and shows porphyritic terture. By the microscopic observation, both parts of phenocryst and groundmass mainly composed of plagioclase are replaced by the secondary minerals such as chlorite, carbonate and quartx.

2-2-3 Geological Structure

The geological structure in the Frizem area is intensely controlled by the schistosity which develops in NNW-SSE direction. The formations in this area is divided into numerous blocks by the schistosity fault with the spacing of several ten meters. Drag folds are recognized in each rectangular blocks, which renders the geological structure more complicated.

Some examples of the drag folds found in this area are shown in Fig. I-11, 12, 13 and a model of general drag folds is given in Fig. I-14.

The relation of a bed to other beds is mostly fault. But the dislocation by the schistosity faults is rather small, viewing from the distribution of each bed. The dislocation is estimated to be some several ten meters. General geological structure is thought to have a trend of NNW-SSE with the dip of 20° - 30° NE. As to the faults other than those of NNW-SSE system, there can be recognized the faults of NNE-SSW system, there can be reacognized the faults of NNE-SSW system and of NW-SE system.

2-2-4 Ore Deposit

The indications of mineralization found in this area are the massive gossan near Frizem (East mineralization zone), and the gossan in veins located at about 1 - 1.5 km west of Frizem (West mineralization zone.)

(1) East Mineralization Zone (Fig. I-18, Fig. I-19)

The mineralization zone is represented by the gossans contained in the marly pelitid schist, which overlies the acidic volcanics. Two layers are recognized as to the main indications of mineralization. The sizes of the individual gossans are 10 m x 60 m, at the largest. Along the schistosity plane of the host rock, these gossans are discontinuously distributed in a distance of some 500 m in the direction of NNW-SSE, and total 7 orebodies are recognized among them. This mineralization zone gradually changes to carbonate-quartz veins in the northern extension, while in the southern extension the condition of the mineralization zone is not clear as it is covered with Quarternary sediments.

The main constituent minerals of the gossan are siderite, hematite, goethite, and quartz, associated with green copper minerals in some places. The gossans are remarkably brecciated.

For the potentiality at the depth where the gossans are located on the surface, BRPM carried out 9 holes of drilling, total length of which is 2,526 m. Low grade Cu-Pb-Zn dissemination was caught by the drilling. The assay result of the main part of the dissemination at the depth is as shown below:

Drill No.	Depth (m)	Intv (m)	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)
FS-11	29.6 - 51.6	22.0	0.22	0.57	1.63	14
FS-12	49.7 - 56.5	6.7	0.32	0.73	1.85	14
FS-12	60.0 - 70.8	10.8	0.32	0.95	2.88	23
FS-12	178.0 - 183.0	5.0	0.19	0.22	1.83	11
FS-12	186.0 - 191.0	4.6	0.26	0.03	1.53	8
FS-13	174.9 - 181.4	6.5	1.01	0.84	0.64	9
FS-14	85.1 - 89.7	4.6	0.25	1.23	2.95	26
FS-15	78.9 - 83.8	4.9	0.59	0.23	0.30	9
Av.		8.1	0.36	0.63	1.76	15

(by BRPM, 1986)

The dissemination caught by the drilling is found in the uppermost part of the white tuff and in the marly-pelitic schist overlying it. The main constituent ore minerals are pyrite, pyrrhotite, chalcopyrite, galena and sphalerite.

The white tuff is correlated to the uppermost horizon of the acidic volcanics. Therefore, the general dipping of this white tuff is thought to be 20° - 30° ENE. This rock and the overlying and underlying sedimentary beds are apparently seen steeply dipping, but the real inclination is estimated to be very gentle.

(2) West Mineralization Zone

The west mineralization zone is composed of brecciated gossaneous carbonates-quartz veins, developed in the psammitic-pelitic schist which underlies the formation of acidic volcanics. The gossaneous veins are composed mainly of siderite, calcite and quartz, associated with ore minerals such as hematite, goethite and a small amount of pyrite, occasionally disseminated by galena, sphalerite and chalcopyrite. The gossaneous veins are numerously developed parallel to the schistosity planes. The general trend of the gossaneous veins is NNW-SSE, dipping 50° - 70° to the east. The main indications are found sporadically in the fault fracture about 10 km and 1.4 km west of Frizem, where the width is 3 m at the largest but 2 m in average, extending as far as 1.5 km. The assay result of the mineralized parts is as follows:

Sample No.	Intv. (m)	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	
405	1.0	0.01	0.17	0.12	0.4	(gossan)
406	1.0	0.01	0.62	0.12	1.2	(gossan)
431	1.0	0.11	0.44	0.22	2.6	(gossan)
434	1.0	0.24	1.00	0.88	0.1	(gossan)
808	1.0	0.21	1.12	0.28	1	(vein)
919	2.0	0.20	0.12	0.21	3	(vein)
920	0.1	6.06	0.17	0.44	3	(vein)

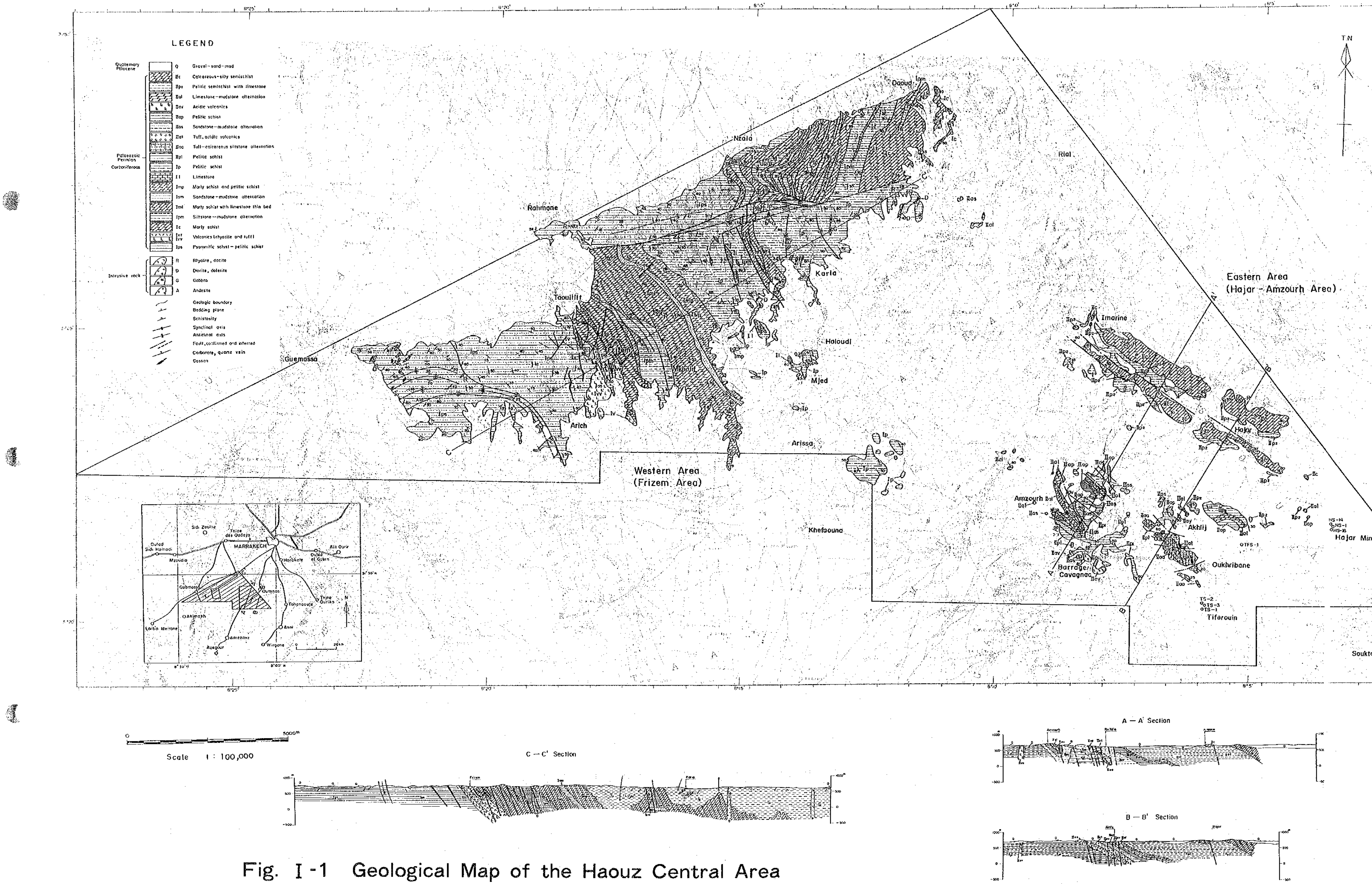
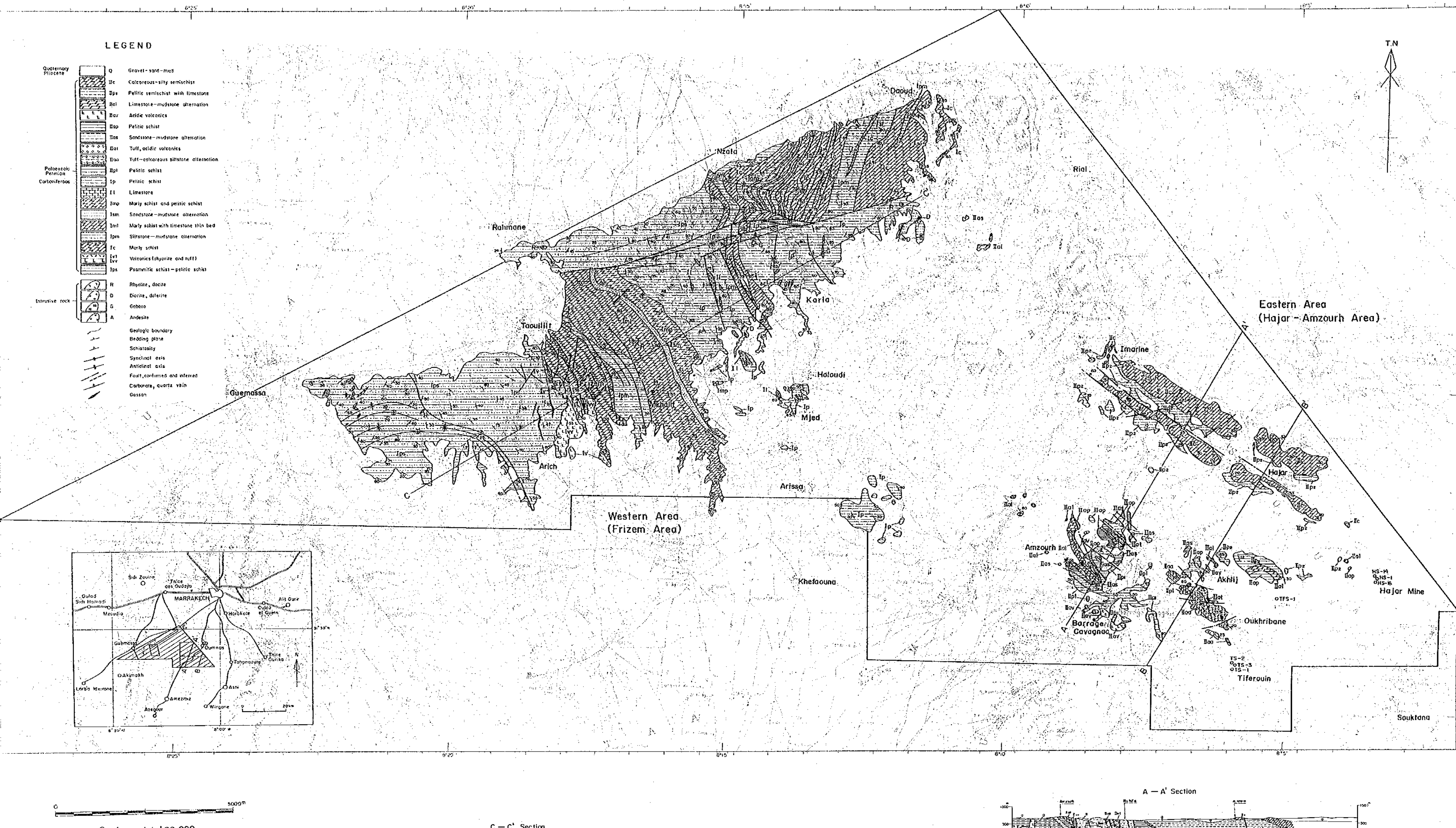
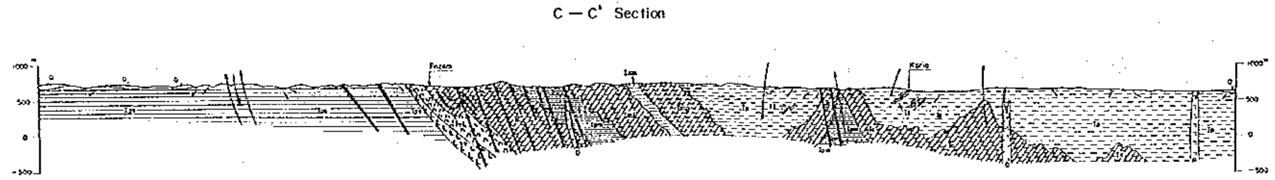


