

4-5 Anomaly area

4-5-1 Selection of an anomaly area

The criterion for selection of an anomaly area is a set of threshold value on a graph in Claude LEPELTIER's method. That is,

1st class anomaly value values higher than $2t$

2nd class anomaly value values between t and $2t$

3rd class anomaly value values between t' and t

Where " t' " is the value either equal to or less than 10% of cumulative frequency percentage of " t value", or corresponds to less than 16% of the highest value of total number of cumulative frequency (in other words, it is almost equal to background plus 2 times standard deviation).

In case of stream sediment, anomaly areas are examined by plotting them on a map and study was them in relation to geological data. In case of soil samples selection of anomaly area is based on the following tentative standard, because there are too many anomaly areas if t value is standard :

- (a) one point higher than $2t$
- (b) two adjacent points higher than t
- (c) four adjacent points higher than t'

4-5-2 Evaluation of anomaly areas

Evaluation of anomaly areas should be determined by number of anomaly points which are included. For this, it is necessary that sampling pattern is homogeneous. But it is difficult to be realize this premise practically. The sampling pattern in this survey was not homogeneous and thus evaluation of anomaly was as follows.

Stream sediment : It was attempted to collect samples at $1/\text{km}^2$ intervals,

but samples couldn't be taken in all streams in each drainage area. The boundary of the anomaly area was drawn on the basis of the water system map. Therefore, the evaluation of anomaly areas was based on geological data, alteration, and anomaly values.

Soil samples : In the evaluation of an anomaly area the following was considered : number of anomaly values for each indicator element, its continuity, and the maximum analysis value included in it.

A rank : The unit area which contains more than ten values which are higher than t and two higher than $2t$ for the adjacent sample localities.

B rank : The unit area which contains more than five values which are higher than t and one higher than $2t$.

C rank : (1) The unit area which contains two points higher than t , and ten higher than t' .

(2) The unit area which contains three points higher than t , and five higher than t' .

(3) The unit area which contains four points higher than t .

D rank : (1) The unit area which contains one point higher than $2t$.

(2) The unit area which contains five points higher than t' and one higher than t .

(3) The unit area which contains ten points higher than t' .

E rank : (1) The unit area which contains four points higher than t' .

(2) The unit area which contains two points higher than t .

All of these area for the adjacent sample localities.

4-5-3 Relation between anomaly area and its geology and mineralization

Ultimately, twenty-five anomaly unit areas for stream sediments and forty-four anomaly areas for soil samples were drawn on the map. They are shown in PL. 22, 23, 24 and 25 and the classification of each rank in as follows :

		A	B	C	D	E
Stream sediment	Cu	-	-	1	-	2
	Pb	-	-	1	-	1
	Zn	-	-	1	-	4
	Mo	-	-	-	-	-
Soil sample	Cu	4	2	3	18	1
	Pb	-	2	4	13	-
	Zn	-	-	1	15	3
	Mo	-	1	2	4	2

Stream sediment : The geochemical anomalies were assumed to be related to mineralization and alteration, and were classified on the basis of statistic treatment, they are as follows :

- 1) Anomaly areas related to quartz diorite.
- 2) Anomaly areas related to porphyry or dacite.
- 3) Anomaly areas located along streams in area where the Munzur Formation and Düzpelit Formation are distributed.

The main anomaly areas are explained later.

Soil samples : Relation between geochemical anomaly areas, stratigraphy, intrusive rocks, geological structures, alteration zone and mineralized area are indicated in Table 4, 5.

Those anomaly areas are classified on the basis of Table 5, (2) and

PL. 23, 24, 25. They are as follows :

		Due to mineralization	Due to alteration	Others
(1)	Anomaly areas related to dacite	GP 28	GP (6) 8, 9, 10, 11, 12, 15, 18, 19, 20, 21, 23, 24, 25, 26, 29, 30, 31, 32, 33, 34, 39, 40, 41, 42	GP 16, 17, 18, 43
(2)	Anomaly area related to quartz-diorite	GP (1), 6	GP 1, 2, 3, 4, 5, 13, 34	
(3)	Anomaly area due to different rock in geological unit		GP 39	GP 14, 24, 35, 36, 37, 38

The ore deposits related to dacite are represented by Sin mine. Sin dacite and Çet dacite are accompanied by alteration. The ore deposits related to quartz diorite are represented by Mamlis mine. The Mamlis mine is related to Bulanık quartz diorite.

The anomaly areas in the (3) group coincide with limestone in the Eocene and Permian sediments.

The Marden tepe mine, situated in GP 35 anomaly area, is located in Permian Limestone. Also mineralizations of vein type near the anomaly area, (GP 36, 37, 38) were assumed.

Table 4 Geochemical anomaly areas (stream sediments)

No.	Name	Total classification	No. of unit anomaly	Number of Anomaly point								Max. value ppm				Reration of the Geology	
				Cu		Pb		Zn		Mo		Cu	Pb	Zn	Mo	Intrusive	Alteration and mineralization
				t't	t	t't	t	t't	t	t't	t						
1	Pokir Q-Dio		1, 2, 3, 4, 5, 6	1	1	-	-	5	-	-	135	212	255	5	Q-Dio		
2	Tulluk Porphy		7, 8, 9, (10)(11) 12, 13	1	3	1	-	6	2	3	230	183	340	10	Porphyrite		
3	Aşağıbor		14, 15, 16, 17 18, 19	9	-	3	1	12	2	-	105	400	1200	5			
4	Pagan		20, 21	4	2	7	2	6	-	-	140	216	270	-			
5	Kaya kömürleri		22, 23, 24, 25	-	-	5	-	1	-	-	50	160	236	5.5			

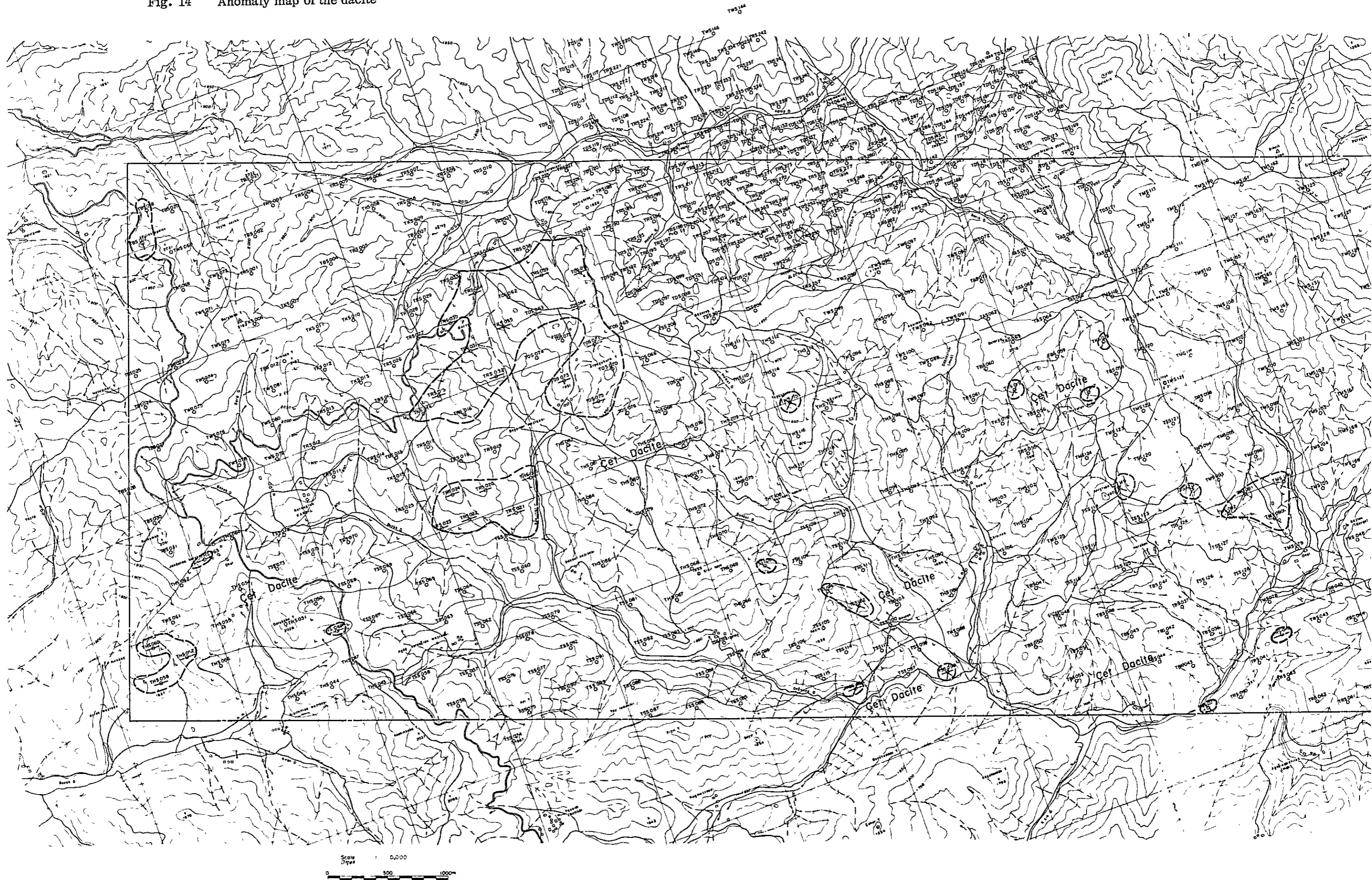
Table 5 Geochemical anomaly areas of the soil samples

