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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Turkey Investigation Report
(IR) TU-4

AEROMAGNETIC INTERPRETATION AND MINERAL INVESTIGATIONS IN THE EZİNE, ÇANAKKALE-KARABİGA, MARMARA, AND KAPIDAĞ AREAS OF NORTHWESTERN TURKEY

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U. S. Geological Survey
OPEN FILE REPORT 72-187
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1972

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ABSTRACT

Aeromagnetic surveys and mineral investigations are planned or in progress in ten areas of northwestern Turkey (fig. 1). This report reviews results obtained from August 1967 to January 1, 1968, through aeromagnetic interpretation and field investigations in four of the areas (Areas 2, 3, 4 and 5).

Aeromagnetic interpretation identified 27 prominent anomalies, 17 of which were checked in the field. The majority of these anomalies were found to be caused by minor amounts of magnetite in igneous rocks, including granite stocks, mafic flows, and mafic dikes. Other anomalies are caused by magnetite in metamorphic rocks or by topographic effects. However, massive magnetite boulders were observed in three adjoining localities (Anomalies E2, E3, and E4, fig. 2) in area 2, and magnetite partly replacing a limestone boulder was found in area 3 (Anomaly CK3, fig. 3). Further study of these magnetite exposures is planned.

In addition, two iron prospects and one lead prospect were briefly examined. All the prospects were considered small and not worthy of further study at this time.

INTRODUCTION

Purpose of project

This is the first of a series of progress reports planned for subproject 2 (Aeromagnetic Surveys and Mineral Investigations) of the cooperative mineral investigations project being undertaken by the Mineral Research and Exploration Institute of Turkey (MTA) and the U. S. Geological Survey (USGS). The project is being conducted under the auspices of the Agency for International Development (AID), U. S. Dept. of State, at the request of the Government of Turkey.

In accordance with project plans discussed by Jacobson, Cornwall, and Reinemund (written commun., 1967), subproject 2 aims to determine the possibilities for iron ore deposits in ten areas of northwestern Turkey (fig. 1) by means of interpretation of aeromagnetic maps, investigation of aeromagnetic anomalies on the ground, and detailed geologic studies of selected mineralized areas detected by the aeromagnetic surveys. Simultaneously, the subproject aims to provide training and experience for MTA personnel in all phases of mineral exploration.

Scope of investigation

Aeromagnetic surveys were started by MTA in the MTA-USGS project areas in August 1967. Subsequently, MTA prepared aeromagnetic maps for the Ezine (Area 2), Çanakkale-Karabiga (Area 3), Marmara (Area 4), and Kapıdağ (Area 5) areas (fig. 1). The authors interpreted the maps during November 1967 and investigated selected aeromagnetic anomalies in the field during December 1967. Additional fieldwork is in progress.

Acknowledgments

The authors are grateful for the guidance received from Dr. S. Alpan, General Director of MTA, Dr. M. Dizioğlu and Dr. R. Ovalioğlu. We also wish to thank the aircraft crew: Pilot F. Köroglu, navigator M. Uysal, and instrument operator I. Yükseker under the direction of M. M. Babayiğit, and the aeromagnetic map compilation staff under the direction of R. Özakçay for providing good quality aeromagnetic data. These men are to be particularly complimented for very accurate positioning of magnetic data on the aeromagnetic maps.

REGIONAL GEOLOGY

The areas described in this report, and the other areas where future work is planned (fig. 1), were chosen because they have similar geological characteristics favorable for iron mineralization. Each area contains one or more granitic masses that have been intruded into Paleozoic sedimentary and metamorphic rocks, including phyllite, quartzite, marble, sandstone, and limestone. The contacts of the intrusives with the carbonate rocks are considered particularly favorable exploration targets for contact-metasomatic iron deposits.

The granite intrusives and Paleozoic rocks are in part overlain by younger sedimentary rocks, volcanic rocks, and unconsolidated alluvium. The volcanic rocks include magnetite-bearing units such as basalt or andesite, which cause some of the aeromagnetic anomalies. In addition, localized exposures of serpentine and of mafic dikes commonly contain magnetite, and cause magnetic anomalies.

AEROMAGNETIC SURVEYS

Aeromagnetic surveys were started in the areas described in this report on August 8, 1967. The surveys totalled 15,438 line kilometers which were flown in 32 flight days. The flying was done by the MTA Aero Commander aircraft along flight lines 500 meters apart perpendicular to the principal geologic trends. Mean terrain clearance as determined from altimeter records was 700 feet.

Magnetic measurements were made with a proton nuclear precession magnetometer (Barringer Model AM 101) set at a sensitivity of ±5 gammas. Simultaneously, terrain clearance was measured by a radio altimeter and aircraft position was recorded by an Aeropath camera. A ground-monitor magnetometer was operated while the aircraft was flying to check the diurnal variation of the earth's magnetic field.