Fig. I-1 Geological Map of the Haouz Central Area





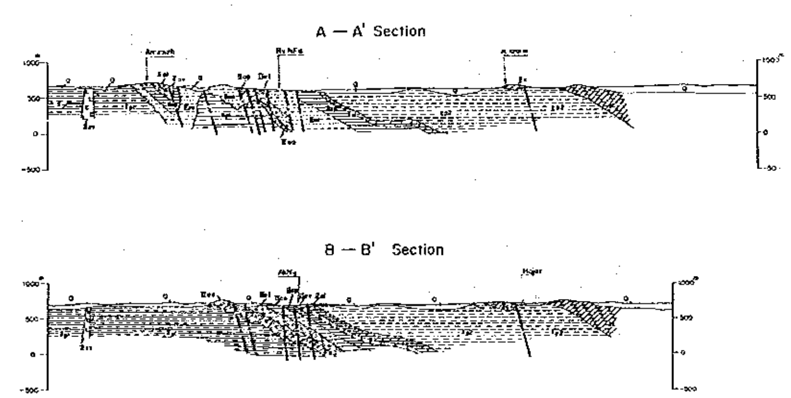


Fig. I -1 Geological Map of the Haouz Central Area

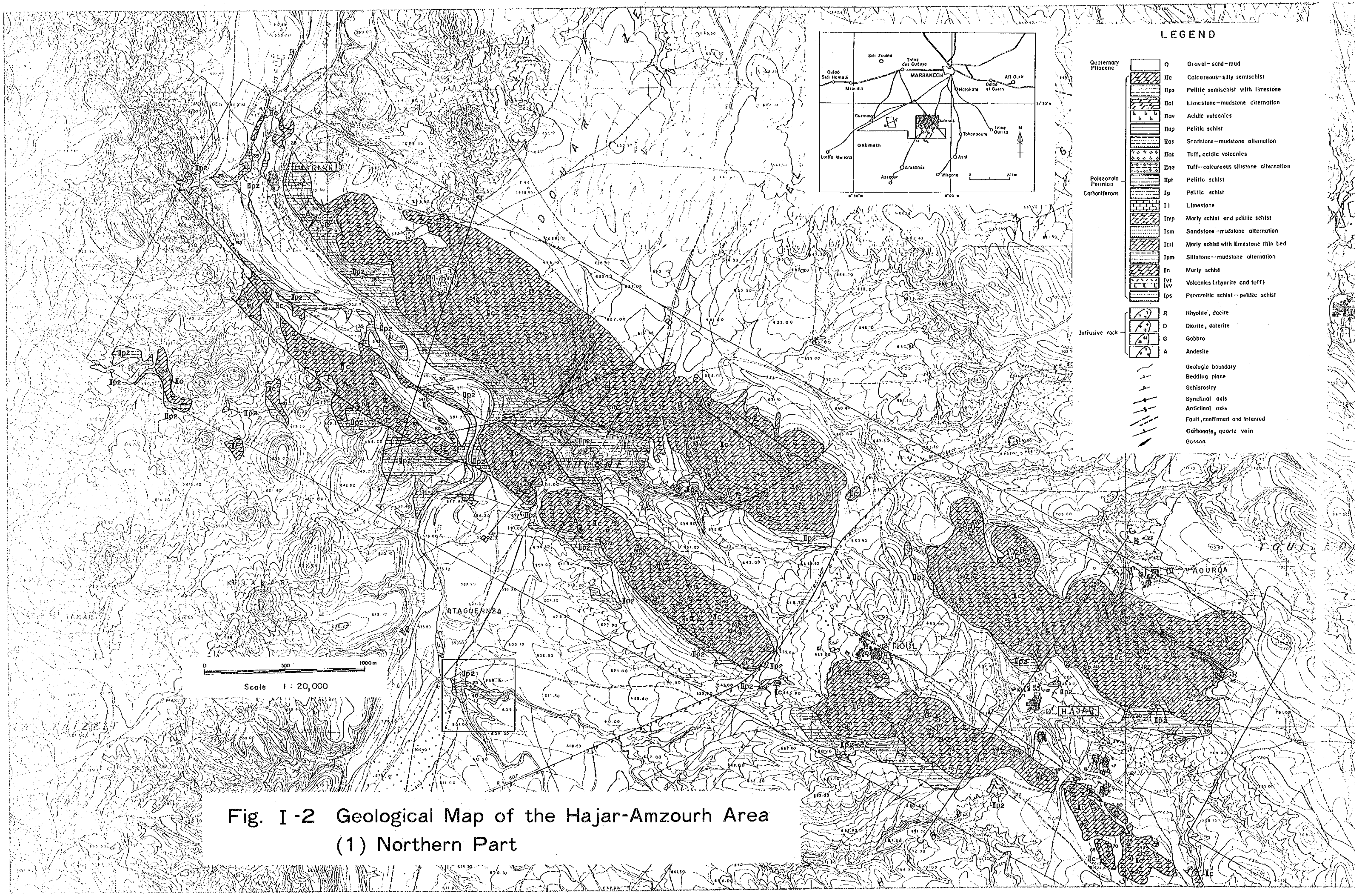


Fig. I-2 Geological Map of the Hajar-Amzourh Area
(1) Northern Part

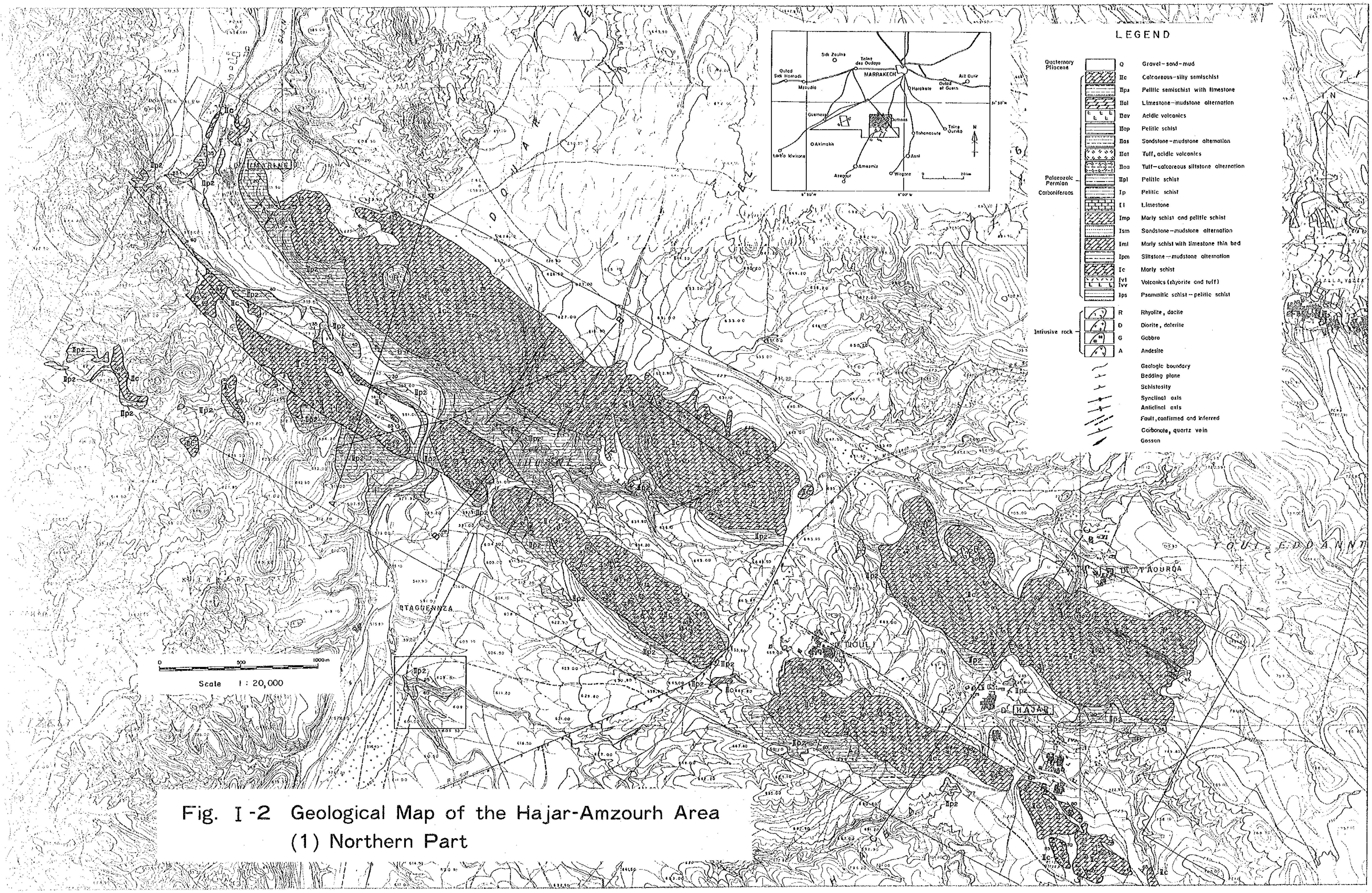
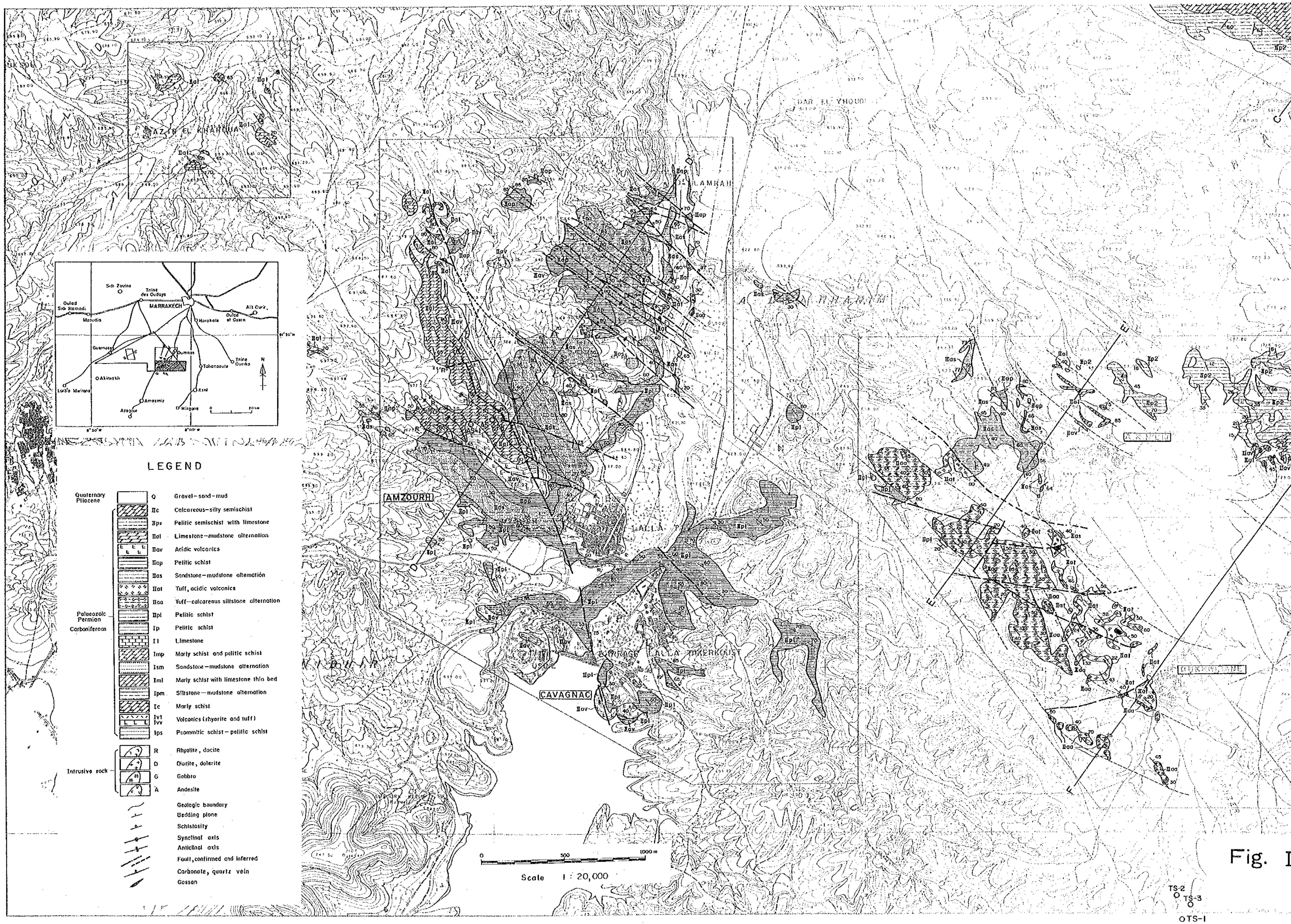