No.	Locality	No. of unit anomaly	Classification	Area km ²	Cu			Max. value P.P.M.	Classification	Area km ²	Pb			Max. value P.P.M.	Classification	Area km ²	Zn			Max. value P.P.M.	Classification	Area km ²	Mn			Max. value P.P.M.	Geological unit	Intrusive R.	Alteration and Mineralization	Name of mine or mineralized area	Interpretation	Remarks
					t'	t	2t				t'	t	2t				t'	t	2t				t'	t	2t							
i)	Mamlis	T-1	A		6	11	4	1,600	C		1	2	1,685													Bulanik Gt up Duz F.		arg., Zn d'as silf., limonite	Mamlis mine	Mineralization		
"	"	T-2	A		3	7	8	850	C		2	3	950													Bulanik Gt		arg., sil, limonite	"			
"	"	T-3	D			4	1	1,030																		Bulanik Gt		arg., limonite, Cu, Pb, Zn,	"			
"	"	T-4	C		2	2	3	1,800	B		6	2	5	1,871												Bulanik Gt up, Duz F.		Vein	"			
"	"	T-5						570	D		2	1	1	570												Up DuzF	Bulanik Gt	arg., limo	"			
"	"	T-6	D		1		1	6,900	C		5		1	5,500	D		1	3,700								Bulanik Gt up, Duz F.		arg., limonite, Cu, Pb, Zn, Net	"			
"	"	T-7						531	D		2		1	531												"		arg.	"			
ii)	Ağaç	T-8	A		4	9	2	240																		Çet Dt		"	"		Alteration by Intrusive	
"	"	T-9	C		2	4		150																		Çet Dt up, Duz F.		arg.	"			
"	"	T-10	E		1	2		100																		Çet Dt		"	"			
iii)	Kozluk	T-11														1	1	2	3,750							Çet Dt		"	"	Limestone		
"	Haraban	T-12														1	1	1	3,300							Bulanik Gt		arg.	"			
"	Gfrok	T-13														3	1		650							Çet Dt		"	"			
"	Mevkil	T-43														4			385							Up, DuzF		"	"			
"	"	T-44														2	3	1	2,100							"	(Çet Dt)	arg.	"			
iv)	east Koçtepe	T-14	D				1	200	D		2	1	615			1	2		850							"		"	"			
v)	Gabunkulafı tepe	T-15	D				1	850	C		2	1	8,335													"	(Çet Dt)	arg., limonite	"			
"	Karataş tepe	T-16									1	1	1,385													"		"	"			
"	"	T-17									1	1	500	D		1		1	1,020							"		"	"			
vi)	Gulbahçe	T-18	D				1	10,400																		Sin Dt		"	"			
"	"	T-19	D		1			110																		"		"	"			
"	"	T-20	D					410																		"		"	"			
"	"	T-21	D					320	D		4	2		500	D		1	3		870						Sin Dt up, Duz F.		"	"			
"	"	T-22	B					280																		Sin Dt		"	"			
"	"	T-23	D		1	2	1	210																		"		"	"			
vii)	Kömtepe	T-24	C				3	2	620																	"		"	"			
viii)	east Gulbahçetepe	T-25	B-C		1	8	12	1,500																		Atad. F.		"	"			
"	"	T-26							D			1	1,300	D			1		4,130							Sin Dt		arg.	"			
"	"	T-27	D					125																		Atad. F.	(Sin Dt)	"	"			
"	"	T-28	A		12	19	17	3,300	D		6	1	730	D		1	1	1	1,800							Sin Dt		arg.	"	Sin mine		
ix)	Sin	T-29							D							1		1	7,300							Sin Dt Atad. F.		"	"			
"	"	T-30																								"		"	"			
"	"	T-31	D			1	1	820	D			1	460	D				1	1,500							Sin Dt		"	"			
"	"	T-32	D		1		1	2,100	D				3,500	D		1	1	1	2,600							"		"	"			
"	"	T-33	D					240																		"		"	"			
"	"	T-34	D		2	3	1	490	D		9	1	2	950	D		5	1	1,350							Sin Dt Atad. F.		Kargilar Çet	"			
x)	Siliç	T-35	D					240																		Manzur F.		"	"			
"	"	T-40	D					5,150																		Karataş Dt		"	"			
"	"	T-41	D					330																		"		"	"			
"	"	T-42	D					330																		"		"	"			
xi)	Marden T. and Siliç	T-36	E		1	2		85																		Manzur F.		"	"			
"	"	T-37							D		1	1	1	193	D			1	480							"		"	"			
"	"	T-38							B		1	1	4	360	C		2	300								"		"	"			
"	"	T-38							D								2	2	360							"		"	"			

*) Classification of the anomaly is decided tentatively as follows.

A rank	2t: 2 points	t: 10 points	C rank	(1) t: 2 points	t': 10 points	D rank	(1) 2t: 1 point	E rank	(1) t': 4 points
B rank	2t: 1 point	t: 5 points		(2) t: 3 points	t': 5 points		(2) t: 1 point		(2) t: 2 points
				(3) t: 4 points			(3) t': 10 points		