The magnetic data was initially plotted on a scale of 1:25,000 and magnetic contour maps were prepared at a 25-gamma contour interval. These maps were subsequently reduced to a scale of 1:100,000 (figs. 2-5).

The 1:25,000-scale maps were employed for the initial aeromagnetic interpretation.

AEROMAGNETIC INTERPRETATION

Interpretation methods

The aeromagnetic interpretation was aimed at the selection of aeromagnetic anomalies which possibly represent magnetic iron deposits of economic importance. The following procedure was employed:

1. Study of aeromagnetic maps, magnetic flight records, and radio altimeter records.
2. Correlation of magnetic data with regional geology as shown on MTA 1:100,000-scale geological maps.
3. Elimination of anomalies due to broad geologic features (for example, intrusives).
4. Elimination of very weak anomalies of a few hundred gammas.
5. Elimination of anomalies caused by topographic effects.
6. Detailed interpretation of the remaining anomalies using methods described by Smellie (1967), and Gay (1967).
7. Classification of the anomalies according to the apparent calculated depth below the surface of the geologic body causing the anomaly, and place all anomalies with a depth of less than 200 meters in a first priority group.
8. Field check of selected anomalies by means of simultaneous ground magnetic and geologic traverses.
9. Revision of the interpretations based on field data.
10. Selection of anomalies for detailed field investigation.

Ezine (Area 2) interpretation

Regional geologic maps (1:100,000) of the area show the presence of a large granite intrusive stock southwest of Ezine. The aeromagnetic map (fig. 2) reveals two broad connected magnetic anomalies (E 1(*) and E 5) roughly corresponding to the area of granite, indicating that accessory magnetite in the granite caused the anomaly.

Between the granite and the Agean seacoast most of the area is covered by soil, but boulders of marble and skarn were observed. In this area there are four very local sharp magnetic anomalies (E2, E3, E4, E6) which are evident on flight records but are too small to be shown on the magnetic-contour map (fig. 2). At three of these anomalous sites (E2, E3, E4), massive magnetite boulders 5-20 cm. in diameter were found, but no significant magnetic anomaly was detected during the field checks. Anomaly E4 is near the granite contact and anomalies E2 and E3 are 1 to 2 km. west of the contact. Presently available data do not indicate the presence of an important iron deposit, but a more detailed study of the area was started on February 21, 1968.

The magnetic anomalies in the southeastern portion of the map area (fig. 2) including anomaly E7, are probably due to accessory magnetite in a volcanic sequence which includes andesite, basalt, trachyte, tuff, and agglomerate, according to the regional geologic map.

Çanakkale-Karabiga (Area 3) interpretation

Area 3 (fig. 3) contains a diversified collection of aeromagnetic anomalies (table 1) which may be grouped according to their magnetic and geologic characteristics:

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*Numbered anomalies are also listed in table 1.

TABLE 1
List of aeromagnetic anomalies

Area	Aeromagnetic Anomaly No.(X)	Field examination performed	Apparent cause of anomaly
Ezine			
(area 2)	E 1	no	Magnetite in granite
	E 2 (L)	yes	Local massive magnetite
	E 3 (L)	yes	Local massive magnetite
	E 4 (L)	yes	Local massive magnetite
	E 5	no	Magnetite in granite
	E 6 (L)	yes	Unknown; anomaly not found on ground
	E 7	no	Magnetite in volcanic rocks
Çanakkale Karabiga (area 3)			
	CK 1	no	Magnetite in granite
	CK 2	no	Unknown; field examination planned
	CK 3	yes	Magnetite partly replacing limestone
	CK 4 (L)	yes	Magnetite in mafic dike
	CK 5 (L)	yes	Unknown; weak anomaly on ground
	CK 6	yes	Magnetite in andesite
	CK 7	yes	Unknown; anomaly not found on ground
	CK 8	yes	Magnetite in serpentine
	CK 9 (L)	yes	Unknown; anomaly not found on ground
	CK 10(L)	yes	Unknown; anomaly not found on ground
	CK 11(L)	yes	Magnetite in diabase (?) dike
	CK 12(L)	yes	Unknown; anomaly not found on ground
Marmara			
(area 4)	M 1	no	Magnetite in granite
Kapıdağ			
(area 5)	K 1	yes	Magnetite in metasediments
	K 2	no	Topography
	K 3	no	Topography
	K 4	yes	Unknown; very weak anomaly on ground
	K 5	yes	Magnetite in serpentine
	K 6	no	Topography
	K 7	no	Topography

Notes

(X) Numbers of anomalies shown on aeromagnetic maps

(L) Local anomaly detected as sharp point on aeromagnetic profiles but not shown on contour maps.

