tuff(A_1+T_1) and Pleistocene Gevşek volcanic ash.

(3) Unit C

This unit is distributed near the central part of the survey area in the localities of Unit B distribution. It occupies topographically the highest part and the smallest portion (about 3%) of all delineated units.

The tone of colour is lilac and chrome yellow in F/C, light blue in R/C_1 yellowish green in R/C_2 images. The texture is fine-grained. The resistance of the rocks is very high.

The distribution of this unit, according to existing data, is in Miocene siliceous tuff and Eocene andesite, tuff(A_1+T_1) localities.

(4) Unit D

This unit is distributed from the northeast to the southwestern part of the survey area. It occupies 18% of the survey area in topographic low parts along the major rivers.

The tone of colour is blue and chrome yellow in F/C, red and greenish blue in R/C_1 and yellow and royal purple in R/C_2 images. The texture is generally fine-grained and mosaic pattern suggesting farmland is observed in many parts. The drainage meanders in this envronment. The resistance of the rocks is very low.

The distribution of this unit, according to existing data, is in Holocene alluvium (Al), terrace deposits (Ta), talus deposits (Qd) and Pliocene Göl sedimentary rocks (n) zones.

3-2 Alteration Zones

Attempts were made to extract alteration zones from the prepared images, but the whole survey area is covered by vegetation and thus it was not possible to identify colour tones characteristic of alteration from any of the Landsat images. Good examples of alteration zones in satellite images are the pale greenish tone indicating the ore deposits of the Goldfield, Escondida※[1], and other mines.

As reported in section 2-1, however, Unit C has high resistance, forms rounded to protruded ridges and the relief is quite large. These are characteristics different from other units and the locations coincide with those of the siliceous tuff (A_1+T_1) reported in previous work. From these

※[1] The alteration zones related to the gold mineralization at Goldfield mine (Nevada, USA) and of the auriferous porphyry copper mineralization of the Escondida mine (northern Chile) are expressed in pale greenish tone in the false colour images prepared by applying blue, green, red to bands 4, 5, 7 respectively. The spectra for iron oxide in visible, near-infrared zone is shown in Figure 2-15 and those for clay minerals in shorter wavelength infrared zone in Figure 2-16. It is seen from Figure 2-16 that the alteration zone near the Goldfield mine shows the highest reflectivity for Band 5, and it contains clay minerals which absorbs Band 7 spectra. The pale greenish tone reflects the effect of Band 5.

facts, it is inferred that Unit C might contain silicified zones or siliceous dike-like bodies such as those seen in the gold producing areas of southern Kyushu, Japan.

3-3 Interpretation of Geologic Structures

3-3-1 Fold Structures

Folding is usually identified by tracing the bedding. The bedding or schistosity of the survey areas as mentioned in section 2-1 Unit A, however, are observed in Unit A in the southwestern part and they extend in NE direction with monocline structure dipping NW. And the foldings cannot be identified in this area by tracing schistosity or bedding.

On the other hand, curved drainage patterns and ridges arranged parallel in NE direction are observed in two localities of Units A and B in the eastern part of the area. These are interpreted to be synclinal structures with NE trending axes. Thus focusing attention on drainage patterns can yield relevant structural information in many cases.

3-3-2 Lineaments

Two hundred and ten lineaments were exracted and interpreted (Fig.2-14). The density of distribution is higher from northeast to the southern parts (Fig.2-17).

Rose diagrams of the number, lengths and a histogram of the lengths of the lineaments of the survey area are laid out in Figure 2-18. It is seen that the prevailing direction is, in general, NE, but the number and the length of lineaments do not coincide in some directions.

Direction	Number	Length	Remarks
N45~75°E	38%	54%	Many long lineaments, in northeastern to southern parts, indicate direction of major geologic structures.
N15~35°E	22	17	Many short lineaments, in the northern part.

The lengths; 85 lineaments less than 2km long, 75 between 2~4km and these constitute 76% of all lineaments. Three lineaments are over 20km long.

3-3-3 Annular Structure

A total of 17 annular structures were extracted and interpreted from the images prepared.

Annular form	Number	Geology				Size(diameter)
		Unit A	B	C	D	
Nearly complete	10	-	7	-	3	3~6 km
Incomplete	7	1	6	-	-	1~2.5

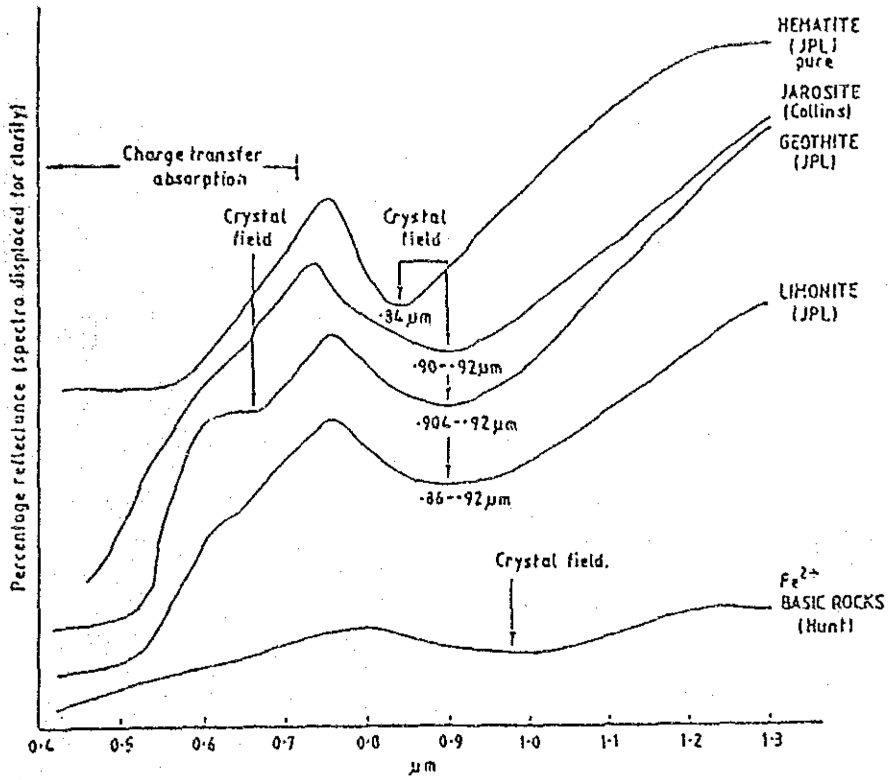
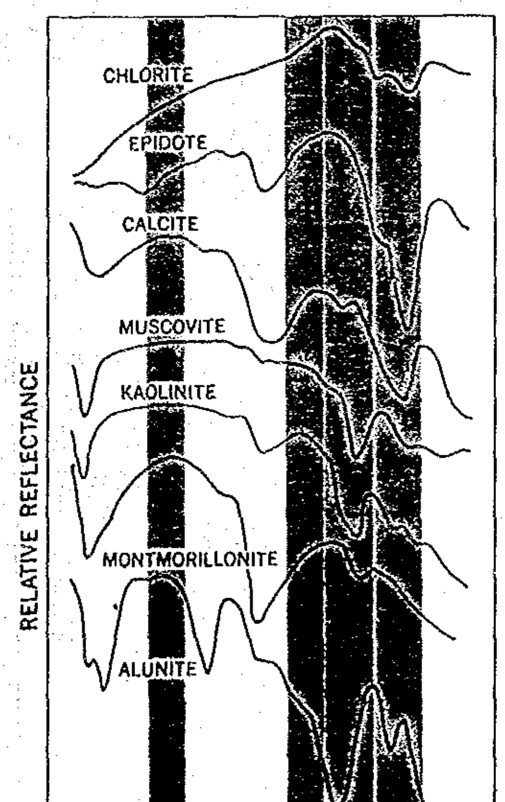


Fig. 2-15 Spectra for Iron Oxide in Visible Near-infrared Zone (MMAJ and ERSDAC ,1986)



BAND No.	WAVELENGTH(µm)	BAND No.	WAVELENGTH(µm)
1	0.52~0.60	5	1.60~1.71
2	0.63~0.69	6	2.01~2.12
3	0.76~0.86	7	2.13~2.25
4	0.76~0.86(STEREO)	8	2.27~2.40

Fig. 2-16 Spectra for Clay Minerals in Shorter Wavelength Infrared Zone (ERSDAC ,1988)

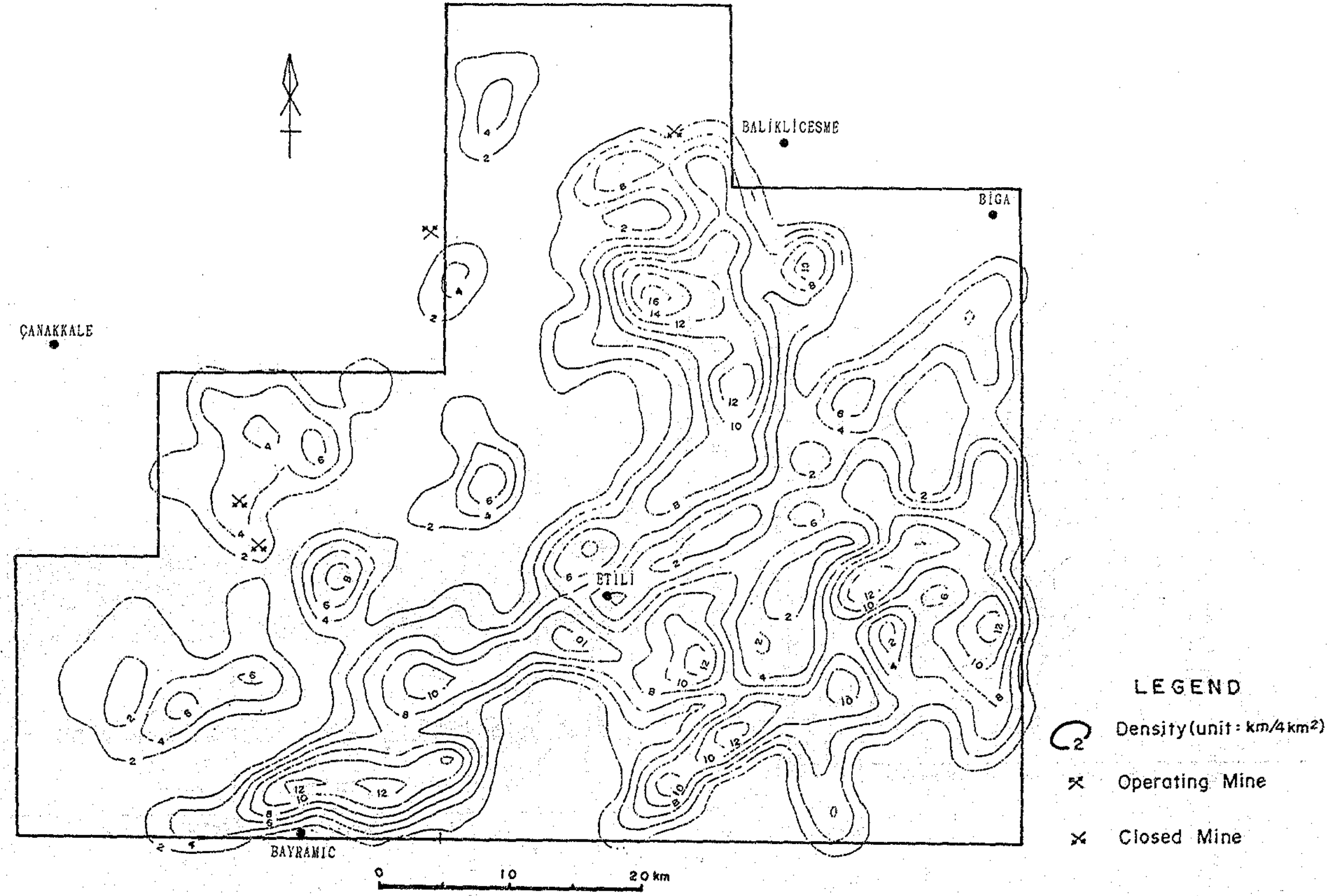
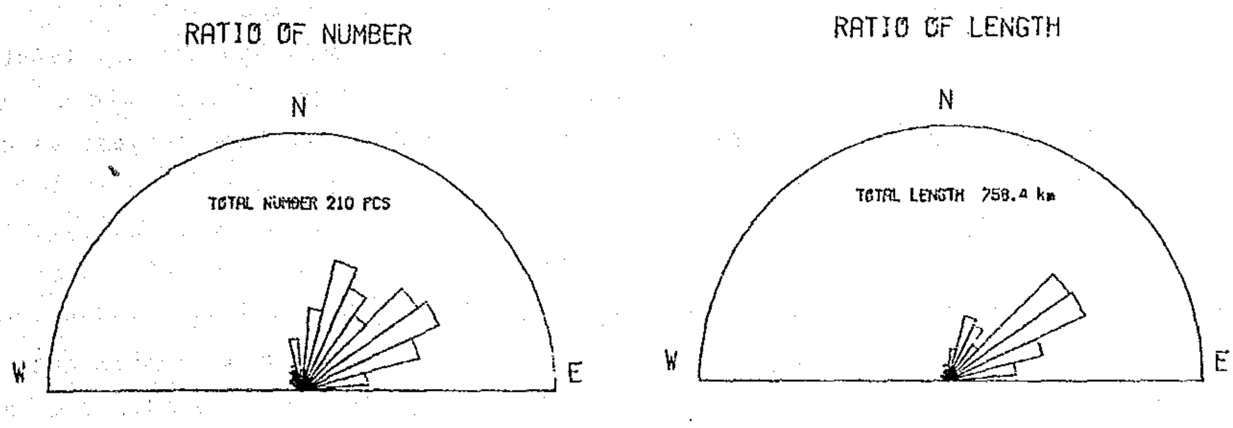
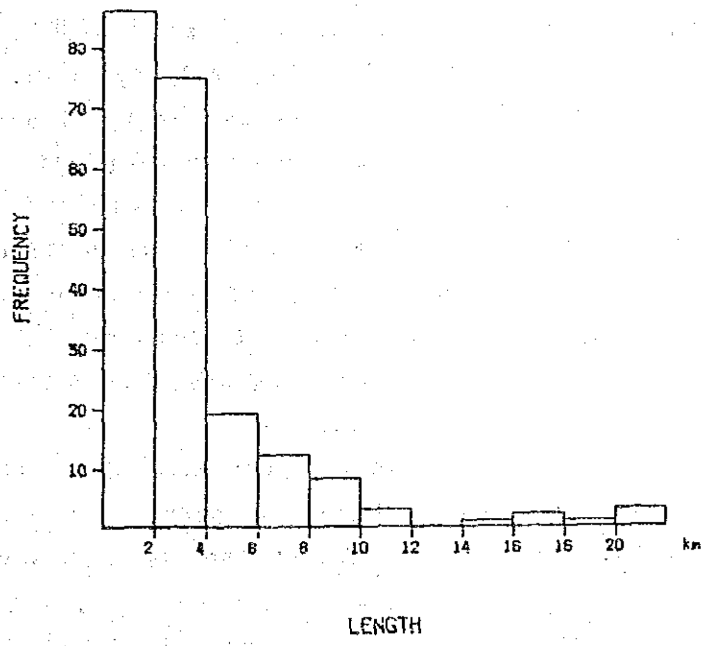


Fig. 2-17 Density Map of Lineaments





DIRECTIONS	NUMBER PCS	NUMBER %	LENGTH km	LENGTH %
N90°E-N85°E	2	1	7.5	1
N85°E-N75°E	13	6	71.6	9
N75°E-N65°E	24	11	102.1	13
N65°E-N55°E	30	14	156.7	21
N55°E-N45°E	28	13	153.7	20
N45°E-N35°E	18	9	45.0	6
N35°E-N25°E	22	10	63.4	8
N25°E-N15°E	26	12	69.4	9
N15°E-N 5°E	16	8	32.8	4
N 5°E-N 5°W	4	2	10.7	1
N 5°W-N15°W	10	5	16.1	2
N15°W-N25°W	5	2	9.4	1
N25°W-N35°W	4	2	4.2	1
N35°W-N45°W	3	1	3.6	0
N45°W-N55°W	0	0	0.0	0
N55°W-N65°W	3	1	7.6	1
N65°W-N75°W	1	0	1.3	0
N75°W-N85°W	1	0	3.3	0
N85°W-N90°W	0	0	0.0	0
TOTAL	210		758.4	

Fig. 2-18 Rose Diagrams of Number, Lengths and Histogram of Lengths of Lineaments

These annular structures are observed in parts where the lineament density is relatively low, but the overall trend of their distribution is NE, similar to the prevailing direction of the lineaments.

It is not possible to determine the relation between the annular structure and Unit C because the size of the individual bodies of the unit is very small. These structures occur near the Unit C and in some localities the unit occur within the annular structure.

3-4 Discussions

As reported above, the outline of the geology and the geologic structure of the survey area was clarified by the analysis of Landsat data. The information which is considered to bear important significance regarding mineral exploration, particularly for gold exploration is summarized as follows.

(1) Unit C has high resistance, forms rounded or protruding ridges and has strong relief, and its distribution coincides mostly with that of siliceous tuff (A_1+T_1). It is inferred from above that this unit consists of silicified zone and/or siliceous bodies such as dikes, which occur in the gold-producing area in southern Kyushu, Japan.

It is considered that the relation between this unit and the "Low temperature gold mineralization associated with Late Tertiary acidic volcanism and Quaternary hot spring activity" which is one of the known mineralization of this area, is one of the most important targets for further work.

(2) The genesis of annular structures is not clear, but it is observed that they often occur in Unit B which is surrounded by the geologic basement of the survey area, Unit A. Some of the annulars contain Unit C and the unit also occurs near these structures. Two or three annulars are observed in younger Unit D.

The overall trend of these annular structures is NE which coincides with the prevailing direction of the lineaments. If these structures are related to igneous activities, they could have acted as the conduits for mineralization.

(3) Of the lineaments of the area extracted from the images, those of Unit B in the western part of the area have N-S or NW trends and there are annular structures and Unit C nearby. These features are different from other parts of the area.

(4) As to the relationship among the lineations, it seems that those of the NE system are transected by the E-W system along the Koca Çay River, and in western Yenice, the NE and E-W lineament seem to be cut by N-S system.

There is a large NW trending fracture (joining Çanakkale and Eceabat) at right angles to the Dardanelles Strait (Çanakkale Strait) outside of the survey area. And if the lineaments with this trend are faults, they would be younger than those of the NE system, but there are very few lineaments with this trend in the area. If the mineralization in the area is related to younger activities, these lineaments or fractures should be carefully studied during the field work.

(5) Attempts were made to extract silicified and argillized zones by false colour images, but the "pale greenish tone" which is characteristic of alteration could not be observed because of vegetation. Also alteration zones could not be identified by ratio images because of the same reason.

This is also a matter of the density of vegetation cover and exposed surface, we will make efforts to reflect the results of the surface survey in the future image analyses.

From the above reasoning, the zones relevant for mineral prospecting in this area are considered to be:

- Vicinity of Unit C which possibly contains iron silicification and alteration. Together with Unit B nearby.
- Annular structures and vicinity.
- Unit B zone in the western part where there is a unique lineament distribution pattern (N-S and NW direction).

From the the above studies and the results of geological survey, the major points of the Landsat image analysis are summarized as follows.

(a) The geologic units inferred to be the silicified zones by remmote sensing are silicified rock bodies and kaolinized alteration zones were found near the these bodies. The distribution of silicified zone read from the Landsat images mostly agreed with the gruond survey, but there were cases where the areal extent of the silicified zones read from the images tended to be somewhat smaller than the actual dimentions. Also the existence of some silicified bodies was confirmed on the ground which could not be read from the images.

(b) Regarding the lineaments which indicated fractures on Landsat images, it was inferred geologically and geomorphologically that such fractures should exist and the information played very effective roles in understanding the regional tectonics of the area.

(3) Regarding the annulaar structures read from the images, it was found that they do not necessarily indicate identical geologic phenomenon. Some of the annular structure are the form of silicified bodies, anticlinal structures and distribution of young volcanic activities.

PART III GEOLOGICAL CONSIDERATION

PART 3 REGIONAL CONSIDERATIONS

CHAPTER 1 GEOLOGICAL SURVEY OF THE ÇANAKKALE AREA

1-1 Outline

The Çanakkale Area mineral exploration survey of the Republic of Turkey was started in 1988 and this report contains the results of the work conducted during the first year of the three year project. Prior to the field work, data and information regarding previous geological and geochemical work in the area were acquired and studied and together with the analysis of the Landsat images of total area of 3,400km², three zones, namely Zones A (100km²), B (300km²) and C (100km²) were delineated as warranting prospecting for metallic resources. Geological and geochemical work were carried out in these areas.

The survey area lies within the Western Pontids Belt of the tectonic division of Turkey. The geology of this belt is similar to that of the Eastern Pontids Belt where the Trabzon Area is situated and geological survey was carried out three times in the past. The geology consists of Triassic metamorphic complex -the basement- and unconformably overlying Tertiary intermediate volcanic rocks. Granodiorite, Serpentinite and other intrusive bodies are distributed where the Triassic basement is developed. The predominance of intermediate volcanics during Eocene to Miocene is also characteristic of this area, and small scale vein-type mineralization is observed and alteration zone is developed in association with these igneous activities.

From geological considerations, the type of metallic resources which can be anticipated to occur in this area are; porphyry molybdenum-copper deposits, small scale high grade copper, lead, zinc vein deposits and gold deposits in silicified zones. Of these deposits, glod veins in silicified zones are known in two localities. There is a report that they were once worked and subsequently new veins were discovered by MTA (Higgs,1962), but other data do not exsist. Similar silicified zones extend eastward and thus gold project was the major object in Zones A and B. In zone C, copper, lead, zinc molybdenum geochemical anomalous zones were extracted. These are believed to be associated with the intrusion of granodiorite and the potential for porphyry molybdenum-copper deposit is considerable.

1-2 Survey Methods

Topographic maps of 1:25,000 scale was enlarged to 1:10,000 scale and were used as the base map for geological survey. Rock samples for analysis were collected at closer intervals near the known and newly found mineral showings and silicified zones and detailed survey was carried out so that the changes of mineralization could be clarified.

The total traverse amounted to 750km and the geologic map was compiled in 1:25,000 scale. Results of; 1,010 rock samples analyzed, 15 samples with complete analysis, 16 samples assay, 15 samples microscopically studied and 150 samples analyzed by X-ray diffraction were used.

CHAPTER 2 GEOLOGICAL SURVEY OF ZONE A

2-1 Outline of Geology

The geology of the zone consists mostly of volcanic rocks,they are; Çamyayla Volcanics, Balcılar Volcanics, Dededağ Volcanics and Balaban Basalt in the ascending order. The flat part between Dondurma Village and Balcılar Village is covered by Alluvium. Fossils indicating Middle Eocene was found from calcareous silt in the Çamyayla Volcanics and it was correlated to the Akçaalan Volcanics. The geologic map and cross sections, stratigraphic column are shown in Figures 3-1 and 3-2.

2-2 Stratigraphy

2-2-1 Çamyayla Volcanics

Type locality: NE zone A, vicinity of Yaylalar Village

Thickness: +700m

Distribution: Çamyayla Volcanics is stratigraphically the lowest volcanic unit in Zone A and it occupies more than 3/4 of the total area. It does not occur in the southeastern part of the zone.

Lithology and occurrence: It shows a variety of colours, dark grey, dark green and chocolate. The lithology also varies considerably, andesite lava, andesitic agglomerate and tuff breccia are the major rocks with intercalations of tuff and sandy tuff. The lava and pyroclastics are sometimes transitional horizontally or exist mixed together and there are no clear boundaries between the two. Also dark grey calcareous silt and greyish white limestone occur from the central to the upper part of the volcanic body. Nummulites spp. fossils which indicate Middle Eocene were discovered from the dark grey calacreous silt. The blocky limestone in this unit could be olistolith.

