Siliceous ore consists of strongly brecciated and silicified volcanic rocks. Matrix of the breccia is white to gray clay and sulfide minerals. The ore is also cut by pyrite-quartz veinlets. Because the siliceous ore is found at the top of the orebody, the ore is usually affected by weathering.

(c) **Small Gossan**

Small Gossan occurs about 300 m northwest of Main Gossan. This gossan covers an area of 120 m by 30 m. Several faults and fractures trending a NW direction are found int the gossan zone.

No sulfide minerals are found in Small Gossan due to intense weathering. The zone is argillized and completely gossanized. The zone also present strong silicification and brecciation and is more siliceous compare with the zone of Main Gossan. Because of argillization, this zone may correspond to the siliceous ore in the Hayl as Safil deposit. The matrix of breccia contains mainly hematite and limonite, but geothite is also observed in places.

(d) **Noth of Small Gossan**

This mineralized zone was confirmed by a drill holes of HS-7 which completed by BRGM. The zone consists of massive ore with overlying argillized gossan zone. The massive ore encounted is shallow depth between 28.55 m and 42.25 m, and the average grade is 3.69% Cu. The gossan zone above the massive ore shows similar nature of Small Gossan. Therefore this gossan zone continues to Small Gossan. Additional drill holes completed by BRGM did not confirm the extension of the mineralized zone and encountered the thrust fault at the northern end the orebody.

1-3 Geophysical Survey

In order to delineate an extension of the Hayl as Safil deposit and to obtain the guideline of the further drilling survey, Charged Potential (CP) survey of 611 measuring points in total was conducted over an area of 3 km^2 in the Area A.

Location map of CP stations is shown in Fig. II-1-12.

1-3-1 Methodology

1. Outline of Charged Potential Method

Charge Potential (CP) method is an electrical-exploration method, in which one current electrode (C1) is positioned in a conductor either in outcrop or in a borehole. The other current electrode (C2) is a great distance away and the potential electrodes (P1) are moved about with the objective of mapping the mineral deposit. In this method, a far current electrode (C2) is commonly placed more than 4 km away from charging point (C1) in a such manner as that C1 acts like a mono-pole. And a far potential electrode (P2), utilized as a standard potential point (0 mv), is

