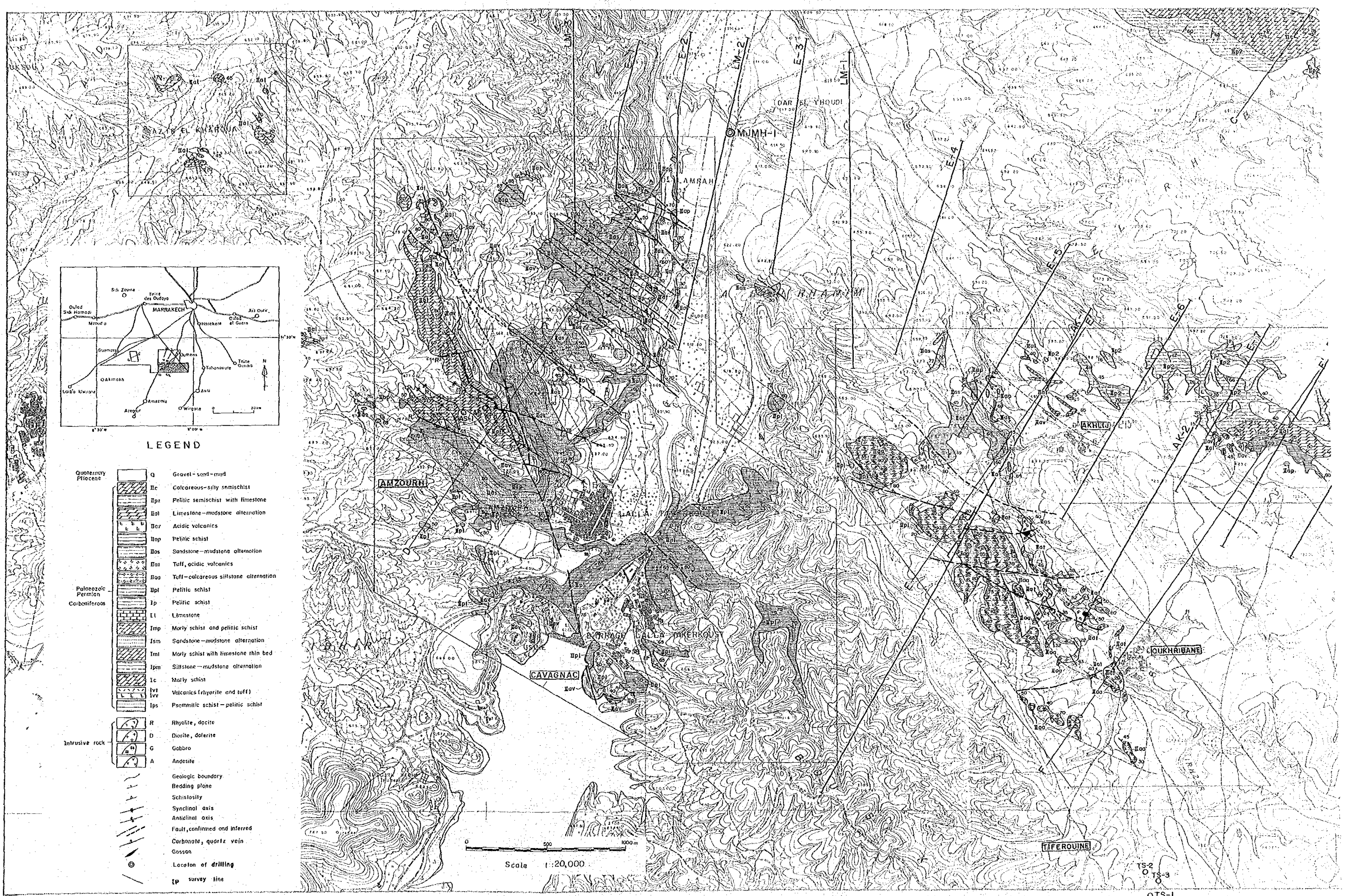


LEGEND
Quaternary Pliocene
Q Gravel-sand-mud
IIc Calcareous-silty semischist
IIpz Pelitic semischist with limestone
IIal Limestone-mudstone alternation
IIav Acidic volcanics
IIap Pelitic schist
IIas Sandstone-mudstone alternation
IIat Tuff, acidic volcanics
IIaa Tuff-calcareous siltstone alternation
Palaeozoic Permian Carboniferous
IIpl Pelitic schist
Ip Pelitic schist
Il Limestone
Imp Marly schist and pelitic schist
Ism Sandstone-mudstone alternation
Iml Marly schist with limestone thin bed
Ipm Siltstone-mudstone alternation
Ic Marly schist
Ivt Ivv Volcanics (rhyorite and tuff)
Ips Psammitic schist-pelitic schist
Intrusive rock
R Rhyolite, dacite
D Diorite, dolerite
G Gabbro
A Andesite
Geologic boundary
Bedding plane
Schistosity
Synclinal axis
Anticlinal axis
Fault, confirmed and inferred
Carbonate, quartz vein
Gossan
Location of drilling
IP survey line
MARRAKECH
AMZOURH
CAVAGNAC
AKHLIJ
OUKHRIBANE
TIFEROUINE
BARRAGE LALLA TAKERKOUST
MJMH-1
DAR EL YHOUDI
LM-1
LM-2
E-2
E-3
E-4
E-5
E-6
AK-1
AK-2
TS-2
TS-3
OTS-1
Scale 1:20,000
0 500 1000m

