Part 4 DISCUSSIONS AND CONCLUSIONS

PART IV DISCUSSIONS AND CONCLUSIONS

Chapter 1 Discussions

1-1 Geologic Structure and Mineralized Zones

The major mineralization of the surveyed area are skarn,veins and dissemination. The skarn type mineralization occurs in massive limestone intercalated in andesite and andesitic pyroclastics of the Zigana Formation and in the andesite and limestone of the hanging wall side. Skarn such as minerals epidote,actinolite and garnet are abundant in this zone. In most case, mineralization consists mainly of specularite and magnetite, and the former is far more abundant. Sometimes small amount of chalcopyrite, sphalerite and galena are associated with the iron minerals. In the areas where these skarn type mineralization occur, young granodiorite bodies are widely distributed near the mineralized zones. The direction of intrusion of these bodies varies slightly, for example it is NE-SW in Zone A while it is N-S in Karadağ area. The vein type mineralization occurs along the E-W fissures which is the general structural lineation of the surveyed area and NE-SW,NW-SE which derived from the E-W system. For example, the veins which were formed along the E-W fissures are Midi mine (sphalerite presently being worked) in Kırıklı Formation and Köstere mine (closed) consisting of chalcopyrite, galena, sphalerite in the Zigana Formation. Those in the NE-SW, NW-SE systems which derived from the E-W fissures are barite veins in the Gümüşhane Granite and Mastra argentiferous galena mine (closed last year) in Venk Yayla Formation. The vein type mineralization occur in all formations except the Kurtoğlu Metamorphic complex. The characteristics of the veins varies somewhat by the host rocks, but they are generally, thin, do not extend very much in the strike direction and deteriorate rather quickly downward. They are mostly high grade but small in scale.

Dissemination is associated with the intrusion of young granodiorite. Dissemination occurs near large intrusive bodies (batholiths)and stocks derived from batholiths. The mineralization of Beşkise, Hasandere and other zones extends from the stocks the host rocks. At Degırmen Dere and Diker Alteration Zones of Torul Granodiorite, mineralization is observed in the large rock mass. These mineralized zones are arranged with ENE-WSW trend. Dissemination is also found at Sarıdere area where stocks have intruded into the Gümüşhane Granite. The characteristics of these dissemination type mineralization is that they are accompained by a large amount of pyrite in the host rocks and along the fissures, and strong alteration. The fissures do not have clear patterns and the mineralization occurs along minute cracks without any directional control. When the mineralization is mostly pyrite, alteration often consist of sericitization.

1-2 Mineralized Zones and Geochemical Anomalies

Fifty anomalous zone were obtained from the results of the geochemical prospecting of the first year and the existing data. These zones were examined on the basis of the results of the geological survey and five important geochemical amnomalous zone were selected (Rank A only).

Of these zones the anomalies of Hasandere, Karadag and Belen Tepe zones are as follows (Table 8).

	area(km^2)	Cu(ppm)	Mo(ppm)	Pb(ppm)	Zn(ppm)
Hasandere area	5.3	780	28	202	685
		(8)	(6)	(1)	(3)
Karadag area	10.8	340	8	2,100	1,060
		(13)	(1)	(14)	(6)
Belen Tepe area	6.5	620	19	9,000	2,270
		(7)	(4)	(3)	(6)

Upper:maximum value, ( ):number of anomalous value

The background geochemical values vary in accordance with the local geology. But in the case of stream sediments, the general ranges are Cu 50-100 ppm and Mo 2-5 ppm, and the anomalies which indicate mineralized zones are said to be Cu 250-500 ppm and Mo 15-20 ppm.

Thus, siginificant anomalies are detected from the stream sediments of the above three zones. In the Hasandere zone, W anomalies as well as those of Mo-Cu were detected and in the Karadağ zone, Cu-Pb-Zn anomalies were confirmed in two streams which were formed by the effect of mineralization near the old mine. At Belen Tepe, there are at least nine old adits near the summit and related mineralization is expected in the vicinity, Ag-Cu-Pb-Zn anomalies have been detected. In these cases, the mineralized zones in the upstream area have considerably affected the geochemical environment of the downstream areas. These anomalies were all detected in areas of Upper Cretaceous Zigana Formation.

The Midi mine area, Eski Gümüşhane area and others where anomalies were detected by geochemical prospecting the ore deposits are small,at the most several hundred thousand tons. The grades, however are high. At Euria Tepe, although mineralizationdoes occur, iron minerals are predominant with small amount of sulphide minerals. From these considerations Hasandere, Karadağ and Belen Tepe are the most notable anomalous zones within those of Rank A.

An example of recent discovery by gechemical prospecting is porphyry molybdenum deposit (prabable reserves 2.6 billion tons, Cu equivalent 1%) at Mocoa in Columbia.In this case, the anomalies of the stream sediments were, Cu:over 100 ppm with maximum of 430 ppm, Mo:over 5 ppm with maximum of 124 ppm (Silitone et al.1984). In the case of La Caridad (reserve 700 million tons,Cu 0.72%) of Mexico, the deposit was found in the area of the stream sediment anomalies of Cu over 500 ppm and Mo over 20 ppm (Coolbaugh,1979).

1-3 Porphyry Copper Deposit of Turkey

The surveyed area is located at the eastern parts of Pontids Fold Belt. This belt is a part of the zone where the African Plate is subducted under the Eurasian Plate. This zone extends from the Minor Caucasus of Iran and USSR through Pontids Fold Belt to Bulgaria. Porphry copper deposis have been discovered along this zone.

Both old granites which intruded during the Hercynian Orogency (Carboniferous according to age determination) and young granites which intruded during Alpine Orogeny occur in the surveyed area. The former is the Gümüşhane Granite and the latter is Torul, Kürtün, Kopuz and Hasandere Granodiorite. The period of intrusion of the later rocks is from Late Cretaceous to Early Tertiary.

The prophyry type deposits reported from Turkey are Dereköy, Sukurpasa, İkiz Tepe at Demirköy area near the Bulgarian border. These are located at the western part of the Pontids Fold Belt.

Dereköy is located 20 km northwest of Demirköy and drilling was carried out. The pontential of the deposit is 1 billion tons of reserve with low grade ores,Cu 0.33%. At Sukurpasa near the Bulgarian border, 20 holes were drilled and it is said that skarn type porphyry copper deposit has been confirmed, but the details are not known. It is also said that porphyry type dissemination has been discovered at İkiz Tepe near Demirköy, but the details have not been reported.

In eastern Pontids Fold Belt, mineral showings at Bakirçay, Ulutas, Maçka, Merzifon are reported to be of porphyry type. At Bakirçay, it is said that 19 holes were drilled. At Ulutas it is reported that 1.2 billion tons of ore with grade of Cu 0.2 %, Mo 0.012% was found by drilling.

The results of the past surveys show low Cu-Mo grades and workable deposits have not yet been found. This is believed to be due to the fact that the major exploration efforts for copper in Turkey have been directed to relatively high grade bedded (massive) deposits and that exploration for porphyry type deposits has just begun. Dissemination deposits are of low grade and thus they were not of interest while many high grade bedded-massive (Kuroko type)deposits have been discovered as the results of intensive exploration.

In recent years, however, Sar Cheshmeh(reserve 450 million tons, Cu 1.13% , Mo 0. 03 %) of Iran at the southeastern extension of the Pontids Fold Belt and Medet (reserve 200 million tons, Cu 0.4%) of Bulgaria at the northwestern extension have been discovered and are being worked. From these data, the possibility of finding workable dissemination deposits in the Ford Belt of Turkey has been reconsidered, work has started and now although sporadic, dissemination showings are being reported from various localities .