Bedding is observed in various parts of this unit, the strike of these beddings varies and the dip ranges from 5° to 30°. Fold structure with relatively gentle dip is observed, and small scale E-W and N-S anticlines are inferred in these parts of the area.

Stratigrapic position: Geological unit underlying this volcanic unit is not observed.

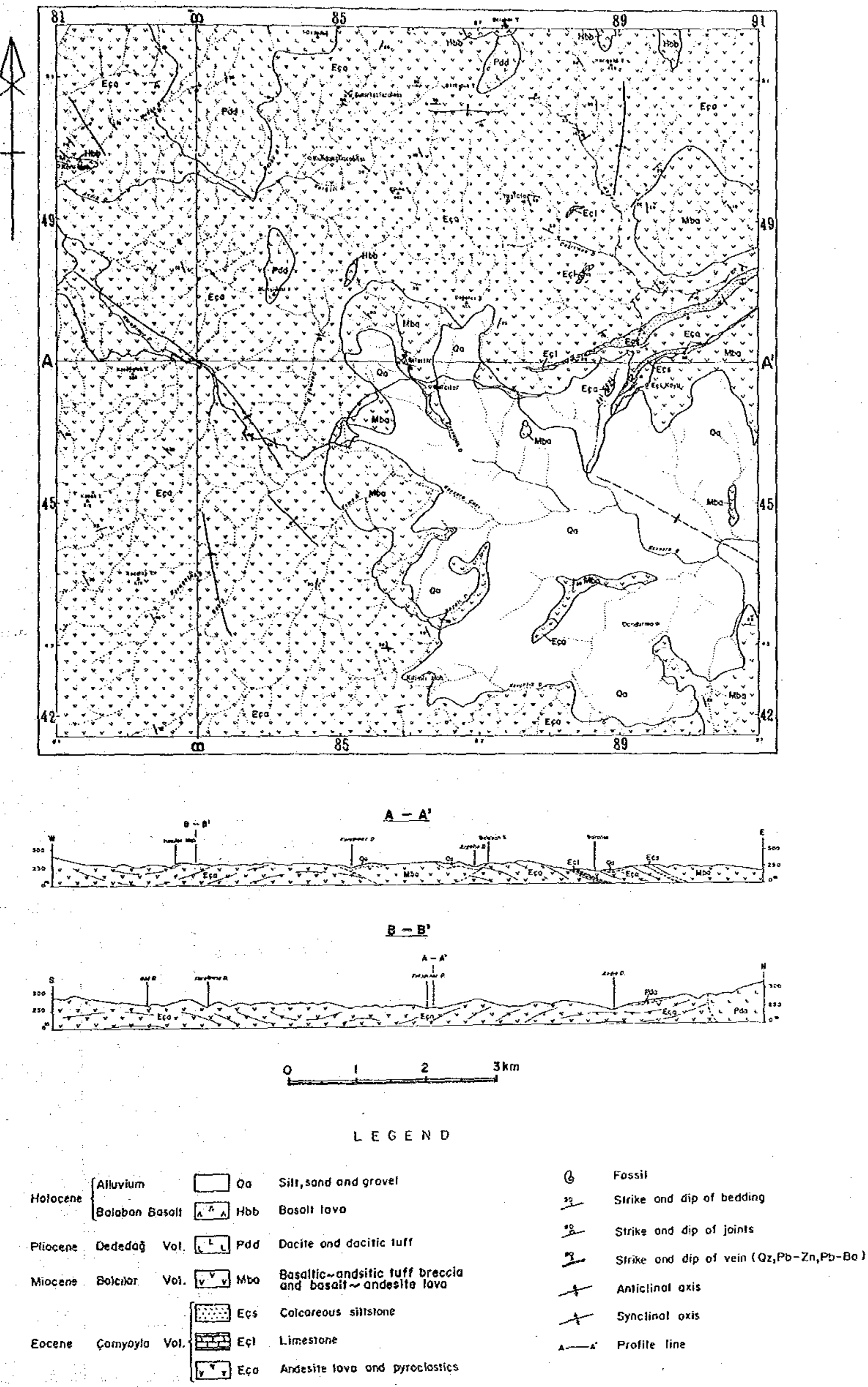


Fig. 3-1 Geologic Map and Cross Sections of the Zone A

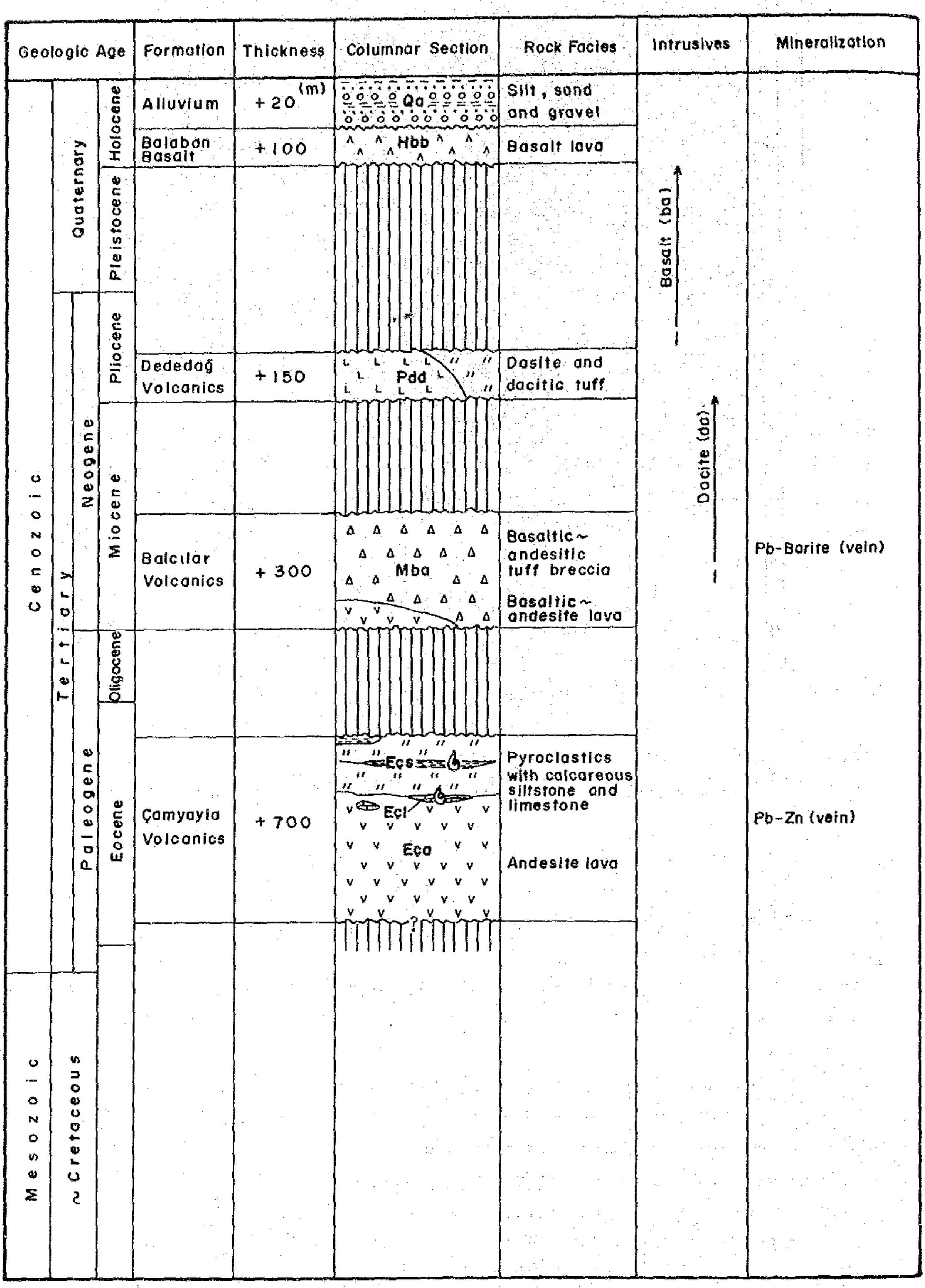


Fig. 3-2 Schematic Column of the Zone A

2-2-2 Balcılar Volcanics

Type locality: Vicinity of Balcılar Village

Thickness: +300m

Distribution: It is distibuted from the Balcılar Village at the central part of the zone to the Eçi Village in the east.

Lithology and occurrence: It is dark green to dark greyish green at the Balcılar and Eçi Villages consisting of basaltic~andesitic lava and agglomerate. There are noteable filmy calcite in the agglomerate. Pale green tuff containing green patches is the main component to the north of Eçi Village. The green patches are weakly argillized, and bedding with NW~N-S strike and dip 10°~20° are observed in this part.

It is seen microscopically that augite and plagioclase phenocrysts, and the matrix are storongly altered to chlorite.

Stratigraphic position: This unit overlies the Çamyayla Volcanics unconformably and is overlain by alluvium.

2-2-3 Dededag Volcanics

Type locality: Southern part of Dededag

Thickness: +150m

Distribution: It is distributed in a small area from Dededag in the northern-most part of the area to the southern part of Balaban Tepe.

Lithology and occurrence: Consists of pale brown to greyish white biotite dacite and dacitic pyroclastic rocks. Mostly massive, but partly has vertical flow structure. Dededag(elevation 719m) is composed of this lava and forms an independent peak. It is therefore inferred that intrusive dome was formed after extrusion during the earlier phases of volcanism. Same pyroclastics are exposed continuously in the mid to down stream parts of Andik. Here, it is partly lava with flow structure. Lava is not altered while the pyroclastics are weakly kaolonized.

This unit intrudes Çamyayla Volcanics which is weakly silicified and argillized near the Dededag Volcanics. Thus the alteration is inferred to be related to the Dededag Volcanics.

It is noted microscopically that that biotite and plagioclase phenocrysts as well as the matrix are weakly chloritized.

Stratigraphic position: This unit intrudes Çamyayla Volcanics and covered by Balaban Basalt.

2-2-4 Balaban Volcanics

Type locality: Mt.Balaban(elevation 710m)

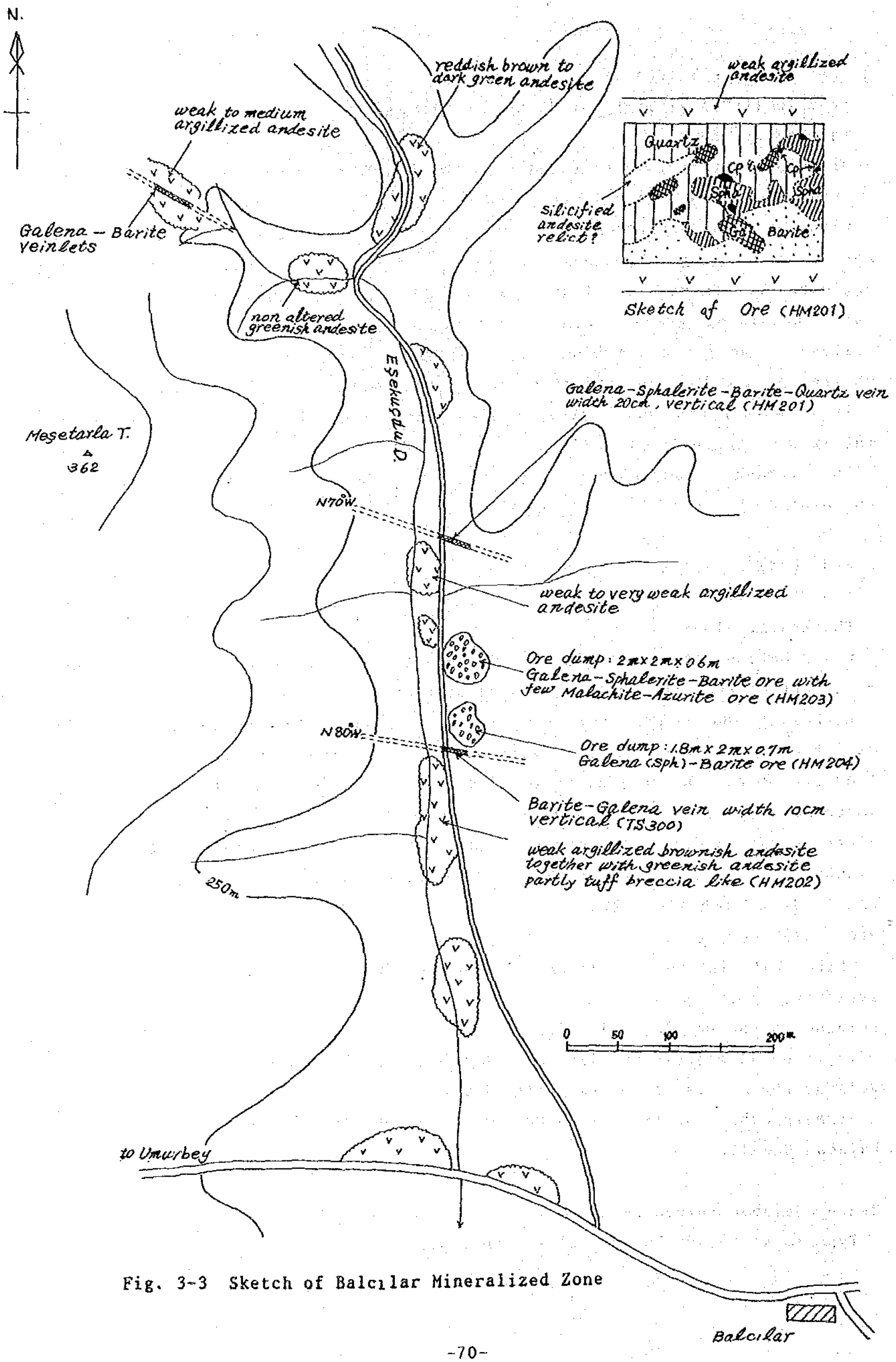
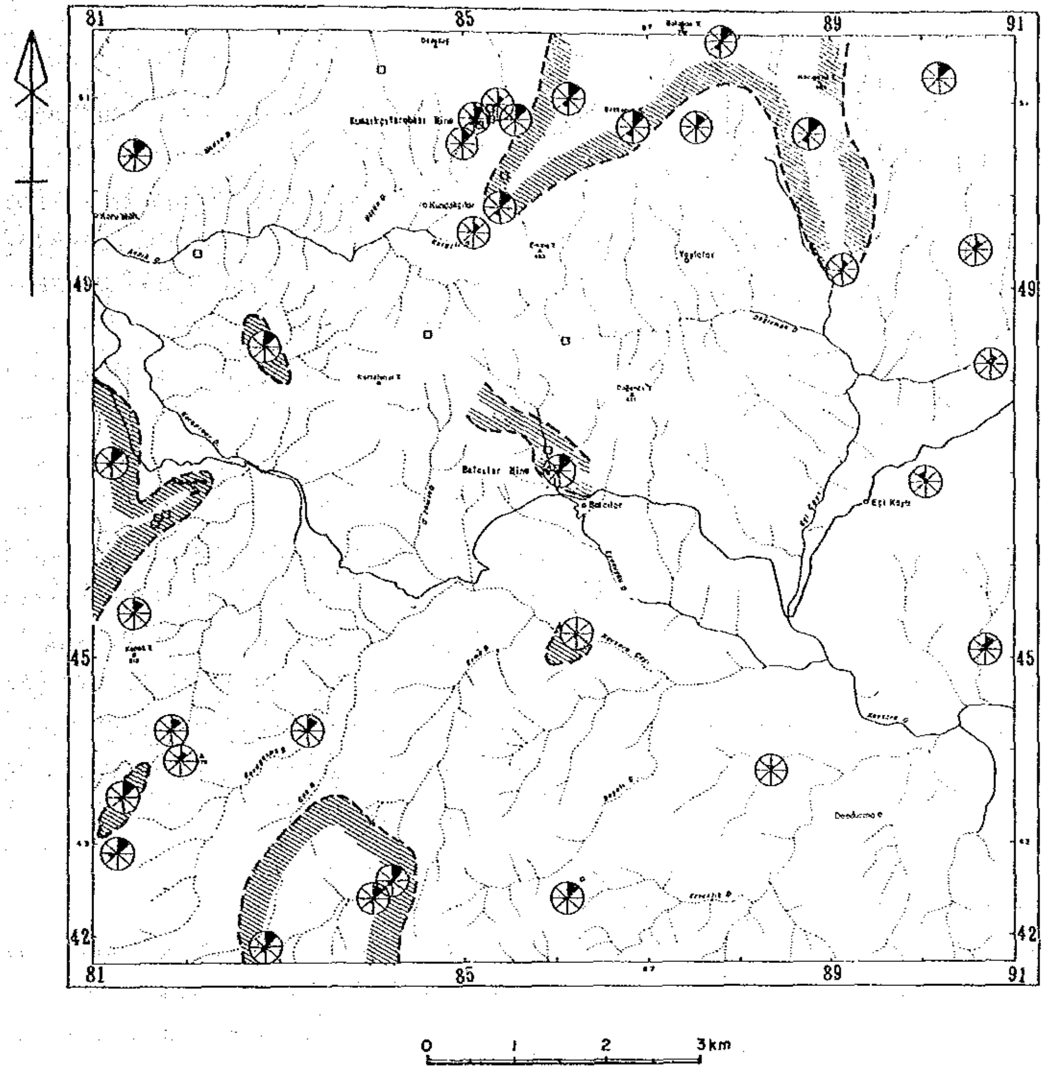
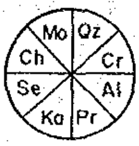


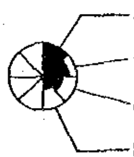
Fig. 3-3 Sketch of Balcılar Mineralized Zone



LEGEND



Qz : Quartz
Cr : Cristobalite
Al : Alunite
Pr : Pyrophyllite
Ka : Kaoline
Se : Sericite
Ch : Chlorite
Mo : Montmorillonite



□ Au>50 ppb


Kaoline zone

Fig. 3-4 Gold Occurrence and Alteration Map of the Zone A

Thickness: +100m

Distribution: It is distributed in three localities at the northeastern margin of this zone. These are all topographic highs.

Lithology and occurrence: It has blocky fine-grained, compact lithology. Overlies the Dededag and Çamyayla Volcanics unconformably. Dikes trending E-W with 1.2~3m width are exposed at several localities in the down stream part of Eçi River, the lithology is glassy in this part.

Stratigraphic position: This unit intrudes Çamyayla Volcanics and unconformably covers Dededag and Çamyayla Volcanics.

2-2-5 Alluvium

There is a flat topography in the vicinity of Kavsara Stream in the upstream part of the Kocabaş River which flows westward from Biga and the alluvium is distributed in a wide area from Dondurma Village to Balcılar Village. It consists of sand gravel layer composed of silt, sand and gravel. A part of this alluvium covers the Balcılar Volcanics along the stream. The flat alluvial area is suited for cultivation, and vegetables and wheat are being grown.

2-3 Intrusive Bodies

Basalt dikes which are inferred to be the intrusive part of the Balaban Basalt occur at a locality 1km northwest of Balcılar Village and in the downstream section of Eçi Stream. There are no other intrusive bodies observed in this zone.

2-4 Geologic Structure

The investigation of geologic structure is very difficult in this zone because of the predominant volcanic rocks. From the strike and dip measured in some localities, however, it is inferred that there is a undulated structure. Gently wavy parallel anticline-syncline in NW-SE direction was observed from Kocataş Tepe to Koru Village. Also near the Eçi Village, the structure is E-W trending and southward dipping while at the Kavsara Stream, basin structure is inferred and thus a synclinal axis is anticipated in this part of the zone.

2-5 Mineralization and Alteration

Çamyayla Volcanics are generally argillized (kaoline, sericite, chlorite) and medium to strongly altered parts are locally accompanied by iron hydroxide. Quartz veins containing galena, sphalerite, chalcopyrite and pyrite (Kundakçılar obası mine) are developed in E-W direction in the Çamyayla

Volcanics 1km southeast of Dededag. It seems to have been mined systematically in the past, but now the adit (at approximately right angles to the veins N20°W) is collapsed. Veinlets are observed near the entarance, but the details are unknown except for a small amount stored ores.

There is an iron orebody consisting mainly of hematite at 1km east of Koru Village and there is a trace of small scale digging in the N65°W direction carried out sometime ago. This iron oxide concentration is considered to have been formed by replacing the small limestone beds intercalated in the andesitic rocks. There is an outcrop of weakly recrystallized limestone approximately 300m northwest of the locality. The iron oxide body, however, is limited in size because the underlying andesite is exposed on the surface.

At least these galena-spalerite-barite bearing quartz veins are developed (Balcılar mine, Fig.3-3) in NW-SE to E-W direction in the Balcılar Volcanics.

The thick parts of the veins are 20~30cm thick. Although the veins are thin, there are parts with very high silver content (Table 3-14). There is a stock piles of ores along the road from Balcılar Village running parallele to Eşekuçdu Stream. According to the local people the ores were mined 10 to 15 years back and only the high-grade ores were shipped.

CHAPTER 3 GEOLOGICAL SURVEY OF ZONE B

3-1 General Geology

The basement rocks of this zone are Taşdibek Formation consisting of weakly metamorphosed green schist and crystalline limestone, and the Akpınar Granite which intrude into the Taşdibek Formation. Although fossils have not been found this formation, it is correlated to the Triassic Karakaya Group because of the weakly metamorphosed lithology. The granite is not associated with mineralization, but the crystalline limestone in the vicinity underwent contact metasomatism and has been skarnized. Kirazlı Conglomerate covers these basement rocks unconformably and although the age determination by the fossils discovered during this survey is not yet completed, it is inferred to be Jurassic. The intermediate volcanic activity began in Eocene and the units continue from Çamyayla Volcanics, Şapçı Volcanics to Osmanlar Volcanics, then Karaköy Formation consisting of conglomerates deposited during the long volcanic interval. Quaternary volcanic rocks -Kocaçakıl Basalt- is observed as small outcrops where the Taşdibek Formation is distributed. The geologic map, geologic cross sections, stratigraphic columns and the mineralized alteration zones are shown in Figures 3-5~3-8.

3-2 Stratigraphy

3-2-1 Taşdibek Formation

Type locality: Vicinity of Mt. Taşdibek (elevation 572m)

Thickness: +2,000m

Distribution: It is distributed in the central part of the zone extending 6km E-W and 3km N-S.

Lithology and occurrence: Black pelitic schist is predominant in the eastern side of Kirazlı Village, while in the Oluk Stream in the southeastern part where Taşdibek Formation is distributed, green schist and leucocratic to greyish white equigranular crystalline limestone is dominant. Akpınar Granite intrudes into the limestone. In general, minute fractures are developed in this formation. Skarns are observed near the contact of the limestone with the granite and there are hematite concentrations. There are quartz-limonite veins (strike N10°W, dip 55°E, 46cm thick) in the granitic body.

Stratigraphic position: This formation is distributed in the central part of the zone in oval shape and is overlain unconformably by Şapçı Volcanics in the north, but in other parts, Kirazlı Conglomerate overlies it unconformably.

3-2-2 Kirazlı Conglomerate

Type locality: From the eastern slope of Kestane Dağı (elevation 809m) to the upper reaches of the Pekmez Stream.

