formed the peneplane before the sedimentation of Triassic System, and that the inclination due to the fault-block movements was started after the sedimentation. On the other hand, the southern margine of the Triassic System is severed by Tarat-n-Yaqoub Fault and Iguidi Fault which trending NE-SW or E-W.

Northern and southern boundaries of the Cretaceous System in this area, are fault-contact with the Paleozoic Groups by the Ighir Fault and the Agadim Fault which showing the direction east to west. These facts indicate that block movements were made in this area after the end of Mesozoic age. According to survey results of the first phase, it is assumable that these movements were made during the period of the Alpine Orogenic Movement at the end of Tertiary age.

1-3 Results of Geochemical Survey

In the southern Area, geochemical survey was carried out, in parallel with the geological survey by collecting stream sediments for the analysis of miner metal elements contained in them.

The purpose of this survey is to clarify the distribution of indicating of mineralization in this area, especially to elucide the presence of undiscovered favorable ore deposit through the examination of the results of analysis.

The localities of the sampling points, total amounts of 698 points, are shown in the PL. 1-3-1, and the results of analysis are listed in Table A-8.

Values of the chemical analysis were treated statistically and the consideration was given on the characters of the population, the anomalies and the correlative relation among the elements.

The anomalous values detected are shown in the PL. 1-3-2 to the PL. I-3-5.

1-3-1 Statistic Treatment

For the statistic treatment, logarithm of the analysis value, which show almost normal distribution, was employed for the consideration, as the distribution of the analysis value of each elements had an extreme partiality for low grade side.

However, no statistic treatment was carried out on W, because the W-values of 692 samples out of 698 were obtained at lower than 50 ppm.

Statistical values of every element and thresholds for anomalous values are shown in Table I-1. The histograms of the logarithmic value of the Cu, Pb, Zn and Mo elements, are shown in Fig. I-4-1 - Fig. I-4-4 and culmulative frequency distribution of above element are shown in Fig. I-5.

For establishing anomalous values, statistic values of G, G+σ and G+2σ were employed as the standards of the classification. Indicated zone, weak anomalous zone, and strong anomalous zone are determined as follows and the results are shown in the above Plates.

Strong Anomalous Zone	$> G + 2$
Weak Anomalous Zone	$G + 2\sigma > \sim > G + \sigma$
Indicated Zone	$G + \sigma > \sim > G$

The characters of population of each element and the relation to the anomalous value, and correlative relation among the elements are discribed as follows:

1) Cu: Points of inflections are observed on the cummulative frequency distribution graph near Cu 23 ppm and near Cu 100 ppm. The former posi-

tion approximately corresponds to G value, and the latter position approximately corresponds to G+2σ value. Especially, since values below 23 ppm and above 23 ppm belong to different populations respectively, it is considered that values below 23 ppm indicate the background values of Cu in this area. It is, therefore, considered that establishments of anomalous values and thresholds as above are allowable required conditions.

2) Pb: Point of inflection is observed on the cummulative frequency distribution graph near Pb 17 ppm. This point approximately corresponds to the level of G value. It is considered that values below 17 ppm indicate the background values of Pb in this area. It is, therefore, considered that establishments of anomalous values and thresholds as above are allowable required conditions.

3) Zn: Points of inflections are observed on the cummulative frequency distribution graph near Zn 50 ppm and near Zn 90 ppm. These positions corresponds to G value and G+σ value respectively. Especially, groups of values below 50 ppm and values above 50 ppm are belonging to different populations respectively, and it is considered that those below 50 ppm indicate the background values of Zn in this area. It is, therefore, considered that establishments of anomalous values and thresholds as above are allowable required conditions.

4) Mo: The chemical analysis values of Mo has a detectable limits of 1 ppm. Therefore, the half of those values were represented on making statistic treatments on them. Since 67% of logarithmic values of analysis results biassed toward low grade side (Mo less than 1 ppm) on the histogram, such distribution can not be regarded to be of normal. On the other hand, point of inflection is observed on the cummulative frequency distribution graph at near Mo 3 ppm. This point approximately corresponds to the level of G+σ. It is, therefore, considered that groups of values below 3 ppm on the group of above 3 ppm are belonging to different populations respectively. In this connection, analysis results obtained on Mo were classified into two, which were strong anomalous and weak anomalous.

5) W: The detectable limits of 99.1% of the analysis results of W were below 50 ppm. Therefore, these are unsuitable for statistic treatments. The strong anomalous value of more than 54 ppm which was obtained during the first phase survey was adopted on this consideration.

6) Mutual relation among the analyzed elements: Correlation coefficients of elements, Cu, Pb, Zn, Mo, and W, were shown in Table I-2. Based on this table, the slight relationship between Cu and other elements were found, but no relationship were found between Pb and other elements, except the slight relationship between Pb and Zn. Although it seems that there are the relationship between Mo and W, it is difficult to discuss on the correlations of these, since the most of analysis results of both elements having the values below detectable limits.

<u>1-3-2 Considerations on Anomalous Values</u>

Majority of the southern area is mainly composed of the basins of the N'fis River. However, a branch of the Al Mal River, a branch of the Mdad River, and a branch of the Targa River are forming small scaled basins at the northwestern part, southeastern part, and southwestern part of this area

Table I-1 Statistic Values and Threshold Values of Stream Sediment Samples in Southern Area

Variable \ Element	Cu	Pb	Zn	Mo	W
Number	698	698	698	698	698
Minimum value	7.000 ppm	5.000 ppm	5.000 ppm	< 1.000 ppm	< 50.000 ppm
Maximum value	11,000.000 ppm	2,000.000 ppm	500.000 ppm	150.000 ppm	1,000.000 ppm
Arithmetic mean	63.126 ppm	29.060 ppm	60.373 ppm	2.077 ppm	–
Logarithmic mean (Lm)	1.357	1.228	1.709	0.023	–
Logarithmic standard deviation (SD)	0.315	0.334	0.252	0.400	–
$G = \log^{-1}$ (Lm)	22.8 ppm	16.9 ppm	51.2 ppm	1.1 ppm	–
$G + \sigma = \log^{-1}$ (Lm + SD)	47.0 ppm	36.5 ppm	91.4 ppm	2.6 ppm	–
$G + 2\sigma = \log^{-1}$ (Lm + 2SD)	97.1 ppm	78.7 ppm	163.2 ppm	6.7 ppm	–
Skewness (SK)	2.994	1.874	−0.321	1.194	–
Kurtosis (KU)	18.631	4.784	1.606	1.547	–
Classification of anomalies					
Strong anomaly ($\geqq G + 2\sigma$)	≧ 97 ppm	≧ 79 ppm	≧ 163 ppm	≧ 7 ppm	(≧54 ppm)
Weak anomaly	97 ppm >~≧	79 ppm >~≧	163 ppm >~≧	7 ppm >~≧	–
($G + 2\sigma >\sim\geqq G + \sigma$)	47 ppm	37 ppm	91 ppm	3 ppm	–
Indication	47 ppm >~≧	37 ppm >~≧	91 ppm >~≧		–
($G + \sigma >\sim\geqq G$)	23 ppm	17 ppm	51 ppm		–