1. Anomalies related to large lithologic units. Anomaly CK1 (fig. 3) consists of a broad positive magnetic anomaly south of a broad negative anomaly. The area is underlain in part by granite and the anomaly is probably due to accesory magnetite in the granite. However, no field check was performed and further investigation on a low priority basis is suggested. Anomaly CK2 may also represent an intrusive, but a planned field check of the anomaly remains to be performed. Anomaly CK6 apparently is due to magnetite in andesite porphyry, and anomaly CK8 is due to magnetite in a northeasterly-trending, 350-meter wide serpentine belt.

2. Anomalies related to mafic dikes. Anomalies CK4 and CK11 (table 1) are both very local sharp magnetic peaks which were noted on the aeromagnetic profiles but are not shown on the magnetic contour map (fig. 3). At both anomalies mafic magnetite-bearing dikes (dolerite?) were observed.

3. Anomaly related to magnetite replacement of limestone. Anomaly CK3, in the southwest corner of area 3 (fig. 3), was examined briefly in the field; boulders of limestone partially replaced by magnetite were observed. A detailed study of the anomalous area is planned.

4. Anomaly CK7. The anomaly (fig. 3) consists of a weak positive peak detected on one flight line south of a weak negative peak detected on another flight line. A ground magnetic and geologic traverse was made between the flight lines to determine whether the observed aeromagnetic anomaly was part of a stronger anomaly between the flight lines.

The traverse (in an area covered by alluvium) confirmed the weak aeromagnetic anomaly, and no significant ground anomaly was detected.

5. Doubtful anomalies. Four anomalies (CK5, CK9, CK10, CK12) were represented by sharp points on the aeromagnetic profiles, but ground traverses failed to find a magnetic anomaly. At CK5 boulders of limestone and andesite were observed. CK9 and CK10 are in an area of granite, and CK12 is in an area covered by alluvium.

It is possible that these anomalies as well as others of the same type resulted from sporadic erratic readings in the airborne magnetometer.

Marmara (Area 4) interpretation

Marmara Island consists of marble with a central east-trending granite core. The aeromagnetic survey (fig. 4) shows the presence of a broad elongated magnetic anomaly (M 1) corresponding to the area of granite.

Kapıdağ (Area 5) interpretation

The Kapıdağ area was the first of the areas flown by a relatively inexperienced crew who deviated from terrain clearance specifications in an area of considerable relief. Among the aeromagnetic anomalies detected (fig. 5), four (K2, K3, K6, K7) resulted from flying too close to the ground in an area where traces of magnetite are present in metamorphosed sedimentary rocks. In addition, these anomalies have the characteristics of broad formational anomalies rather than anomalies caused by discrete magnetite deposits.

Two other anomalies were found to be related to local concentrations of magnetite of several percent in different rocks. Anomaly K1 is apparently due to magnetite in a metamorphosed sedimentary rock (argillite?), and anomaly K5 is apparently due to magnetite in serpentine(?) overlain by limestone.

In addition, anomaly K4 was examined in the field because of its favorable geological situation, even though the anomaly is weak. A very weak anomaly was also found on the ground. The anomaly may be due to very local magnetite concentration in an intrusive contact zone.