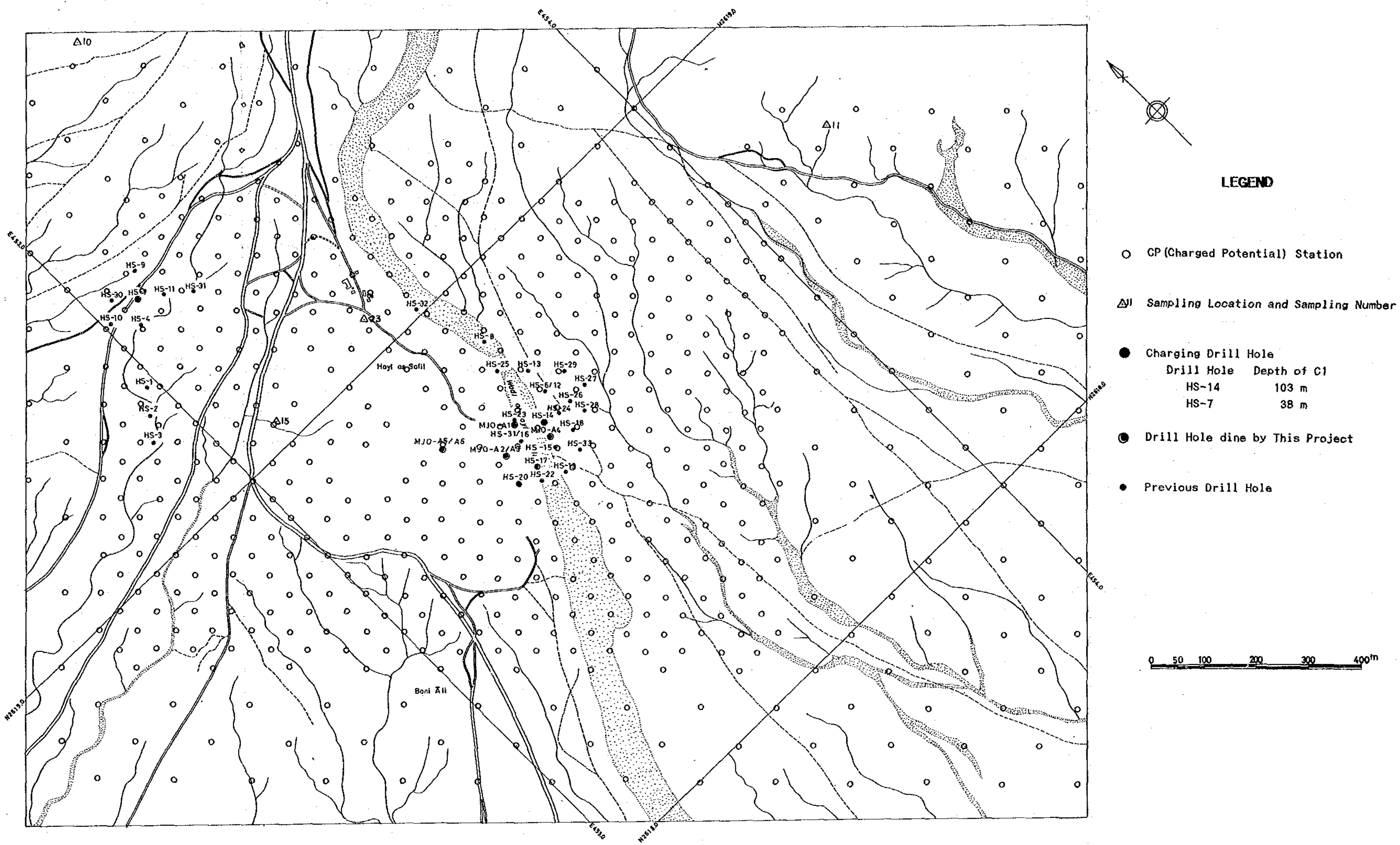


Fig. II-1-12 Location Map of CP Survey Stations in Area A

placed also 4 km away from charging point (C1) either at the opposite side of C2 or at the middle point between C1 and C2.

Schematic illustration of this method is given in Fig. II-1-13.

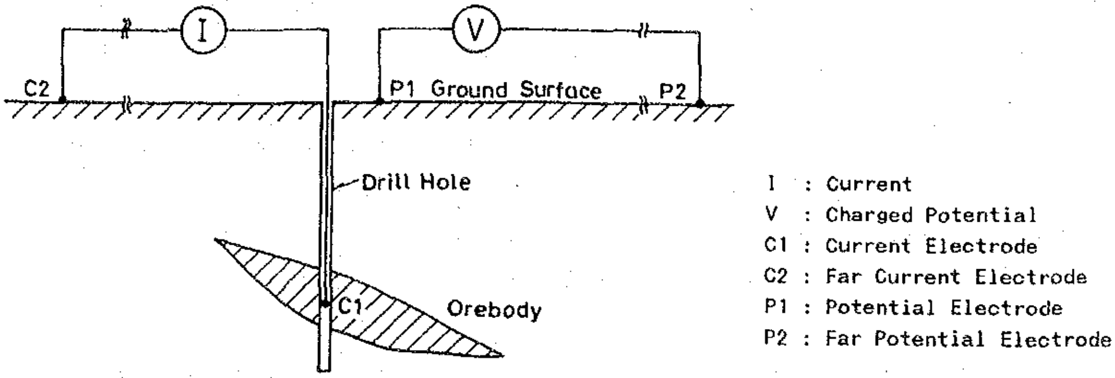


Fig. II-1-13 Schematic Illustration of Charged Potential Method

This method is also called mise-a-la-masse method and/or excitation-at-the-mass method.

And this method is commonly utilized in the mineral exploration and recently adopted in the geothermal exploration to delineate the distribution of the geothermal reservoir.

Fig. II-1-14 illustrates a charged potential distribution showing a concentric circle pattern, when current is introduced at one point in the homogenous earth. When r is the distance between C1 and P1, r' is the distance between an image of C1 and P1, ρ is the resistivity of the earth, and I is a charging current, the charged potential (V) at P1 is given by the following equation:

$$V = (\rho I / 4\pi) \cdot (1/r + 1/r')$$

While, Fig. II-1-14 (b) shows the potential distribution, when current electrode is placed in a conductor (orebody). In this illustration, charged potential distribution shows a pattern suggesting the extension of the conductor (orebody).

