UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Turkey Investigation Report
(IR) TU-21

GEOLOGY OF AREA A, ÇATAK IRON DEPOSIT, EĞRİGÖZ MOUNTAINS, KÜTAHYA PROVINCE, TURKEY

by

Patrick J. Barosh
U.S. Geological Survey

U. S. Geological Survey
OPEN FILE REPORT
This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature

1972

GEOLOGY OF AREA A, CATAK IRON DEPOSIT, EGRIGOZ MOUNTAINS KUTAHYA PROVINCE, TURKEY

by

Patrick J. Barosh
U. S. Geological Survey

CONTENTS

Page

BSTRACT.... 1

NTRODUCTION.... 2

GIONAL GEOLOGIC SETTING 3

THOLOGY.... 4

Igneous rocks.... 4

Quartz monzonite.... 4

Aplite.... 5

Metamorphic rocks.... 5

Quartzite-schist.... 5

Calc-silicate hornfels.... 6

Chloritic hornfels.... 7

Magnetite-bearing rock.... 7

RUCTURE.... 8

Attitudes of the metamorphic rocks.... 8

Joints.... 9

Shears.... 9

Faults.... 10

INERAL DEPOSITS.... 11

Lens A.... 12

Lens B.... 13

Lens C.... 14

Other deposits.... 15

Magnetometer survey.... 15

Origin of the magnetite.... 16

Relative grade 17

REFERENCES 19

APPENDIX A 20

ILLUSTRATIONS

Figure 1. Index map showing location of Catak iron deposit, Kütahya Province, Turkey 2a

2. Geologic map of Area A, Catak iron deposit, Eğrigöz Mountains, Kütahya Province .... In pocket

3. Geologic cross section .... In pocket

4. Eğrigöz massif, Çatak-Emet Magnetometer study, Area A .... In pocket

TABLE

Table 1. Chemical analyses of magnetite-bearing samples, Area A Çatak iron deposit 18

GEOLOGY OF AREA A, ÇATAK IRON DEPOSIT, EĞRIGÖZ MOUNTAINS, KÜTAHYA PROVINCE, TURKEY

by

Patrick J. Barosh, U. S. Geological Survey

ABSTRACT

The Çatak iron deposit consist of magnetite-bearing lenses distributed along the northeast-trending contact of the north end of the Eğrigöz granitic massif in Kütahya Province. Area A is near the northeast end of the deposit and contains three main irregular magnetite lenses. A body of calc-silicate hornfels, almost surrounded by quartzite and schist, lies a short distance from the contact with quartz monzonite and contains the magnetite-bearing lenses. A west-northwest to northwest-trending structural grain is expressed by schistosity, joints, shears, lithologic contacts and outcrop patterns, although the mineralized rock and general intrusive contact trend northeast.

The ranges of the average content of Fe, Si, and S, determined from drill data are: 33.54-53.95 percent; 5.86-12.25 percent; and 8.33-9.49 percent, respectively.

INTRODUCTION

The Çatak iron deposit is located along the northwest side of the Eğrigöz Mountains in Kütahya Province (fig. 1). It consists of magnetite lenses distributed along a 5-kilometer northeast-trending belt in the Kütahya J22-a1 and J22-a2 quadrangles.

Area A at the northeast end of the deposit includes several magnetite lenses, on steep forested slopes, that are mainly covered by colluvium. Average altitude is about 1330 meters. Area A can be reached from Değirmisaz, the nearest railhead, via 11 km of poor dirt road. Several opencuts, trenches, and pits in Area A attest to past interest in the deposit, but there is no record of any past production and little magnetite could have been shipped. Some, however, is stockpiled at two locations.