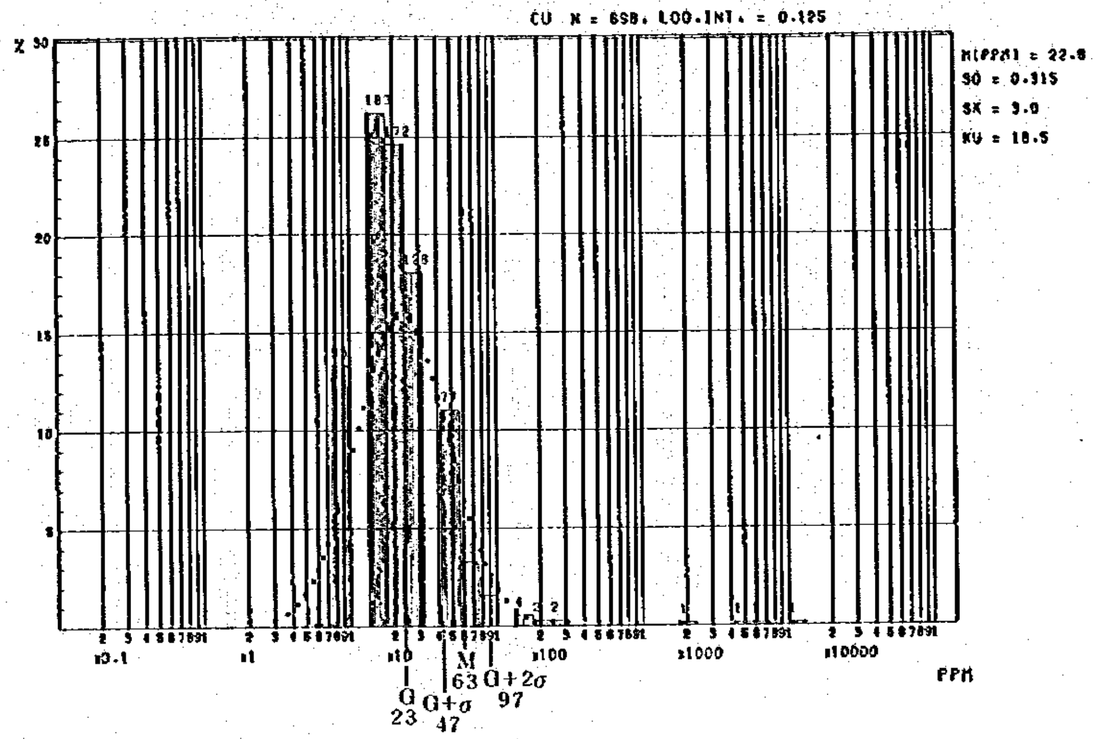


Fig. I -4-1 Histogram for Cu of Stream Sediment Samples in Southern Area

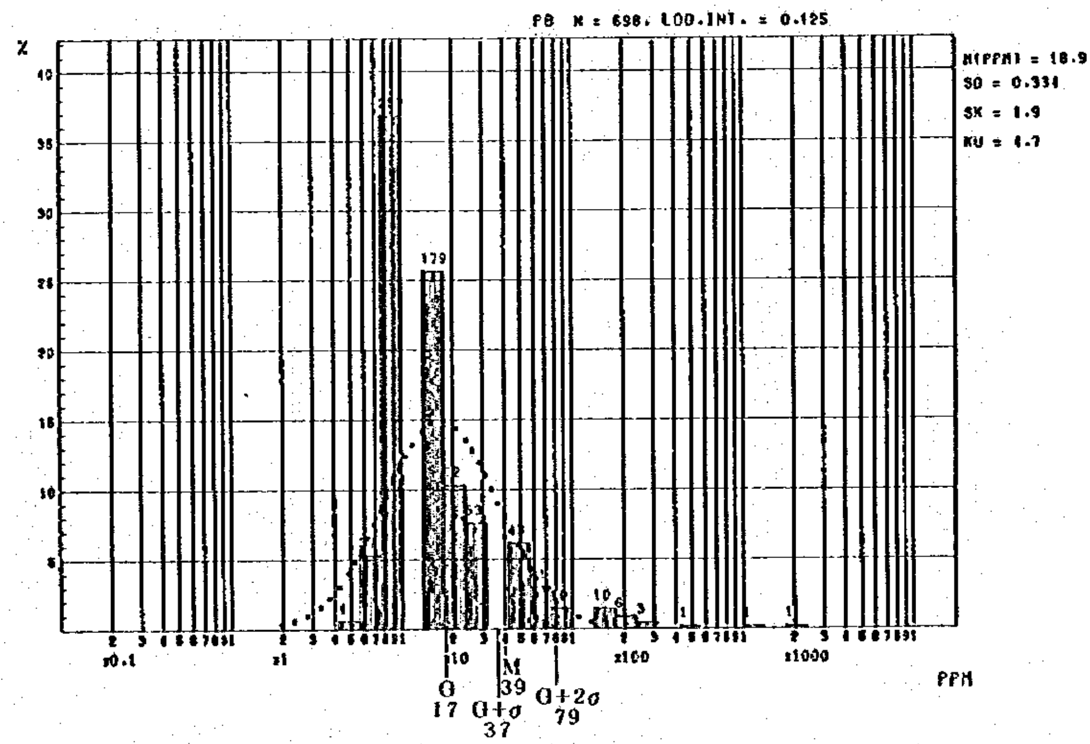


Fig. I -4-2 Histogram for Pb of Stream Sediment Samples in Southern Area

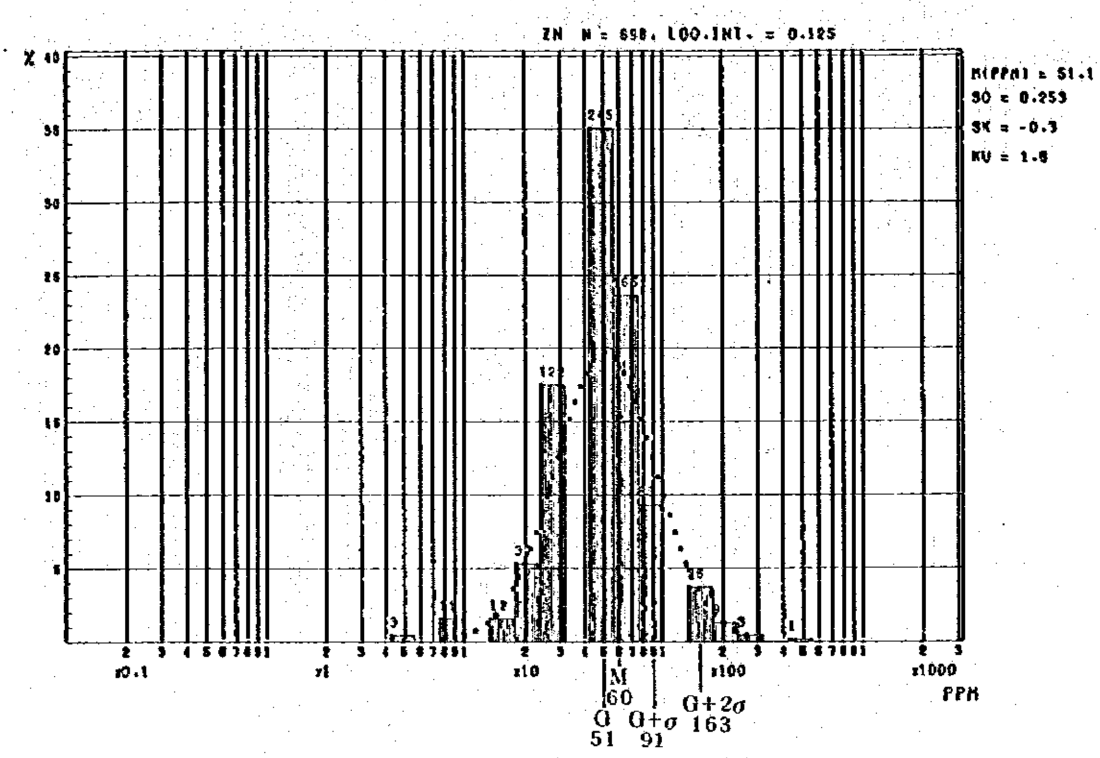


Fig. I-4-3 Histogram for Zn of Stream Sediment Samples in Southern Area

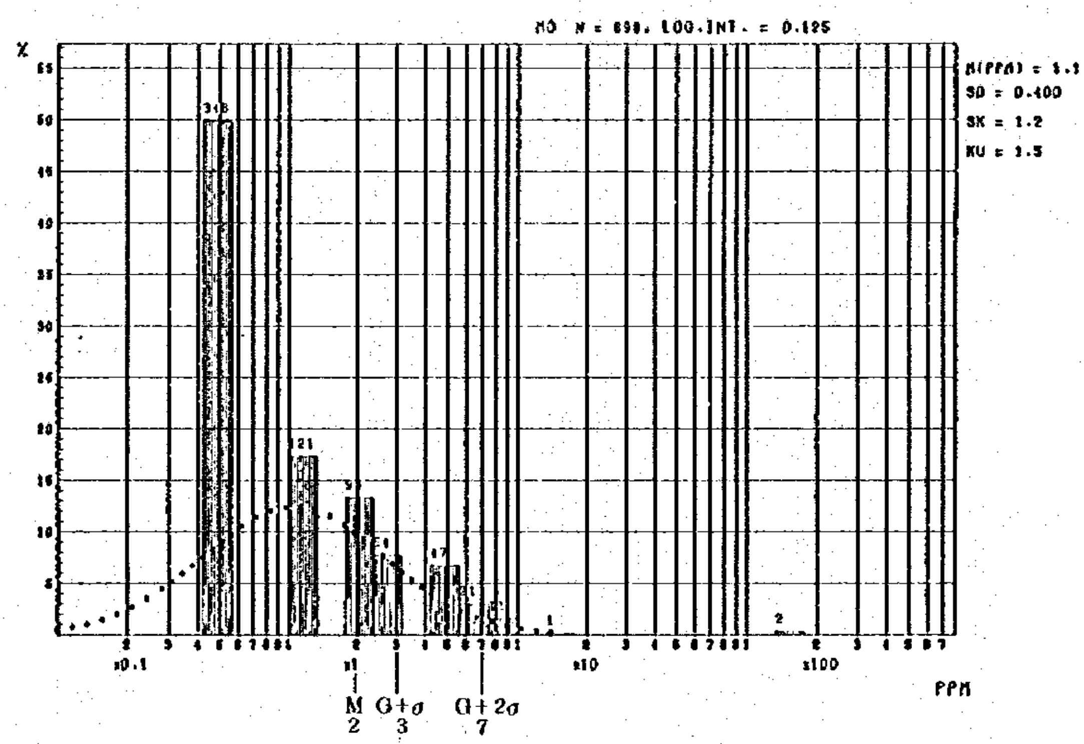


Fig. I-4-4 Histogram for Mo of Stream Sediment Samples in Southern Area

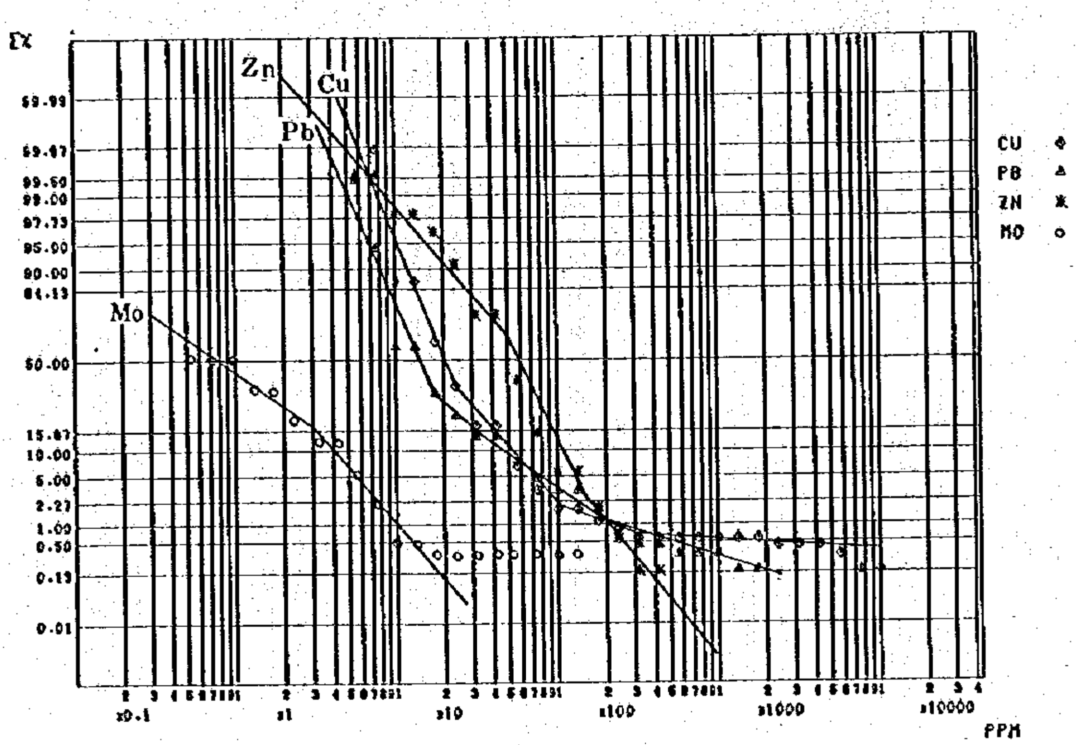


Fig. I -5 Cumulative Frequency Distribution for Cu. Pb. Zn and Mo of Stream Sediment Samples in Southern Area

Table I -2 Correlation Cofficients of Stream Sediment Samples in Southern Area

	Cu	Pb	Zn	Mo	W	Note
Cu	1.00000 0.0000 698	0.13012 0.0006 698	0.13852 0.0002 698	0.28584 0.0001 698	0.34792 0.0001 698	---- CORRELATION COEFFICIENTS ---- PROB > IRI UNDER HO: RHO=0 --- NUMBER OF OBSERVATIONS
Pb	0.13012 0.0006 698	1.00000 0.0000 698	0.57263 0.0001 698	0.06532 0.0848 698	0.01656 0.6624 698	
Zn	0.13852 0.0002 698	0.57263 0.0001 698	1.00000 0.0000 698	0.09703 0.0104 698	0.03857 0.3092 698	
Mo	0.28584 0.0001 698	0.06532 0.0848 698	0.09703 0.0104 698	1.00000 0.0000 698	0.73226 0.0001 698	
W	0.34792 0.0001 698	0.01656 0.6624 698	0.03857 0.3092 698	0.73226 0.0001 698	1.00000 0.0000 698	

respectively. It is considered that the geochemical survey by the stream sediments would bring the results reflecting the mineralization at the upper parts of respective rivers. Therefore, the examination on the anomalous values was made to corrilate above-mentioned basins.

1) Cu (Refer to PL.I-3-2)

Strong anomalous values were observed at 23 points. 5 Points of them are concentrated in the basin of the Ougandis River, which is the branch of the N'fis River in the northeastern area. Weak anomalous values were observed at 12 points in this basin. It is considered that these anomalous values indicate existences of the Gundaha Mine and the cupper-quartz veins in the Pre-Cambrian Group. In the northeastern are, another strong anomalous value associated with seven weak anomalous values were recognized which was considered to be correspond to the Iguidi Disseminated Copper Ore Deposit.

Six strong anomalous values are detected in the southeastern area. Four points of them are in the lower area of the l'Ounein Copper Deposit and the Achdirt Copper Deposit associated with weak anamolous values. Many weak anamolous values are detected at the upper part of this basin. These anomalous values indicate that the existence of copper ore deposits in the Pre-Cambrian Group.

Five strong anomalous values and 5 weak anomalous values are recognized in the southern part of the central area. It is considered to be corresponds to the ancient mine.

Four strong anamolous values were detected in the upper part of the N'fis River in the southwestern area. Three points of them are correspond to strong mineralizations of the Agadir Copper Skarn Deposit and the Ikissan Molybdenum Vein Deposit, and eight weak anomalous values are also observed in this area. The rest of strong anomalous values are observed in the southern slope of Mt. Idga accompanying 14 weak anomalous values in its circumferential area. These should be due to the existence of the small copper ore deposits in this area.

One strong anomalous value was recognized in the upper part of the Ougdamt River and other was recognized in the upper part of the Al Mal River. However, in this area, many weak anomalous values are concentrated. It seems to be the influence of the existences of the Taddart Ore Deposit and many other small copper veins.

2) Pb (Refer to PL.I-3-3)

Strong anomalies were detected at 23 points. Five points of them are concentrated in the northeastern area and seven points are concentrated in the southern part of the central area.

The former in the northeastern area are in the basin of the Ougandis River, and 8 weak anomalous values are recognized in the same basin. It is in correspondence with the Gundaha Mine (Cu, Pb, Zn). The Later in the southern part of the central area are in correspondence with the ancient mine in the basin of the branch of the Mdad River, and 9 weak anomalous values are detected in the area.

Six strong anomalies were scattered at 6 points in the southeastern area. It is considered that 2 points of them are related to the existence of the l'Ounein Mine and 2 other points accompanied with weak anomalous values are related to the mineral indications described in the previous report. Some weak anomalies in this area suggests the existence of vein-type copper, lead and zinc ore deposits.

Four strong anomalies are detected at 4 points in the basin of the N'fis River in the southwestern area. Furthermore, 9 weak anomalous values are detected in the circumferential areas of the Agadir Mine and the Ikissan Mine. These are in correspondence with the mineralization of copper, Lead, and Zinc of above ore deposits. Three strong anomalous values are detected in the basin of the branch of the Targa River. Although no remarkable mineralization is confirmed in this area, further detailed survey work should be necessary in this area.

In the northwestern area, 3 strong anomalous values are detected at the middle part, and 2 strong anomalous values are detected at the upper part of the Ougdamt River. Furthermore, 2 strong anomalous values are recognized in the upper part of the Al Mal River. Corresponding mineralization to these points have not been clarified yet. As for the former two strong anomalies, further investigational work should be done to clarify the cause of these weak anomalous values.

3) Zn (Refer to PL.I-3-4)

Strong anomalies were detected at 13 points. Five points of them are concentrated in the southern part of the central area, and the other 4 points are in the southwestern area.

Strong anomalies in the southern part of the central area are in the lower area of the ancient mine and at the branch of the Mdad River accompanied with weak anomalous values. Corresponding mineralization to strong anomalies along the branch of the Targa River has not been confirmed yet.

Beside one strong anomalous value in the northeastern area near the Gundaha Mine, 8 weak anomalous values are detected in the basin of the downstream of the Ougandis River. This corresponds to the Gundaha Mine. 5 Points indicating weak anomalous values are detected in the lower parts of the Iguidi Ore Deposit.

Thirteen weak anomalous values were recognized in the southeastern area which corresponded to the existence of mineral ore deposits and mineral indications in the area.

One strong anomalous value was recognized in the southwestern area which corresponded to mineralization in the area. However, weak anomalous values detected in this area were not correspond to the mineralization.

In the northwestern area, one strong anomalous value is detected at the middle branch dale of the Ougdamt River and 2 strong anomalous values are detected at the upper branch dale of the Al Mal River. However, their correspondence to the mineralization has not been clarified. Further investigational work in this area should be done in future to confirm the positive evidence of the weak anomalous values which concentrated at the middle part and upper part of the Ougdamt River.

4) Mo (Refer to PL.I-3-5)

Thirty five points indicating strong anomalous values were detected. Fifteen points of them are concentrated in the southern part of the central area and six points are detected at the upper part of the N'fis River in the Southwestern area.

In southern part of the central area, these strong anomalies are distributed in the area correspond to the ancien mine, which including the Tizi-ni-Test Ridge. Weak anomalous values are also concentrated in this area. Although no existence of Mo mineralization has been known, it should be necessary to pay attention in this area.

In the southwestern area, several strong anomalous values are concentrated in the upper part of the N'fis River accompanied with many weak anomalous values. It is considered to caused by the Ikissan Molybdenum

Ore Deposit and Agadir Skarn Ore Deposit in this area.

In the northeastern area, 3 strong anomalous values and 17 weak anomalous values are detected in the circumferential area of the Gundaha Mine and in the basin of the Ougandis River respectively. Although this area is not characterized by the mineralization of Mo, the existence of minor amount of Mo associated with the mineralization of copper, lead, and zinc in the Gundaha Mine is presumable.

In addition, 5 strong anomalous values in the southeastern area, and many weak anomalous values were detected along the branches in the eastern part. There is no report discussing for Mo mineralization in this area. However, since the mineralizations in this area are made up relatively high grade metals contents. These show large possibilities that minor amount of Mo is accompanied with the those mineralization.

