show idiomorphic texture, and the groundmass is cryptocrystalline felsic consisting of quartz, feldspar microlite, and glass. Quartz, chlorite, sericite, and calcite are seen as alteration minerals.

(e) Kaçkar Granite

The Kaçkar granite is distributed around Duygulu and Bülüzan in the southwestern area, intruding into the dacite of the Alemağaç Formation and the basalt of the Çağlayan Formation. It is thought that the granite bodies have intruded in a trend east to west around Duygulu, and northeast to southwest around Bülüzan. The granite consists of the granodiorite (Kgd) and porphyritic biotite- dacite (Kdb), showing olive-gray to dark green, and contains quartz, feldspar, biotite, and amphibole. The granite body around Duygulu has given hydrothermal alteration and pyritization to the surrounding aphyric dacite (Adcu), therefore it would be caused by some mineralization process.

It is thought that the granite is correlated to the Kaçkar Granite to the south of the area.

[Microscopic Observation]

Porphyritic biotite dacite (Kgd): Showing significant porphyritic texture. Abundant in quartz and plagioclase phenocrysts, together with biotite. Showing high grade alteration by abundant chlorite, sericite, calcite, quartz, and pyrite.

(f) Dolerite (Dol)

The dolerite is appears in many places as dykes and small bodies, especially large number of the bodies around the Durak River. The orientation of the intrusive bodies is dominantly northeast to southwest. Sheets of the dolerite are seen along the Durak River. A large-scale dolerite sheet is seen along the forest road from Pınarlı to Bülüzan, but it is difficult to distinguish from the basalt. The dolerite is dark green, compact rock, and consists of plagioclase, augite, and oxide iron minerals as the principal components, and biotite and alkali as accessory component under the microscope. Chlorite, sericite, and zeolite are seen as secondary minerals.

1-3-2 Geological Structure

The geological setting in the area is quite different between both sides of the Garimani Fault, running northeast to southwest through the Garimani mineralized zone. In the northern side of the fault, the basalt of the Çağlayan Formation (Cbs) lacks, and the lower member of the Alemağaç Formation crops out there. Some small bodies of the purple dacite (Adcp) and the green dacite (Adcg), and small dykes of the dacite extending northeast to southwest have intruded in the Alemağaç Formation. On the other hand, the basalt of the Çağlayan Formation is broadly distributed in the southern side of the fault. and a mineralized zone extending northeast to southwest exists in the dacite of the lower member of the Alemağaç Formation, centering to the watershed of the Hemsin River. It is thought that the basement structural system controls this dominant northeast to southwest structural systems such as the fault systems, and trend of the intrusive rocks and mineralized zones. Except for this northeast to southwest system, some northwest to southeast systems are recognized in the area, reflecting the water systems of the Hemsin and Durak Rivers.

As shown in Figure II-1-4, a circular structure, 3 kilometers in diameter, is seen on the southwest of Bülüzan in the TM image of LANDSAT. It is presumed that the purple dacite (Adcp) and green dacite (Adcg) of the upper member of the Alemağaç Formation in this area were formed related with this structure.

1-3-3 Mineralization and Alteration

Alteration zones related to mineralization are distributed along the Hemsin River in the area. The principal zones are the Garimani, Yeşilköy West, Köpruköy, and Duygulu Mineralized Zones, and Yukarı Occurrence. These are emplaced in the dacitic rocks (Adcu, Adcl, Atf) of the lower member of the Alemağaç Formation. Figure II-1-5 shows the mineralized zones and occurrences.

(1) Alteration

(a) Alteration Mineral Zoning

Table II-1-1 shows the result of the X-ray diffraction analysis, and Figure II-1-6 shows the alteration mineral zoning. Following alteration mineral assemblages have been recognized from the X-ray diffraction analysis in this year.

1) quartz
2) quartz - sericite - chlorite
3) quartz - (sericite) - (chlorite) - sericite / smectite mixed layer minerals
4) quartz - (sericite) - (chlorite) - laumontite
5) sericite

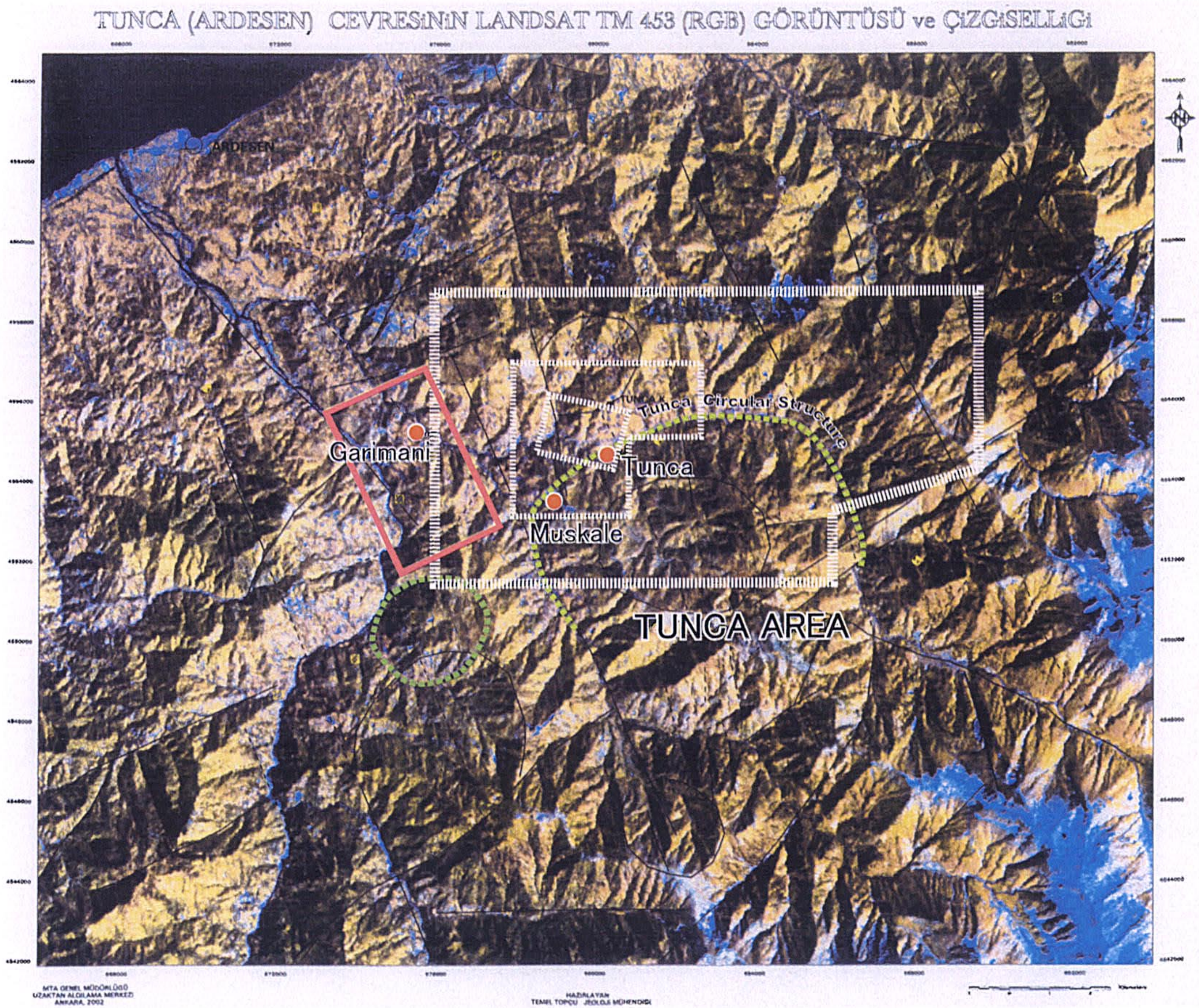
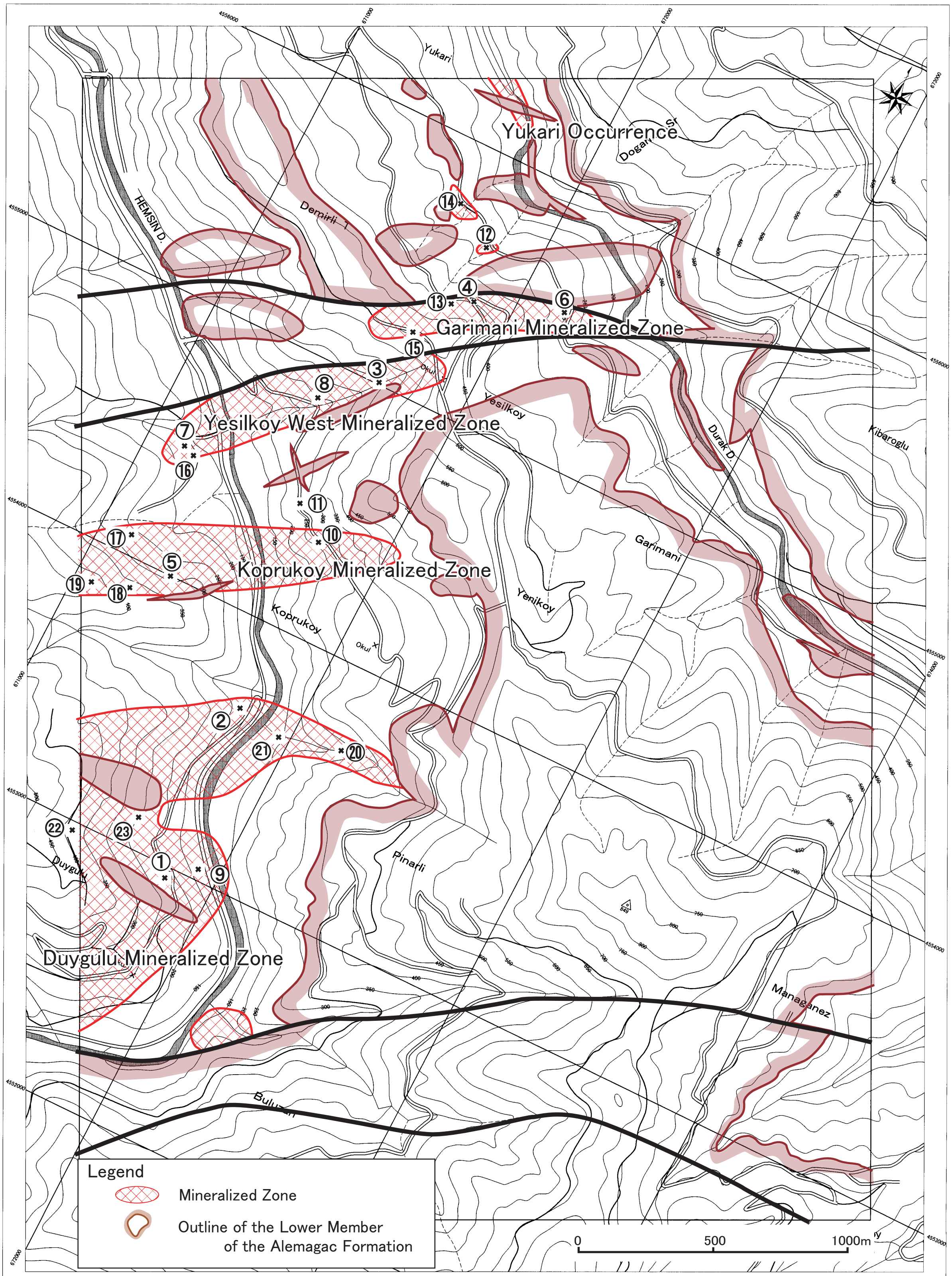


Fig. II-1-4 Photogeological Interpretation Map and LANDSAT TM Image of the Tunca Area



No.	Sample	Au (ppm)	Ag (ppm)	Cu (%)	Pb (%)	Zn (%)	Ba (%)	S (%)	No.	Sample	Au (ppm)	Ag (ppm)	Cu (%)	Pb (%)	Zn (%)	Ba (%)	S (%)
①	M031	0.10	2.10	0.166	0.001	0.020	0.360	40.64	⑬	Q071	0.27	1.40	0.118	0.005	0.150	0.388	1.12
②	M035	0.02	0.95	0.002	0.002	0.002	0.030	13.00	⑭	R011	0.08	0.50	0.002	<0.001	0.021	0.055	4.99
③	M040	<0.01	0.50	0.002	<0.001	0.007	0.077	2.00	⑮	R020	0.18	0.65	0.419	0.001	0.008	0.022	3.33
④	M073	0.01	0.65	0.018	0.007	0.812	0.014	1.23	⑯	R041	0.92	0.50	0.002	<0.001	0.004	0.043	4.64
⑤	M081	0.02	0.60	0.032	0.001	0.020	0.040	1.69	⑰	R043	1.64	0.50	0.001	<0.001	0.008	0.027	0.07
⑥	N011	0.12	2.00	0.537	0.006	5.130	0.011	12.90	⑱	R050	0.04	10.00	0.080	0.003	0.019	0.027	30.79
⑦	N031	<0.01	0.75	0.034	0.002	0.020	0.036	0.12	⑲	R057	<0.01	1.35	0.005	0.002	0.008	0.035	25.70
⑧	N034	0.07	0.75	0.002	<0.001	0.060	0.085	38.40	⑳	R088	<0.01	2.25	0.004	0.001	0.003	0.026	2.10
⑨	N042	<0.01	0.50	0.001	<0.001	0.002	0.035	3.66	㉑	R091	<0.01	0.50	0.001	0.001	0.032	0.015	1.12
⑩	Q027	<0.01	0.50	0.001	0.001	0.006	0.042	2.70	㉒	R098	<0.01	0.45	0.003	0.001	0.062	0.035	1.41
⑪	Q031	<0.01	0.45	0.014	<0.001	0.006	0.049	0.69	㉓	R100	<0.01	0.60	0.002	<0.001	0.004	0.038	4.56
⑫	Q069	0.01	1.40	0.015	0.006	0.323	0.045	2.65									

Fig. Ⅱ-1-5 Distribution Map of Mineralized Zones of the Garimani Area

Table Ⅱ-1-1 Results of X-ray Diffraction

No.	Sample	Location	Coordinates UTM-E	Coordinates UTM-N	ROCK TYPE	Alteration zone	Quartz	K-Feldspar	Albite	Epidote	Smectite	Sericite/Smectite	Chlorite/Smectite	Sericite	Chlorite	Kaolin Minerals	Halloysite	Laumontite	Analcime	Gypsum	Barite	Pyrite	Chalcopyrite	Sphalerite	Siderite	Dolomite	Calcite	Goethite	Remarks
1	M001	Kibaroğlu	73750	55237	Cbs	Zeo			3				1					<1									7		
2	M007	Doğanay	72725	55777	Atf	S/Sm	28		4			<1		<1															
3	M019	Doğanay	72363	56367	Adcg	S/Sm	19					<1		<1															
4	M028	Duygulu	71814	52547	Adcu	Ser-Ch	30		3		<1			<1	<1														
5	M031	Duygulu	71877	52938	Adcu	Ser-Ch	11							<1	3														
6	M035	Duygulu	71787	53710	Adcu	Ser-Ch	15							2	<1							1							
7	M040	Yeşilköy	71655	54943	Atf	Ser-Ch	23							1	2							<1							
8	M048	Bülüzan	72260	52580	Adcu	Ser-Ch	24		5					<1	<1							<1					1		
9	M053	Manganez	74162	53254	Atf	-	34		8	<1																			
10	M059	Manganez	74286	53647	Atf	S/Sm	30		2			<1			<1							<1					3		
11	M063	Garimani	73430	54809	Atf	-	16	2	6	<1	<1			<1				<1				<1							
12	M066	Garimani	72249	55412	Atf	S/Sm	22		2			<1										<1							
13	M073	Yeşilköy	71816	55411	Adcl	Ser-Ch	39							<1	<1							<1		<1					
14	M077	Pınarlı	72524	53690	Adcg	Ser-Ch	30		2					<1															
15	M081	Köprüköy	71259	53921	Adcu	Ser-Ch	32							1	1							<1					<1		
16	N005	Garimani	72654	55305	Atf	-	28		6		<1																		
17	N011	Garimani	72179	55525	Atf	Ser-Ch	7							4								1		2			<1		
18	N017	Kibaroğlu	72480	55625	Atf	-	20		9					<1	<1												1		
19	N019	Garimani	72965	54685	Ctf	Zeo	15		5						<1			3				<1					5		
20	N022	Garimani	72183	55486	Atf	S/Sm	34		2		<1			<1															
21	N031	Köprüköy	71125	54485	Adcu	Ser-Ch	2							<1								8					<1		
22	N034	Yeşilköy	71500	54835	Clay	Ser								2								6							
23	N042	Duygulu	71950	53045	Adcu	Ser-Ch	35							1								<1							
24	N043	Yukarı	71653	56207	Atf	Ser-Ch	28							<1	2							<1							
25	N046	Bülüzan	72937	52520	Ctf	Zeo	22							<1	<1			<1	4										
26	N050	Bülüzan	73137	52275	Adcg	-	26		15		<1				<1							<1					<1		
27	N056	Manganez	74547	53695	Atf	Zeo	15	2	2	1	<1			<1				<1											
28	P004	Manganez	73518	53905	Ctf	-	26		6					<1															
29	P040	Yeşilköy	72130	55020	Ctf	S/Sm	16	<1			<1			1															
30	Q013	Yeniköy	72850	54140	Ctf	Zeo	34		5		<1							2											
31	Q027	Köprüköy	71790	54380	Atf	Ser-Ch	26	<1						<1								2							
32	Q028	Köprüköy	71715	54400	Atf	Ser-Ch	24							<1								<1							
33	Q031	Köprüköy	71545	54600	Atf	Ser-Ch	27							<1	<1							<1							
34	Q034	Kibaroğlu	73050	55800	Cbs	Zeo	2		4		2				1			3									7		
35	Q069	Yukarı	71790	55600	Atf	Ser-Ch	31							<1	<1							6							
36	Q071	Yeşilköy	71785	55410	Adcl	Q	32														<1	<1						<1	
37	R011	Yukarı	71635	55760	Atf	Ser-Ch	18							<1	4							<1							
38	R020	Yeşilköy	71740	55260	Atf	Ser-Ch	39							1								<1							
39	R041	Köprüköy	71145	54480	Adcu	Ser-Ch	29							2	<1							<1		1				<1	
40	R043	Köprüköy	71150	54090	Adcu	Ser-Ch	30							2	2							<1							
41	R050	Köprüköy	71260	53930	Adcu	Ser-Ch	3							<1	<1							4					<1		
42	R057	Köprüköy	71075	53845	Adcu	Ser-Ch	8							<1								5							
43	R060	Köprüköy	70385	55260	Adcu	-	13		21						<1							<1							
44	R076	Bülüzan	73495	52695	Adcg	S/Sm	8		<1			<1		<1															
45	R088	Pınarlı	72275	53715	Adcu	Ser-Ch	20							<1								3							
46	R091	Pınarlı	71950	53610	Adcu	Ser-Ch	10		1					<1	4							<1							
47	R098	Duygulu	71410	52955	Adcu	Ser-Ch	30							<1	<1							<1							
48	R100	Duygulu	71595	53120	Adcu	Ser-Ch	35							1								<1							
*	A101	Garimani	72217	55451	Adcl	K-Ser	40	2						2								1		5			1		2002 survey

Q : Quartz, Ser-Ch : Quartz-Sericite-Chlorite, S/Sm : Quartz-(Sericite)-(Chlorite)-Sericite/Smectite mixed layer
Zeo : Quartz-Smectite-Laumontite, Ser : Sericite K-Ser : Quartz-K feldspar-Sericite

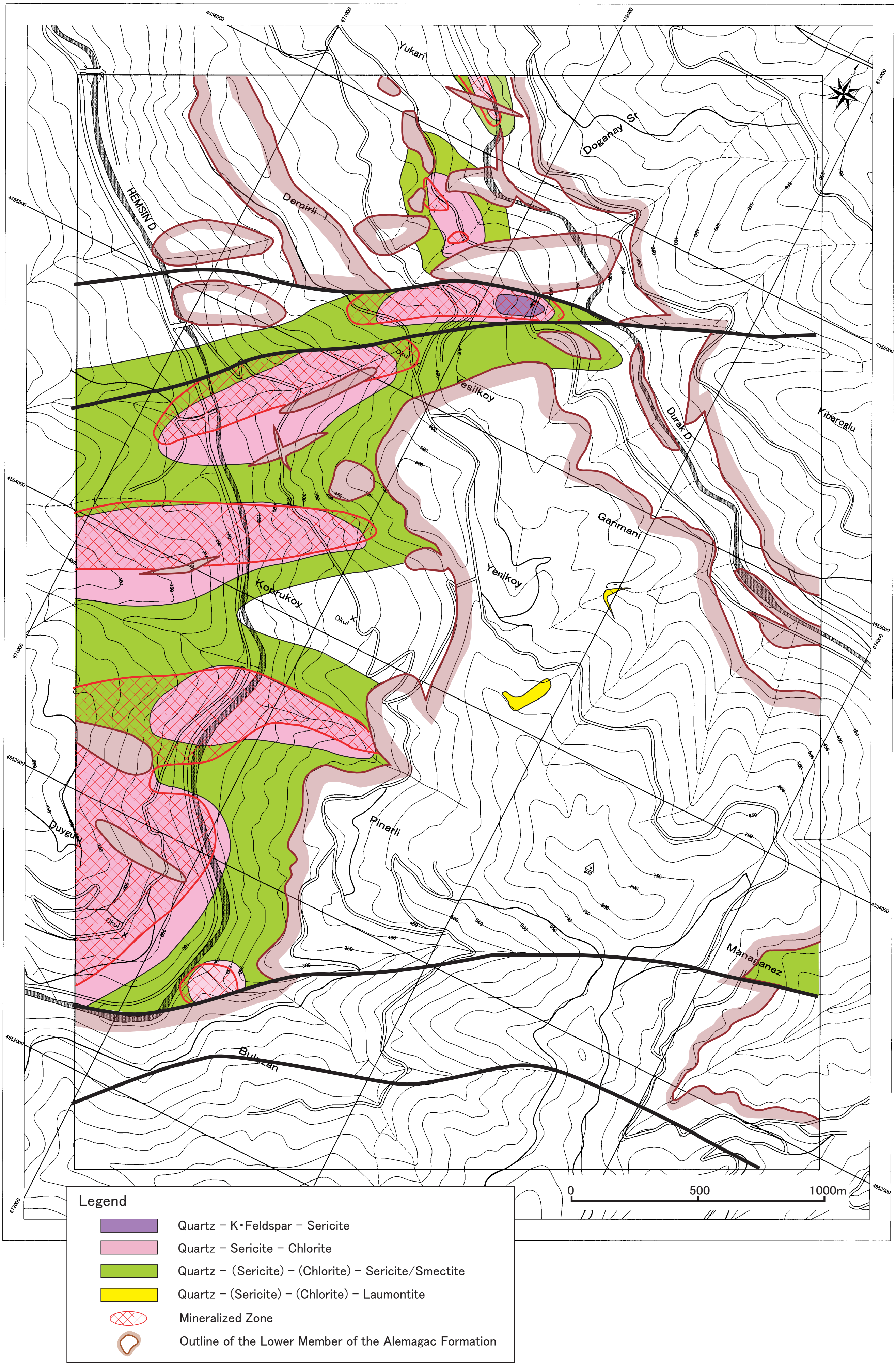


Fig. II–1–6 Distribution Map of Alteration Zones of the Garimani Area

Among these mineral assemblages, 1) quartz zone is present a part of the Garimani Mineralized zone, 2) quartz-sericite-chlorite zones are distributed around the mineralize zones and occurrences. These zones extend northeast to southwest, and 3) quartz - (sericite) - (chlorite) - sericite / smectite mixed layer minerals zones surround these. 3) zones are broadly distributed in the watershed of the Hemsin River, also in Manganez. 4) (sericite) - (chlorite) - laumontite zones are seen in the acidic tuffs (Ctf) in the basaltic rocks in the Çağlayan Formation. 5) sericite zones are seen in the clay filling crash zones in the Yeşilköy West Mineralized Zone, accompanied with some pyrite.