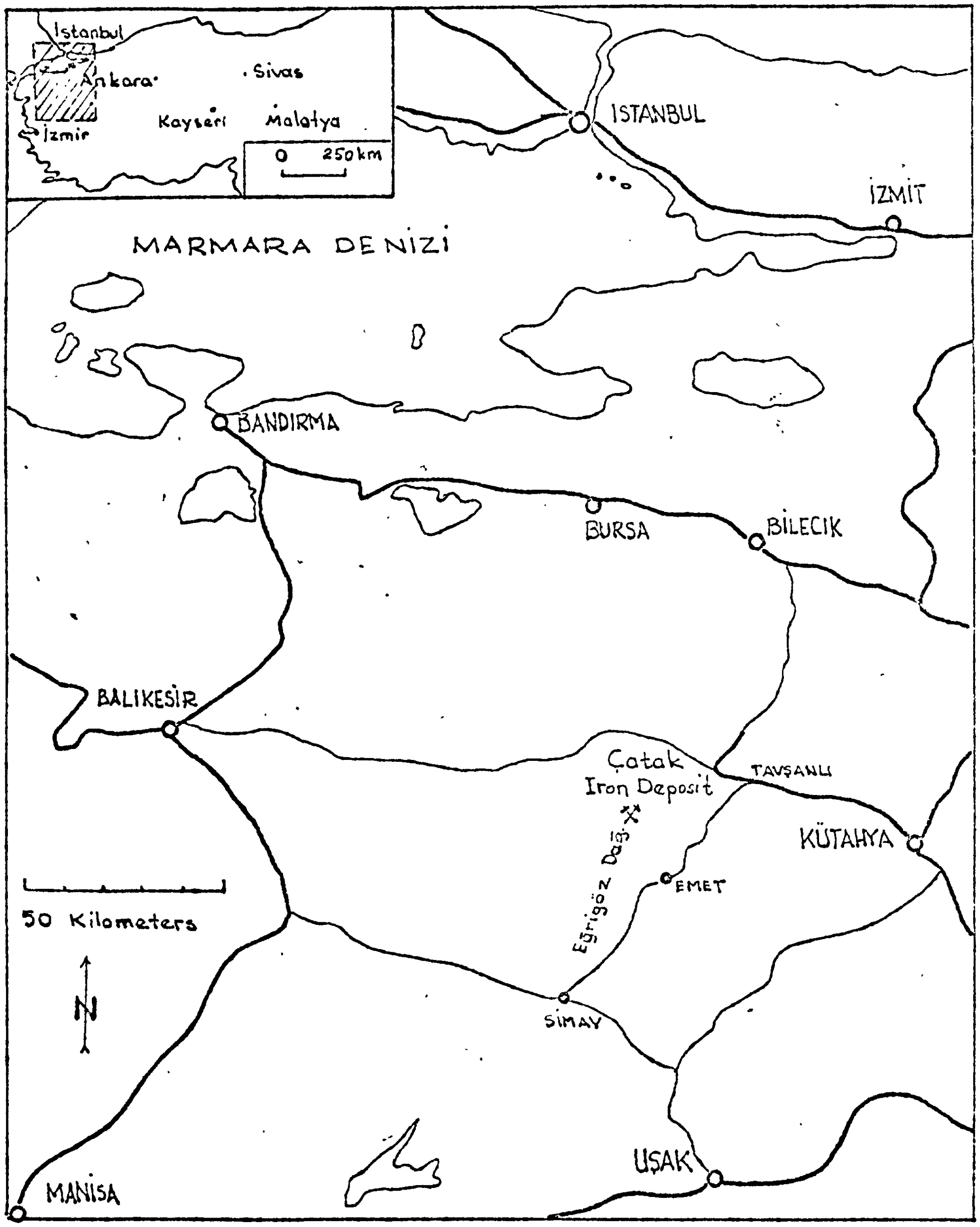
The Çatak deposit is briefly mentioned in several unpublished MTA reports. The most detailed information is given by Dr. Altan Gümüş (1967), who presented a geologic sketch map and notes on the deposit, and by Güner Aytuğ (1967) who produced similar maps and described the general geology.