Thickness: +200m

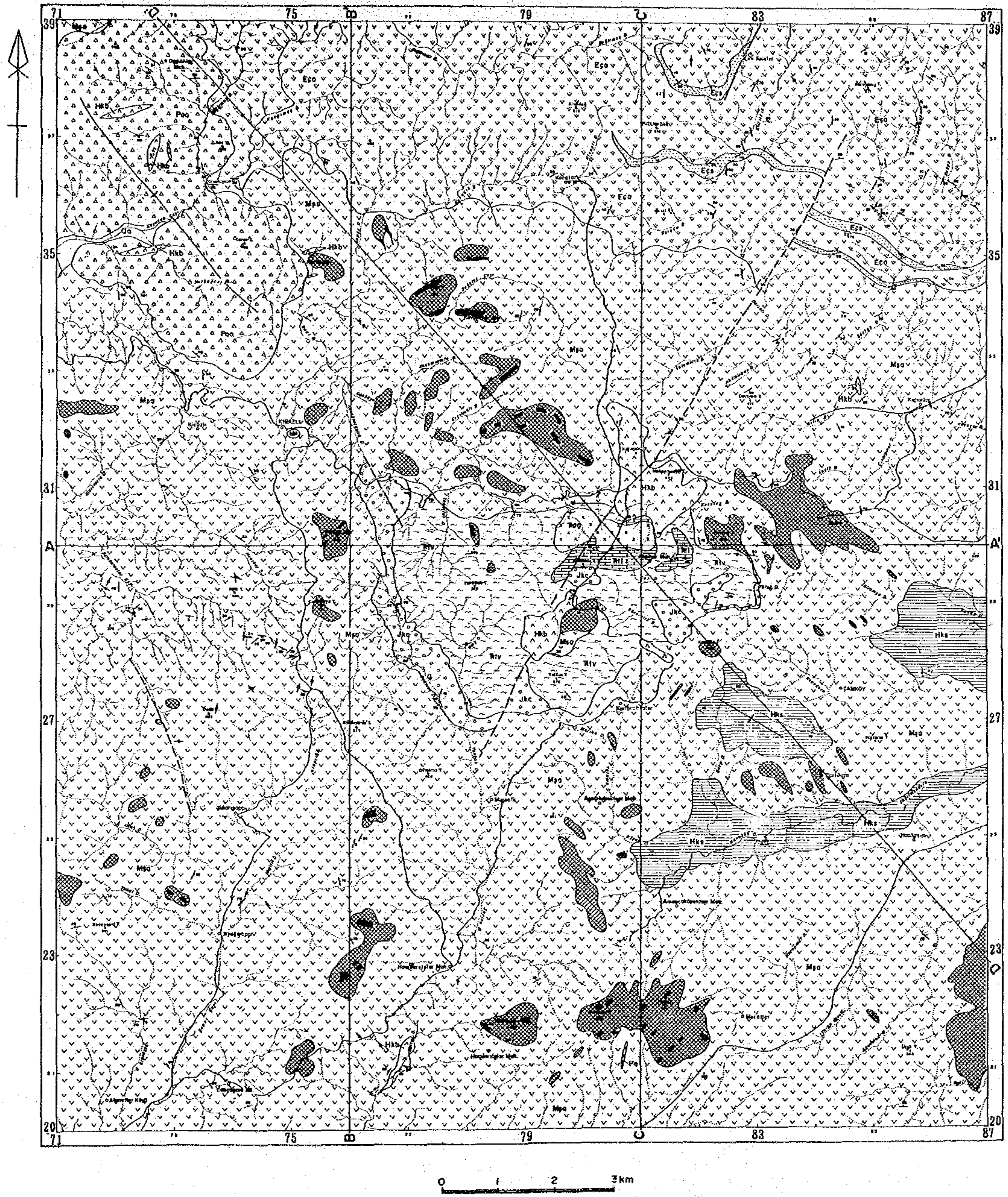
Distribution: Small scale distribution surrounding the outcrop or directly over the underlying Taşdibek Formation.

Lithology and occurrence: This formation consists of pale green siltstone, fine-grained tuff and greyish white to dark grey conglomerate. The pebbles are mostly chert, green schist, and quartzite and they are well rounded. They are mostly 1～3cm, but there are cobbles of 20～30cm. The rock is argillized and pyrite occurs scattered in the conglomerate. The formation is without bedding in most of the zone. Fossils were discovered from Pekmez Stream, but they have not been identified yet and the accurate age is not known. From the pebbles and the relation with the overlying Tertiary system, this is inferred to be a Jurassic formation.

Stratigraphic position: The fact that this formation contains pebbles of the underlying Taşdibek Formation and also the distribution indicate that this is the basal conglomerate overlying the Taşdibek Formation.

3-2-3 Çamyayla Volcanics

Type locality: It is distributed widely around the Çamyayla Village. The village is located between Zones A and B.



LEGEND

Holocene	Alluvium	Qa	Silt, sand and gravel
	Kocaçakıl Basalt	Hkb	Basalt lava
	Karaköy F.	Hks	Sandstone and conglomerate
Pleistocene	Osmanlar Vol.	Poa	Andesitic agglomerate and andesite lava
Miocene	Şapçı Vol.	Msa	Andesite lava and pyroclastics
Eocene	Çamyayla Vol.	Eçs	Calcareous siltstone
		Eça	Andesite lava with andesitic agglomerate
Jurassic	Kirazlı Conglomerate	Jkc	Conglomerate with siltstone and sandstone
Triassic	Taşdibek F.	Tag	Akpınar granite
		Ttv	Meta-volcanics with meta-sediments
		Ttl	Crystalline limestone
	Intrusive rock	po	Porphyry
	Alteration		Silicified zone
			Strongly silicified zone
			Fossil
			Strike and dip of bedding
			Strike and dip of schistosity
			Lineation
			Strike and dip of joints
			Fault
			Strike and dip of vein (Qz, Qz-Pb-Zn)
			Anticlinal axis
			Synclinal axis
		A——A'	Profile line

Fig. 3-5 Geologic Map of the Zone B

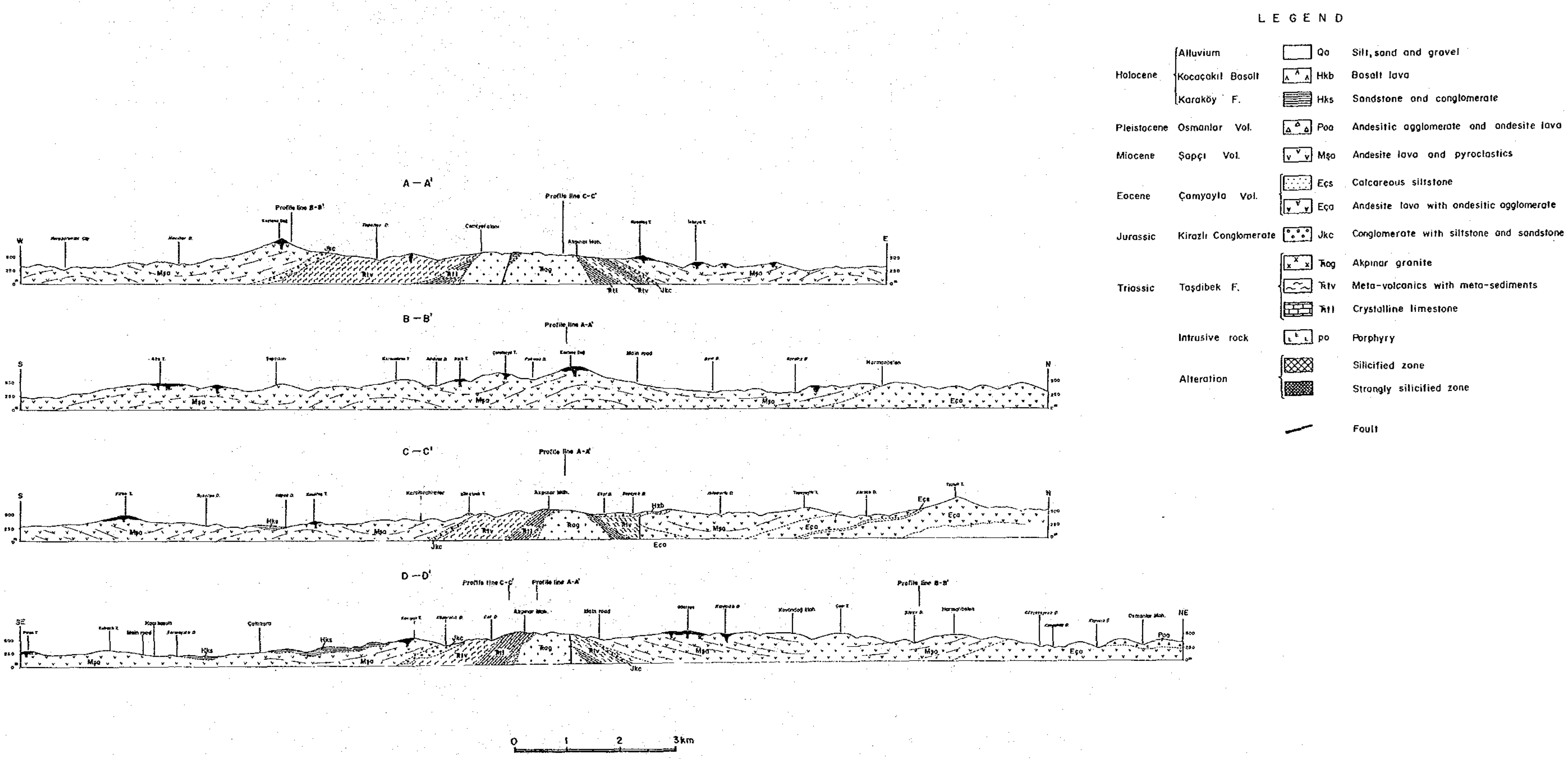


Fig. 3-6 Cross Sections of the Zone B

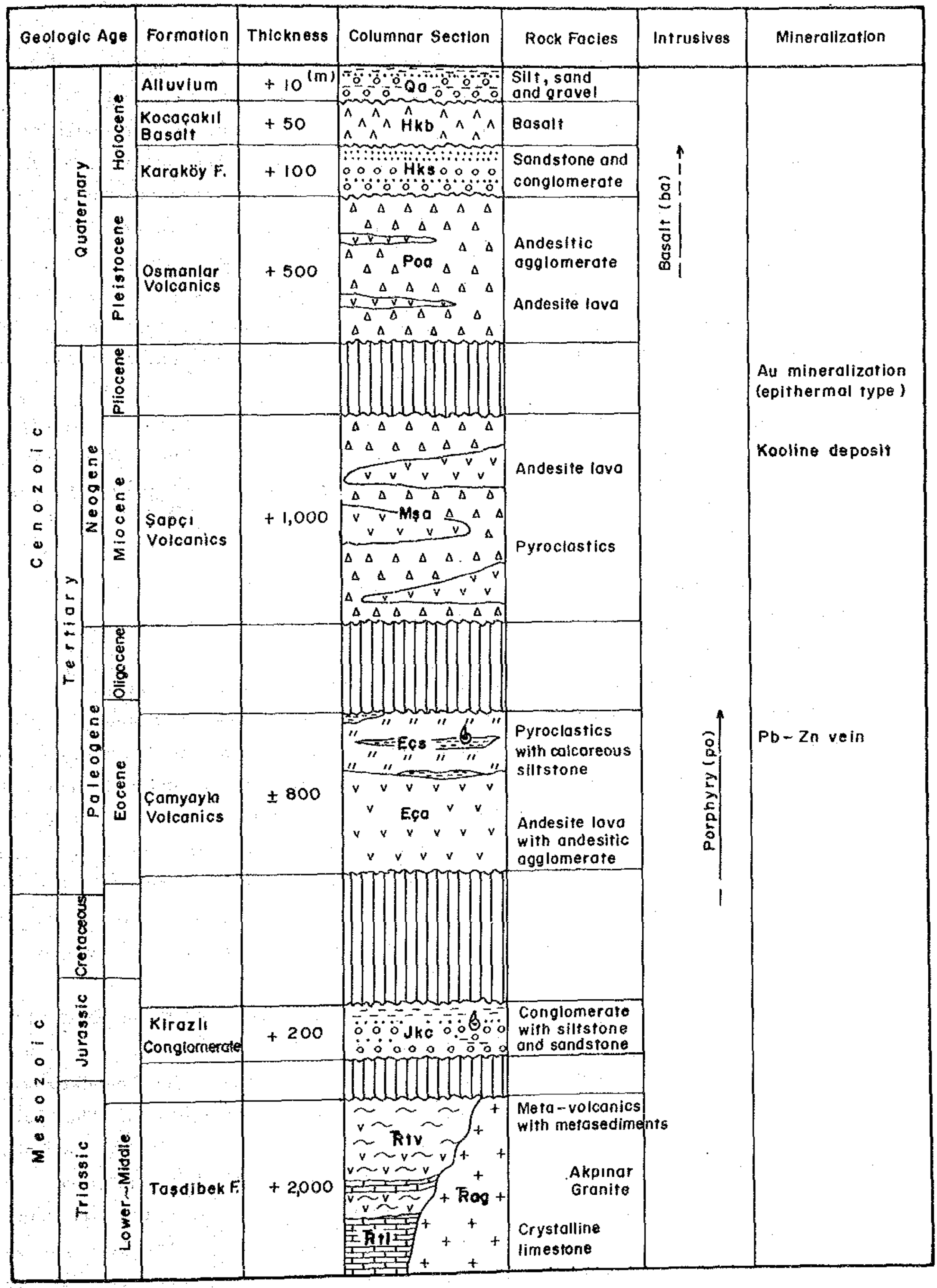


Fig. 3-7 Schematic Column of the Zone B

Thickness: +800m

Distribution: These rocks occur developed from Çamyayla Village to Zone A, and are developed in E-W direction in the northern part of this Zone B.

Lithology and occurrence: Greenish tuff (green layered) is predominant in the northeastern edge of the zone and andesite lava is the major constituent near Tuzlukdag. Pyroclastics become more abundant southward where Şapçı Volcanics are distributed. Pale green to grey fine tuff is intercalated near Şapçı Volcanics. The boundary with the Şapçı Volcanics is characterized by pale brown calcareous siltstone and bedded carbonate sediments. The Çamyayla Volcanics are mostly propylitized to epidote-chlorite rock except in strongly altered parts. The strong alteration is evident microscopically and plagioclase, hornblende and augite phenocrysts were identified by their shape. Chloritization and epidotization are strong in both phenocrysts and matrix.

Stratigraphic position: The stratigraphic relation with Şapçı Volcanics is not clear, but Çamyayla Volcanics is unconformably overlain by Şapçı Volcanics.

3-2-4 Şapçı Volcanics

Type locality: Vicinity of Şapçı Village

Thickness: +1,000m

Distribution: This is the largest unit and covers most of the zone.

Lithology and occurrence: The major part of these rocks are andesite lava accompanied by andesitic pyroclastics, mainly tuff. The unaltered part of these rocks are dark grey and generally they are argillized and silicified to weak to medium intensity with strong alteration in some parts. The detailed lithological division is thus, difficult. It is clear, however, that pyroclastics are more aboundant in the south than in north and that lava is predominant in west compared to the eastern part. These variations of lithology indicate the changes in the time and location of the centres of volcanic activities.

At the Balıklı Stream, pale green pumice tuff with green patches which partly contains biotite occur with intercalations of red shale (containing 20cm thick iron-bearing quartz) and grey fine-grained tuff. The boundary with the underlying Çamyayla Volcanics is the carbonate sediments of the lower unit. Brownish grey biotite andesite lava and pyroclastics occur near Kumarlar Village. To the north of the village, dark grey andesite with notable plagioclase phenocrysts are distributed. This volcanic unit has a general vertical trend of changing from pumice tuff through biotite andesite to andesite with notable plagioclase phenoctyst in the ascending order. Some of the andesite have notable biotite phenocrysts while the biotite in others

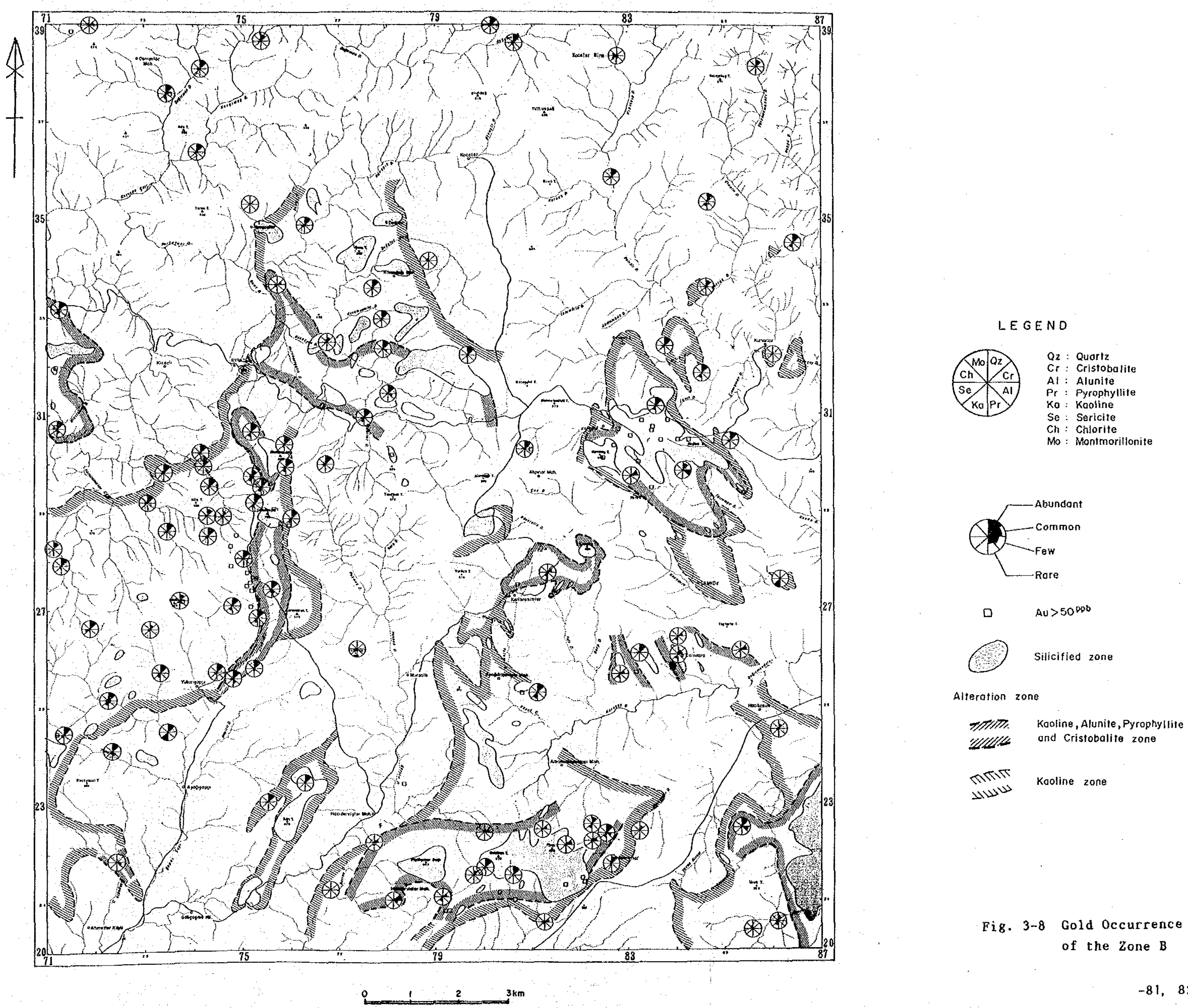


Fig. 3-8 Gold Occurrence and Alteration Map of the Zone B

cannot be seen by the unaided eyes. Also in some localities, such as southeastern part of this zone, they show flow structure.

Argillization of these rocks can be grouped into non-altered to weakly altered parts and intermediate to strongly altered parts. There are parts to the south of Ada Dag where the two types of alteration occur mixed. Generally, the argillized parts are leucocratic, but hematitized or limonitized parts are reddish brown to brown. Native sulfur occur in north of the Yukarşapçı Village and some other localities.

Silicification zones often result in the formation of isolated mountains and examples are among others, Kestane Dağı, Dededag, Ada Dag. The original rocks of these localities are difficult to identify. Many of the joints and fissures in the southwestern part of the zone trend E-W, although the strike is generally not discernable.

The structure of these volcanic rocks is mostly the massive form, but the strike of the fine-grained tuff varies in many directions N-S, NE-SW, E-W and the dip is 20-30° near Akpınar Village in the central part of this zone.

It is shown microscopically, that phenocrystsmost abundant are plagioclase most aboundant with biotite, hornblende and augite. The argillization was kaloinization and chlorite and epidote do not occur.

Straigraphic position: This unit unconformably overlies the Kirazlı Conglomerate and Taşdibek Formation and is covered by Karaköy Formation and Kocaçakıl Basalt.

3-2-5 Osmanlar Volcanics

Type locality: From Osmanlar Village westward

Thickness: +500m

Distribution: These rocks are distributed from Osmanlar Village in the northwest edge of Zone B to the west and southern parts.

Lithology and occurrence: Most of this unit consists of dark green to dark grey andesitic agglomerate. Very small amount of fine-grained tuff is observed and its strike is NW-SE, dip 20～30°SW in the north while in the south the strike is the same, but the dip is NE. This indicates the existance of a NW-SE trending synclinal axis in the centre of Osmanlar Volcanics. The massive subangular pebbles of the agglomerate are dark green while the clastic parts are dark grey. Although there are local weak alteration, these rocks are generally unaltered and microscopic study revealed the plagioclase, biotite and hornblende phenocrysts and the matrix to be unaltered.

Stratigraphic position: This unit unconformably overlie the Çamyayla Volcanics and Şapçı Volcanics.

3-2-6 Karaköy Formation

Type locality: Karaköy Stream

Thickness: +100m

Distribution: The formation is distributed in the vicinity of Karaköy Stream and Kasap Stream

Lithology and occurrence: Most of the formation is grey to greyish white, with locally yellowish brown and pale green parts. The formation is generally poorly consolidated and consists of tuffaceous conglomerate, sandstone and siltstone. It is generally unaltered. These beds form alternations dip 10°～20° and the dominant trend is NW. The pebbles of the conglomerate are, in some cases, silicified and argillized which are found in this zone. Wood fossils have been discovered in the silt beds (to the east, outside of this zone).

Stratigraphic position: This formation unconformably overlie the Şapçı Volcanics which occur widely in the lower parts in the southeastern parts of this zone.

3-2-7 Kocaçakıl Basalt

Type locality: Mt. Kocaçakıl

Thickness: +50m

Distribution: The basalt occurs in limited parts at Dededag (elevation 624m) in the central part and also to the southwest of Balcılar Village.

Lithology and occurrence: The rock is black～dark green, fine-grained and compact basalt. Joints are developed and the many pyroxene phenocrysts are unaltered. It forms blocks of 20～30cm in diameter and seems to have flowed to the depressions with structure in harmony with the topography.

Stratigraphic position: It overlies the Şapçı Volcanics and Taşdibek Formation unconformably.

3-2-8 Alluvium

Alluvium consisting of sand and gravel is distributed along the Kuyucuk River in the northwestern part of the zone.

3-3 Intrusive Bodies

(1) Akpınar Granite: Chemically, this granitoid has granodiorite composition. It is hornblende diorite in the northern part of Alanbaş Tepe. It is relatively fine-grained and holocrystalline. Weak chloritization is observed microscopically.

(2) Porphyry: In this area, porphyry occurs NW-SW trenching dikes in the southern part where Şapçı Volcanics are distributed.

(3) Basalt: Basalt occurs as dikes which are inferred to be the intrusive part of Kocaçakıl Basalt in the area where Osmanlar Volcanics are distributed.

3-4 Geologic Structure

In the central part of this zone, the basement composed of Taşdibek Formation and Akpınar Granite is uplifted and Tertiary volcanic rocks overlie unconformably. The volcanic rocks are often massive and it is not easily to understand the geologic structure, but the Çamyayla Volcanics in the northern part of the zone gently dip southward. Although the Şapçı Volcanics do not have bedding and the structure is not clear, it is assumed that the structure is gentle and wavy.

Anticlinal structure is not clearly observed except in the above uplifted part and the synclinal structures are observed in the Osmanlar Volcanics and the Karaköy Formation.