In the northwestern area, a strong anomalous value is detected in the upper part of the Al Mal River and 2 strong anomalous values are seen at the upper part of the Ougdamt River respectively. However, it is considered that these are isolated each without accompanying weak anomalies, and the mineralization in this area seems to comparatively weak.

5) W (Refer to PL.I-3-5)

W Anomalies were observed only at 6 points being concentrated in the area near the Agadir Village at the upper part of the N'fis River in the southwestern area. Since many mineralizations such as the Agadir Skarn Ore Deposit, the Ikissane Molybdenum Ore Deposits, are found in this area, and since the scheelite has been confirmed in the skarn ore deposit, it is considered that these anomalies correspond to such mineralizations.

1-4 Mineralization

Thirty nine localities of mineralization of ore deposits or mineral indications in the outhern area have been clarified by this survey. The locations of these mineralization are shown in Fig. I-6, PL 1-4-1, and the outline of the ore deposits and the mineral indication are shown in Table I-3.

As to the types of mineralization, although vein-type ore deposits are found most frequently, skarn-type ore deposits and a stockwork ore deposit are observed as well. The vein-type ore deposits contain copper, lead, zinc, silver, molybdenum, and barite, the skarn-type ore deposits contain copper, tungsten, and iron, and the stockwork ore deposit contains copper. The country rock of all of these ore deposits are exclusively rocks of the Pre-Cambrian Group, the Palerozoic Groups, and the intrusive rock of Hercynian Period, and none of mineralization exists in the rocks after Paleozoic age. This facts suggests that the mineralizations in this area have the close relationship with the intrusive rocks in the Hercynian period of the end of Palerozoic Era.

The outlines of the ore deposits of each type of mineralization is discribed in the followings.

1) Vein-Type Ore Deposits

The country rocks emplacing vein type ore deposits are the andesites of the Pre-Cambrian Group, the sedimentary rocks and the metamorphic rocks of Paleozoic Groups and the granites. As the vein-type ore deposits in the andesites of the Pre-Cambrian Group, the barite and copper ore deposit in the area near the Ighir village in the eastern area (32). the copper ore deposits near the Anammer village (34, 35, 36, 37, 38), and the copper ore deposit near the Tandilt village in the southeastern area (39).

The Ighir Barite Ore Deposit consist of several high-angled veins, about 30 cm width, trending from east to west, and some of the veins is disseminated by minor amount of copper. Other copper ore deposits are also high-angled quartz vein of which the strikes are running toward various directions such as NE-SW, NNW-SSE, WNW-ESE, etc. The Cu grades of ore deposit vary from 0.06% to 3.75%. There are several other working barite ore deposits in Pre-Cambrian Group.

Vein-type ore deposits in the Paleozoic groups are copper, lead, and zinc ore deposits emplaced in the CI Formation in the eastern area, and copper ore deposit emplaced in the CIII Formation in the western area. The former is represented by working or under exploration ore deposits such as the Gundaha Mine (22, 23, 24, 25, 26, 27), l'Qunein Mine (20, 21), etc. The Gundaha Mine is the copper, lead and zinc ore deposits of which the vein are more than 1,000 m length, and varying from 20 cm to 2.00 m in width. The direction of the vein trends from WNW to SES and dips 75° southward and it is composed of 4 veins. The productions of this mine in the past were 320,000 tons of crude ore, 3,600 tons of copper concentrate (Cu 6%), 11,000 tons of lead concentrate (Pb 19%), and 45,000 tons of zinc concentrate (Zn 75%). Although this mine is not being worked at present, the small scaled explorations are being made by B.R.P.M.

The l'Qunein Mine is the copper and quartz vein deposits at about 1 km south of the Tawrirt village. This deposit is composed of 3 veins of which the veins more than 1,000 m length and vary from 20 cm to 2.00 m in width. The direction of the veins trends from WNW to SES, and dip steeply northward or southward. Main ore minerals are chalcopyrite, bornite, and chalcocite accompanied with minor amounts of azurite, covelline, malachite, and pyrite. The Cu grade of stock pile indicates from 11.75% to 17.00% (Table A-3-1, Table A-7). Another vein-type ore deposit in the southeastern area is in the area near the Achidir village (29, 30, 31), of which strikes are running either NNW-SSE or NNE-SSW. Widths of veins varies from 50 cm to 150 cm, and the length of some of them reaches more than 50 m. Ore minerals of the deposit are chalocopyrite accompanied with gallena, and the Cu grade is relatively good, about 2%.

The vein-type mineral deposit in western area emplaced in the C Ⅲ Formation is the copper-quartz vein deposit represented by the Taddart Deposit (7). This deposit is located at about 1 km southeast of the Taddart village which is in the northwestern part of the area. This deposit is emplaced in the conglomerate of the C Ⅲ Formation. The ore minerals are chalcopyrite, malachite and pyrite. The strikes of the veins shows 3 directions of S-N, NE-SW, and WNW-ESE. Although the mineralized area (60 m x 60 m) was confirmed during the survey of this phase, the extension of mineralization northward is presumable. The maximum width of veins is 150 cm and minimum width is 10 cm, but it indicated about 30 cm in general. The Cu grades of samples of the vein vary from 0.15% to 5.20% (PL I-5-2).

Many Cu mineralizations accompanied by the small quartz veins are observed from northwestern part to southwestern part of the survey area. All of them are emplaced in the C Ⅲ Formation predominated by limestone. The direction of veins shows various trends, such as S-N, NE-SW, WNW-ESE, ENE-WSW, and they dip steeply. The veins form from 5 cm to 10 cm and their Cu grades hardly reached 1%.

Vein-type mineral deposits emplaced in Granite is represented by Ikissan ore deposit (1) in northwestern part of the area. This ore deposit is at the north of the Ikissan village. This is the molybdenum-quartz vein emplaced in Granite contacting with C Ⅲ Formation. The deposit is composed of 5 to 7 parallel veins of which strikes are running WNW-SES. The

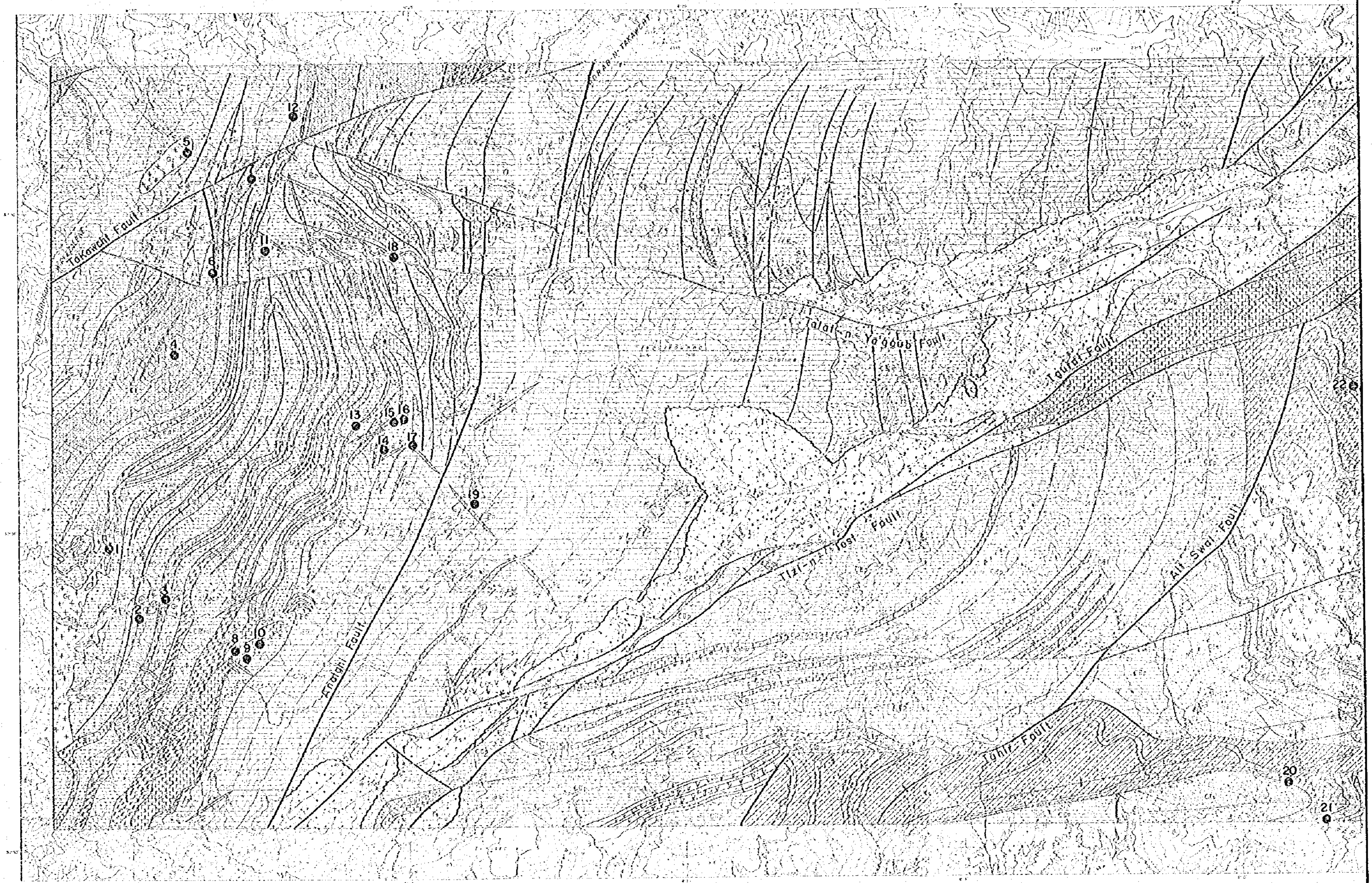
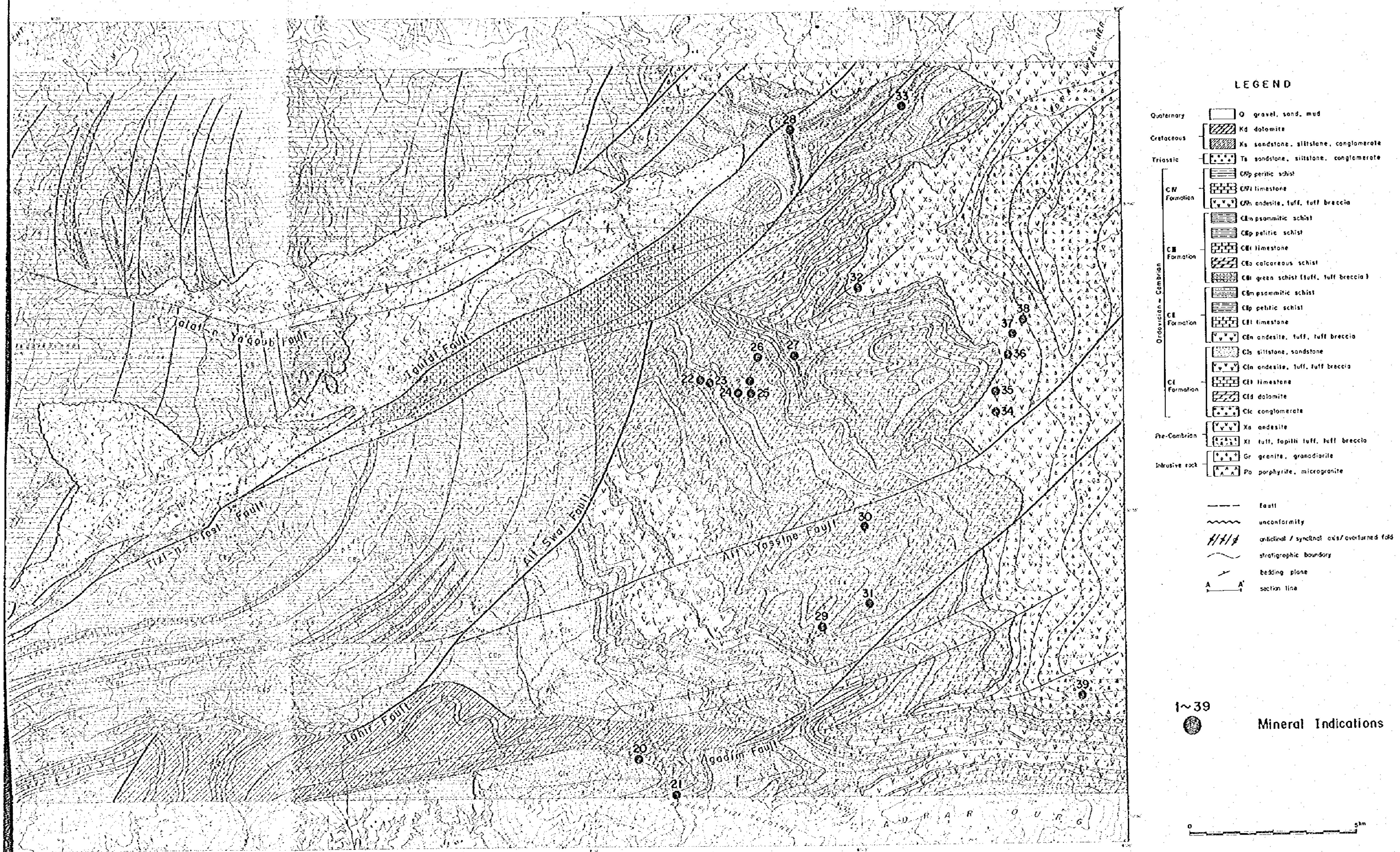