Fig. 14 Anomaly map of the dacite





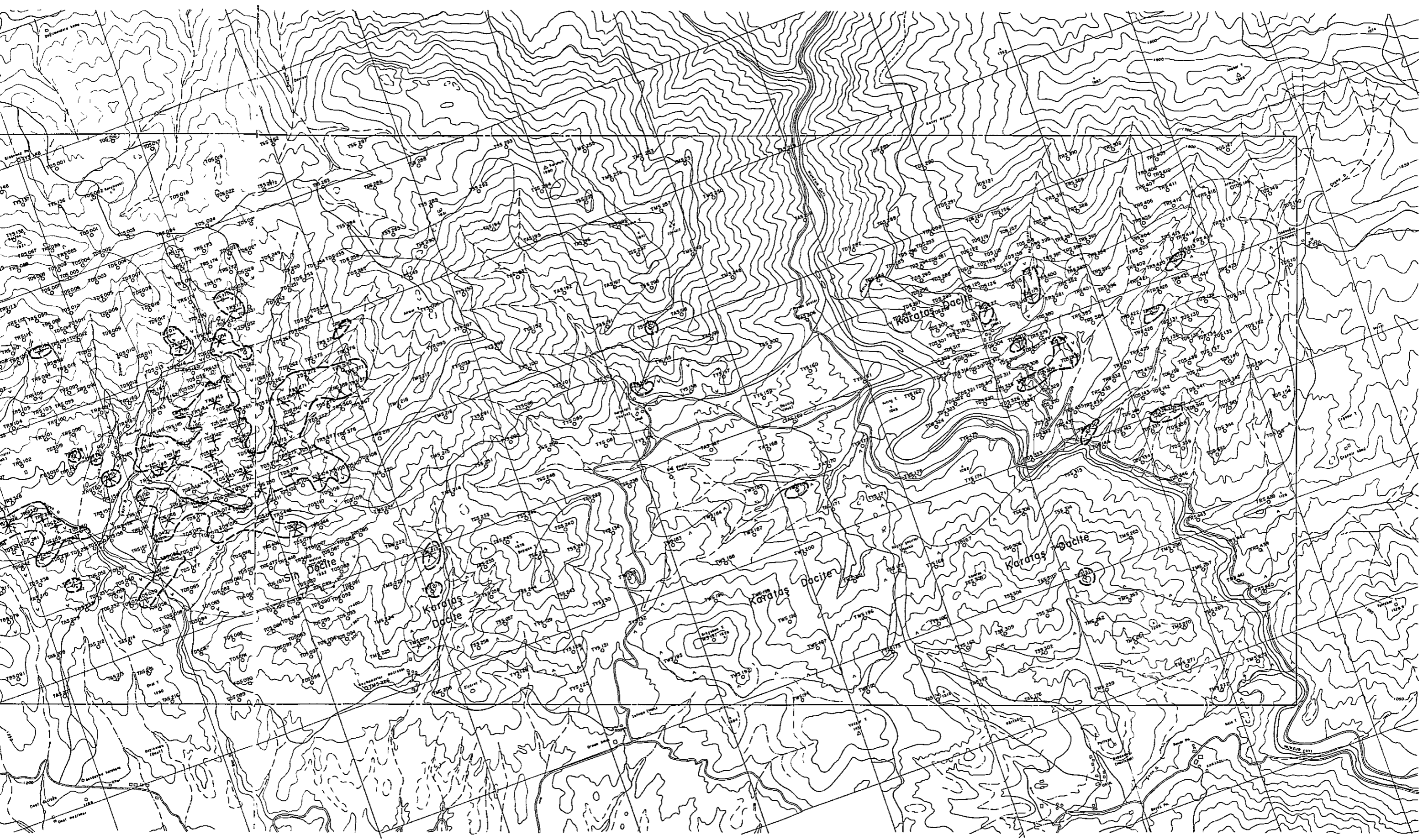
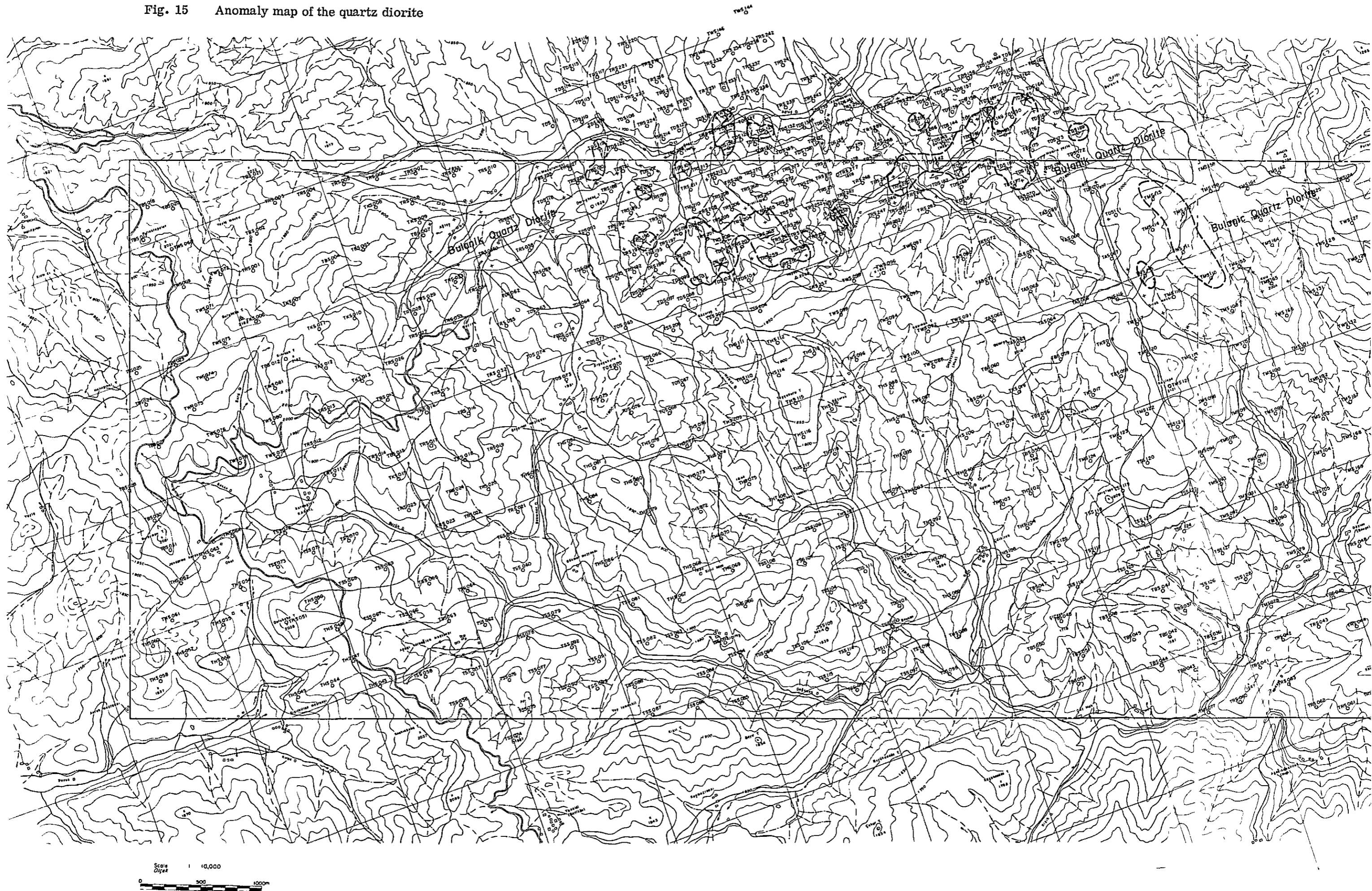
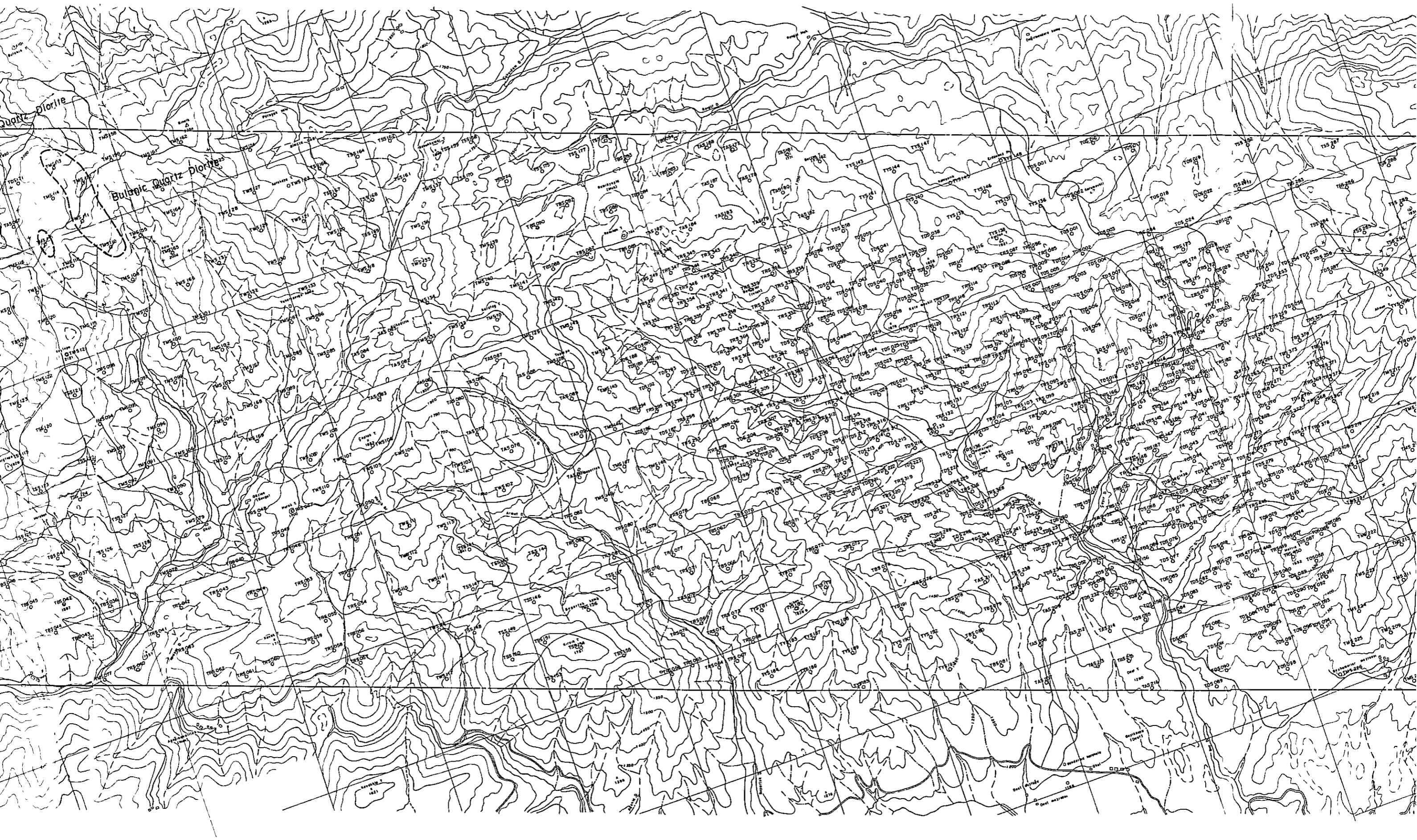
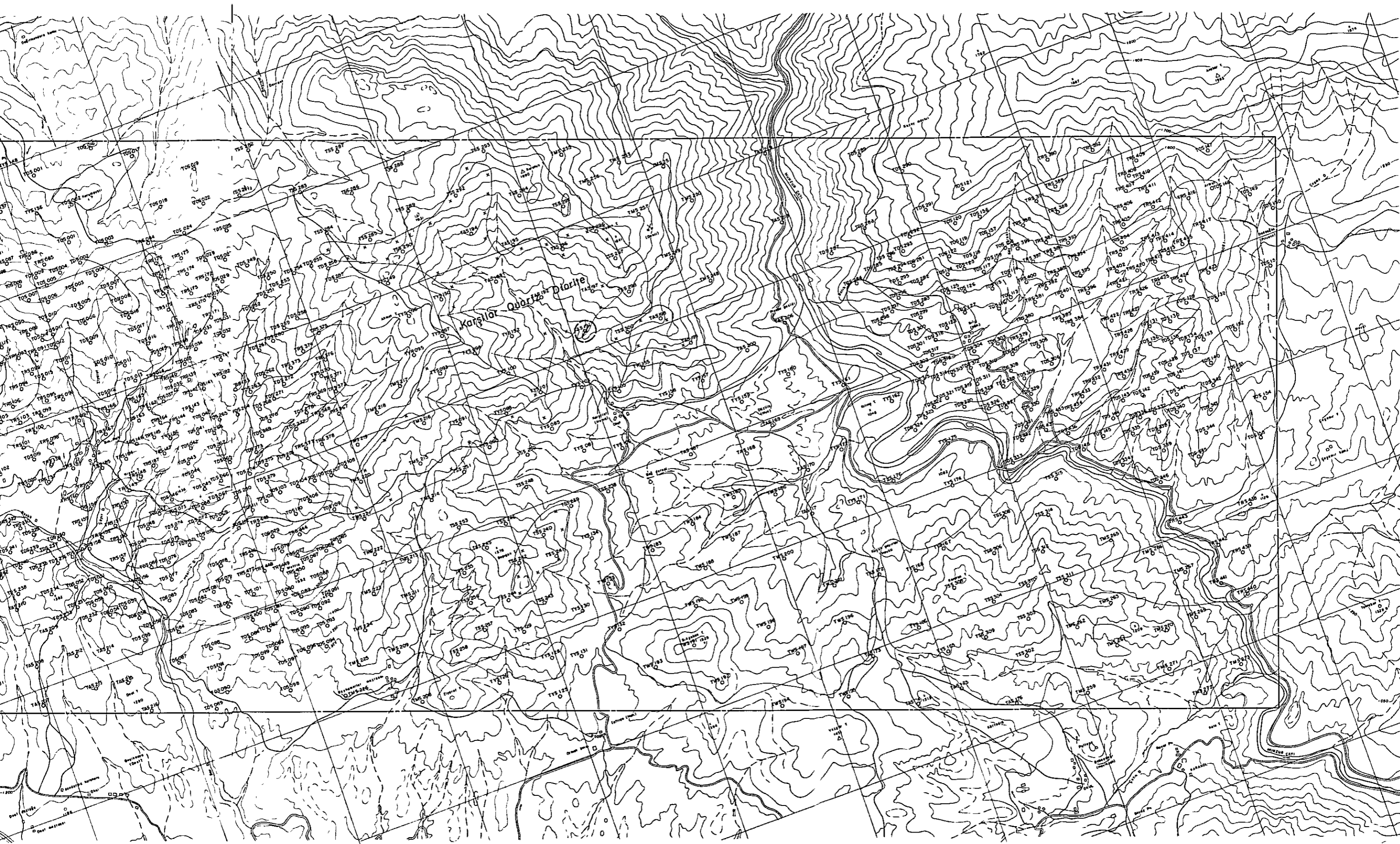