On the basis of the 1967 reports and magnetometer surveys, MTA in May 1968 undertook a drilling program in the area. The study described herein was undertaken in June 1968, as part of a cooperative program of mineral resource appraisal by the Maden Tetkik ve Arama

ŞEKİL : 1
Figure

ÇATAK DEMİR MADENİNİN COĞRAFİ DURUMUNU GÖSTERİR HARİTA

Index map showing location of the ÇATAK iron deposit, western TURKEY



M.T.A. Arşiv No. 23186

Enstitüsü(MTA) and the U. S. Geological Survey(USGS) sponsored by the Government of Turkey and the Agency for International Development, U. S. Department of State.

An outcrop map was prepared during July 1968 on a 1:500 scale topographic map prepared by MTA. Most outcrops were located by tape from known survey points, but those at a distance from mineralized areas were measured by pacing.

REGIONAL GEOLOGIC SETTING

The Çatak iron-bearing lenses lie in a northeast-trending belt adjacent to the Eğrigöz granitic massif and consist of magnetite and some pyrrhotite. The country rocks northwest of the massif are regionally metamorphosed schists, quartzites, gneisses, and marbles.

The magnetite lenses in Area A are a short distance from a contact with quartz monzonite within calc-silicate hornfels that is almost surrounded by quartzite and schist. The calc-silicate hornfels grades into the quartzite and schist through a narrow irregular zone of chloritic rocks(fig. 2).

LITHOLOGY

Three main rock units are exposed in the area: intrusive granitic rock, metamorphic country rock composed of schist and quartzite, and calc-silicate hornfels containing magnetite lenses. In some outcrops two or three rock types are intimately intermixed and not readily divisible.

Igneous rocks

Quartz monzonite

Quartz monzonite of the Eğrigöz massif crops out in the south and south-east parts of the mapped area (fig.2) and was penetrated by drill hole A1' at a depth of 71.49 meters (1231.0 meters altitude) (fig.3). The rock is medium-grained; light gray and locally has a pinkish cast; it weathers slightly darker and limonite stains the fractures. It originally contained a few percent of biotite, much of which is altered to chlorite. Various types of quartz-bearing, light gray altered rock, stained by hematite and limonite, locally crop out near the contact. Most of these outcrops are altered quartz monzonite and aplite, but some may be altered hornfels.

The exposure in the southern part of the mapped area suggest that the contact between quartz monzonite and calc-silicate hornfels is an interfingering one with the digitations having a northwest trend. The contact in that area (fig.2) was drawn graphically to represent such relationship.

Aplite

In few places very light gray altered aplite crops out along the trail to the north of Yukari Karakütük tarlasi Fresh aplite float was noted on Yukari Karakütük tarlasi.

Metamorphic rocks

Quartzite-schist

The regionally metamorphosed rocks in the area range from quartzite to schist; most of the rocks are varieties of micaceous quartzite and quartzose schist. No boundaries between the varieties were located within the mapped area, and they appear to be part of a single sequence.

The more quartzose rocks, such as those west of point P 6 (fig.2), are light-gray, fine-grained quartzite having a few micaceous seams and minor disseminated mica. Irregular wavy lenticular laminae 1 to 2 mm wide and 2 to 5 cm long are present in places. One piece of float that has banding similar to the laminae appears to be a stretched-pebble conglomerate. The quartzite adjacent to calc-silicate hornfels locally contains minor chlorite.

An increase in mica content results in a schist containing thin alternating layers of quartz and mica. The schistose rock is light tan to medium gray, weathers darker and is stained by limonite. The layering is coarse in a few places, and the rock appears gneissic.

The quartzite-schist sequence was probably originally sandstone with silt or clay admixture, and perhaps minor pebble conglomerate.

Minor amounts of sericitic quartzite downslope from drill site A1 and dark-gray quartzitic hornfels along the road at the northwest edge of the map have been included with quartzite on the map.

Calc-silicate hornfels

Calc-silicate hornfels forms an irregular, northeast-trending body in the central part of the area. It is typically a dense, fine-grained, dark-green rock mottled with lighter shades of green and lesser amounts of brown; in places it is banded. It weathers slightly darker and has dark limonite and manganese stains on fracture surfaces. The rock is composed of epidote, garnet, chlorite, minor quartz, and probably diopside. Locally the hornfels is rich in garnet; in places it contains minor pyrrhotite, pyrite, and calcite veinlets. Very minor covellite and chalcopyrite are present at a few places in the calc-silicate hornfels penetrated by drill hole A1. Where chlorite is noticeable the calc-silicate hornfels is designated as chloritic on the map.