Fig. I-6 Ore Deposits and Mineral Indications Map in Southern Area



ig. I-6 Ore Deposits and Mineral Indications Map in Southern Area

Table I -3 List of Ore Deposits and Mineral Indications in Southern Area

No.	Name of Mine & Indication	Location	Kind of Ore	Type	Host Rock	Ore Deposits			Grade						Ore Mineral	Remarks
						Strike & Dip	Length (m)	Width (cm)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Mo (%)	W (%)		
1	Ikissane	Ikissane	Cu, Mo, W	Vein	Gr	N60W,50SW	10-80	26-40	-	max 0.07 0.03	-	-	max 0.92 0.24	max 0.02 <0.01	Mo, Py, Po, Bi	5 quartz veins
2	Maouass	Agadir S 1km	"	Skarn	CⅢt	NS,40E	10	100-300	-	max 0.70 0.15	-	-	<0.01	max 0.02 <0.01	Py, Hm, Mg	
3	Agadir	Agadir	"	"	CⅢl	NS-N30E, 80E-80W	10-15	30-40	-	max 1.60 0.54	-	-	0.01	max 0.41 0.09	Cp, Bi, Te	Skarn 200mx30m
4	Tizi-n-Oumzro	Tizi-n-Oumzro	Cu	Vein	CⅢt	N20E,60E	2	10	3	0.04	<0.01	<0.01	-	-	Cp, Py	
5	Tamsoult	Tamsoult	"	"	Gr	N60E,30N	3	100	10	0.03	0.01	<0.01	-	-	As	
6	Ansa	Ansa SE 2.0km	"	"	CⅢm	N50E,80N	-	20	-	-	-	-	-	-	Cp, Py	
7	Taddart A	Taddart	"	"	CⅢt	NS,N25E, N60W,60E	10-100	10-150	12	2.72	<0.01	<0.01	-	-	Gn, Py, Cp	15-20 quartz veins
8	Igherm A	Igherm S 1.6km	"	"	CⅢl	N45W,85N	-	5-10	15	0.25	0.02	0.04	-	-	Cp, Py	
9	Igherm B	Igherm SSE 1.7km	"	"	"	N60W,85N	-	5	7	0.06	<0.01	0.02	-	-	Cp, Py	
10	Igherm C	Igherm SE 1.7km	Pb	"	"	N70E,70N	-	5	-	-	-	-	-	-	Gn, Sp	
11	Amslouh	Amslouh E 1.7km	Cu	"	CⅢm	N70W,70N	-	30	2	0.65	<0.01	<0.01	-	-	Cp, Py	
12	Taddart B	Taddart NE 2.3km	"	"	CⅢt	NS,90	100	30-70	10	8.02	<0.01	<0.01	-	-	Cp, Py	Stock pile of Malachite 1,000t
13	Tirmouza A	Tirmouza NW 1.6km	"	"	CⅢm	N35W,80E	-	10	1	1.60	<0.01	0.03	-	-	Cp, Py	
14	Tirmouza B	Tirmouza W 0.5km	"	"	"	NS,80E	-	20	1	0.05	0.01	0.02	-	-	Py	
15	Tirmouza C	Tirmouza NNW 1.0km	"	"	"	NS,85E	-	10	7	2.20	0.01	<0.01	-	-	Cp, Py	
16	Tirmouza D	Tirmouza N 1.2km	"	"	"	EW,70N	-	10	15	0.09	0.15	<0.01	-	-	Py	
17	Tirmouza E	Tirmouza NE 0.5km	"	"	CⅣp	N55E,80S	-	10	0.5	0.04	0.15	0.02	-	-	Py	
18	Arg	Arg W 1.5km	"	"	CⅢl	N5E,90	-	5	10	0.40	<0.01	0.03	-	-	Cp, Py	
19	Zaywat Askar	Zaywat Askar	"	"	CⅣp	N80W,70N	-	-	1	1.80	<0.01	0.08	-	-	Cp, Sp	
20	L'Ounein A	Tawrirt S 0.6km	"	"	CⅠd	N60W,75S	-	120	190	11.75	0.03	0.38	-	-	Bo, Cp	Length Width 1500m x 1-3m 3 quartz veins (Nos. 20-21)
21	L'Ounein B	Tawrirt SSW 2.0km	"	"	"	N65W,75N	-	200	215	19.00	0.07	0.48	-	-	Ma	
22	Gundafa	Gundafa	Cu, Pb, Zn	"	"	N70W,75S	500+	30	10	3.06	0.68	18.50	-	-	Cp, Gn, Sp	Crude ore 320,000t (1927 - 1970) Length Width 800m x 0.2-3.0m 6 quartz veins (Nos. 22-27)
23	"	"	"	"	"	N70W,75S	"	200	7	0.03	0.05	0.15	-	-	Py	
24	"	"	"	"	"	N80W,65S	600+	20	10	7.05	0.03	0.05	-	-	Cp, Py	
25	"	"	"	"	"	N40W,75NE	600+	30	10	4.02	0.19	0.30	-	-	Cp, Gn, Sp	
26	"	"	"	"	"	N85E,75N	-	300	-	-	-	-	-	-		
27	"	"	"	"	"		-	-	-	-	-	-	-	-		
28	Iguidi	Iguidi	Cu	Network vein	CⅠd	N70E,50NW	-	400-500	3	2.31	<0.01	0.04	-	-	Cp, Hm	
29	Achdirt	Achdirt NE 0.5km	"	Vein	"	N35W,85SW	50	120-150	4	2.70	<0.01	0.14	-	-	Az	Under mining by SOCOMIS
30	Agadirane	Agadirane NW 2.0km	"	"	"	N10E-N10W	-	60	-	-	-	-	-	-		
31	Imi-n-Tislit	Imi-n-Tislit, NE 0.1km	"	"	"	N35W,30SW	13	500	-	-	-	-	-	-		
32	Ighir	Ighir	Ba	"	Xa	N75W-N80E 90	-	20-30	-	-	-	-	-	-	Ba	5-6 Barite veins
33	Tizi-n-Iguidi	Tizi-n-Iguidi	"	"	CⅠd	N30E,80E	300-500	300-700	-	-	-	-	-	-	Ba	3 Barite veins
34	Anammer A	Tagdit-n-Oufella E 1.7km	Cu	"	Xa	N10W,20W	-	15	12	0.64	<0.01	<0.01	-	-	Cp, Py	
35	Anemmer B	Tagdit-n-Oufella E 2.0km	"	"	"	N40E,60E	-	300	280	3.75	<0.01	<0.01	-	-	Cp, Py	
36	Anammer C	Anammer S 1.6km	"	"	"	N40E,75W	-	50	8	0.44	<0.01	0.01	-	-	Cp, Py	
37	Anammer D	Anammer S 1.0km	"	"	"	N60W,80N	-	50	4	0.06	<0.01	0.01	-	-	Cp, Py	
38	Anammer E	Anammer S 0.5km	"	"	Xt	N25E,70W	-	30-50	4	3.00	<0.01	0.01	-	-	Cp, Py	
39	Tandilt	Tandilt	"	"	Xa	N10W,60W	16	400	-	-	-	-	-	-		

Host Rock

Formation		Rock Name
Ordvician – Cambrian	CⅠ	p ... pelitic schist
	CⅡ	m ... psammitic schist
	CⅢ	l ... limestone
		t ... green schist (tuff, tuffbreccia)
	CⅣ	d ... dolomite
Pre-Cambrian (PⅢ)		Xa ... andesite
		Xt ... tuff, taffbreccia

Ore Mineral

As ... Arsenopyrite	Ma ... Malachite
Az ... Azrite	Mg ... Magnetite
Ba ... Barite	Mo ... Molybdenite
Bi ... Bismuth	Po ... Pyrrhotite
Bo ... Bornite	Py ... Pyrite
Cp ... Chalcopyrite	Sp ... Sphalerite
Gn ... Galena	Te ... Tetradymite
Hm ... Hematite	

veins are about 30 cm in width and they occur from several meter to several hundreds meters in length. The ore mineral of this deposit is molybdenite which is accompanied with minor amount of chalcopyrite, pyrite and pyrrohtite. The Cu grade of samples were obtained at Cu 0.01 - 0.07%, and Mo 0.03 - 0.46% (PL. I-5-1). The low grade Cu mineralization accompanied with quartz vein, 100 cm width, is observed in the Granite near the Tamsoult village in the northwestern area.

2) Skarn-Type Ore Deposit

The skarn-type ore deposits, observed in the area near the Agadir village in the southwestern part of the area, are the Agadir Ore Deposit (3) and the Maouass Ore Deposit (2). Both deposits are located in adjacent to the Tichka Granite which indicates close relations between the mineralization and the intrusion of Granites. Outcrops of the Agadir Ore Deposit are observed along the rivers flowing southern side of the village. The skarn zones are formed along the hanging and bottom boundaries of limestone, of which is about 100 m width and trends northward, and along that of the granite.

The width of the skarn zone is shown 10 m - 30 m and the zone is traceable more than 200 m. The skarn minerals are garnet, actinolite, diopside, hedenbergite and the ore minerals are pyrrohtite, chalcopyrite, pyrite, limonite, and extremely minor amounts of native bismuth and tetradymite ($Bi2(TeS)3$) (Table A-2-1: WR-3, WR-4; Table A-3-1: WM-33, WM-35; Table A-4: WM-32, WM-33, WM-35). Beside these minerals, existence of scheetite is known. Analysis results on the samples taken from the outcrops shown Cu 0.06 - 1.60%, W 0.01 - 0.41% (PL. I-5-1).

The Maouass Ore Deposit is located at about 1 km south of the Agadir village. This is a skarn ore deposit replaced limestone in the conglomerate of the CIII Formation. The outcrop of the deposit is about 5 m width and about 40 m length. This outcrop is so severely weathered that its color changed into brown. Skarn minerals are composed of aggregation of fine garnet, hornblende, pyroxene, etc., and the ore minerals are chalcopyrite, pyrite, pyrrohtite, hematite, etc. Analysis results of samples taken from the outcrop are Cu 0.02 - 0.70%, Mo 0.01%, and W 0.01 - 0.02%. Since these samples were taken from oxidized zone, it is expected that grades of those samples would be improved the lower value than true grade of ore deposit (Table A-3-1: WM-27; Table A-4: WM-25, WM-26, WM-28, WM-31; PL. I-5-1).

3) Stockwork Ore Deposit

The stockwork ore deposit existing in this area is the Iguidi Ore Deposit (28) located in the west of the Iguidi village in the northeastern part of the surveyed area.

The country rock of this deposit is the dolomite bed of the CI Formation. This dolomite bed trends east-northeast and dips about 40° westward. The thickness of the dolomite bed is about 15 meters.

The mineralization is recognized along the upper five meters part of the dolomite bed, therefore, it forms apparently stratiformed ore deposit.

Ore minerals are observed in the network quartz veins which is several mili-meter to several centimeter and in the surrounding host rock.

Ore minerals are chalcopyrite, pyrite, malachite and azurite.

Comfirmed length of the ore deposit is about 500 meters along the dolomite bed, and vertical depth is about 50 meters. However, many mineralized boulders are found at about 2 kilometers upstream of this ore deposit.

The above fact suggests that the mineralization is continued horizontally more than 500 meters length.

The results of the chemical analysis of the samples from the stock pile near the pit are shown the grades at Cu 0.82 - 3.80% (PL. I-5-2).

1-5 Discussions

Many mineral indications including mined ore deposits have been reported in the southern area. However, considerations and evaluations on them have hardly been made in relation to the geological structure of the surrounding areas. In this phase, the regional geological survey including the detail mapping of the mineral indications and the geochemical survey by stream sediments (analysis elements: Cu, Pb, Zn, W, and Mo) were carried out in order to clarify geological structure of the southern area, and to elucidate the relation between mineralization and geological structure. Subsequently, on the basis of the results of the survey, the favorable areas of emplacement of ore deposits have been selected.

Clarified geology, geological structure, and mineralizations in this area by this phases survey are summarized as follows:

The geology of this area is mainly composed of the Pre-Cambrian Group, the Paleozoic Groups, the Mesozoic Groups, and the Intrusive Rocks in Hercynian age. The Pre-Cambrian Group consists of andesite and andesitic pyroclastics, and are distributed in the eastern part of this area. This group shows the monoclinic structure as a whole which dips about 30° westward. This group is correlated to the uppermost formation (P III) of Pre-Cambrian Groups.

The Paleozoic Groups are considered to be of Ordovician - Cambrian age, are widely distributed in much of the area. This groups can be divided into four formation which is ascending order are CI, CII , C III and CIV Formations based on differences of their lithology, metarmorphism and geological structure.

The characteristics of their consitituent rocks and geological structures of them are as follows:

CI Formation: The CI Formation consists of the alternation of dolomite, siltstone, andesites and limestone. The Formation is distributed in the eastern part of the area, and uncomformably covers the Pre-Cambrian Group. The formation forms the monoclinic structure as a whole, that dips 10° ∿ 20° westward.

C II Formation: The C II Formation consists of psammitic schist, pelitic schist and crystalline limestone. The Formation unconformably overlies the CI Formation and lies in fault contact with the C II Formation which is distributed from the central part to the southern central part in this area. The metamorphism of this Formation is comparatively strong to form various crystaline schists. It forms a manoclinic structure that dips 30° - 60° westward.

C III Formation: The C III Formation consists of psammitic schist, pelitic schist, green schist, crystalline limestone and calcareous schist. The Formation is correlated to the limestone predominant formation in the northern area which named in the first phase survey. It is conformably overlain by the C IV Formation, but a relationship with the underlining formation is unknown. The C III Formation is distributed in the western part of the area, and is characterized by the prevalence of folded structure having short piched of north-south axis.

C IV Formation: The C IV Formation mainly consists of pelitic schist, and is widely distributed in the central part of the surveyed area. It comformably covers the C III Formation, but the thickness and upper limits of which are not defined. The folded structure having north-south axis are developed in this Formation.

The Mesozoic Groups in this area are composed of the Triassic System and the Cretaceous System. The Triassic System consists of red sandstone and conglomerate and is slenderly distributed northeast in the central part of the area. The Triassic System rests uncomformably upon the peneplane of the Paleozoic Groups at the northwest border of the system. On contrary, it is in fault-contact with the Paleozoic Groups at the southeast border of the system.

The Cretaceous System consists of the alternation of red sandstone and dolomite, and is slenderly distributed in the southern margine of central part of this area which is in east-west trending faults - contact with the Paleozoic Groups. The system dips about 10° southward but shows the drag foldings beside the faults.