Potassium-feldspar (A101), together with quartz and sericite, was detected at the center of the Garimani Mineralized Zone in the Phase I's survey, even this year's survey failed to detect. It is thought that some quartz-potassium feldspar-sericite zone exists in the 2) quartz-sericite-chlorite zone in this mineralized zone. A quartz - potassium feldspar - sericite zone is distributed around the center of the Tunca Deposit of the volcanogenic massive sulphide ores.

(b) Alteration Index

The whole-rock analysis has been performed to measure the alteration intensity associated with the mineralization. The specimens prepared for the analysis are the dacitic rocks (Adcu, Adcl, Atf) of the lower member of the Alemağaç Formation, and their alteration index (AI) has been calculated. Table II-1-2 shows the obtained figures, and Figure II-1-7 shows the distribution of the values. The AI values over 90 percent have been found in the Garimani, Yeşilköy West, Köpruköy, and Duygulu Mineralized Zones, Yukarı Occurrence, and some points in Manganez. The values 80 to 90 percent have been detected at the point (M010) around Doğanay on the right bank of the Durak River. The strong alteration zones showing over 90 percent reflect the geological structure extending northeast to southwest, except the Duygulu Mineralized Zone.

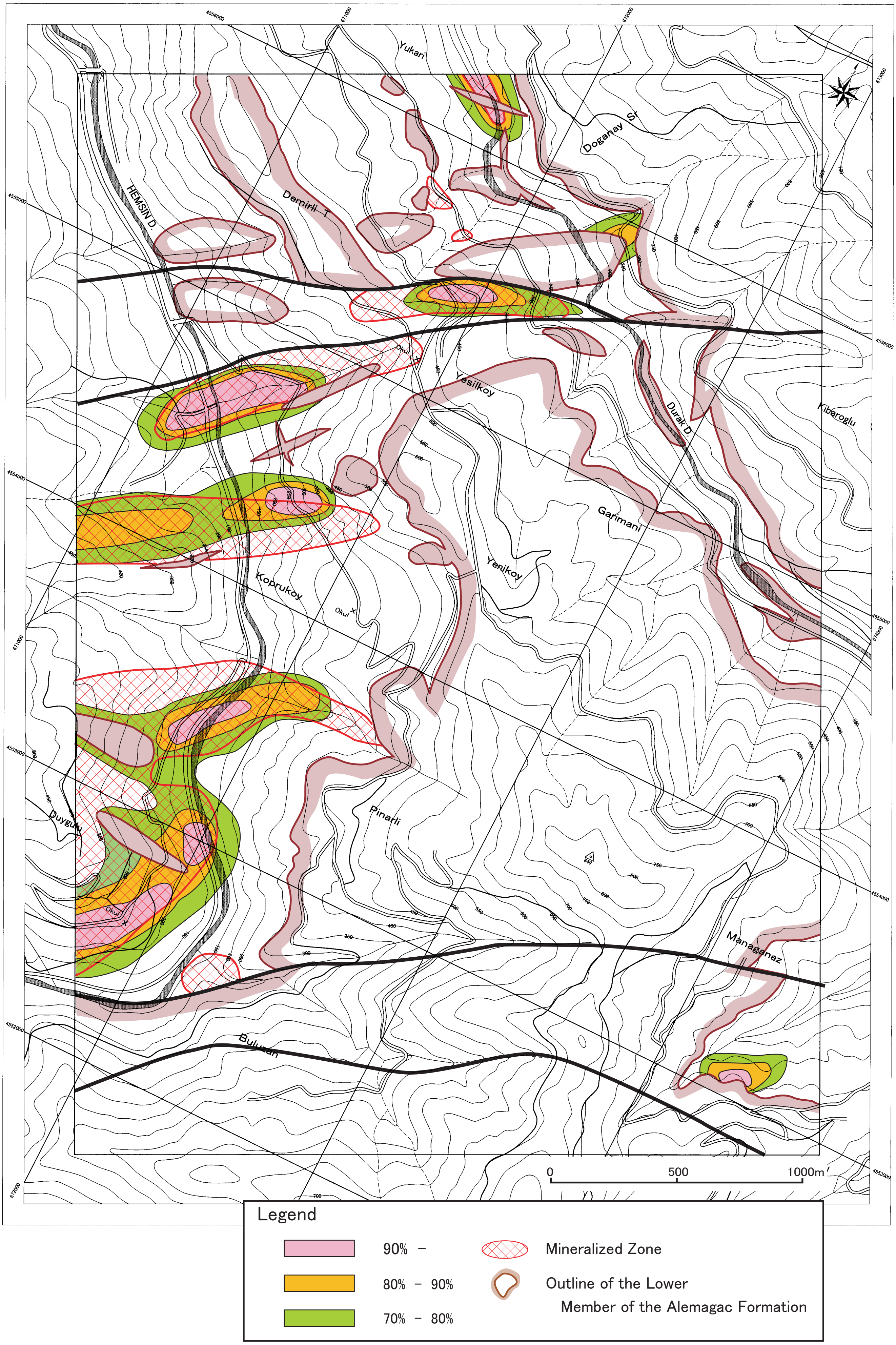


Fig. II-1-7 Distribution Map of Alteration Index of the Garimani Area

Table II-1-2 Alteration Index of the Garimani Area

Sample	Coordinates		Rock	Alteration	Ca	K	Mg	Na	Sample	Coordinates		Rock	Alteration	Ca	K	Mg	Na
	UTM-E	UTM-N	Type	Index(AI)	%	%	%	%		UTM-E	UTM-N	Type	Index(AI)	%	%	%	%
M007	72725	55777	Atf	68	0.39	1.90	0.62	0.73	N013	72178	55575	Adcl	57	0.10	1.73	0.47	1.53
M010	72396	55887	Atf	82	0.22	3.09	1.04	0.64	N016	72382	55755	Atf	30	1.22	1.10	0.48	2.32
M026	71712	52466	Adcu	97	0.01	2.21	0.28	0.06	N018	72835	55505	Atf	30	0.96	1.27	0.60	3.44
M028	71814	52547	Adcu	95	0.03	2.42	0.35	0.10	N022	72183	55486	Adcl	74	0.08	2.13	0.34	0.72
M030	71566	53003	Adcu	40	0.05	0.97	0.14	1.51	N029	71130	54515	Adcu	96	0.03	2.13	0.21	0.05
M034	71728	53412	Adcu	98	0.03	1.66	1.60	0.04	N038	71025	54745	Adcu	37	0.54	1.31	0.50	2.51
M037	71788	55070	Atf	28	0.16	1.10	0.14	2.78	N040	72175	52725	Adcu	38	1.02	1.36	0.63	2.21
M042	71455	54761	Atf	97	0.03	2.35	1.11	0.06	N043	71653	56207	Atf	97	0.04	2.14	1.44	0.07
M043	71376	54733	Atf	97	0.02	2.40	0.25	0.06	N056	74547	53695	Atf	54	2.37	2.73	0.75	0.37
M048	72260	52580	Adcu	29	1.69	1.28	0.28	1.98	Q025	71885	54330	Atf	19	0.24	0.67	0.30	3.81
M052	74126	52974	Atf	63	0.11	2.02	0.27	1.13	Q028	71715	54400	Atf	98	0.01	3.57	0.59	0.06
M053	74162	53254	Atf	9	0.89	0.42	0.09	4.07	Q054	71470	54275	Adcu	72	0.26	1.52	1.46	0.94
M059	74286	53647	Atf	35	3.36	1.73	0.51	0.48	Q056	71620	54095	Adcu	61	0.14	1.94	0.97	1.70
M062	74281	53107	Atf	91	0.08	1.56	0.23	0.08	R060	70930	54805	Adcu	22	1.10	0.16	1.12	4.40
M063	73430	54809	Atf	53	1.13	3.42	0.45	2.00	R066	70385	55260	Adcu	8	0.17	0.28	0.10	4.42
M065	72645	55310	Atf	33	0.22	1.07	0.51	2.97	R067	70615	54940	Adcu	54	0.88	2.36	0.67	1.55
M066	72249	55412	Atf	67	0.46	3.17	0.92	1.45	R084	72465	53640	Atf	9	0.11	0.28	0.03	2.81
M074	71885	55414	Adcl	98	0.02	1.84	0.50	0.03	R092	71965	53635	Adcu	88	0.08	1.56	2.50	0.52
M080	71940	53029	Adcu	97	0.01	2.49	0.27	0.07	R102	71575	53380	Adcu	68	0.09	1.53	1.18	1.25
N005	72654	55305	Atf	25	0.23	0.15	0.74	2.86									

(2) Geochemical Survey

Geochemical survey has been carried out for rock chips to understand characteristics of mineralization in the area. A total number of 77 specimens have been selected mainly form dacite and dacitic pyroclastics of the lower member of the Alemağaç Formation for analysis. The analysis (ICP-AES method) for followings 28 elements (with detecting limit) has been asked for ALS Chemex.

Au(0.001ppm), Ag(0.5ppm), Al(0.01%), As(2ppm), Ba(10ppm), Be(0.5ppm), Bi(2ppm), Ca(0.01%), Cd(0.5ppm), Co(1ppm), Cr(1ppm), Cu(1ppm), Fe(0.01%), K(0.01%), Mg(0.01%), Mn(5ppm), Mo(1ppm), Na(0.01%), Ni(1ppm), P(10ppm), Pb(2ppm), S(0.01%), Sb(5ppm), Sr(1ppm), Ti(0.01%), V(1ppm), W(10ppm), and Zn(2ppm).

Appendix 4 shows results of chemical analysis for rock specimens. As for Sb and W, all specimens shows under the detection limit value and most of these elements include Au, Ag, As, Bi, Cd, Mo, and S show the values of less than the detection limit value. Univariate analysis and Principle component analysis have been applied for chemical analytical data.

(a) Univariate Analysis

Univariate analysis has been applied for the specimens of the lower member of the Alemağaç Formation. A total number of 39 specimens have been selected. The statistic data and results are shown in Table II-1-3～Table II-1-6 and appendix 5. The

Table Ⅱ-1-3 List of Statistic Data of Whole Rocks

Whole Rock	Au ppm	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	K %
No. of samples	77	77	77	77	77	77	77	77	77	77	77	77	77	77
Max.	0.038	2.0	7.87	51	900	1.3	8	6.66	5.3	6	106	273	7.7	3.57
Min.	<0.001	<0.5	4.14	3	10	<0.5	<2	0.01	<0.5	1	10	1	0.6	0.15
Arithmetic Mean	0.004	0.3	6.15	10	221	0.7	1	0.64	0.4	1	42	34	2.48	1.69
Arithmetic σ	0.007	0.3	0.83	11	194	0.3	1	1.22	0.8	1	21	63	1.53	0.89
Geometric Mean	0.001	0.3	6.10	6	145	0.7	1	0.18	0.3	1	37	10	2.11	1.35
Geometric σ	3.444	1.5	1.15	3	3	1.6	2	5.57	1.9	2	2	5	1.79	2.22
Geometric $\mu+\sigma$	0.005	0.4	7.00	16	399	1.0	2	1.00	0.6	2	65	47	3.76	3.00
Geometric $\mu+1.5\sigma$	0.009	0.5	7.50	25	661	1.3	2	2.37	0.8	2	86	100	5.03	4.48
Geometric $\mu+2\sigma$	0.016	0.7	8.04	40	1,098	1.6	3	5.59	1.0	3	115	213	6.72	6.67

Whole Rock	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sr ppm	Ti %	V ppm	W ppm	Zn ppm
No. of samples	77	77	77	77	77	77	77	77	77	77	77	77	77	77
Max.	2.50	5,470	4	4.42	10	530	750	3.03	<0.5	521	0.49	237	<10	779
Min.	0.03	65	<1	0.03	<1	20	<2	<0.01	<0.5	3	0.06	<1	<10	8
Arithmetic Mean	0.63	895	1	1.46	3	175	36	0.26	–	67	1.11	14	–	129
Arithmetic σ	0.51	1,023	1	1.38	2	113	121	0.66	–	99	0.64	37	–	143
Geometric Mean	0.46	551	1	0.63	2	142	9	0.02	–	31	0.82	6	–	86
Geometric σ	2.45	3	2	5.13	2	2	4	8.05	–	4	2.74	3	–	2
Geometric $\mu+\sigma$	1.12	1,568	2	3.22	4	286	31	0.17	–	114	2.23	19	–	212
Geometric $\mu+1.5\sigma$	1.75	2,646	2	7.30	6	406	59	0.48	–	217	3.70	34	–	332
Geometric $\mu+2\sigma$	2.74	4,465	3	16.55	9	576	113	1.36	–	414	6.12	60	–	520

Table Ⅱ-1-4 List of Statistic Data of the Lower Member of the Alemağaç Formation

Whole Rock	Au ppm	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	K %
No. of samples	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Max.	0.038	2.0	7.87	51	900	1.3	8	6.66	5.3	6	106	273	7.7	3.57
Min.	<0.001	<0.5	4.14	3	10	<0.5	<2	0.01	<0.5	1	10	1	0.6	0.15
Arithmetic Mean	0.004	0.3	6.15	10	221	0.7	1	0.64	0.4	1	42	34	2.48	1.69
Arithmetic σ	0.007	0.3	0.83	11	194	0.3	1	1.22	0.8	1	21	63	1.53	0.89
Geometric Mean	0.001	0.3	6.10	6	145	0.7	1	0.18	0.3	1	37	10	2.11	1.35
Geometric σ	3.444	1.5	1.15	3	3	1.6	2	5.57	1.9	2	2	5	1.79	2.22
Geometric $\mu+\sigma$	0.005	0.4	7.00	16	399	1.0	2	1.00	0.6	2	65	47	3.76	3.00
Geometric $\mu+1.5\sigma$	0.009	0.5	7.50	25	661	1.3	2	2.37	0.8	2	86	100	5.03	4.48
Geometric $\mu+2\sigma$	0.016	0.7	8.04	40	1,098	1.6	3	5.59	1.0	3	115	213	6.72	6.67

Whole Rock	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sr ppm	Ti %	V ppm	W ppm	Zn ppm
No. of samples	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Max.	2.50	5,470	4	4.42	10	530	750	3.03	<0.5	521	0.49	237	<10	779
Min.	0.03	65	<1	0.03	<1	20	<2	<0.01	<0.5	3	0.06	<1	<10	8
Arithmetic Mean	0.63	895	1	1.46	3	175	36	0.26	–	67	1.11	14	–	129
Arithmetic σ	0.51	1,023	1	1.38	2	113	121	0.66	–	99	0.64	37	–	143
Geometric Mean	0.46	551	1	0.63	2	142	9	0.02	–	31	0.16	6	–	86
Geometric σ	2.45	3	2	5.13	2	2	4	8.05	–	4	1.44	3	–	2
Geometric $\mu+\sigma$	1.12	1,568	2	3.22	4	286	31	0.17	–	114	0.22	19	–	212
Geometric $\mu+1.5\sigma$	1.75	2,646	2	7.30	6	406	59	0.48	–	217	0.26	34	–	332
Geometric $\mu+2\sigma$	2.74	4,465	3	16.55	9	576	113	1.36	–	414	0.31	60	–	520

Table Ⅱ-1-5 Correlation Coefficient of Whole Rocks

(N=77)

	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sr	Ti	V	Zn
Au	1.00																									
Ag	0.35	1.00																								
Al	-0.07	-0.02	1.00																							
As	0.57	0.18	0.11	1.00																						
Ba	0.28	0.33	0.05	0.18	1.00																					
Be	-0.24	-0.06	0.43	-0.12	0.13	1.00																				
Bi	0.56	0.79	-0.13	0.14	0.25	-0.17	1.00																			
Ca	-0.07	-0.07	-0.18	-0.04	-0.21	-0.16	-0.08	1.00																		
Cd	0.16	0.02	-0.07	0.03	0.23	-0.04	0.02	-0.07	1.00																	
Co	-0.03	-0.06	0.18	-0.03	-0.21	-0.35	-0.08	0.35	-0.04	1.00																
Cr	-0.12	-0.04	-0.30	-0.15	-0.16	-0.25	-0.11	-0.18	-0.10	0.13	1.00															
Cu	0.59	0.14	-0.04	0.36	0.40	-0.20	0.37	0.04	0.30	0.11	-0.16	1.00														
Fe	0.08	0.04	-0.10	0.07	0.05	-0.11	0.17	0.05	-0.05	0.35	0.07	0.25	1.00													
K	0.23	0.17	0.38	0.27	0.42	0.58	0.19	-0.21	0.06	-0.22	-0.39	0.14	-0.06	1.00												
Mg	-0.04	-0.05	0.30	-0.01	0.07	-0.10	-0.16	0.44	0.14	0.77	-0.09	0.20	0.44	-0.03	1.00											
Mn	-0.10	-0.09	0.16	-0.02	0.23	-0.02	-0.17	0.21	0.59	0.25	-0.12	0.18	0.26	0.03	0.55	1.00										
Mo	0.61	0.55	-0.24	0.26	0.59	-0.17	0.59	-0.12	0.09	-0.16	-0.03	0.47	0.23	0.12	-0.05	-0.01	1.00									
Na	-0.29	-0.19	0.14	-0.30	-0.32	-0.12	-0.24	-0.21	-0.18	-0.07	0.36	-0.32	-0.23	-0.59	-0.25	-0.21	-0.28	1.00								
Ni	-0.07	-0.07	-0.06	-0.08	-0.23	-0.23	-0.10	0.66	-0.09	0.77	0.19	0.09	0.31	-0.25	0.68	0.17	-0.13	-0.14	1.00							
P	-0.09	-0.01	0.35	0.01	-0.02	-0.04	-0.04	0.28	-0.07	0.41	-0.06	0.06	0.28	-0.11	0.52	0.33	-0.13	0.18	0.25	1.00						
Pb	0.07	0.35	0.00	0.15	0.45	0.05	-0.03	-0.02	0.10	-0.08	0.00	0.38	-0.03	0.10	0.09	0.07	0.32	-0.15	-0.03	-0.03	1.00					
S	0.16	0.10	-0.10	0.08	0.13	-0.19	0.19	-0.09	-0.04	-0.01	0.03	-0.03	0.16	0.12	-0.01	-0.06	0.13	-0.22	-0.12	0.00	0.03	1.00				
Sr	-0.14	-0.12	-0.01	-0.02	-0.15	-0.05	-0.14	0.70	-0.11	0.21	-0.13	-0.05	-0.03	-0.17	0.28	0.03	-0.21	0.03	0.49	0.26	-0.05	-0.14	1.00			
Ti	0.03	-0.05	0.63	0.14	0.03	0.06	-0.06	0.03	-0.05	0.48	-0.19	0.13	0.30	0.15	0.60	0.36	-0.12	0.04	0.20	0.76	-0.07	0.01	0.15	1.00		
V	-0.02	-0.06	0.25	0.07	-0.12	-0.28	-0.07	0.27	-0.06	0.81	0.10	0.18	0.51	-0.14	0.79	0.42	-0.08	-0.10	0.64	0.49	-0.07	-0.04	0.17	0.67	1.00	
Zn	-0.01	0.05	0.15	0.04	0.43	0.15	-0.10	-0.08	0.77	-0.10	-0.18	0.30	-0.04	0.15	0.21	0.64	0.08	-0.19	-0.12	-0.02	0.34	-0.14	-0.11	-0.01	-0.03	1.00