Fig. 15 Anomaly map of the quartz diorite







Karsilar Quartz Diarite

BAYIRI BAYIRI

KARADAGI

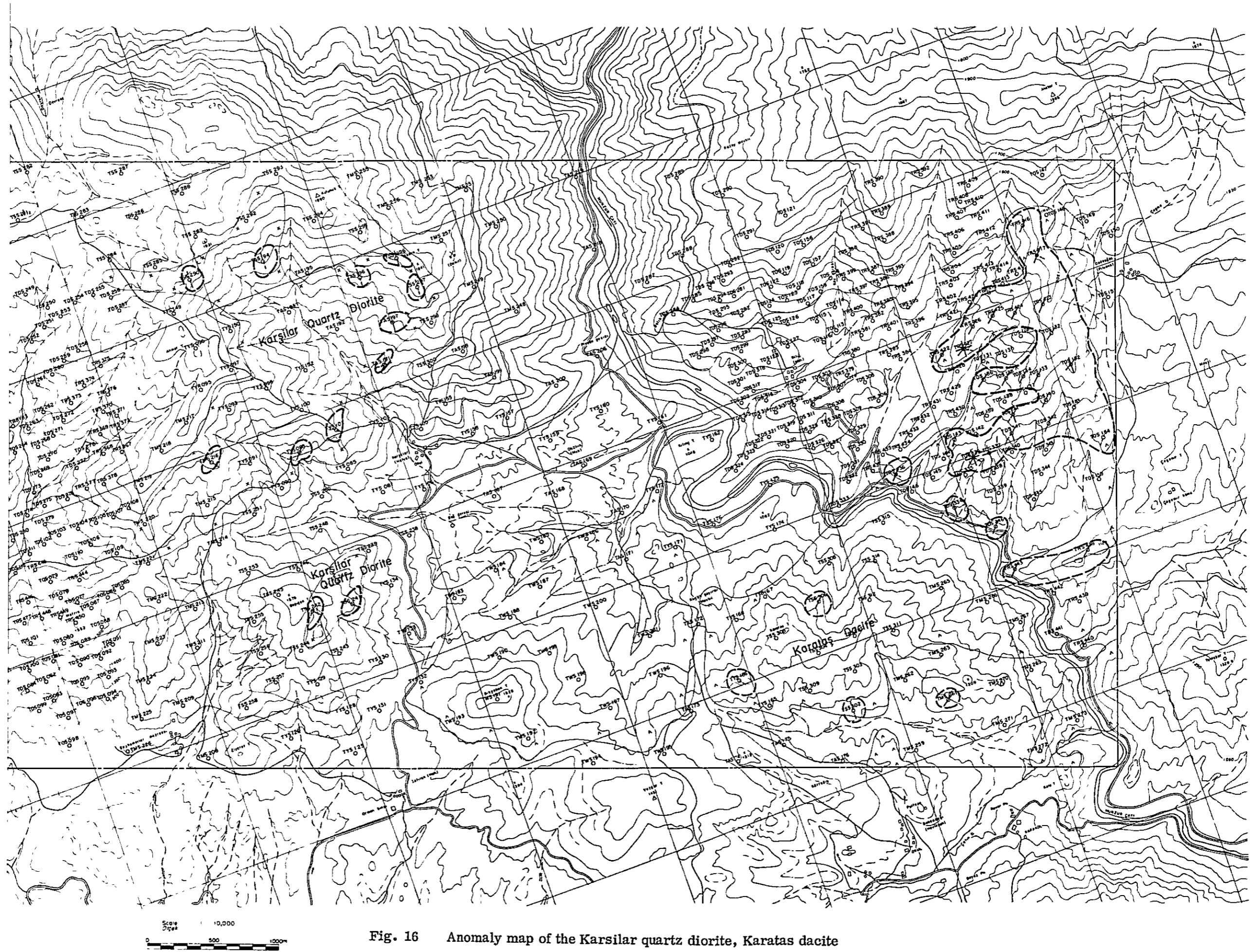
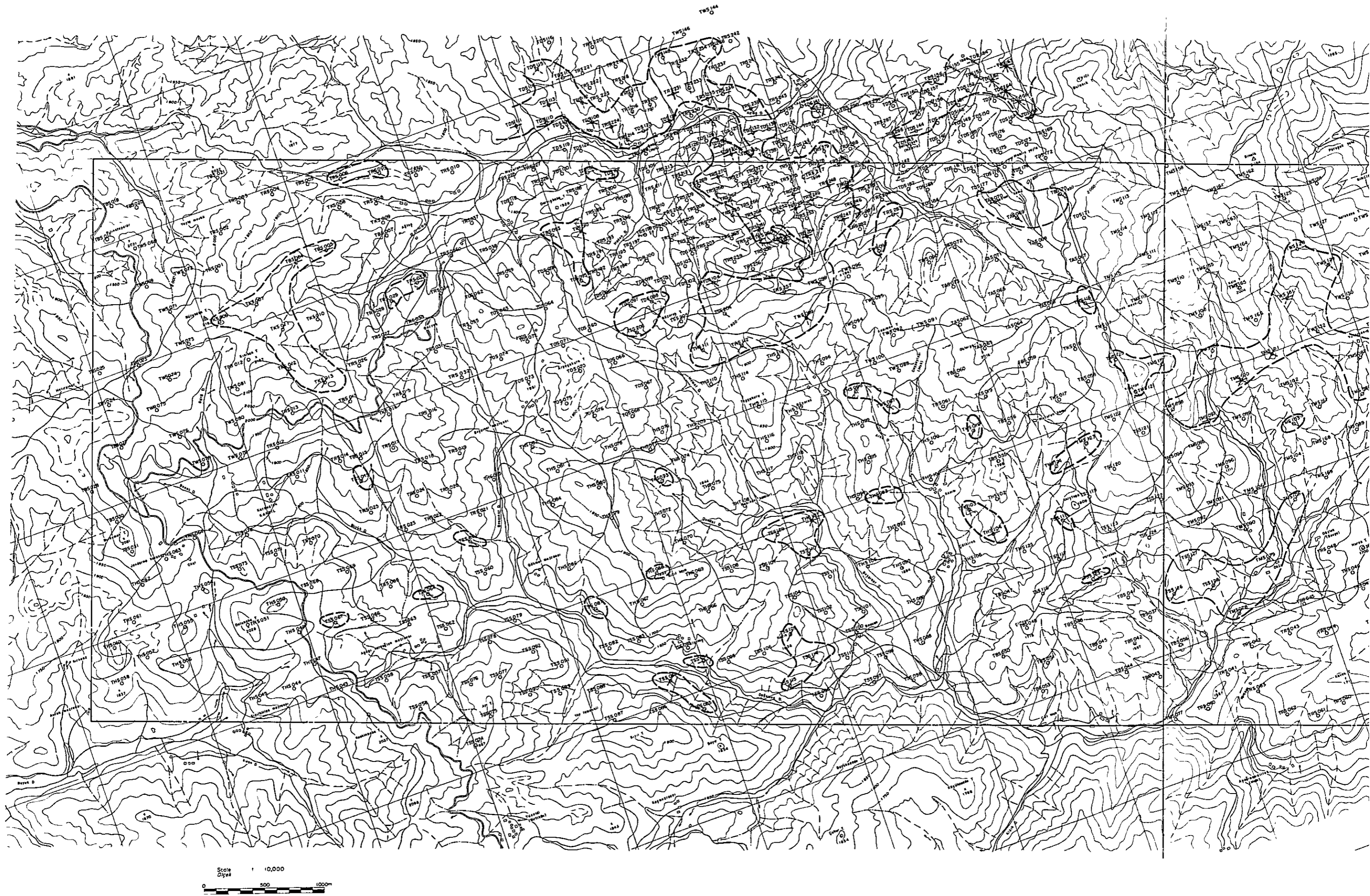