In the area of present investigation, stocks which intruded from Late Cretaceous to Eocene are important. The mineralization is strongly controled by the shape and the periphery of the intrusive bodies and the increase of grade is related to the development of faults and fractures.

Two types of dissemination deposits are excepted to occur in this area, one is Cu-Mo and the other without Mo. The former is expected in Hasandere are and the latter in Karadag area associated with skarn.

Chapter 2 Conclusions

2-1 Conclusions

The objective of the present investigation is to clarify the occurrence of ore deposits and the potetial of mineralization of the Gümüşhane area. Geological survey and geochemical prospecting were conducted over an area of 2,800km^2.

During the couse of the geological survey, more than 55 mineralized zones and alteration zones were confirmed;the scale, type and the relation of the mineralization and the geology were clarified. By geochemical prospecting, the data obtained by UNDP and the present work were processed, analysed and interpreted, and as a result 50 geochemical anomalous zone were extracted.

It was found that many of the anomalous zones warranted further detailed study after examining the scale of mineralization, grade of ore, geological environment andthe size and extent of the anomalies. It is concluded by considering the combined results of geological and geochemical surveys that of these mineralized zones, the following three zones are selected as having high possibilities for finding ore deposits by further work, say exploratory work for the second year.

(1) Hasandere area··············Mo,Cu (Large dissemination ~network deposits)
(2) Karadağ area··················Cu (Large dissemination ~network deposits)
(3) Belen Tape area ············Cu,Pb,Zn (Skarn deposits)

(1) Hasandere area

The mineralization occurs in the granite stock and the host rocks and the major constituents are molybdenite-chalcopyrite-pyrite. High geochemical anomalies were confirmed in stream sands and soils. The anomaly values attained 28 ppm Mo and 780 ppm Cu in stream sands. The anomalous values of soil samples are 5-9 fold higer than those of stream sediments. The extent of the Mo,Cu soil anomalies is 1.7km× 1.4km, but it is anticipated that they will extend northward and northwestward. It is inferred that potassic-phyllic-propylitic alteration zoning characteristic of porphyry copper exists with the pophyritic granite in the centre and there is a good possibility of mineralized zone developing in the lower parts.

(2) Karadag area

Skarnization occured around the boundary of massivse limestone intercalated in the andesite-basalt and the andesitic pyroclastics(A1) of the Zigana Formation. The minerlization is dissemination (Cu,Pb-Zn) associated with the intrusion of granodiorite stocks. The skarn minerals are garent and epidote. The amount of specularite, magnetite and pyrite are small compared to other skarn minerals such as Belen Tepe. At the old adits, chalcopyrite and sphalerite are observed, but most of them are oxidized and secondary oxidized copper minerals are the most common ore minerals. Such oxidezed copper zone could be traced in north-south direction along the limestone for more than 1 km. Also large amount of slag is found and fair size mining (selective high-grade mining) must have been done in the past. But the level of mining is limited, and the granodiorite stock associated with pyrite mineralization has small exposure on the surface and thus it is expected that the intrusive body will be larger below the limestone horizon. From these observations it is inferred that untouched dissemination deposit exist in the lower parts.

(3) Belen Tepe area

The mineralization of this area is a skarn type which is developed at the boundary of massive limestone intercalated in the andesite, andestic pyroclastics (A2) of Zigana Formation. The mineralized zone forms irregular lenses consisting of specularite, magnetite, chalcopyrite, sphalerite, galena and pyrite. Outcrops and old adits are found at nine localities at the surface which indicate that mineralization occured over a considerably large area. The skarn ore deposits consist of lensshaped bodies and thus in the past, often only the high grade parts near the surface were mined and abandoned when individual body was exhausted. Thus exploration is insufficientin this area. Young granodiorite is distributed near the eastern side of the mineralized zone, and this body is expected to extend downward below the massive limestone (ore-bearing zone). Thus the ore potential of the lower part probably is high.

2-2 Recommendations for the Second Year

It is recommended that the following work be conducted at the most promising areas mentioned above(Fig.41).

(1) Hasandere area:- Detailed geological survey for clarifying the pattern of alteration and the fracture system, and drilling for investigation of the lower horizons. It is expected that dissemination type mineralization will be found and that it will extend to the lower parts. This inferrence is baseed on the results of the geological survey and geochemical prospecting of the stream sediments and soil.

(2) Karadag area: Geological survey and geophysical prospecting. Conduct IP survey and clarify the low resistance zones and FE anomalies, subsequently conduct detailed survey by SIP method for the IP anomalies. SIP will provide a large mount of information. It is expected that the ore deposits in this area will be found in the gerneral contact zone of limestone, andesitic basalt and intrusive bodies. The above geophysical survey will enable us to locate the mineralized zone in the lower parts.

(3) Belen Tepe: The detailed gological survey will clarify the distribution of limestone and intrusive rocks and thus the ore-bearing horizon of various mineralized. In geophysical prospecting,the low resistivity zone anomalies will be studied in detail by SIP method. This will provide us with information on the ore deposits in the deeper parts.