Table Ⅱ-1-6 Correlation Coefficient of the Lower Member of the Alemağaç Formation

(N=39)

	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sr	Ti	V	Zn
Au	1.00																									
Ag	0.32	1.00																								
Al	-0.24	-0.08	1.00																							
As	0.55	0.13	0.23	1.00																						
Ba	0.26	0.35	-0.06	0.07	1.00																					
Be	-0.40	-0.10	0.56	-0.13	0.09	1.00																				
Bi	0.55	0.78	-0.31	0.10	0.25	-0.32	1.00																			
Ca	-0.18	-0.13	0.31	-0.11	-0.26	0.32	-0.15	1.00																		
Cd	0.13	-0.01	-0.16	-0.03	0.14	-0.07	-0.01	-0.12	1.00																	
Co	-0.12	-0.09	0.12	-0.08	-0.04	0.16	-0.11	0.10	0.07	1.00																
Cr	-0.18	0.00	-0.33	-0.19	-0.14	-0.16	-0.12	-0.06	-0.14	-0.05	1.00															
Cu	0.58	0.11	-0.18	0.31	0.43	-0.25	0.37	-0.20	0.29	-0.08	-0.28	1.00														
Fe	0.16	0.11	0.05	-0.05	0.31	-0.19	0.38	-0.12	-0.07	0.25	-0.15	0.39	1.00													
K	0.29	0.23	0.18	0.40	0.51	0.28	0.22	-0.18	0.04	-0.15	-0.30	0.21	0.10	1.00												
Mg	-0.09	-0.04	0.34	-0.08	0.45	0.29	-0.21	-0.05	0.34	0.45	-0.14	0.12	0.44	0.14	1.00											
Mn	-0.14	-0.12	0.15	-0.19	0.26	0.11	-0.21	-0.04	0.76	0.28	-0.10	0.14	0.21	-0.04	0.76	1.00										
Mo	0.72	0.65	-0.26	0.23	0.61	-0.30	0.71	-0.17	0.05	-0.19	-0.12	0.54	0.34	0.28	0.09	-0.07	1.00									
Na	-0.38	-0.25	0.07	-0.36	-0.44	-0.02	-0.30	0.00	-0.23	-0.06	0.31	-0.37	-0.22	-0.67	-0.25	-0.16	-0.41	1.00								
Ni	-0.23	-0.08	0.26	-0.17	0.03	0.40	-0.14	0.35	-0.14	0.00	-0.21	-0.15	-0.21	-0.07	-0.05	-0.06	-0.13	-0.01	1.00							
P	-0.17	0.03	0.19	-0.10	0.01	-0.07	-0.02	-0.08	-0.10	0.36	0.23	-0.06	0.49	-0.21	0.34	0.29	-0.07	0.25	-0.32	1.00						
Pb	0.03	0.33	0.01	0.11	0.53	0.09	-0.06	-0.12	0.08	-0.14	0.09	0.37	-0.06	0.12	0.22	0.08	0.35	-0.18	0.04	-0.07	1.00					
S	0.10	0.06	-0.28	-0.01	0.07	-0.32	0.15	-0.17	-0.08	0.35	0.16	-0.09	0.33	0.12	0.05	-0.13	0.11	-0.28	-0.19	0.03	-0.02	1.00				
Sr	-0.23	-0.16	0.38	-0.07	-0.08	0.32	-0.19	0.44	-0.14	0.02	-0.12	-0.23	-0.14	0.04	-0.10	-0.14	-0.28	0.19	0.57	-0.13	-0.12	-0.18	1.00			
Ti	0.02	-0.10	0.46	0.15	0.15	0.16	-0.12	-0.14	-0.07	0.43	-0.30	0.05	0.47	0.20	0.58	0.32	-0.09	-0.10	-0.01	0.57	-0.12	-0.01	0.21	1.00		
V	-0.06	-0.04	0.31	0.07	0.07	-0.04	-0.05	-0.03	-0.04	0.43	-0.22	0.10	0.53	-0.01	0.58	0.39	-0.03	-0.13	-0.09	0.50	-0.07	-0.02	-0.08	0.78	1.00	
Zn	-0.06	0.03	0.17	-0.01	0.30	0.09	-0.15	-0.08	0.81	0.04	-0.17	0.30	0.00	0.05	0.56	0.86	0.04	-0.25	0.02	0.01	0.36	-0.21	-0.16	0.05	0.13	1.00

values lower than the detection limit has been calculated, being regarded as the half of the limit value.

Standard deviation value (σ) is applied for set the threshold value. The anomaly is over threshold (geometric mean + 2σ) in most case, but if there is no + 2σ value then geometric mean + 1.5σ is used. The values over detection limit are applied for these elements include Ag, B, Be, Bi, Cd, Hg, La, Mo and S.

The followings are threshold values for each element,

Au : 0.016 ppm	Ag : 0.7 ppm	Al : 7.50%	As : 40 ppm
Ba : 661 ppm	Be : 1.3 ppm	Bi : 3 ppm	Ca : 5.59%
Cd :1.0 ppm	Co : 3 ppm	Cr : 86 ppm	Cu :213 ppm
Fe : 6.72%	K : 3.00%	Mg : 1.75%	Mn : 4,465ppm
Mo : 3 ppm	Na : 3.22%	Ni : 9 ppm	P : 406 ppm
Pb : 113 ppm	S : 1.36%	Sb : - ppm	Sr : 414 ppm
Ti : 0.31%	V : 60 ppm	W : - ppm	Zn : 520 ppm

The characteristics of the distribution of main elements, such as Au, Ag, Cu, Pb, Zn, Ba, S, As and Cd, are described below.

(i) Au

Some anomalous values have been detected in the Yeşilköy West and Duygulu Mineralized Zones. The highest value obtained in the Duygulu Zone is 0.038 ppm Au at the M028 point.

(ii) Ag

Some anomalous values have been detected in the Yeşilköy West and Yukarı Mineralized Zones. The highest value obtained in the Yeşilköy West Zone is 2.00 ppm Ag at the M043 point, showing high gold value of 0.017 ppm Au at the same point. The N043 point on the Yukarı Occurrence shows high value of 0.90 ppm, also showing some anomalous values for Ba, Cd, and Pb.

(iii) Cu

Some anomalous value has been detected in the Duygulu Mineralized Zone, and its highest value is 273 ppm Cu at the M026 point. Multiple points in the

Garimani Mineralized Zone show higher than +σ value.

(iv) Pb

Some anomalous values have been detected in the Garimani and Köpruköy Mineralized Zones and around Yukarı. The highest value of 750 ppm Pb has been obtained at the N403 point in the Yukarı Occurrence. Multiple points in the Garimani and Köpruköy Zones show higher than +1.5 σ value.

(v) Zn

Some anomalous values have been detected in the Duygulu Zone, showing the highest value of 779 ppm at the M034 point. Some high values have been detected in the Garimani Zone.

(vi) As

Some anomalous values have been detected in the Köpruköy Zone, showing highest value of 51 ppm As at the Q028 point.

(vii) Ba

The N043 point in the Yukarı Occurrence shows the highest value of 900 ppm Ba.

(viii) Cd

Some anomalous values have been detected in the Garimani and Duygulu Zones. The highest value of 5.3 ppm Cd has been obtained at the M034 pint in the Duygulu Zone, and over 1.5 σ values have been obtained some multiple points in the zone.

(ix) S

Some anomalous values have been detected in the Yeşilköy West, Köpruköy, and Duygulu Zones. The highest value of 3.03 ppm S has been obtained at the N029 point in the Yeşilköy West Zone. The anomalous zones of other elements also show some high sulfur values.

(x) Survey Result

FigureⅡ-1-8 shows the interpretation result of the rock geochemical survey. The geochemical anomaly zones of Au, Cu, Zn, Cd, and S have been broadly detected in the Duygulu Mineralized Zone, also some points show over +1.5 σ values in As. In this mineralized zone, anomalies of As and Cu, and Zn and Cd are duplicated in the same points. In the Yeşilköy West Mineralized Zone, some anomaly zones of Au, Ag, As, and S have been obtained, showing duplication of Au and Ag. In the Yeşilköy West Mineralized Zone, anomaly zones of Pb, As, and S have been detected. In the Yeşilköy West and Köpruköy Mineralized Zones, the anomaly zones extend northeast to southwest, being as same as that of the mineralized zones. In the Garimani Occurrence, some geochemical anomalous values of Pb have been obtained, also over +1.5 σ values for Ag and Zn. In the Yukarı Occurrence, some anomalous values of Au, Pb, Cd, and Ba have been detected, and some over +1.5 σ values for Cu and Zn.

The geochemical anomaly values in the area have been obtained mainly from the specimens of the aphyric dacite (Adcu) of the lower member of the Alemağaç Formation.

(b) Principal Component Analysis

The principal component analysis has been applied to integrally know the behavior of the elements. The elements strongly reflecting specific rock facies have been eliminated in the analysis. TableⅡ-1-7 shows the result of the analysis.

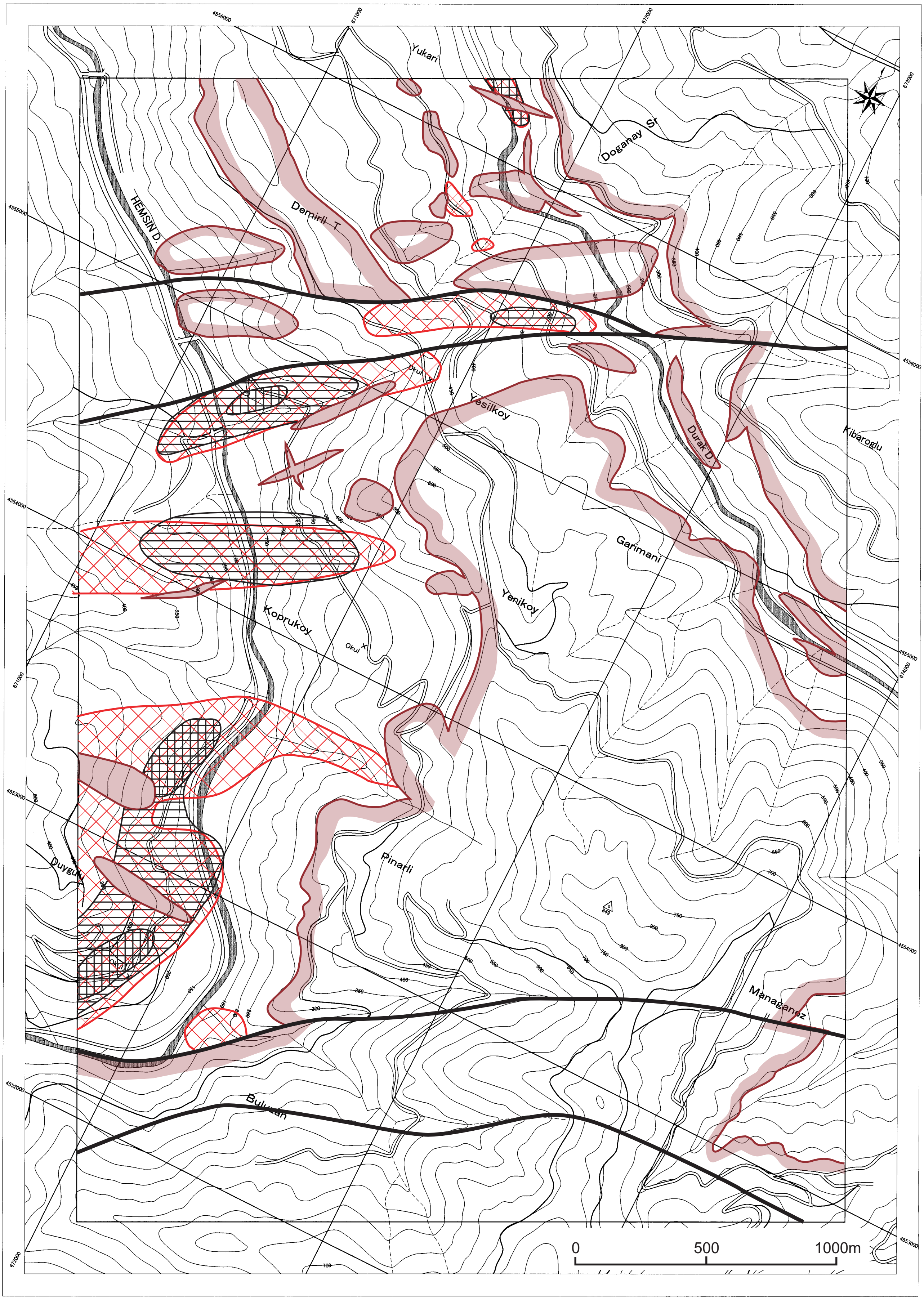
The first factor shows high load of Mo, Au, Ba, Cu, Ag and Bi, and followed by As, Pb, and Zn.It is judged, therefore, that these are the factors to indicate the integral mineralization. The contribution rate is 23.2 percent.

The second factor shows high load of Co, V, Ni, and Mn. It is thought that these reflect a presence of basaltic rocks. The contribution rate is 16.9 percent.

The third factor shows high load of Zn, Cd, and Mn. It is thought that these are factors to indicate the sphalerite mineralization. The contribution rate is 15.3 percent.

The total contribution rate from the first to third principal components is 55.4 percent. The first factor is the most effective one to explain the general mineralization pattern in the area. Figure Ⅱ-1-9 shows the score distributions of the first factor.

The high points over the score 2 have been detected in the Köpruköy and



Legend

- Anomaly of Single Element (Au,Ag,Cu,Pb,Zn,Ba,S,As,Cd)
- Overlapping Anomaly
- Mineralized Zone
- Outline of the Lower Member of the Alemagac Formation

Fig. II-1-8 Distribution Map of Geochemical Anomaly Zones of the Garimani Area

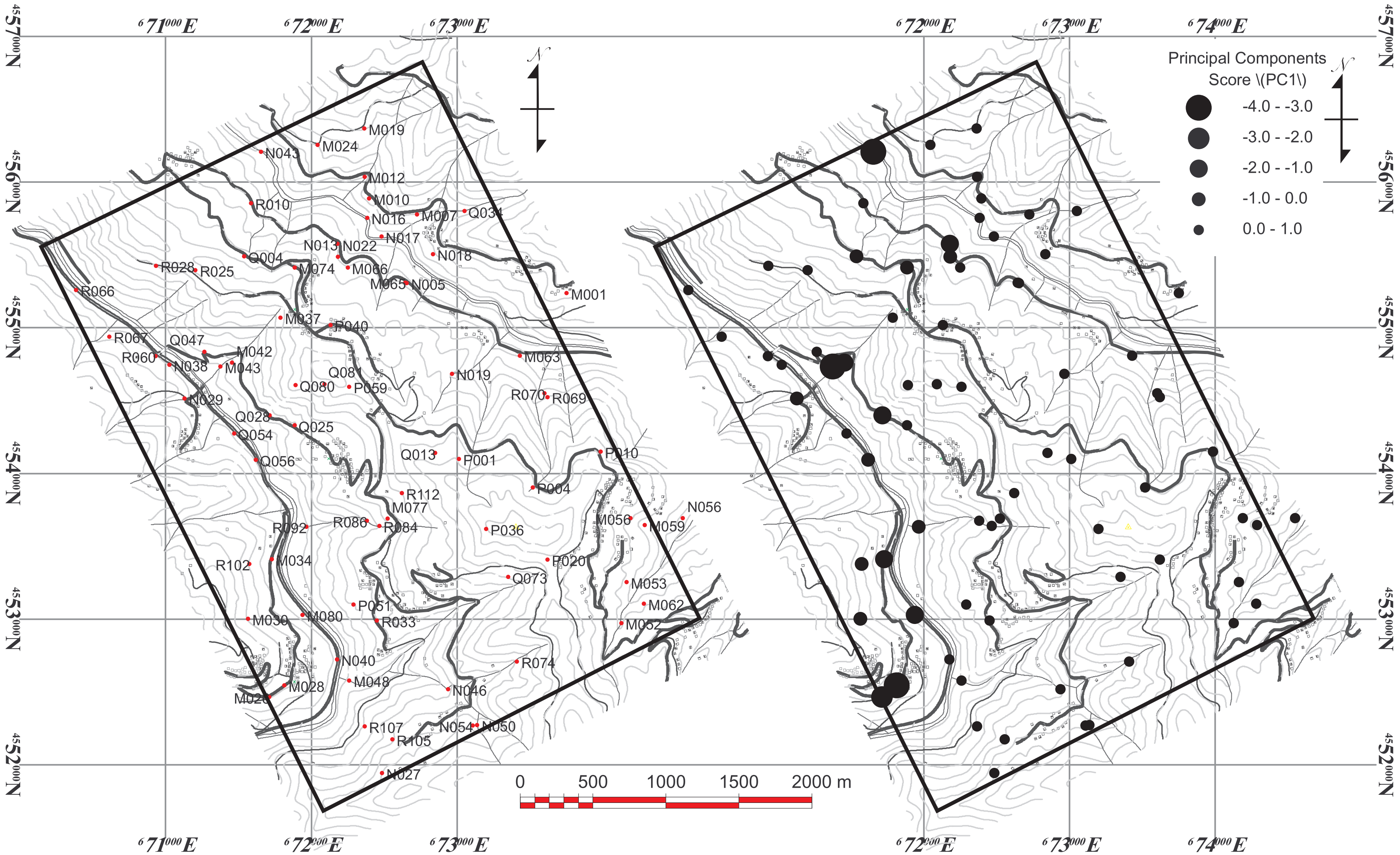


Fig. II-1-9 Distribution Map of Principle Component 1

Duygulu Mineralized Zones, and Yukarı Occurrence. In the Duygulu Zone, many points surrounding the granodiorite body (Kdr) show high scores over 1, indicating existence of some broad mineralized area there.

Table II-1-7 Results of Principle Component Analysis

	Component 1	Component 2	Component 3	Component 4
Au	-0.719	-0.117	0.359	-0.416
Ag	-0.638	0.048	0.315	0.444
As	-0.465	-0.105	0.175	-0.528
Ba	-0.704	0.040	-0.269	0.259
Be	0.093	0.451	-0.407	0.091
Bi	-0.659	0.040	0.479	0.098
Cd	-0.362	-0.245	-0.663	-0.146
Co	0.250	-0.858	0.219	0.069
Cr	0.233	-0.134	0.241	0.420
Cu	-0.670	-0.385	-0.024	-0.212
Mn	-0.121	-0.553	-0.647	-0.003
Mo	-0.806	-0.008	0.242	0.174
Ni	0.276	-0.762	0.212	0.165
Pb	-0.467	-0.050	-0.214	0.477
S	-0.169	0.060	0.261	0.008
V	0.167	-0.862	0.134	0.028
Zn	-0.386	-0.199	-0.824	0.049
Eigenvalue	3.941	2.872	2.606	1.270
Contribution	0.232	0.169	0.153	0.075

(3) Age Determination

The K-Ar age determination has been performed for some sericite specimens taken from the mineralized and alternation zones. The specimens are three from the Garimani volcanogenic massive sulphide type Zone, Köpruköy vein type Zone, and Tunca volcanogenic massive sulphide Deposit, each one. Table II-1-8 shows the age determination result.

Table II-1-8 Results of K-Ar Age Determination

No.	Sample	Location	Coordinates		Rock	K-Ar age	Age	Dating Mineral	Mineralization Type
			UTM-E	UTM-N					
1	N009	Garimani Mineralized Zone	72172	55517	Adcl	83.1±2.1	Upper Cretaceous	Sericite	Volcanogenic Massive Sulphide
2	R051	Koprukoy Mineralized Zone	71235	54790	Adcu	83.2±2.1	Upper Cretaceous	Sericite	Vein
3	A189	Tunca Deposit	78174	54761	Adcl	82.0±1.6	Upper Cretaceous	Sericite	Volcanogenic Massive Sulphide

The result has revealed that the ages for three specimens are almost same, 82.0 ± 1.6 to 83.2 ± 2.1 Ma, in spite of different type of mineralization. It means volcanogenic massive sulphide type mineralization and vein-type mineralization took place in the almost same time, the Santonian stage, 86.6 to 83.0 Ma to the Campanian stage, 83.0 to 74.0 Ma, of the late Cretaceous.

(4) Mineralized Zone

The Garimani, Yeşilköy West, and Köpruköy Mineralized Zones extend northeast to southwest. The purple dacite (Adpc) of the upper member of the Alemağaç Formation and the basaltic rocks (Cbs) of the Çağlayan Formation are distributed around these mineralized zones, but these rocks have not undergone mineralization. Accordingly, the mineralization stage for those mineralized zones is presumably before the formation of the upper member of the Alemağaç Formation. This stage is about the same as that of the volcanogenic massive sulphide mineralization in the Tunca area. The surrounding area of the surveyed area have undergone some tectonic movement before and after the formation of the upper member of the Alemağaç Formation, and these movements have caused the formation of the volcanogenic massive sulphide mineralization and the vein-type mineralization.

The Garimani Mineralized Zone is situated near the Yeşilköy West Mineralized Zone, extending northeast to southwest. It presumably has been formed by the same vein-type of the mineralization. but shows following characteristics.

*The mineralized and altered dacite lava (Adcl) of the lower member of the Alemağaç Formation exists there as same as in case of the Tunca area.

*Quartz-potassium feldspar-sericite alteration zone exists in the center of the mineralization and alteration zone as same as in case of the Tunca Deposit.