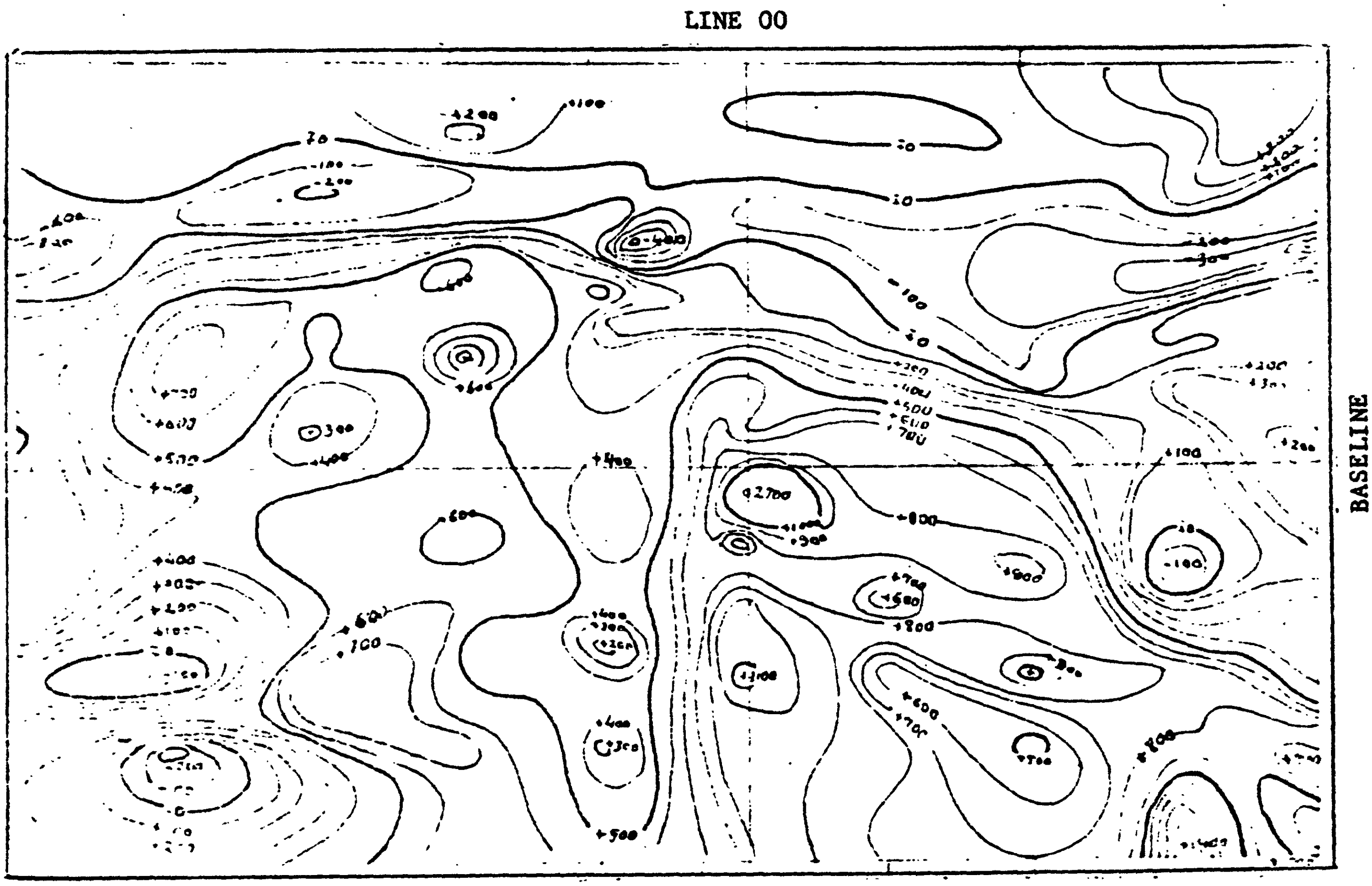
INVESTIGATIONS OF MINERAL PROSPECTS

Bakırlık Tepe (Gürece) iron prospect

The prospect was previously examined by MTA in 1945 and a ground magnetometer survey was recommended (Atabek, 1945). In the present investigation the prospect was examined because it is located between flight lines of the aeromagnetic survey, and a magnetic anomaly could have been missed. No anomaly was detected on the adjoining flight lines (fig. 3). The present investigation consisted of simultaneous geologic and magnetic traverses along traverse lines 100 meters apart over an area 900 meters long and 550 meters wide (figs. 6 and 7).

The Bakırlık Tepe prospect is located in the Çanakkale-Karabiga area (fig. 3) one km. northeast of the village of Gürece near the Biga-Lapseki highway. Bakırlık Tepe is a hill principally composed of granite and siliceous contact metamorphic rocks (fig. 6). Phyllite is exposed north and east of the area. Local outliers of limestone were also noted. Mineralization consists of very local magnetite in pits and in an old shaft in the center of the area.

The magnetic survey was conducted along traverse lines perpendicular to the base line (fig. 7). Measurements of vertical magnetic intensity were made at 25-meter intervals along traverse lines. Local one-station



Magnetic survey by: Hamit Karahacioglu

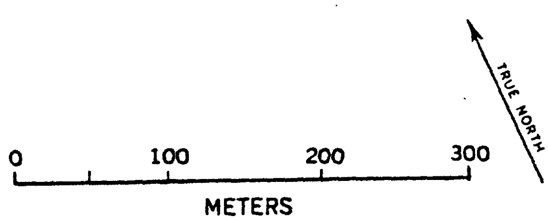


FIGURE 7. MAGNETIC MAP OF THE BAKIRLIK TEPE (GURECE) IRON PROSPECT SHOWING CONTOURS OF VERTICAL MAGNETIC FIELD AT 100 GAMMA INTERVALS

anomalies of 1100 and 2700 and 1400 gammas were detected (fig. 7), but the magnetic map as a whole shows variations of only a few hundred gammas. This magnetic pattern may reflect a few percent magnetite in some of the near-surface rocks or some very local magnetite bodies at a considerable depth.