The fractures in this zone occur in various directions, but the frequencies are low. Lineaments in NE-SW direction in the southeastern part of the zone, (the central part of the remote-sensing zone) were Landsat data. Although it was not confirmed by surface study, fault was inferred NNE-SSW and NW-SE directions associated with those lineaments.

Table 3-1 List of Ore Analysis

Area	Sample No.	Ore Name	Ag g/t	Cu %	Pb %	Zn %	Mo %	WO_3 %	Sb %	Type of Ore	Location
A	HM201	Pb-Zn ore	195	0.12	3.76	12.10	tr	0.014	0.004	vein	Balcılar
	HM203	Cu ore	32500	15.40	4.36	0.57	tr	1.320	0.007	oxid.	ditto
	HM204	Pb-Barite ore	50	0.06	14.00	6.49	tr	0.013	0.002	vein	ditto
	HS269	Pb-Zn-Cu ore	33	0.90	8.51	1.72	tr	0.034	0.001	vein	S.Dededag
B	KS102	Pb-Zn ore	273	1.54	40.90	14.60		0.015	0.047	vein	Kocayokuş T.
C	KB005	Mo-W ore	1.3	<0.01	<0.01	<0.01	0.002	0.031	tr	diss.	Yaylayurt D.
	KB006	Sb ore	1.3	0.05	0.02	0.01	-	0.036	0.014	veinlet	ditto
	NY046	W ore	0.8	<0.01	<0.01	<0.01	-	0.022	tr	veinlet	ditto
	SR038	Zn ore	7.2	<0.01	<0.01	1.05	tr	0.009	tr	vein	Sıgırirek D.
	KB007	Sulphide ore	0.5	<0.01	<0.01	<0.01	-	-	0.001	vein	ditto
	KB024	Mo ore	0.8	<0.01	<0.01	<0.01	0.088	0.129	0.003	vein	Domuzdamı D.
	KB037	Mo ore	8.8	0.04	0.68	0.03	0.178	0.060	-	vein	ditto
	KB047	Pb-W ore	30.0	<0.01	0.32	0.06	0.001	0.083	tr	float	ditto
	KB050	W ore	1.5	0.02	0.03	0.02	tr	0.023	0.010	diss.	ditto
	HB012	W ore	<0.5	<0.01	<0.01	<0.01	-	0.059	0.004	float	ditto
	KS006	Pb ore	30.0	<0.01	1.45	0.01	tr	0.022	0.011	float	SE.Karagedik T.

The NNE-SSW faults transect through the central part of the zone, and they cut through the Şapçı Volcanics, but are covered by Kocaçakıl Basalt.

The NW-SE faults are inferred to run through the Kirazlı Conglomerates to

Table 3-2 Results of Microscopic Observation of The Polished Sections

NO.	Ore	Cp	Co	Cc	Bo	Ma	Wo	Sp	Ga	St	Mo	Mt	He	Po	Py	Su-m	H-Fe	Qz	Pl	Bi	Se	Ch	Ep	Ca	Gy	Ah	Remarks
HM201	Pb-Zn ore	□						◎	○						△			◎									
HM203	Cu ore	△	△			◎		○	○								□	◎						○			
HM204	Pb-Barite ore	△	□					○	○								◎	◎									
HS269	Pb-Zn-Cu ore	◎	□					△	◎						○			◎				◎					
KS102	Pb-Zn ore	◎	△	○				◎	◎						○		△	◎									
KB005	Cu ore	□					□	□						○	○			◎									
KB006	Mo ore						○	□							○		○	◎									
NY046	Mo ore	△	△				□								□		○	◎						○			
SR038	Sb ore						□	□		◎					△		○	◎				◎					
KB007	Mo-W ore	△					○				◎				□		△	◎									
KB024	Cu ore						△				○				△			◎									
KB037	Sb ore		□					○	○						△		○	◎									
KB047	Pb ore	□	□				△	◎	○								◎	◎									
KB050	Sulphide ore						△	○			○		◎				◎	◎									
HB012	Mo ore						△				○							◎									
KB006	Pb ore							○	○				○		○		○	◎				○		○			

Abbreviations:

◎:Abundant ○:Common □:Few △:Rare

Cp:Chalcopyrite, Co:Covelline, Cc:Chalcocite, Bo:Bornite, Ma:Malachite, Cu:Native copper, Sp:Sphalerite, Ga:Galena, St:Stibnite

Mo:Molybdenite, Mt:Magnetite, He:Hematite, Po:Pyrhotite, Py:Pyrite, Su-m:Sulphide Mineral, H-Fe:Hydroxide Iron

Qz:Quartz, Pl:Plagioclase, Bi:Biotite, Se:Sericite, Ch:Chlorite, Ep:Epidote, Ca:Calcite, Gy:Gypsum, Ah:Anhydrite

Wo:Wolframite

the east of Mt.Kestane and to the west of Dededağ (elevation 883m).

The existence of anticlinal axes was not confirmed, but synclines were inferred from the trends of the Osmanlar Volcanics and Karaköy Formation.

3-5 Mineralization and Alteration

There are two types of mineralization and alteration in this zone, namely those of the Çamyayla Volcanics and Şapçı Volcanics. In the northeastern margin of the zone where Çamyayla Volcanics are developed, there were no notable mineralization other than the old adit (Kocalar) which probably mined lead and zinc.

The Şapçı Volcanics, on the other hand, have been silicified and argillized almost throughout the zone. The strongly altered parts are shown in Figure 3-8. The silicified zones often result in protuding topography and they can be identified by Landsat images.

The silicified zones which occur in slopes with thick vegetation and relatively flat parts were newly found during the present survey. They are shown in Figure 3-8, the strongly silicified parts are shown separately. The strongly silicified zones are distributed surrounded by silicified and argillized zones. The strongly silicified rocks are massive and stratified, but there are also brecciated parts which do not show the structure of the original rocks. They are all aggregates of fine-grained quartz with SiO_2 over 90%. They are hard, compact and porous. The tone of colour is mostly white, but it becomes dark grey when containing pyrite, red with hematite and yellow to brown with limonite. Clay minerals (mainly kaoline) are sometimes contained in small amount in the not-compact parts. Native sulfur, chrysocolla and other minerals occur in some druses.

Argillized zones occur surrounding the silicified zone. The clay zones consist of white parts and yellow-brown parts. The former consists mainly of quartz and clay minerals(kaoline, pyrophyllite, alunite etc.), while the latter parts contain limonite and hematite aside from the clay minerals. These are probably products of oxidation of pyrite and other sulfides.

CHAPTER 4 GEOLOGICAL SURVEY OF ZONE C

4-1 General Geology

The basement rocks of this zone are Emeşe Formation composed of green schist, pelitic schist and crystalline limestone and Ovacık Granite(Triassic). The Emeşe Formation occurs widely in the southern part of the zone, and it is overlain unconformably by Sarısuvat Formation in the northern part. The Sarısuvat Formation comprises sandy limestone, and the age is Late Jurassic.

Cretaceous sediments are lacking here, and Karanlık Formation has deposited

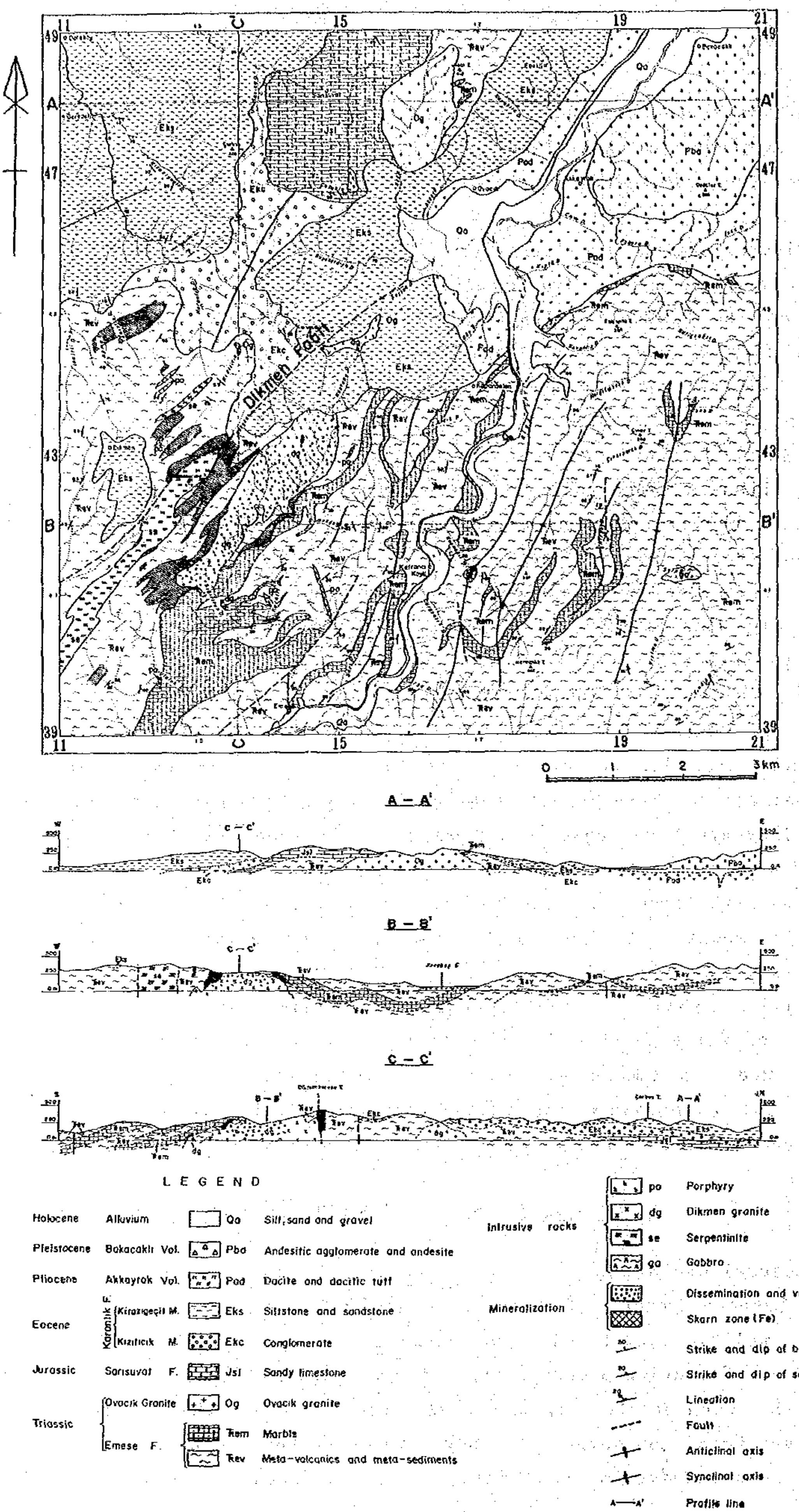


Fig. 3-9 Geologic Map and Cross Sections of the Zone C

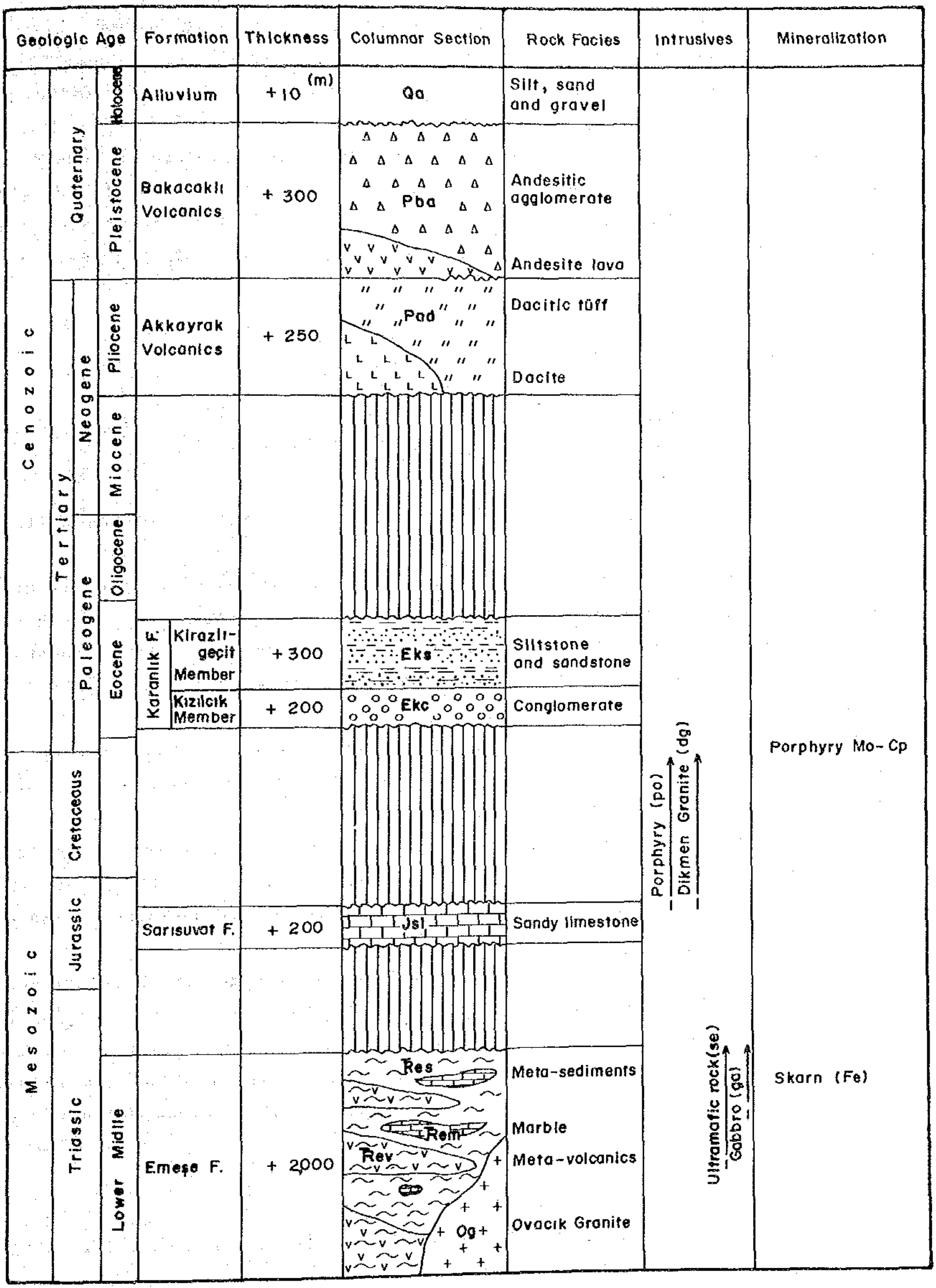


Fig. 3-10 Schematic Column of the Zone C

in Tertiary. The lower part of this formation is Kızılcık Member which is believed to be the basal conglomerate and the upper part consists of Kirazlıgeçit Member composed of silt and sandstone altenation. These are considered to be flysch type sediments.

Eocene and Miocene volcanics are lacking, and Akkayrak Volcanics consisting of post Late Tertiary dacite, and Bakacaklı Volcanics consisting of andesites overlie Karanlık Formation unconformably. The geologic map, cross sections, stratigraphic columns and Dikmen mineralized zone are shown in Figures 3-9 to 3-11.

4-2 Stratigraphy

4-2-1 Emeşe Formation

Type locality: vicinity of Emeşe Village.

Thickness: +2,000m

Distribution: This formation is distributed mainly in the southern half of this zone.

Lithology and occurrence: This formation is composed mainly of green schist which was derived from basic volcanic rock, metagabbro, black pelitic schist, metasediments derived from sandstone, congromerate and crystalline limestone (marble). Green schist is more abundant downward and pelitic schist increases upward.

Apart of the crystalline limestone is considered to be olistoliths supplied from underlying units (fossils were not found in this zone, but Permian fossils occur in other areas).

This formation has been metamorphosed but weakly, and a series of fold structure are revealed and the crystalline limestone of the southern part can be correlated by considering the schistosity of the pelitic schists as bedding and interpreting the geology.

All of the above are of the same horizon including the massive olistoliths.

Stratigraphic position: In the southern part of the zone, this formation is correlated by alluvium which is distributed along the Biga River. In the north, it is overlain by the Karanlık Formation to the west of the Dikmen Fault and unconformably by the Karanlık Formation and Akkayrak Volcanics to the east.

4-2-2 Sarısuvat Formation

Type locality: From the upstream part of Çubuklu Stream to the Sarısuvat Village

Thickness: +200m

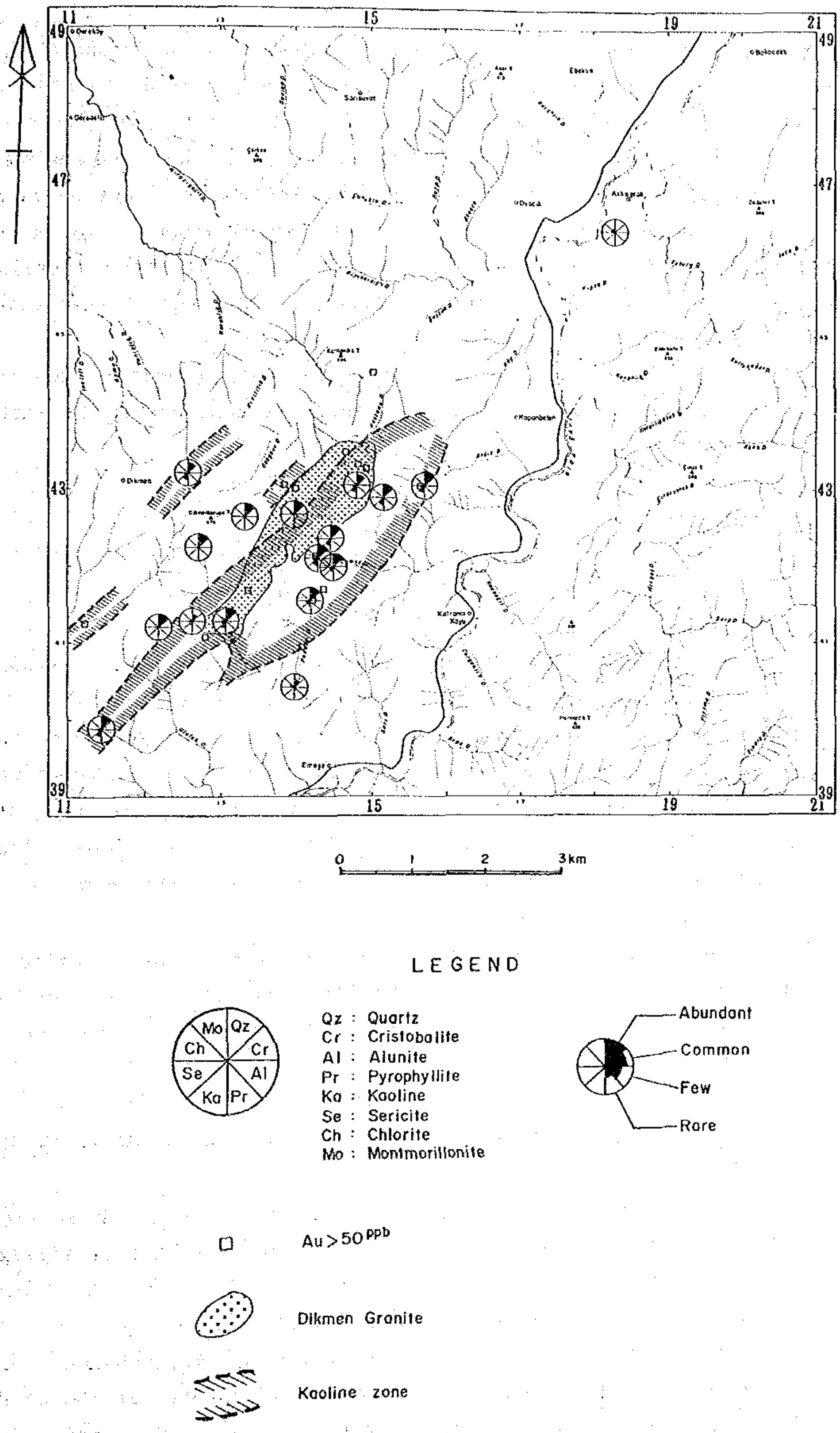


Fig. 3-11 Gold Occurrence and Alteration Map of the Zone C

Distribution: The formation occurs in the part of the zone from the upperstream of the Çubuklu Stream to Sarısuvat Village.

Lithology and occurrence: The exposure is poor, but the massive and brecciated parts of the pale gray to grayish white sandy limestone are observed. Although the contact points with Ovacık Granite cannot be seen, it is believed that the limestone deposited after the intrusion of the granite. Fragments of fossils were found, but the preservation of these fossils was poor. Bedding is observed in somewhat siliceous upper parts of this formation, but the general trend could not be confirmed.

Stratigaphic position: This formation unconformably overlies the Ovacık Granite and the Emeşe Formation, and is overlain unconformably by Karanlık Formation.

4-2-3 Karanlık Formation

(1) Kızılcık Member

Type locality: Midstream section of Kızılcık Stream

Thickness: +200m

Distribution: This member occurs at midstream section of Kızılcık Stream and upstream part of Karanlık Stream, and other parts of the zone.

Lithology and occurrence: The formation is pale gray and consists of poorly consolidated porous conglomerate with pebbles of 5～6cm. The pebbles are not well rounded and show subrounded to platy form. The bedding and sorting of the conglomerate are poor. The rocks are oxidized by weathering and discoloured. The pebbles are green schist, metavolcanics, marble and metasediments. The matrix are predominantly quartz and micas.

Stratigraphic position: The formation overlies the Emeşe Formation and Sarısuvat Formation unconformably and overlain conformably by the upper Kirazlıgeçit Member.

(2) Kirazlıgeçit Member

Type locality: Kirazlıgeçit Stream and downstream section of Karanlık Stream

Thickness: +300m

Distribution: The rocks of the formation occur in the upstream section of Dereköy in the northwestern end of the zone, and vicinity of Ovacık Village.

Lithology and occurrence: The lower portion of this member consists of grayish white sandstone. It is poorly consolidated, and is believed to have deposited under the same environment as the lower Kızılcık Member. Those modes of occurence are observed near the lower Kızılcık Member at the south of Dereköy Village and the vicinity of Ovacık Village. The upper part consists of rhythmical alternation of pale gray to pale green siltstone and pale brown fine-to medium-grained sandstone. The exposure is good, the bedding is well developed and there are portions with exposure continuous for several hundred meters. The unit beds of sandstone and siltstone are 10~20cm thick, and they are well sorted with homogeneous grain size. The strike is E-W with southward dip in the upstream section of Dereköy in the northern part of the zone, while in the south, it dips north to 10~20°NW with the same strike. The general geologic structure is gentle synclinal structure.

Stratigraphic position: This formation unconformably overlies the Ovacık Granite, Emeşe Formation, Sarısuvat Formation, and the Dikmen Granite, but is conformable with the Kızılcık Member. It is overlain unconformably by the Akkayrak Volcanics near the Ovacık Village.

4-2-4 Akkayrak Vocanics

Type locality: From the Akkayrak Village to the Kışla Stream in the south.

Thickness: +250m

Distribution: The rocks occur along both banks of the Biga River which flows northward in the central part of the zone. To the east of the river, the rocks are distributed from Akkayrak Village to the Kışla Stream and Fakara Stream in the south, and to the west of the river, it is distributed at Ovacık Village and Köy Stream.

Lithology and occurrence: The major components of this unit are grayish white to pale yellow dacite lava with flow structure and dacitic pyroclastic rocks. The lower beds of this unit are exposed in the southern part and most of them are grayish white to pale yellow tuff. It is generally argillized by weathering and diagenesis. X-ray diffraction showed the constitutent to be montmorillonite, kaoline and other clay minerals. Bedding is not observed and the structure of the unit is difficult to clarify, but the general layout indicates a synclinal structure with depression along the Biga River.

Stratigraphic position: The rocks overlie the Emeşe Formation and Karanlık Formation, and are unconformably covered by the Bakacaklı Volcanics and Alluvium deposits.