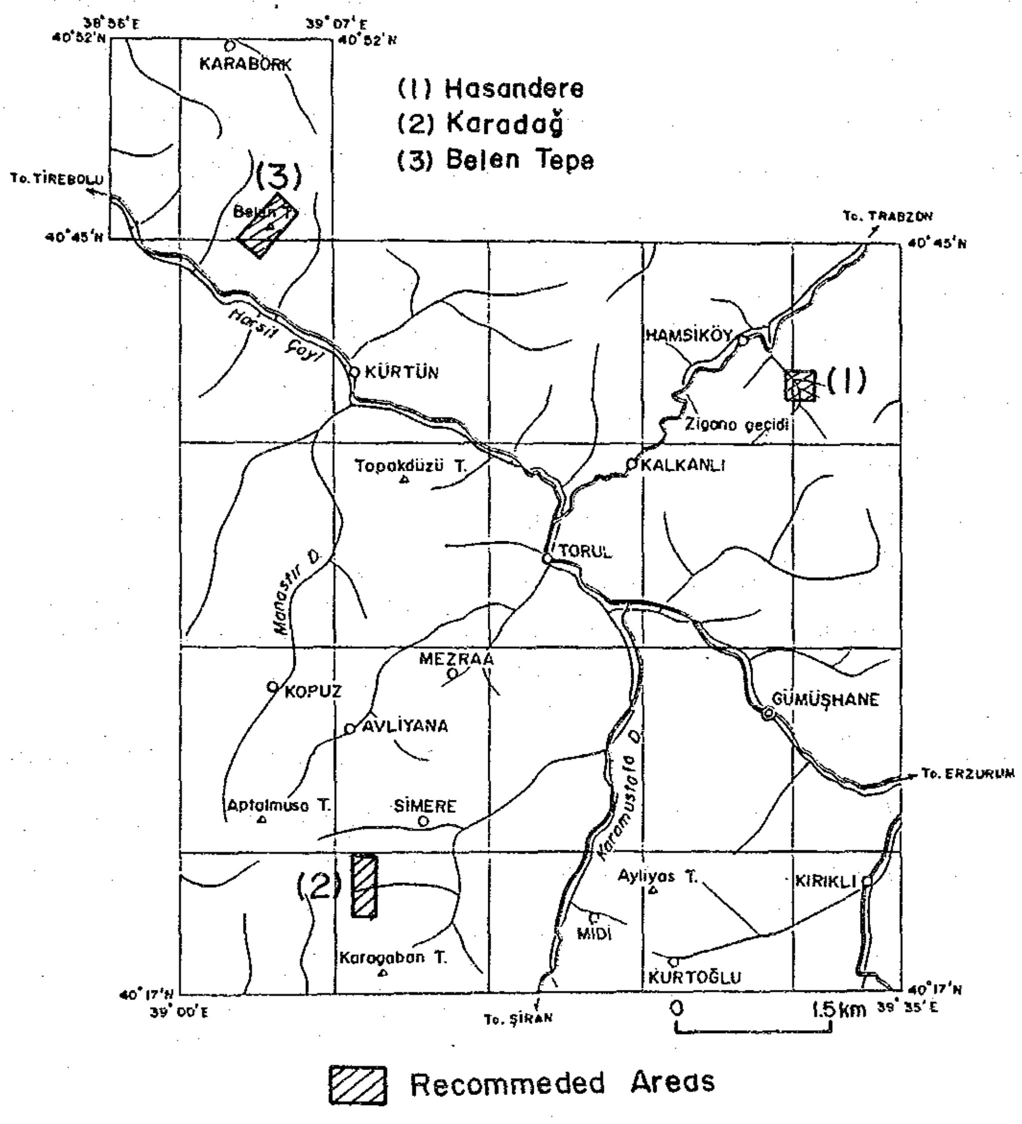

Fig.41 Recommendation Map

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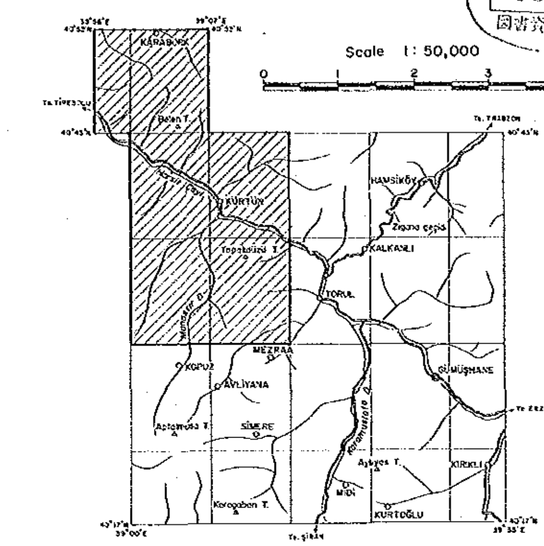
PL. I-1

REPORT ON THE MINERAL EXPLORATION
OF GÜMÜŞHANE AREA, THE REPUBLIC OF TURKEY

GEOLOGICAL MAP OF THE SURVEYED AREA



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JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