Fig. I-2 Geological Map of the Hajar-Amzourh Area
(1) Northern Part



MARRAKECH
Sidi Zouine
Trine des Oudaya
Oulad Sidi Hamadi
Mzoudia
Ait Ourir
Oulad et Guern
Harakala
Guemassa
Tahanaoute
Trine Ourika
Akiouakh
Lorba Idwirane
Amezmiz
Asni
Wirgane
Asegour
LEGEND
Quaternary Pliocene
Q Gravel-sand-mud
IIc Calcareous-silty semischist
IIp2 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
IIpl Pelitic schist
Palaeozoic Permian Carboniferous
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
DAR EL YHOUDI
LAMRAH
AKRLU
AMZOURH
LALLA
BARRAGE LALLA TAKERKOUST
CAVAGNAC
Scale 1:20,000
0
500
1000m
TS-2
TS-3
OTS-1

Fig. I

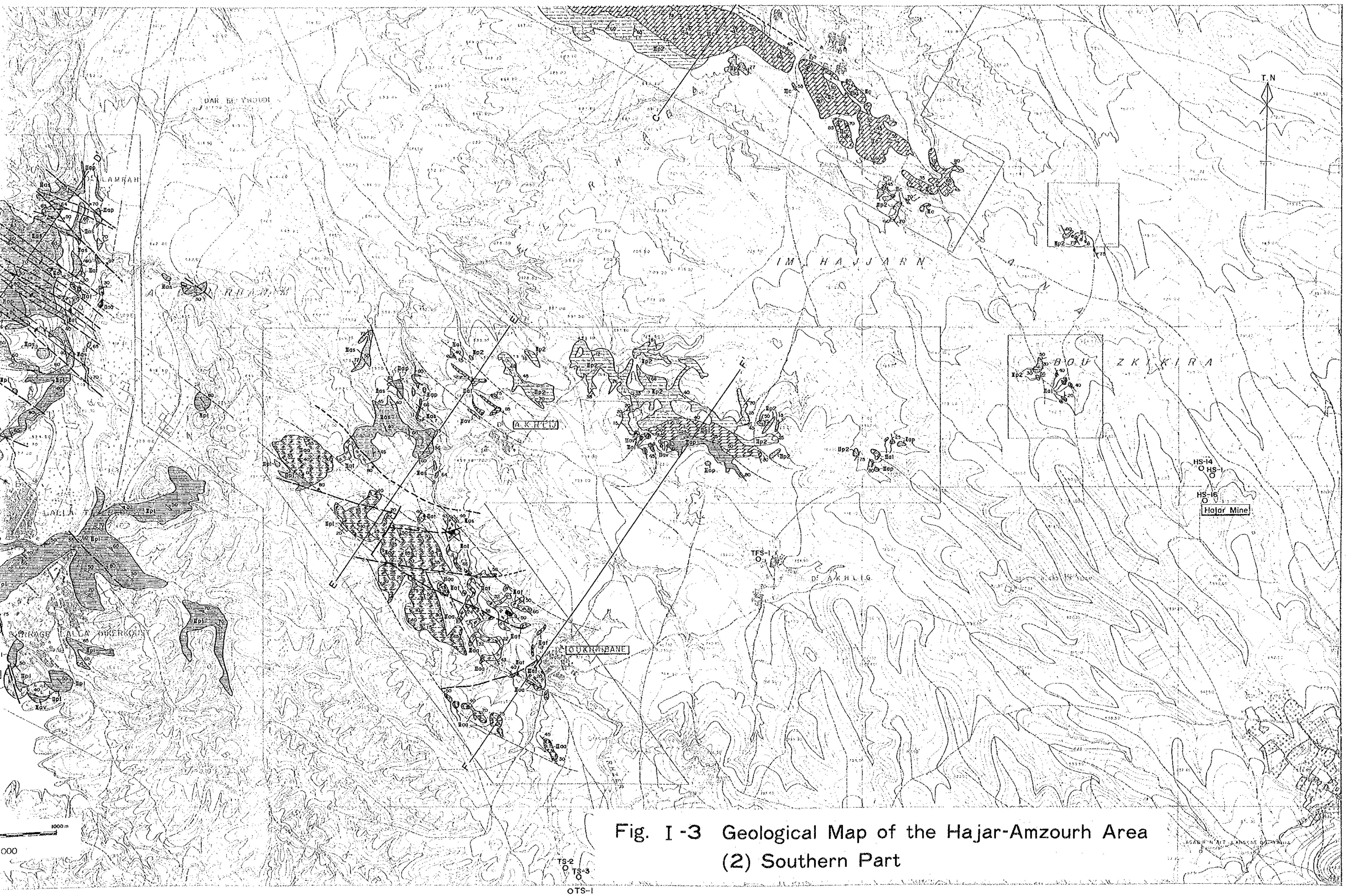


Fig. I-3 Geological Map of the Hajar-Amzourh Area (2) Southern Part

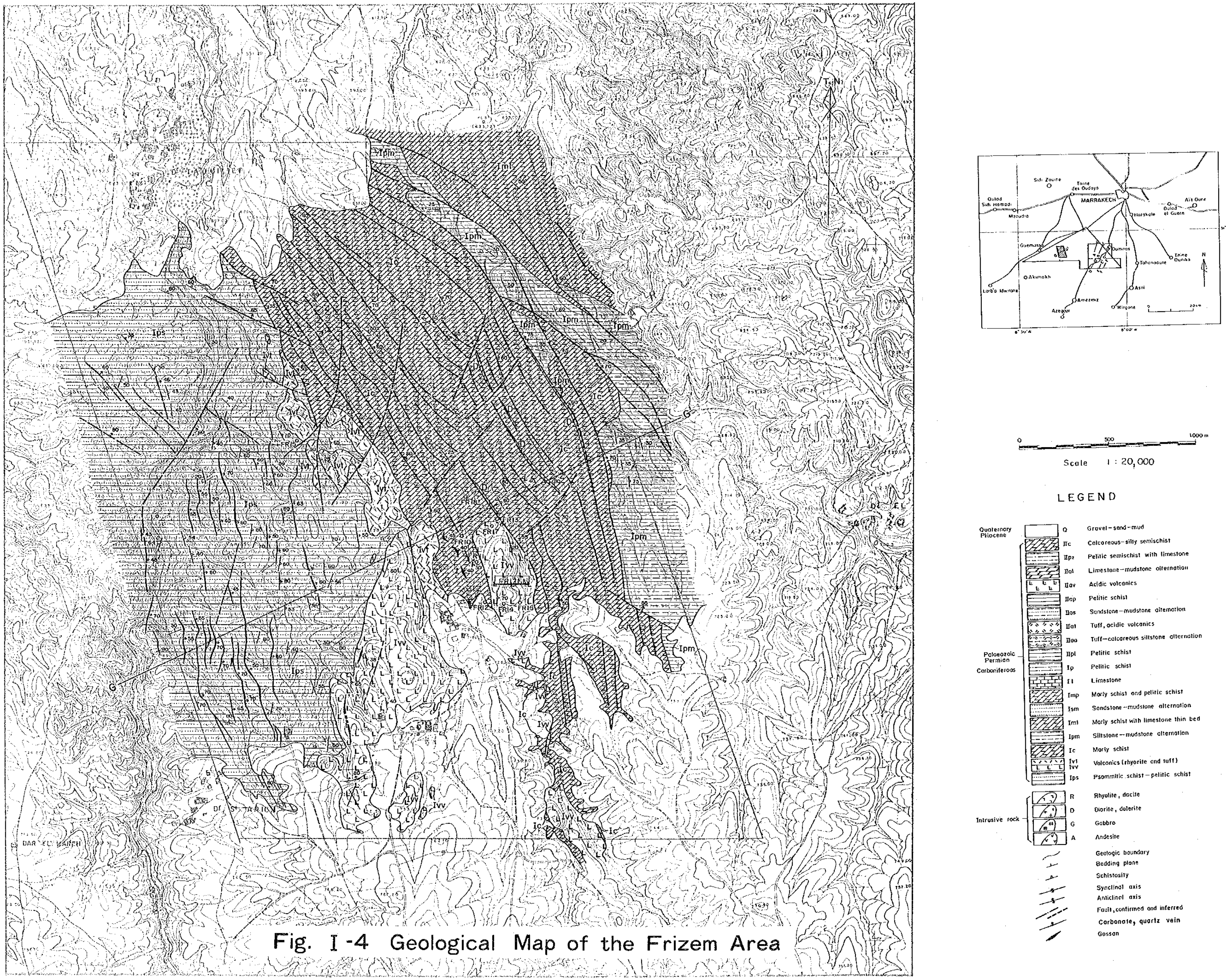


Fig. I-4 Geological Map of the Frizem Area

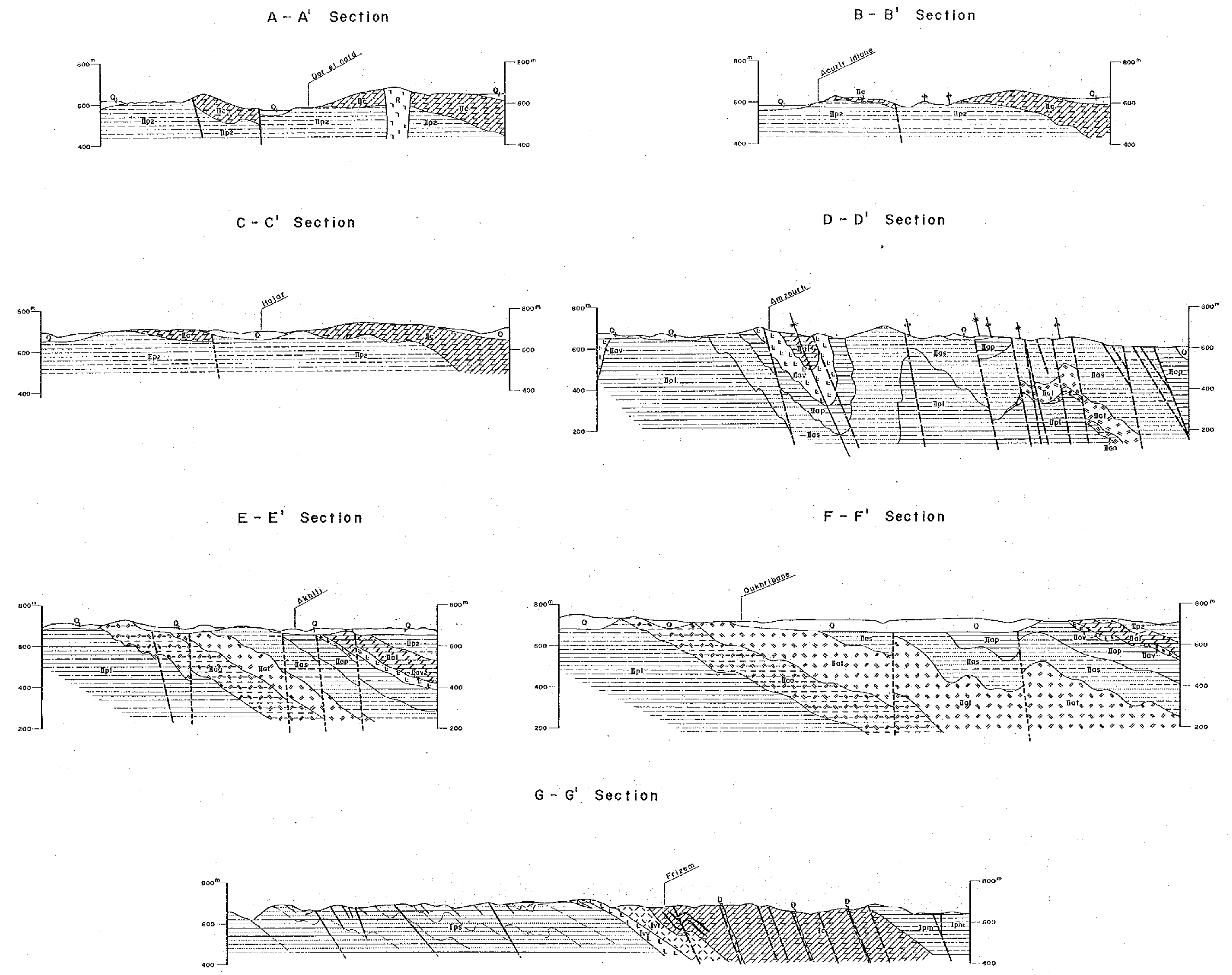
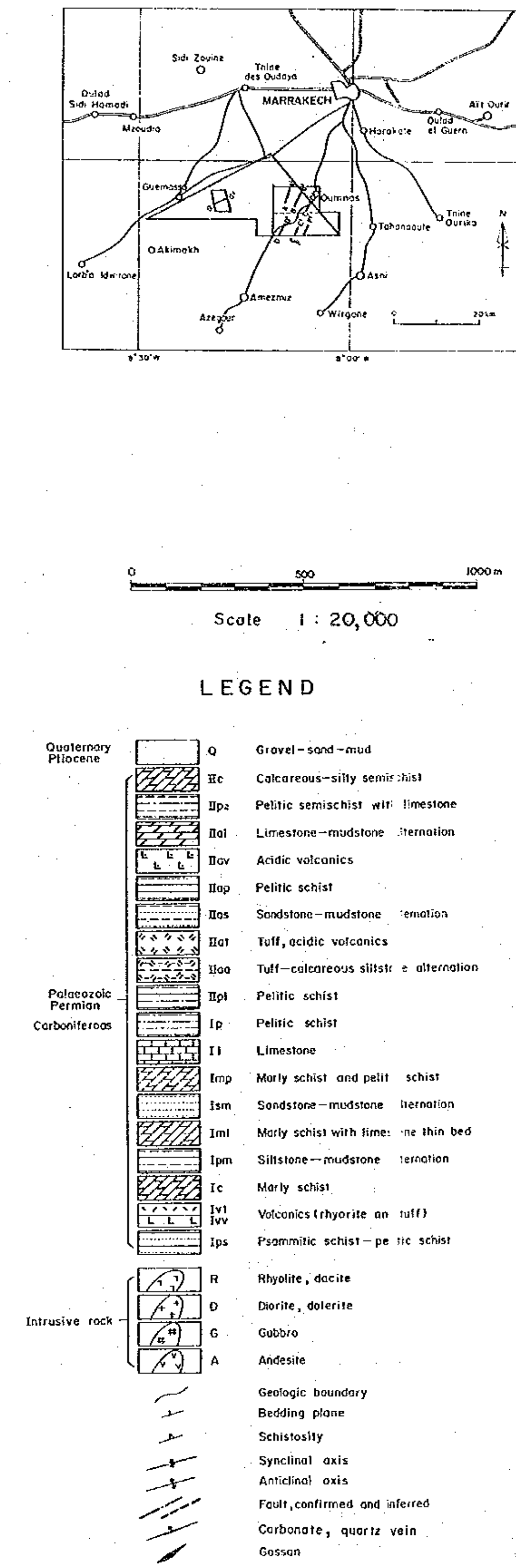
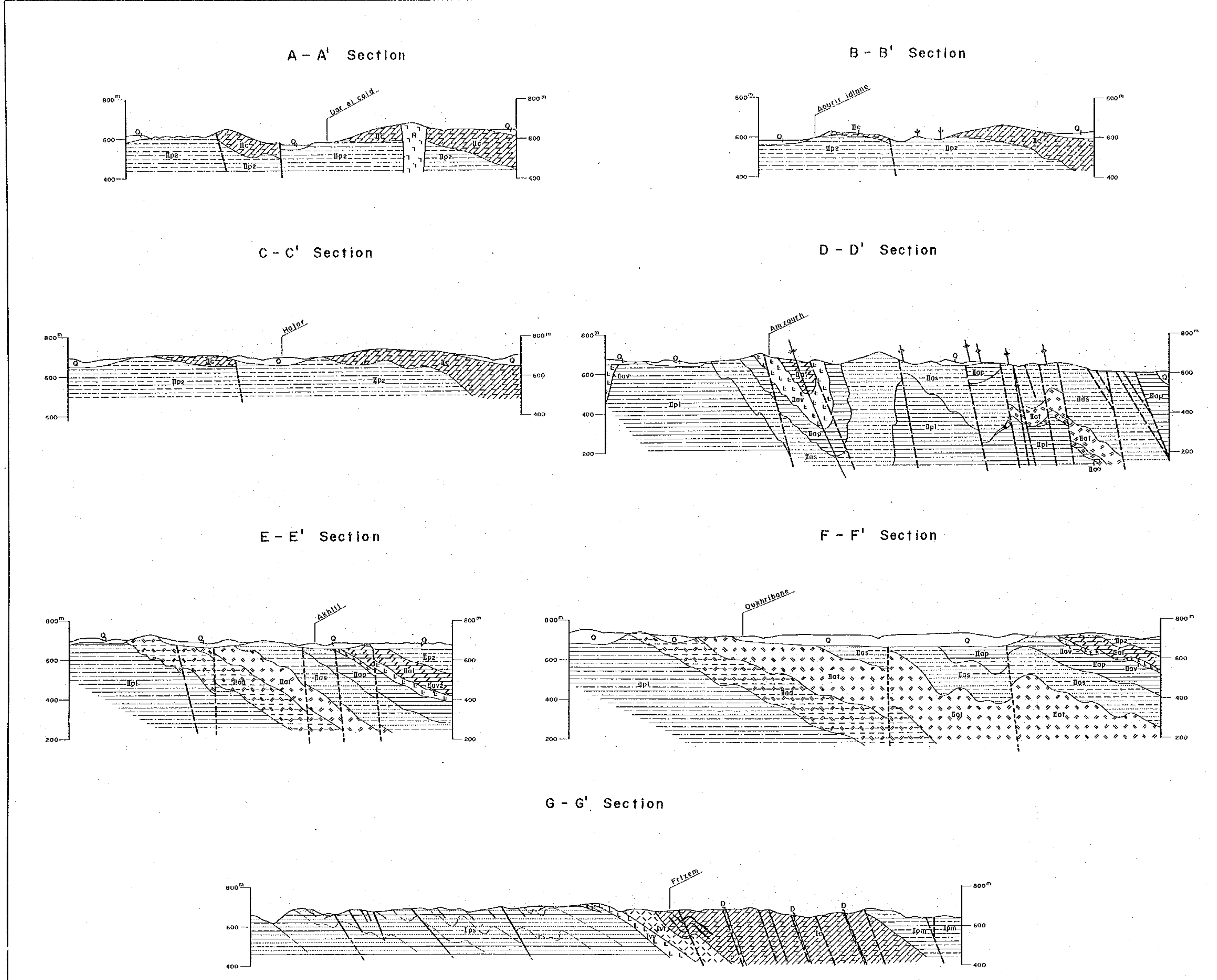