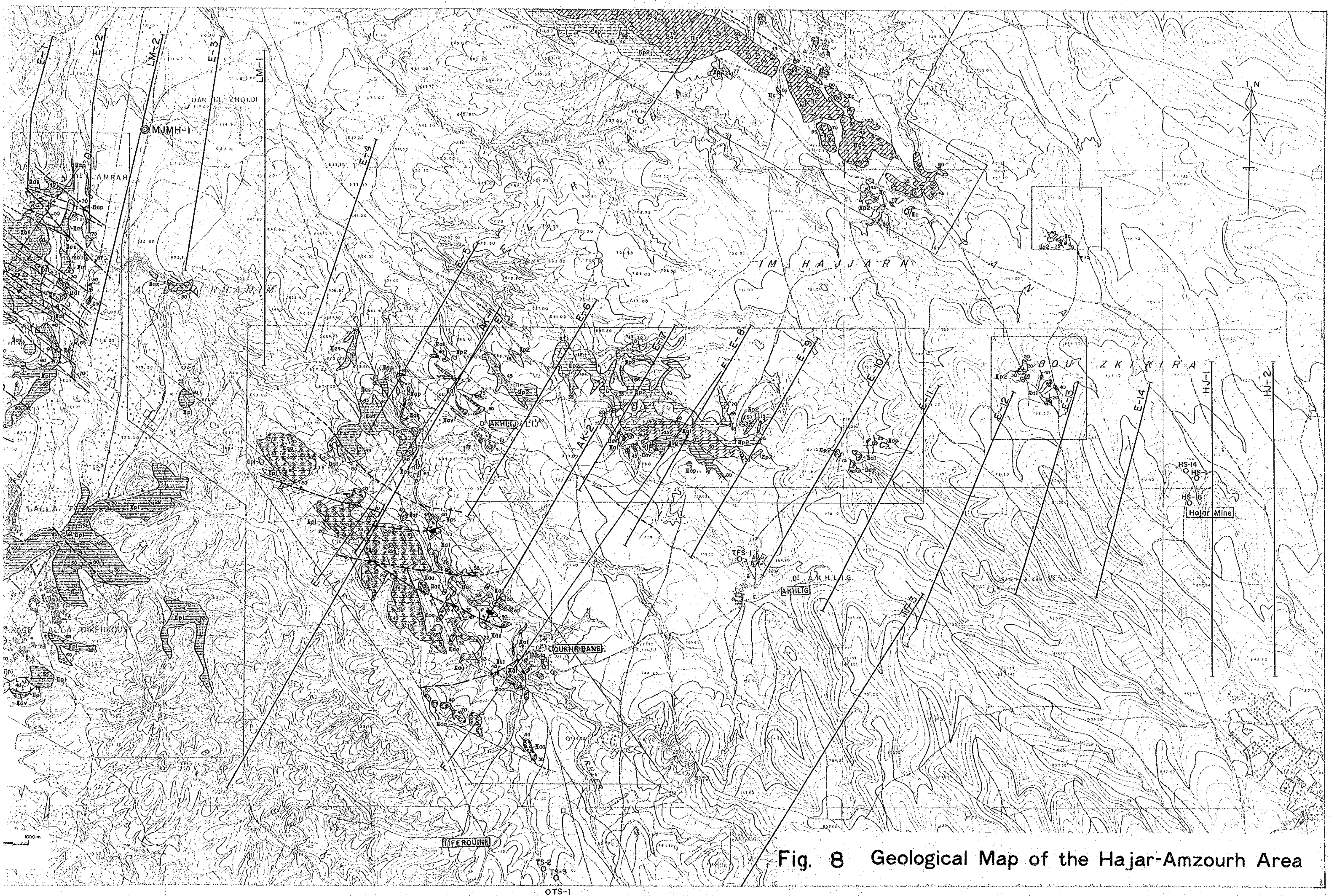


Fig. 8 Geological Map of the Hajar-Amzourh Area

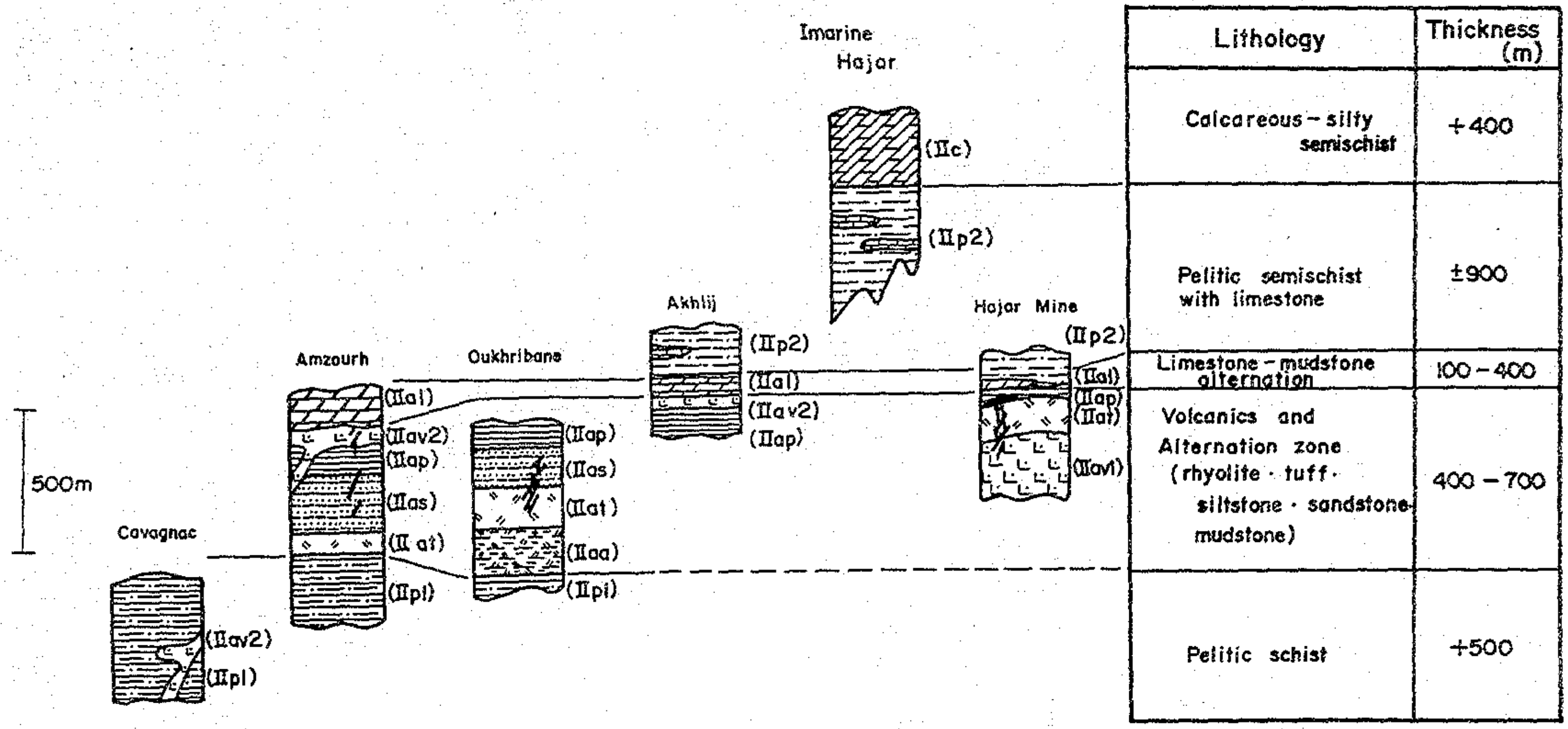


Fig. 9 Schematic Geological Column of the Hajar-Amzourh Area

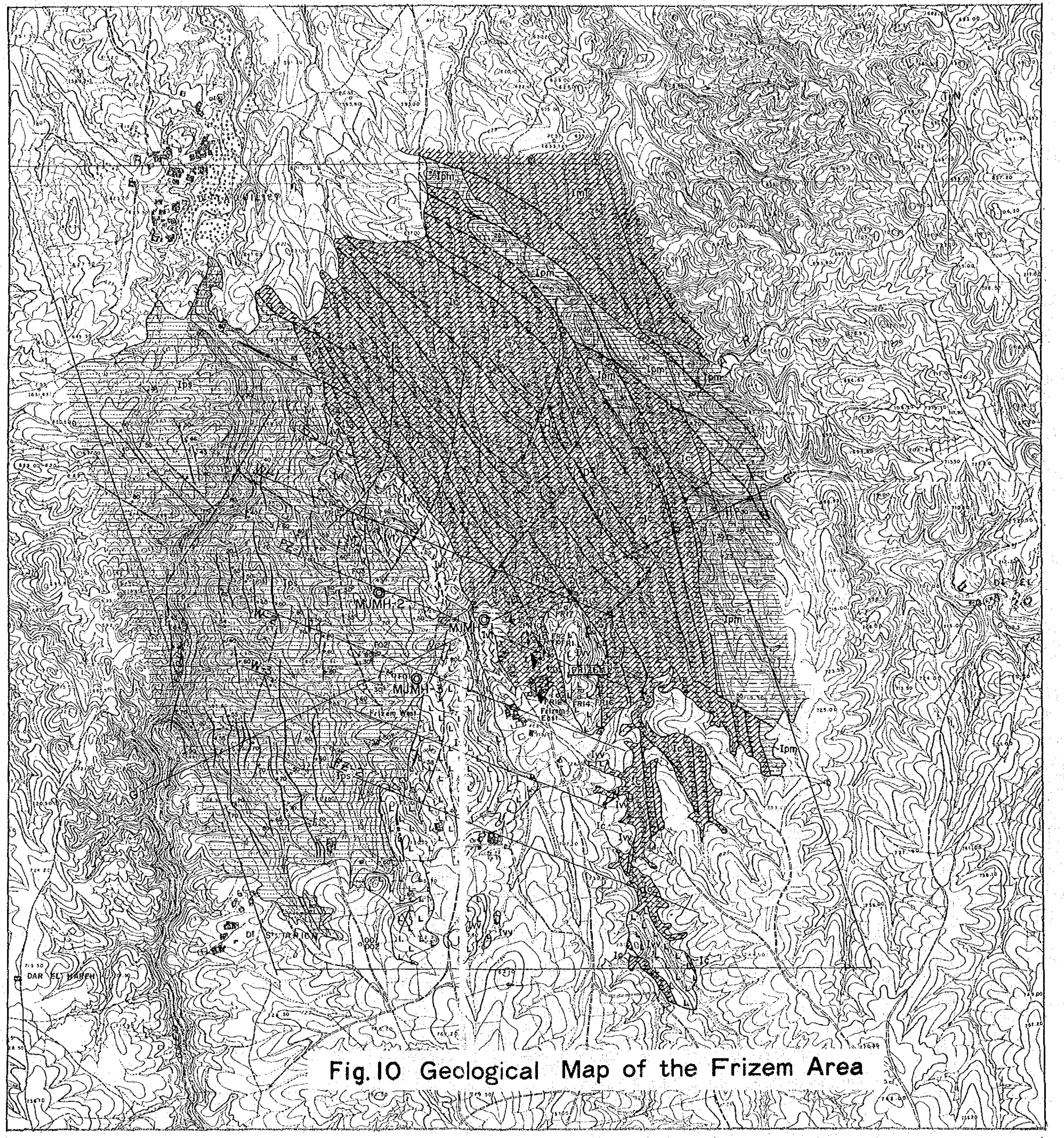