4-2-5 Bakacaklı Volcanics

Type locality: Vicinity of Bakacaklı Village.

Thickness: +300m

Distribution: The rocks are distributed from the Bakacaklı Village in the northeastern end of the zone to the Dedeler Tepe(elevation 388m) in the south.

Lithology and occurrence: Dark green and lava occur near the Dedeler Tepe, while in other parts of the zone, the rocks are agglomerate. Thus there is no bedding and the structure of these rocks is not known.

Stratigraphic position: These rocks overlie the Akkayrak Volcanics, and are overlain by alluvium. The relationship to both upper and lower units is unconformable.

4-2-6 Alluvium

This unit occur only along the Biga River, and they form sand and gravel consisting of silt, sand and gravel.

4-3 Intrusive Bodies

(1) Ovacık Granite: This is distributed from the upstream portion of Sarp Stream to Asar Tepe (elevation 412m). It is holocrystalline and equigranular. It contains relationaly large amount of biotite. Mineralization and alteration were not observed in this unit, and geochemical anomalies do not occur in the stream sediments in the vicinity. The age is inferred to be Triassic (SIYAKO 1987), because similar rock is covered by Jurassic sediments. It is observed microscopically that biotite has altered to chlorite and potash feldspar to epidote.

(2) Serpentinite: This has intruded into Emeşe Formation mainly along the Dikmen Fault. It is approximately 500m wide and over 3km long. Serpentinite also occurs in samll scale in the northeastern part of the Dikmen Village. Similar rock is distributed outside of the survey area, and is considered to be be latest Triassic (SIYAKO 1987).

(3) Dikmen Granite: This granite occurs at two localities in the upstream section of the Sıgırirek Stream, east of Dikmen Village and along the Şeytan Stream.

At the Şeytan Stream, it is relatively fine-grained, equigranular, and mineralization and alteration are not observed. At the Sıgırirek Stream upstream portion, it is 500m wide and 3km long in the direction as the Dikmen Fault. Quartz veinlets are developed containing molybdenite and pyrite (chalcopyrite) in the Sıgırirek Stream body. Regarding the age of intrusion, similar rock intruded into the latest Cretaceous melange, and is overlain by Neogene sediments. Thus the intrusion is inferred to have taken place between the end of Cretaceous to Miocene(SIYAKO 1987). Although the rock appears unaltered under unaided eyes, alteration of potash feldspars to chlorite and epidote is observed microscopically.

(4) Porphyry: Quartz, hornblende, plagioclase and other phenocrysts are conspicuous in this body. Plagioclase is mostly altered to sericite. The

direction of intrusion is NE-SW to the west of Dikmen Fault and NW-SE to the east of the fault. The age of intrusion is not clear, but is inferred to be latest Cretaceous at the time of Dikmen Granite intrusion.

4-4 Geologic Structure

The Emeşe Formation which is widely distributed in the eastern part of this zone, dips westward to the Dikmen Fault and eastward to the above fault. The fault trends NE-SW in the eastern part of the Dikmen Village. Emeşe Formation becomes folded zone with N-S fold axis in the eastern part. Karanlık Formation also is gently folded to the west of Dikmen Fault. The existence of the Dikmen Fault is inferred also from Landsat image analysis and geological survey revealed the intrusion of Dikmen Granite and serpentinites parallel to this fault, it is inferred that fractures not observed are developed in NE-SW direction.

It was not possible to interpret the geological structure direct from Akkayrak Volcanics and Bakacaklı Volcanics, it is inferred that this zone is located at the southwestern end of the depression formed by the Late Tertiary volcanism.

4-5 Mineralization and Alteration

Dikmen Granite occurs at two localities at the upper stream section of Sığırirek Stream and to the east of Dikmen Village and along the Şeytan Stream. Mineralization alteration are not observed at Şeytan Stream, but mineralization accompaning molybdenite and copper oxide accidentals are seen at Sığırirek Stream(Dikmen mineralization). In this zone, there are also the skarn associated with Dikmen Granite, although of local scale. There are high gold content areas.

(1) Dikmen Mineralized Zone: The Dikmen Granite occur in the upperstream section of the Sığırirek Stream in the same direction as the Dikmen Fault, and the dimension are 500m wide and 3km long. The colour is grayish white to pale green by alteration(sericite-epidotization), fractures are developed and quartz veinlets and pyrite occur along these fissures. Pyrite occurs as weak dissemination throughout the rock body and also as dissemination in the sericitized Emeşe Formation, adjacent to this granite. The quartz veinlets contain molybdenum as the main ore mineral, and pyrite is relatively rare. Also chrysocolla occurs fairly abundantly as boulders on the left bank of the Sığırirek Stream. The exposure in this part is poor in spite of the strong sericitization. The rock analysis show a relatively high content of mercury and barium.

(2) Skarn: The skarn of this zone is green skarn consisting mostly of epidote with minor amount of chlorite, calcite, magnetite and hematite. The existence of parallel skarn zones were confirmed by geological survey. Although of local scale, high grade gold content is found by analysis of a sample (NY032) of skarn near the Dikmen Granite. The content of minor elements such as mercury, antimony and barium are also high in the skarn sample from this locality.

CHAPTER 5 TOTAL ROCK ANALYSIS

A total of 15 samples, six granite and nine volcanic rocks were analysed. The granite samples were, one Triassic Akpınar Granite sample from Zone B; two Triassic Ovacık Granite and three upper Cretaceous～Eocene Dikmen Granite samples from Zone C. The volcanic rock were eight Eocene to Pliocene andesite samples from Zone A and B, and one Pleistocene dacite sample. The elements analysed were 13 including BaO. The analytical method used was potassium permanganate titration for FeO, and ICP-AES for other elements. The results of analysis, calculated norm, differentiation index and solidification index are shown in Table 3-2. The analysed sample were studied microscopically.

(a) Granitic rocks

The chemical composition of Triassic Akpinar Granite and Ovacık Granite and the upper Cretaceous～Eocene Dikmen Granite was studied by the diagrams in Figures 3-11～3-17. The results are as follows.

① The granites of this survey area are the grandiorite of Bateman et al(1963), namely those with low normative orthoclase in the quartz-plagioclase-orthoclase diagram. The results of the Gümüşhane Project (1984-1987) show that the older granite(Devonian Gümüşhane Granite) were quartz monzonite while the younger (upper Cretaceous～Eocene) are granodiorite. There was a significant difference between these granitoids, but in the present area, difference of composition by age was not observed.

Age	Triassic	Upper Cretaceous～Eocene
Plutonic rock	Akpınar Granite Ovacık Granite	Dikmen Granite
D.I.	86～93	90～93
SiO_2	63～66	64～68
MgO	0.8～1.9	0.6～1.6
CaO	4.5～4.9	3.4～4.5

② Both granites do not have clear range of compositional variation in D.I.-oxide.

③ Similar tendency exists for CaO-alkali ratio and the granites are in high CaO zone (Fig.3-15).

Table 3-3 Chemical Analyses and CIPW Norms for Granitic Rocks and Volcanics

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No.	AK026	AK036	HB036	HB211	HS099	HS217	KB023	KB041	KS005	KS015	KS062	KS128	KS190	TS078	TS093
SiO_2	66.08	64.50	67.91	51.35	55.51	73.19	64.70	67.42	66.19	64.90	66.01	57.58	63.66	61.21	58.40
TiO_2	0.43	0.58	0.28	0.87	0.65	0.20	0.35	0.25	0.26	0.30	0.39	0.73	0.53	0.61	0.70
Al_2O_3	15.66	17.45	16.06	19.60	16.95	13.97	17.94	16.91	17.72	17.70	15.03	17.23	15.57	16.60	18.10
Fe_2O_3	1.27	2.36	1.41	6.47	2.42	1.32	1.19	0.84	0.75	1.16	1.58	2.82	2.24	5.21	5.52
FeO	1.66	0.54	0.74	0.42	2.99	0.10	1.55	1.09	0.98	1.20	1.32	2.50	2.03	0.64	0.81
MnO	0.11	0.08	0.04	0.05	0.15	0.04	0.09	0.06	0.05	0.07	0.08	0.13	0.12	0.17	0.05
MgO	1.28	0.93	0.67	1.04	1.86	0.32	1.58	0.83	0.84	1.32	1.27	3.19	1.92	1.83	0.75
CaO	2.83	3.34	3.60	6.50	5.85	0.94	4.53	3.41	4.68	4.86	1.92	6.64	4.52	5.42	3.49
Na_2O	3.07	3.82	3.96	4.45	4.82	4.09	4.85	4.32	4.90	4.80	2.07	3.27	3.20	3.49	2.78
K_2O	4.22	5.27	2.67	0.39	0.26	4.00	1.38	2.54	1.21	1.49	5.85	2.92	2.42	2.75	2.74
P_2O_5	0.18	0.23	0.11	0.21	0.18	0.05	0.14	0.13	0.12	0.12	0.09	0.27	0.18	0.21	0.16
BaO	0.09	0.12	0.04	0.02	0.02	0.09	0.04	0.06	0.04	0.04	0.16	0.08	0.07	0.09	0.08
H_2O+	2.02	1.50	1.64	5.08	2.34	0.76	1.53	1.79	1.52	1.43	2.84	1.33	3.94	0.54	3.66
H_2O-	0.71	0.23	0.17	2.79	2.20	0.62	0.25	0.37	0.13	0.10	0.85	0.44	0.29	0.91	2.30
Total	99.61	100.95	99.30	99.24	96.20	99.69	100.12	100.02	99.39	99.49	99.46	99.13	100.69	99.68	99.54
Q	23.94	14.27	26.27	9.37	11.33	31.79	18.90	23.95	21.75	19.07	25.55	10.20	23.26	17.52	23.61
C	1.33	0.00	0.38	0.99	0.00	1.38	0.57	1.17	0.13	0.00	2.02	0.00	0.00	0.00	4.60
or	24.94	31.15	15.78	2.30	1.54	23.64	8.16	15.01	7.15	8.81	34.57	17.26	14.30	16.25	16.19
ab	25.96	32.30	33.49	37.63	40.76	34.59	41.02	36.53	41.44	40.59	17.51	27.65	27.06	29.51	23.51
an	12.87	14.91	17.14	29.67	23.86	4.19	21.56	16.07	22.43	22.36	8.94	23.72	20.98	21.51	16.27
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
di-wo	0.00	0.07	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.40	0.00	3.12	0.11	1.67	0.00
di-en	0.00	0.06	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.29	0.00	2.40	0.08	1.45	0.00
di-fs	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.08	0.00	0.39	0.02	0.00	0.00
hy-en	3.19	2.25	1.67	2.59	3.63	0.80	3.93	2.07	2.09	3.00	3.16	5.54	4.70	3.11	1.87
hy-fs	1.49	0.00	0.00	0.00	2.12	0.00	1.45	1.01	0.84	0.80	0.62	0.91	1.20	0.00	0.00
ol-fo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
mt	1.84	0.32	1.70	0.00	3.51	0.00	1.72	1.22	1.09	1.68	2.29	4.09	3.25	0.85	0.74
hm	0.00	2.14	0.23	6.47	0.00	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.62	5.00
il	0.82	1.10	0.53	0.99	1.23	0.30	0.66	0.47	0.49	0.57	0.74	1.39	1.01	1.16	1.33
ru	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tn	0.00	0.00	0.00	0.85	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.43	0.54	0.26	0.50	0.43	0.12	0.33	0.31	0.28	0.28	0.21	0.64	0.43	0.50	0.38
S.I.	11.26	7.33	7.20	8.58	15.36	3.30	15.15	8.70	9.76	13.40	10.65	22.12	16.57	13.66	6.22
D.I.	74.84	77.72	75.54	49.30	53.63	90.02	68.08	75.49	70.34	68.47	77.63	55.11	64.62	63.28	63.31

Area	No.	Sample No.	Rock Name	Coordinates	Rock Unit	Location
A	4	HB211	Andesite	8840 4830	Balcılar Volcanics	Çam Tepe
	6	HS217	Dacite	8505 5190	Dedadağ Volcanics	Dededağ
B	2	AK036	Andesite	7205 3735	Osmanlar Volcanics	Southwest of Osmanlar Mah
	15	TS093	Andesite	7610 2155	Şapçı Volcanics	Northeast of Gökçeşme Köyü
	14	TS078	Andesite	7680 2040	Şapçı Volcanics	Kemut Tepe
	5	HS099	Andesite	7310 2470	Şapçı Volcanics	North of Aşagışapçı
	1	AK026	Andesite	7370 3895	Çamyayla Volcanics	Northwest of Osmanlar Mah
	12	KS128	Andesite	8090 3155	Çamyayla Volcanics	Kocaçakıl Tepe
	11	KS062	Andesite	8555 3610	Çamyayla Volcanics	Northwest of Alan Tepe
	13	KS190	Granite	7995 3030	Akpınar Granite	Cemiyet alanı
C	7	KB023	Granite	4275 1440	Dikmen Granite	Domuzdamı Dere
	8	KB041	ditto	4295 1475	ditto	ditto
	3	HB036	ditto	4320 1475	ditto	ditto
	9	KS005	ditto	4445 1480	Ovacık Granite	South Karagedik Tepe
	10	KS015	ditto	4690 1520	ditto	Southeast of Çüçül Tepe

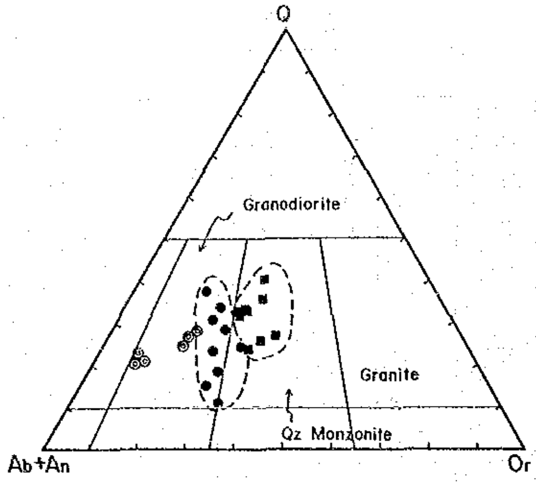


Fig. 3-12 Normative Qz-Pl-Or Diagram for Granitic Rocks

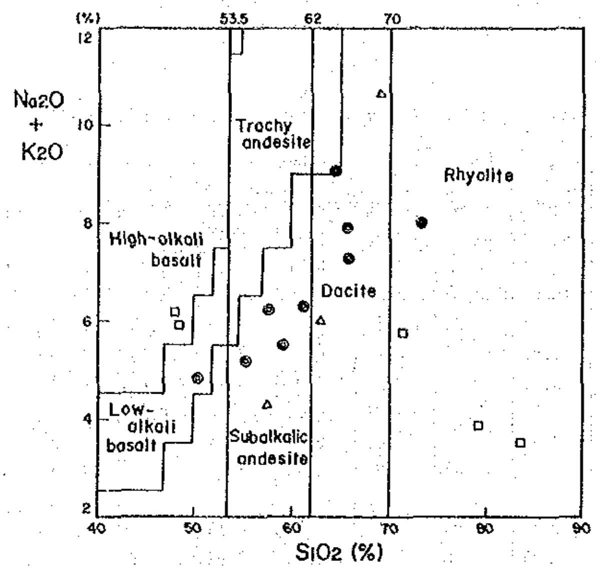
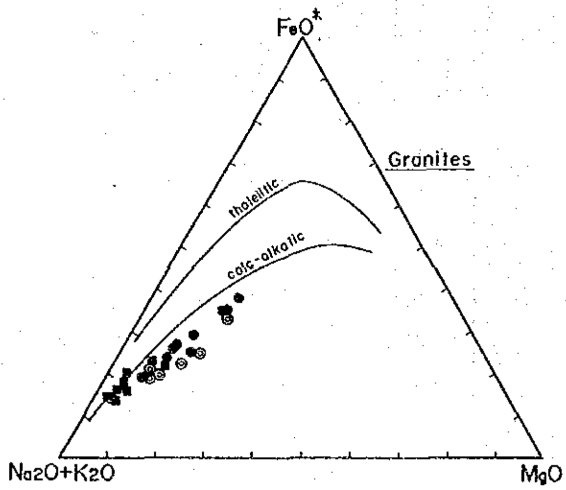


Fig. 3-13 $SiO_2 \cdot (Na_2O + K_2O)$ Diagram for Volcanics



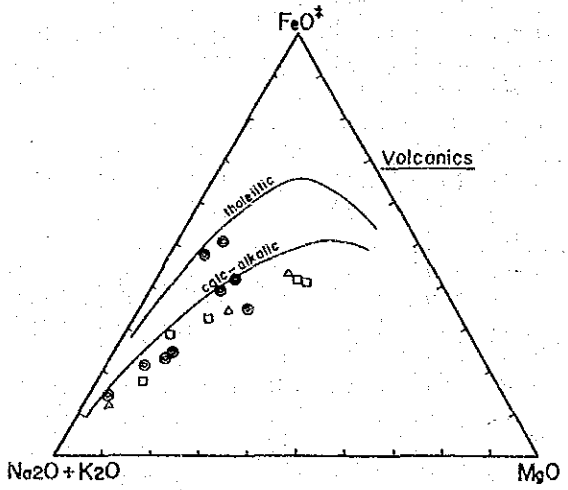
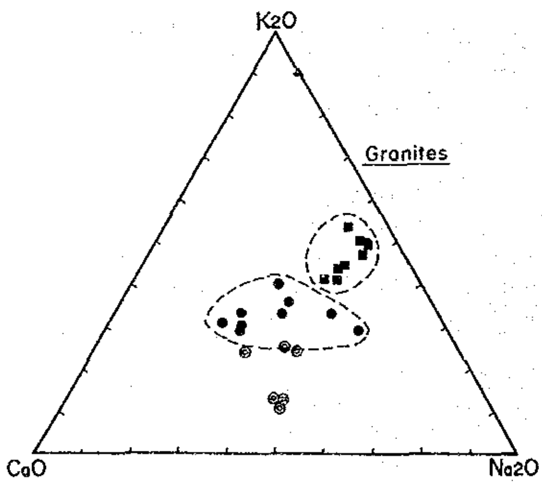


Fig. 3-14 MFA Diagrams



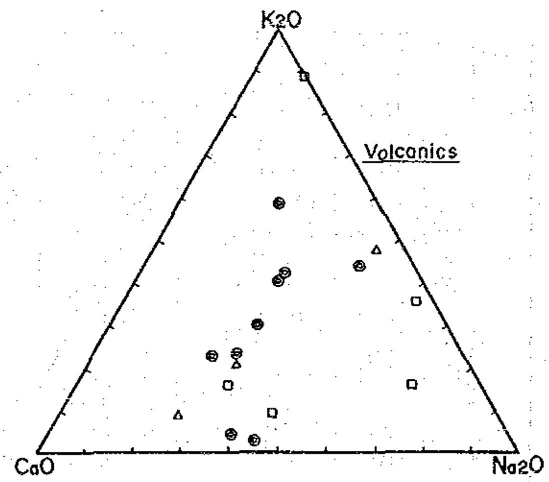


Fig. 3-15 $CaO\text{-}Na_2O\text{-}K_2O$ Diagrams

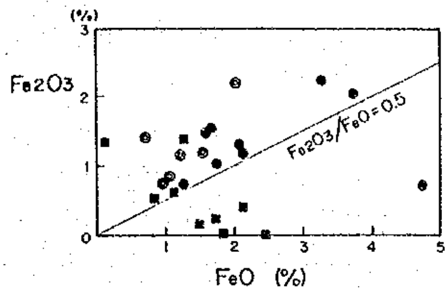


Fig. 3-16 Fe_2O_3-FeO Diagram for Granitic Rocks

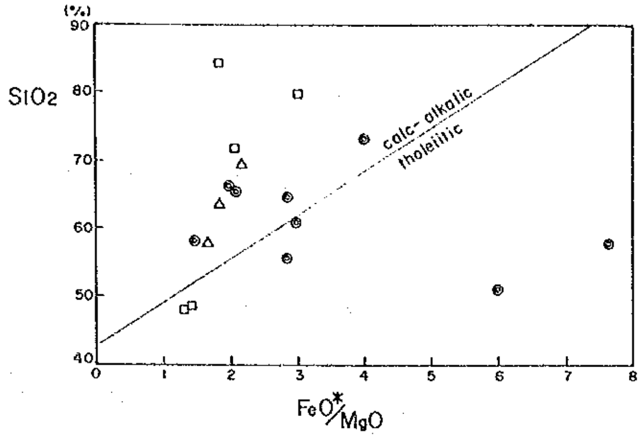


Fig. 3-17 SiO_2-FeO* /MgO Diagram for Volcanics

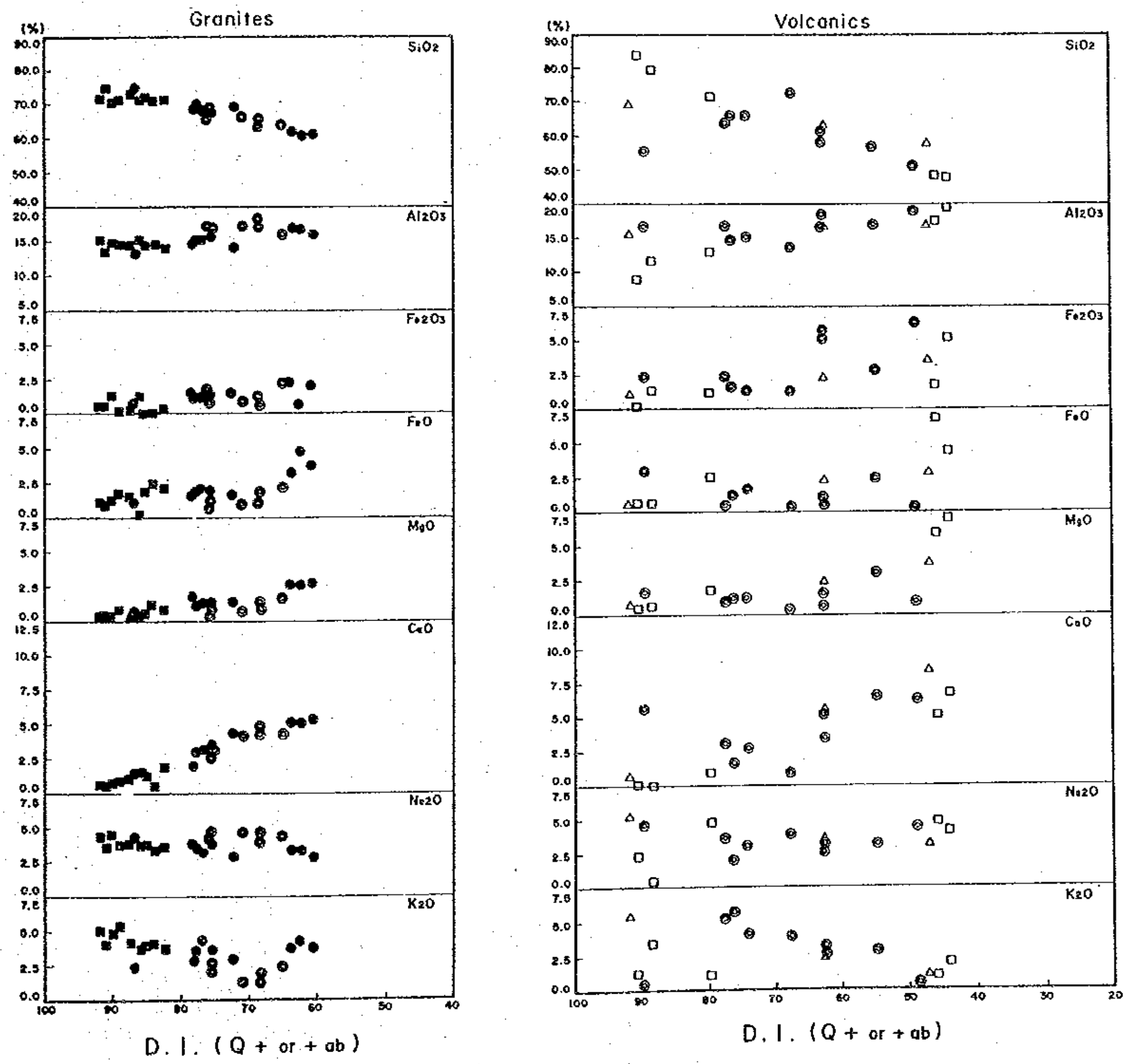


Fig. 3-18 Variations Diagrams (D.I.- Oxides)

Symbols (Same as in Fig.3-12~Fig.3-18)

Granites

Çanakkale Area ◎: Granodiorite (Triassic–Eocene)

Gümüşhane Area
- ■: Gümüşhane Granite (Devonian ?)
- ●: Younger Granitic rocks (Upper Cretaceous–Eocene)

Volcanics

◎: Andesitic rocks (Eocene–Pliocene)

▲: Venk Yayla Formation (Eocene, Andesite)

△: Zigana Formation (Uppur Cretaceous, Andesite)

Table 3-4 Results of Microscopic Observation of Thin Sections

Sample No.	Rock Name	Rock unit	Texture	Phenocryst									Groundmass									Alteration
				Qz	Kf	Pl	Bi	Ho	Au	Hy	Mf	Op	Qz	Pl	Bi	Ho	Au	Hy	Mf	Op	G	
HB211	Andesite(Balcılar V.)	Mba	Porphyritic			◎?		○?	○?											◎		Ch.(vs arg)
HS217	Dacite(Dededağ V.)	Pdd	ditto			◎	○					△		◎						○	○	Ch.(vs arg)
AK036	Andesite(Osmanlar V.)	Pod	ditto			◎	○	○				△		◎						◎	○	
TS093	Andesite(Şapçı V.)	Msa	ditto		□	◎	○	○				○		◎		○	○			○	◎	
TS078	Andesite(Şapçı V.)	Msa	ditto			◎	□	◎	○			○		◎		○	○			○	◎	
HS099	Andesite(Şapçı V.)	Msa	ditto			◎		○?	○?			○	○?	◎		○?	○?			○	○	Mafic→Ch. Ep.
AK026	Andesite(Çamyayla V.)	Eça	ditto		□?	◎	□?	○?	○?			△	○?	◎		○?	○?			△	◎	Mafic→Ch. Ep.
KS128	Andesite(Çamyayla V.)	Eça	ditto			◎	○	□	○	□		□		◎		○	○			○	○	
KS062	Andesite(Çamyayla V.)	Eça	ditto	□		◎		○?	□?			△								□	◎	Ch. Ep.
KS190	Granodiorite		Holocrystalline	○		◎	□	○				○										Ch.
KB023	Dikmen Granite		ditto	◎	○	◎	○					□										
KB041	ditto		ditto	◎	○	◎	○					□										Kf→Ch. Ep.
HB036	ditto		ditto	◎	○	◎	○					△										Kf→Ch. Ep.
KS005	Ovacık Granite		ditto	◎	○	◎	◎					△										Kf→Ch. Ep.
KS015	ditto		ditto	◎	◎	◎	○					△										Kf→Ch. Ep.