The Intrusive Rocks of Hercynion age are composed of the huge granite stock (Tichika Granite) in the southwestern part, the small granodiorite stock in the northwestern part and many granite and porphyrite dykes in the western part of the area.

The Paleozoic Groups in the vicinity of Tichika Granite are undergone severe thermal metamorphysm by the Granite.

From the geological characteristics and structures of the above formations in each geological age, it is considerable that the geological history is followings:

The active volcanism associated with the massive effusion of andesite took place at the latest stage of Pre-Cambrian age. And then, the Pre-Cambrian Groups has been affected a stablization and formed the basements in this area.

During the sedimentation peride of the CI Formation, this area was under the continental to shallow water environment, and andesite volcanism is still active. Therefore, the alternation of dolomite and tuffacion siltstone were formed, and uncomformably overlain the Pre-Cambrian Basements. The transgression took place during the sedimentation period of C II Formation in this area and the environment of this area changed into the suitable condition for the sedimentation of sandstone and mudstone. During the period of the sedimentation of the C III Formation, this area is under the shallow water environment associated with volcanism which characterized by limestone, sandstone, mudstone and andesitics. This area was subsided again during the sedimentation period of the CIV Formation and the environment of this area change into the suitable condition to form the thick mudstone formation.

At the beginning of the Hercynian arogenetic movement of the end of Paleozoic age, the Paleozoic Groups were subjected to strong compressional stresses leading to the regional metamorphism and resulting in fold and faults. Especially, since the foldings and metamorphism are recognizable to shift more intensely to the upper formation, these stresses are infered from the cause of the subsidence of central region of geocyncline.

It is considered that the plutonic rocks represented by the Tichika Granite occurred at the end of Hercynian orogenic movement, because to these rocks were showing a inharmonious stocks and dykes with folded structures of Paleozoic formation.

After the Hercynian orogenic movement, whole of this area was uplifted and formed a peneplane there. The subsidence started at the biginning of Mesozoic time and transgression and regrestion were repeated during from Triassic age to middle of Tertiary age. Faults and block movements occurred in the Alpine orogenic movement of the late Tertiary. Especially, at the end of this movement it is considered that the great faulting were occurred and resulting in upheaval of Haute Atlas area and relative subsidence of Malakesh area.

Mineral deposits and mineral indications in the southern area are observed only in the pre-Mesozoic, and none of them are observed in the post-Paleozoic formations. Furthermore, it is considered that the mineralization in this area occurred during the Hercynian orogenic movement at the end of Paleozoic, because to the skarn-type ore deposits are formed in the outer side of granites in the end of Hercynian microgranite, and then, because to the microgranite and porphyrite dykes seems to be in same origine, were frequently observed in the vicinities of main mineral deposits. Mineralizations observed in this area are classified according to the mineral component and its host rocks as follows:

(1) Vein-type copper quartz deposit and vein type barite deposit in the Pre-Cambrian Group

(2) Vein-type copper-lead-zinc-quartz deposit in the CI Formation (eastern area and southeastern area).

(3) Stockwork copper deposit in dolomite of the CI Formation (northeastern area).

(4) Vein-type copper-quartz deposit in the C III Formation (northwestern area).

(5) Skarn-type ore deposit of copper-tungsten-iron in limestone in the C III Formation in the vicinity of the Tichika Granite. (southwestern area).

(6) Vein-type molybdenum quartz deposit in the granite. (southwestern area).

The Gundaha copper-lead-zinc deposit in the northeastern area, which was mined in full scale in the past, and vein type copper quartz deposits in the southeastern area (l'Ounein Deposit, etc.) are included in those mineralizations. Beside above, the comparatively strong mineralized areas revealed by this survey are three areas as follows:

(1) Agadir area in the southwestern part: This area situated at the east of the Tichika Granite, in which three ore deposit are observed. the Agadir Mine and the Maonass Ore Deposit are the skarn-type copper tungsten and iron ore deposits which replaced limestone of the P III Formation, and the Ikissan Ore Deposit is the vein-type molybdenum quartz ore deposit in granite. Total mineralized zone is more than 2 km x 2 km. Especially, skarn zone of Agadir Ore Deposit, more than 30 meters width, is formed at the hanging and the foot walls of limestone layer and at its contact margine of granite, and this skarn zone is continued more than 500 m along the limestone layer. The best grades of the samples taken from the outcrops were obtained at 1.60%, copper and 0.41% tungsten.

(2) Iguidi area in northeastern part: Geology of this area is composed mainly the CI Formation. Quartz veinlets and copper dissemination are observed in the upper part, about 5 meter, of the dolomite layer of which thickness is 15 meters. The mineralization is traceable more than 500

meters horizontal along the dolomite layer, and more than 50 meter vertical. The analysis result of samples from the ore stock are shown 0.82% - 3.80% copper.

(3) Taddart area in northwestern part: There is a vein-type copper quartz ore deposit in the conglomerate of the C III Formation. The strikes of the veins are running toward 3 directions, such as NE-SW, WNW-ENE, and N-S. Width of the vein shows the range of 30 cm - 150 cm, and mineralized area was confirmed to be more than 60 m x 60 m. Grades of the ore veins indicated at the range of 0.15% - 5.20% copper.

According to the results of geochemical survey by stream sediments, it was revealed that anomalies of copper, lead, and zinc were distributed corresponding to the mineral deposits and mineral indications as above, anomalies of molybdenum were distributed in Agadir area in southwestern part, in southern part of central area, etc., and anomalies of tungsten were distributed in Agadir area in southwestern part. This fact indicates that the results of geochemical survey are almost corresponded to locations of the mineralizations. Furthermore, it suggests that this geochemical survey method is effective.

As a result of this survey, the relationship between mineralization and geological structure in the southern area has been clarified as described above, and then, the favorable areas of mineralization has been assumed.

It is considered that the possibility to discover the ore deposit is high if the further detailed survey are executed continiously.

CHAPTER 2 ERDOUZ SECTOR

In this sector, vein-type or stratiformed copper, lead and zinc deposits were confirmed in the tight folded alternation of limestone, psammitic schist, and pelitic schist of the C Ⅲ Formation. The mineralized zones were confirmed in the ranges of 100 m x 100 m at the northern slope and of 150 m x 200 m at the southern slope, according to the results of the semi-detailed geological survey, and geochemical survey by soil during the first phase.

In order to clarify continuity of mineralized zones between the two and in the depth, geochemical survey by soil (analyzed elements: Cu, Pb, Zn) were carried out in this phase. The results of geophysical exploration by CSAMT Method carried out in the northern part of this sector are described in the later part of this report.

2-1 Geology and Ore Deposits

Since the detailed descriptions on geology and mineral deposits in this sector are made in the report of the first phase, the outline of them are described hereunder.(Fig. I-7)

Geology of this sector is entirely composed of the limestone predominant of the C Ⅲ Formation. The constituent rocks are crystalline limestone, pelitic schist, psammitic schist, green schist, and calcareous schist. Geological structure of this sector is characterized by the anticlinal folded structure having almost horizontal axis trending northeast, by the block-faultings of trending of northeast and east-west, and by the microgranite dyke of same directions. Mineralizations in this sector are observed - as the vein-type copper, lead and zinc ore deposits, and concentrated mineralizations are observed as the north ore deposit at the north slope and as the south ore deposit in south slope.

The north ore deposit was emplaced at the folding axis of the limestone. The ore deposit consists of five northeast trending veins with several ore bodies of about 10 meters in length and about 10 centimeters in width are assumed. The results of chemical analysis of the samples were taken from the outcrop are shown Cu: 0.4% ±, Pb: 8% ±, Zn: 8 ∿ 10%, and Ag: about 100g/t. The south ore deposit was observed in the tight folded limestone trending north-south. Mineralizations of the south ore deposit are observed as a vein along the north-south fault and as the intercalated bed in the limestone near the fault. The ore deposits are 10 - 50 centimeters in width and 10 - 20 meters in length in vein-type, and about 30 cm in width and about 10 meters in length in stratiformed types. It is estimated that grades of ore deposits should be Cu: 0.8% ±, Pb: 2% ±, Zn: 7 ∿ 10%, and Ag: about 90 g/t.

2-2 Results of Geochemical Survey

Geochemical survey by collecting the soils for the analysis of minor elements contains in them was carried out in Erdouz sector. The purpose of this survey is to make clear the continuity between the two ore deposits. Surveyed area is about 4.5 km^2 contains ore deposits of about 3.6 km south to north and about 1.2 km east to west. Samples of soil were taken at each 50 meters horizontal intervals on 19 east-west traverse lines which were set taking the interval of every 200 m from north to south. Total number of samples is 412, in addition, since there remained 96 samples taken in this sector during the first phase survey. The consideration has been done on 508 samples included these samples. Sampling locations of those samples are shown in PL. I-6(1) ∿ (4) and analysis results are shown in Table A-9-1, and in Table A-9-2.

Values of the chemical analysis were treated statistically and the consideration was given on the characters of the pupulation, the anomalies and corrilative relation among the element. Detected anomalies were illustrated in PL. I-7(1) ∿ (4), PL. I-8(1) ∿ (4) and PL. I-9(1) ∿ (4).

2-2-1 Statistic Treatment

For the statistic treatment, logarithm of the analysis value, which show almost normal distribution, was employed for the consideration, as the distribution of the analysis value of each elements had an extreme partiality for low grade side.

Statistical values of each element and thresholds for anomalous values are shown in Table I-4. The histograms of the logarithmic value of the Cu, Pb, Zn elements are shown in Fig. I-8-1 ∿ Fig. I-8-3 and cummulative frequency distribution of each element are shown in Fig. I-9.

Indicated zone, weak anomalous zone, and strong anomalous zone are determined by the same way on the northern area.

The characters of population of each element and the relation to the anomalous value, and correlative relation among the elements are discribed as follows:

1) Cu: Points of inflections are observed on the cummulative frequency distribution graph near Cu 190 ppm and near Cu 38 ppm. The former position approximately corresponds to G+2σ value, and the latter position approximately corresponds to the level of G value. Especially, since values below and above 38 ppm belong to different population respectively, it is considered that values below 38 ppm indicate the background values of Cu in this sector. It is, therefore, considered that establishment of anomalous values and thresholds as above are allowable required conditions.

2) Pb: Point of inflection is observed on the cummulative frequency distribution graph near Pb 50 ppm. This point approximately corresponds to the level of G value. Since values below and above 50 ppm belong to different population respectively, it is considered that values below 50 ppm indicate the background values of Pb in this sector. It is, therefore, considered that establishment of anomalous value as above are allowable required conditions.

3) Zn: Point of inflection is observed on the cummulative frequency distribution graph near Zn 120 ppm. This point corresponds to the level of G value. Since groups of values below and above 120 ppm belong to different populations respectively, it is considered that values below 120 ppm indicate the background values of Zn in this sector. It is, therefore, considered that establishment of anomalous value as above are allowable required conditions.

4) Mutual relation among the analysed elements: Correlative coefficients among elements, Cu, Pb, and Zn, were obtained as shown in Table I-5. Based on this table, the slight relationship was found between Cu and Pb to indicate the correlation coefficient as low. Stronger relationship was observed between Cu and Zn to indicate the correlation coefficient of 0.68. Strongest relationship was observed between Pb and Zn to indicate the correlation coefficient of 0.77. These relationships suggested that the ore deposits in this area are mainly consisted of lead and zinc

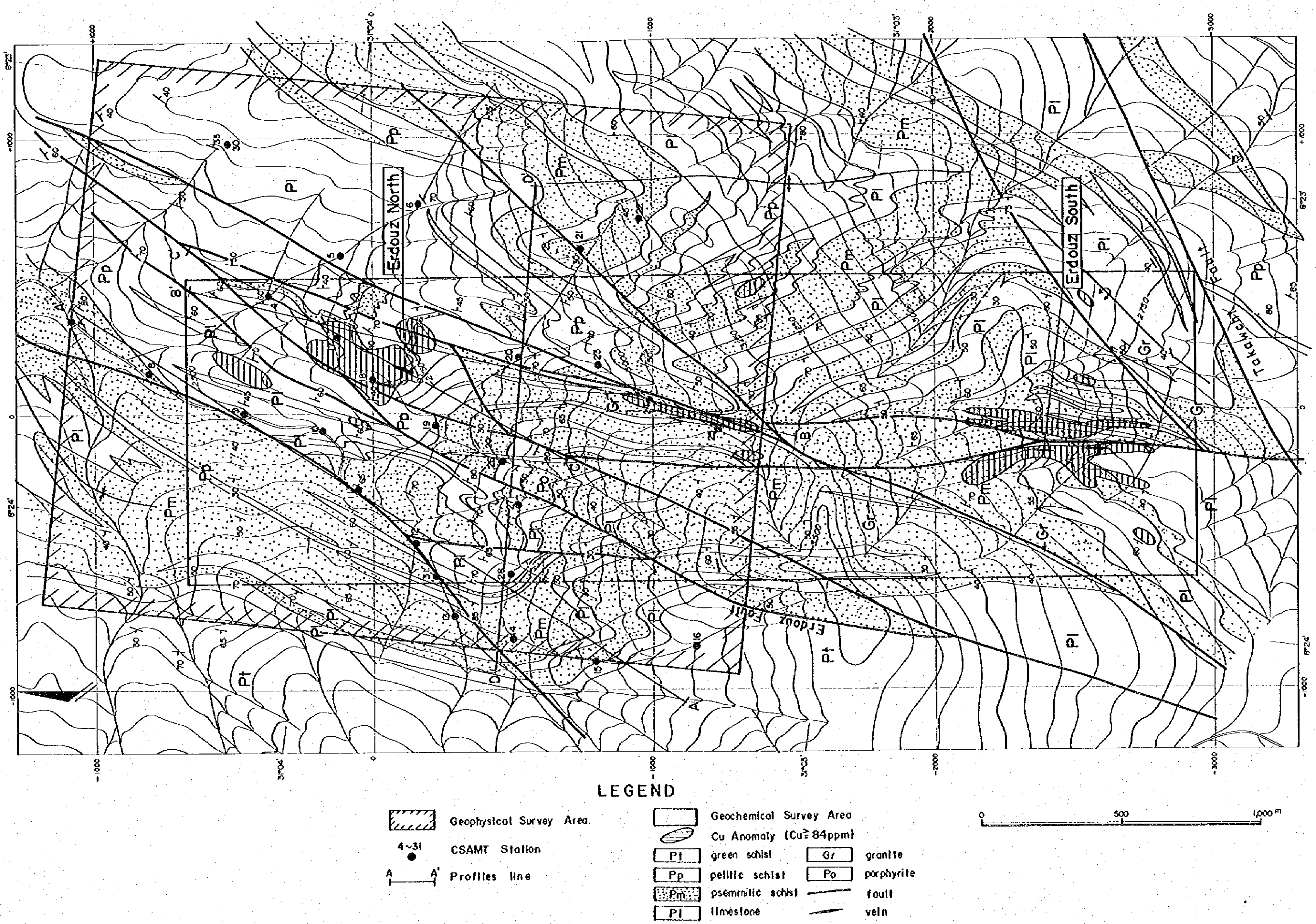


Fig. I-7 Index Map of Erdouz Sector.