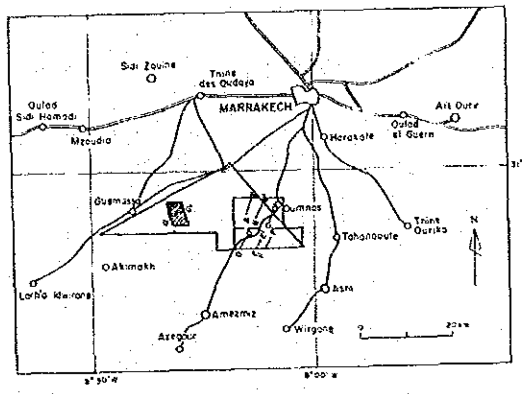
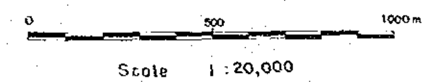
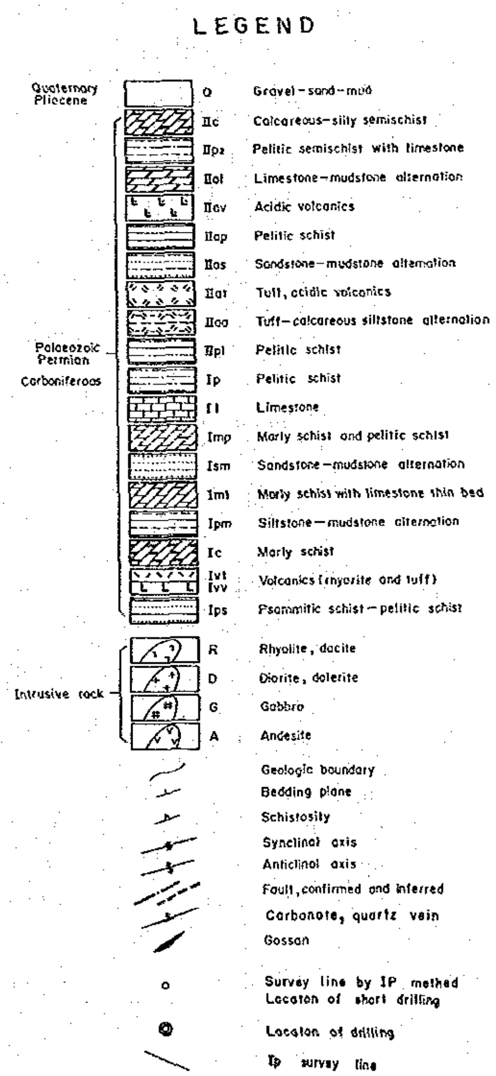


Fig. 10 Geological Map of the Frizem Area







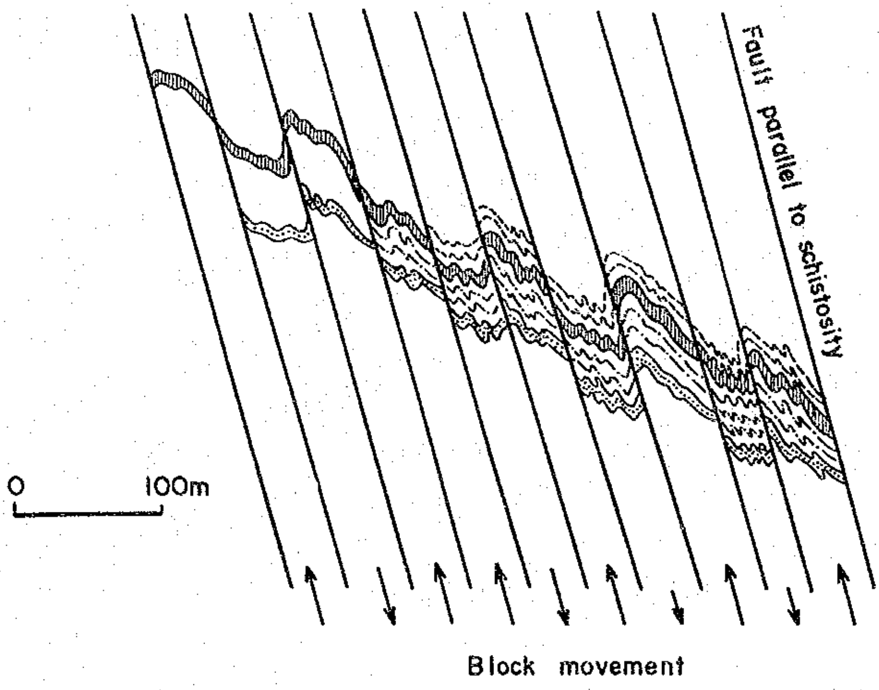


Fig. 11 Schematic Model of Drag Fold (Section)