Fig. 16 Anomaly map of the Karsilar quartz diorite, Karatas dacite

Fig. 17 Anomaly map of the Miocene



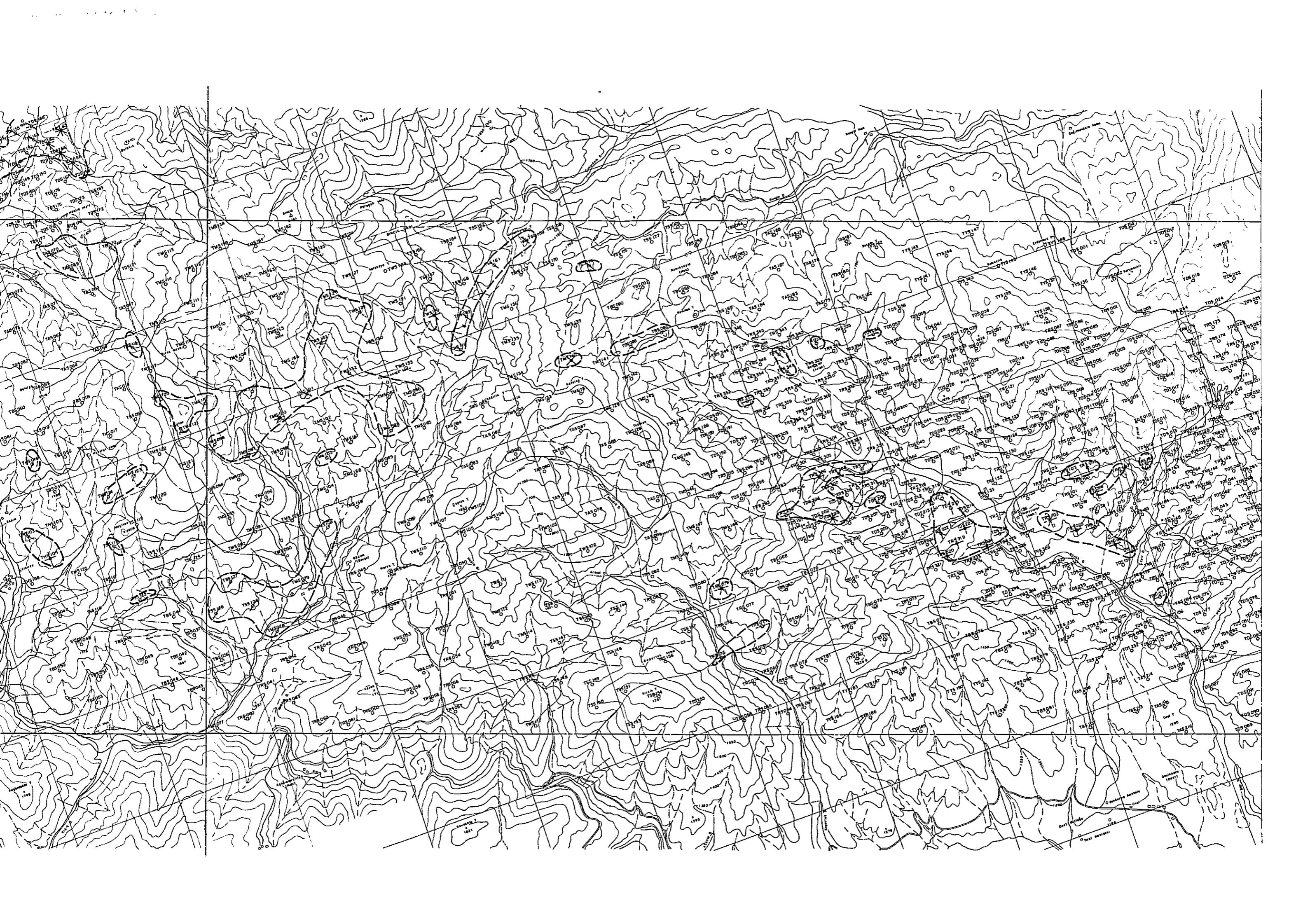