*It is rich in the copper and zinc mineralization, different from other mineralization zones in the area

It is possible to say that the mineralized zone in this zone has been formed by the volcanogenic massive sulphide mineralization.

The Duygulu Mineralized Zone is emplaced in the dacitic rocks of the lower member of the Alemağaç Formation as well as other mineralized zones, showing northeast to southwest trending in the northern part. In the southern part, an alteration zone related to the mineralization surrounds the granodiorite intrusive body, being correlated to the Kaçkar Granitic rocks of the Eocene, and some weak mineralization has occurred in the basaltic rocks of the Çağlayan Formation to the east. Accordingly, it is thought that the southern part of the mineralized zone has been formed during Eocene time, being related to the intrusion of the granodiorite body. It is possible that the mineralized zone in the area has been caused by two different mineralization, late Cretaceous vein-type one and Eocene zone activity related to the granodiorite intrusion, closely situated each other, and apparently one mineralized zone.

The alteration zones related to mineralization in the area are principally composed of pyrite dissemination, rarely containing minor amounts of chalcopyrite and sphalerite. Sulphide veinlets are very local and in small-size. No quartz vein exists.

Some concentration of oxide manganese related to the reddish calcareous mudstone, intercalated in the basaltic rocks of the Çağlayan Formation, exists in the area, but quite limited.

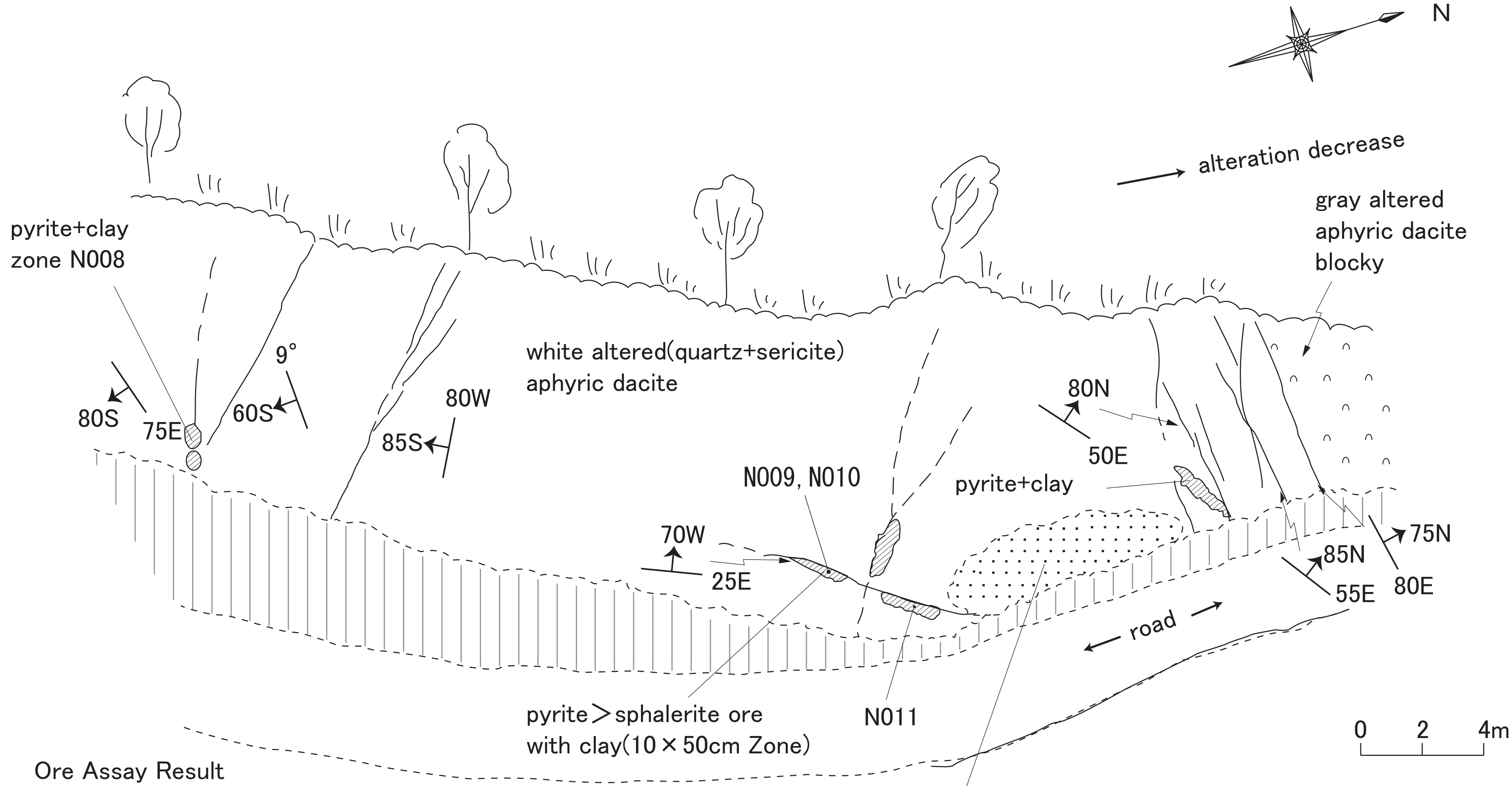
Followings are the characteristics of the principal mineralized zones and occurrences.

(a) Garimani Mineralized Zone

The Garimani Mineralized Zone is emplaced in the dacite lava (Adcl) and dacitic pyroclastic rock (Atf) of the lower member of the Alemağaç Formation suffered silicification, sericitization, and chloritization, and is distributed from the Garimani Occurrence to the ridge situated to the west of Yeşilköy, extending about 800 meters northeast to southwest. Figure II-1-10 shows the sketch of the Garimani Occurence.

The mineralized zone is situated about one kilometer northwest of Garimani village, and is seen in the road cutting, 80 meters in width and 30 meters in height. It is thought that here is the center of the mineralized zone, distributing strongly silicified dacite (Adcl). The rock is correlated with the foot-wall dacite lave emplacing the Tunca Deposit and Muskale Mineralized Zone, and quartz-potassium feldspar-sericite zone is situated in the center of the alteration zone. The sulphide is mainly composed of disseminated pyrite, and increases chalcopyrite and sphalerite in the Garimani Occurrence, partly showing veinlet form.

Under the reflection microscope, chalcopyrite, sphalerite, tetrahedrite, and pyrite are seen. The assay result of the four specimens is as follows; 0.01 to 0.27 g/t Au,



Ore Assay Result

Sample	Au	Ag	Cu	Pb	Zn
N011	0.12 g/t	2 g/t	0.54%	0.01%	5.13%

K-Ar Dating Result

Sample	Rock	K-Ar age	Age	Dating Mineral
N009	Adcl	83.1±2.1	Upper Cretaceous	Sericite

Fig.Ⅱ-1-10 Garimani Occurrence

0.65 to 2.00 g/t Ag, 0.01 to 0.54 % Cu, <0.01 to 0.01 % Pb, 0.01 to 5.13 % Zn, 0.01 to 0.05 % Ba, and 1.23 to 12.90 % S. The specimen (N011) from the Garimani Occurrence shows 0.12 g/t Au, 2.00 g/t Ag, 0.54 % Cu, 0.01 % Pb, 5.13 % Zn, 0.01 % Ba, and 12.90 % S, rich in zinc. The mineralized zone is richer in copper and zinc compared with other mineralized zones, and some secondary oxidized copper minerals are seen along the forest road near Yeşilköy.

It is presumed that the mineralized zone has been formed by the volcanogenic massive sulphide mineralization, and the K-Ar age determination result indicates 83.1 ± 2.1 Ma.

Some Pb anomalies have been detected in the mineralized zone as a result of the rock geochemical survey.

(b) Yeşilköy West Mineralized Zone

The Yeşilköy West Mineralized Zone is situated to the west of Yeşilköy, close to the Garimani Mineralized Zone. The mineralized zone extends about 1,000 meters northeast to southwest, continuing the west bank of the Hemsin River. The mineralized zone is emplaced in the aphyric dacite (Adcu) of the lower member of the Alemağaç Formation, having been intruded by unaltered purple dacite around. The mother rock has undergone silicification, sericitization, and chloritization, stronger silicification and abundant pyrite dissemination in the west bank of the Hemsin River.

Under the reflection microscope, chalcopyrite, sphalerite, pyrite, and hematite are seen. The assay result for the five specimens is as follows: <0.01 to 0.92 g/t Au, 0.45 to 0.75 g/t Ag, <0.01 to 0.03 % Cu, <0.01 % Pb, <0.01 to 0.06 % Zn, 0.04 to 0.08 % Ba, and 0.12 to 38.40 % S.

Some Au, Ag, As, and S anomalies of the rock geochemical survey have been detected in the mineralized zone.

(c) Köpruköy Mineralized Zone

The Köpruköy Mineralized Zone is distributed to the west to north, both sides of the Hemsin River. The area is underlain by the aphyric dacite (Adcu) of the lower member of the Alemağaç Formation, having been intruded by dolerite intrusive rocks. The alteration zone related mineralization extends about 1,000 meters long and 200 meters width, extending northeast to southwest. The height difference between the highest and lowest, points reaches 300 meters. Silicification, sericitization and chloritization related to mineralization have occurred in the zone, mainly argillization in the upper part and silicification in the lower part. A pyrite-disseminated zone is seen, partly containing small-amounts of chalcopyrite.

Under the reflection microscope, pyrite and chalcopyrite are seen. It is presumed that the mineralized zone has been formed by the vein-type mineralization controlled by the geological structure in the area as well as the case of the Yeşilköy West Mineralized Zone. The K-Ar age determination result indicates 83.2 ± 2.1 Ma. The assay result for the five specimens is as follows: <0.01 to 1.64 g/t Au, 0.50 to 10.00 g/t Ag, <0.01 to 0.08 % Cu, <0.01 % Pb, 0.01 to 0.02 % Zn, 0.04 % Ba, and .07 to 30.79 % S.

Pb, As, and S anomalies of the rock geochemical survey have been detected in the mineralized zone.

(d) Duygulu Mineralized Zone

The Duygulu Mineralized Zone is situated near Duygulu village to the north of Pınarlı in the southwestern area. The surrounding area is underlain by the aphyric dacite (Adcu) of the lower member of the Alemağaç Formation. The granodiorite (Kgd) correlated to the Eocene Kaçkar Granitic rocks has intruded in the center of the zone, and the broad area of the dacitic rocks surrounding this granitic body has undergone silicification, sericitization, and chloritization as well as pyrite dissemination. Under the reflection microscope, chalcopyrite and pyrite are seen.

The northern part of the mineralized zone is disseminated by coarse-grained pyrite along crush zones, extending northeast to southwest. It is, therefore, possible that the mineralized zone has been formed by the vein-type mineralization before the formation of the upper member of the Alemağaç Formation as well as the case of the Köpruköy Mineralized Zone, and two stages of the mineralization possibly duplicated in the same place. The assay result of the seven specimens are as follows: <0.01 to 0.02 g/t Au, 0.45 to 2.25 g/t Ag, <0.01 to 0.17 % Cu, <0.01 % Pb, <0.01 to 0.06 % Zn, 0.04 to 0.36 % Ba, 1.12 to 40.64 % S, low grade for all elements except sulfur.

The rock geochemical survey result indicates some Au, Cu, Pb, Cd, and S anomalies in the mineralized zone.

(e) Yukarı Mineral Occurrence

The Yukarı Occurrence is seen on the floor of the Durak River in the north edge of the area, and the aphyric dacite (Adcu) of the lower member of the Alemağaç Formation there has undergone silicification, sericitization, and chloritization, being disseminated by pyrite.

The rock geochemical survey result indicates some Au, Pb, Cd, and Ba anomalies.

(f) Other occurrence

Other than the above-mentioned occurrence, small-scale pyrite dissemination zones are seen along the Hemsin River and the Durak River in the northern area.

Part Ⅲ

Conclusion and Recommendation

Part Ⅲ Conclusion and Recommendation

Chapter 1 Conclusion

The survey was composed of geological survey in the Garimani area. Conclusion from this survey are shown in the Fig.Ⅲ, and described as follows,

1-1 Geology

The area is underlain by the Alemağaç, Çağlayan, and Sivrikaya Formations of the upper Cretaceous, and the Hamidiya Formation of the Tertiary from the bottom, having been intruded by dacite, granitic rocks, and dolerite intrusive bodies. The Alemağaç Formation is divided into two members, lower member composed of the aphyric dacite (Adcu), dacite lava (Adcl), and dacitic pyroclastic rocks (Atf), and the upper member composed of the purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Attf). The lower member is distributed along the Hemsin and Durak Rivers, having undergone alteration related to the mineralization. The purple dacite (Adcp), green dacite (Adcg), and dacitic pyroclastic rocks (Adcg) are different rock facies from the same body, and the granitic rock is correlated with the Kaçkar Granitic Rocks situated to the south of the area. The northeast to southwest structure system is dominant in the area, reflecting to the trend of the fault system, intrusive bodies, and mineralized zones.

1-2 Mineralization

Three types of mineralization are recognized in the area, the volcanogenic massive sulphide mineralization and vein-type mineralization, having occurred before the formation of the upper member of the Alemağaç Formation, and the mineralization associated with the Eocene granitic intrusive rock. The mineralized zones other than the Duygulu Zone are controlled by the geological structure, extending northeast to southwest. The mineralized zones are composed of pyrite dissemination zones, and the grade for copper and zinc is low. The mineralized zones do not change their state vertically and laterally. Accordingly, it is judged that the economic potential for the minerals is low in the area.

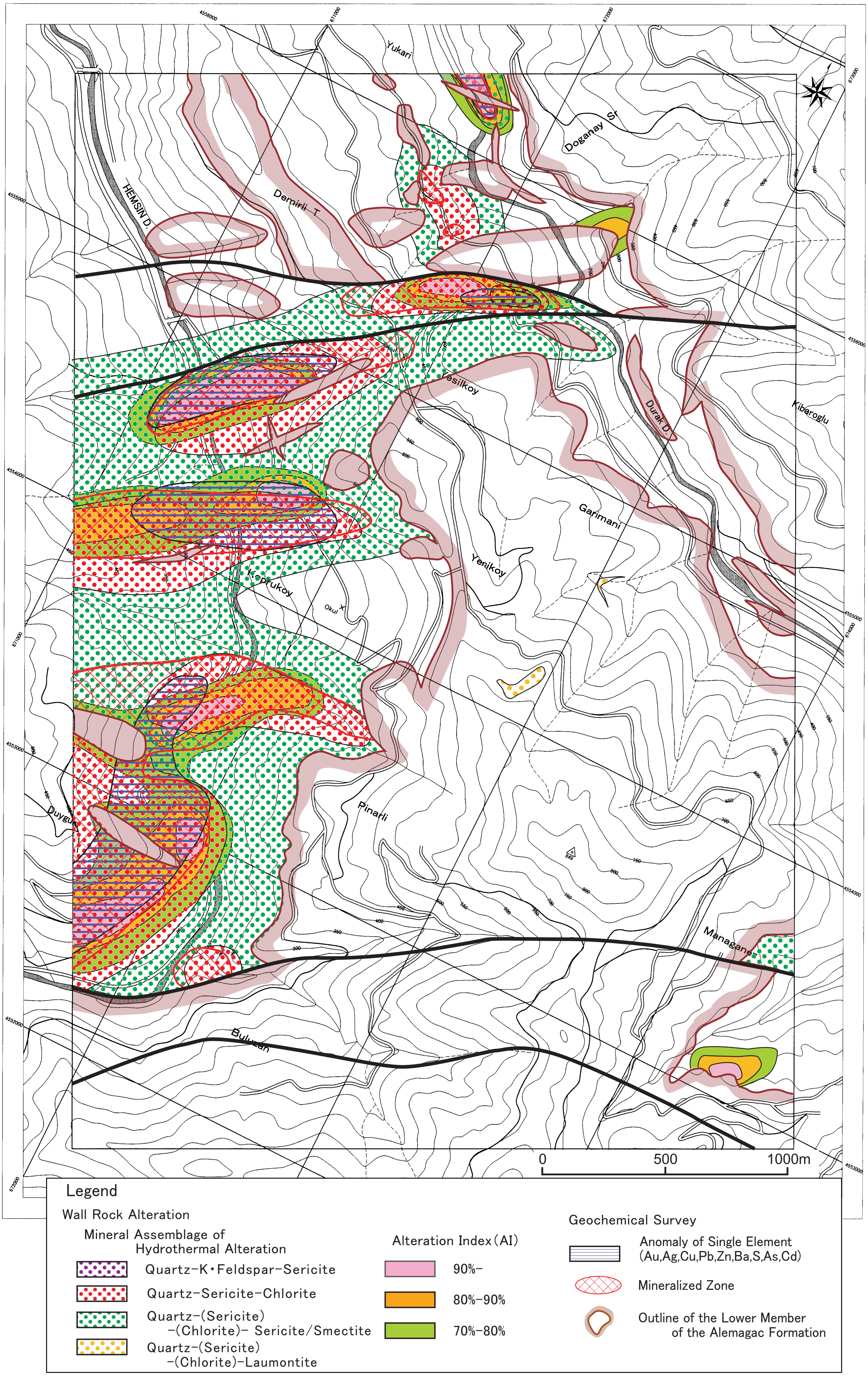


Fig.Ⅲ Integrated Interpretation Map of the Garimani Area

Chapter 2 Recommendation for Future

The third year's survey has revealed that the economic potential of the mineralized zones confirmed in the Garimani area is low for development in future.

However, the high grade Çayeli Deposit, 3.6 % Cu and 5.7 % Zn, and 16 million tons of ore reserve, is situated about 25 kilometers to the southwest of the area, and its ore horizon extends to the area. It is judged that the potential for economic ores is high in the surrounding area of the area.

It is important to expand prospecting areas to the surrounding area in future.

References

REFERENCES

Aizawa K., Date J., Sato Y. (1981): Exploration for the Ezuri Kuroko Deposit, Akita Pref., Japan. Exploration for ore deposits in Japan 160-167 (in Japanese)

Çağatay M. N. (1993): Hydrothermal Alteration Associated with Volcanogenic Massive Sulfide Deposits: Examples from Turkey. Economic Geology vol. 88, 606-621

Date J. (1993): Kuroko Type Deposits in Turkey. Soc. Mining Geol. Japan, vol. 44(1) 65-74 (in Japanese)

Eren M.,Kadir S.(2001): Color genesis of Upper Cretaceous pelagic red sediments within the Eastern Pontides, NE Turkey. Yerbilimleri, 71-79

Erendil, M. (1994): Geology of the Anatorian Peninsula. Geology & Mineral Resources of Turkey. MTA 1-10

ERSDAC(1999): Study for Satellite Images Analytical Technique on Exploration of Metal Resources on Trabzon Area, Turkey. Report on Research and Development of Remote Sensing Technology for Non-renewable Resources 3/5 241-285 Phase Ⅰ (in Japanese)

ERSDAC(2000): Study for Satellite Images Analytical Technique on Exploration of Metal Resources on Trabzon Area, Turkey. Report on Research and Development of Remote Sensing Technology for Non-renewable Resources 3/5 223-269 Phase Ⅱ (in Japanese)

Fehn U., Doe B. R., Delevaux M. H. (1983): The Distribution of Lead Isotopes and the Origin of Kuroko Ore Deposits in the Hokuroku District, Japan. Economic Geology Monograph 5, 488-506.

ERSDAC (2001): Study for Satellite Images Analytical Technique on Exploration of Metal Resources on Trabzon Area, Turkey. Report on Research and Development of Remote Sensing Technology for Non-renewable Resources 3/5 1.3.16-1 - 1.3.16-15 Phase Ⅲ (in Japanese)

Friedman I., O'Neil, J.R. (1977): Compilation of Stable Isotope Fraction Factors of Geochemical Interest. USGS Professional Paper, Data of Geochemistry, Chapter KK, KK1-KK12.