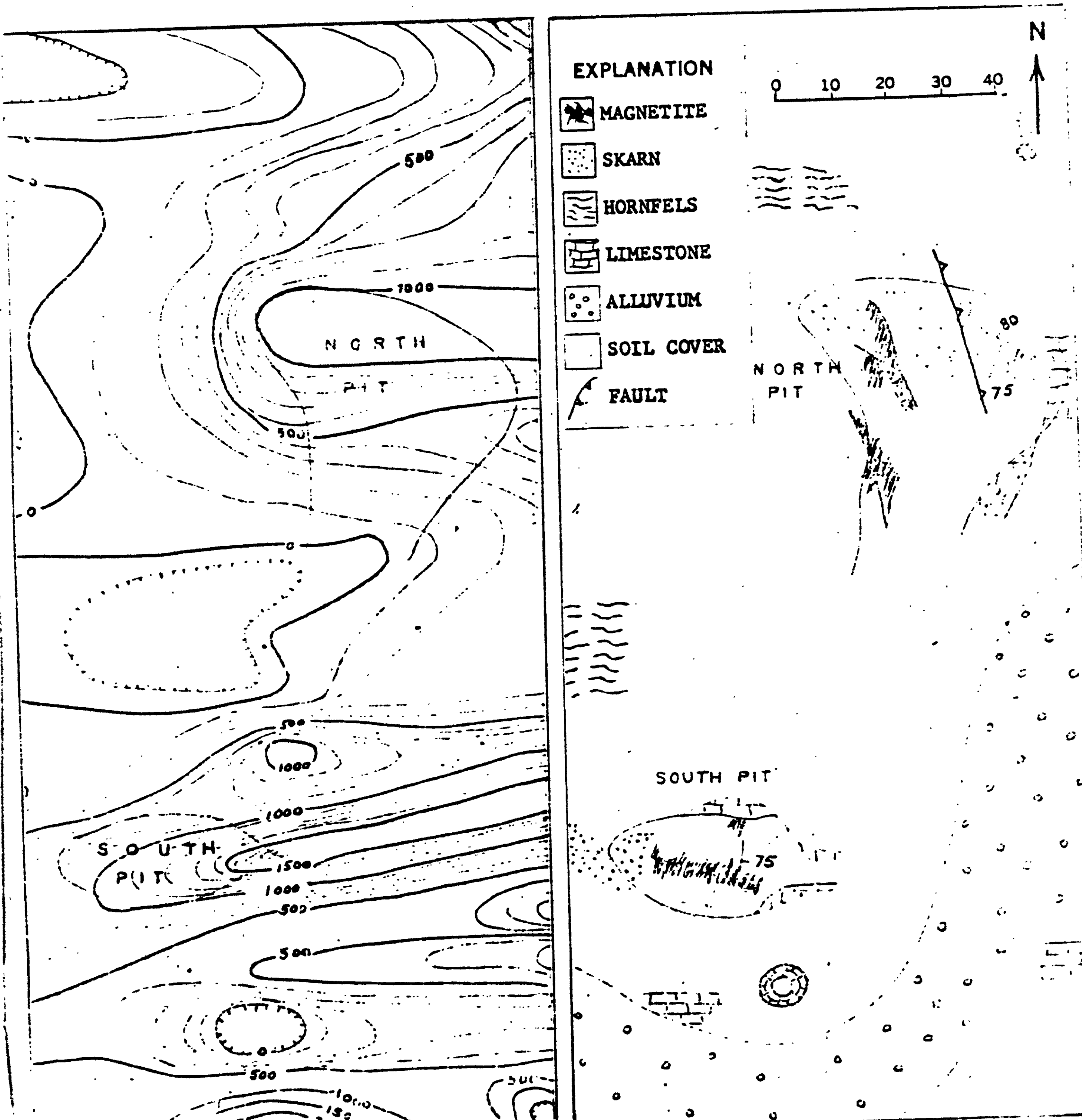
Because no evidence of the possible presence of an economic iron deposit was found, no further work is recommended at Bakırlık Tepe at the present time.

Hacıdede Tepe iron deposit

There are no previous MTA reports on this deposit and no aeromagnetic anomaly was detected in the vicinity. However, the deposit was examined because it is within the Çanakkale-Karabiga area (fig. 3) and because according to local residents it was an active mine from 1950 to 1957.

Hacıdede Tepe is located 1.5 km. northeast of Çakırlı village and is readily accessible by road. Magnetite was mined from irregular narrow lenses in two open pits (fig. 8) where the magnetite is surrounded by skarn, hornfels, and limestone. No igneous rocks were noted in the area. The magnetite is massive and is present in steeply dipping lenses about 5 meters wide.

The magnetic map of the area (fig. 8) is based on three north-south traverses 50 meters apart and does not show the individual magnetite lenses. The map does not however indicate two anomalous zones corresponding to the areas of the two pits. These anomalies extend east from the pits and indicate the possible presence of some additional magnetite mineralization, especially east of the south pit.



By Hamit Karahacioglu

MAGNETIC MAP - 100 GAMMA CONTOUR INTERVAL

By Necat Hatay

GEOLOGIC SKETCH MAP

FIGURE 8. GEOLOGIC AND MAGNETIC MAPS OF THE HACIDEDE TEPE IRON DEPOSIT

The small size of the known iron exposures, the relatively weak ground magnetic anomaly, and the absence of an aeromagnetic anomaly indicate that additional possible iron reserves are very small. Further study of the area is recommended only on a very low priority basis.