Table I-4 Statistic Values and Threshold Values of Soil Samples in Erdouz Sector

Variable \ Element	Cu	Pb	Zn
Number	508	508	508
Minimum value	10.000 ppm	7.000 ppm	20.000 ppm
Maximum value	2700.000 ppm	12600.000 ppm	22400.000 ppm
Arithmetic mean	61.264 ppm	194.154 ppm	434.551 ppm
Logarithmic mean(Lm)	1.578	1.669	2.084
Logarithmic standard deviation (SD)	0.347	0.567	0.460
$G = \log^{-1}(Lm)$	37.9 ppm	47 ppm	121 ppm
$G+\sigma = \log^{-1}(Lm+SD)$	84.3 ppm	172 ppm	350 ppm
$G+2\sigma = \log^{-1}(Lm+2SD)$	187.5 ppm	635 ppm	1,008 ppm
Skewness (SK)	7.168	1.322	2.300
Kurtosis (KU)	2.482	1.823	6.077
Classification of anomalies			
Strong anomaly ($\geqq G+2\sigma$)	$\geqq$188 ppm	$\geqq$635 ppm	$\geqq$1008 ppm
Weak anomaly ($G+2\sigma > \sim \geqq G+\sigma$)	188 ppm$>\sim\geqq$84 ppm	635 ppm$>\sim\geqq$172 ppm	1008 ppm$>\sim\geqq$350 ppm
Indication ($G+\sigma > \sim \geqq G$)	84 ppm$>\sim\geqq$38 ppm	172 ppm$>\sim\geqq$47 ppm	350 ppm$>\sim\geqq$121 ppm

Table I-5 Correlation Cofficients of Soil Samples in Erdouz Sector

	Cu	Pb	Zn	Note
Cu	1.00000 0.0000 508	0.37884 0.0001 508	0.67637 0.0001 508	----- CORRELATION COEFFICIENTS ----- PROB > IRI UNDER HO:RHO=0 ----- NUMBER OF OBSERVATIONS
Pb	0.37884 0.0001 508	1.00000 0.0000 508	0.76604 0.0001 508	
Zn	0.67637 0.0001 508	0.76604 0.0001 508	1.00000 0.0001 508	

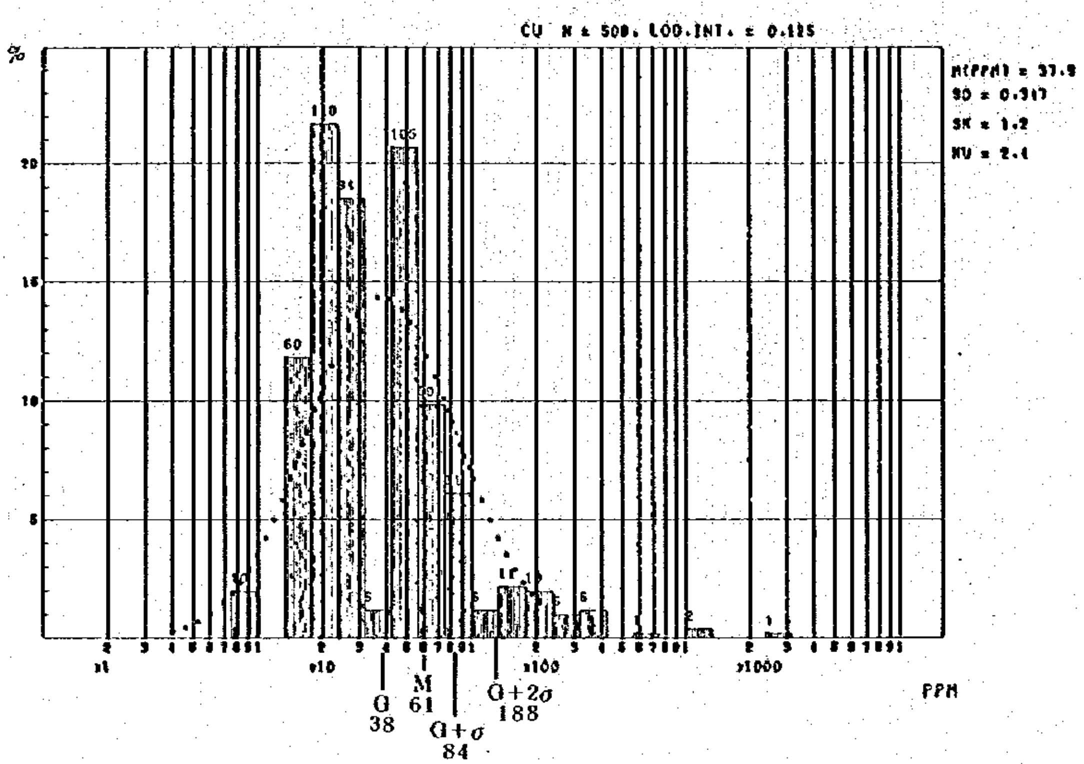


Fig. I -8-1 Histogram for Cu of Soil Samples in Erdous Sector

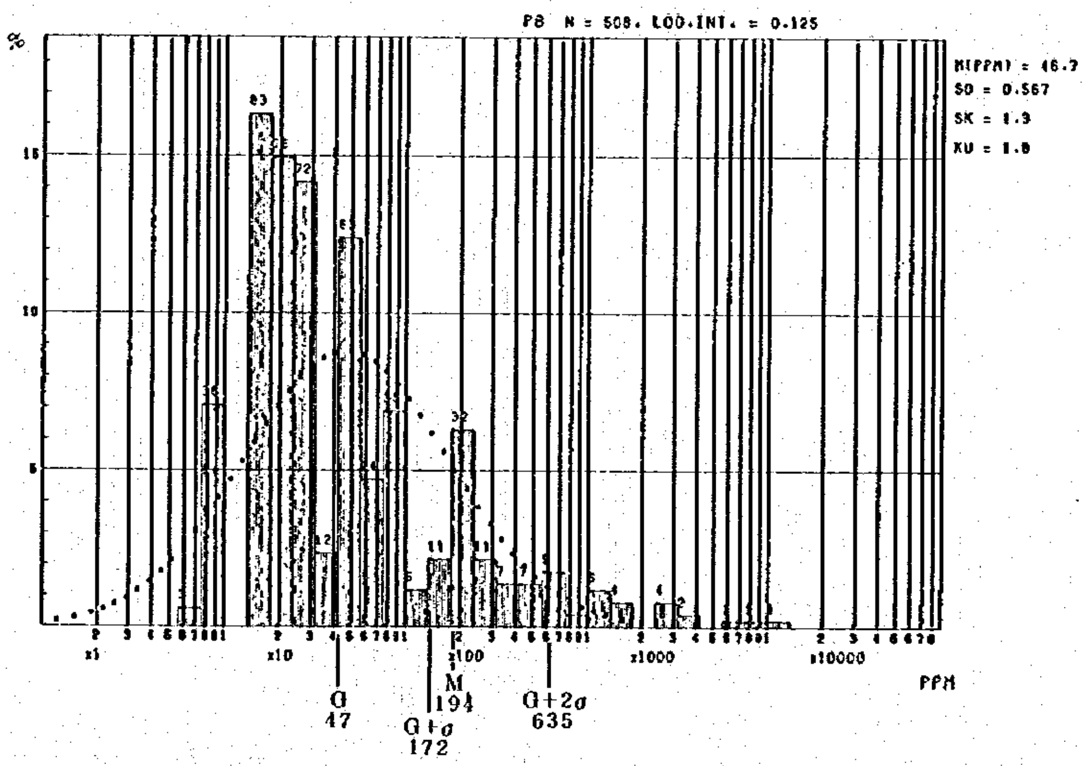


Fig. I -8-2 Histogram for Pb of Soil Samples in Erdouz Sector

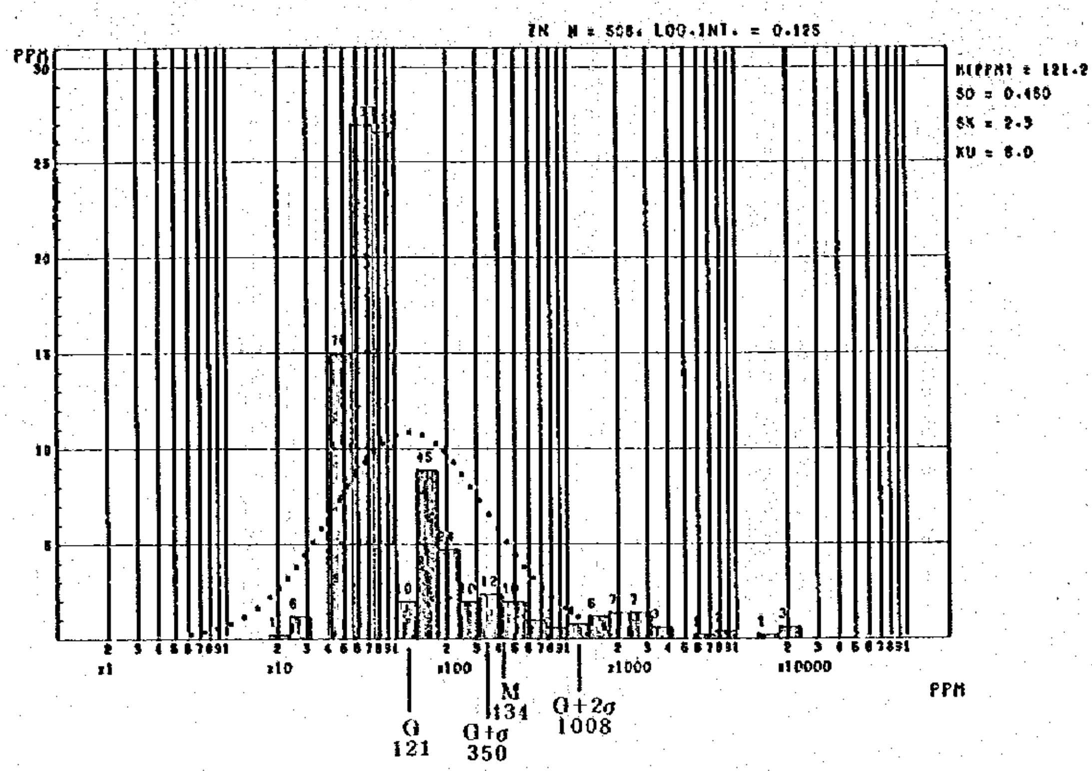


Fig. I-8-3 Histogram for Zn of Soil Samples in Erdouz Sector

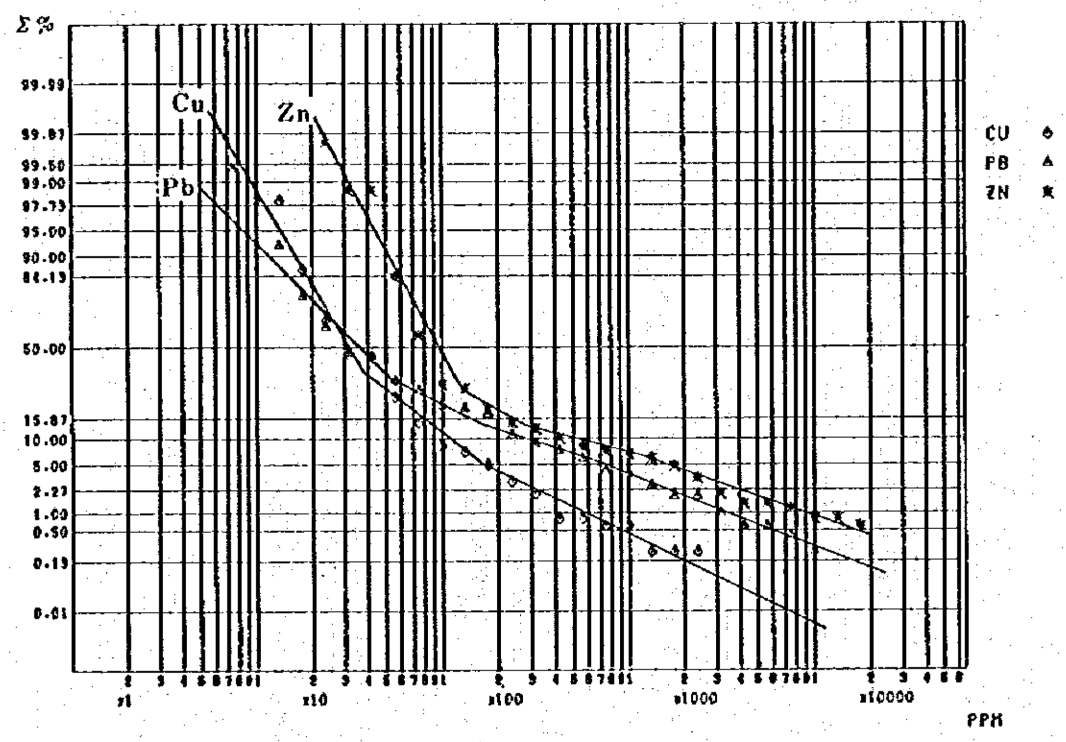


Fig. I-9 Cumulative Frequency Distribution for Cu, Pb and Zn of Soil Samples in Erdous Sector

and that copper mineral is less in amount, and that the mineralization made the zonal distribution.