Abbreviations:

◎:Abundant ○:Common □:Few △:Rare

Qz:Quartz, Kf:Potassium feldspar, Pl:Plagioclase, Bi:Biotite, Ho:Hornblende, Au:Augite, Hy:Hypersthene, Py:Pyrpxene,

Mf:Mafic mineral Op:Opaque minerals Ser:Sericite Ch:Chlorite Ep:Epidote C:Calcite Ah:Anhydrite G:Glass

vs:very strong arg:argillization

Genetic classification of granitoids has been proposed by Chappell and White(1974), Ishihara (1977) and others. In Chappell and White's classification, $Al_2O_3/(Na_2O + K_2O + CaO)$ molar ratio, normative diopside and normative corundum values are used for the basis of grouping. From these basis both the older and younger granites of the survey area belong to type I. Ishihara uses the mode of opaque minerals under microscope and the Fe_2O_3/FeO ratio for his classification. Although microscopic study of polished sections has not been done in the present work, the mode of opaque minerals and the Fe_2O_3-FeO diagram (Fig 3-16) indicates the granites of the survey area to be of the magnetite series.

(b) Volcanic rocks

Çamyala Volcanics, Şapçı Volcanics and Balcılar Volcanics are all andesite, and Dededağ Volcanics dacite. In the $SiO_2 \cdot (Na_2O+K_2O)$ diagram (Fig.3-13), however, the andesites are in the dacite range, and so-called dacite belong to the rhyolite zone. The reason for these rocks being in the dacite and rhyolite ranges chemically is believed to be the increase of SiO_2 content by 5~6% through alteration. The andesite of the Çamyala Volcanics has somewhat high (Na_2O+K_2O) content, and this agrees with the alteration observed microscopically. Also the MFA diagram (Fig.3-14) and the SiO_2-FeO/MgO diagram(Fig.3-17) show that the volcanic rocks of this area belong to the calc-alkali series.

CHAPTER 6 GEOCHEMICAL PROSPECTING

6-1 Geochemical Prospecting of Stream Sediments

6-1-1 Geochemical Prospecting Carried out by MTA

The Geochemical prospecting carried out by MTA in the Çanakkale in the northwestern Part of Biga Peninsula was done by stream sediments. This work covered the 3,400km² area which was studied by Landsat image analysis during the present work. Contents of six elements; copper, lead, zinc, molybdenum, arsenic and antimony were analyzed and a geochemical anomaly map of 1:100,000 scale was prepared. The anomalies within this 3,400km² area were extracted and listed in Table 1-1.

The objective of the work at Çanakkale was prospecting for metal deposits and the commodities were copper, lead, and zinc. Thus the anomalies were mostly distributed in or near the granodiorite zones and most of them were showings of copper-lead-zinc vein type mineralization.

6-1-2 Re-analysis of the Previous Samples

Small lead-zinc veins occur and previously worked Madendağı gold mine and Kartaldağı mine exist in Çanakkale, and the area has been attracting attention for the gold potential. In the present work, eight elements, gold, silver, fluorine, mercury, thallium, selenium, aesenic and antimony were newly determined for the remaining samples of the previous MTA project.

The remaining samples were less than 10g. Since the analysis of gold required 10g of sample, two to three original samples from the same streams were combined to prepare new samples of more than 20g each for analysis. Samples were mostly selected from Zones A,B and C and total of 304 samples including those from the vicinity of the above zones were analyzed.

6-1-3 Analytical Methods

All the samples were analyzed by Chemex Labs Ltd., of Canada. Gold was analyzed by wet method and atomic absorption, fluorine by ion polilize and other elements by atomic absorption spectrometry. The limits of detection of the elements are as follows.

Table 3-5 Ditection Limit and Analyzed Element of Stream Sediment

Element	Detection Limit	Element	Detection Limit
Au	5ppb	Ag	0.2ppm
F	20ppm	Hg	10ppb
Tl	0.1ppm	Se	0.2ppm
As	1ppm	Sb	0.2ppm

The result of the analysis is shown in Appendx Table 1.

6-1-4 Statistical Analysis of the Chemical Results

(1) Outline of Method

Basic statistical values and Calculated matrix of the chemical values of the stream sediments were caluculated and principal component analysis -a method of multivariate analysis- was carried out.

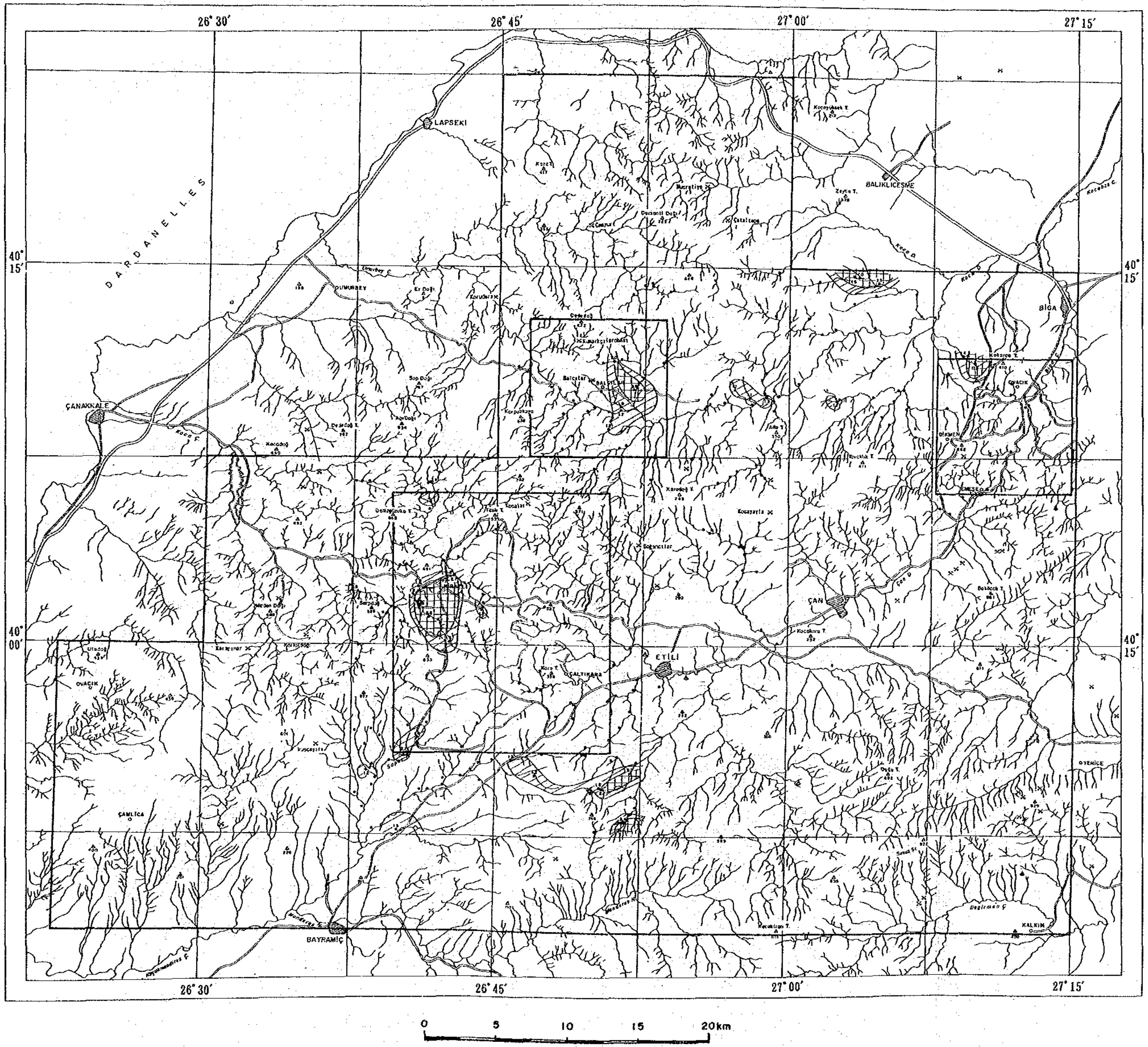
【Basic Statistical Values】

Average, dispersion, standard deviation, maximum and minimum values were calculated for each element and listed in Table 3-6.

Table 3-6 List of Basic Statistical Values on Stream Sediments

Element	Mean	Dispersion	S.D.	Min.	Max.
Au (ppb)	3.975	0.176	0.420	0.000	400.000
Ag (ppm)	0.111	0.026	0.162	0.100	1.200
As (ppm)	18.317	0.166	0.407	3.000	2100.000
Hg (ppb)	100.739	0.062	0.248	30.000	4700.000
Sb (ppm)	0.432	0.355	0.596	0.000	26.000
Se (ppm)	0.241	0.116	0.341	0.000	5.000
F (ppm)	354.745	0.161	0.402	0.000	1150.000
Tl (ppm)	0.314	0.185	0.430	0.000	2.100

S.D.:Standard Deviation



LEGEND

1.5 • Component Score of Chip Sample

Component Score is more than 1

Component Score is more than 2

Operating Mine

Closed Mine

Hot water spring

Fig. 3-19 Component Score Map of Stream Sediments

Table 3-7 List of Coefficient and Covariance Matrix on Stream Sediments

	Au	Ag	As	Hg	Sb	Se	F	Tl
Au	0.176	0.20003	0.21644	0.16656	0.15775	0.02232	-0.03149	0.05826
Ag	0.014	0.026	0.27036	0.10751	0.22549	-0.02520	-0.15653	0.09481
As	0.037	0.018	0.166	0.14344	0.69940	0.17248	0.04533	0.35578
Hg	0.017	0.004	0.015	0.062	0.11441	-0.12591	-0.03791	-0.11749
Sb	0.039	0.022	0.170	0.017	0.355	0.42080	0.39225	0.61919
Se	0.003	-0.001	0.024	-0.011	0.085	0.116	0.52914	0.49799
F	-0.005	-0.010	0.007	-0.004	0.094	0.072	0.161	0.50813
Tl	0.011	0.007	0.062	-0.013	0.159	0.073	0.088	0.185

【Principal Component Analysis】

The aim of the principal component analysis is to represent the large number of variables by a smaller number of factors with a minimum loss of information. This will provide a greater efficiency in terms of information compression over the original data, and will gain interpretability of the relations among the original variables. In applying this method for mineral prospecting, the relations among the variables(elements) and the variables caused by identical phenomena are compressed into small number of factors, the eigenvectors, unique to the factors, and the scores of the samples are calculated. Then the nature or characteristics of the mineralization or significant regional information are obtained by studying and interpreting the result of the calculation. The calculation is done either by correlation matrix, or covariance matrix. In this work, correlation matrix was used.

(2) Basic Statistical Values

Basic statistical values and correlation coefficients for the eight components with a population of all 304 samples were calculated. Of the eight elements, gold content was at times below the limit of detection and 5ppb was used for samples below 10ppb and 2.5ppb was used for below 5ppb. In general, the arsenic, mercury and selenium values were high, but the fluorine and thallium values were low for the stream sediment samples. The basic statistical values are laid out in Table 3-6 and the correlation among the elements listed in Table 3-7.

(3) Principal Component Analysis

The values for gold, many of which were below the detection limit, were processed with the same method as for the basic statistical values. Principal component analysis with all 304 samples as the population was carried out. Computation shows that the eigenvalue exceeds 0.841 and the population exceeds 10.5% when the components up to accumulated proportion of 78% are taken. Thus, those up to the fourth principal component express the major variations of this area.

Table 3-8 List of Eigenvector and Eigenvalue of Stream Sediments

	Z(1)	Z(2)	Z(3)	Z(4)	Z(5)	Z(6)	Z(7)	Z(8)
Au	0.12364	0.40089	0.23778	0.84141	-0.23328	-0.06559	-0.00126	0.02761
Ag	0.12757	0.47852	-0.44295	0.07817	0.72734	-0.04277	-0.13839	-0.04922
As	0.38755	0.38596	-0.14752	-0.29249	-0.45173	0.18346	-0.23748	-0.54719
Hg	0.01542	0.39637	0.77500	-0.32495	0.28468	0.05114	0.22205	-0.05899
Sb	0.52627	0.15705	-0.02560	-0.21901	-0.16127	-0.04669	-0.12367	0.77863
Se	0.40617	-0.31158	0.05356	0.19728	0.21903	0.78868	0.15755	-0.03675
F	0.37101	-0.39917	0.32779	0.08769	0.23792	-0.34703	-0.60801	-0.20291
Tl	0.48828	-0.15218	-0.11789	0.01425	0.02944	-0.46149	0.68217	-0.21243
Eigenvalue	2.78590	1.66552	0.95171	0.84090	0.70506	0.48233	0.36842	0.20016
Proprtion	0.34824	0.20819	0.11896	0.10511	0.08813	0.06029	0.04605	0.02502
Accum. Prop.	0.34824	0.55643	0.67539	0.78050	0.86864	0.92893	0.97498	1.00000

First principal component: Components with large absolute eigenvector are; arsenic, antimony, selenium, fluorine and thallium.

Second principal component: Gold, silver, arsenic, mercury show positive while selenium and fluorine negative values.

Third principal component: Gold, mercury, fluorine show positive while arsenic negative values.

Fourth principal component: Gold and selenium show positive while silver, mercury, antimony negative values.

The above are the components with large absolute eigenvector. The first principal component is affected by weathering and it represents the variations which disperses for relatively far distances. The second and third principal component express the variation of the mineralization of the sampled stream area, and the components are those elements with high analytical values in the known mineral showings. The third and the fourth components express the variation of specific components judging from the proportion of 10% and the large eigenvector for mercury in the third component and for gold in the fourth component. From the above considerations, the score distribution for the second principal component which clearly shows the variation of the area is shown in Figure 3-19.

6-2 Geochemical Prospecting of Chip Samples

6-2-1 Sampling

Chip samples were collected from the 500km^2 zone for semi-detailed survey and the vicinity of the MTA concession in the south of Zone B. Sampling density of two samples per square kilometer was aimed. In Zones A and B, mostly silicified and argillized zones were sampled and in Zone C, mostly Dikmen Granite area was sampled. A total of 1,010 samples were collected.

6-2-2 Analytical Methods

All the samples were analyzed by Chemex Labs Ltd., of Canada. Gold was analyzed by wet method and atomic absorption, fluorine ion polilize and other elements by atomic absorption spectrometry. The limits of detection of the elements are as follows.

Table 3-9 Ditection Limit and Analytical Element on Chip Samples

Element	Detection Limit	Element	Detection Limit
Cu	1ppm	Pb	1ppm
Zn	1ppm	Au	5ppb
Ag	0.2ppm	Mo	1ppm
Hg	10ppb	As	1ppm
F	20ppm	Ba	10ppm
Tl	0.1ppm	Se	0.2ppm
Cd	0.1ppm	Sb	0.2ppm
Bi	0.1ppm		

6-2-3 Statistical Analysis of the Chemical Results

(1) Outline of Method

Basic statistical values and correlation matrix of the chemical values of the chip samples were calculated and principal component analysis was carried out in the same manner as in the case of stream sediments.

Table 3-10 List of Basic Statistical Values on Chip Samples

Element	Mean	Dispersion	S.D.	Min.	Max.
Au (ppb)	5.066	0.362	0.602	0.0001	10000.000
Cu (ppm)	16.662	0.498	0.706	0.0001	10000.000
Mo (ppm)	1.859	0.297	0.545	0.0001	1000.000
Pb (ppm)	14.788	0.666	0.816	0.0001	10000.000
Zn (ppm)	16.219	0.615	0.784	0.0001	10000.000
Ag (ppm)	0.156	0.244	0.494	0.0001	100.000
Cd (ppm)	0.141	0.241	0.491	0.0001	198.000
As (ppm)	20.431	0.400	0.632	0.0001	10000.000
Se (ppm)	0.427	0.287	0.535	0.0001	82.000
Hg (ppb)	80.169	0.588	0.767	0.0001	100000.000
Sb (ppm)	1.405	0.672	0.820	0.0001	1000.000
Bi (ppm)	0.363	0.497	0.705	0.0001	200.000
F (ppm)	179.436	0.203	0.450	0.0001	7400.000
Ba (ppm)	186.028	0.299	0.547	0.0001	10000.000
Tl (ppm)	0.320	0.232	0.481	0.0001	10.000

S.D.:Standard Deviation

Table 3-11 List of Coefficient and Covariance Matrix on Chip Samples

	Au	Cu	Mo	Pb	Zn	Ag	Cd	As	Se	Hg	Sb	Bi	F	Ba	Tl
Au	0.362	0.33387	0.30145	0.38154	0.19777	0.44824	0.31131	0.32224	0.16351	0.25627	0.31520	0.31312	0.13284	0.09577	0.05968
Cu	0.142	0.493	0.32087	0.40243	0.61129	0.46816	0.43657	0.45466	0.25326	0.36543	0.35864	0.21753	0.25382	0.19173	0.23653
Mo	0.099	0.123	0.297	0.19551	0.18930	0.18737	0.20373	0.30892	0.12710	0.29910	0.34315	0.19394	0.13110	0.04705	0.09280
Pb	0.187	0.232	0.087	0.666	0.48651	0.55001	0.44778	0.45345	0.22510	0.29823	0.47068	0.35968	0.18547	0.21546	0.22285
Zn	0.093	0.338	0.081	0.311	0.615	0.39858	0.65650	0.40232	-0.01707	0.37243	0.39848	0.00057	0.18469	0.16858	0.23687
Ag	0.133	0.163	0.050	0.222	0.154	0.244	0.49910	0.40685	0.14245	0.45232	0.48475	0.29695	0.01111	0.14854	0.04893
Cd	0.092	0.151	0.054	0.179	0.253	0.121	0.241	0.27982	-0.03478	0.39852	0.35190	0.06850	0.07850	0.12923	0.11575
As	0.123	0.203	0.108	0.234	0.199	0.127	0.087	0.400	0.23821	0.49397	0.67811	0.32893	0.10757	0.14729	0.14681
Se	0.053	0.096	0.037	0.098	-0.007	0.038	-0.009	0.081	0.287	0.05570	0.06962	0.41499	0.29084	0.23053	0.23058
Hg	0.118	0.198	0.125	0.187	0.224	0.171	0.150	0.239	0.023	0.588	0.66656	0.13054	0.00125	0.07440	0.02060
Sb	0.155	0.208	0.153	0.315	0.255	0.196	0.142	0.351	0.031	0.419	0.672	0.29497	-0.03408	0.00974	0.01546
Bi	0.133	0.108	0.075	0.207	0.000	0.103	0.024	0.147	0.157	0.071	0.170	0.497	0.18788	0.08721	0.14849
F	0.036	0.081	0.032	0.068	0.065	0.002	0.017	0.031	0.070	0.000	-0.013	0.060	0.203	0.44382	0.49409
Ba	0.032	0.074	0.014	0.096	0.072	0.040	0.035	0.051	0.068	0.031	0.004	0.034	0.109	0.299	0.47260
Tl	0.017	0.081	0.024	0.088	0.089	0.012	0.027	0.045	0.059	0.010	0.006	0.050	0.107	0.124	0.232

(2) Basic Statistical Values

Basic statistical values for the 15 components with a population of all 1,010* samples were calculated. Of the 15 components, gold content was at times below the detection limit and thus below 2.5ppb was used for samples below 5ppb. The content of arsenic, antimony, selenium was high while that of fluorine, copper, zinc and barium was low. The basic statistical values are shown in Table 3-10. (* sample TS170 was lost and the analytical result of 0 was assigned.)

(3) Principal Component Analysis

The values for gold, many of which were below the detection limit, were processed with the same method as for the basic statistical values. Also as in the case for stream sediments, principal component analysis was carried out with all samples as the population. The correlation matrix is shown in Table 3-11. The results are that, the eigenvalue exceeds 0.89% and the proportion exceeds 5.9% when the components up to accumulated proportion of 70% are taken. Thus, those up to the fifth principal component express the major variations of this area.

First principal component: Components with large absolute eigenvector are gold, copper, molybdenum, arsenic, mercury and antimony.

Second principal component: Selenium, fluorine, barium, thallium show positive while antimony and mercury negative values.

Third principal component: Selenium, bismuth show positive while zinc and cadnium show negative values.

Fourth principal component: Gold, lead, silver, cadnium, bismuth show positive while molybdenum, arsenic, mercury and antimony show negative values.

Fifth principal component: Gold, molybdenum show positive while arsenic, antimony show negative values.

The above are the components with high absolute eigenvectors. The first principal components are metallic elements and they express the variation caused by epithermal mineralization. These are the elements with high content in the mineral showings in all three zones.