Tab. 2 List of Mineralized Zones

No	Name	Type of Indication	Location	Com-modi-ty	Shape of Ore body	Type of Minerali-zation	Host Rock		Scale of Ore body (m)	Scale of Zone (m)	Strike and Dip	Grade of Ore	Ore Mineral	Gangue Mineral	Remarks
							Fm. #	Rock							
1	Hajar Deposit	Magnetic Anomaly	Hajar	Cu Pb Zn Ag	massive	sedi-mentary	II at	Tuff	100×400 ×500	+500	NW-SE, 50° NE	Ag= 74ppm Cu= 0.86 % Pb= 2.78 % Zn= 9.45 %	Cp·Gl Sp·Po Py	Qt·Talc Chl·Ser Cal	DDH = 27holes Shaft= 235 m Adit = 293 m
2	Oukhribane-E	Gossan	Oukhribane	Cu Zn	network	fissure-filling	II at	Tuff	20×60	+100	NW-SE, 80° NE	Ag= 0.3ppm Cu= 0.06 % Pb= tr Zn= 0.01%	Hm·Ge	Qt	
3	Oukhribane-W	Gossan	Akhilj	Cu Zn	network	fissure-filling	II at	Tuff	20×70	+100	WNW-ESE 80° NE	Ag= 0.3ppm Cu= 0.06 % Pb= tr Zn= 0.01 %	Hm·Ge	Qt	
4	Tiferouine	Magnetic Anomaly	3km S from Akhilj	Cu	dissemi-nation	replace	II p	Slate	20				Cp·Py Mg·Po	Qt	DDH = 3holes
5	Tifratine		Akhlig	Pb Zn	dissemi-nation	sedi-mentary	II at	Tuff	?			Ag= 7ppm Cu= 0.01 % Pb= 0.2 % Zn= 0.6 %	Sp·Po	Qt	DDH = 1hole
6	Amzourh	Gossan	Amzourh	Cu Pb Zn	dissemi-nation	fissure-filling	II av	Vol-canic Rock	2×20	+500	NW-SW 80° NE	Ag= 8ppm Cu= 0.85 % Pb= 1.77 % Zn= 1.17 %	Hm·Ge Cu-Ox	Qt·Cal	DDH = 2holes
7	Frizem-E	Gossan	Frizem	Cu Pb Zn	dissemi-nation	sedi-mentary replace	I c	Marl Slate	10×40	+500	NNW-SSE 30° E	Ag= 15ppm Cu= 0.36 % Pb= 0.63 % Zn= 1.76 %	Cp·Gl Sp·Py Po	Sid·Qt Cal	DDH = 9holes
8	Frizem-W	Gossan	Frizem	Cu Pb Zn	dissemi-nation	fissure-filling	I ps	Slate	2×50	+700	NNW-SSE 50° E	Ag= 5ppm Cu= 2.25 % Pb= 0.81 % Zn= 1.63 %	Hm·Ge Cu-Ox	Qt·Sid Cal	DDH = 1hole
9	Mjed	Gossan	6km E from Frizem		dissemi-nation	replace	I I	Lime-stone	2×50	+300	NNW-SS E 80° E	Ag= 1ppm Cu= tr Pb= tr Zn= 0.01 %	Hm·Ge Po	Sid·Qt	DDH = 1hole