LEGEND

Quaternary		Qa	Alluvium
		Qt	Travertine
Tertiary	Gavurdağı Volcanics	Tga	Andesite lava and pyroclastics
	Venk yayla F.	Tvf	Flysh
		Tva	Andesite lava and pyroclastics
		Tvl	Limestone
		Tvc	Conglomerate
Upper Cretaceous	Zigana F.	Kzl	Limestone and red limestone
		Kzd2	Dacite lava and pyroclastics (D2)
		Kza2	Andesite · lava and pyroclastics (A2)
		Kzd1	Dacite lava and pyroclastics (D1)
		Kza1	Andesite · lava and pyroclastics (A1)
		Kzf	Flysh (Kermut dere)
Jurassic	Kuşakkaya Limestone	Jkul	Limestone
	Kırıklı F.	Jkb	Basalt lava and pyroclastics
		Jks	Sandstone, mudstone, chert and coal
		Jkd	Dacitic pyroclastics
		Jkc	Conglomerate
Paleozoic	Gümüşhane Granite	Pgg	Paleozoic granite
	Kurtoğlu Metamorphics	Pkg	Gneiss and schist
Intrusive rocks		gd	Granodioritic rocks
		Pg2	Porphyritic granite
		Pg1	Porphyritic granite
		qp	Quartz porphyry
		dl	Diorite
		da	Dacite
		dol	Dolerite
			Strike and dip
			Fault
			Thrust fault
			Anticlinal axis
			Synclinal axis
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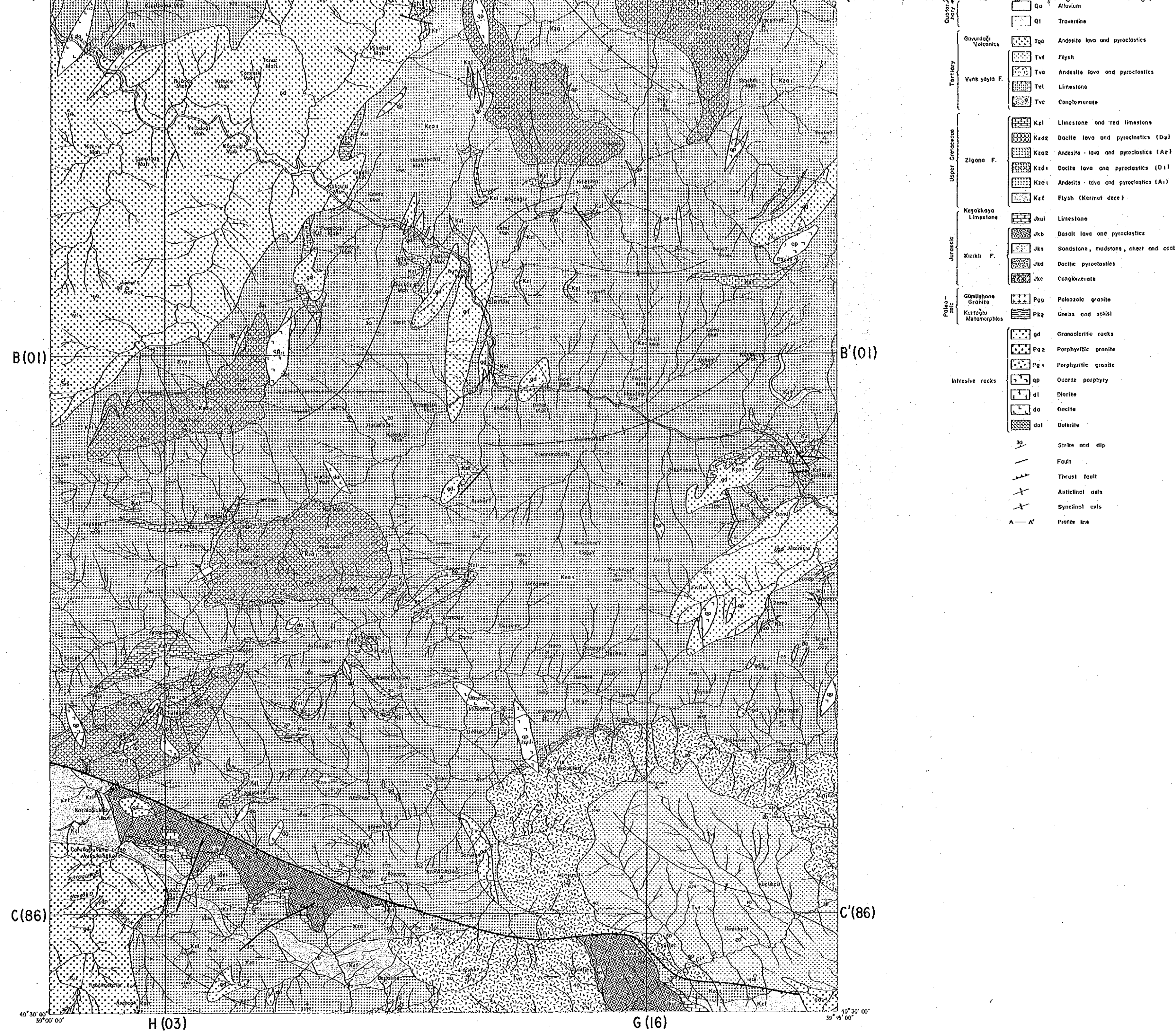
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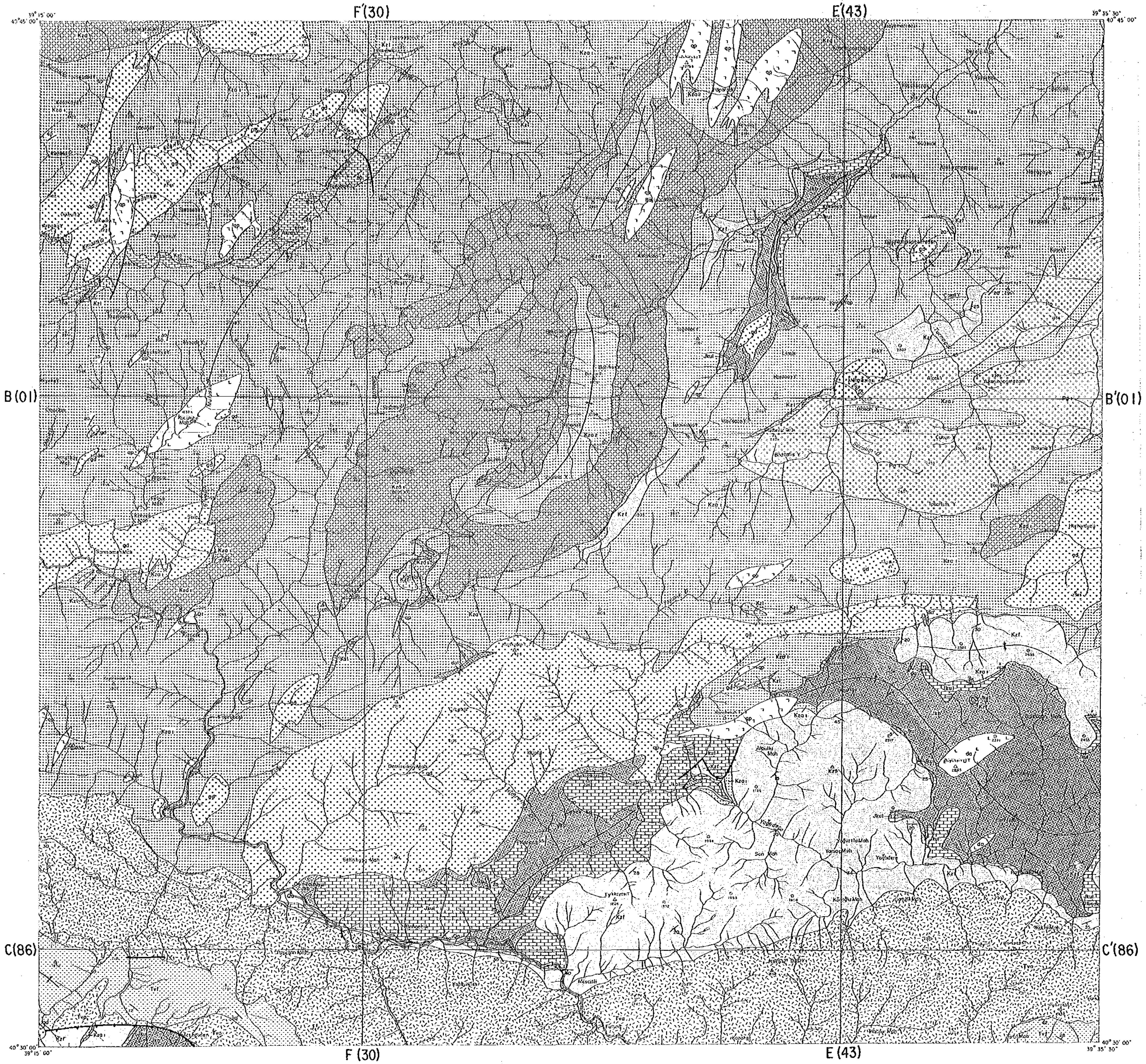
B'(01)
C(86)
C'(86)
H (03)
G (16)