2-2-2 Considerations on Anomalous Zones

The results of consideration on anomalous zones of each elements in this survey were as follows:

Cu: Strong anomalous values were observed at 23 points. 17 points of them and 6 points of them are concentrated in the areas of the north ore deposit and the south ore deposit and the south ore deposit respectively. All of them are located right above respective outcrops of the mineral deposits. Especially, the anomalous values in the circumferential area of the north ore deposit are distributed along the strikes of the vein which surmised by the data obtained in the past. Weak anomalous points are observed in the circumferential area right above faults and micro granite dykes beside they are located surrounding outside of the strong anomalous zone. Although they are distributed in the elongated area south to north along the south ore deposit, they shows mass distribution in the area of the north ore deposit, and no extension along the strike of vein is observed there. Beside the indication zones are distributed in the surroundings such anomalous zones, and shows the tendency of distribution along the faults of north-northeast trend.

Pb: The strong anomalous values were observed at 28 points. 24 points of them are concentrated in the circumferential area of north ore deposit. 1 point is located in the northeast of the north ore deposit and 3 point are located in the circumferential area of south ore deposit.

All of those points are closely related to the outcrops of mineral deposits. The weak anomalous zones are located outside of strong anomalous zones, and the indication zones are located further outside of the weak anomalous zones. Tendencies of those zones are extended toward NNE-SSW in the northern area and toward N-S and NE-SW in the southern area.

Zn: The strong anomalous values were observed at 33 points. 26 points of them are located in the circumferential area of the north ore deposit, the other 1 point are located in the northeast area of the north ore deposit and 6 points are located in the circumferential area of the south ore deposit. All of those points are distributed in the form corresponding to the outcrops of the ore deposits. Furthermore, it is assumed that those points are distributed in the form corresponding to the strikes of those ore deposits. The weak anomalous zones are distributed the surroundings strong anomalous zones. Although the indicated zones are distributed the further surroundings the weak anomalous zones, some of them are scattered all over the sector.

According to the results of geochemical survey, it was revealed that all of Cu, Pb, and Zn anomalies were distributed being reflected by the ore deposits or mineral indications.

Especially, the anomalies of Pb and Zn, are distributed with the well correspondence to the ore deposits. Since identification accuracy for mineralization of Zn is better than Pb, it seems that mineralization zones including zones of mineral indication can be identified more accurately by detecting Zn. On the contrary, although even slight mineralization can be detected by Cu element, there is a possibility that identification of Cu would also indicate the existence of granite dykes or faults themselves sometime. In this connection, the interpretation of the results should be made cautiously.

2-3 Discussions

Existence of mineral deposits have been known in this sector, and small scaled minings and explorations on them have been carried out. However, sufficient elucidations on the ore deposit have not been made on the view point of the relations between geology, geological structure and mineralization due to the precipitous topography of this sector. In this sector, the semi-detailed geological survey and geochemical survey by soil along the survey route were carried out in the first phase. As the results, it was revealed that geology of this sector is composed of limestone, psammitic schist, pelitic schist, calcareous schist, and green schist of the C Ⅲ Formation, and these rock made up the alternation beds and formed alternative the limestone predominated formation as a whole.

The geological structure of this sector are characterized by the anticlinolium structure having nearly horizontal "S" shaped fold axis that trends northeast in the central part of the sector, and by the block movements caused by faults of which trends NE-SW, N-S, and E-W. As the mineralizations in this sector, the vein-type copper, lead, and zinc deposits trending northeast in the northern slope (north ore deposit), and vein-type and stratiformed copper, lead and zinc deposits trending south to north in the southern slope (south ore deposit) are comfirmed. These two deposits are observed in limestone layer, the former is located near the anticline axis and the latter is enbeded in tightly folded zone, and the mineralizations have a tendency of the extension along the north-east and north-south faults.

The purpose of this phase survey was to examine the continuity of embeded host rock between two ore deposit, especially in the sector about 2.5 km between the two. Therefore, the geochemical survey by the collecting grid-patterned soil samples in the sector including both of those mineral ore deposits, was carried out in this phase.

According to the results of this geochemical survey, it was clarified that all of the three elements, Cu, Pb, and Zn indicated same distribution and that, strong anomalous zones are concentrated in the emplaced area of mineral resources, and strong anomalous zones are scarecely distributed in other places. Although the strong anomalous zone is observed in the circumferential area of the north ore deposit along the strike of the veins, such tendency is less in the circumferential area of the south ore deposit. Including weak anomalous zone, extension of anomalous zone is observed from south to north in the circumferential area of the south ore deposit. However, it is hard to believe the possibility of long continuity of embeded zone connecting between north ore deposit and south ore deposit. It is, therefore, considered that these two deposits are bordered by the fault trending northeast, and geological constituent and structures of those adjacent blocks are quite different each other. That is to say, the north ore deposit is limited at the folding axis in the distribution region of limestone and mineralization is suddenly weakened in the pelitic schist of outer zone of the limestone. Distributions of anomalous zones corresponding to the distributions of limestone were observed in this sector as the results of the geochemical survey. On the other hand, geological structure trending north-south, bordered by the northeast fault passing through the central part, is observed near the south ore deposit. The weak anomalous zone corresponding to the extension of limestone is observed there. However, this weak anomalous zone is discontinued where the limestone layer is cut by faults.

From above mentioned facts, it is assumable that the limestones forming host rocks in north ore deposit and in south ore deposit are of different horizons respectively, and emplacement host rocks in the both deposits are not connected each other. Therefore, that both of ore deposits have a possibility of forming independent mineralization zones respectively. In this connection, it is desirable that further exploration in this sector should be proceeded for the lower parts of each ore deposit.

Ⅱ GEOPHYSICAL SURVEY

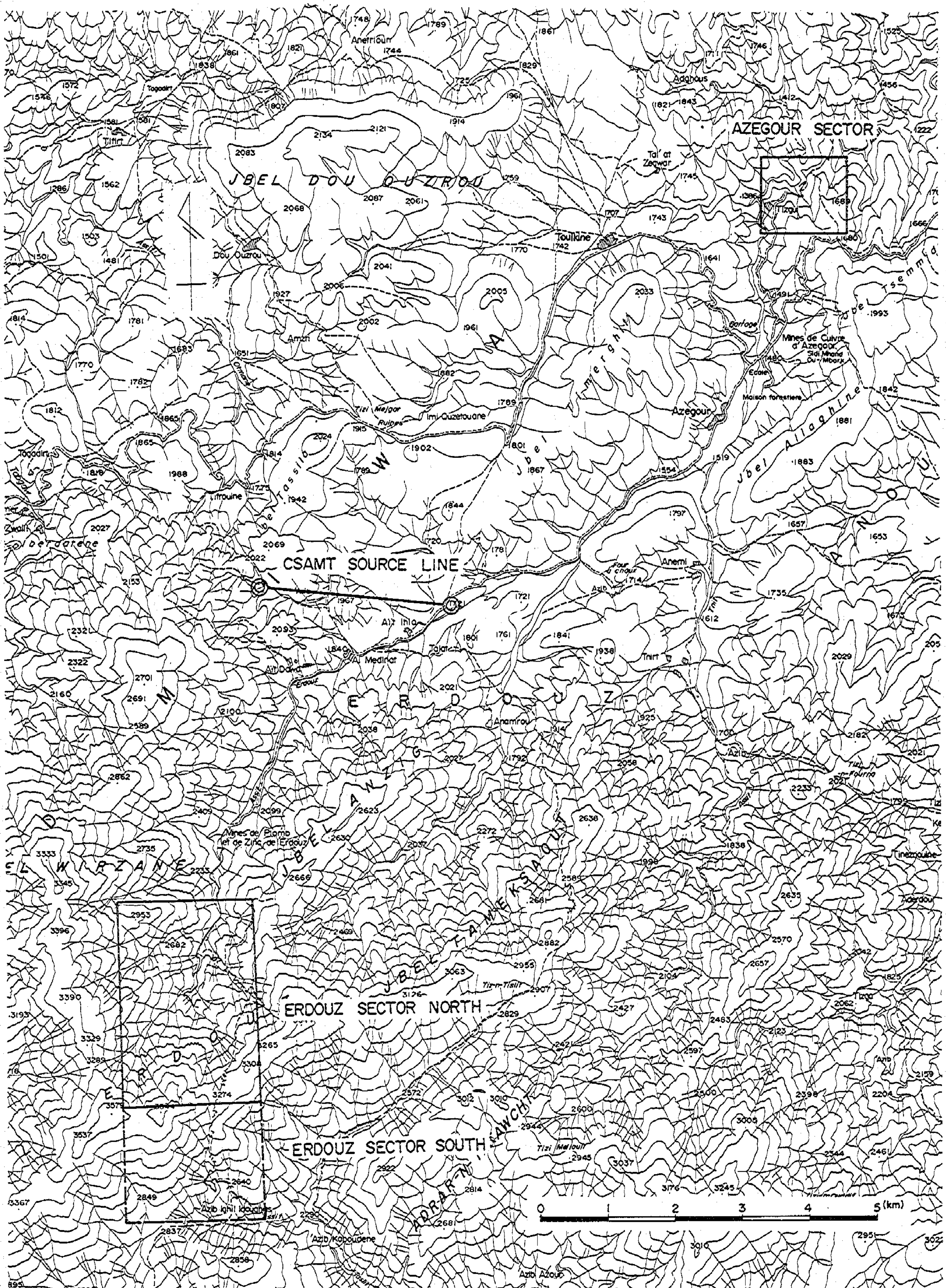


Fig. II-1 Geophysical Survey Area

CHAPTER 1 ERDOUZ SECTOR

1-1 Outline of the CSAMT Survey

1-1-1 Outline of CSAMT Method

CSAMT (Controlled Source Audio Frequency Magnetotelluric) Method is closely related to MT (Magnetotelluric) method. Ordinary MT method uses natural electromagnetic field as signal source and is to study resistivity of the ground by measuring horizontal electric field and horizontal magnetic field which are orthogonal each other. Recording frequency range of MT is normally between 1/10,000 Hz and 100 Hz. CSAMT method uses artificial signal source instead of natural source and measures only audio-frequency range (between 4 Hz and 5,000 Hz).

Because measuring higher frequency, exploration depth of CSAMT method is from tens of meters to 1,000 m.

Artificial source gives CSAMT the following advantages:

(1) The signal is stronger so that a receiver does not need to be so sophisticated as MT equipment and is much smaller.

(2) Because coherent signal is used, it is much easer to separate signal from noise by virtue of filters and other signal enhancement technique.

On the other hand because of artificial signal source being used, if spacing between source and receiver is not large enough, plain wave condition will not be valid and interpretation will be very complicate.

1-1-2 Outline of the Survey

The Erdouz sector extends the north slope and the south slope of Erdouz Mountain in Haut Atlas. The area is 5 km long in N-S direction and 2 km wide in E-W and includes two known ore deposits. In the center of the area there runs mountain range with the elevation over 3,250 m. The highest point in the area is 3,544 m and the lowest is about 2,500 m. Controlled Source Audio Frequency Magnetotelluric (CSAMT) survey has been carried out at 27 stations on the north slope of Erdouz Mountain. The CSAMT survey area is only the north slope of Erdouz Mountain, 2 km in E-W and 2.5 km in N-S, being called as Erdouz North.

The signal source was layed along small creek at the north of Ait Ihla Village. The signal source is an electric cable with both ends being grounded. The direction of the source cable is approximately north-south direction. The distance between the source cable and the closest station is about 5.6 km. At the both end of the source cable ten tin coated iron plates (50 cm by 50 cm) were burried about one meter in the ground and used as electrodes. Through these electrodes electric current was forced to flow into the ground. In order to make contact resistance between electrodes and ground low, mixture of bentnite, salt and water was inserted between them. As a result, the resistance of cable-electrodes-ground system was about 60 ohm-m. The effective length of the source cable is 2.8 km.

The frequencies of the transmitting signal are 4, 8, 16, 32, 64, 128, 256, 512, 1,024, 2,048, and 4,096 Hz.

The transmitting currents are 6 A for frequencies under 1,024 Hz, 5 A for 2,048 Hz, and 3 A or 2.5 A for 4,096 Hz. The dipole moment of the signal source, the product of current and dipole length, for this survey was strong enough to study resistivity of entire Erdouz survey area. The area has very small electromagnetic noise because the nearest power line is in Amezmiz city, about 25 km away from the survey area.

The signal was measured at all 27 stations. At each stations, E-W electrical field with 30 m dipole and N-S magnetic field were measured.

Non-polarized electrodes (copper-copper sulfate) were used to measure electric field and a ferrite core coil for magnetic field measurements. Received signal was stacked and apparent resistivity was calculated at the survey site. Measurement was repeated and change of apparent resistivity by repeat measurements was studied. If the change was within acceptable limit, arithmetic averages of all the recorded apparent resistivity values were calculated and used as an apparent resistivity value of the station at the frequency.