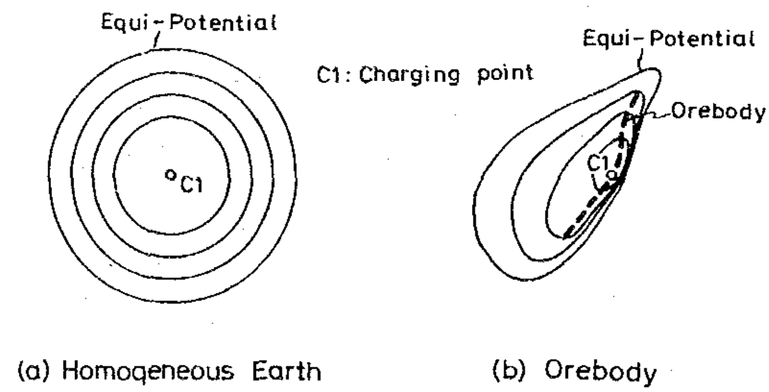


Fig. II-1-14 Charged Potential Distribution

2. Measurmement

In this area A, the 611 CP stations in total were settled at 50 m and 100 m apart each in an area of 3 km^2, by means of the open traverse surveying method. The location of measuring points are shown in Fig. II-1-12. Coordinates of each of CP stations in meters was decided by settling the origin (0, 0) at X=N2619.00 and Y=E453.00, and by setting positive directions towards the south and the east, respectively.

Although, at the beginning of the geophysical survey, the charging point (C1) was planned to be positioned in the MJ0-A4 hole, C1 was placed in the neighbouring HS-14 hole, because the thickness of the massive orebody hit by the MJ0-A4 hole was very thin. And another charging point (C1) was set in the HS-7 drill hole which hit the north orebody located near Small Gossan, in order to clarify the continuation of between the Hayl as Safil and north orebody.

The current electrode (C1) in each drill hole was positioned at the depth of the center of the orebody.

A far current electrode (C2) was placed in the MJ0-B5 hole in Area B, and a far potential electrode (P2) was settled at Wadi Rakah, 4 km south of the middle point between Area A and Area B. The location of a far potential electrode (P2) is shown in Fig. I-1-15.

The depth of current electrode in each of the drill holes is shown below.

Current Electrode	Drill Hole	Depth of Electrode	
Charging Point (C1)	HS-14	103 m	(Hayl as Safil deposit)
	HS-7	38 m	(North orebody)
Far Current Electrode (C2)	MJ0-B5	115 m	(Lower mineralized zone of the Rakah deposit)

By means of introducing an alternative DC (0.1 Hz) current of 1.6 A through 2.5 A between two current electrodes, C1 and C2, charged potential at each CP station (P1) was measured in mV.

3. Survey Instrument

Survey instruments adopted for this survey are as follows:

Instrument	Model	Manufacturer	Specification	Amount
Transmitter	CH-T7801	Chiba Electronics Co. (Japan)	Output; 800 V/3 A/0.1 Hz	1 pc
Receiver	Model 27	John Fluke MFG Co. (U.S.A.)	DC voltage; 0.01 mV to 1 kV	3 pcs
Engine Generator	GPU-2000	Geonics Inc.	Output; 2 kW/115 V/1ϕ/3ϕ	1 pc