Cp : Chalcopyrite
Gl : Galena
Sp : Sphalerite
Po : Pyrrhotite
Py : Pyrite

Mg : Magnetite
Hm : Hematite
Ge : Goethite
Ox : Oxide

Qt : Quartz
Chl: Chlorite
Ser: Sericite
Cal: Calcite
Sid: Siderite

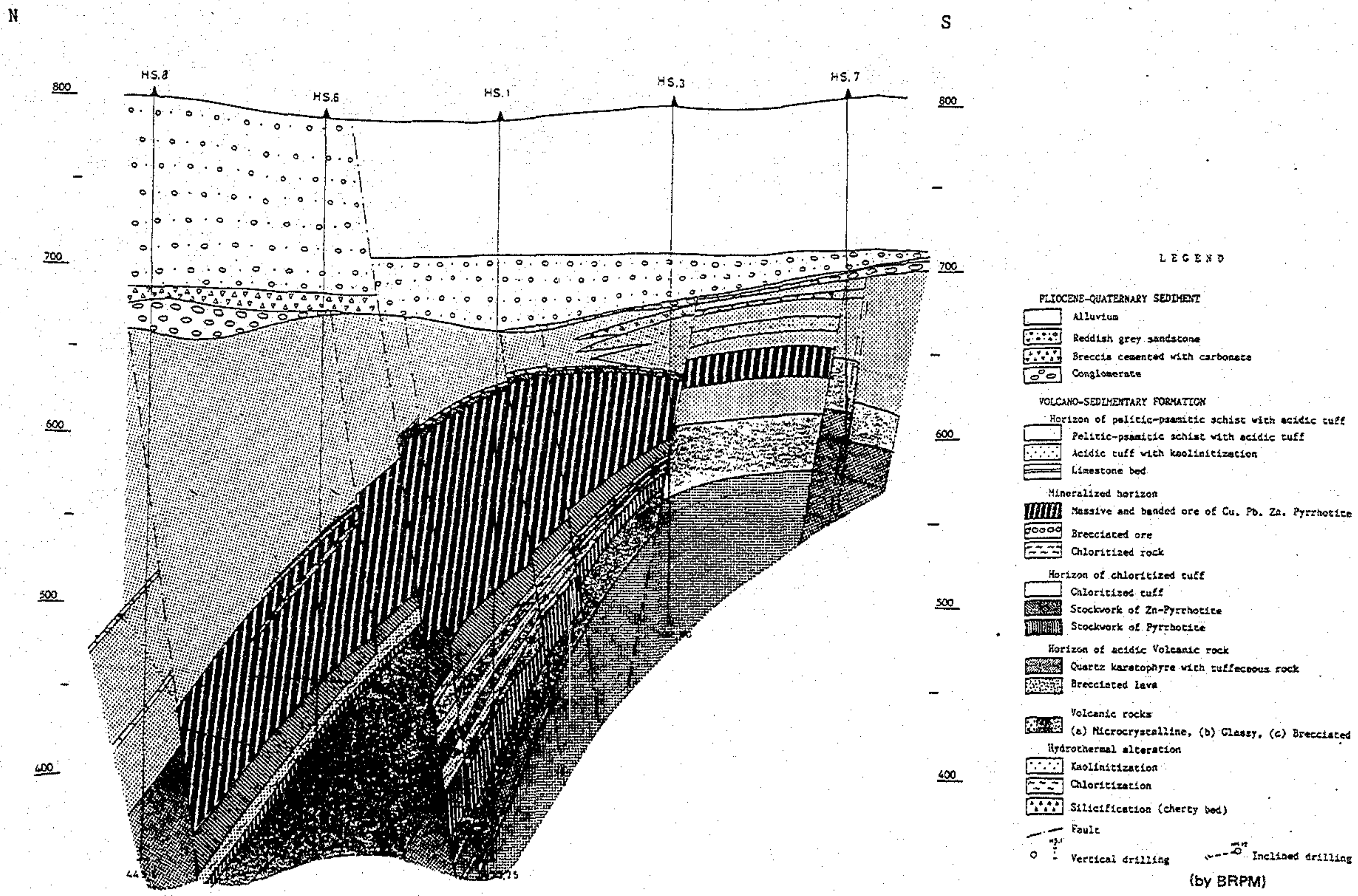
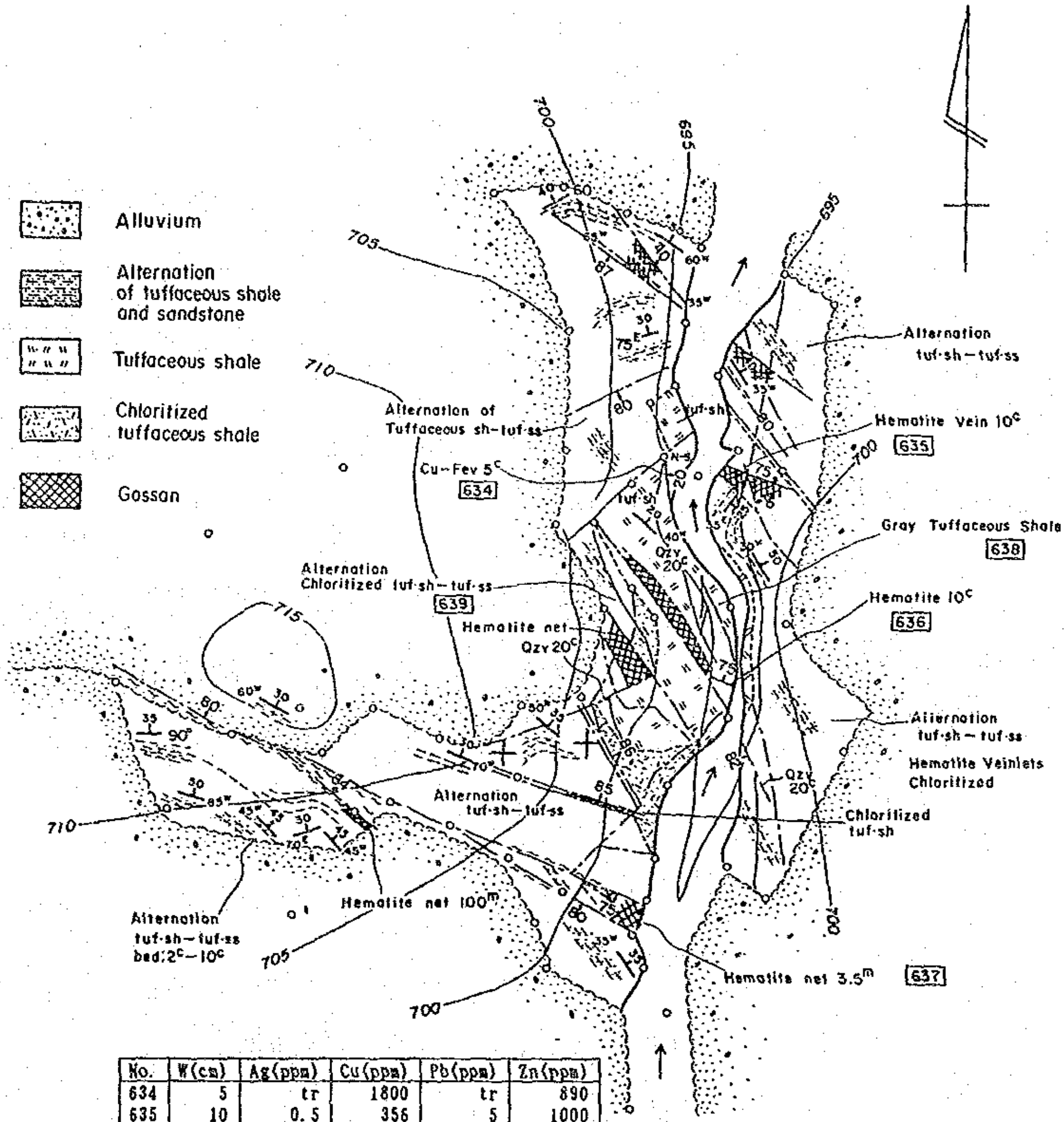
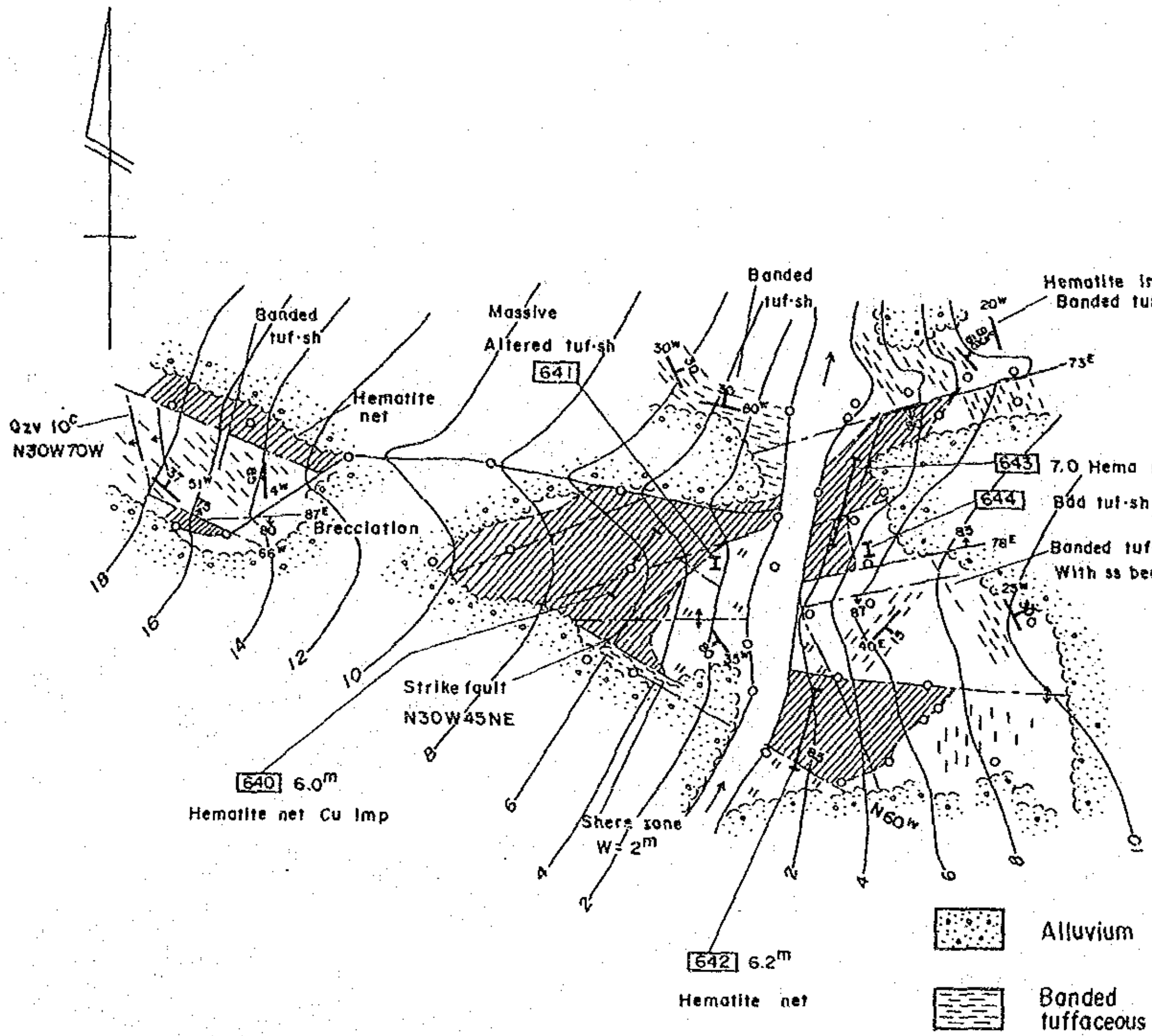


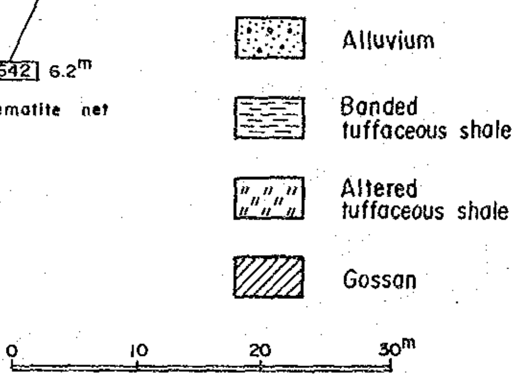
Fig. 12 Geological Section of Haiar Orebody (N-S)



No.	W(cm)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)
634	5	tr	1800	tr	890
635	10	0.5	356	5	1000
636	10	9.5	3350	94	160
637	350	tr	29	tr	180
638	50	tr	270	tr	310
639	50	tr	166	14	410

Fig. 13 Mineral Indication of the East Oukhribane





No.	W(cm)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)
640	600	tr	448	tr	73
641	100	tr	140	tr	160
642	620	0.5	980	tr	134
643	700	0.2	480	tr	61
644	100	tr	171	tr	128