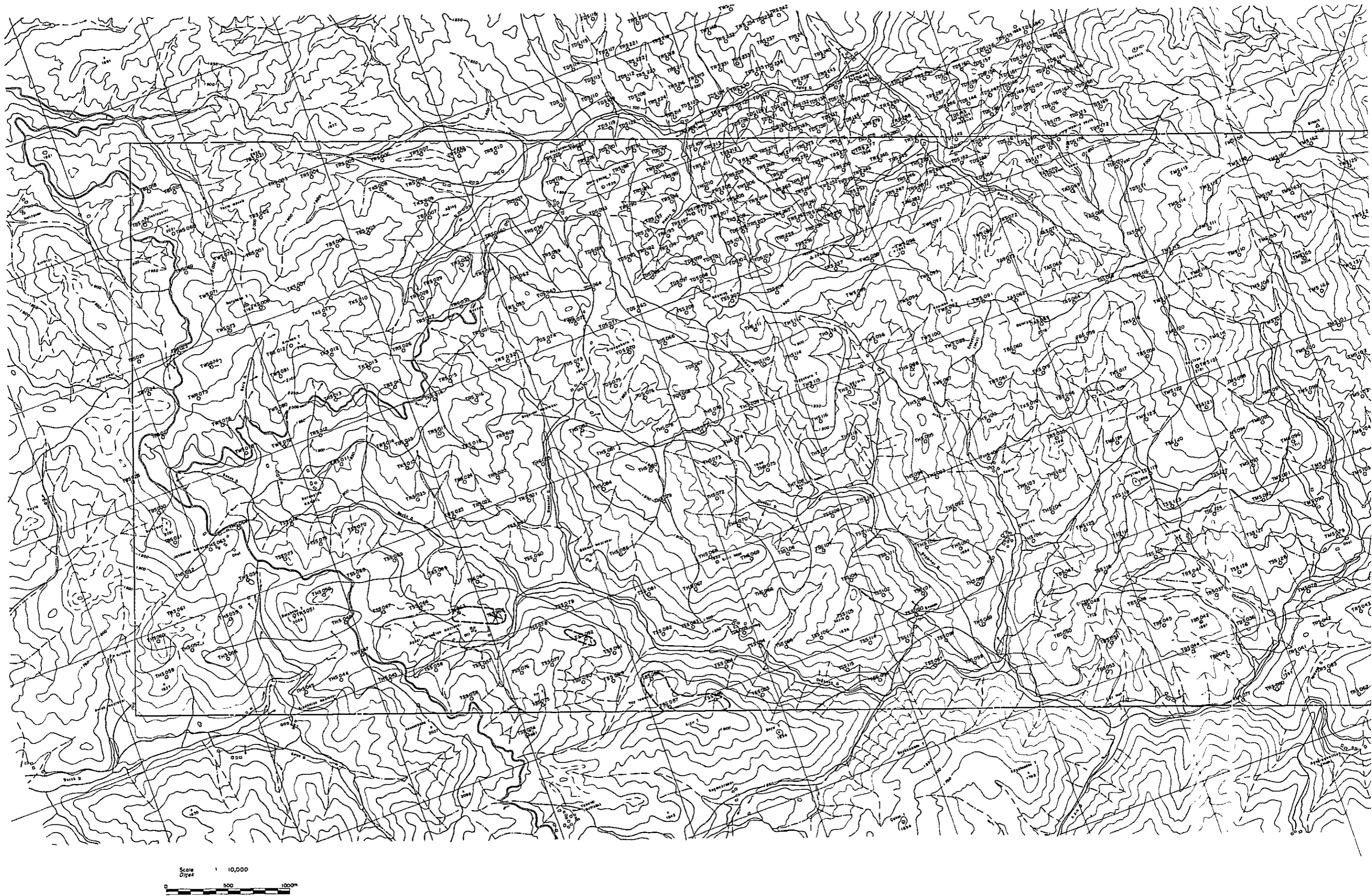
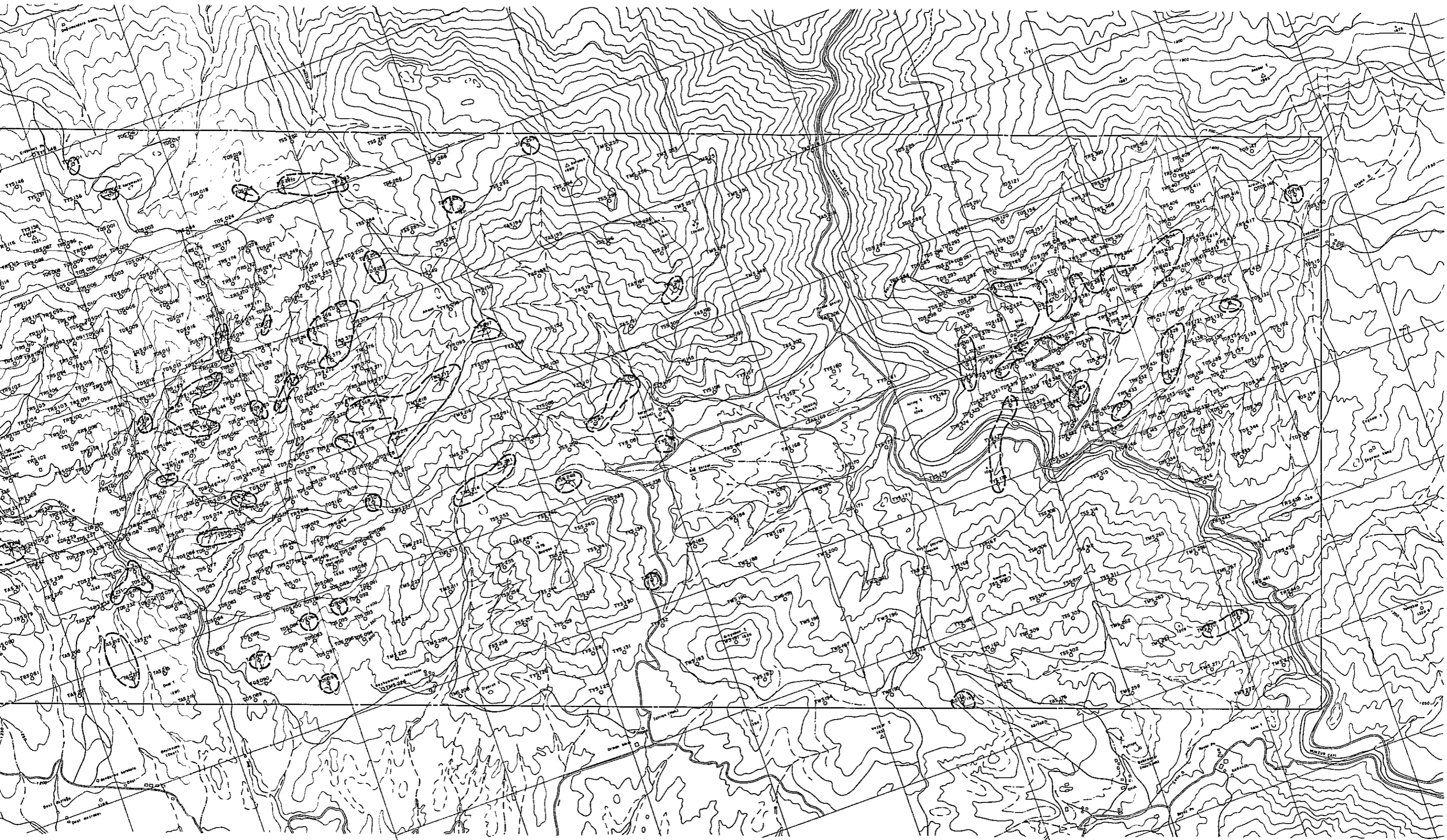
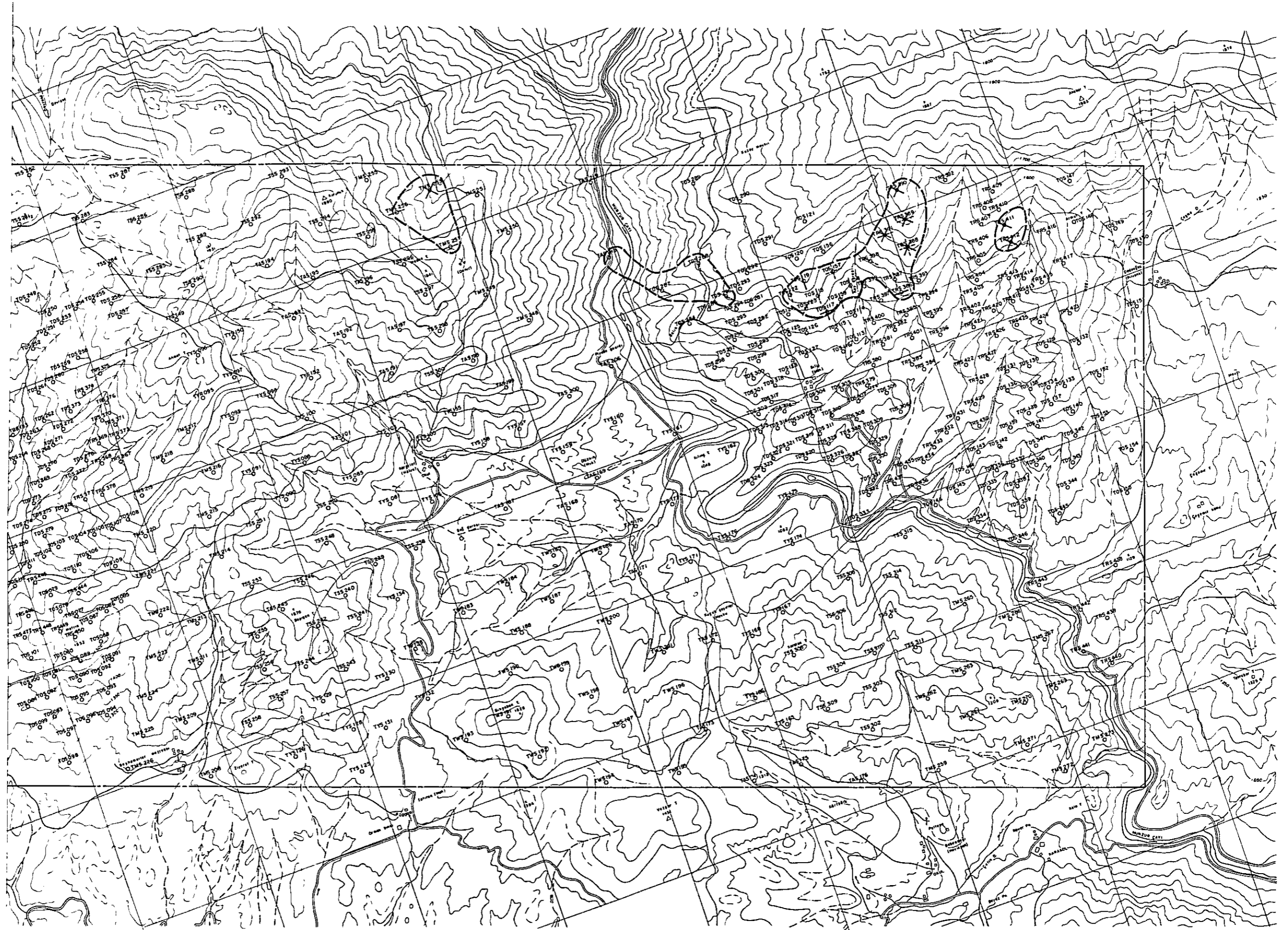