The hornfels commonly is slightly altered and, adjacent to some of the magnetite-bearing rock, is highly altered to a soft, punky, light-gray, yellow tan, or light-brown rock. The altered rock at a few places contains considerable limonite.

The calc-silicate hornfels probably is derived from a carbonate-rich rock that was intercalated in the quartzite-schist sequence.

Chloritic hornfels

An irregular discontinuous zone of fine-grained dark-green chloritic hornfels is gradational between typical calc-silicate hornfels and the quartzite-schist sequence. In a few places this variant of the calc-silicate hornfels contains minor pyrrhotite and pyrite.

Magnetite-bearing rock

The magnetite-bearing rock lies within the calc-silicate hornfels and is concentrated in three main lenses designated, from north to south, A, B, and C (fig. 4). The rock ranges from nearly pure magnetite to calc-silicate hornfels containing minor amounts of magnetite. The magnetite-rich rock in the A lens consists of massive, fine-grained magnetite and admixed pyrrhotite, pyrite, and minor calc-silicate minerals. It generally is readily distinguished from calc-silicate hornfels. The rock weathers to rounded outcrops stained by limonite and yellowish-green material derived from the weathering of sulfides, which usually has a noticeable odor.

The poorer grade of material in B lens contains a greater proportion of calc-silicate minerals, and some in C lens is difficult to distinguish from unmineralized calc-silicate hornfels.

STRUCTURE

Area A has a definite west-northwest to northwest structural grain expressed by schistosity, joints, shears, faults, lithologic contacts, and outcrop pattern. The mineralized rock and general intrusive contact, however, trend northeast.

Attitudes of the metamorphic rocks

The schistosity in the southeastern part of the mapped area strikes northwest and dips steeply southwest; that in the western part strikes northwest to north, and has moderately steep west dips. Laminae in the more quartzitic rocks, such as those east of drill hole A1, are very irregular and contorted and give little information on the general attitude of the rock. The western part of the area contains northwest-trending layers in which calc-silicate hornfels appears to be alternately predominant and subordinate. They could be an expression of original compositional differences and reflect relic bedding.

Joints

Joints are the most noticeable structural feature in the area and form a consistent pattern. There are three main joints sets which strike northwest, west-northwest, and west. Dips of all three joint sets are very steep. The west-northwest trending set appears to be slightly more prominent than the northwest-trending set, with which it is commonly associated. The west-trending set may be a variation of the west-northwest trend and not a distinct set. Locally in the northeastern part of the mapped area a minor east-northeast to northeast set is present. All the joint sets are parallel to known or inferred faults in the area.

Shears

Shears, or closely spaced parallel joint-like fractures along which minor movement is known or inferred, are noticeable in the northeastern part of the area where the exposures are relatively extensive. They dip steeply and have trends similar to those of the joint.

Two parallel shear zones extend northwest from near point P7 to P4 (fig.2), and a west-northwest-trending shear zone is exposed in the road cut southeast of point Py. An extension of the third zone toward drill hole Al would follow the contact with calc-silicate hornfels and would form the southern boundary for the extensive exposures of quartzite and schistose quartzite. A moderate amount of movement may have taken place along this zone.

Faults

Known and inferred faults have trends similar to those of the joints and shears, namely to the northwest, west-northwest, west, and east-northeast.

Abrupt cutoff of the outcrops and shearing indicate probable northwest and west-trending faults in the north-east part of the map. Another possible northwest-trending fault may lie along the road near point P6, as suggested by slight topographic and magnetic breaks. The A lens, south of point P8, is cut by numerous near-vertical west-northwest-striking faults. Southeast of the lens, the sharp cut off of an outcrop and a fault termination indicate a probable east-northeast-trending fault. A small fault may extend eastward from the B lens and some northwest-trending contacts near lens B could be faults.