Ishikawa Y., Sawaguchi T., Iwaya S., Horiguchi M. (1976): Delination of Prospecting Targets for Kuroko Deposits. Based on Mode of Volcanism of Underlying Dacite and Alteration Halos. Soc. Mining Geol. Japan, vol. 26 105-117 (in Japanese)

Ishikawa Y. (1991): Kuroko Deposit.　Kyoritsu Publishing (in Japanese)
JICA and MMAJ（1996）：The Mineral Resources Exploration in The Espiye Area, The Republic of Turkey. Phase Ⅰ
JICA and MMAJ（1997）：The Mineral Resources Exploration in The Espiye Area, The Republic of Turkey. Phase Ⅱ
JICA and MMAJ（1998）：The Mineral Resources Exploration in The Espiye Area, The Republic of Turkey. Phase Ⅲ
Japan International Cooperation Agency（2003）：The Mineral Resources Exploration in The Hopa Area, The Republic of Turkey. Phase Ⅰ
Japan International Cooperation Agency（2004）：The Mineral Resources Exploration in The Hopa Area, The Republic of Turkey. Phase Ⅱ
Korkmaz S., Er M., Van A., Musaoğlu A., Keskin I., Tüysüz N. (1992): Stratigraphy of the Eastern Pontides, NE-Turkey. Proceedings of ISGB (International Symposium on the Geology of the Black Sea Region)
Kraëff, A. (1963): Geology and Mineral Deposits of Hopa-Murgul. MTA Bull., no.60, 45-60
Kraëff, A. (1963): A contribution to the geology of the region between Sirya and Ardanuç. MTA Bull., no.60, 37-59
Kanbara H., Sato K. Sato S., Hirayama H. (1983): Acidic volcanism and kuroko deposits in the Shakanai mining Area, Akita, Japan. Soc. Mining Geol. Japan, Spec. Issue, 11 197-214 (in Japanese)
Matsuhisa Y. Utada M. (1993): Hydrothermal activity responsible for the Kuroko mineralization inferred from oxygen isotopic ratios of altered rocks from the Hokuroku district, northern Japan. Bull. Geol. Surv. Japan, vol. 44 (2/3/4), 155-168 (in Japanese)
MITI (2000): Development for Geochemical Exploration Technique -Isotope Geochemistry- (in Japanese)
MMAJ (2001): Paleo-Tethys Conversion Suture(Turkey-Caucasus) Area　Report on Overseas Satellite Image Analysis. Phase Ⅰ (in Japanese)
MMAJ (2002): Paleo-Tethys Conversion Suture(Turkey-Caucasus) Area　Report on Overseas Satellite Image Analysis. Phase Ⅱ (in Japanese)
MTA (1957): A guide to the known minerals of Turkey.
MTA (1965): Pyrites and Sulphur Deposits of Turkey
MTA (1972): Lead, Copper and Zinc Deposits of Turkey
MTA (1972): Çamlıköy, Peronit, Sivrikaya, Tepeköy, Kutnit, Artvin. Yörelerinin-Maden

Jeolojisi Raporu.
MTA (1994): Exploration of Massive Sulphide Deposits in Ardesen-Hopa Region, Eastern Black Sea, Proposal Report
MTA (2001): A Joint Mineral Exploration Project Proposal Two Areas(Bursa-Eskisehir and Hopa - Fındıklı areas) in Turkey.
MTA (2002): MTA-MMAJ-JICA Team Technical Exploration Program Around Rize-Artvin Area
MTA (2003): Geological Features of Anatolian Peninsula.
Özgür N. (1993): Volcanogenic Massive Sulfide Deposits in the East Pontic Metallotect, NE Turkey. Soc. Resource Geol. Japan, Spec. Issue 17, 180-185
Pearce, J.A. (1983): Role of the Sub-continental Lithosphere in Magma Genesis at Active Continental. Continental Basalts and Mantle Xenoliths. Siva Publishing, 230-249
Sakai H., Matsuhisa Y. (1996): Stable Isotope Geochemistry. Tokyo Univ. Publishing. (in Japanese)
Sasaki.A. (1977): Stable Isotope and Ore Deposit. Basis of Modern Economic Geology. 77-95 Tokyo Univ. Publishing. (in Japanese)
Sato K. (1983): Lead isotopic constraints on the origin of kuroko leads. Soc. Mining Geol. Japan, Spec. Issue, 11 197-214 (in Japanese)
Şkuletiç T. (1973): Semidetailed 1 : 10,000 Scale Mapping and Prospecting of the Tunca - Zigam Area, SE of Ardesen. MTA.
Tanimura S., Yamada R. (1981): Exploration for the Fukazawa Kuroko Deposit, Akita Pref., Japan. Exploration for ore deposits in Japan 151-160 (in Japanese)
Todoroviç Z. and Nebioğlu T. (1972): Tunca Bakir Zuhuru. Derleme. MTA.
Utada, M. (1977): Wall Rock Alteration. Basis of Modern Economic Geology. 77-95 Tokyo Univ. Publishing. (in Japanese)
Utada, M. (1988): Hydrothermal Alteration. Envelope Relating to Kuroko-Type Mineralization: A Review. Soc. Mining Geol. Japan, Spec. Issue, 11 79-92
Yamagishi H. (1985): Recent Study for Subaqueous Volcanic Products. Volcanic Activity of Izu - Mariana Arc(1). The Earth Monthly vol. 78 627-631
Yildiz B. (1983): The Relationships Between Cu-Pb-Zn Mineralizations and Certain Structures Identified on LANDSAT IMAGES in the Eastern Black Sea Region. Bulletin of the Mineral Research and Exploration Institute of Turkey. No.99, 49-55

Appendixes

Appendix 1

Microscopic Observation of Thin Section

Appendix 1 Microscopic Observation of Thin Section (1)

No.	Sample	Coordinates		Rock	Rock Name	Texture	Phenocrysts										Groundmass												Secondary Minerals										Remarks
		UTM-E	UTM-N				Q	Pl	Ab	Bt	Hn	Au	Ol	Fe	Ap	Sp	G	Q	Pl	Ab	Bt	Px	Au	Ol	Op	Fe	Ap	Il	Q	Py	Cl	Ch	Ser	Cal	Ep	Hm	Ze	Fe	
1	M001	73750	55237	Cbs	Olivine augite Basalt	Intergranular, Porphyritic		○				○	△						○				△			△					△	△		·	·		·	△	
2	M012	72365	56036	Adcg	Dacite	Cryptocrystalline, Porphyritic	△	△									○	◎	◎	◎						△			·		△	·		△					
3	M017	72416	56503	Attf	Dacitic lapilli Tuff													△	△										△	·	△	△						·	weakly silicified
4	M031	71877	52938	Adcu	Dacitic lapilli Tuff													△	△											△									
5	M046	72555	52685	Kdb	Porphyritic biotete Dacite	Cryptocrystalline, Porphyritic	◎	◎		△							◎	○	○	○										·		◎	○	△				·	strongly altered
6	M048	72260	52580	Cbs	Augite bearing Basalt	Intersertal		△				△					◎		△										○	△		○		△				·	strongly silicified
7	M053	74162	53254	Adcl	Aphyric Dacite	Hyalopilitic		△									◎												○		○				·			·	strongly silicified
8	M081	71259	53921	Adcu	Aphyric Dacite	Hyalopilitic		△									◎												◎	△			◎					○	strongly silicified Andesite fragment
9	M084	70961	55315	Atf	Aphyric Dacitic Tuff - lapilli Tuff												◎		△										○		○	○						△	strongly silicified
10	N007	71595	55816	Adcg	Aphyric Dacite	Cryptocrystalline	△	△									◎												○		○							·	strongly silicified
11	N014	72125	55917		Basaltic coarse Tuff												◎		○										△			○	△	○				△	Basalt fragment
12	N017	72480	55625	Atf	Acidic coarse Tuff												◎	○	○										△		△	△	△	△	·			·	Dacite fragment
13	N020	72955	54667	Cbs	Aphyric Basaltic Hyaloclastite	Intersertal, Amygdaloidal											◎		◎				○			·						△		△				△	Mud ball contain. pore filled with calcite
14	N025	72990	52645	Dol	olivine Dolerite	Subophitic											△		◎	△			◎	△								△							fresh
15	N026	72500	52015	Adcg	Dacitic lapilli Tuff												◎	△	△										△			△	△	△					Dacite fragment
16	N027	72485	51945	Attf	Dacitic Tuff												◎	△	△										△		○		◎					·	Dacite fragment
17	N038	71025	54745	Adcu	Aphyric Dacitic lapilli Tuff												◎		△										○	·	△	△		·					strongly silicified
18	N044	71675	56191	Dch	Hornblende bearing Biotite Dacite	Cryptocrystalline, Porphyritic	◎	◎		△	△			·			◎	◎	◎	◎	△					·			·			△	△		·			·	Manganese Oxide rich
19	P020	73620	53410	Cms	Manganese bearing Mudstone																																		
20	P021	73850	53605	Dol	Dolerite	Subophitic											○		◎	△	△		◎			○						△	·				·		
21	P058	72188	54600	Adcp	Aphyric Dacite	Cryptocrystalline	△	△						·			△	◎	◎	◎									△										
22	Q047	71265	54835	Dci	Dacite	Cryptocrystalline		△						·			◎	◎	◎	◎						·			△	·	△	△	△						
23	Q073	73350	53290	Ctf	Acidic coarse Tuff												◎	△	△										○		○	△	△		·			·	strongly silicified
24	Q080	71892	54607	Attf	Dacitic lapilli Tuff												◎	○	○										○	·			△	·				·	strongly silicified
25	R011	71635	55760	Adcu	Aphyric Dacitic Hyaloclastite	Hyalopilitic											◎		△										○	·		○	○					·	
26	R025	71205	55395	Adcp	Biotite bearing Dacite	Cryptocrystalline, Hyalopilitic	△	△		·				·			◎	○	○	○						·			△	·		△	△	·				·	
27	R032	72570	53595	Cbs	Aphyric Basalt	Intersertal, Amygdaloidal		△						·			◎		◎				△			△			·			△						·	

◎ : abundant, ○ : common, △ : few, · : rare, Q : Quartz, Pl : Plagioclase, Ab : Albite, Bt : Biotite, Hn : Hornblende, Au : Augite, Ol : Olivine, Fe : Iron Mineral, Ap : Apatite, Sp : Sphane, G : Glass, Op : Opaque Mineral, Il : Ilmenite, Py : Pyrite, Cl : Clay, Ch : Chlorite, Ser : Sercite, Cal : Calcite, Ep : Epidote, Hm : Hematite, Ze : Zeolite.

Appendix 1 Microscopic Observation of Thin Section (2)

No.	Sample	Coordinates		Rock	Rock Name	Texture	Phenocrysts										Groundmass												Secondary Minerals										Remarks
		UTM-E	UTM-N				Q	Pl	Ab	Bt	Hn	Au	Ol	Fe	Ap	Sp	G	Q	Pl	Ab	Bt	Px	Au	Ol	Op	Fe	Ap	Il	Q	Py	Cl	Ch	Ser	Cal	Ep	Hm	Ze	Fe	
28	R062	70765	54990	Dci	Aphyric Dacite	Cryptocrystalline		△									◎	◎	○	○						・			△			△	△	・					
29	R069	73620	54525	Ctf	Acidic Lapilli Tuff												△	△	△										○			○	△	△				・	Dacite, Andesite fragment
30	R070	73600	54550	Ctf	Acidic Lapilli Tuff - Coarse Tuff												◎	△	△										○		○							・	
31	R075	73420	52750	Dch	Dacite	Cryptocrystalline											◎												○			○	△	△					strongly silicified
32	R079	73605	53160	Cbs	Olivine Basaltic Hyaloclastite	Hyalopilitic							△				◎		○							△						△						・	
33	R091	71950	53610	Ads	Augite Andesite	Porphyritic		△				△					◎		○				△			・			○			△	△	△				・	
34	R105	72555	52175	Adcp	Dacite	Porphyritic	△	△						・			◎	◎	◎	◎						・			○				△					・	
35	R112	72620	53865	Ctf	Acidic coarse Tuff												◎	△	○							・			△		△	△	△					・	Dacite, Andesite and Basalt fragment
36	M086	72177	55459	Adcl	Aphyric Dacite	Hyalopilitic		△									◎												◎	△		○	△					・	Sph, Py mineralization
37	M087	74428	53776	Atf	Acidic coarse Tuff - lapilli Tuff												◎	△	△										◎		△	○	○	△					Dacite, Andesite fragment. strongly silicified
38	M088	73396	54833	Atf	Acidic Lapilli Tuff												△		△										◎			△	○	○				・	Dacite fragment. strongly silicified
39	M089	72925	56576	Stf	Acidic coarse Tuff												◎		△										△			△	△					・	Dacite, Andesite and Basalt fragment

◎ : abundant, ○ : common, △ : few, ・ : rare, Q : Quartz, Pl : Plagioclase, Ab : Albite, Bt : Biotite, Hn : Hornblende, Au : Augite, Ol : Olivine, Fe : Iron Mineral, Ap : Apatite, Sp : Sphane, G : Glass, Op : Opaque Mineral, Il : Ilmenite, Py : Pyrite, Cl : Clay, Ch : Chlorite, Ser : Sercite, Cal : Calcite, Ep : Epidote, Hm : Hematite, Ze : Zeolite.

Appendix 2

Microscopic Observation of Polished Section

Appendix 2 Microscopic Observation of Polished Section

No.	Sample	Location	Coordinates		Ore Type	Py	Mc	Hm	Sp	Gn	Cp	Bn	Dg	Cv	Tet	Remarks
			UTM-E	UTM-N												
1	M031	Duygulu	71877	52938	Silicified Tuff breccia with Pyrite dissemination.	◎										
2	M035	Köprüköy	71787	53710	Silicified Dacite with Pyrite dissemination.	◎										
3	M040	Yeşilköy, West	71655	54943	〃	◎					△					
4	M073	Garimani	71816	55411	Silicified Tuff breccia with Pyrite, Chalcopyrite dissemination.	◎			○		△					
5	M081	Köprüköy, West	71259	53921	Silicified Rock with Pyrite dissemination.	◎					△					
6	N011	Garimani	72179	55525	Silicified Dacite with Chalcopyrite, Sphalerite dissemination.	◎			◎		◎				・	
7	N031	Köprüköy, West	71125	54485	Clay with Pyrite.	◎			・		△					
8	N034	Yeşilköy, West	71500	54835	Dacite with Pyrite Vein	◎		・								
9	N042	Duygulu	71950	53045	Silicified Dacite with Pyrite dissemination.	◎					△					
10	R020	Garimani	71740	55260	Argilized Tuff with Pyrite.	◎			△		○	・				
11	R088	Köprüköy	72275	53715	Silicified Rock with Pyrite dissemination.	◎			・							
12	R091	Köprüköy	71950	53610	Silicified Dacite with Pyrite dissemination.	◎										

◎ : abundant, ○ : common, △ : few, ・ : rare

Py : Pyrite, Mc : Marcacite, Hm : Hematite, Sp : Sphalerite, Gn : Galena, Cp : Chalcopyrite, Bn : Bornite, Dg : Digenite, Cv : Covellite, Tet : Tetrahedrite

Appendix 3

Results of Ore Grade Assay

Appendix 3 Results of Ore Grade Assay

No.	Sample	Location	Coordinates UTM-E	Coordinates UTM-N	Ore Type	Au (ppm)	Ag (ppm)	Cu (%)	Pb (%)	Zn (%)	Ba (%)	S (%)	Ga (ppm)	Ge (ppm)	In (ppm)	As (ppm)	Remarks
1	M031	Duygulu	71877	52938	Silicified Tuff breccia with Pyrite dissemination.	0.10	2.10	0.166	0.001	0.020	0.360	40.640	30	< 1	1	47	
2	M035	Köpruköy	71787	53710	Silicified Dacite with Pyrite dissemination.	0.02	0.95	0.002	0.002	0.002	0.030	13.000	26	1	< 1	47	
3	M040	Yeşilköy, West	71655	54943	〃	< 0.01	0.50	0.002	< 0.001	0.007	0.077	2.000	24	< 1	< 1	3	
4	M073	Garimani	71816	55411	Silicified Tuff breccia with Pyrite, Chalcopyrite dissemination.	0.01	0.65	0.018	0.007	0.812	0.014	1.230	16	1	< 1	17	
5	M081	Köpruköy, West	71259	53921	Silicified Rock with Pyrite dissemination.	0.02	0.60	0.032	0.001	0.020	0.040	1.690	26	< 1	< 1	7	
6	N011	Garimani	72179	55525	Silicified Dacite with Chalcopyrite, Sphalerite dissemination.	0.12	2.00	0.537	0.006	5.130	0.011	12.900	38	1	1	305	
7	N031	Köpruköy, West	71125	54485	Clay with Pyrite.	< 0.01	0.75	0.034	0.002	0.020	0.036	0.115	30	< 1	< 1	6	
8	N034	Yeşilköy, West	71500	54835	Dacite with Pyrite Vein	0.07	0.75	0.002	< 0.001	0.060	0.085	38.400	42	< 1	< 1	21	
9	N042	Duygulu	71950	53045	Silicified Dacite with Pyrite dissemination.	< 0.01	0.50	0.001	< 0.001	0.002	0.035	3.660	18	< 1	< 1	5	
10	Q027	Köpruköy, North	71790	54380	Silicified Dacite with Pyrite dissemination.	< 0.01	0.50	0.001	0.001	0.006	0.042	2.700	24	< 1	< 1	27	
11	Q031	Köpruköy, North	71545	54600	〃	< 0.01	0.45	0.014	< 0.001	0.006	0.049	0.692	17	1	< 1	3	
12	Q069	Yeşilköy, North	71790	55600	〃	0.01	1.40	0.015	0.006	0.323	0.045	2.650	5	1	< 1	127	
13	Q071	Garimani	71785	55410	Clay with Pyrite. Gossan	0.27	1.40	0.118	0.005	0.150	0.388	1.120	11	1	4	43	
14	R011	Yeşilköy, North	71635	55760	Silicified Dacite with Pyrite dissemination.	0.08	0.50	0.002	< 0.001	0.021	0.055	4.990	15	< 1	< 1	5	
15	R020	Garimani	71740	55260	Argilized Tuff with Pyrite.	0.18	0.65	0.419	0.001	0.008	0.022	3.330	18	< 1	1	11	
16	R041	Yeşilköy, West	71145	54480	Silicified Dacite with Pyrite dissemination.	0.92	0.50	0.002	< 0.001	0.004	0.043	4.640	12	1	< 1	5	
17	R043	Köpruköy, West	71150	54090	Silicified Dacite with Pyrite dissemination.	1.64	0.50	0.001	< 0.001	0.008	0.027	0.072	4	< 1	< 1	3	
18	R050	Köpruköy, West	71260	53930	Clay with Pyrite. Rich in Pyrite	0.04	10.00	0.080	0.003	0.019	0.027	30.790	30	< 1	2	26	
19	R057	Köpruköy, West	71075	53845	Dacite with Pyrite Vein	< 0.01	1.35	0.005	0.002	0.008	0.035	25.700	9	< 1	< 1	770	
20	R088	Köpruköy	72275	53715	Silicified Rock with Pyrite dissemination.	< 0.01	2.25	0.004	0.001	0.003	0.026	2.100	17	< 1	< 1	49	
21	R091	Köpruköy	71950	53610	Silicified Rock with Pyrite dissemination.	< 0.01	0.50	0.001	0.001	0.032	0.015	1.120	37	< 1	< 1	5	
22	R098	Duygulu	71410	52955	Granodiorite with Pyrite dissemination.	< 0.01	0.45	0.003	0.001	0.062	0.035	1.410	24	1	< 1	8	
23	R100	Duygulu	71595	53120	Silicified Rock with Pyrite dissemination.	< 0.01	0.60	0.002	< 0.001	0.004	0.038	4.560	23	< 1	< 1	7	

Appendix 4

Results of Chemical Analysis for Rock Specimens

Appendix 4 Results of Chemical Analysis for Rock Specimens (1)