Fig. 18 Anomaly map of the Eocene









Scale 1:10,000
 0 500 1000m

Fig. 19 Anomaly map of the Permian

4-6 Discussion of main anomaly areas

4-6-1 Main anomaly areas of stream sediments

Anomaly area related to Pokir quartz diorite

Pokir quartz diorite is distributed around Mt. Pokir. This anomaly area, related to Pokir quartz diorite belongs to water system of Mt. Pokir. There is a copper anomaly area in the central part of Mt. Pokir and lead - zinc weak anomaly area in the eastern part. The alteration in the Atadoğdu Formation near Pokir quartz diorite is very weak, and there are no important geochemical anomaly areas.

Anomaly areas related to Tüllük porphyry

These anomaly areas are distributed in water system of Mt. Meydan, they consist of a zinc - copper anomaly, zinc value increase from 185 to 340 ppm in the upper stream on western part of Mt. Gelincik. Though Tüllük porphyry was expected to have mineralization around it, it was not found by geological survey. Also Tüllük porphyry intrudes the Munzur Formation in eastern area, where copper and zinc anomaly was found in the contact part of limestone and porphyry, it is very narrow.

Aşağıbor area

These anomaly areas are found in the headwaters distributed on Mt. Toht, Mt. Anadar, Mt. Sarıhalıl, and Mt. Kırmızı, where the Munzur Formation is predominant. The anomalies consist of Zn, Cu-Pb-Zn, Cu-Zn and Zn, maximum anomalous value is 1,200 ppm of zinc. Because intrusive rock was not found in this area, it is considered that limestone or pelitic schist contain some primary metallic minerals.

The Cu-Zn anomaly near the east of Mt. Gini, which was found in

superior mudstone in the Atadoğdu Formation, but no mineralization was found by geological survey. The same materials as mentioned above are found in country rocks.