Bergas lead prospect

The Bergas prospect located 1 1/2 km. east of Bergas on the Ezine-Bergas road (fig. 2) consists of a series of old shafts and dumps. The mine workings appear to follow steeply dipping galena-bearing fractures in recrystallized white limestone north of an intrusive contact. The area is mostly covered by soil, and therefore four geochemical stream sediment reconnaissance samples were taken in the surrounding area to test whether an indication of additional heretofore undetected mineralization is present. Anomalous results were obtained in two samples from streams that drain the dumps, but no significant geochemical anomaly was obtained in the other samples. Further study of the area on a low priority basis is suggested.

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Gay, S. Parker, Jr., 1967, Standard curves for interpretation of magnetic anomalies over long tabular bodies: Mining Geophysics, v. 2, p. 512-48.

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APPENDIX: THE S. PARKER GAY METHOD OF AEROMAGNETIC INTERPRETATION

S. Parker Gay, Jr.'s method (Gay, 1967) has been used for interpretation f aeromagnetic profiles and for magnetic profiles obtained in the field.

The method gives approximate values for depth, position of the apex, ip, thickness, and the susceptibility of the geological body which causes he anomaly, assuming that it has a dikelike shape. Demagnetization correction lso can be made, if true susceptibility of the rock is measured.

Interpretation of magnetic profiles by curve matching has been used xtensively in the past, but to construct a curve that would match the agnetic profile in hand involves laborious mathematical work. In this ethod, Gay gives a mathematical transformation of magnetic components f the magnetic field and constructs a set of mathematical curves which escribe all the possible anomalies caused by a dike-like geological body.

The principal work in the method is to match the magnetic profile to ne of Gay's family of curves.

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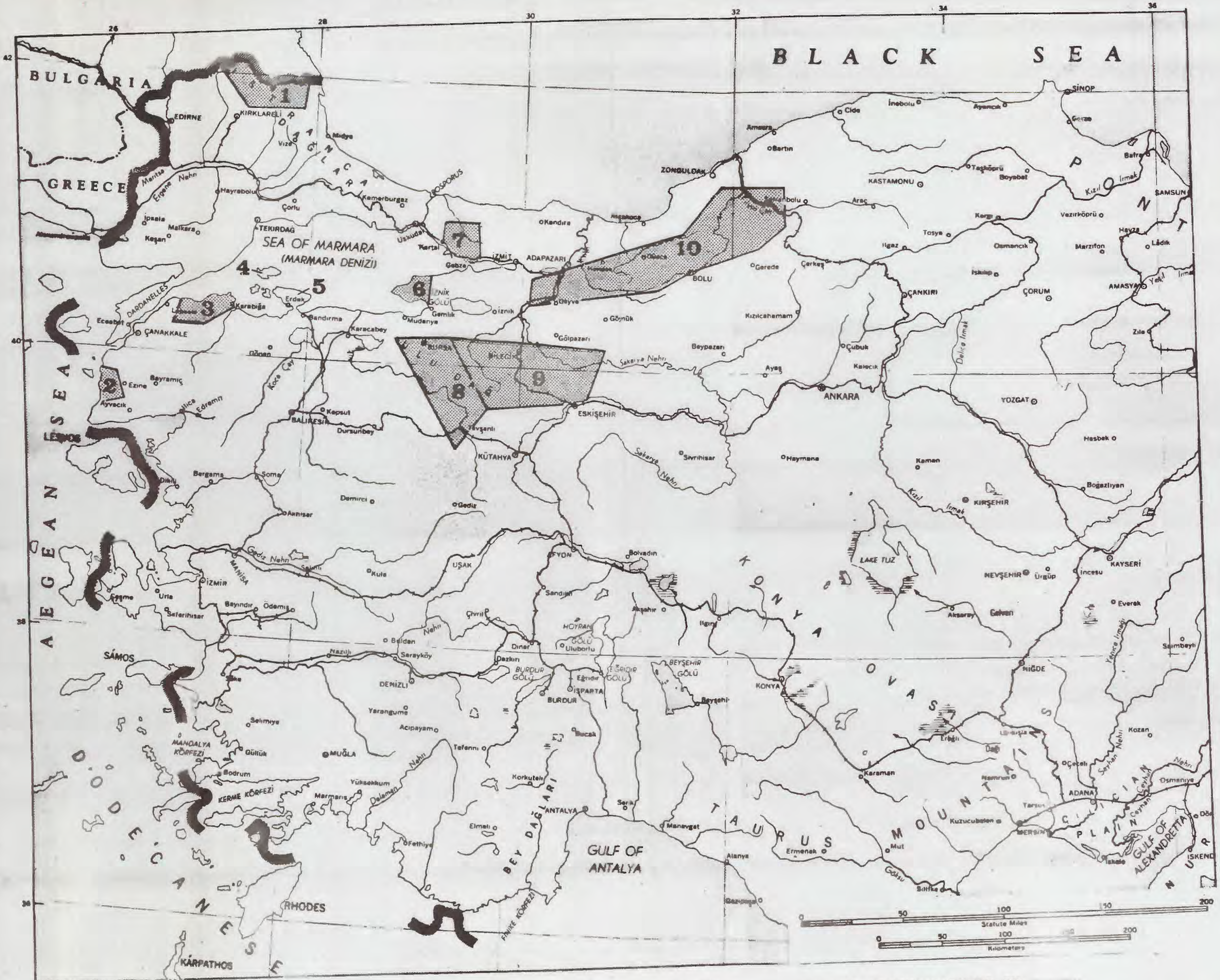