A possible northwest-trending fault is suggested by the straight ravine southwest of C lens because outcrops end abruptly against the ravine. A southeasterly continuation of such a fault would pass near the north-west-trending contact of the quartz monzonite and could account for the apparent offset of the quartz monzonite contact.

MINERAL DEPOSITS

Highly irregular magnetite-bearing lenses form an outcrop belt that trends northeast, approximately perpendicular to the northwest-trending structural grain of the area. The northeast trend, however, parallels the regional trend of the quartz monzonite contact, and the magnetite-bearing belt may be related to this regional contact or to a stratigraphic horizon, although individual lenses within the belt appear to be controlled by the northwest-trending structures. The degree of stratigraphic control could not be determined. However, the lenses are within calc-silicate hornfels, which may have formed from a carbonate-rich zone.

The magnetite-bearing rocks are relatively well exposed in the area. They are resistant to erosion and offer less foothold for vegetation because of their weathering characteristics and sulfide content, and thus tend to crop out well. Three main magnetite-bearing lenses, A, B, and C (fig.4),and a few smaller masses are present.

Lens A

The magnetite-bearing A lens is approximately 73 meters long and, in the central part, 15 meters wide, and has a relief of 45 meters. Very steeply dipping, west-northwest-trending joints and faults appear to be important controls of the deposit. Most of the jointing is older than the magnetite, as the joints generally end abruptly at the contact of the magnetite; in places, banding parallel to the jointing is present in the magnetite-bearing rock. Also, many magnetite contacts are parallel to the joints. Faults locally have undergone post-magnetite movement. The main fault, which crosses the head of the opencut, is marked by a limonitic zone 20-50 cm thick. The fault dips 60° northeast (shown with apparent dip of 51° on fig. 3), which is more gentle than most of the faults in the area.

The A lens ends to the north at a roughly east-northeast-trending contact along which minor shearing is present. The lens, as a whole appears to be near-vertical in dip as suggested by banding, contacts, and topographic expression.

Vertical drill hole A1, north of the lens, did not intersect any magnetite but encountered only calc-silicate hornfels and, near the bottom, some quartzite (see Appendix A). Another hole, A1', which inclines 60° toward the lens from the same site, intersected several layers of pyrrhotite, magnetite, and calc-silicate mineral mixtures within the calc-silicate hornfels between 9.90 meters and 20 meters from the collar. The drill hole entered quartzite and schistose quartzite at 56.90 meters from the collar, and quartz monzonite at 82.55 meters (1231 meters altitude, 71.5 meters vertically below the surface). The inclined hole passed beneath the center of the exposed lens at an altitude of about 1256 meters, approximately 46 meters below the surface, without encountering magnetite, and demonstrated that the lens does not extend to this depth, 17 meters below the altitude of the lowest exposed outcrop of the lens. The magnetite-bearing rock penetrated in the upper part of the drill hole may be connected to the exposed lens along the fault (dip 40°) exposed southwest of point P10 (apparent dip of 31° shown on fig.3).

A direct connection of the calc-silicate hornfels quartzite contacts penetrated by the two holes gives an apparent northerly dip component of 45°.

Lens B

The magnetite-bearing rocks forming B lens are in an oval-shaped area, 46 meters by 30 meters, having a relief of 27 meters. Geologic controls are not as clear for B lens as for A lens, and faults are much less obvious. Almost all exposed contacts, however, follow either the northwest or west-northwest joint directions and are nearly vertical.

Two holes were drilled near the edges of the B lens. Drill hole A2, a vertical hole at the upper exposed edge of the lens, penetrated magnetite-bearing rocks in the first 6 meters and calc-silicate hornfels in the remainder of the hole to a depth of 33.70 meters, which suggests there is no buried southeast extension of the lens. Drill hole A4 is located a short distance north of the lower northern edge of the lens. It dips 50° toward[1/] the lens and penetrated calc-silicate hornfels and three layers of magnetite at depths between 10.15 and 13.78 meters from the collar. This is consistent with a near-vertical northern boundary and a downward extension of the northern edge of the lens from a surface elevation of 1276.7 meters to a little below 1267 meters. However, no additional magnetite layers were penetrated in the rest of the hole, which probably passes about 18 meters below the center of the exposed lens, indicating that the lens has no great downward extension.