Fig. I-5 Geological Sections of the Hajar-Amzourh Area and Frizem Area





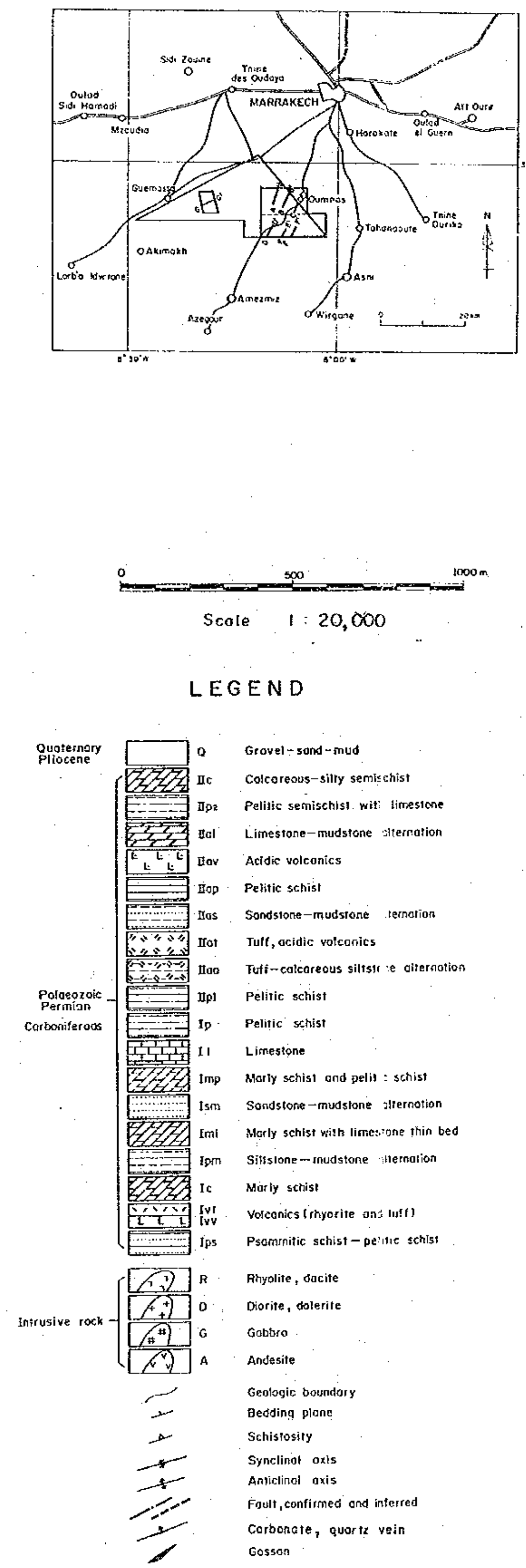


Fig. I-5 Geological Sections of the Hajar-Amzourh Area and Frizem Area

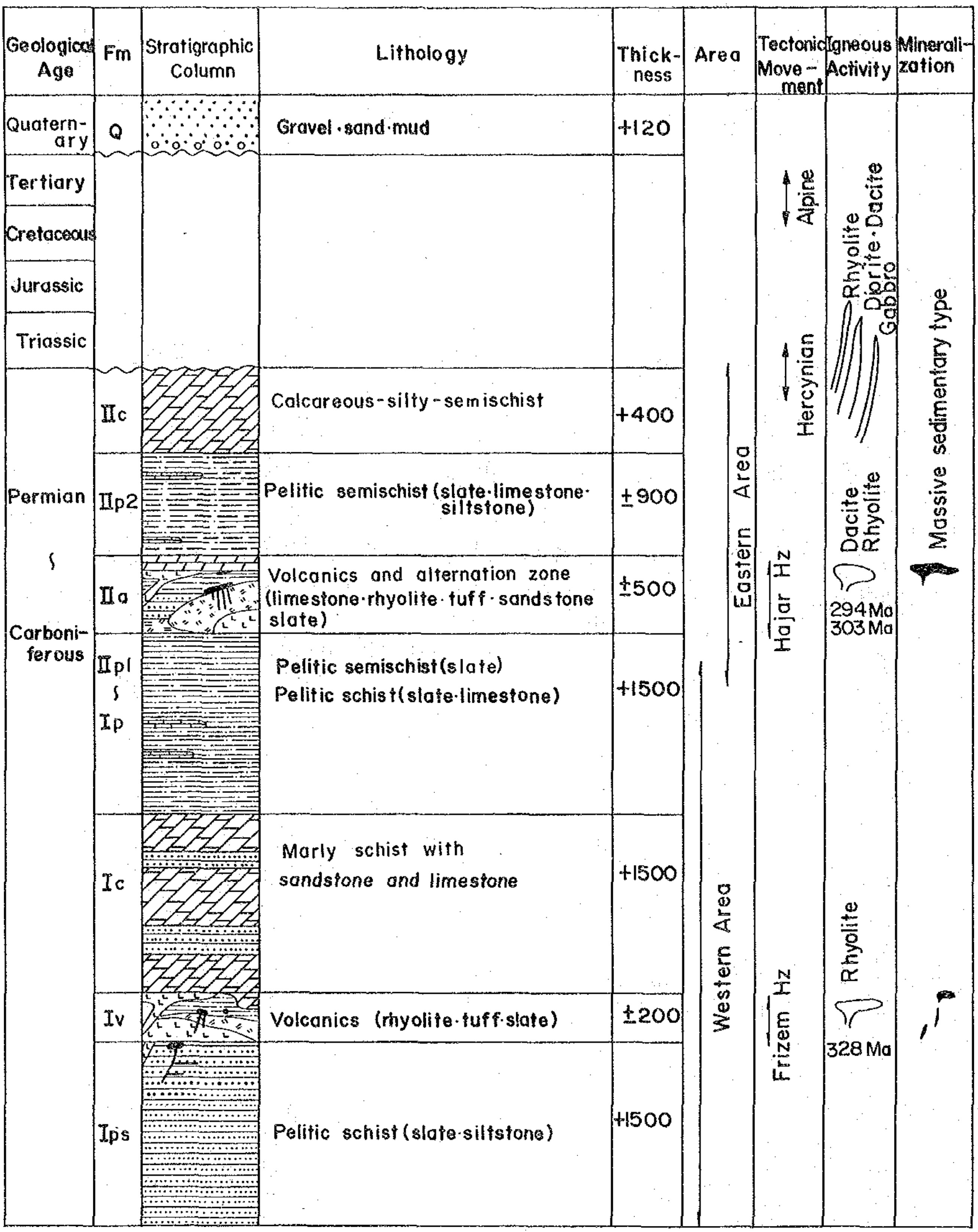
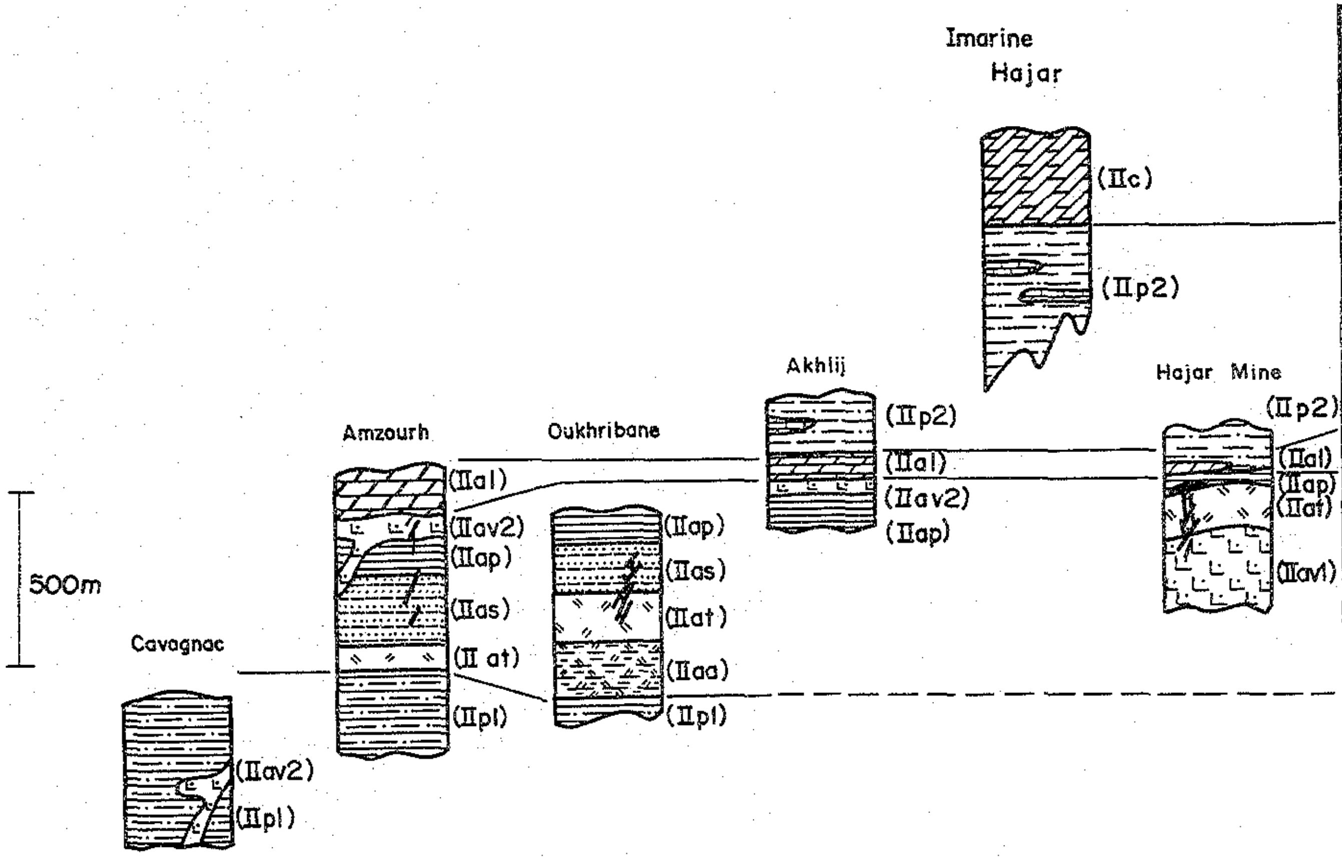
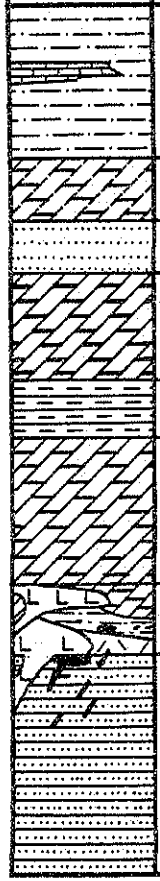


Fig I-6 Schematic Geological Column of the Haouz Central Area



Lithology	Thickness (m)
Calcareous - silty semischist	+400
Pelitic semischist with limestone	±900
Limestone - mudstone alternation	100 - 400
Volcanics and Alternation zone (rhyolite · tuff · siltstone · sandstone · mudstone)	400 - 700
Pelitic schist	+500

Fig. I-7 Schematic Geological Column of the Hajar-Amzourh Area



Stratigraphic column	Lithology	Thickness (m)
	(Ip) Pelitic schist with limestone(Il)	+ 1,000
	(Imp) Marly schist and Pelitic schist	± 250
	(Ism) *Sandstone - mudstone alternation*	± 70
	(Iml) Marly schist with limestone thin bed	± 700
	(Ipm) Siltstone - mudstone Alternation	100 - 300
	(Ic) Marly schist	± 500
	(Iv) Volcanics (rhyolite · tuff · marl · slate)	0 - 200
	(Ips) Psammitic schist - Pelitic schist	+ 1,000

Fig. I - 8 Schematic Geological Column of the Frizem Area

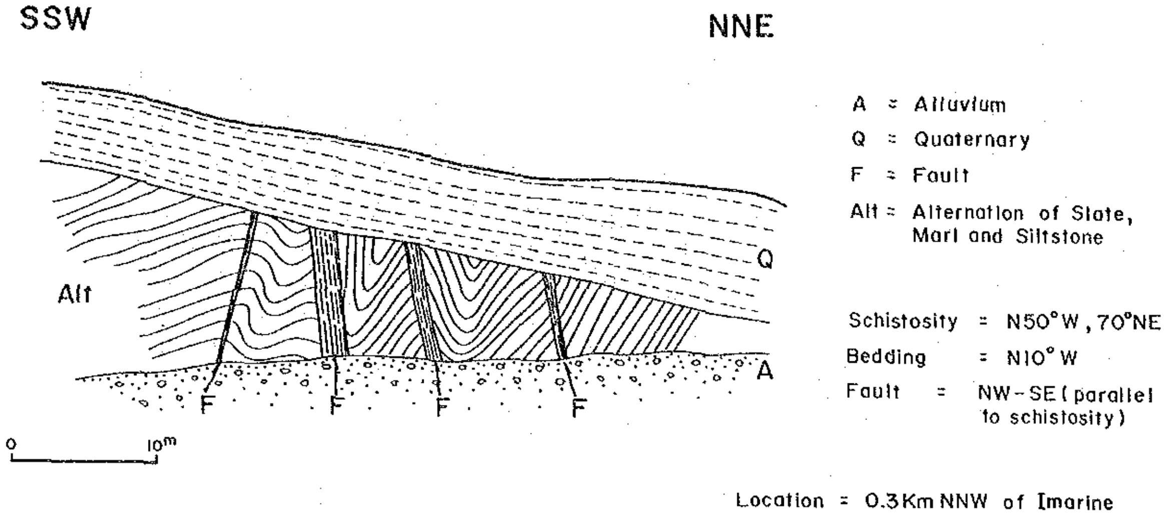


Fig.I-9 Drag Fold and Fault (Section)