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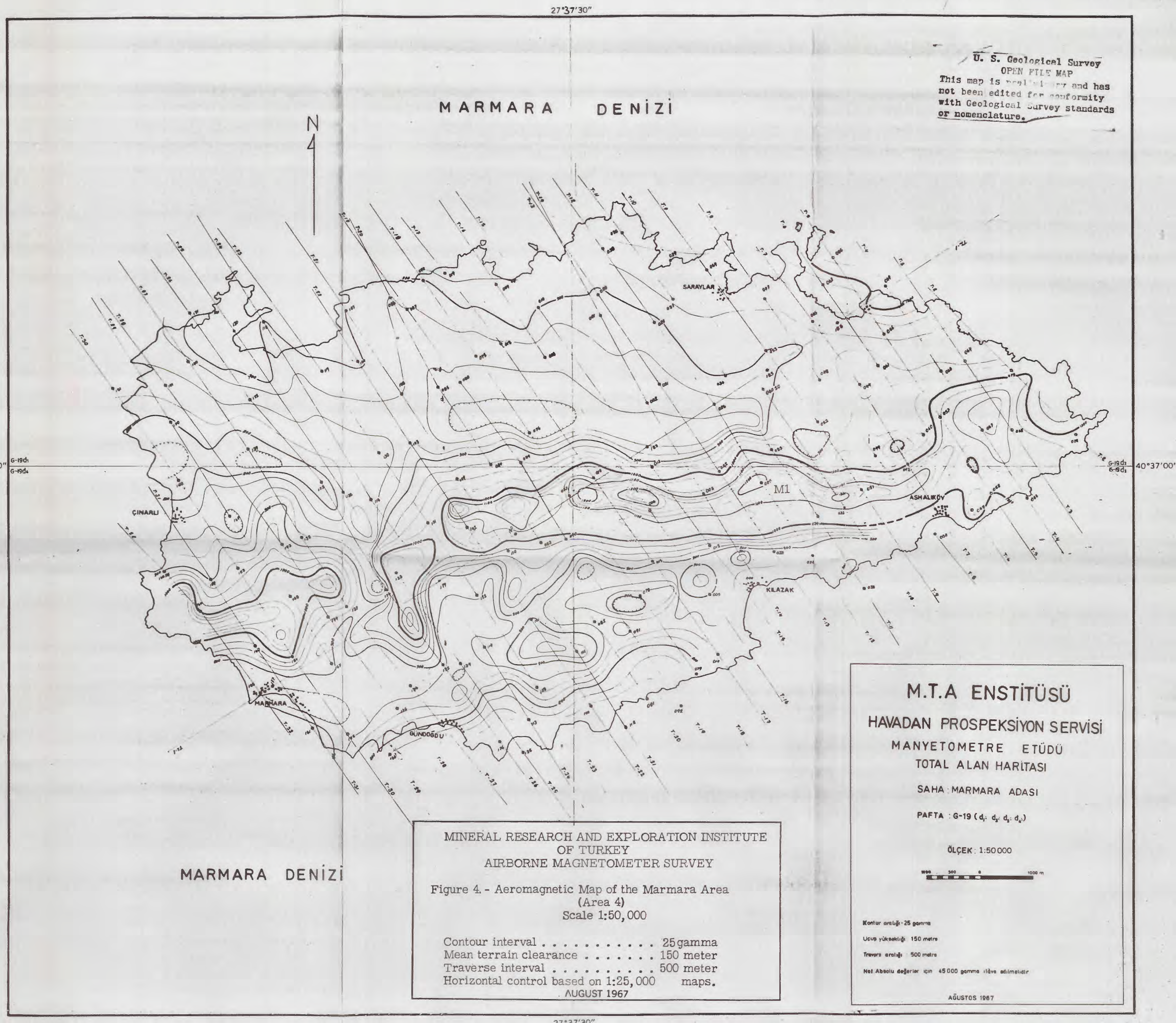