40° 30' 00"
39° 00' 00"
40° 30' 00"
39° 15' 00"
Quaternary
Qa Alluvium
Ql Travertine
Tertiary
Gavurdağı Volcanics
Tga Andesite lava and pyroclastics
Venk yayla F.
Tvf Flysh
Tva Andesite lava and pyroclastics
Tvl Limestone
Tvc Conglomerate
Upper Cretaceous
Zigana F.
Kzl Limestone and red limestone
Kzd2 Dacite lava and pyroclastics (D2)
Kza2 Andesite - lava and pyroclastics (A2)
Kzd1 Dacite lava and pyroclastics (D1)
Kza1 Andesite - lava and pyroclastics (A1)
Kzf Flysh (Kermut dere)
Jurassic
Kuşakkaya Limestone
Jkul Limestone
Kırıklı F.
Jkb Basalt lava and pyroclastics
Jks Sandstone, mudstone, chert and coal
Jkd Dacitic pyroclastics
Jkc Conglomerate
Paleozoic
Gümüşhane Granite
Pgg Paleozoic granite
Kurtoğlu Metamorphics
Pkg Gneiss and schist
Intrusive rocks
gd Granodioritic rocks
Pg2 Porphyritic granite
Pg1 Porphyritic granite
qp Quartz porphyry
dl Diorite
da Dacite
dol Dolerite
Strike and dip
Fault
Thrust fault
Anticlinal axis
Synclinal axis
A — A' Profile line



PL. I – 2

REPORT ON THE MINERAL EXPLORATION
OF GÜMÜŞHANE AREA, THE REPUBLIC OF TURKEY

GEOLOGICAL MAP OF THE SURVEYED AREA

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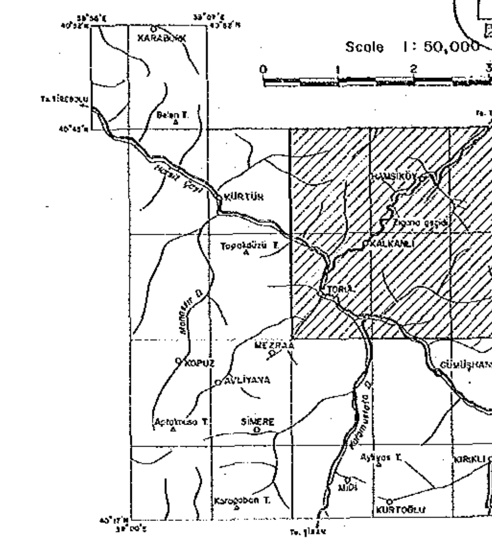