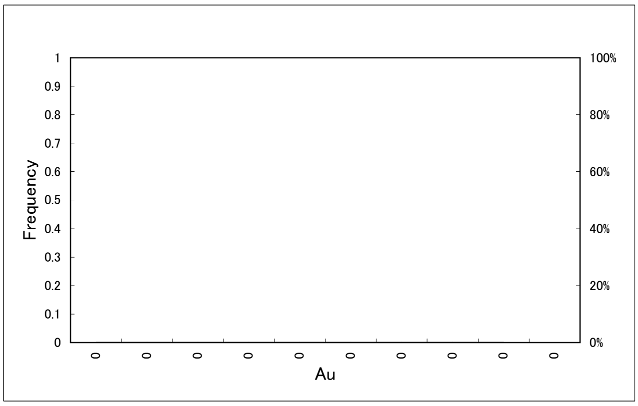
No.	Sample	Coordinates		Rock	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sr	Ti	V	W	Zn
		UTM-E	UTM-N	Type	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	%	%	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
1	M001	73750	55237	Cbs	0.006	<0.5	7.48	7	20	<0.5	<2	7.27	<0.5	29	114	63	6.16	0.96	3.21	1235	<1	2.13	41	450	<2	<0.01	<5	259	0.35	238	<10	72
2	M007	72725	55777	Atf	0.002	<0.5	6.30	21	140	0.9	<2	0.39	<0.5	1	30	7	2.39	1.90	0.62	1135	<1	0.73	3	180	5	0.01	<5	33	0.20	37	<10	83
3	M010	72396	55887	Atf	0.001	<0.5	6.92	<5	470	1.3	<2	0.22	<0.5	1	21	4	1.89	3.09	1.04	1025	<1	0.64	5	20	7	<0.01	<5	67	0.19	5	<10	105
4	M012	72365	56036	Adcp	<0.001	<0.5	4.91	<5	70	1.0	<2	0.63	<0.5	1	57	2	1.49	2.09	0.40	492	<1	0.51	2	20	<2	0.01	<5	18	0.06	<1	<10	120
5	M019	72363	56367	Adcp	<0.001	<0.5	6.56	<5	90	0.8	<2	0.03	<0.5	6	8	3	2.95	2.27	0.78	1135	<1	0.02	3	60	6	<0.01	<5	7	0.13	2	<10	106
6	M024	72044	56254	Adcp	<0.001	<0.5	6.01	<5	120	0.8	<2	0.08	<0.5	3	39	11	1.85	2.87	0.44	666	<1	0.39	3	50	5	<0.01	<5	25	0.11	9	<10	58
7	M026	71712	52466	Adcu	0.009	<0.5	5.04	12	370	0.5	4	0.01	<0.5	<1	12	273	6.67	2.21	0.28	135	2	0.06	1	150	12	0.02	<5	3	0.13	7	<10	60
8	M028	71814	52547	Adcu	0.038	<0.5	5.33	36	330	<0.5	3	0.03	1.5	<1	15	246	2.58	2.42	0.35	643	3	0.10	1	50	23	0.01	<5	5	0.19	5	<10	144
9	M030	71566	53003	Adcu	0.008	<0.5	5.66	34	150	0.6	<2	0.05	<0.5	2	78	4	1.71	0.97	0.14	88	<1	1.51	2	260	6	0.87	<5	85	0.20	3	<10	22
10	M034	71728	53412	Adcu	0.001	<0.5	5.65	<5	220	0.7	<2	0.03	5.3	2	26	78	1.79	1.66	1.60	5470	<1	0.04	1	130	<2	<0.01	<5	5	0.14	9	<10	779
11	M037	71788	55070	Atf	<0.001	<0.5	5.84	<5	100	0.7	<2	0.16	<0.5	2	29	9	0.81	1.10	0.14	182	<1	2.78	2	90	2	<0.01	<5	28	0.14	12	<10	77
12	M042	71455	54761	Atf	0.016	<0.5	5.85	10	440	0.6	<2	0.03	<0.5	<1	41	5	2.43	2.35	1.11	851	3	0.06	2	90	5	0.34	<5	5	0.17	2	<10	57
13	M043	71376	54733	Atf	0.017	2.0	5.42	9	440	0.5	8	0.02	<0.5	1	44	31	4.04	2.40	0.25	92	4	0.06	2	230	11	0.52	<5	4	0.14	11	<10	41
14	M048	72260	52580	Adcu	0.001	<0.5	5.96	<5	70	0.6	<2	1.69	<0.5	1	52	5	2.38	1.28	0.28	783	<1	1.98	3	350	4	<0.01	<5	49	0.19	4	<10	68
15	M052	74126	52974	Atf	<0.001	<0.5	6.34	<5	60	1.1	<2	0.11	<0.5	1	38	1	1.66	2.02	0.27	506	<1	1.13	2	110	4	<0.01	<5	60	0.18	3	<10	72
16	M053	74162	53254	Atf	<0.001	<0.5	6.03	<5	60	<0.5	<2	0.89	<0.5	1	37	3	0.74	0.42	0.09	278	<1	4.07	2	130	5	0.01	<5	333	0.17	7	<10	30
17	M056	74189	53693	Dci	<0.001	<0.5	6.06	6	120	0.5	<2	0.22	<0.5	2	97	4	2.06	0.98	0.38	407	<1	3.90	7	200	3	<0.01	<5	60	0.20	19	<10	55
18	M059	74286	53647	Atf	<0.001	<0.5	5.57	<5	70	0.8	<2	3.36	<0.5	1	33	2	1.79	1.73	0.51	774	<1	0.48	1	160	5	<0.01	<5	32	0.15	26	<10	71
19	M062	74281	53107	Atf	<0.001	<0.5	4.14	<5	50	0.5	<2	0.08	<0.5	<1	62	4	0.60	1.56	0.23	204	<1	0.08	2	60	4	<0.01	<5	16	0.12	8	<10	34
20	M063	73430	54809	Atf	<0.001	<0.5	6.47	8	360	1.2	<2	1.13	<0.5	2	40	2	1.97	3.42	0.45	807	<1	2.00	3	180	12	<0.01	<5	216	0.20	10	<10	84
21	M065	72645	55310	Atf	<0.001	<0.5	6.26	7	300	0.8	<2	0.22	<0.5	<1	26	5	1.31	1.07	0.51	421	<1	2.97	3	70	11	<0.01	<5	83	0.17	11	<10	72
22	M066	72249	55412	Atf	<0.001	<0.5	6.35	12	340	1.1	<2	0.46	<0.5	<1	52	5	1.54	3.17	0.92	408	1	1.45	2	160	4	<0.01	<5	127	0.17	14	<10	47
23	M074	71885	55414	Adcl	<0.001	<0.5	7.18	11	200	0.8	<2	0.02	<0.5	1	10	70	1.45	1.84	0.50	1320	1	0.03	7	110	89	<0.01	<5	5	0.15	9	<10	389
24	M077	72524	53690	Adct	<0.001	<0.5	5.53	<5	80	1.0	<2	0.04	<0.5	2	53	9	2.52	1.90	0.18	615	1	1.09	2	60	7	<0.01	<5	22	0.11	2	<10	67
25	M080	71940	53029	Adcu	0.004	<0.5	5.37	13	500	<0.5	2	0.01	<0.5	<1	37	31	5.01	2.49	0.27	146	2	0.07	1	170	4	1.49	<5	8	0.11	10	<10	40
26	N005	72654	55305	Atf	<0.001	<0.5	5.63	<5	60	0.9	<2	0.23	<0.5	2	32	14	1.67	0.15	0.74	454	1	2.86	6	100	9	<0.01	<5	56	0.15	14	<10	66
27	N013	72178	55575	Adcl	0.001	<0.5	5.62	6	790	0.8	<2	0.10	1.1	1	65	39	2.25	1.73	0.47	2340	2	1.53	2	150	6	<0.01	<5	31	0.10	1	<10	450
28	N016	72382	55755	Atf	<0.001	<0.5	6.14	14	140	0.9	<2	1.22	<0.5	3	51	39	1.83	1.10	0.48	455	1	2.32	3	200	9	<0.01	<5	81	0.14	18	<10	58
29	N017	72480	55625	Ctf	0.001	<0.5	6.53	<5	120	1.0	<2	1.42	<0.5	2	21	10	1.88	2.06	0.89	1150	1	1.98	4	270	10	<0.01	<5	100	0.19	14	<10	95
30	N018	72835	55505	Atf	<0.001	<0.5	6.25	<5	230	0.8	<2	0.96	<0.5	<1	19	4	1.72	1.27	0.60	1055	1	3.44	5	250	6	<0.01	<5	77	0.18	12	<10	92
31	N019	72965	54685	Atf	0.002	<0.5	7.31	10	70	1.0	<2	6.66	<0.5	2	40	14	1.50	0.56	0.59	991	1	0.46	6	60	10	0.01	<5	176	0.06	11	<10	147
32	N022	72183	55486	Adcl	0.001	0.5	7.06	22	100	0.7	<2	0.08	<0.5	<1	14	11	0.95	2.13	0.34	65	<1	0.82	<1	90	116	0.01	<5	16	0.15	5	<10	124
33	N027	72485	51945	Cmc	<0.001	<0.5	8.89	<5	130	1.8	<2	9.01	<0.5	2	4	38	2.56	4.06	1.53	2220	<1	0.11	14	550	16	0.01	<5	88	0.39	36	<10	121
34	N029	71130	54515	Adcu	0.004	<0.5	4.84	<5	70	<0.5	2	0.03	<0.5	<1	58	5	3.47	2.13	0.21	71	1	0.05	2	30	5	3.03	<5	7	0.11	<1	<10	8
35	N038	71025	54745	Adcu	<0.001	<0.5	6.91	8	120	0.9	<2	0.54	<0.5	<1	49	2	2.72	1.31	0.50	617	<1	2.51	3	160	4	0.01	<5	84	0.11	<1	<10	102
36	N040	72175	52725	Adcu	0.003	<0.5	6.28	13	50	0.8	<2	1.02	<0.5	<1	62	8	2.67	1.36	0.63	837	1	2.21	1	360	8	0.12	<5	82	0.20	5	<10	88
37	N043	71653	56207	Atf	0.004	0.9	5.85	10	900	0.9	<2	0.04	1	<1	55	168	2.63	2.14	1.44	1610	3	0.07	3	160	750	0.31	<5	15	0.13	2	<10	406
38	N046	72937	52520	Adct	<0.001	<0.5	6.50	<5	100	0.8	<2	0.93	<0.5	<1	26	3	2.19	1.04	0.97	501	<1	2.57	1	400	8	<0.01	<5	80	0.28	4	<10	86
39	N050	73137	52275	Adct	<0.001	<0.5	5.88	<5	70	0.7	<2	0.47	<0.5	<1	100	27	1.17	0.86	0.38	404	1	2.88	4	90	2	<0.01	<5	75	0.12	8	<10	62
40	N054	73108	52270	Adct	0.001	<0.5	5.54	5	60	0.7	<2	3.11	<0.5	<1	47	2	1.89	1.68	0.74	807	<1	0.57	1	230	6	<0.01	<5	45	0.19	1	<10	84

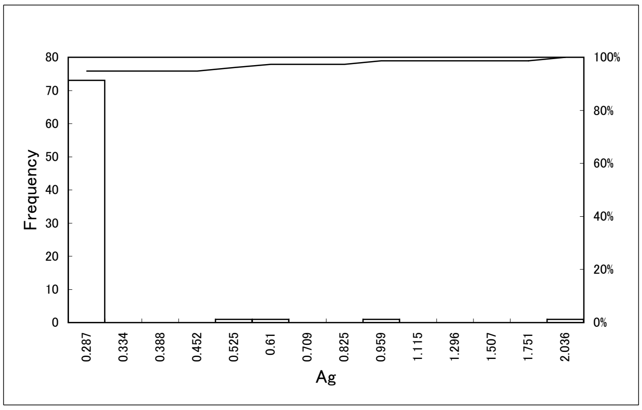
Appendix 4 Results of Chemical Analysis for Rock Specimens (2)

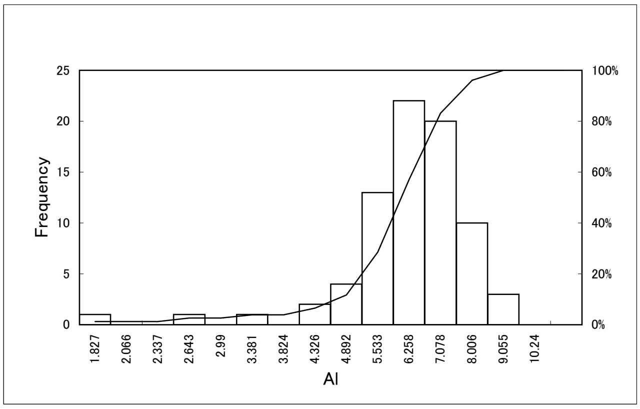
No.	Sample	Coordinates UTM-E	Coordinates UTM-N	Rock Type	Au ppm	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	K %	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sr ppm	Ti %	V ppm	W ppm	Zn ppm
41	N056	74547	53695	Atf	<0.001	<0.5	7.87	12	260	1.1	<2	2.37	<0.5	1	13	17	3.48	2.73	0.75	565	<1	0.37	10	80	6	0.01	<5	521	0.29	10	<10	118
42	P001	73011	54100	Ctf	<0.001	<0.5	3.28	<5	120	0.5	<2	0.31	<0.5	1	98	7	1.03	0.51	0.18	600	1	1.63	11	90	9	<0.01	<5	71	0.06	10	<10	75
43	P004	73518	53905	Ctf	<0.001	<0.5	6.14	<5	30	0.7	<2	0.08	<0.5	<1	43	3	1.33	0.94	0.18	46	2	2.90	2	70	2	0.14	<5	47	0.16	12	<10	4
44	P010	73983	54150	Cms	0.001	<0.5	2.43	10	40	<0.5	<2	29.40	<0.5	3	8	51	2.17	0.01	1.62	1685	1	0.02	25	460	53	<0.01	<5	755	0.09	31	<10	117
45	P020	73620	53410	Ctf	<0.001	<0.5	1.69	11	50	0.7	<2	0.10	<0.5	<1	104	13	15.05	0.15	0.82	1240	2	0.02	16	40	26	<0.01	<5	13	0.04	47	<10	41
46	P036	73199	53620	Cms	0.001	<0.5	3.95	<5	10	<0.5	<2	18.70	<0.5	12	6	4	3.05	0.04	1.67	1440	<1	0.11	24	140	8	0.01	<5	138	0.04	37	<10	29
47	P040	72130	55020	Adcp	0.001	<0.5	8.01	<5	150	1.4	<2	0.06	<0.5	<1	22	4	2.54	3.96	0.96	488	<1	0.03	3	20	7	<0.01	<5	27	0.09	7	<10	211
48	P051	72290	53101	Kgr	<0.001	<0.5	6.11	6	160	0.7	<2	1.20	<0.5	1	59	5	3.04	0.98	0.98	709	<1	1.94	2	140	5	<0.01	<5	109	0.11	12	<10	109
49	P059	72260	54595	Adcp	<0.001	<0.5	6.56	8	110	<0.5	<2	0.97	<0.5	3	56	3	1.08	0.06	0.59	2130	1	4.05	6	100	7	<0.01	<5	83	0.12	7	<10	71
50	Q004	71540	55490	Adcp	0.001	<0.5	5.43	10	440	0.8	<2	0.03	<0.5	<1	32	25	1.59	1.90	1.11	743	3	0.06	2	120	5	<0.01	<5	6	0.13	8	<10	82
51	Q013	72850	54140	Ctf	0.001	<0.5	4.96	<5	50	0.7	<2	1.69	<0.5	1	65	11	1.33	0.47	0.35	650	<1	1.42	5	160	9	<0.01	<5	157	0.11	18	<10	57
52	Q025	71885	54330	Atf	0.001	<0.5	5.92	<5	40	0.6	<2	0.24	<0.5	<1	106	44	1.27	0.67	0.30	792	<1	3.81	3	160	122	0.02	<5	56	0.10	2	<10	151
53	Q028	71715	54400	Atf	0.010	0.6	7.47	51	180	0.6	<2	0.01	<0.5	<1	31	40	0.73	3.57	0.59	308	1	0.06	<1	90	101	0.25	<5	5	0.17	10	<10	198
54	Q034	73050	55800	Cbs	0.001	<0.5	7.86	<5	30	<0.5	<2	10.60	<0.5	20	84	59	4.14	0.24	3.24	1800	<1	1.38	39	300	<2	0.01	<5	216	0.34	200	<10	50
55	Q047	71265	54835	Adcp	<0.001	<0.5	6.68	<5	60	0.8	<2	0.77	<0.5	1	48	2	2.64	0.97	0.61	714	1	3.03	1	180	3	0.01	<5	52	0.15	1	<10	96
56	Q054	71470	54275	Adcu	0.003	<0.5	5.92	<5	240	0.8	<2	0.26	<0.5	6	50	2	4.15	1.52	1.46	1165	<1	0.94	1	320	4	2.47	<5	23	0.22	3	<10	41
57	Q056	71620	54095	Adcu	0.001	<0.5	6.34	<5	460	0.7	<2	0.14	<0.5	1	69	70	2.90	1.94	0.97	1490	1	1.70	1	330	5	0.01	<5	47	0.21	7	<10	150
58	Q073	73350	53290	Cbs	<0.001	<0.5	5.47	7	20	<0.5	<2	2.92	<0.5	27	60	52	4.93	0.50	2.67	595	<1	0.29	27	420	<2	<0.01	<5	100	0.25	140	<10	62
59	Q080	71892	54607	Adcp	<0.001	<0.5	5.46	<5	90	0.7	<2	0.21	<0.5	1	79	7	1.49	1.06	0.12	499	1	2.64	2	140	5	<0.01	<5	37	0.12	7	<10	51
60	Q081	72089	54614	Adcp	<0.001	<0.5	6.21	<5	30	1.0	<2	0.11	<0.5	<1	44	2	2.40	0.11	0.24	499	<1	4.28	3	40	6	<0.01	<5	35	0.07	4	<10	213
61	R010	71585	55855	Adcp	0.001	<0.5	5.07	<5	40	0.6	<2	0.10	<0.5	<1	128	3	1.12	0.16	0.05	148	1	3.71	3	30	3	<0.01	<5	51	0.10	2	<10	69
62	R025	71205	55395	Adcg	<0.001	<0.5	7.87	7	220	1.0	<2	0.43	<0.5	3	54	5	3.02	0.80	0.97	873	<1	4.80	3	880	17	<0.01	<5	126	0.38	21	<10	82
63	R028	70935	55425	Adcg	<0.001	<0.5	4.79	<5	50	0.5	<2	0.08	<0.5	1	48	5	0.94	0.71	0.27	142	<1	2.14	1	60	4	<0.01	<5	47	0.09	9	<10	114
64	R033	72450	52990	Cbtf	<0.001	<0.5	8.10	6	30	0.5	<2	0.30	<0.5	15	11	28	6.29	0.49	1.73	1155	1	3.22	1	550	4	<0.01	<5	101	0.49	116	<10	108
65	R060	70930	54805	Adcu	<0.001	<0.5	6.74	<5	30	0.7	<2	1.10	<0.5	<1	51	2	4.37	0.16	1.12	1415	1	4.40	<1	160	3	<0.01	<5	28	0.13	1	<10	199
66	R066	70385	55260	Adcu	<0.001	<0.5	6.56	<5	10	0.5	<2	0.17	<0.5	<1	39	1	2.88	0.28	0.10	647	<1	4.42	1	420	5	<0.01	<5	40	0.18	5	<10	78
67	R067	70615	54940	Adcu	<0.001	<0.5	7.24	8	60	1.0	<2	0.88	<0.5	<1	68	3	2.85	2.36	0.67	682	<1	1.55	<1	270	3	<0.01	<5	45	0.17	2	<10	103
68	R069	73620	54525	Ctf	0.001	<0.5	6.80	7	110	2.0	<2	1.59	<0.5	<1	52	5	3.69	3.72	0.55	974	<1	0.58	8	150	8	<0.01	<5	77	0.16	18	<10	86
69	R070	73600	54550	Ctf	<0.001	<0.5	5.69	<5	130	0.8	2	0.05	<0.5	<1	36	4	1.58	2.93	0.16	207	<1	0.61	3	90	6	0.01	<5	24	0.17	9	<10	68
70	R074	73410	52710	Adct	0.001	<0.5	6.49	6	70	0.7	<2	0.89	<0.5	2	51	2	2.74	1.68	0.71	500	<1	1.67	2	160	4	<0.01	<5	44	0.12	10	<10	96
71	R084	72465	53640	Atf	0.001	<0.5	4.80	5	30	<0.5	<2	0.11	<0.5	1	81	5	1.76	0.28	0.03	203	<1	2.81	4	140	4	<0.01	<5	19	0.08	9	<10	16
72	R086	72380	53675	Cbtf	0.001	<0.5	6.79	17	120	<0.5	<2	3.42	<0.5	14	58	37	5.64	1.86	1.69	4930	1	0.57	7	450	10	0.34	<5	38	0.38	171	<10	71
73	R092	71965	53635	Adcu	0.002	<0.5	7.74	13	330	0.6	<2	0.08	<0.5	4	21	79	7.74	1.56	2.50	3350	1	0.52	1	530	11	0.34	<5	13	0.49	237	<10	254
74	R102	71575	53380	Adcu	<0.001	<0.5	5.40	<5	580	0.6	<2	0.09	0.9	<1	64	4	2.60	1.53	1.18	2880	1	1.25	3	230	7	<0.01	<5	42	0.15	6	<10	346
75	R105	72555	52175	Adcp	<0.001	<0.5	4.84	<5	30	<0.5	<2	0.16	<0.5	<1	54	3	1.42	0.16	0.08	115	<1	3.40	2	90	3	<0.01	<5	38	0.08	6	<10	24
76	R107	72365	52265	Adcp	0.001	<0.5	5.01	<5	50	0.5	<2	0.16	<0.5	1	138	11	1.32	0.23	0.09	164	1	3.41	5	150	12	<0.01	<5	52	0.11	2	<10	44
77	R112	72620	53865	Cbtf	<0.001	<0.5	7.58	6	150	1.0	<2	1.87	<0.5	1	13	6	2.42	1.78	1.19	911	<1	1.56	3	320	9	<0.01	<5	236	0.22	11	<10	114

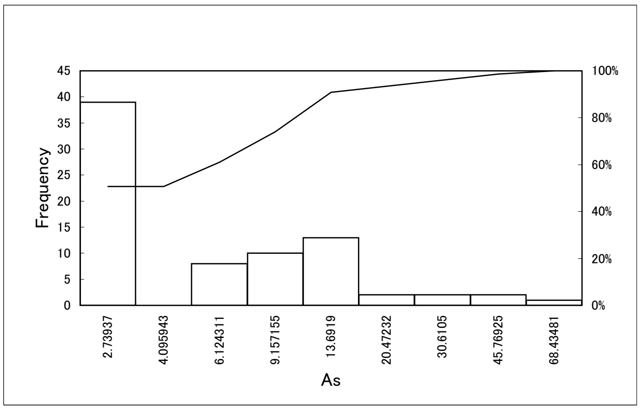
Appendix 5

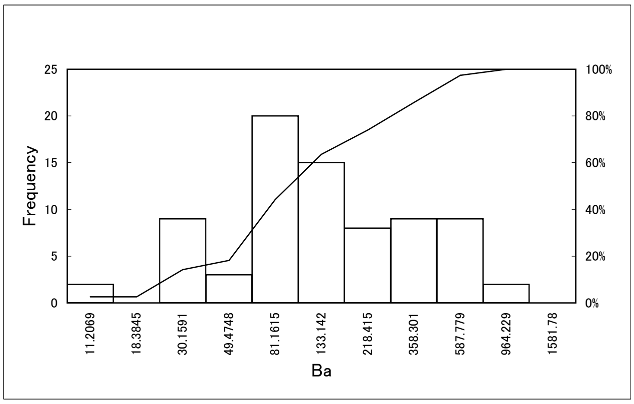
Cumulative Frequency Diagram and Histogram