Fig. 14 Mineral Indication of the West Oukhribane

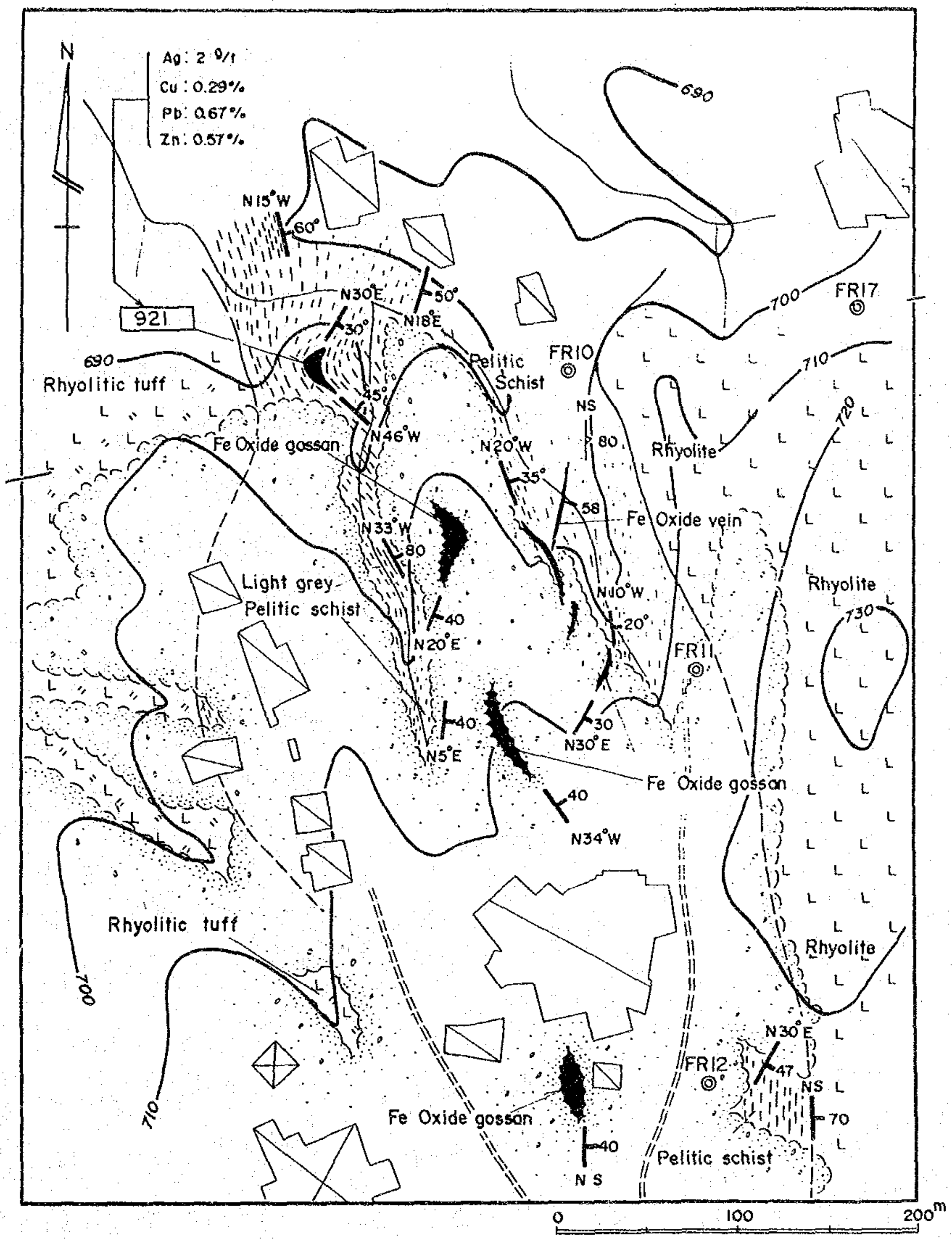


Fig. 15 Mineral Indication of the East Frizem Area

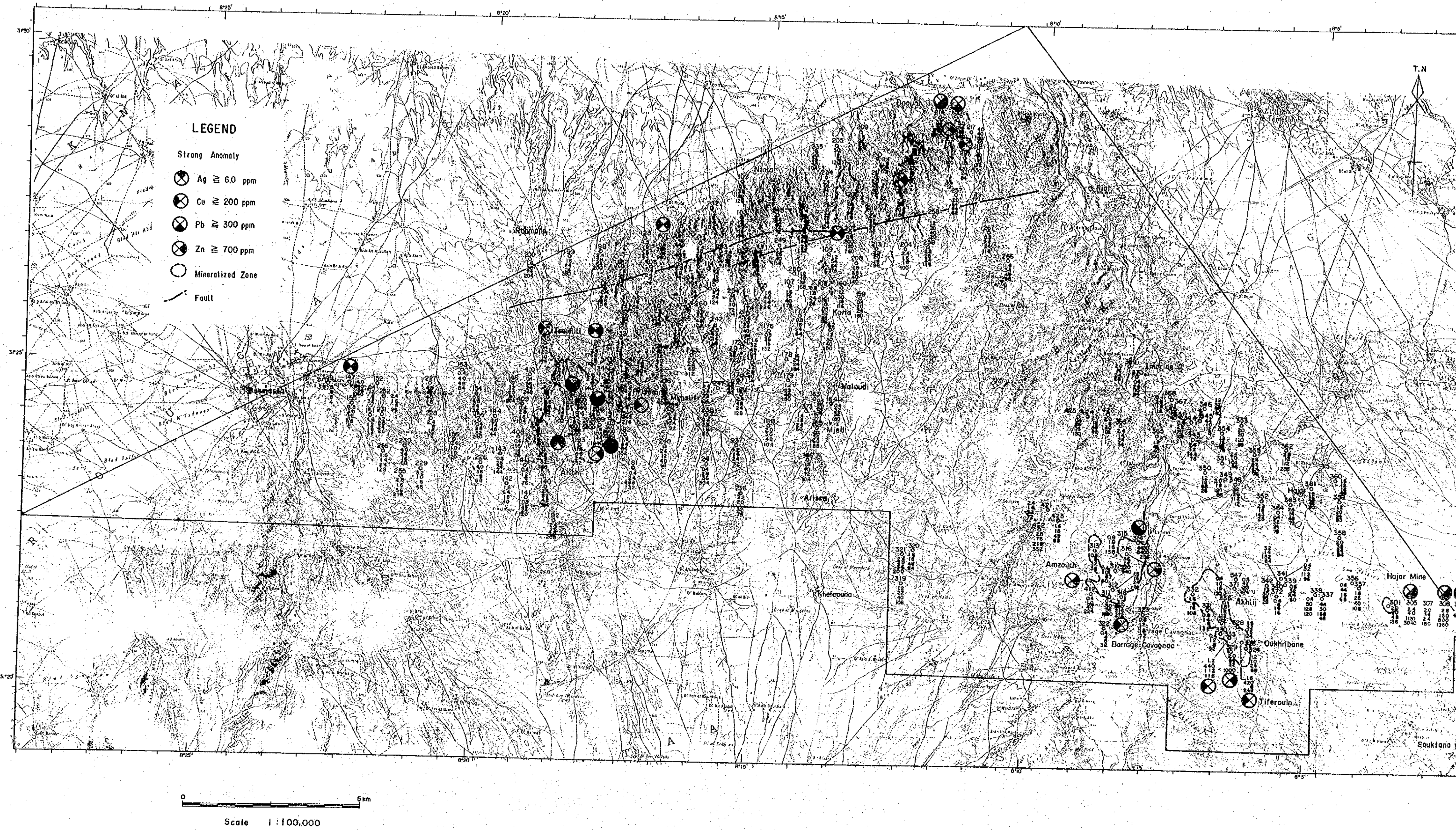


Fig. 16 Distribution of Geochemical Anomalies

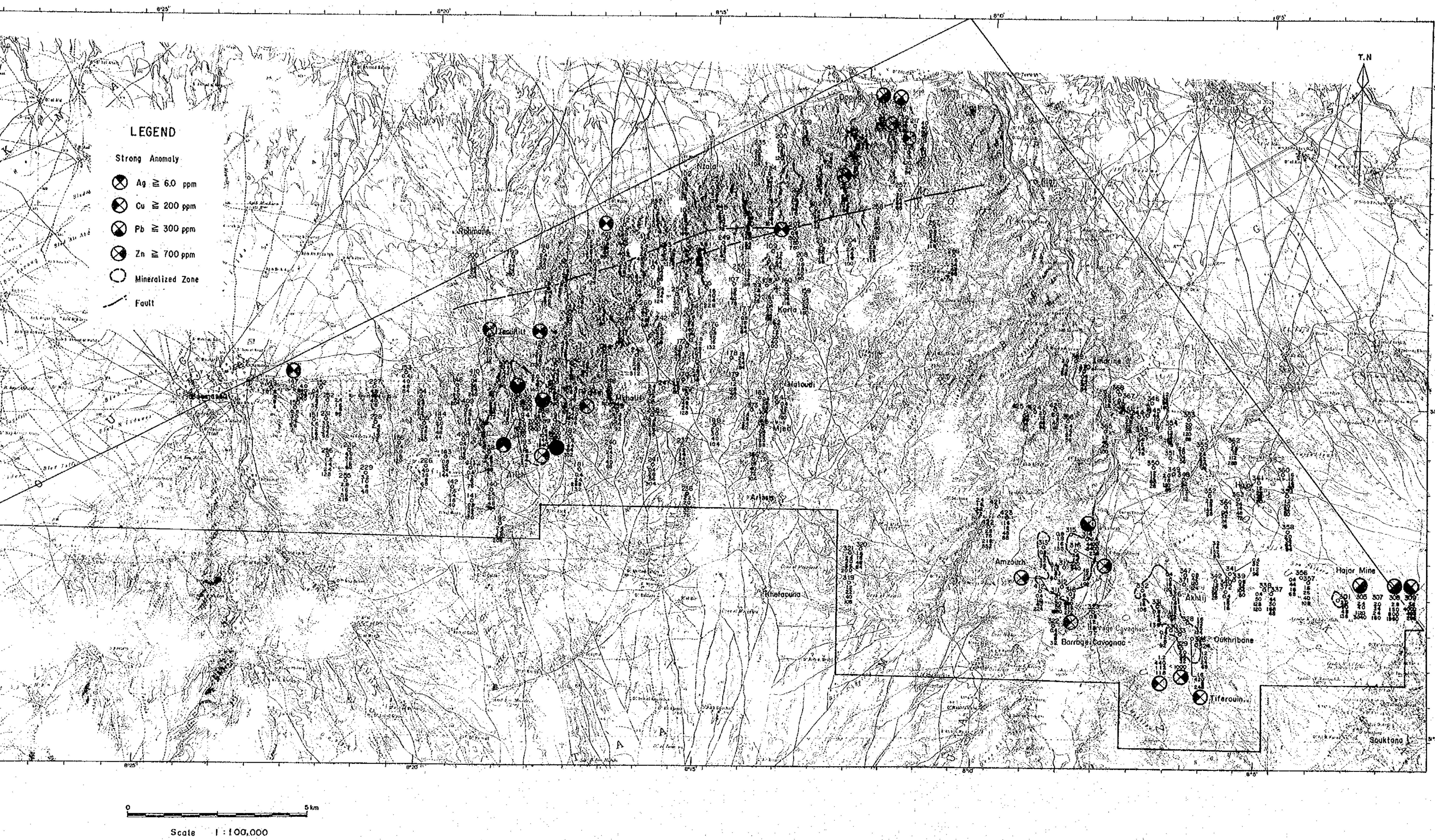


Fig. 16 Distribution of Geochemical Anomalies

Tab. 3 Statistical Values of Geochemical Assay Results

(Phase I)

	Classification	No.	Ag (ppm)			Cu (ppm)			Pb (ppm)			Zn (ppm)		
			Mean	M + σ	M + 2σ	Mean	M + σ	M + 2σ	Mean	M + σ	M + 2σ	Mean	M + σ	M + 2σ
	Total	202	1.32	2.81	5.96	26.8	67	170	36.0	91	229	120	292	713
0	Intrusive rock	4	0.28	0.57	1.13	7.0	11	17	11.3	17	25	40	91	211
1	Ips (Pelitic schist)	48	1.16	2.66	6.12	27.5	78	223	21.0	41	79	117	316	854
2	Iv (Volcanics)	3	1.37	4.26	13.90	110.5	524	2490	217.5	313	451	374	1519	6167
3	Ic (Carbonatic schist)	54	1.67	3.30	6.53	30.8	87	243	41.0	100	244	142	339	805
4	Ip (Pelitic schist)	37	1.27	2.34	4.33	28.5	48	82	34.9	58	98	125	175	245
5	IIp_1 (Pelitic semischist)	2	0.57	0.92	1.51	11.0	12	14	25.3	48	92	127	283	632
6	IIal (Alternate semischist)	18	1.44	2.59	4.65	30.4	89	263	38.6	169	737	180	580	1869
7	IIav (Volcanics)	2	1.13	1.85	3.02	11.3	18	30	27.7	34	42	83	272	887
8	IIp_2 (Pelitic semischist)	15	1.08	2.57	6.10	25.3	40	63	63.1	147	341	80	179	402
9	IIc (Carbonatic semischist)	19	1.76	2.91	4.81	17.7	28	43	63.5	133	280	74	145	283

M (Mean) = Geometric mean

σ = Standard diviation

Phase II)

Geologic Unit	No. of Samples	Cu (ppm)				Pb (ppm)				Zn (ppm)				Ag (ppm)			
		Mean	Std	Min	Max	Mean	Std	Min	Max	Mean	Std	Min	Max	Mean	Std	Min	Max
Total	268	40.15	62.74	6	560	26.49	51.87	1	400	157.11	184.88	28	1400	0.11	0.05	0.1	0.6
Intrusive	6	15.33	7.92	10	31	69.33	141.63	3	358	128.67	168.51	37	470	0.10	0.00	0.1	0.1