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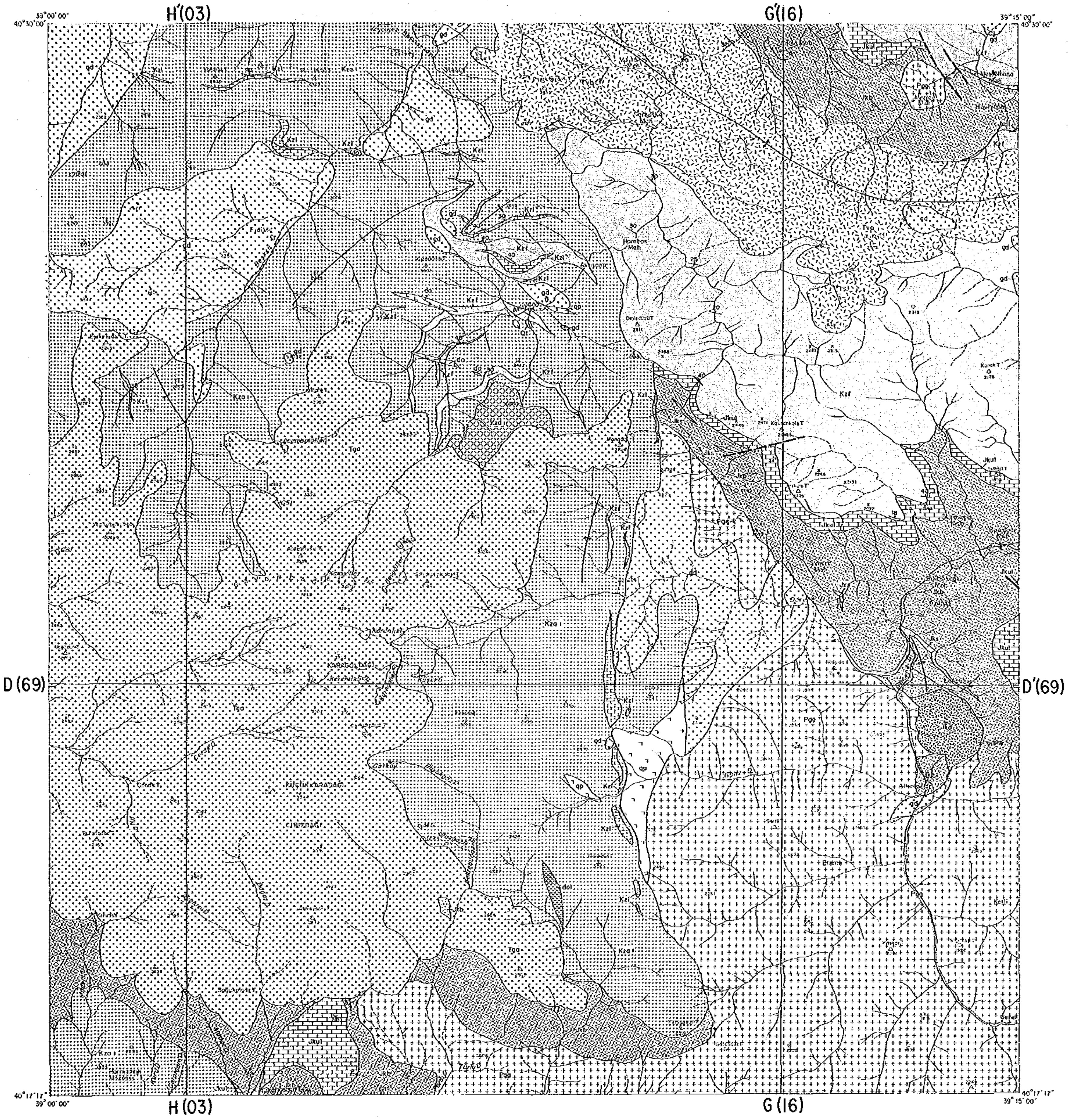
METAL MINING AGENCY OF JAPAN

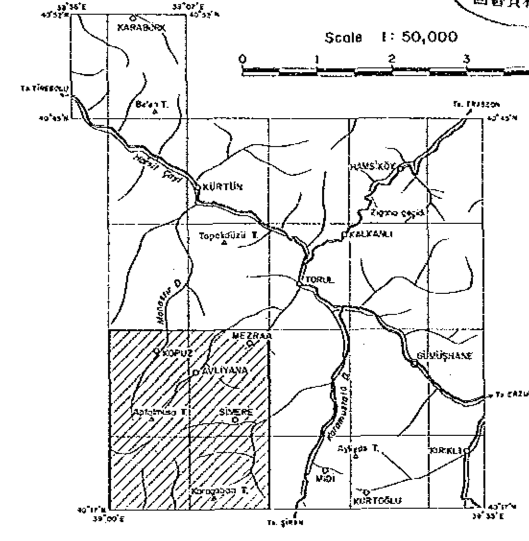


PL. I-3

REPORT ON THE MINERAL EXPLORATION
OF GÜMÜŞHANE AREA, THE REPUBLIC OF TURKEY

GEOLOGICAL MAP OF THE SURVEYED AREA

Scale 1: 50,000



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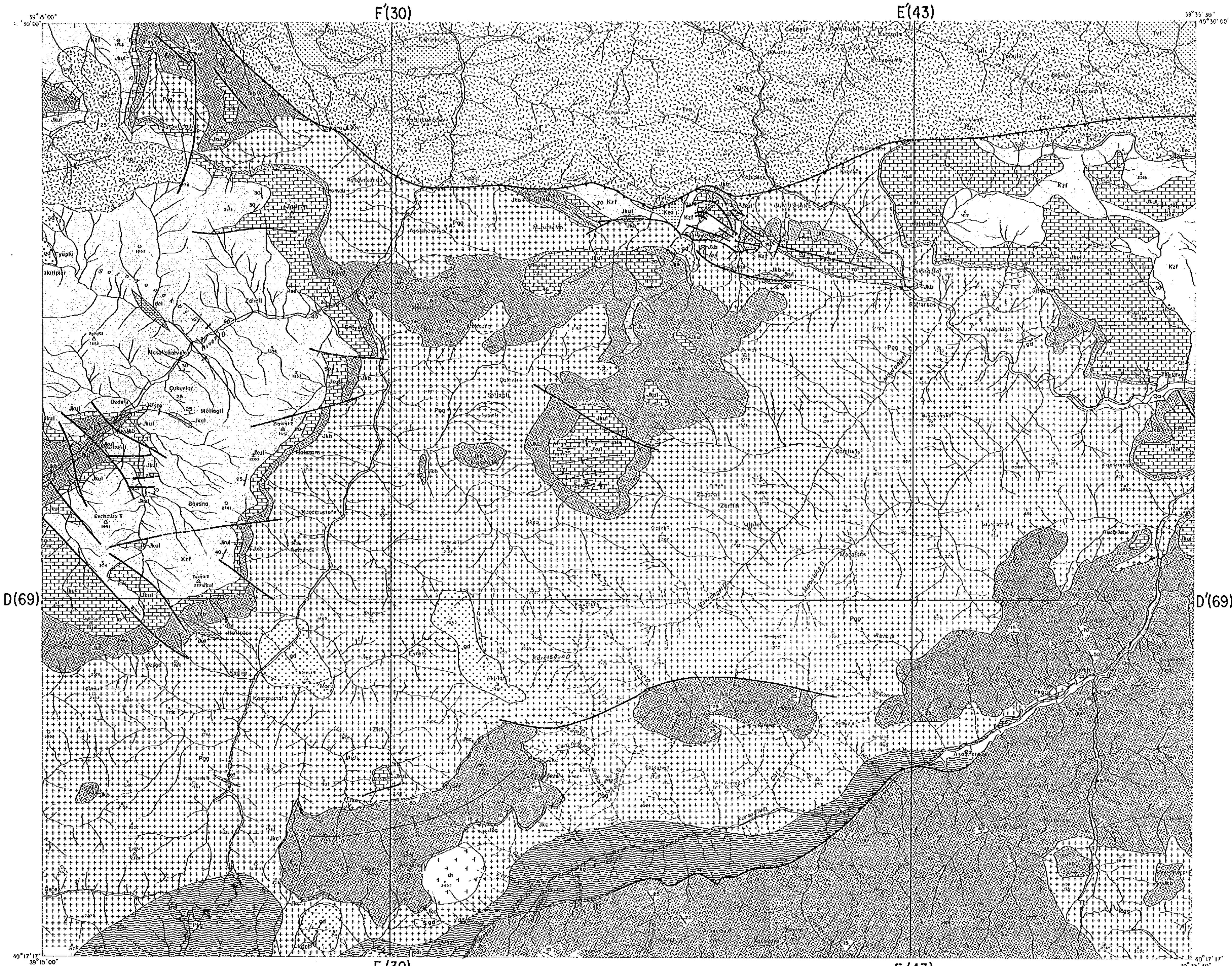