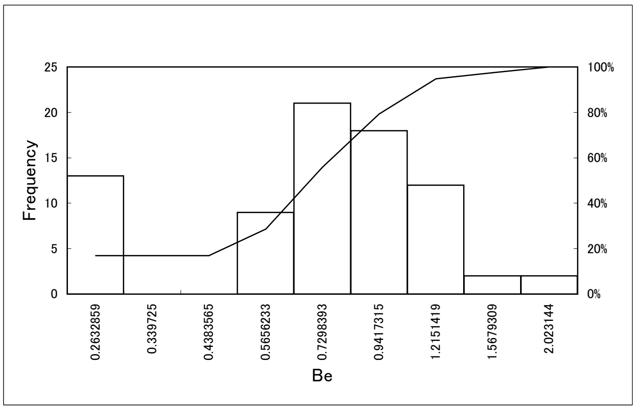


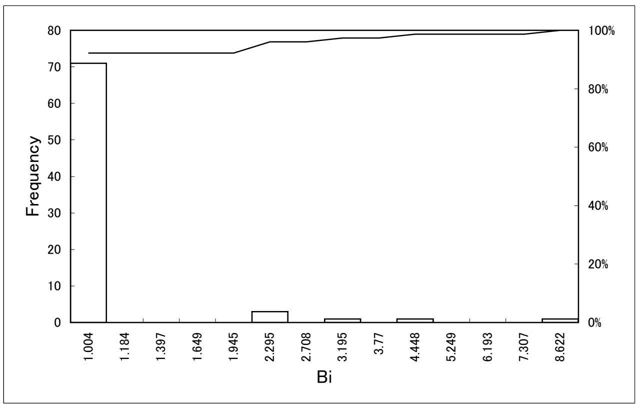


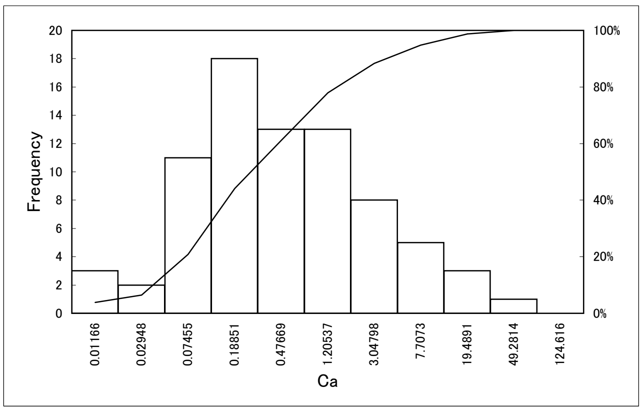




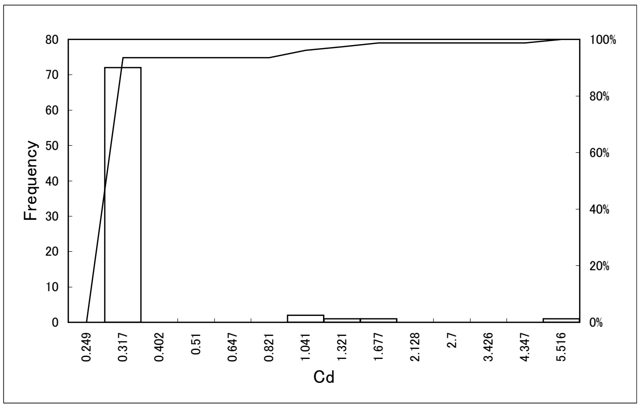


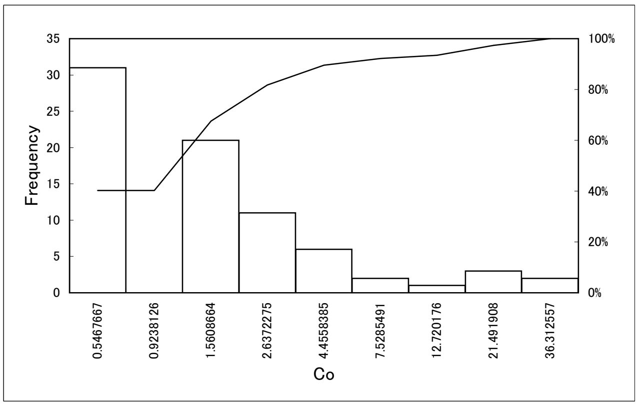


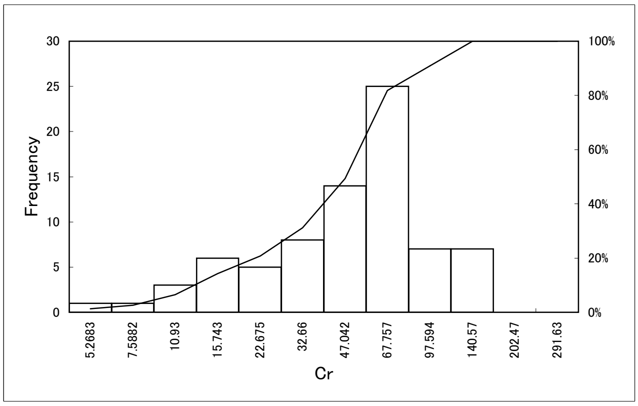


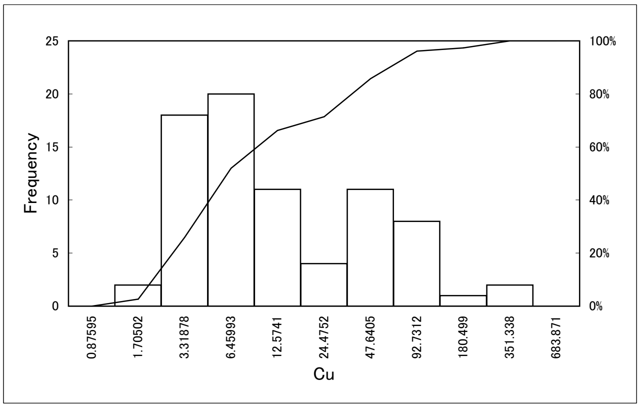


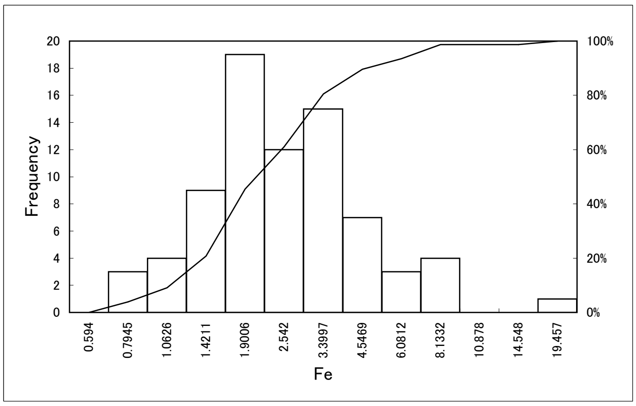
Appendix 5 Cumulative Frequency Diagram and Histogram (Whole Rock) (1)

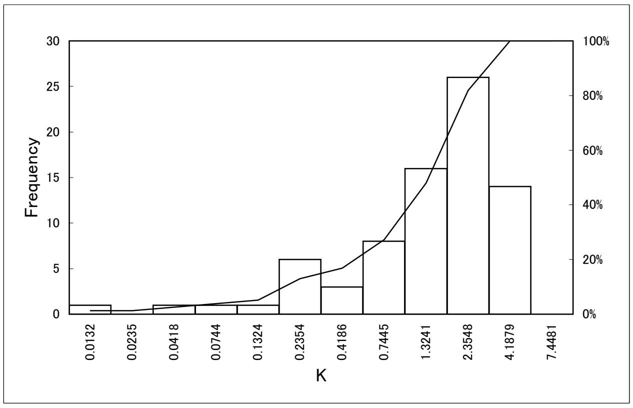


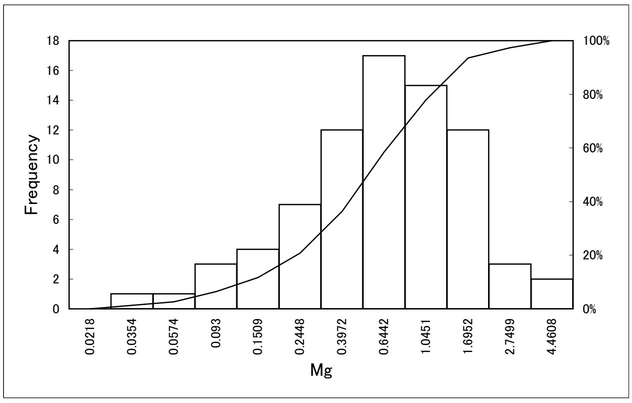


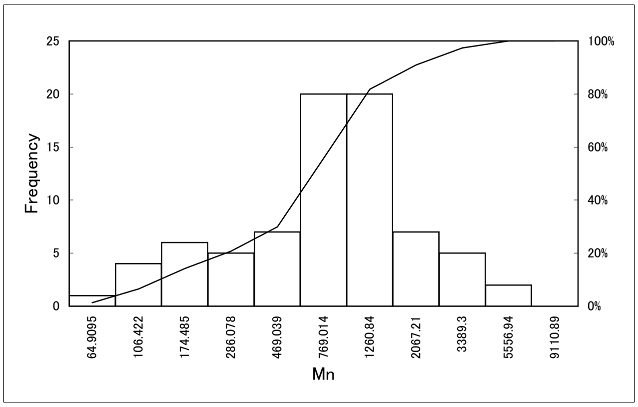




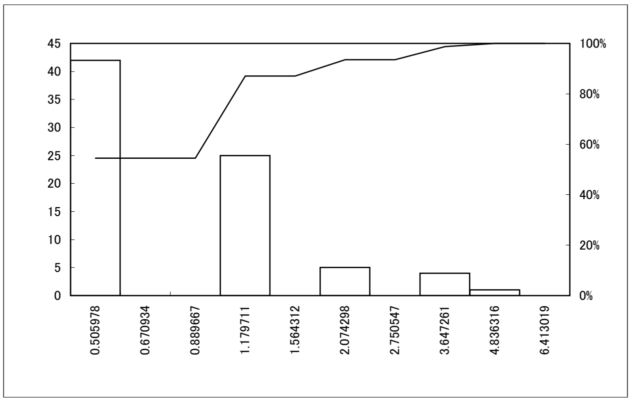


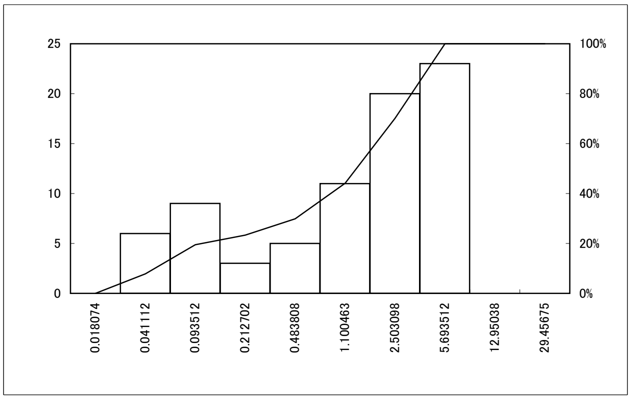


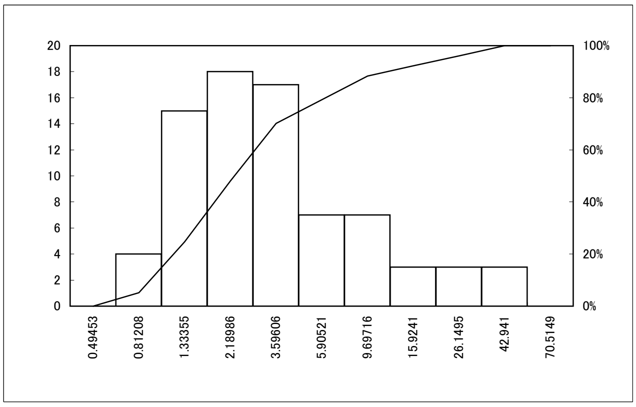


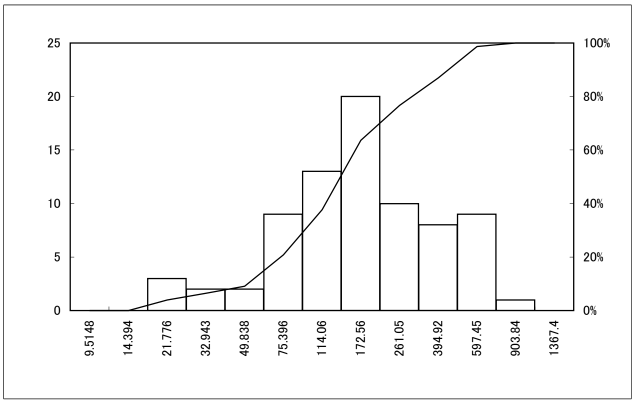


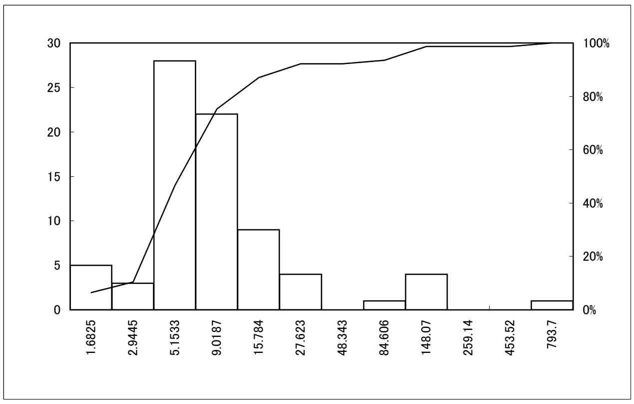
Appendix 5 Cumulative Frequency Diagram and Histogram (Whole Rock) (2)

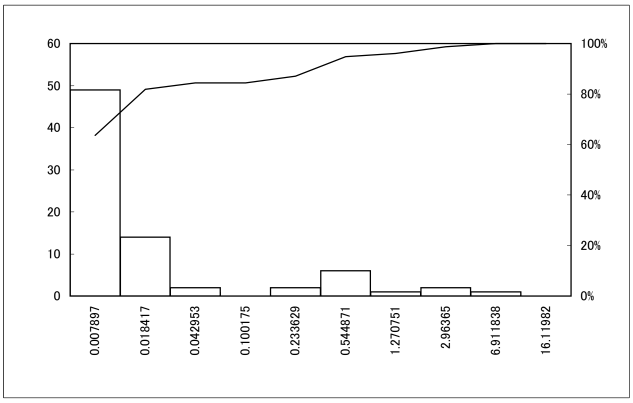


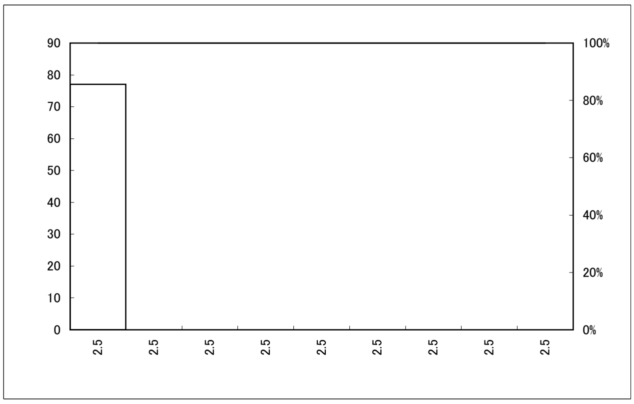


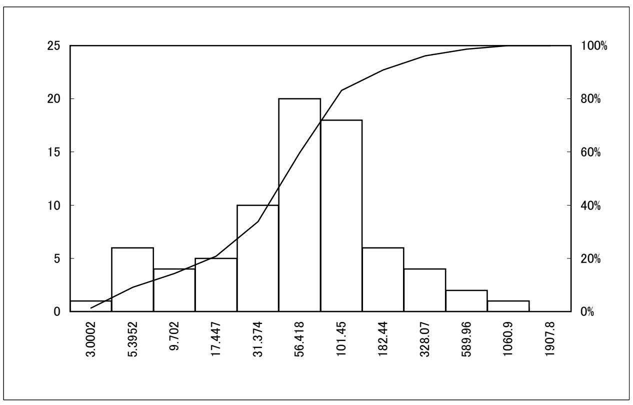




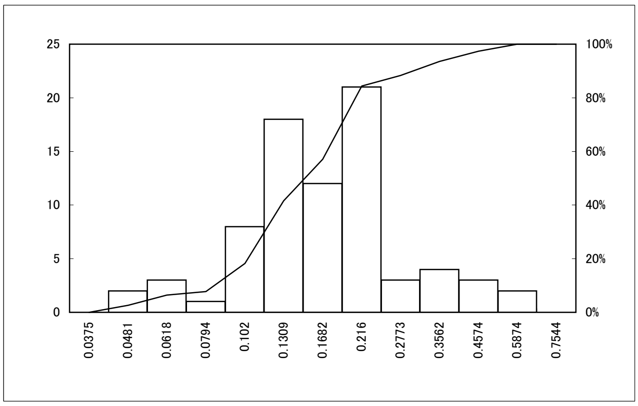


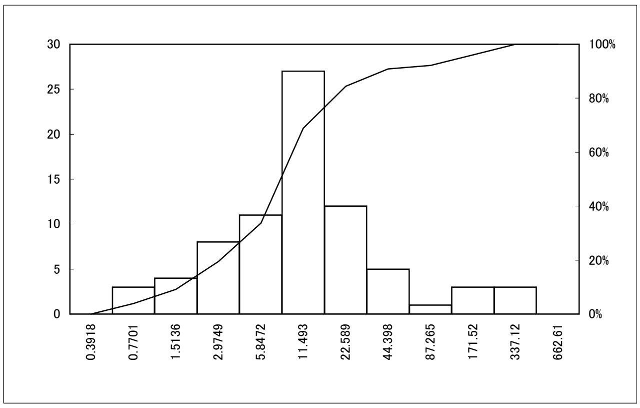


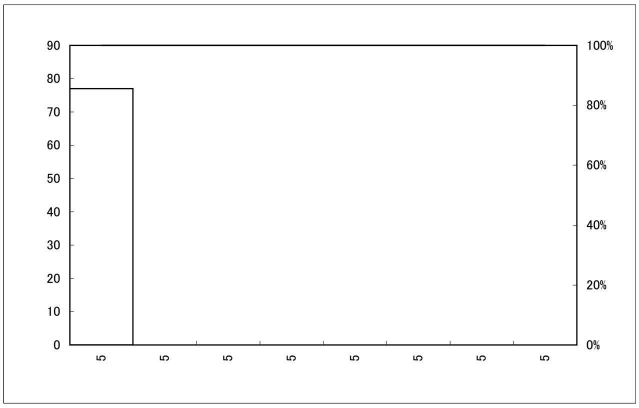


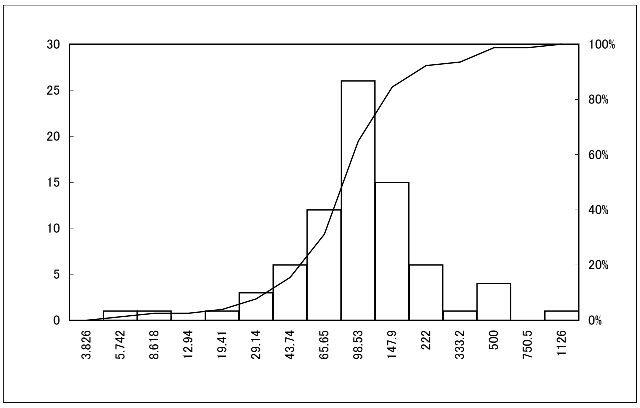


Appendix 5 Cumulative Frequency Diagram and Histogram (Whole Rock) (3)

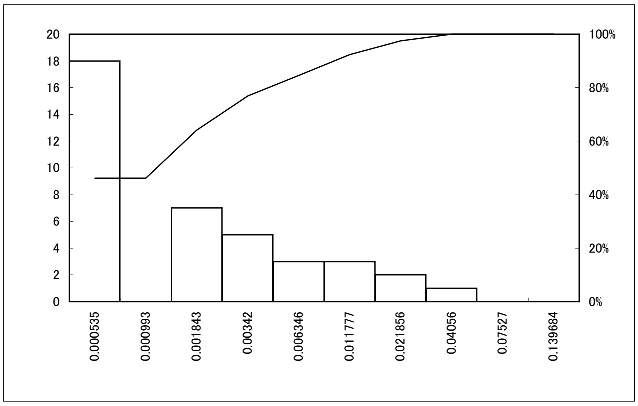


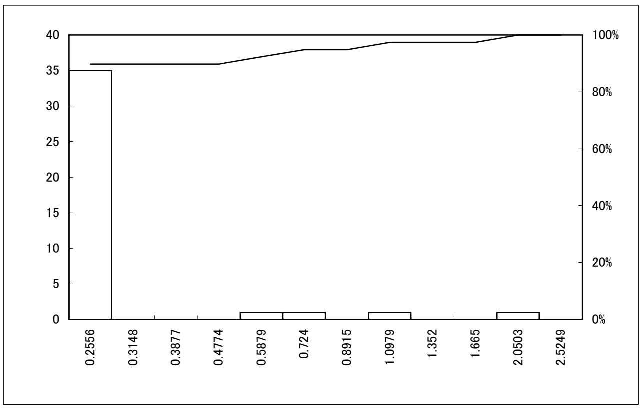


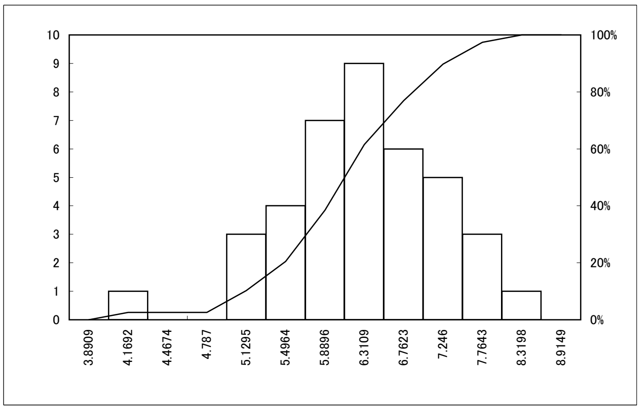


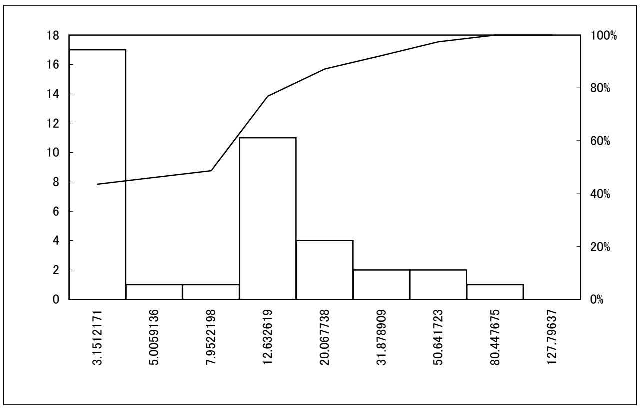


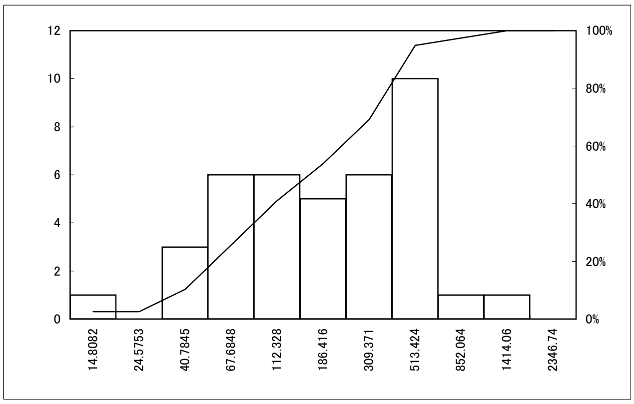
Appendix 5 Cumulative Frequency Diagram and Histogram (Whole Rock) (4)