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AIRBORNE MAGNETOMETER SURVEY

Figure 4.- Aeromagnetic Map of the Marmara Area (Area 4)
Scale 1:50,000

Contour interval . . . . 25 gamma
Mean terrain clearance . . . . 150 meter
Traverse interval . . . . 500 meter
Horizontal control based on 1:25,000 maps.
AUGUST 1967

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MINERAL RESEARCH AND EXPLORATION INSTITUTE OF TURKEY
AIRBORNE MAGNETOMETER SURVEY
Figure 5 - Aeromagnetic Map of the Kapidağ Area (Area 5)
Scale 1:50,000
Contour interval 25gamma
Mean terrain clearance . . . . 150 meter
Traverse interval . . . . 500 meter
Horizontal control based on 1:25,000 maps.
AUGUST 1967
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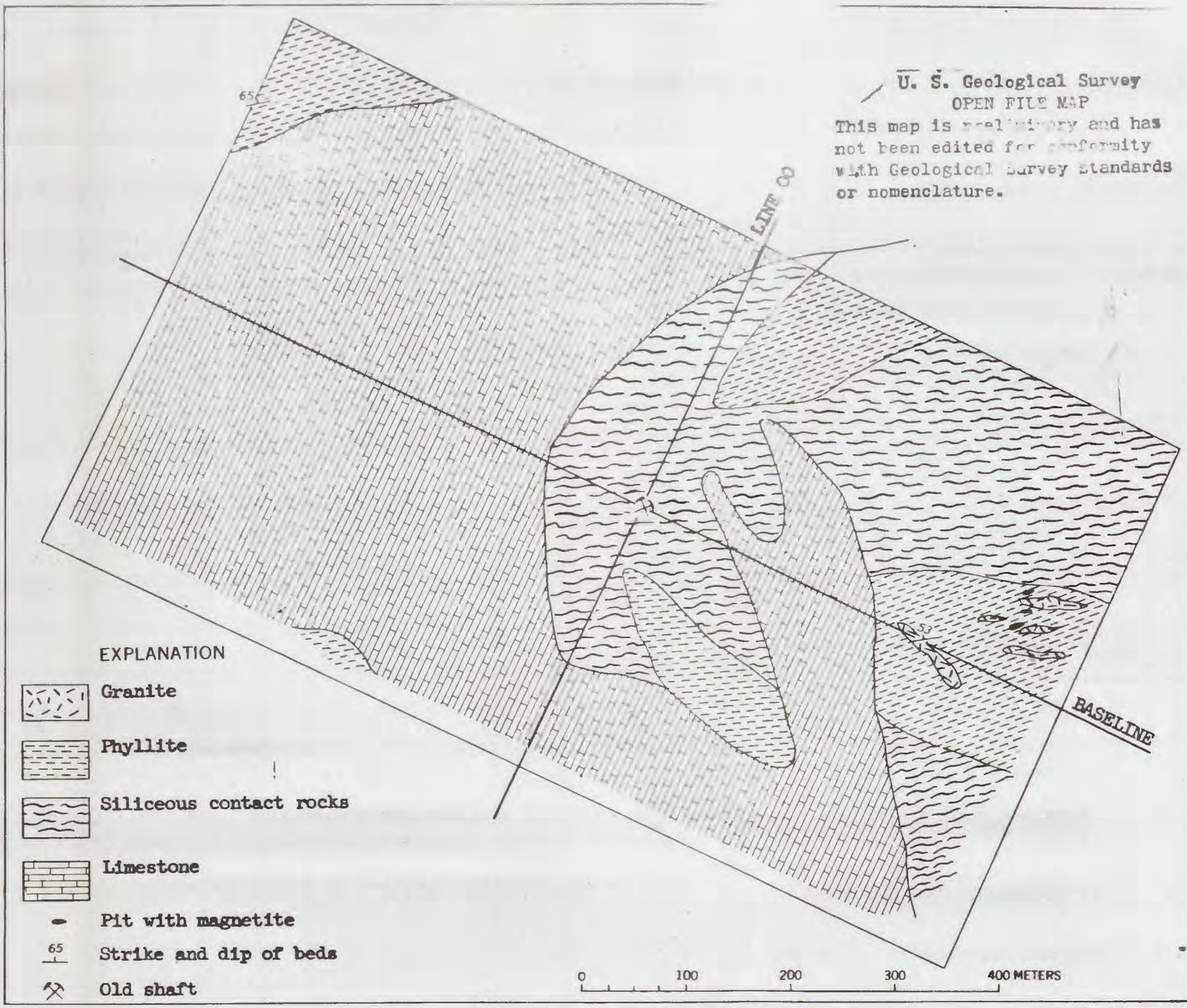

By Necat Hatay

Figure 6.-Geologic sketch map of the Bakirlik Tepe (Gurece) iron prospect.