Lens C

The magnetite-bearing C lens is bi-lobed in shape. The northwest end is about 30 meters by 18 meters, and the southeast end 25 meters by 15 meters. The total relief is 33 meters, 17 meters on the northwest end, and 16 meters on the southeast end. The controls of the lens are not clear, although some of the exposed contacts parallel joint directions.

1/ Presumed, as direction is not given in log.

Drill hole A3 was put down 42.60 meters from near the center of the southeast lobe and penetrated magnetite-bearing rocks in only the top 3 meters, indicating an average thickness of 1 1/2 to 2 meters for this lobe.

Other deposits

Several minor deposits of magnetite-bearing rock are present in the southeastern part of the area. A cluster of small magnetite-bearing outcrops west of the stream gully west of the C lens are thought to be separated from the C lens by a fault and are probably a separate small deposit.

A very thin west-northwest trending layer of magnetite-bearing rock crops out about 40 meters south of the C lens and small outcrops containing magnetite are about 60 meters southwest of the C lens.

Magnetometer survey

The belt of magnetic anomalies is generally coincident with exposed magnetite-bearing rocks, and all the anomalies are confined to the belt of calc-silicate hornfels. No anomalies are present northeast or southwest of the exposed ends of the mineralized zone, or northwest or southeast of the zone.

The magnetic irregularities (fig.4) reflect irregularly scattered magnetite-bearing rock. The A lens shows up distinctly as a positive anomaly. B lens is not quite as distinct. It straddles the slope between a positive and negative anomaly; most of the exposures lying in the negative anomaly. C lens is even less distinct as no southern boundary is indicated. It also straddles positive and negative anomalies, although the greater part of the exposure lies in the positive anomaly. The broad lobe of the positive anomaly extending southwest from the C lens may indicate other magnetite-bearing rocks in addition to the two outcrops shown. The three magnetite-bearing outcrops 60 meters southwest of C lens show up as the north end of a positive anomaly.

The magnetic map does not indicate any significant extensions of A lens. The anomaly over B lens suggests possible small extensions of the magnetite deposit to the west and southeast. Likewise C lens might extend farther south, but judging from the surface geology, small isolated low-grade deposits are more probable. Most of the positive anomaly 60 meters southwest of C lens is based on only one reading and the actual anomaly may be much smaller.

Origin of the magnetite

The magnetite-bearing lenses are contact-metasomatic deposits that are thought to have formed as a replacement of a carbonate-rich rock or calc-silicate hornfels.

The belt of magnetite trends northeast as does the calc-silicate hornfels, perhaps reflecting stratigraphic control. The individual lenses trend northwest, apparently as a result of local control by northwest-trending structures.

Relative grade

The percentage of magnetite in the magnetite-bearing rocks decreases to the southwest, and the silica content increases. Lenses B and C are of poorer grade than lens A. This is reflected in the outcrop appearance. Parts of the B lens and much of C lens take on the weathering characteristics of contact silicate hornfels, including the preservation of joints. The content of sulfides, pyrrhotite, and some pyrite is high but also decreases to the southwest and may remain in the same proportion to the decreasing amount of magnetite.

Chemical analyses were made by the MTA laboratories of samples of magnetite-bearing intervals sampled in the drill holes (see table 1). The ranges of the average grade for each drill hole are:

Fe	33.54-53.95	Percent
SiO_2	5.86-12.25	"
S	8.33- 9.49	"

These magnetite-bearing rocks would require beneficiation and an admixture of non-sulfide-bearing ore in order to be utilized.