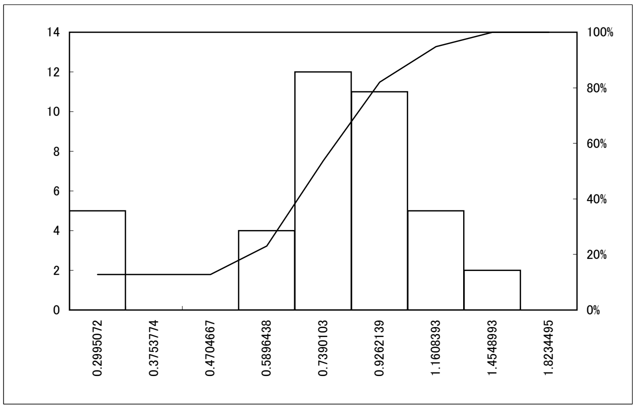


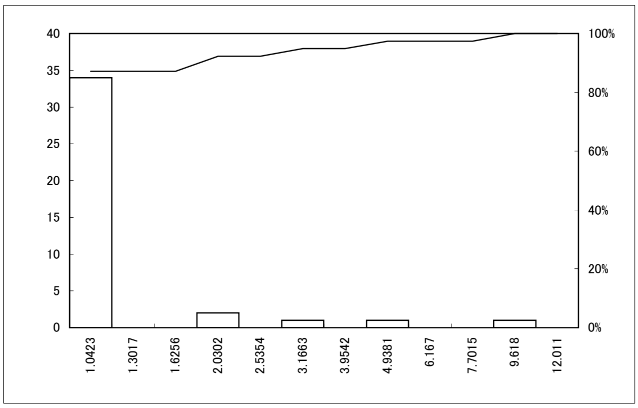


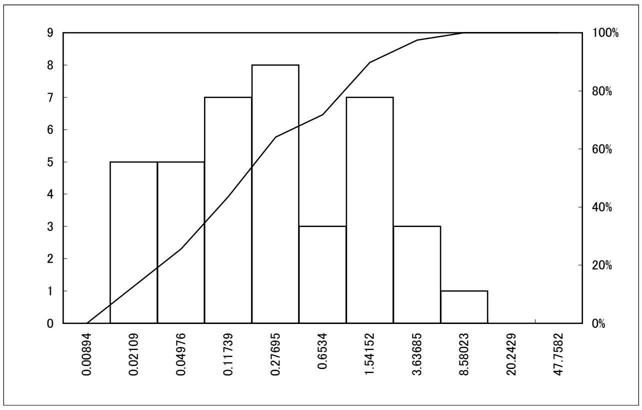




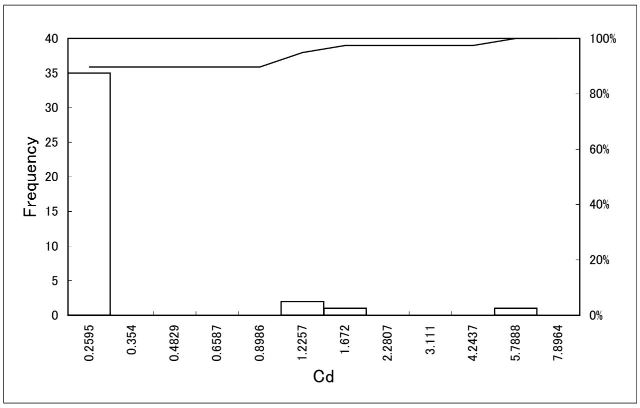


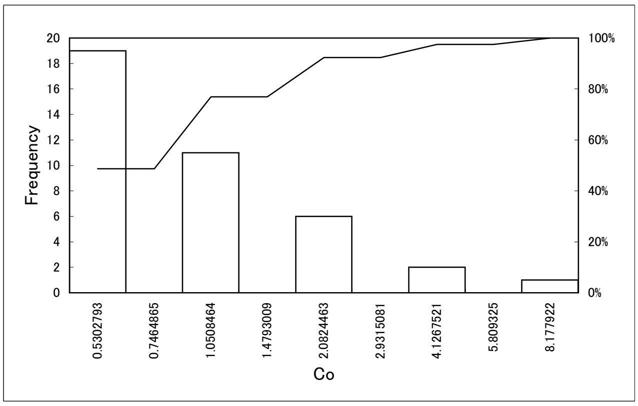


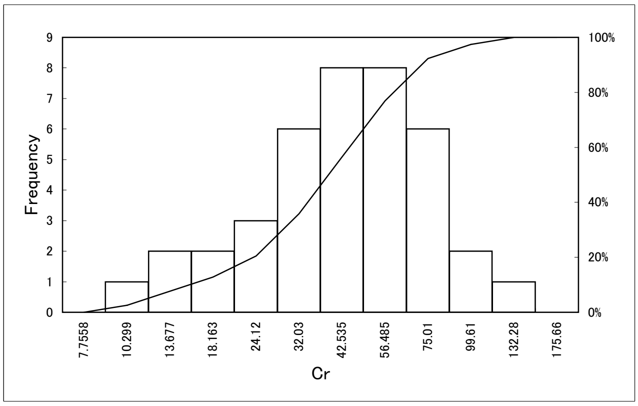


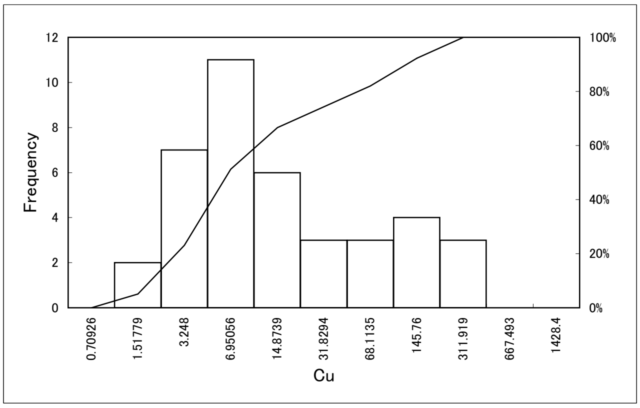


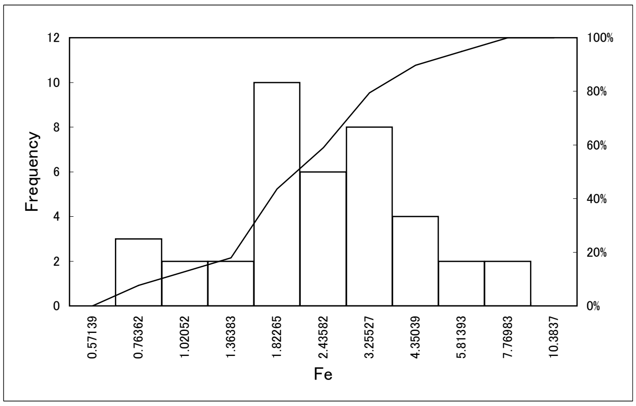
Appendix 5 Cumulative Frequency Diagram and Histogram (the Lower Member of the Alemağaç Formation) (1)

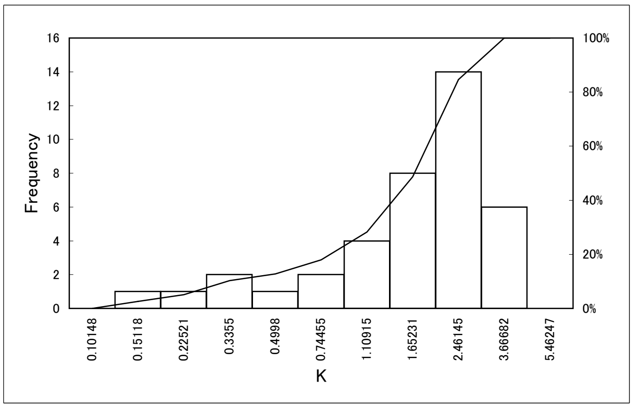


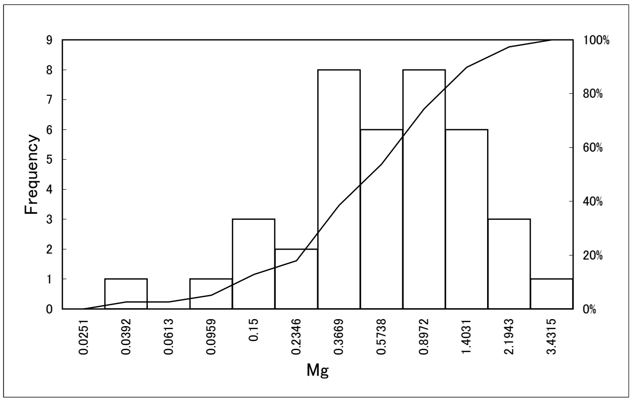


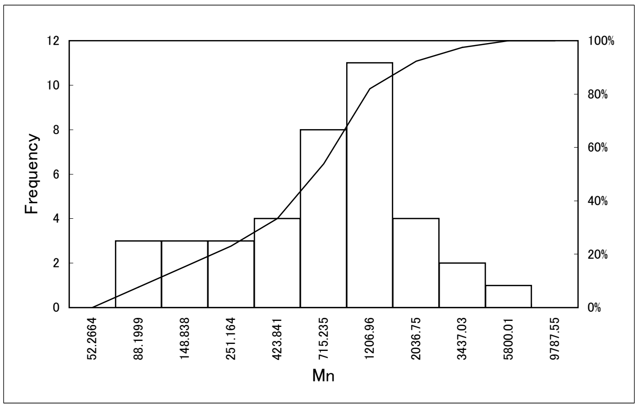




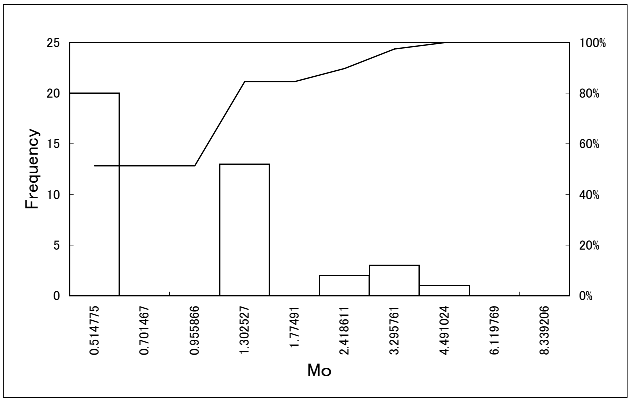


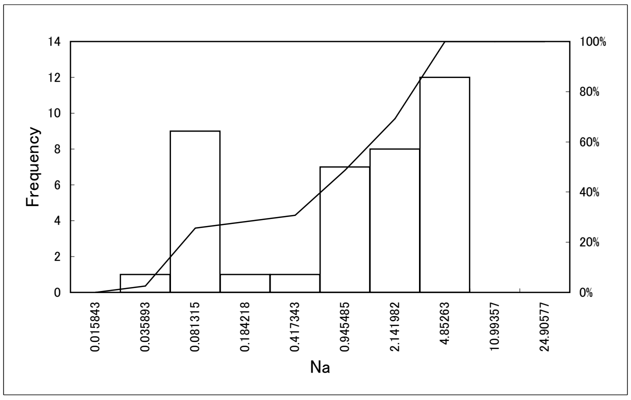


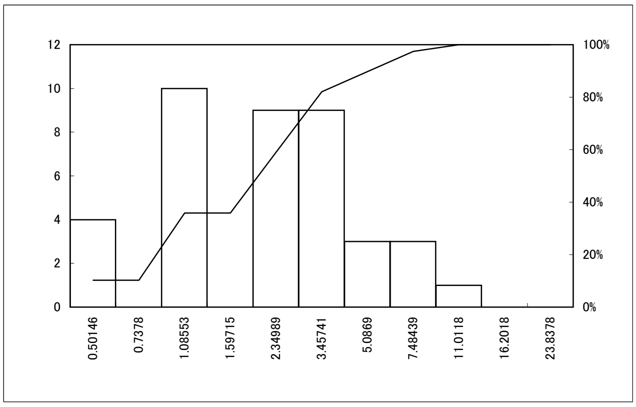


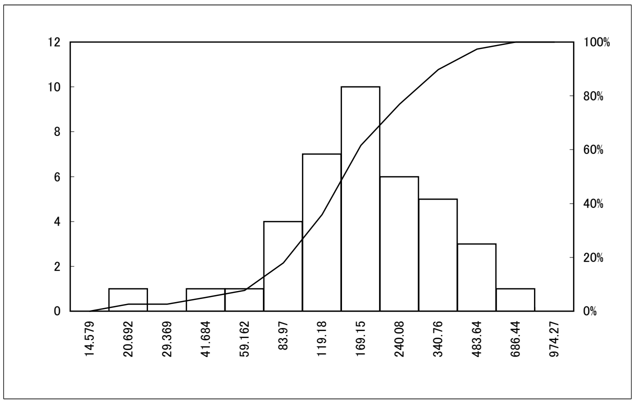


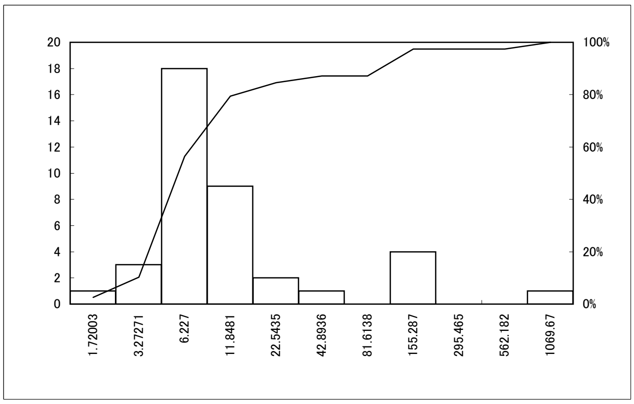
Appendix 5 Cumulative Frequency Diagram and Histogram (the Lower Member of the Alemağaç Formation) (2)

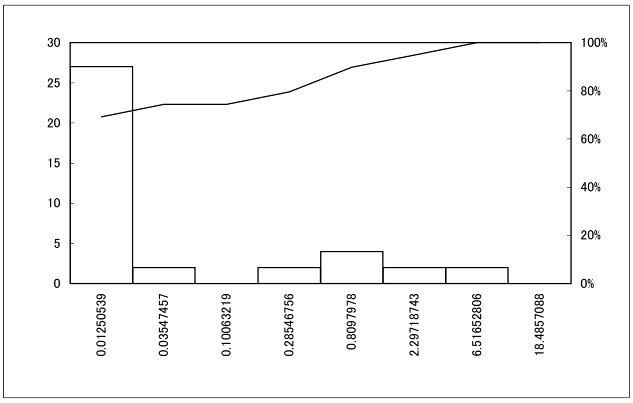


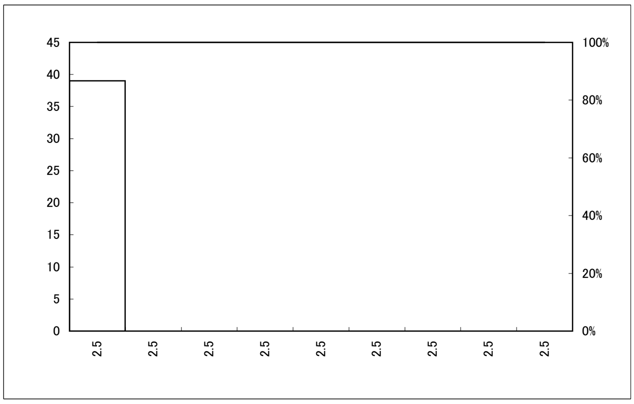


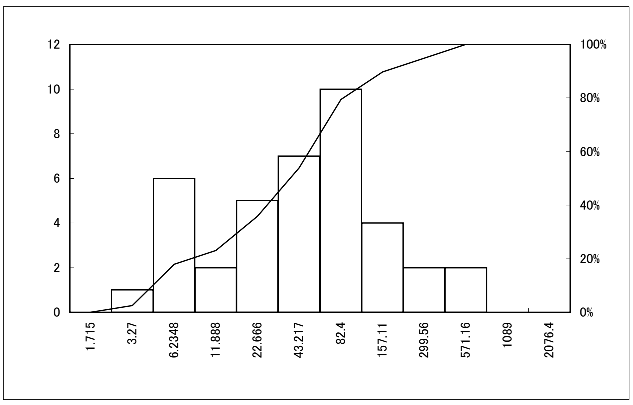




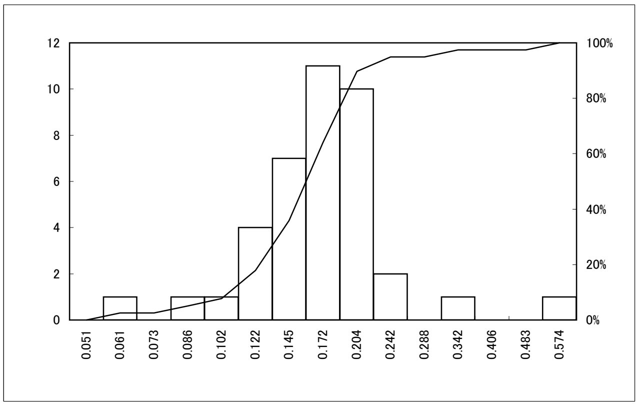


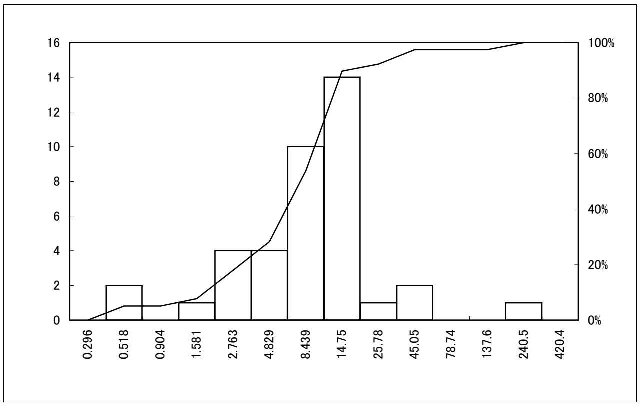


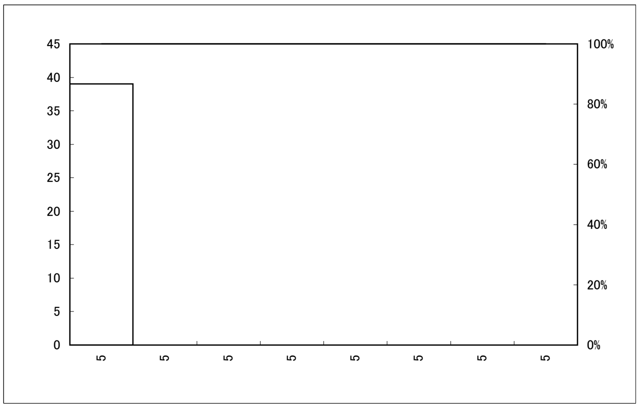


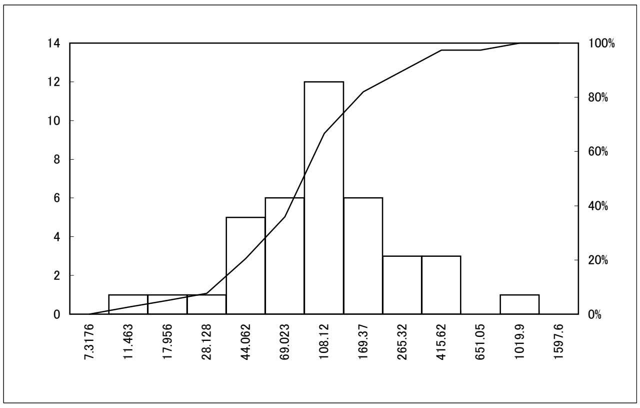


Appendix 5 Cumulative Frequency Diagram and Histogram (the Lower Member of the Alemağaç Formation) (3)









Appendix 5 Cumulative Frequency Diagram and Histogram (the Lower Member of the Alemağaç Formation) (4)