Pagan area

The Karataş dacite is distributed widely in the west part of the survey area and it is in contact with the Tüllük porphyry. The anomalies found in the above-mentioned area are copper and lead. They are in the Bentepe Formation and the Atadoğdu Formation. Therefore they probably represent a concentration of some minerals scattered in the country rocks and the intrusive rocks.

Kaya kömleri area

The anomalies are zinc in Keçikıran kömleri dere and Kortan Br. , and lead and zinc in Uran kayalığı. The former is located in the calcareous mudstone~ calcareous sandstone in the Atadoğdu Formation. The latter is located in the Munzur Formation. No mineralization and alteration was observed anomalous areas and they show weak geochemical anomaly.

4-6-2 The main anomaly areas of the soil samples

Mamlis area (GP 1~7)

These anomalous areas are located at close intervals and both their dimension and intensity are the largest within the investigated area.

GP 1 anomalous area: This anomaly is copper, lead, and molybdenum anomalous area. It is distributed on the north side of quartz diorite and is assumed to have been caused by alteration related to the quartz diorite intrusion. Quartz veins with malachite stain and sphalerite were observed during the geological survey.

GP 2 anomalous area : It contains anomalies of copper, lead and molybdenum which are located in the pyroclastic rocks surrounding the Bulanık quartz diorite. There is remarkable silicification and argillization. During the geological survey, gossans with limonite were found in the area, and sometimes partial network of sphalerite was observed. It is expected that new ore deposits may be found in the investigation area.

GP 4 anomaly : It is a copper, lead and molybdenum anomaly located around the Bulanık quartz diorite. The anomaly area coincides with the distribution of the gossan with limonite, in which copper, lead and zinc vein is found near the GP 3 anomaly. The relation between the eastward extension of the GP 2 and GP 4 anomaly should be investigated in the future.

GP 6 anomaly : Copper, lead and zinc anomaly areas are distributed around the Bulanık quartz diorite. They indicate the Mamlis mine and its mineralized zone and coincide with the distribution of the gossan with limonite in the pyroclastic rocks. The zinc anomaly is only located near the gossan with limonite. It is clear that this anomaly is related to the intrusion of Bulanık quartz diorite.

Ağtaş area (GP 8, 9)

These anomaly areas of copper area located in the dacite. The anomaly areas are distributed widely in spite of lack mineralization found by the geological survey. Because these anomalies do not include lead and zinc, they are assumed to have been caused by a different mineralization.

Kozik tepe, Haraban, Girek mevki area (GP 11~13, GP 43, 44)

These zinc anomalies are assumed to be incident mineralization in the dacite. The zinc anomaly shows high value in the surveyed area, but the

anomaly near Mt. Kozik is small. Many anomalies of zinc are scattered near the Kurçtepe and Koçtepe and they are small. The Girek mevki anomaly (GP13) coincides with quartz diorite, but it is not important geochemically, because it is small both in size and anomaly value.

East Koçtepe area (GP 14)

The anomaly is copper, lead, and zinc. The area is an eastward extending belt. This anomaly is assumed to have been caused by minerals in limestone, because it coincides with the distribution of limestone in the Düzpelit Formation. It is not important geochemically, due to its small size and low anomaly value.

Gabunkudesi tepe ~ Karataş tepe area (GP 15~17)

These anomalous areas are all in the Düzpelit Formation. They indicate mineralization related to the intrusion of dacite, but both scale and anomaly value are small, and individually anomalies over 2t are independent, but it is necessary to investigate it in the future, because alteration zone is wide and extends eastward.

Gülbağçe tepe area (GP 18~23)

The anomalies are copper, lead, and zinc, the areas are scattered and separate, and coincide with distribution of small scale dacite intrusions. The alteration near anomaly areas is remarkable and is expected to be a westward extension of the Sin mine.

Kömtepe area (GP 24)

These anomalies are copper, they are in the sandstone - mudstone of the Atadoğdu Formation. It is not very important geochemically due to its low anomaly value.

East of Gülbahçe tepe (GP 25~27)

These anomalies are copper, lead, zinc, and molybdenum, the areas are distributed along the boundary of dacite, the anomaly of copper and molybdenum almost coincides with the distribution of dacite, but the distribution of copper and zinc is small. Though mineralization was not found by geological survey, anomaly areas are large and there is expected to be have mineralization around the anomaly areas.

Sin area (GP 28~34)

These anomaly areas are distributed near the Sin village and are scattered and small. The anomalies are copper, lead and zinc. Many anomaly areas are located around Sin dacite and are assumed to be caused by alteration related to the intrusion of Sin dacite. During geological survey, malachite stain and Cu-Pb-Zn veins were found. Due to their high values and large areas, they are significant geochemically. The anomalies of high value and small size are distributed in the north of this area. It is assumed that there is a network or mineralization of vein type in the dacite.

Siliç area (GP 39~42)

The molybdenum anomalies are characteristic in this area. These anomaly areas are related to mineralization also caused by Sin dacite. A small copper anomaly exists between the Munzur Formation and the Atadoğdu Formation, it is assumed to be located along a fault. There are also some other high anomaly areas around the dacite, but they are not extensive and therefore not considered important.

Maden tepe and North of Siliç area

These anomalies are in the Munzur Formation of the Permian. Copper is found near the Maden tepe, lead and zinc anomalies are in other areas.

The anomalies almost coincide with the distribution of limestone, so that it is assumed that the anomaly is caused by primary minerals in the sediments.

4-7 Conclusion

Many geochemical anomaly areas were found in this surveyed area and most of them coincide with ore deposits, mineralized zones, and alteration areas which were found by geological survey. Main anomalies are related to the dacite and quartz diorite. According to the geochemical survey, anomaly areas which indicate that the Mamlis mine is related to the Bulanık quartz diorite, and the Sin mine is related to Sin dacite, are first class anomalies in the survey area. Though anomalies in the Ağtaş and Gülbahçe areas are large in area and have high values, mineralization was not found by field survey. There are expected to be found by a detail geological survey in the future.

The geology of the area investigated is composed of Flysch-type sedimentary rocks overlying unconformably the Munzur Formation (Permian limestone), and dacite - andesitic pyroclastic rocks accumulated in Miocene. Intrusive rocks consist of quartz-diorite, diorite, hornblende-dacite, porphyry and andesite. They were most likely formed in Miocene. Mineral occurrences are divided into Sin type and Mamlis type, the former is characterized by disseminated ore with sphalerite-copper oxide, the latter by stockwork ore with sphalerite-galena (chalcopyrite). Sin mineralization was formed by the Sin dacite, while Mamlis ore resulted from the activity of Bulank quartz diorite. Because they are important in the investigated area, soil samples have been taken at intervals of 100 m, and detailed geological survey on a scale of 1 : 2,000 have been done.

Relation between chemical analysis and geological data requires further study especially at anomalous points which are known in both areas. However, those data merely offer information about the surface, it is necessary to get information about the rocks 200 ~ 300 m underground. Therefore we recommend the geophysical survey in both areas; the geophysical method to be used should be chosen after examination of rock properties. Areas to be covered by the geophysical survey are 3 km² in Sin and 5 km² in Mamlis area. The results of geological survey in 1978, the following were found:

1. Mineralization zone from Mamlis mine to Garipuşığı hamlet.
2. Wide-spread alteration zone around Kört mine.
3. Alteration zone found in Mehmet hamlet.

We recommend a geological and geochemical survey of these areas (Mamlis mine - Kört mine - Mehmet hamlet). Geological survey on a scale of 1 : 10,000 should be carried out to clarify the state of ore occurrence. Geochemical survey by Ridge and Spur method should be undertaken. Soil samples should be taken with a density of 12 samples 1 km², the area to be covered is about 50 km².

The above-mentioned mineralizations and alterations were formed by the Bulanik quartz diorite.

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