PL. I - 4

REPORT ON THE MINERAL EXPLORATION
OF GÜMÜŞHANE AREA, THE REPUBLIC OF TURKEY

GEOLOGICAL MAP OF THE SURVEYED AREA

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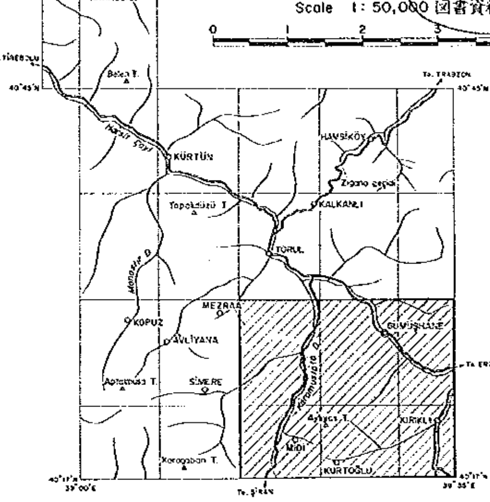

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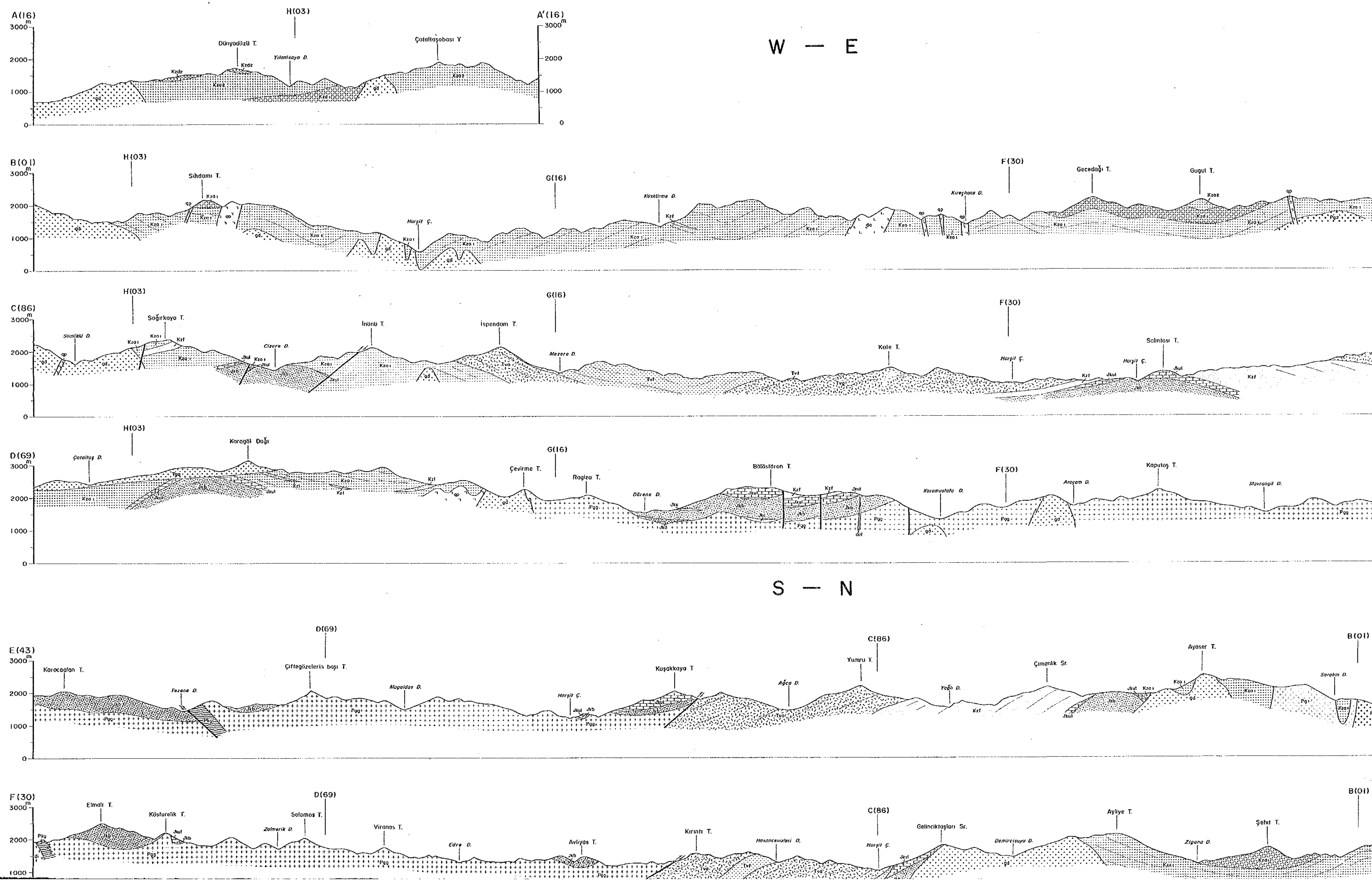
METAL MINING AGENCY OF JAPAN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Çataltaşabası Y
Yılanlıkaya D.
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Sıhdamı T.
G(16)
F(30)
Gecedağı T.
Gugul T.
Harşit Ç.
C(86)
Sağırkaya T.
İnönü T.
İspendam T.
Kale T.
Salıntaşı T.
D(69)
Çataltuş D.
Karagöl Dağı
Çevirme T.
Ragiza T.
Bölüştören T.
Kaputaş T.
S — N
E(43)
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Çiftegözelerin başı T.
Kuşakkaya T
Yumru T.
Çimenlik Sr.
Ayaser T.
Elmalı T.
Kösturelik T.
Solomos T.
Viranos T.
Avliyas T.
Kırıntı T.
Gelinciktaşları Sr.
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Şehit T.
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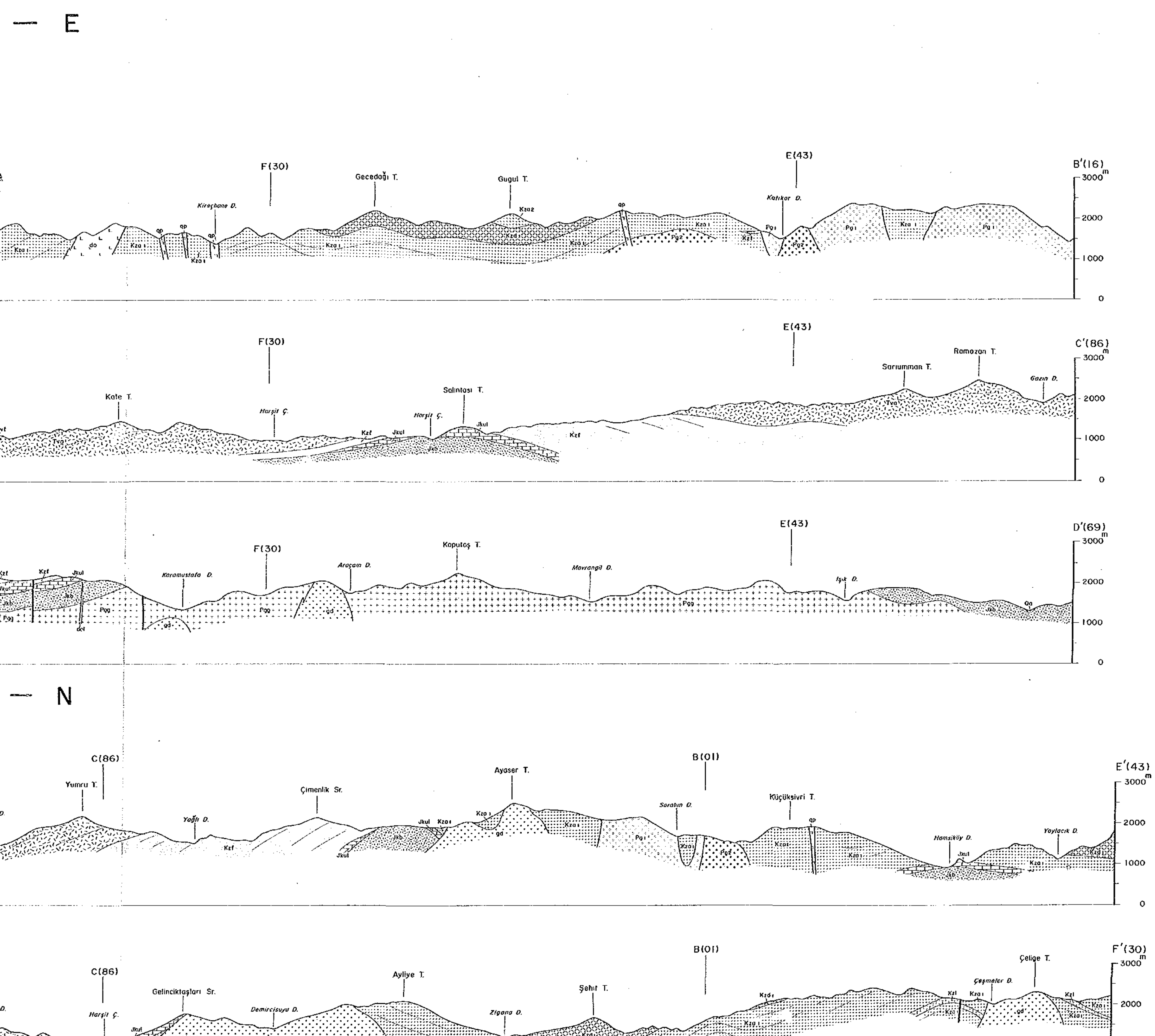
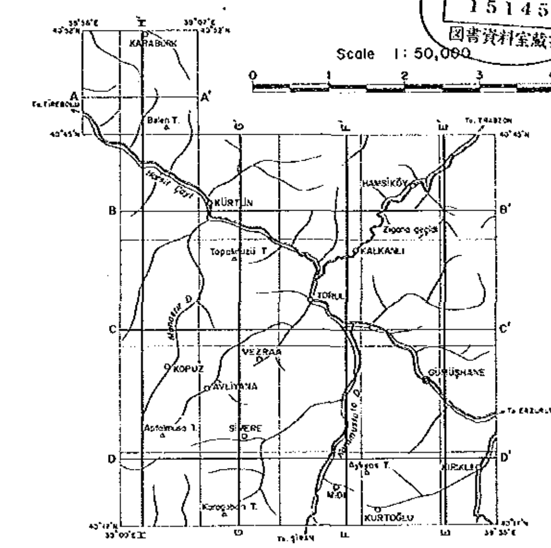
2000
1000
0