The proportion is somewhat low but the eigenvalues are high. The second principal component is mostly non-metallic with high scores in areas excepting alteration zones. Thus these are considered to express variations caused by igneous activity and other factors. The third principal component is believed to show the variation of the silicified and argillized zones. The fourth and fifth principal components are believed to indicate a part of the mineralization because they contain metals although the proportion and the eigenvalues are low. By showing the localities with the first principal component exceeding 1 on maps (Figures 3-20～3-22) they cover the known vein deposits in Zone A, most of the localities where gold was detected in Zone B and the mineralization associated with Dikmen Granite in Zone C.

Table 3-12 List of Eigenvector and Eigenvalue of Chip Samples

	Z(1)	Z(2)	Z(3)	Z(4)	Z(5)	Z(6)	Z(7)	Z(8)	(9)	Z(10)	Z(11)	Z(12)	Z(13)	Z(14)	Z(15)
Au	0.25032	-0.02751	0.20497	0.31505	0.45664	-0.41813	-0.10454	0.49798	0.09618	-0.09080	-0.26246	0.18142	0.15586	0.07950	0.05606
Cu	0.32384	0.05079	-0.13785	-0.00424	0.19188	0.46277	-0.25767	0.23288	0.11137	-0.27517	0.38605	-0.14443	0.25128	-0.15362	-0.39644
Mo	0.20431	-0.03241	0.16153	-0.45805	0.66593	-0.03413	0.09417	-0.45779	0.17580	0.06925	0.03988	-0.08705	-0.06829	-0.00397	0.09391
Pb	0.32620	0.02709	0.00741	0.32400	-0.16296	-0.03098	0.36954	-0.18954	0.29535	0.35335	-0.19621	-0.34658	0.34631	-0.29685	-0.09524
Zn	0.30455	-0.06219	-0.45358	0.02934	0.01024	0.32323	0.12579	0.06553	0.05607	0.07877	0.00067	0.15342	0.16621	0.39840	0.59401
Ag	0.32123	-0.14268	0.02345	0.36583	-0.07809	-0.17741	-0.25113	-0.17411	-0.02706	-0.19837	0.20933	-0.48102	-0.49131	0.12328	0.19812
Cd	0.28771	-0.14159	-0.37068	0.24492	0.13056	0.02701	0.00837	-0.28821	0.31040	0.08686	-0.18626	0.47380	-0.28565	-0.17466	-0.35172
As	0.32479	-0.07587	0.16952	-0.28858	-0.26753	0.07161	0.09706	0.32842	0.36192	0.07380	0.04992	0.26942	-0.45057	-0.38279	0.14732
Se	0.13955	0.34259	0.40300	0.06833	-0.09686	0.42826	-0.46173	-0.16903	0.02327	0.13186	-0.45994	0.06448	-0.04551	0.15885	0.02410
Hg	0.28720	-0.24230	0.00131	-0.36092	-0.19738	-0.19025	-0.30741	-0.02224	-0.48164	-0.06990	-0.16087	-0.10843	0.35499	-0.32799	0.22427
Sb	0.32200	-0.26157	0.14841	-0.28604	-0.25960	-0.11906	0.15612	0.06813	-0.02289	0.06981	-0.04374	-0.03512	0.01995	0.62611	-0.45974
Bi	0.19598	0.15461	0.52210	0.21235	-0.06782	0.07639	0.35928	-0.15770	-0.34792	-0.17742	0.41302	0.30034	0.15116	0.00207	0.13946
F	0.13081	0.50653	-0.10117	-0.12370	0.14755	-0.03407	0.11370	0.33725	-0.44603	0.47169	0.10842	-0.26385	-0.21777	0.01056	-0.02903
Ba	0.13851	0.43874	-0.18750	-0.06378	-0.19952	-0.46617	-0.34604	-0.22955	0.27534	0.12790	0.33330	0.28258	0.17251	0.07746	-0.02593
Tl	0.14062	0.47685	-0.19492	-0.16008	-0.08966	-0.09480	0.30829	-0.04169	0.01277	-0.65601	-0.35808	-0.09855	-0.07632	-0.00686	-0.03305
Eigenvalue	4.95859	2.07652	1.48295	0.99824	0.88987	0.75818	0.64279	0.55328	0.52114	0.48059	0.45832	0.41682	0.32087	0.23162	0.21022
Proportion	0.33057	0.13843	0.09886	0.06655	0.05932	0.05055	0.04285	0.03689	0.03474	0.03204	0.03055	0.02779	0.02139	0.01544	0.01401
Accum.Prop.	0.33057	0.46901	0.56787	0.63442	0.69375	0.74429	0.78714	0.82403	0.85877	0.89081	0.92136	0.94915	0.97054	0.98599	1.00000

6-3 Geochemical Prospecting by Heavy Minerals

6-3-1 Objective of Heavy Mineral Prospecting

Heavy mineral prospecting was carried out with the objective of searching for gold deposits. There are Madendağı and Kartaldağı mines in the survey

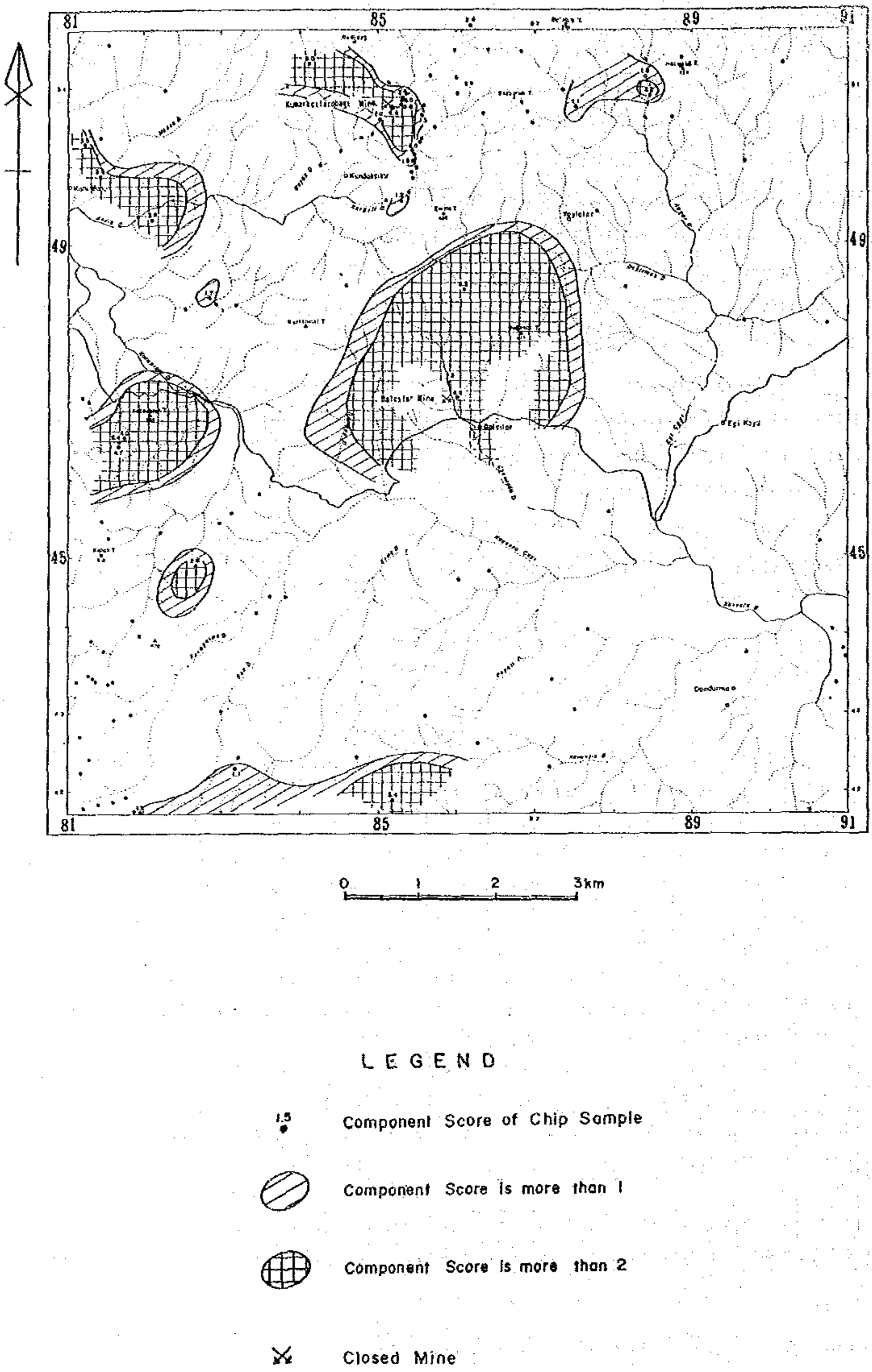
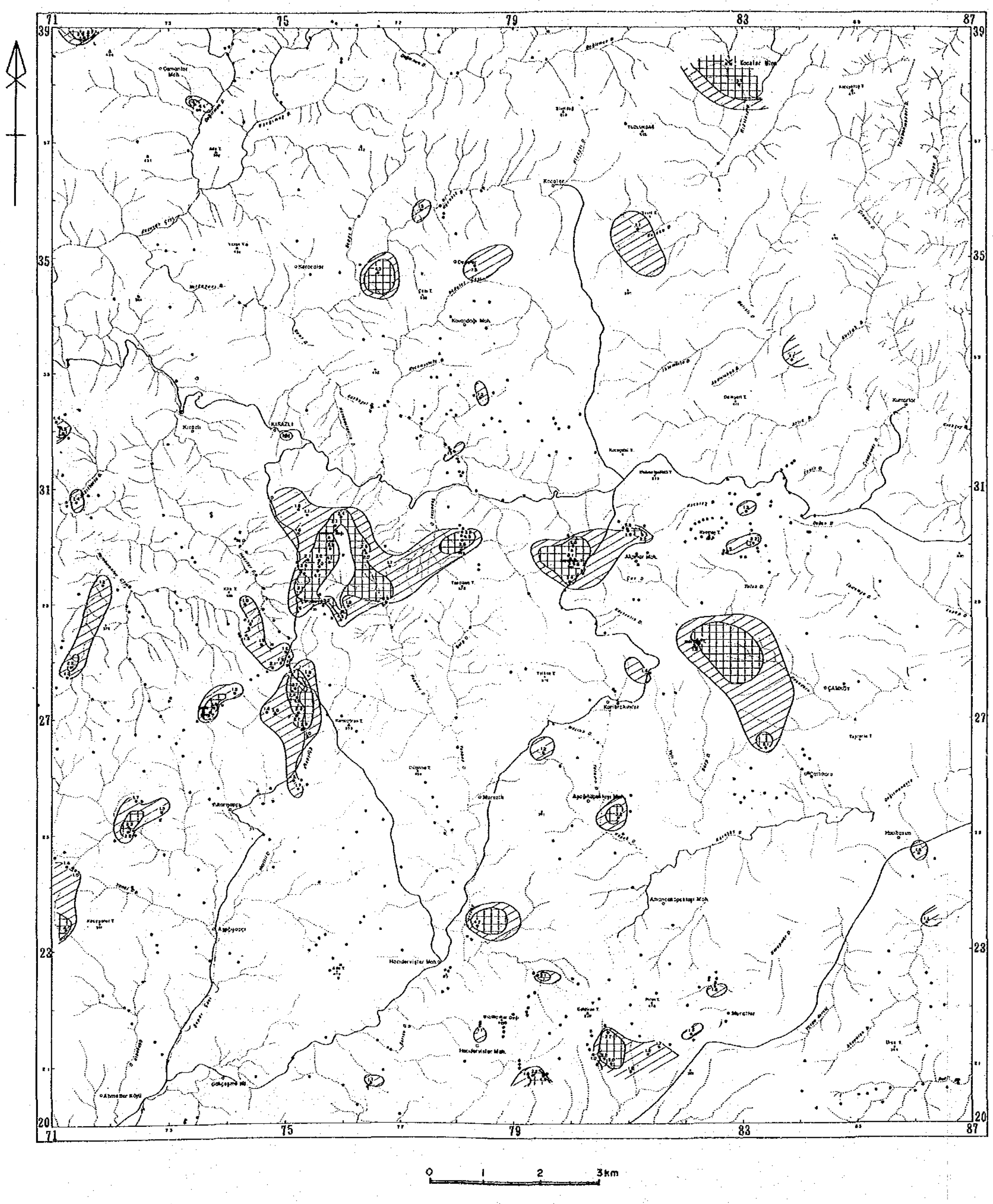


Fig. 3-20 Component Score Map of Chip Samples in the Zone A



LEGEND

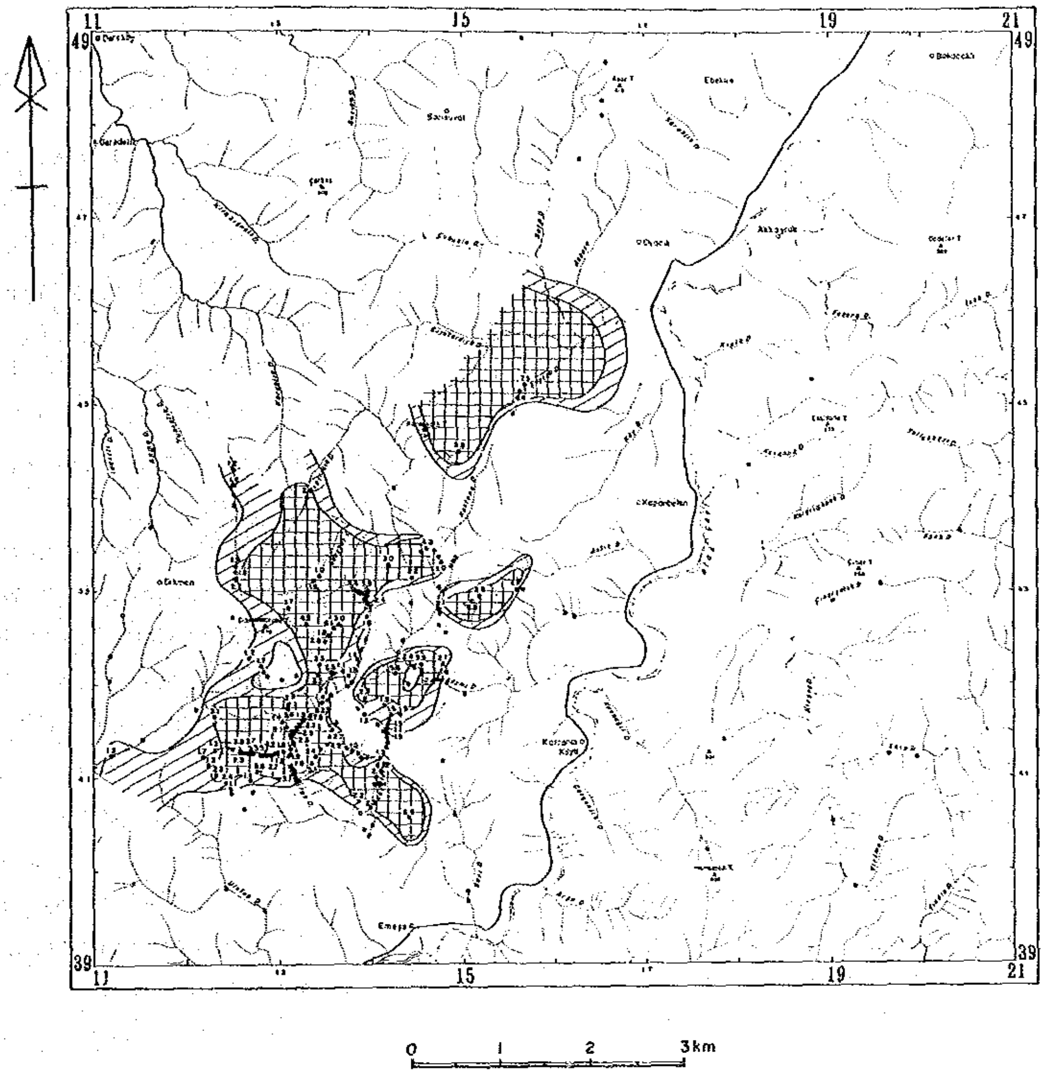
Component Score of Chip Sample

Component Score is more than 1

Component Score is more than 2

Closed Mine

Fig. 3-21 Component Score Map of Chip Samples in the Zone B



LEGEND

1.5 Component Score of Chip Sample

Component Score is more than 1

Component Score is more than 2

Fig. 3-22 Component Score Map of Chip Samples in the Zone C area, and the work stated with clarifying the nature of gold grains scattered in the stream sediments and soil near these mines.

As the investigation progressed,silicified and argillized zones were found, and the collected heavy mineral samples increased in A and B Zones. In B Zone, many silicified bodies were found and exceeded the expectation from the Landsat image studies. Most of the sampling points of these heavy minerals were several kilograms downstream of the silicified bodies.

6-3-2 Sampling and Processing

Three to eight kirograms(average 5kg, dry weight) of heavy minerals smaller than 2mm were sampled. In the survey area many streams are dry. Thus water was carried to the sampling points, and the minerals were sized to -2mm. These samples were first classified into "dry stream sediments", "flowing stream sediments" and "sediments due to flooding of streams". Then the samples were further grouped into "well sorted sediments with large proportion of -2mm grains", "ill-sorted sediments with large amount of over 2mm grains", and "sediments from streams where soil and sands have flowed in". These samples were washed at the flowing streams or Çeşme, and carefully sized to under 1mm. Samples 100～500kg (average 200g dry) were carried to the camp, and panned. The extraction of heavy minerals by panning was done carefully by using stereomicroscope as the grains were small. The final result was several grams of heavy minerals, the gold grains were counted, and those with size of several tens of microns were measured.

Table 3-13 Contents in Heavy Minerals Sampled

	Classification	Test No	Percentage(%)
Zone	Zone A	14	11(%)
	Zone B	87	66
	north part of Zone A	4	3
	vicinity part of Zone B	26	20
Sediments	stream sand	105	80
	soil	26	20
Classfication by stream condition	dry stream sediments	97	74
	flowing stream sediments	20	15
	sediments due to flooding of stream	14	11
Classfication by sample condition	well sorted sediments	50	38
	ill-sorted sediments	66	50
	sediment from streams where soil and sand flowed in	15	12

The major part of heavy mineral sampling was done in Zone B where strongly silicified alteration zones are distributed from Madendagı and Kartaldagı mines, but some samples were collected in Zone A as well. The sampled points are shown in Plate 16, and the results of the study of the 131 samples collected are shown in Appendx Table 6

6-3-3 Heavy Mineral Studies

The following items were studied, measured and recorded for each sample.

(1) The nature of the pebbles at the sampling points.

(2) The geology (formation name) of the sampling point and catchment area upstream.

(3) The mineral composition of the sample.

(4) The size and amount of gold grains if any gold was observed.

(5) The form of gold grains in order to estimate the distance of transportation.

6-3-4 Study Results

The results of the above study are laid out in Appendx Table 6, and summarized in Table 3-14.

Table 3-14 Contents of Gold Grains Observed

	counts of gold grain	samples	remarks
Gold grains observed	1~3	32	
	4~19	37	
	20~		Madendagı mine area 2 Kartaldagı mine area 4 Zone A(Pb-Zn veins) 1 inside of Zone B 8 around Zone B 4
Gold grains not observed		43	

6-3-5 Results of the Heavy Mineral Prospecting

Heavy mineral samples which indicate the possible existence of gold deposits in the upstream areas were selected from the 131 samples, and are listed locality-wise in Table 1-10. Also the number of gold grains and the stream in Figure 3-23. The promising areas are as follows.

(1) Karaibrahimler: Sample TA069D collected downstream of the Karaibrahimler Village contained many gold grains, and thus samples (TA113D, TA114D, TA115D) were collected upstream where three streams join. These all containd gold grains, and the soil (TA116T) of the silicified and argillized zone also contained gold grains. Adjacent to the point, Şapçı Volcanics have undergone silicification and argillization. Although there are gold grains exceeding 300μm in size, most of them are smaller than 50μm. The shape is euhedral to subhedral, and it is inferred that these grains have been transported for 1~2km. Silicified zone is confirmed here, and it is probably is the source of the gold grains. Gold grains are also found in the Sarp Stream which lies to the west of the silicified body. This is accompanied by a large amount of barite, and it characterizes this occurence.

(2) Kestane Dağı: Gold grains were found at two localities (TA075D,TA076D) in the stream west of the Kestane Dağı. TA075D contained grains larger more than 300μm. Gold grains were also found in three points of the stream to the north of Kestane Dağı. These are more rounded than the gold grains of (1), and they were probably transported for 2~3km. Kestane Dağı could be the source of these gold, the Kestane Dağı is strongly silicified and thus forms this protruding topography. Şapçı Volcanics are also distributed in the vicinity and are altered. Galena is included in the heavy minerals fraction.

(3) Kocataş Tepe: A large number of gold grains were extracted from the sample (TA0083D) collected from İncirlik Stream. There is a silicified rock of the Kocataş Tepe upstream which could be the source of this gold. Epidote is abundant in the heavy fraction, and barite rare.

(4) Arlık Dere: Gold grains were found in the sample (TA037D) collected at Arlık Dere. There is a large silicified zone in the upstream section of this Stream. The silicified zone of (1)~(3) formed protruded topography, but this zone occur in the pine forest, and thus could not be identified by Landsat analysis.

(5) Koracaören Tepe: Gold grains were found in the samples collected at Gökyakan Stream (TA039D) and Egri Stream (TA095D). These are near the southern ridge of Koracaören Tepe. TD039D contains abundant barite, and the distance of transportation is estimated to be in the order of 2km, but the geological investigation shows the general area to consist of Şapçı Volcanics, and silicified zone which could be the source of the gold is not yet found.

(6) Other localities : Gold grains have been found from five localities in the argillized Çamyayla Volcanics. They are, Kirazlıçamtepe TA009D, Armutçuk TA013D, Karacalar TA066D, Çeşmetepe TA049D, and Çaltıkara TA066D. The grains from samples other than TA049D are fine-grained - less than 50μm -, and somewhat rounded. They probably were transported from silicified bodies at distance of 1~2km. The above names are localities of the silicified bodies except Armutçuk which is the sampling point. A silicified body has been found by geological survey to the north of Armutçuk, and this is considered to be the source of gold.