TABLE 1- Chemical Analyses of magnetite-bearing samples, area A, Catak Iron Deposit

Drill Hole	Interval	Fe (Percent)	SiO_2 (Percent)	S (Percent)
A1	Average	49.76	5.86	8.74
A2	Average	33.54	12.25	8.47
A3	Average	44.20	10.81	9.49
A4	10.95-11.25 meters	55.78	7.16	5.27
	11.95-13.20 meters	52.13	6.46	11.38
	Average(2)	53.95	6.81	8.33

REFERENCES

Aytuğ, Güner, 1967, Çatak iron occurrences: MTA unpub. rept. no. 857, 1:25,000 and 1:10,000-scale geologic maps, and 1:10,000-scale geologic cross section (in Turkish).

Gümüs, Altan, 1967, Çatak (Simav-Dağardi) magnetite-pyrrhotite occurrence: MTA unpub. rept. no. 732, 4 p.; index map; 1:25,000-scale geologic map (in Turkish).

APPENDIX A

Simplified drill logs from Area A, Çatak (drill holes A2, 3 and 4 logged by Güner Aytuğ and Ali Dinçel)

A1: Coordinates E.83517, N.67970

Altitude, top, 1302.5 meters, bottom, 1222.5 meters; length 80.000 meters.

Dip:90°; date 17-6-68 to 5-7-68

Log interval	Lithology
0-2.00	Colluvium
2.00-77.70	Calc -silicate hornfels; minor disseminated pyrrhotite and pyrite and traces of magnetite.
77.70-80.00	Quartzite.

A1':Coordinates E.83517, N.67970

Altitude, top 1302.5 meters,bottom 1222.6 meters; length 92.25 meters.

Dip 60°, direction S.18°E; date 6-7-68 to 8-8-68

Long interval	Lithology
0-1.50	Colluvium.
1.50-9.90	Calc-silicate hornfels; minor quartzite.
9.90-10.30	Pyrrhotite and magnetite.
10.30-11.60	Calc-silicate hornfels;minor pyrrhotite
11.60-12.15	Magnetite, pyrrhotite and calc-silicate hornfels.

A3: Coordinates E.83459.7, N.67831.1

Altitude, top 1308.3 meters, bottom 1265.7 meters;

length 42.60 meters

Dip 90°; date 2-9-68 to 16-9-68

log interval	Lithology
0-1.45	Magnetite
1.45-1.95	Calc-silicate hornfels.
1.95-3.00	Magnetite
3.00-42.60	Calc-silicate hornfels with local minor magnetite.

A4: Coordinates E.83469.7 N.67899.5

Altitude, top 1276.7 meters, bottom 1243.6 meters;

length 43.15 meters.

Dip 50°, direction unknown; date 23-9-68 to 7-10-68

Log interval	Lithology
0-10.15	Calc-silicate hornfels.
10.15-11.25	Magnetite
11.25-11.95	Calc-silicate hornfels
11.95-13.20	Magnetite
13.20-13.50	Calc-silicate hornfels.
13.50-13.78	Magnetite.
13.78-43.15	Calc-silicate hornfels.

log interval	Lithology
12.15-13.00	Calc-silicate hornfels
13.00-13.65	Magnetite; minor calc-silicate hornfels
13.65-14.55	Calc-silicate hornfels
14.55-16.00	Pyrrhotite; calc-silicate hornfels and magnetite.
16.00-17.15	Calc-silicate hornfels and minor pyrrhotite.
17.15-17.85	Pyrrhotite; calc-silicate hornfels and magnetite.
17.85-18.30	Calc-silicate hornfels
18.30-20.00	Magnetite; calc-silicate hornfels and pyrrhotite.
20.00-56.90	Calc-silicate hornfels;minor pyrrhotite and pyrite.
56.90-78.60	Quartzite; schistose quartzite and schist.
78.60-82.55	Choloritic hornfels;minor pyrrhotite,pyrite and magnetite in lower part.
82.55-92.25	Quartz monzonite, altered.

A2: Coordinates, E.83484, N.67863.8

Altitude, top 1302.7 meters, bottom 1269.0 meters;length 33.70 meters.

Dip 90°; date 12.8.68 to 3-9-68

log interval	Lithology
0-3.00	Calc-silicate hornfels
3.00-6.00	Calc-silicate hornfels and magnetite
6.00-33.70	Calc-silicate hornfels.