IIc	38	17.68	4.75	9	31	18.00	15.88	4	90	111.58	144.11	44	880	0.11	0.04	0.1	0.3
IIp2	37	29.70	18.26	8	112	19.19	22.84	4	144	111.62	79.08	28	460	0.10	0.00	0.1	0.1
IIal	22	27.64	14.36	9	76	17.18	16.69	1	71	152.59	119.74	41	470	0.10	0.02	0.1	0.2
IIav	7	19.86	9.86	10	37	15.29	8.88	4	28	97.43	37.35	60	160	0.11	0.04	0.1	0.2
IIap	11	69.27	85.61	9	288	21.82	15.18	6	56	258.09	384.18	57	1400	0.12	0.06	0.1	0.3
IIas	24	28.00	30.50	6	126	15.04	22.06	1	94	108.54	95.14	28	410	0.11	0.03	0.1	0.2
IIat	16	162.31	160.12	8	560	24.06	51.63	1	198	278.88	304.40	76	1150	0.10	0.00	0.1	0.1
IIaa	23	48.78	67.32	10	307	2.83	3.88	1	17	100.30	34.31	53	183	0.12	0.08	0.1	0.5
IIpl	15	19.33	9.69	6	36	13.33	9.24	2	38	101.87	38.49	46	173	0.10	0.00	0.1	0.1
Iml	1	209.00	0.00	209	209	30.00	0.00	30	30	165.00	0.00	165	165	0.20	0.00	0.2	0.2
Ipm	4	22.00	6.68	16	31	6.75	6.29	2	16	64.50	9.26	57	77	0.10	0.00	0.1	0.1
Ic	24	39.46	51.35	13	264	50.88	89.20	8	400	229.58	288.38	49	1250	0.15	0.12	0.1	0.6
Ivt+Ivv	15	24.80	13.62	11	61	99.20	92.57	8	334	243.27	144.31	72	630	0.14	0.08	0.1	0.4
Ips	25	43.64	50.98	11	238	31.52	61.98	1	278	224.08	229.17	50	900	0.11	0.03	0.1	0.2

Mean : Geometric Mean

Std : Standard Deviation

Min : Minimum

Max : Maximum

CHPATER 2 GEOPHYSICAL SURVEY

2-1 CSAMT Method

As for the First Phase survey, the geophysical prospecting by CSAMT method was carried out in the southern area about $150km^2$, where mineral indications and igneous rocks were distributed. Measurement stations were 302 points. By this prospecting, low electric resistivity anomalies were detected in the surrounding area of the Hajar ore deposit, in the Hajar horizon distribution area, and in the Frizem area.