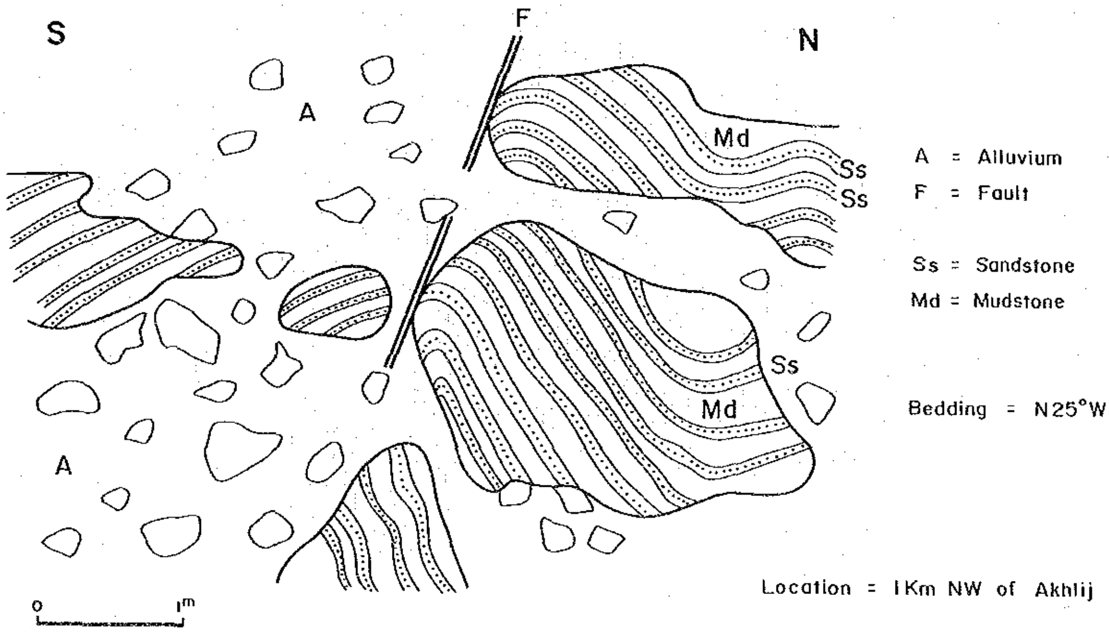


Fig.I-10 Drag Fold in the Sandstone - Mudstone Alternation (Sketch)

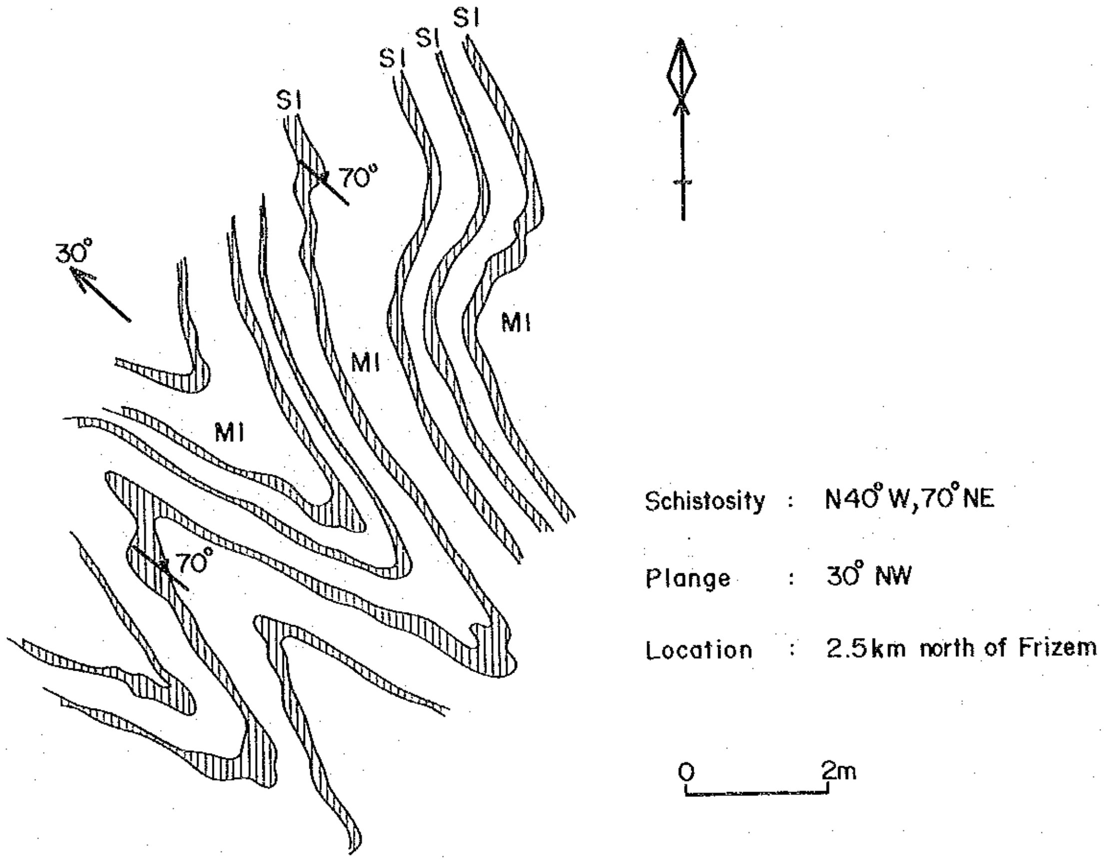


Fig. I-11 Drag Fold in the Marl Formation (Plane)

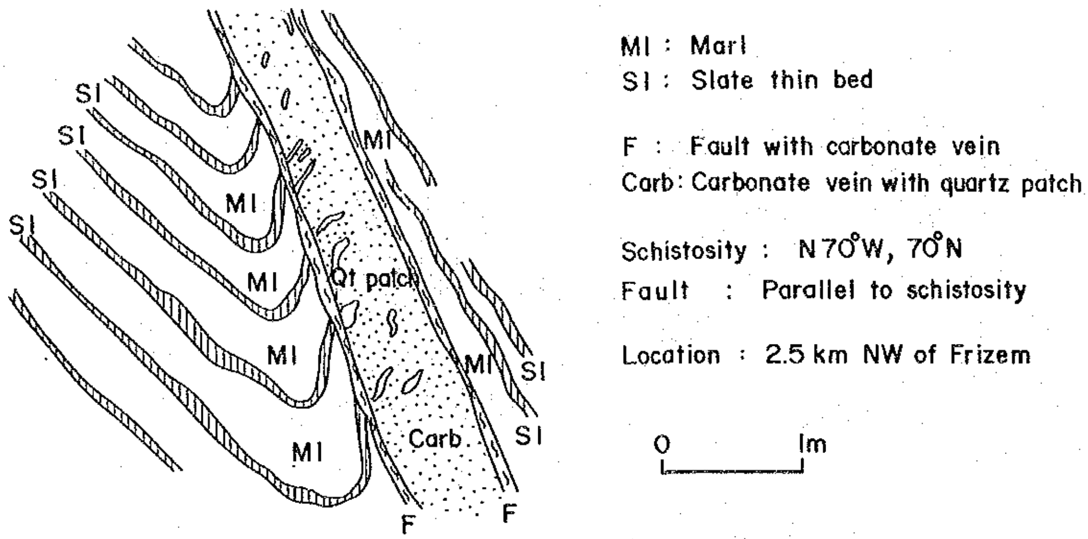


Fig. I-12 Relation of Drag Fold and Fault (Section)

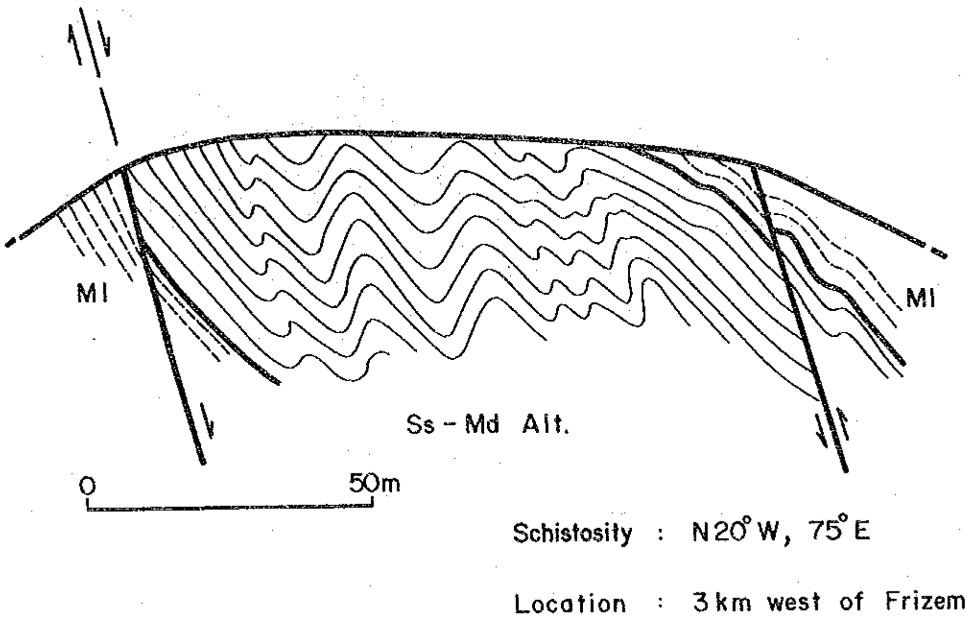


Fig. I-13 Drag Fold in the Sandstone Formation (Section)

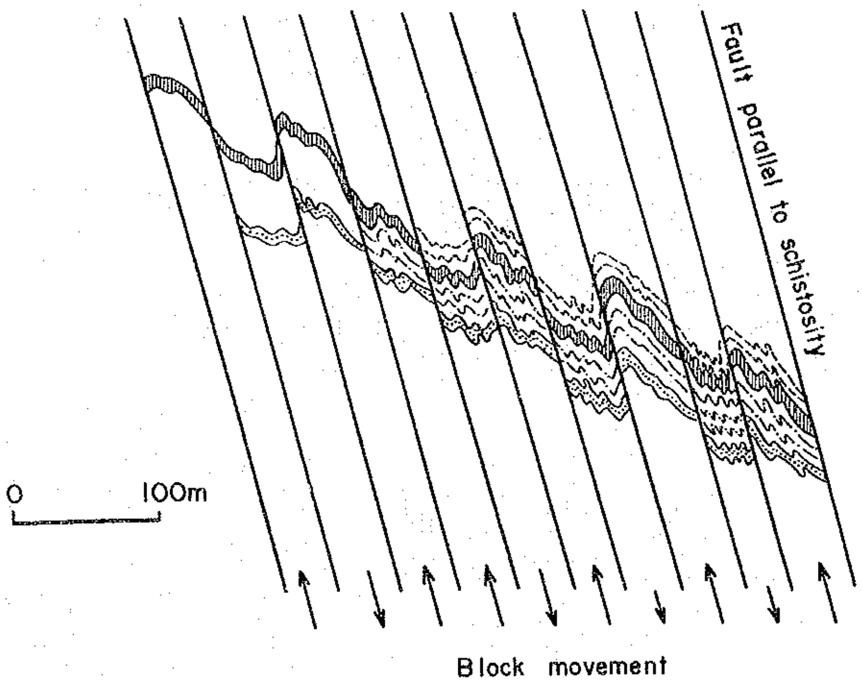
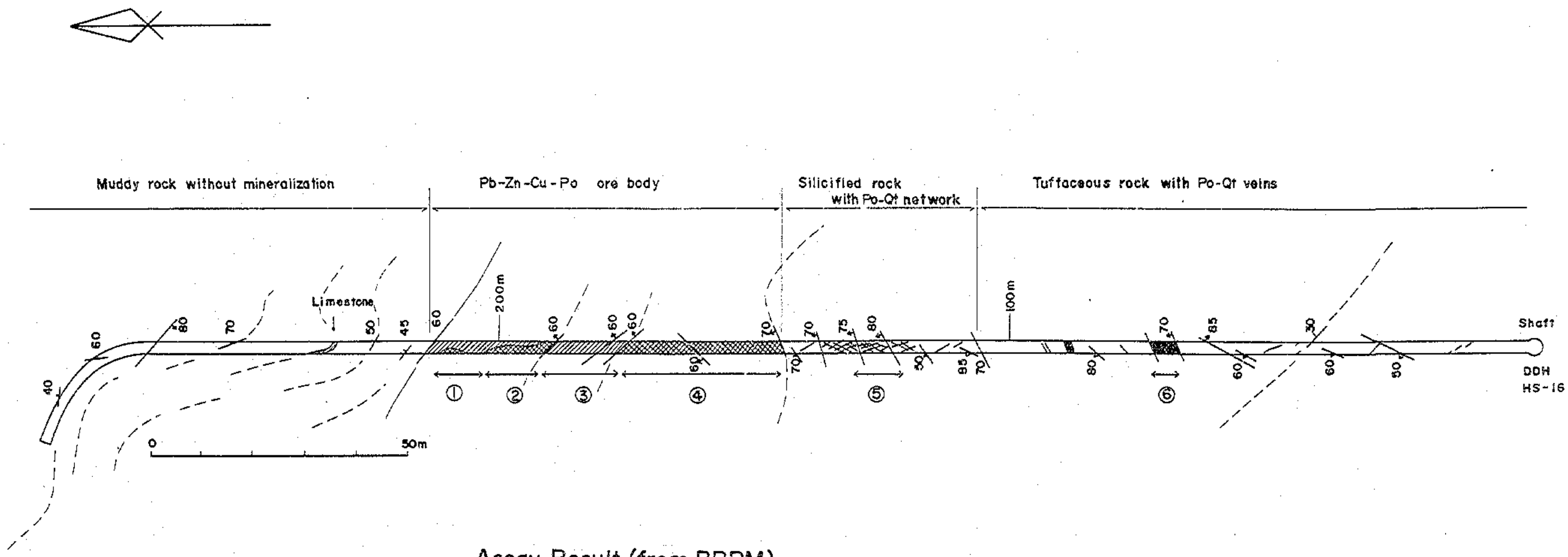