PL. 2

REPORT ON THE MINERAL EXPLORATION
OF GÜMÜŞHANE AREA, THE REPUBLIC OF TURKEY

PROFIL MAPS OF THE SURVEYED AREA
(E-W & N-S DIRECTIONS)



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JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

LEGEND

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		Jkd	Dacitic pyroclastics
		Jkc	Conglomerate
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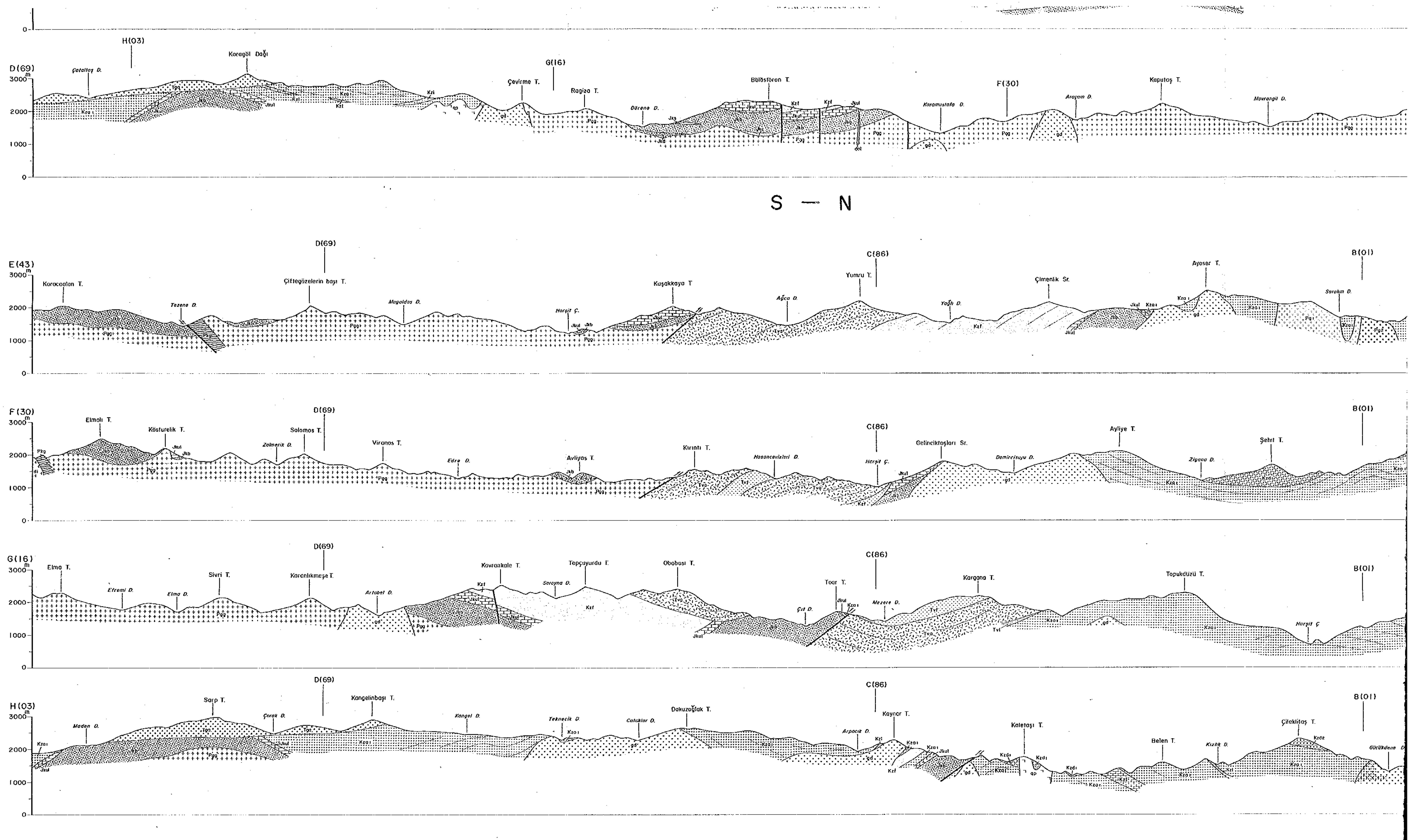
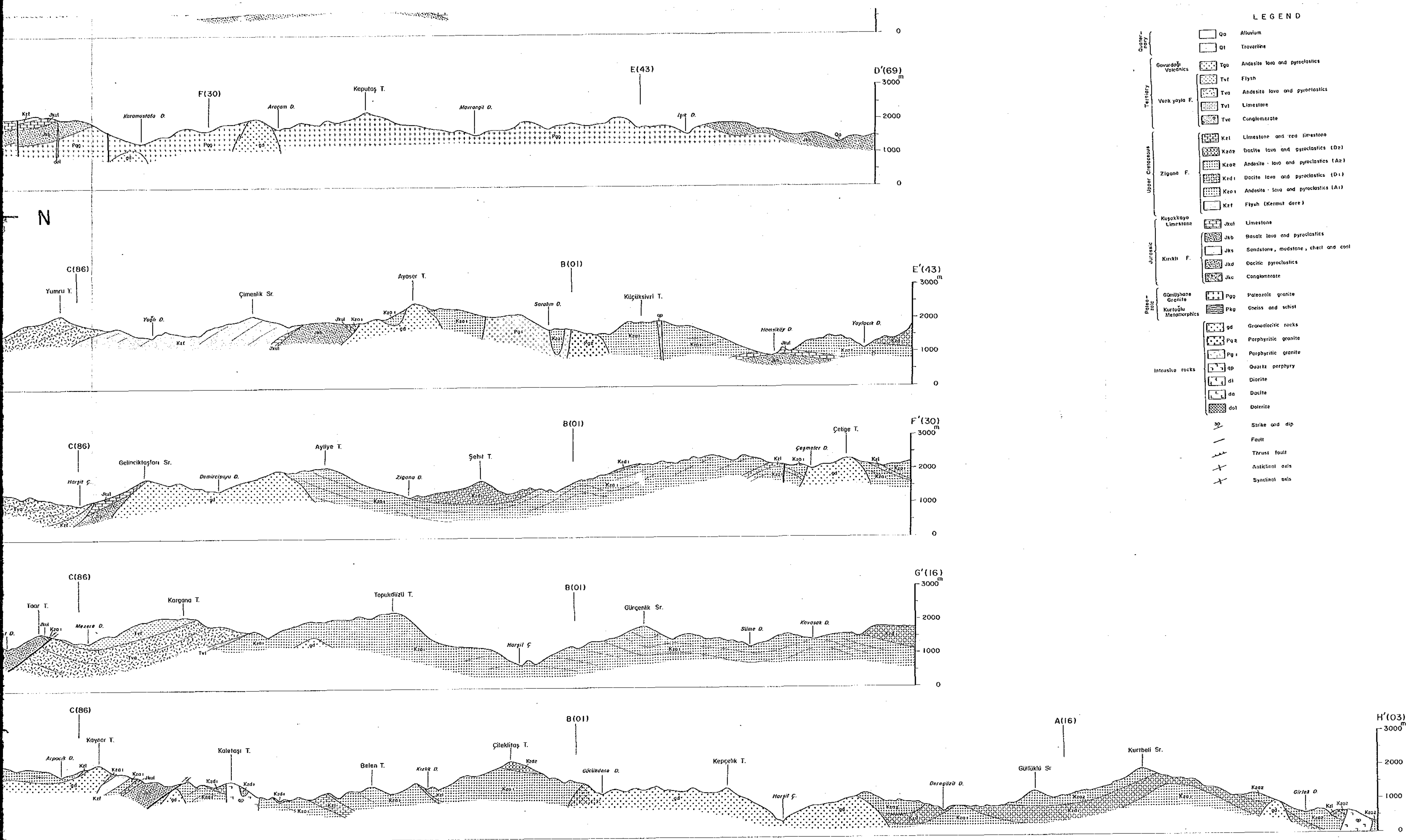
	Kurtoğlu Metamorphics	Pkg	Gneiss and schist
Intrusive rocks		gd	Granodioritic rocks
		Pg2	Porphyritic granite
		Pg1	Porphyritic granite
		qp	Quartz porphyry
		di	Diorite
		da	Dacite
		dol	Dolerite
		30	Strike and dip
			Fault
			Thrust fault
			Anticlinal axis
			Synclinal axis



S — N
D(69)
H(03)
Karagöl Dağı
G(16)
Çevirme T.
Ragiza T.
Bölüstören T.
F(30)
Karamustafa D.
Kaputaş T.
E(43)
Karacaalan T.
D(69)
Çiftegözelerin başı T.
Kuşakkaya T
C(86)
Yumru T.
Çimenlik Sr.
Ayasar T.
B(01)
F(30)
Elmalı T.
Kösturelik T.
Solomos T.
Vironos T.
Avliyas T.
Kırıntı T.
Gelinciktaşları Sr.
Ayliye T.
Şehit T.
G(16)
Elma T.
Sivri T.
Karanlıkmeşe T.
Kavrankale T.
Topçuyurdu T.
Obabaşı T.
Taar T.
Kargana T.
Topukdüzü T.
H(03)
Sarp T.
Kangelinbaşı T.
Dokuzağlak T.
Kaynar T.
Kaletaşı T.
Belen T.
Çileklitaş T.
3000 m
2000
1000
0



N
E(43)
D'(69)
F(30)
Kaputaş T.
Karamustafa D.
Araçam D.
Mavrangil D.
Işık D.
C(86)
B(01)
E'(43)
Yumru T.
Çimenlik Sr.
Ayasar T.
Küçüksivri T.
Sarahım D.
Yağlı D.
Hamsiköy D.
Yaylacık D.
F'(30)
Ayliye T.
Gelinciktaşları Sr.
Demircisuyu D.
Zigana D.
Şehit T.
Çeşmeler D.
Çelige T.
Harşit Ç.
G'(16)
Topukdüzü T.
Kargana T.
Taar T.
Mezere D.
Gürçenlik Sr.
Süme D.
Kovasak D.
A(16)
H'(03)
Kaynar T.
Arpacık D.
Kaletaşı T.
Belen T.
Kızlık D.
Çilekditaş T.
Gücükdere D.
Kepçelik T.
Deregözü D.
Gülüklü Sr
Kurtbeli Sr.
Girlek D.
3000 m
2000
1000
0
LEGEND
Quaternary
Qa Alluvium
Qt Travertine
Tertiary
Govurdağı Volcanics
Tga Andesite lava and pyroclastics
Venk yayla F.
Tvf Flysh
Tva Andesite lava and pyroclastics
Tvl Limestone
Tvc Conglomerate
Upper Cretaceous
Zigana F.
Kzl Limestone and red limestone
Kzd2 Dacite lava and pyroclastics (D2)
Kza2 Andesite lava and pyroclastics (A2)
Kzd1 Dacite lava and pyroclastics (D1)
Kza1 Andesite lava and pyroclastics (A1)
Kzf Flysh (Kermut dere)
Jurassic
Kuşakkaya Limestone
Jkul Limestone
Kırklı F.
Jkb Basalt lava and pyroclastics
Jks Sandstone, mudstone, chert and coal
Jkd Dacitic pyroclastics
Jkc Conglomerate
Paleozoic
Gümüşhane Granite
Pgg Paleozoic granite
Kurtoğlu Metamorphics
Pkg Gneiss and schist
Intrusive rocks
gd Granodioritic rocks
Pg2 Porphyritic granite
Pg1 Porphyritic granite
qp Quartz porphyry
di Diorite
da Dacite
dol Dolerite
Strike and dip
Fault
Thrust fault
Anticlinal axis
Synclinal axis