(7) Madendağı mine to Kartaldağı mine zone: The survey of this zone was conducted with the purpose of clarifying the mode of occurence of gold grains. Large amount of gold grains dispersed from the two mines were found. Gold

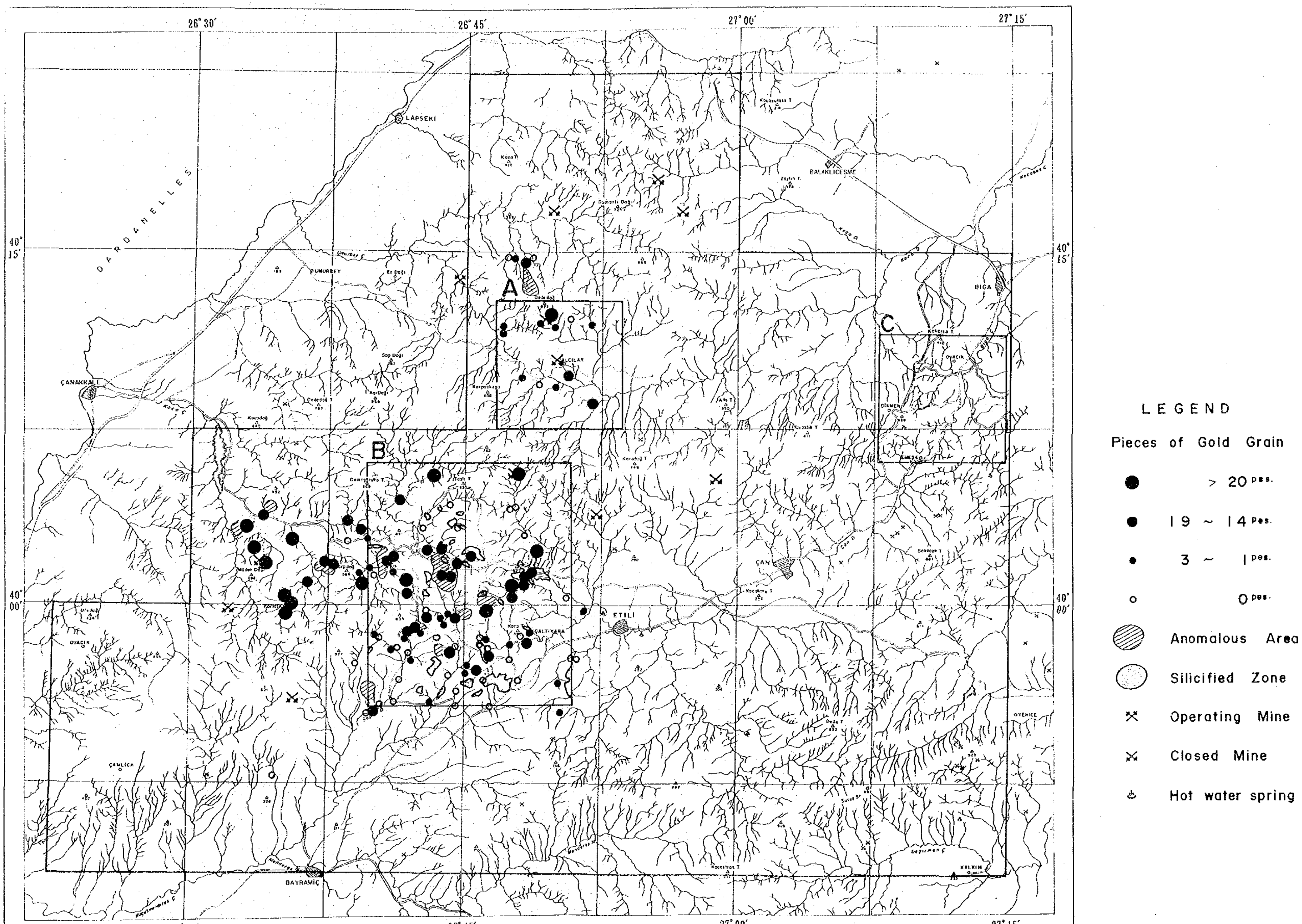


Fig. 3-23 Showing Map of Gold Grain Occurrence

were found in six localities at some distances from the mines, and these are inferred to be strongly silicified parts in Şapçı Volcanics area.

(8) Dededag: This is located at the northern end of the Zone A, and the elevation is 622m. The geology consists of Dededağ Volcanics (dacite, dacitic pyroclastics). Gold grains are found from the downstream section on the northern side. This locality is outside of the survey area, and the details of alteration are not clear.

6-4 Geochemical Anomalies and Mineralization

6-4-1 Stream Sediments and Mineralization

The stream sediment samples previously collected by MTA were analyzed for additional eight elements, namely gold, silver, fluorine, mercury, thallium, selenium, arsen and antimony with the purpose of searching for gold deposit as mentioned previously in the report.

The samples collected mainly from Zones A, B and C, and with some additions from other parts, a total of 304 samples were analyzed. Gold content of over 20 ppb was detected from 14 samples ; three samples from Zone A, three from Zone B, one from Zone C and seven from outside area of semi-detailed survey area. The details are as follows (Table 1-6).

Zone A : Samples which contained gold are JT153, 155 and 158. JT158 was collected in the Balcılar Volcanics, down stream of the Balcılar Veins. JT153 came from Çamyayla Volcanics in a locality considered to be a part of the halo zone of Kundakçılarobası mine area. Both are from the vicinity of confirmed ore veins. JT155 was collected from an area where gold showings have not been confined, however, since the sample contained gold, although in minor amount, it is inferred that vein type mineralization did occur in the vicinity.

Zone B : Gold was confirmed from two samples (JT003, JT004) collected from a stream to the west of Kestane Dagı. Also gold was found in southeastern part of Karaibrahimler. Both locations are in the Şapçı Volcanics, and gold occurs in stream sediments as well as in rock samples. It is thus inferred that gold mineralization occured in this area.

Zone C : Although in minor amount, gold was found in the southeastern part of Ovacık. Mineral showings have not been located in the area, but the Dikmen Fault transects the area, and this may have affected the gold content.

It was clarified from above that, gold-silver were detected from the vicinity of lead-zinc vein deposits in Zone A. The gold mineralization in Zone B is associated with arsenic, mercury, antimony and barium. Together with the results of X-ray diffraction, it is seen that the mineralization is acidic-sulfate-type epithermal activity.

In Zone C, the Dikmen Zone(copper, lead, molybdenum)which had been already delineated by MTA as anomalous zone was the only mineralization found.

6-4-2 Rocks and Mineralization

Chip composition and mineralization: One thousand samples were collected from the semi-detailed survey area and ten samples from the MTA prospects outside of the above. The analyzed elements are, gold, silver, fluorite, mercury, thallium, selenium, antimony, arsenic, copper, lead, zinc, molybdenum, cadmium, bismuth and barium. The samples were collected from the alteration zones -silicification, argillization- in Zones A and B, Dikmen Granite and the mineralized zone near this intrusive body were sampled in Zone C. The localities with samples exceeding 50 ppb gold and 100 ppm molybdenum are as follows (Tables 1-7～1-9, Plates 3, 7 and 10).

Zone A: From this zone, 135 rock samples were analyzed. Of these, 15 samples contained gold in excess of 50 ppb, these are gold associated with vein-type mineral of Kundakçılarobası and Balcılar veins as seen in the Table 1-7.

Zone B: From this zone 664 chip samples were analyzed. It is noted that almost all of these samples contained small amounts of copper, lead, zinc while the content of arsenic, mercury, antimony, bismuth, barium were relatively higher together with gold (Table1-8). The localities of the samples are Karaibrahimler, Arlık River, Mt. Piren and the Mt. Kestane. There are samples from other localities which contained significant metals, but these occur isolated and the minerals have not been confirmed by heavy mineral investigation, thus they are considered to be of smaller scale mineralization.

Zone C: From this zone, 200 chip samples were analyzed. Most of the samples were collected from the Dikmen Granite and the alteration zones in the vicinity. There is porphyry molybdenum-copper mineralization in the quartz veinlets in and near the Dikmen Granite. Elements of lower temperature mineralization such as gold, mercury, antimony and barium were detected, and it is inferred that two different types of mineralization occurred in the same locality at different times.

Other zones: Ten samples from the MTA prospect south of Zone B were analyzed, but noteworthy results were not obtained.

6-4-3 Heavy Minerals and Mineralization

Heavy mineral investigation conducted as a part of gold prospecting. Samples were collected from the silicified and argillized zones which extend in both A and B Zones from the vicinity of Madendağı and Kartaldağı mines. The sampling points were mostly down stream of the silicified zones. The total number of heavy mineral samples collected amount to 131, and they are listed in Appendix Table 6. The samples which appear to indicate promising areas for gold concentration in the upstream areas are listed locality-wise in Table 1-10.

The major notable areas are as follws.

Zone B: Karaibrahimler: Gold grains were found in sample TA069D from the down stream area of Karaibrahimler Village, samples TA113D, TA114D, TA115D from the upstream section of the Village where three streams join, and the soil sample (TA-116T) from the alteration zone in the vicinity. This is a silicified and argillized zone of the Şapçı Volcanics. The large gold grains are more than 300μm, but most of them are smaller than 50μm, and the shape of the electrum is somewhat rounded. It is estimated that they are transported for distances of 1~ 2km. Gold grains are also found in the Sarp Stream to the west of this silicified body. In all of these cases, considerable amount of barite is associated in the heavy mineral samples.

Kestane Dağı: Gold grains were discovered from two localities (TA075D, TA076D) in the stream west of the Kestane Dağı, and also these localities in streams to the north of the mountain. These were ten grains exceeding 300μm in TA075D. These grains probably were transported for a distance of 2~ 3km. Şapçı Volcanics also distributed here, and suffered sillicification and argillization. Galena is a common heavy mineral.

Kocataş Tepe: A number of gold grains were found in a sample (TA083D) collected at İncirlık Stream. In the upstream section on this stream, there is the Kocataş Tepe silicified rock. These gold grains are assumed to be from this silicified body. There is not much barite, but epidote is abundant in the heavy minerals.

Arlık Stream : Gold grains were found in a sample (TA037D) from Arlık Stream. There is a silicified zone of considerable size in the upstream part of this stream.

Koracaören Tepe: Gold grains were discovered at two localities Koracaören Stream (TA039D) and Egri Stream (TA095D) in the vicinity of the southern ridge of the Koracaören Tepe. TA039D is accompanied by a large amount of barite, and the shape of the gold grains indicate the distance to the exposure at about 2km. This is an area of Çamyayla Volcanics, and silicified zone have not been found.

Area outside of Zones A, B and C

(1) Madendağı～ Kartaldağı mine area : Heavy minerals were sampled in this area in order to clalify the mode of occurence of gold grains. Large amount of gold grains have been found, and they are believed to have dispersed from the two mines. Gold grains were also discovered from six localities at some distance from these mines. Although the area has not been investigated geologically, it is considered that the sources of these gold are silicified zone of the Şapçı Volcanics.

(2) Dededağ: The geology of this area, Dededağ (elevation 622m) of Zone A to the north, contsists of Dededag Volcanics (dacite, dacitic pyrocrastics). Gold grains were found in the sample from the down stream section to the north of Dededağ. This is also outside of the semi-detailed survey area, and the geology is not clear.

6-5 Evaluation of Geochemical Prospecting Methods

The significant results of stream sediment, the rock analyses and the heavy mineral studies are laid out in Tables 1-6～1-10. It is seen from these tables that the stream sediment analyses are effective for copper, lead, zinc deposit (for example vein type), but for epithermal gold prospecting, the grade is lowered by silicification and the dispersion from the outcrop is difficult to clarify. Whereas with chip samples, the halos of the gold and associated elements are easier to understand, and is more effective than using stream sediments. But at the same time, in the brecciated zones where gold appear to be concentrated, the limonite, hematite and clay are difficult to use, thus the rock analysis is not effective in these cases. The reason being the strong oxidation of the rocks. Heavy mineral analysis is effective in these cases, and the combination of rock and heavy mineral investigation is a very effective method for gold prospecting. The relationship of these methods together with X-ray diffraction results are shown in Table 1-11.

CHAPTER 7 DISCUSSION

7-1 Geologic Structure

Zone A: The geology of this zone is composed of Eocene Çamyayla Volcanics and Miocene Balcılar Volcanics, and it was not possible to clarify the geologic structure of this zone. There are copper, lead, zinc vein mineralization in the rocks. The mineralization is epithermal veins accompanied by barite with high content of gold and silver. Acid alteration such as those in the silicified and argillized zone in Zone B are not observed here. The alteration consists of weak argillization resulting in sericite, chlorite and epidote with minor amount of kaoline. The kaolinization in this zone is weak but occurs widely.

Zone B: The basement rocks of this zone are Taşdibek Formation and Akpınar Granite. This basement is uplifted in the central part of this zone. The alteration of the Şapçı Volcanics which occur surrounding the basement complex is very strong. The volcanic rocks on the outer part is also altered, but gold mineralization is limited to the proximity of the raised basement rocks. The alteration in the proximity of the basement is acidic and associated with cristobalite, kaoline, alunite and pyrophyllite. Rock analysis yielded copper, lead, zinc, silver, mercury, arsenic, cadmium, antimony together with gold, and these elements are believed to be associated with the same mineralization. The Quaternary Kocaçakıl Basalt effused through the NNE-SSW trending fault in the uplifted basement, and the lava covers a limited area. This is another evidence that the vicinity of the basement is a zone of conduit for hydrothermal solutions which resulted in gold mineralization.

Zone C: Triassic Emeşe Formation is predominant in the southern part of this zone. There are NE-SW trending lineations parallel to the Dikmen Fault. Serpentinite intruded along these faults, and Dikmen Granite intruded in the same direction from Late Cretaceous to Eocene. A part of the limestone and meta-volcanics of the Emeşe Formation was skarnized by this granite, alteration occured and quartz veinlets accompanied by molybdenite and other sulfide minerals occur along the fissures formed by the granite intrusion.

Intermediate volcanism became active in Tertiary, and a large amount of lava and pyroclastics deposited from Eocene to Miocene. Silicification and argillization became intense in Çanakkale from late Tertiary to Quaternary, and mineralization associated with these alteration are observed. The NE-SW lineations probably still existed during this time and high gold content is observed along this direction within a limited zone of 4km long and 2 km wide.

7-2 Mineralization

The epithermal gold mineralization in the survey area is the high sulfur system (alunite-arsenopyrite type) chemically, and also the hot spring type from the mode of the activity. It is associated with the volcanic activity of intermediate ~ acidic magma, and the minerals were precipitated from the hydrothermal solution in the fissures of rocks.

In Zone B, gold mineralization occurs in the silicified and argillized parts. Generally the gold content is high where the argillized parts surrounds the silicified bodies which are brecciated and filled by oxidized limonite, hematite and clay minerals. Quartz veins are not observed in these altered parts.

The gold exists in the altered bodies as very fine electrum grains. Silver is generally low, constantly at about 0.1g/t regardless of the gold mineralization. The lead and zinc assume anomalous values when the silver content is high, and thus it is inferred that silver exists as pyrargyrite which often occurs in mesothermal deposits. It is also characteristic of the mineralization of this area that barite generally exist near the surface. Arsenic, antimony, mercury and tungsten are the minor elements concentrated by epithermal activity, and stibnite and wolframite characterize the mineralization of Zone C.

7-3 Mineralization in the Deeper Zone

At the Round Mountain deposit, whose mineralization is very similar to that of the surey area, auriferous quartz vein network is developed below the silicified bodies, and brecciated zone -quartz veins- sulfide veins are developed further down. Thus the hot spring type gold deposits near the surface, and the deeper auriferous quartz veins are believed to be connected and continuous. On the other hand, the Nansatsu type gold deposits and the those of the silicified bodies of Izu do not seen to extend further downward. The auriferous quartz veins of this area probably do not exist below the silicified and argillized bodies -similar to Nansatsu type-. From regional perspective, there are vein deposits in Zone A adjacent to the Zone B, and probably they are related as a hydrothermal system.

7-4 Gold and Silicified Zone

The shape of the silicified bodies of Zone B is characterized by relatively small lower part with larger upper part - mushroom-shaped vertical section. This is similar to the Iwato Deposit(Urashima 1981) of the Nansatsu type.

The horizontal dimensions of each silicified body are in the order of 100m wide and over 200m long. This is surrounded by silicified and argillized zones. A very large example in Zone B is located 5 km east of Kirazlı Village, here the altered area is 2km × 3 km. In general, however, the altered bodies are in the order of 1 km^2. There is a kaolinized zone around it. In these cases, it is difficult to identify the original rock, but it probably was andesitic pyroclastic rock.

In this area, the silicified body (mineralization) extends horizontally at the pyroclastic horizon, and is pillar-shaped in the lower andesite zone with the overall mushroom-shape. This is similar to the Iwato deposit. This indicates that the hydrothermal fluid rose through the andesite and flowed horizontally in the permeable pyroclastic layer.

7-5 Alteration

The study of epithermal fluid shows that it is mostly of groundwater origin which reacted with the surrounding rocks. The fluid is inferred to be chemically near neutral in most cases, judging from the host rock alteration and the composition of the gangue minerals. The steam separated from the fluid is hydrogen sulfide rich, and is oxidized near the surface, and this sulfide acidic fluid reacts with the host rocks forming the alteration zone containing alunite and kaoline.

The argillized bodies of this area have regular zonal structure from the centre of the silicified body (breccia zone) outward. And the centre of the gold-bearing hydrothermal activity is believed to be the later stage epithermal alteration because alunite, pyrophyllite and crystobalite are abundant.

The following is the characteristics of alteration of the three zones.

Zone A: Major alteration mineral is sericite with some kaoline. The rocks which appear fresh by the unaided eyes have been altered microscopically, and have suffered kaolinization regionally.

Zone B: Sericite is not observed in the silicified and argillized zones. By X-ray diffraction, almost all samples contain kaoline and alunite, pyrophyllite, and cristobalite are developed near gold mineralization.

Zone C Selicitization is intense in Dikmen Granite near the porphyry molybdenite mineralization. Kaoline is detected where gold mineralization is found.

PART IV CONCLUSIONS AND RECOMMENDATIONS

PART IV CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 1 CONCLUSIONS

The survey was conducted with the purpose of clarifying the metal deposits and of assessing the metallic resources potential of the Çanakkale Area. Prior to the field survey, data related to geoscientific work conducted previously were studied and Landsat image analysis of an area of 3,400km² was carried out. As a result of these studies, three promising Zones A, B and C were delineated for field work of the first phase. Geological survey and geochemical prospecting were conducted in these zones.

Geological survey was carried out over a total area of 500km² consisting of Zones A 100km², B 300km² and C 100km². The mineralized zones and alteration zones were located, and the dimensions and the nature of mineralization were clarified. Regarding geochemical prospecting, data from both previous MTA work and the present survey were analyzed. The results revealed the scale, grade of the mineralization and the promising anomalies. Four localities in Zone B and one in Zone C were extracted as promising. The geologic environment and the extent of the geochemical anomalies indicate that these localities have high resources potential and warrant further detailed survey.

These localities are listed below.

(1) Arlık Dere	epithermal gold mineralization
(2) Karaibrahimler	epithermal gold mineralization
(3) Kestane Dağı	epithermal gold mineralization
(4) Piren Tepe	epithermal gold mineralization
(5) Dikmen	porphyry molybdenum, copper mineralization and epithermal gold mineralization

The above four localities (1)～(4) are located in the Şapçı Volcanics, and gold anomalies have been delineated in the alteration zones during the present survey. They are:

(1) Arlık Dere: Significant amount of gold grains was found from the heavy mineral samples collected from Arlık Dere. Also fairly large silicified and argillized zones were found in the upstream parts of this Arlık Dere and many rock samples from the silicified zone also contained gold.

(2) Karaibrahimler: Significant amount of gold was detected in all samples

collected the from down stream section of Karaibrahimler Village, a locality where the three streams join in the upstream part of the village and from the silicified, argillized alteration zones nearby. The Şapçı Volcanics have suffered hydrothermal alteration in the vicinity. The gold grains are in some cases as large as over 300μm, but most of them are smaller than 50μm. The shape is irregular, amoebic and they are presumed to have been transported from 1～2km upstream. Gold grains were also found in Şarp Stream to the west of the silicified body. At two localities here, the ore is accompanied by barite.

(3) Kestane Dağı: Gold grains were found from five localities, two from the western stream and three from west of Kestane Dağı. Large grains exceeding 300μm were found. These gold grains are inferred, from the shape, to have been transported from 2～3km upstream. Here also the Şapçı Volcanics have suffered silicification and argillization. Galena is the associated heavy mineral.

(4) Piren Tepe: Gold anomalies were detected in the silicified zone which is located to the south of the large alteration zone. The zone extends in E-W direction in the vicinity of the Piren Tepe.

(5) In Zone C, a porphyry molybdenum-copper deposit associated with the intrusion of the Dikmen Granite was discoverd. The mineralization extends from the eastern side of the Dikmen Granite which extends in NW-SE direction to the Emeşe Formation in the Sığırirek Stream. The Emeşe Formation is altered and minor amounts of sulfides such as molybdenite, chalcopyrite, wolframite, sphalerite and pyrite occur in the quartz veinlets. The analytical results show the existence of gold, arsenic, mercury and antimony. This shows that epithermal mineralization occurred after the porphyry molybdenum mineralization and they now overlap spatially .

The results of the present work summarized above in (1)～(4), indicate the possibility of large scale low grade gold deposits in the alteration zone near the basement rocks. The porphyry molybdenum deposit mentioned in (5) also is expected to be a large scale low grade deposit as this type of mineralization is extensive in the lower parts. This contains gold and antimony locally, and it may turn out to be a very important target if significant gold is found in the overlapping portion.

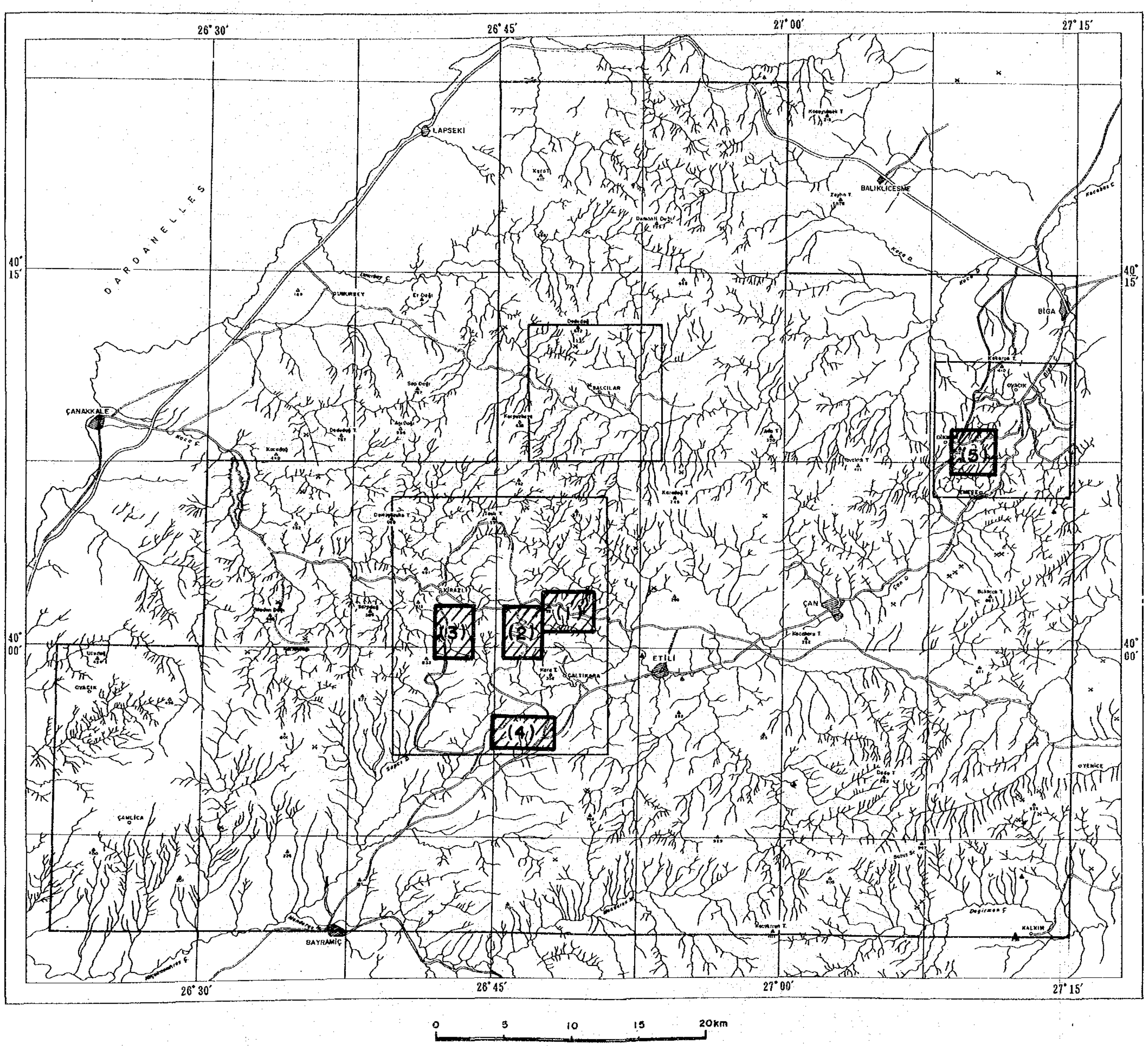


Fig. 4-1 Location Map of the Promising Area