Fig. I-14 Schematic Model of Drag Fold (Section)



Assay Result (from BRPM)

		Length(m)	No.of samples	Pb(%)	Zn(%)	Cu(%)	Ag(g/t)	S(%)
1	Bedded ore body	7.50	9	4.50	8.25	0.14	112	11.53
2	Bedded ore body	10.50	11	9.83	19.39	0.23	209	35.32
3	Disseminated ore	14.40	15	1.78	3.10	0.13	29	7.60
4	Bedded ore body	32.20	34	2.31	8.33	0.58	36	31.94
5	Pyrrhotite-Quartz network	10.00	10	0.15	0.08	0.53	4	8.64
6	Vein type ore body	6.00	6	0.58	4.12	0.40	6	28.79

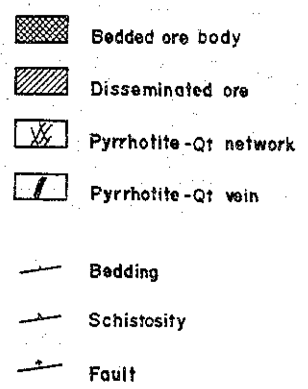
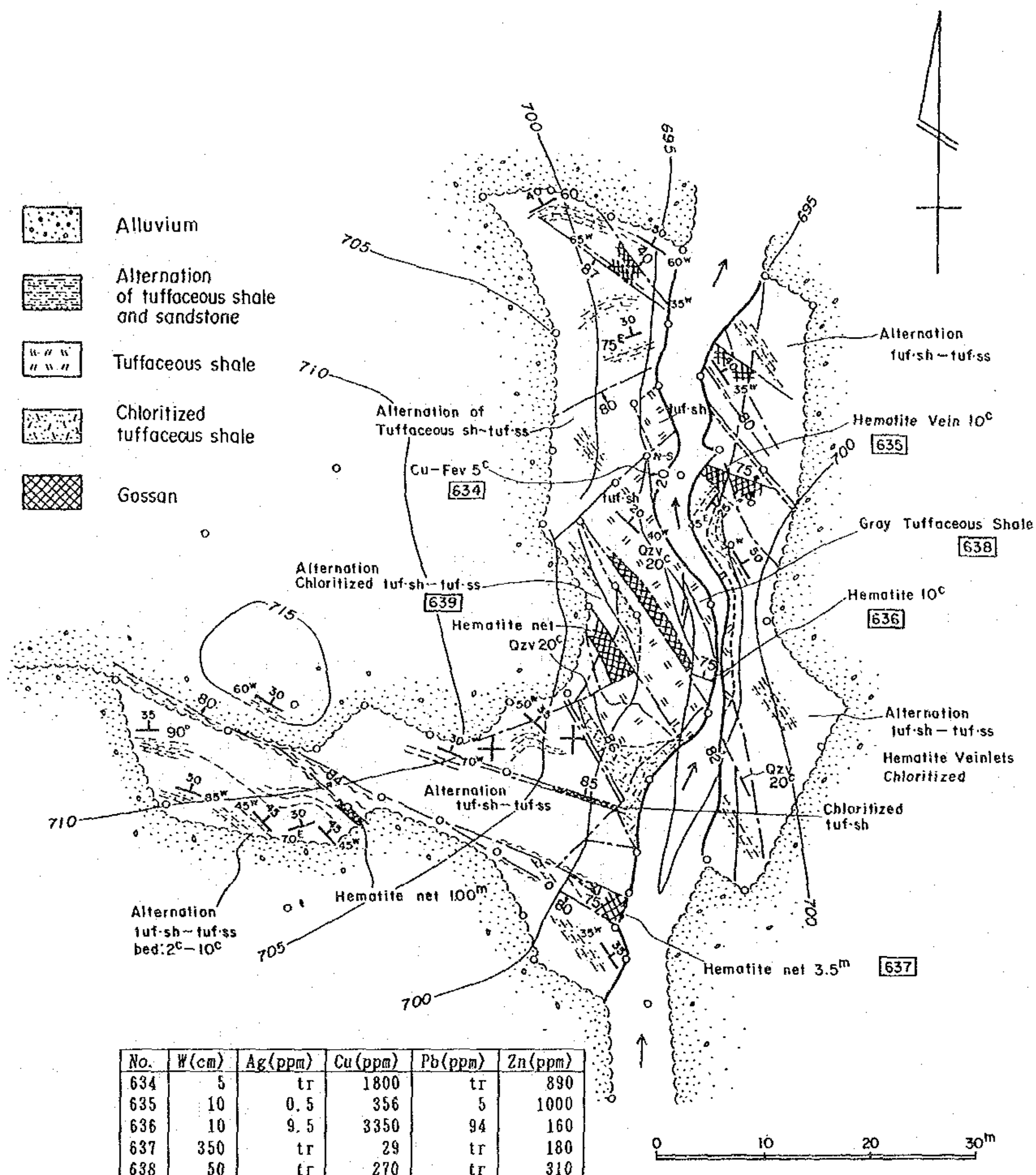
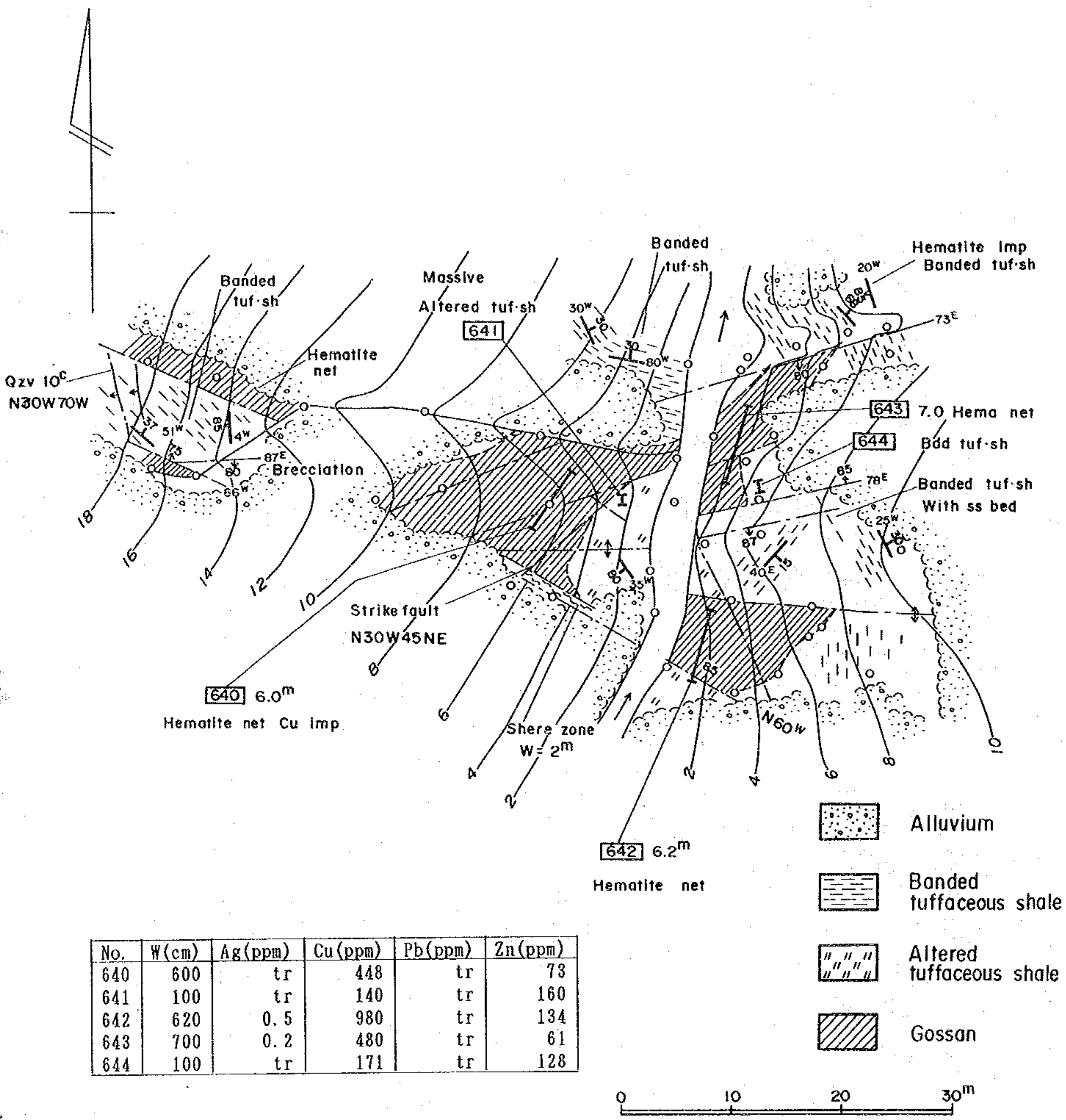


Fig I-15 Ore body Observed in Crosscut —235mL of the Hajar Mine



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.1-16 Sketch map of Mineral Indication of 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. I-17 Sketch map of Mineral Indication of West Oukhribane