Equipments used are as follows:

(1) Transmitter

XMT-12 Transmitter Controller:	product of Zonge Engineering and Research Organization, Inc. (hereafter called as ZERO), frequency range: 1/1024 to 4096Hz
GGT-6 Transmitter:	product of ZERO, frequency range: DC to 10 kHz Max. output power: 1,000 V, 27 A
ZMG-5 Engine Generator:	product of ZERO, 5 kW, 400 Hz, AC generator
Voltage Regulator:	product of ZERO, regulating output voltage of ZMG-5

(2) Receiver

GDP-12 Data Processor:	product of ZERO, amplifier, filter, and data processor
Cassette Recorder/Printer:	product of ZERO, record on cassett tape and print hard copy
Eprom Loader:	product of ZERO, load programs on GDP-12
AMT Antenna Coil:	product of ZERO, magnetic sensor
Electrode Pot:	copper - copper sulfate non polarize electrode
Transceiver:	pro ct of Motorola 5W radio

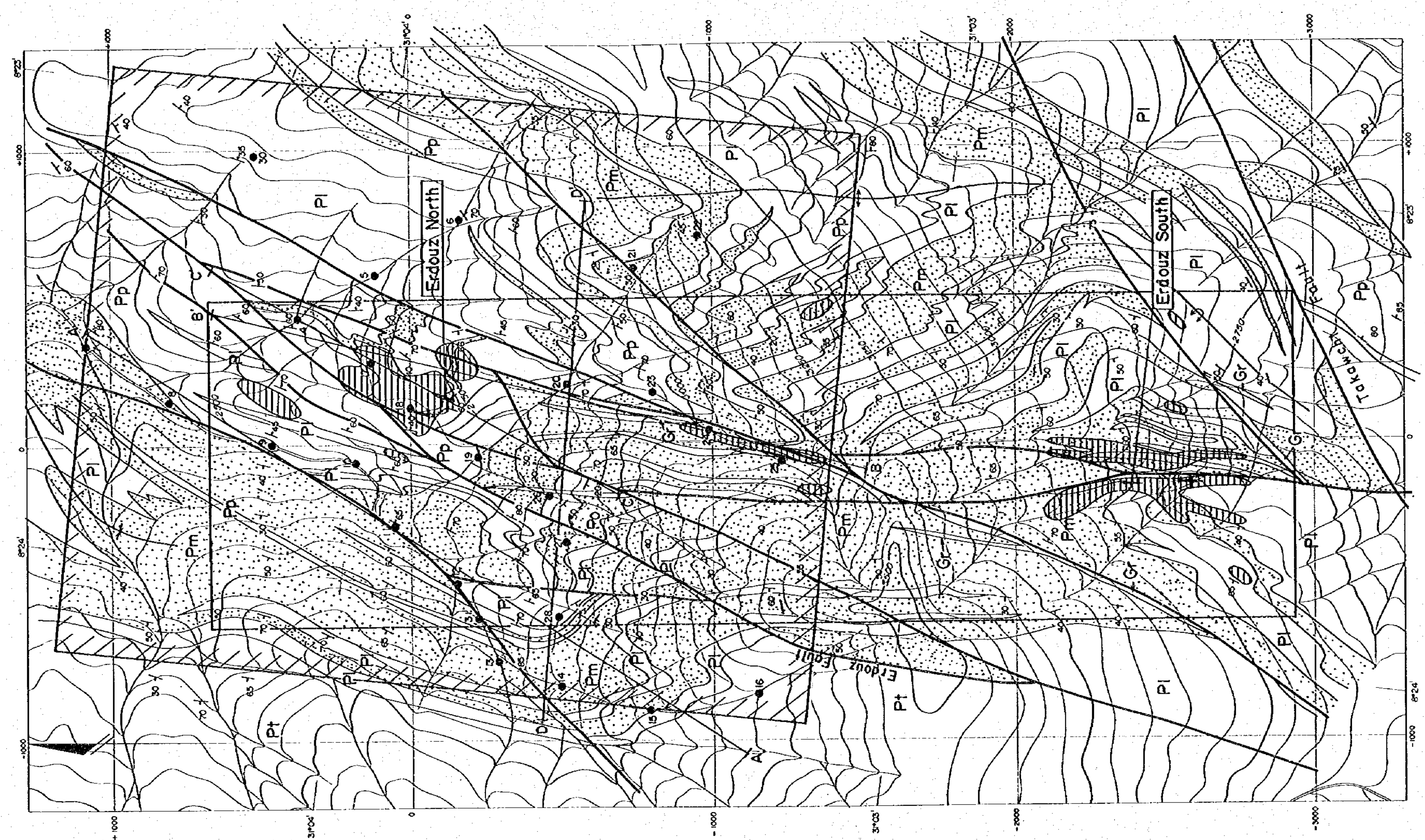
1-2 Results of CSAMT Measurements

The results of the measurements are compiled as "Apparent Resistivity Pseudo Section with Infered Structures" (Fig. II-1-1 to Fig. II-1-4) and "Apparent Resistivity Plan" (PL. II-1-2 to PL. II-1-12). The apparent resistivity values for these figures and plates are arithmetic average of all repeatedly measured values at the same stations and the same frequencies. Their effective values used are first two digits of calculated values.

1-2-1 Horizontal Distribution of Apparent Resistivity

At the most stations and most frequencies, apparent resistivity value decreases with frequency values especially under 500 Hz.

On the Apparent Resistivity Plans, all stations west of the line



LEGEND

Geophysical Survey Area		Geochemical Survey Area	
4~31 CSAMT Station		Cu Anomaly ($Cu \geq 84$ppm)	
A—A' Profiles line		Pl green schist	Gr granite
		Pp pelitic schist	Po porphyrite
		Pm psammitic schist	fault
		Pl limestone	vein

0 500 1,000 m

Fig. II-2 Geology and CSAMT Stations, Erdouz Sector.

running NNE-SSW direction passing about 200 m to 300 m west of Erdouz Northern ore deposit show about ten times larger resistivity than those of the east of the line. Apparent resistivity values at the stations 20, 23, 24, and 25 in the east of the fault are high, similar to them of the west of the fault.

Apparent Resistivity Plans were drawn for eleven discrete frequencies. On each plan, equi-resistivity lines are at 1×10^N, 2×10^N, 5×10^N ohm-m (N = 1 to 4). Here we discuss only 4.096 Hz (PL. II-1-2(1) to (3)), 128 Hz (PL. II-1-7(1) to (3)), and 4 Hz (PL. II-1-12(1) to (3)).

Table II-1 Skin Depth vs Resistivity

	4 Hz	128 Hz	4,096 Hz
1 ohm-m	250 m	44 m	7.9 m
10 ohm-m	800 m	140 m	25 m
100 ohm-m	2,500 m	440 m	79 m
1,000 ohm-m	8,000 m	1,400 m	250 m
10,000 ohm-m	25,000 m	4,400 m	790 m

The relation of skin depth, signal frequency and ground resistivity is shown in Table II-1. Skin depth is an effective depth of penetration of electromagnetic energy in a conducting medium and is used as an effective depth of survey. However an effective depth of survey varies by resistivity structure of the ground and an analized depth is usually shallower than a skin depth.

The general trend in the apparent resistivity plans are discribed in the following paragraphs.

(1) Apparent Resistivity Plan of 4,096 Hz

At the Apparent Resistivity Plan of 4,096 Hz, apparent resistivity values are generally between 1,000 ohm-m and 37,000 ohm-m. The area where apparent resistivity is lower than 500 ohm-m is measured at the center of the survey area. This low resistivity zone extends in NNE-SSW direction. The location of this low resistivity zone corresponds to that of the ore-hostable zone, where host rock of the area, limestone, is fractured, folded and altered.

Resistive zones are along and in the west of Erdouz fault and the stations 20, 22, 23, 24, and 25. Resistivity of the resistive zones is greater than 5,000 ohm-m. The distribution of the resistive zone in the east of Erdouz fault may relate to it of psammitic schist.

(2) Apparent Resistivity Plan of 128 Hz

Apparent resistivity values at 128 Hz are about one third to one fifth of them at 4,096 Hz. At the center of the survey area, low resistivity zone with resistivity below 500 ohm-m is recorded and is wider than that at 4,096 Hz. Inside of this conductive zone more conductive zone with resistivity below 200 ohm-m extends NNE-SSW direction. Resistive zone with resistivity over 1,000 ohm-m lays in the similar area as the zone with resistivity over 5,000 ohm-m at 4,096 Hz.

(3) Apparent Resistivity Plan of 4 Hz

Apparent resistivity values of 4 Hz is generally lower than them of higher frequencies. Conductive zone with resistivity below 100 ohm-m is widely distributed, from the center to the east side of the survey area. At around Erdouz Northern ore deposit, resistivity is lower than 20 ohm-m. Resistive area with resistivity over 200 ohm-m is at the west side of the survey area. This resistive area extends along Erdouz fault and is thought a reflect of the fault.

1-2-2 Apparent Resistivity Pseudo Section

Four apparent resistivity pseudo sections were drawn to study resistivity distribution of the area (Fig. II-1-1 to Fig. II-1-4).

Three section lines, A-A', B-B', and C-C', have N-S to NNE-SSW direction and run approximately parallel to general strike of geological structures. The D-D' section is E-W and cuts Erdouz fault and general strike of geological structures. The general features of the apparent resistivity pseudo sections are as follows:

(1) Pseudo Section A-A'

The section A-A' is in the west side of Erdouz fault and mostly in a valley. The elevation of the south side of the line is higher. The elevation of the station 16, the south most station of the line A-A', is about 3,200 m and the north most station, the station 7, is 2,400 m. Apparent resistivity along this line is relatively high. Low resistivity area, apparent resistivity values being below 200 ohm-m is only at frequencies lower than 16 Hz on the station 7. Apparent resistivity distribution at all stations except at the station 14, where apparent resistivities are higher than others, are uniform. The general feature of the section is that 5,000 ohm-m contour line extends at around 500 Hz and parallel to the topographic surface. Apparent resistivities at frequency over 500 Hz are very high, higher than 5,000 ohm-m, and at frequencies below 500 Hz are lower. Apparent resistivities at around 100 Hz are about 500 ohm-m and lower the frequency they are lower but declination of curves are not so steep as frequency higher than 100 Hz. At apparent resistivity values between 1,000 ohm-m and 10,000 ohm-m, apparent resistivity changes linear to frequency.

(2) Pseudo Section B-B'

The section B-B' is in the east of Erdouz fault and runs from Erdouz Northern ore deposit to Erdouz Peak. Low apparent resistivities below 20 ohm-m are measured at the stations 4, 17, and 18 at frequency below 16 Hz. At the station 4, apparent resistivity value at 4 Hz is very low, 5 ohm-m. Apparent resistivity at stations south of the station 20 are greater than 200 ohm-m. Apparent resistivities at the south most station of the section B-B' are very high, between 2,400 ohm-m and 39,000 ohm-m.

(3) Pseudo Section C-C'

The section C-C' is almost parallel to the section A-A' but in the east of Erdouz fault. However apparent resistivities are approximately 1/30 of them at the section A-A'. Apparent resistivities at the stations 4, 17, 18, and 20 at low frequencies are less than 20 ohm-m. Even at high frequency, apparent resistivity values of over 500 ohm-m were not measured except at the station 26.

(4) Pseudo Section D-D'

The section D-D' cuts the survey area in E-W direction. Apparent resistivities at the stations 27 and 21 at frequencies below 16 Hz are less than 50 ohm-m. At the stations 14 and 20, apparent resistivities are high, and all apparent resistivities at the station 14 are greater than 1,000 ohm-m.

Table Ⅱ-2 CSAMT Apparent Resistivity of All Stations

Current electrode : electrode 1 (West) — electrode 2 (East)

	electrode 1 (West)	electrode 2 (East)
Latitude	31 Deg. 7.1 Min. (N)	31 Deg. 7.0 Min. (N)
Longitude	8 23.1 (W)	8 21.3 (W)
Elevation	1980(m)	1720(m)

St. No.	(Hz) 4096	(Hz) 2048	(Hz) 1024	(Hz) 512	(Hz) 256	(Hz) 128	(Hz) 64	(Hz) 32	(Hz) 16	(Hz) 8	(Hz) 4
	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)	(Ωm)
4	468	545	533	313	153	71.0	37.2	23.8	15.9	9.35	5.35
5	1,990	2,120	1,710	1,120	675	378	204	113	53.9	21.0	9.08
6	1,280	1,170	886	573	364	235	129	67.5	31.8	16.8	14.4
7	8,300	7,330	5,040	2,850	1,450	748	423	269	176	120	86.8
8	11,000	11,100	8,240	4,690	2,290	1,160	659	459	343	257	195
9	12,000	13,200	10,200	5,860	2,730	1,380	849	665	547	445	340
10	12,700	13,500	11,900	7,080	3,440	1,740	1,000	728	600	466	364
11	9,740	9,960	9,280	5,600	2,750	1,310	768	576	499	432	352
12	5,260	5,500	5,620	3,720	1,900	974	538	413	360	325	279
13	5,640	6,460	6,630	4,670	2,450	1,170	615	475	456	498	430
14	9,850	15,300	20,700	17,000	10,200	4,810	2,310	1,570	1,400	1,370	1,220
15	3,880	5,710	5,410	4,150	2,390	1,250	683	512	445	400	356
16	7,640	10,600	11,600	7,930	4,370	1,970	1,250	1,060	903	803	748
17	259	300	275	204	112	50.1	43.3	43.1	37.0	27.7	19.9
18	384	429	465	365	236	153	97.7	77.6	53.0	33.8	17.9
19	163	108	77.2	66.9	62.4	62.2	56.9	50.4	36.1	21.5	12.8
20	15,400	9,480	7,810	5,280	3,090	2,070	1,550	1,250	967	629	337
21	2,650	2,060	1,370	801	429	237	125	72.0	44.9	29.1	18.8
22	19,400	13,600	9,210	5,710	3,180	1,730	801	427	251	140	54.0
23	20,000	13,000	10,800	7,380	4,080	2,390	1,440	1,030	754	531	369
24	7,840	6,920	5,670	4,040	2,240	1,190	669	474	360	277	206
25	36,500	38,900	33,200	22,900	12,200	6,360	4,030	3,440	3,240	2,650	2,420
26	3,090	2,840	2,710	1,920	1,300	749	418	246	144	80.0	44.0
27	2,040	2,130	2,210	1,810	1,170	619	277	137	65.8	33.6	17.9
28	2,660	3,930	4,370	3,270	1,720	893	570	508	506	488	539
30	4,460	3,330	1,960	977	494	283	121	63.0	34.1	20.2	18.9
31	3,170	4,360	4,750	3,430	1,880	876	454	304	254	266	223