(1) Results of the Measurement of Rock Property

The measured results of the resistivity, density and magnetic susceptibility of the pieces of rock samples collected in this survey are as follows:

1) As to the basement rocks, resistivity and density are remarkably high, but magnetic susceptibility is low.
2) As to the Quaternary sediments, resistivity and density are comparatively low, and magnetic susceptibility is also low.
3) As to the pieces of ore samples collected from the Hajar ore deposit, they have remarkably low resistivity, high density and high magnetic susceptibility, which are quite characteristic compared with other rocks composing the geology in this area.

(2) Outline of the Resistivity Structure

The resistivity structure in this area is, on the whole, constituted by three layers. The first layer, from the top, is the one bearing low resistivity including resistivity variation zone near the surface. It is correlated to the covering layers of the Pliocene to Quaternary sediments. The second layer is the resistivity basement with very high resistivity, which is correlated to the upper part of the basement rocks composed of Carboniferous to Permian Systems. The third layer is the one bearing comparatively low resistivity, which is thought to be correlated to the low resistivity beds of the ascending part of the basement rocks.

The resistivity structure has an extension in the direction of NW-SE, reflecting the bedding trend, but he appearance of resistivity structure is quite different in the western part and in the central to eastern part.

In the western part, the resistivity basement bearing very high resistivity and homogenuity is extensively seated in the shallow part below the surface. On the other hand, in the central to eastern part, the resistivity structure has ups and downs of the resistivity basement, reflecting extent of exposures of the basement rocks.

The first low resistivity layer in the central to eastern part is as thick as under 100 meters where the thickness is rather thin, while it is as thick as more than several 100 meters where the layer develops well and the variation of resistivity is recognized, which is thought to be by the effect of underground water. In this area, fairly wide range of the variation of resistivity in the resistivity basement can be observed and the low resistivity anomalies forming depression of the resistivity basement have been recognized in many places.

(3) Correlation with the Results of the Past Geophysical Prospecting

The following relations have been confirmed by the correlation of the resistivity structure with the results of the magnetic survey and the gravity survey carried out in this area.

1) The magnetic base in the western part is quite different from the anomalies in the other parts in view of the period of formation and the magnetic susceptibility. Also, the gravity base is rather shallow. These facts are coincident with the point that the structure of the high resistivity basement in this area is different from that in the other area.

2) In the central to eastern part, the extension in the direction of NW-SE can be seen with both of the magnetic anomalies and the resistivity anomalies with which the extension of the high gravity anomalies is in good harmony.

3) Correlation is recognized between the high magnetic bodies and the low resistivity anomalies and between the high gravity anomalies and the high resistivity distribution.

4) At the southernmost part of the surveyed area, there is a remarkable low resistivity anomaly. As a depression of the low gravity anomaly is recognized corresponding to this resistivity anomaly, it is thought that the covering sediments of low density containing aquifer are distributed.

5) Typical magnetic anomaly and a high gravity anomaly have been detected in the area corresponding to the locaion of the Hajar ore deposit. As to the resistivity structure, it has been caught as the relatively low resistivity portion (depression) in the resistivity basement.

(4) Relation between the Resistivity Structure and the Mineralization

In the low resistivity structure in the area where the Hajar ore deposit is found, the mineralization and alteration zone in and around the ore deposit is recognized to form a low resistivity anomaly (depression) in the resistivity basement. the areas where the same pattern of the resistivity structure is recognized have been extracted in an area west of Taguennza, in an area near Lamrah, in an area east of Barrage Cavagnac, in an area southeast of Oukhribane, in an area east of Barrage Cavagnac, and in an area west of Frizem. It is recognized that all of them are showing strong correlation to the magnetic anomalies, and they are thought to have mineral potentiality for the emplacment of the type of the Hajar ore deposit.

The areas where the above low resistivity anomalies (depression) are detected are distributed, except the area west of Frizem, in a zone with the approximate width of 3km extending in NNW-SSE direction to connect west of Taguennza - Lamrah - Oukhibane. It is estimated that this zone is representing the area of high potentiality for the emplacement of ore deposits.

Also, in the area southeast of the Hajar ore deposit, low resistivity depressions in the resistivity basement are connected and a high gravity anomaly has been detected. Therefore, this area in the southeast of the Hajar ore deposit is thought to warrant further exploration.

2-2 IP Method

From the studies on the physical properties of the rock and ore samples collected in this area, IP method was considered to be one of the most effective prospecting technique for this area. Accordingly, IP survey was carried out on the Hajar horizon area in the Eastern Area and on the Frizem mineralized area in the Western Area for the Second Phase and Third Phase surveys. The adopted dipole length and sparation were 100m and n = 1 - 5, respectivelly.

(1) Measurement of the Physical Properties

The measured values of the physical properties for the rock samples collected in this area are as follows (Tab. 4).

Rock Type	No.of Sample	Resistivity (Ωm)	PFE (%)	Density (g/cc)	Susceptibility (10-5cgs/emu)
Querternary	2	73(50-120)	1.1(1-2)	2.21(2.0-2.5)	2
Basement	18	510(300-800)	0.8(0.2-4)	2.70(2.6-2.8)	2
Ore (Hajar)	4	18(14-23)	15(12-20)	4.25(3.8-4.6)	530

( ):distribution range

The ore samples taken from the Hajar orebody show considerably different properties from the rock samples taken from the basement group, that is to say, about 1/30 times in electic resistivity, about 20 times in PFE (frequency effect), 2.2 times in density, and 250 times in magnetic susceptibility.

(2) Measured Values of AR and PFE

The measured values of apparent resistivity (AR) and percentage of frequency effect (PFE) on each survey line are shown in the Tab. 5 and Tab. 6.

Area	Depth	AR (Ωm)	PFE (%)
Eastern Area	Shallow place	20 - 40	0.5 - 1
	Deeper place	40 - 150	1 - 2
Western Area	Shallow place	120 - 130	2 - 3
	Deeper place	120 - 280	3 - 4

As shown in the upper table, a remarkable difference is found in the measured values of both AR and PFE between the Eastern Area and the Western Area.

1) Both AR and PFE values of the Western Area show higher than that of the Eastern Area.
   It means the difference of rock type and geological structure in the two areas.
2) In the Eastern Area, low AR and low PFE values are measured in the shallow places below the surface, and AR value increases to the deeper places.
   These trends of the physical properties are correspondent with the distribution of the Quaternary sediments and the basement rocks.
3) In the Western Area, high AR and medium PFE values are measured. PFE value shows a tendency to increase to the deeper place, although AR value remains similar value in the deeper place. These trend of the physical properties in this area means that the basement rocks are exposed on the surface, moreover, the basement rocks suffer mineralization.