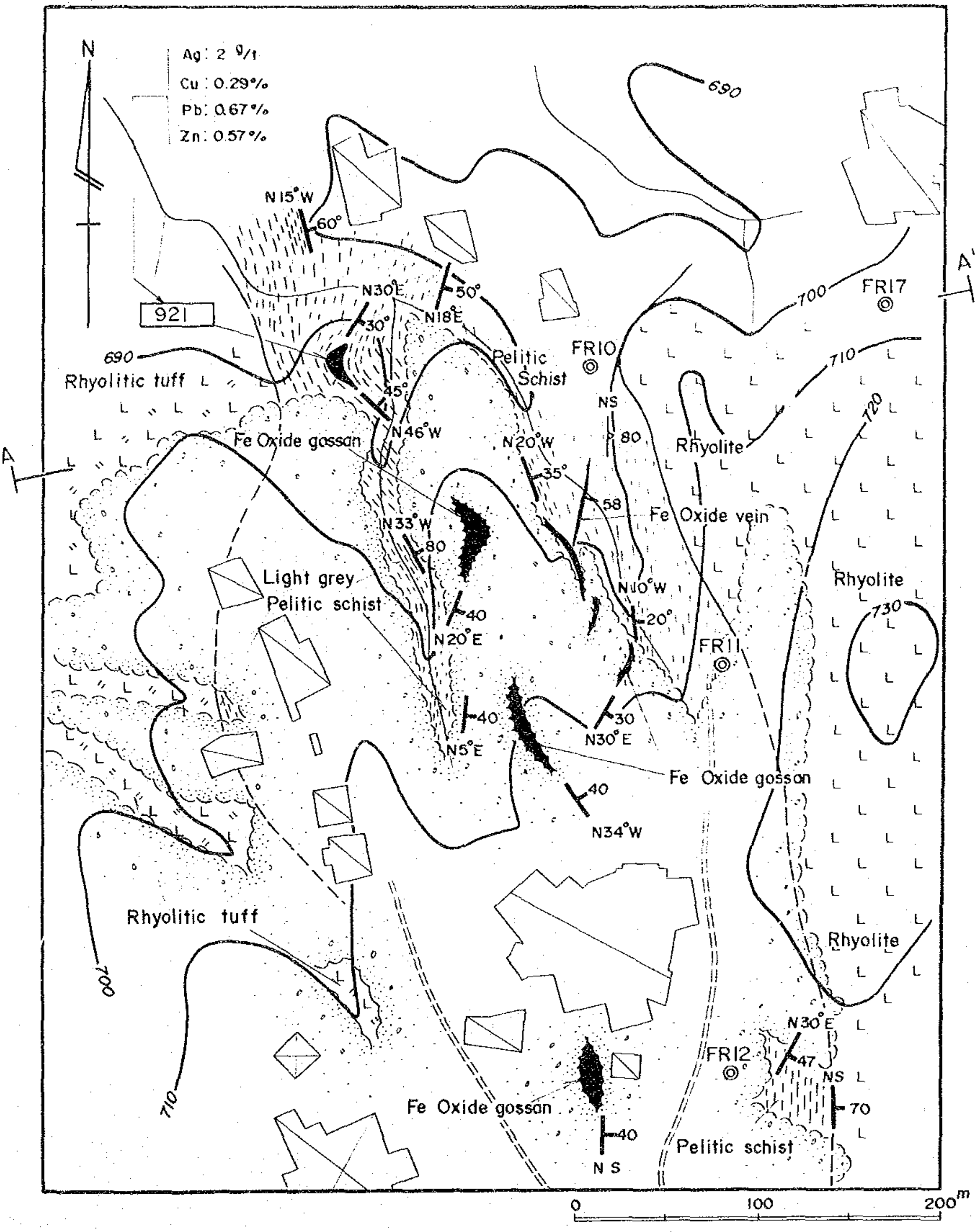
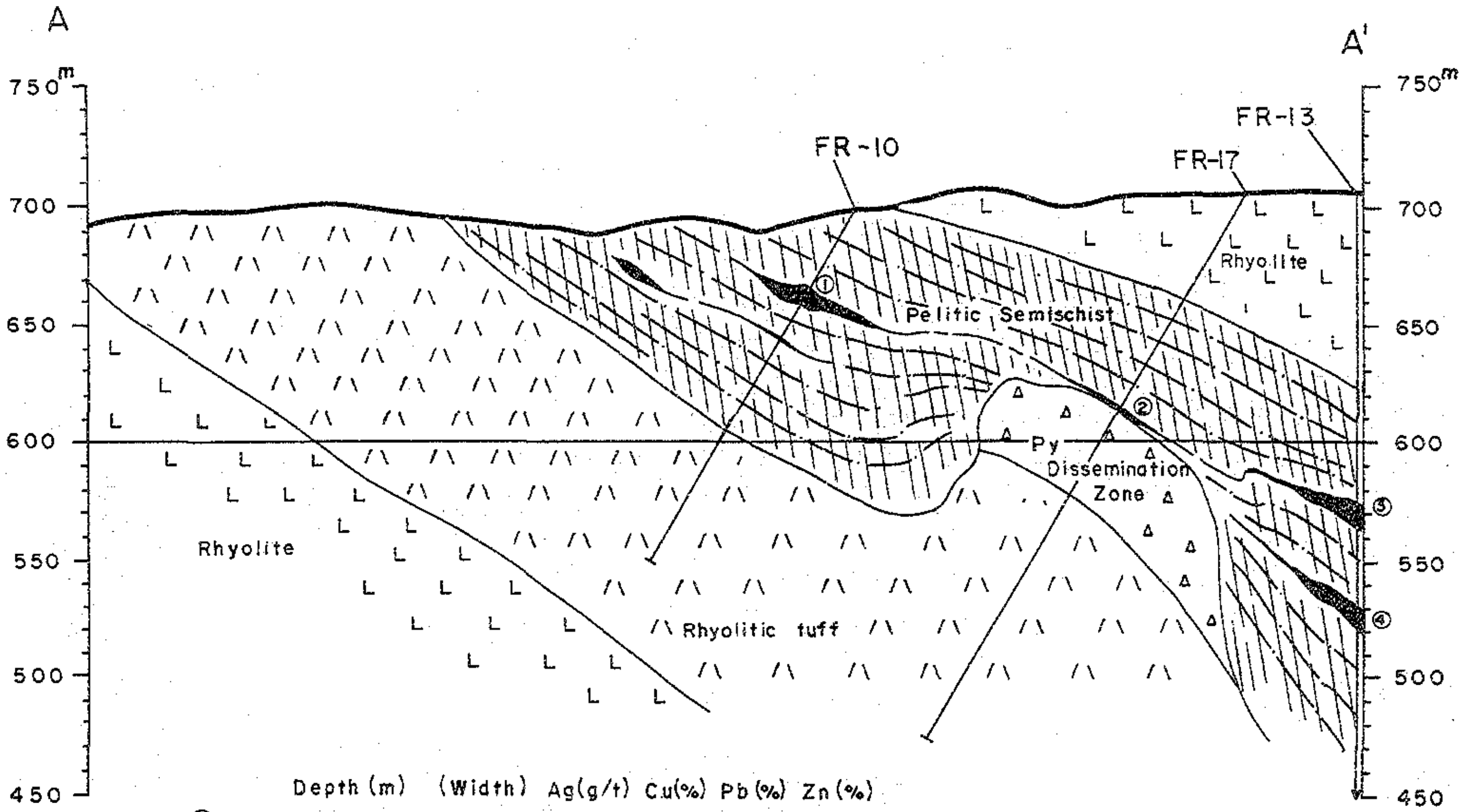


Fig. I – 18 Sketch map of Mineral Indication in Frizem



	Depth (m)	(Width)	Ag(g/t)	Cu(%)	Pb(%)	Zn(%)
①	36.35 - 46.25	(9.90)	5.0	0.4	0.06	0.19
②	104.50 - 106.35	(1.85)	8.3	0.21	0.09	0.62
③	129.80 - 140.55	(10.75)	7.14	0.26	0.22	0.35
④	174.90 - 181.40	(6.50)	8.91	1.01	0.84	0.64

Fig. I - 19 Cross Section of Mineral Indication in Frizem

CHAPTER 3 GEOCHEMICAL SURVEY

3-1 Purpose of the Geochemical Survey

The following two items were taken up as the purpose for the geochemical survey in the Second Phase.

1) Confirmation of the degree of concentration of metal elements in each rock type and stratum.

2) Confirmation of the distribution of geochemical anomalies.

3-2 Method of Survey and Data Analysis

(1) Survey Method (Fig. I-20, Fig. I-21)

Total 282 samples of rock including 14 samples of gossan were collected. Sampling points were arranged along the lines crossing at right angle to the stratigraphic trend. Sampling length was 1 m in principal and weight of each sample was about 2 kg. Collected samples were crushed to powder at the Laboratory of BRPM in Rabat and the powder samples about 500 g each in weight were send to the Laboratory in Canada. ICP method was adopted for chemical analysis. The detection limits were 1 ppm in Cu, Pb and Zn, and 0.1 ppm in Ag. The results of geochemical analysis are shown in the Ap. 1-7.

(2) Method of Data Analysis

SPSS statistic package, Lotus-123 and other computer program were used for the statistical analysis on the geochemical data. The correlation coefficients between each metal element in total 282 samples were calculated and the dispersion diagram were prepared for the studying of correlation between each metal element.

For 268 rock samples excluding 14 gossan samples, histograms and cumulative frequency curves of geochemical assay data were prepared and geometric mean as well as standard deviation was calculated to extract geochemical anomalies. In addition, all rock samples were classified by specific rock formations and geometric means as well as standard deviation were calculated respectively. The variation of geochemical values was compared to stratigraphical structure in main sampling lines. (Fig. I-25).

3-3 Results of Data Analysis

(1) Correlation between Each Element

Fig. I-22 is the dispersion diagram of each element for total 282 geochemical samples.

The correlation coefficients between each metal element are as follows:

	Cu	Pb	Zn	Ag
Cu	1.0000	.4360	.5516	.7037
Pb	.4360	1.0000	.8182	.1425
Zn	.5516	.8182	1.0000	.1163
Ag	.7037	.1425	.1163	1.0000

Clear positive correlations are found between Pb and Zn, and between Cu and Zn. The high value of correlation coefficient between Ag and Cu is influenced by the reason that many Ag values show lower than the detection limit. According to the dispersion diagram, a weak positive correlation is found in the relation between Ag and Cu.

(2) Geochemical Anomaly

The histograms and cumulative frequency curves of geochemical assay data for 268 rock samples except for gossan samples are shown in the Fig. I-23. The value of geometric means and standard deviations are shown in the Tab. I-2. The values of geometric mean plus double standard deviation (m + 2σ) for each element are as follows:

Cu = 165.63 ppm

Pb = 130.23 ppm

Zn = 526.85 ppm

Ag = 0.21 ppm

The values of (m + 2σ) are most adequate for the threshold values to extract geochemical anomalies by the reason that the inflection point is found around the values of (m + 2σ) in the cumulative frequency curves.

Depended on the above mentioned threshold values, the number of anomalous geochemical rock samples is 29 excluding gossan samples. The number of anomalous values for each metal element are 13 in Cu, 12 in Pb, 10 in Zn, and 6 in Ag. The list of geochemical anomalies is shown in the Tab. I-3, and the locations of geochemical anomalies are shown in the Fig. I-20 and Fig. I-21.

The geochemical anomalies classified by areas and formations are summarized as shown in the following page:

Judging from the numbers of anomalies, Cu-anomalies are centralized in the formation of IIat (tuffaceous green rock) in the Oukhribane Block and Pb-anomalies are centralized in the formation of Ivv (acidic volcanic rock) in the Frizem Area.

Area	Formation	No. of Anomalies
Imarine	Intrusive rock	1 Sample (Pb 1)
	IIc	1 Sample (Zn 1, Ag 1)
	IIp2	1 Sample (Pb 1)
Amzourh	IIap	2 Samples (Cu 2, Zn 1, Ag 1)
Oukhribane	IIat	8 Samples (Cu 7, Pb 1, Zn 2)
	IIaa	1 Sample (Cu 1, Ag 1)
Frizem	Iml	1 Sample (Cu 1)
	Ic	4 Samples (Cu 1, Pb 2, Zn 2, Ag 2)
	Ivt	1 sample (Pb 1)
	Ivv	5 samples (Pb 4, Zn 1, Ag 1)
	Ips	4 samples (cu 1, Pb 2, Zn 3)

(3) Concentration of Metal Elements by Each Formation

The statistical values of metal contents in 268 geochemical rock samples such as geometric mean, standard deviation, maximum value and minimum values are shown in the Tab. I-2 classified by each formation. The geometric means of Cu, Pb and Zn are shown by graph in the Fig. I-24.

Geometric values of Zn is 157 ppm, more than two times content of Clarke number (= 70 ppm). It proves that this area is rich in Zn element.

Considering geometric means of metal contents in each formation, Cu element is concentrated extraordinary in the formation of IIat in the