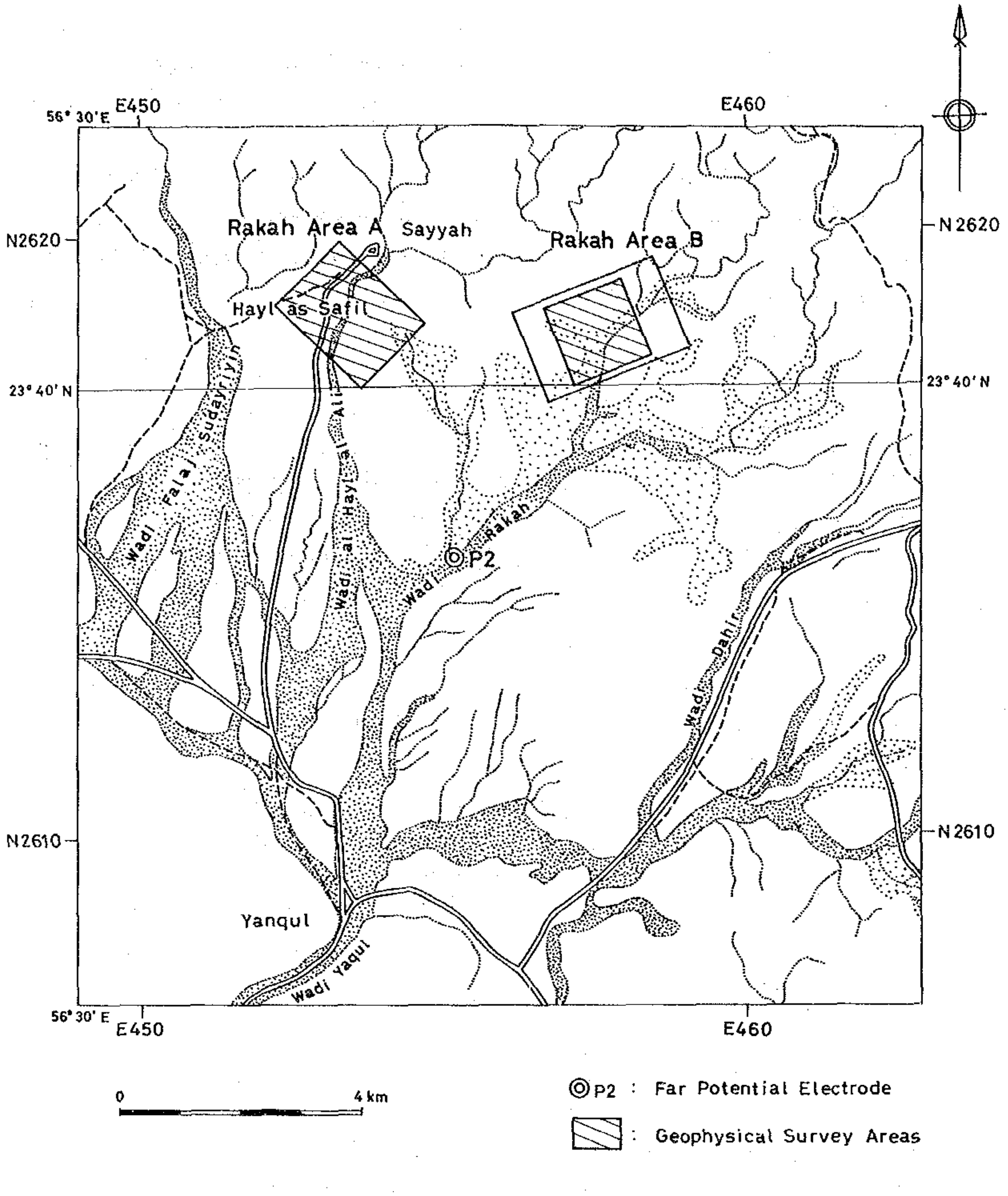


Fig. II-1-15 Location Map of Far Potential Electrode

4. Data Arrangement and Analyses

Charged potentials in mV/A at each CP station were obtained by means of dividing measured potentials in mV by current in A. And the plan map of the charged potential was made for each of the two HS-14 and HS-7 drill holes. The charged potentials at each CP station are shown in Appendix 1.

On the charged potential map, the highest potential is shown above and/or near the charging point (current-introduced drill hole), and charged potentials decrease towards the whole directions, showing the distortions which suggest the extension of the conductor including orebody. However, it is very difficult to estimate the boundary of the conductor from this map only.

Electric field (E) is given by the following equation:

$$|E| = |\partial\phi/\partial \mathbf{h}|$$

Where, ϕ is the charged potential, and **h** is the unit normal vector to equi-potential line.

While, the extreme values of the electric fields coincide with the boundary of the conductor, as shown in Fig. II-1-16. Therefore, the plan map of the electric fields was made for each charging hole.

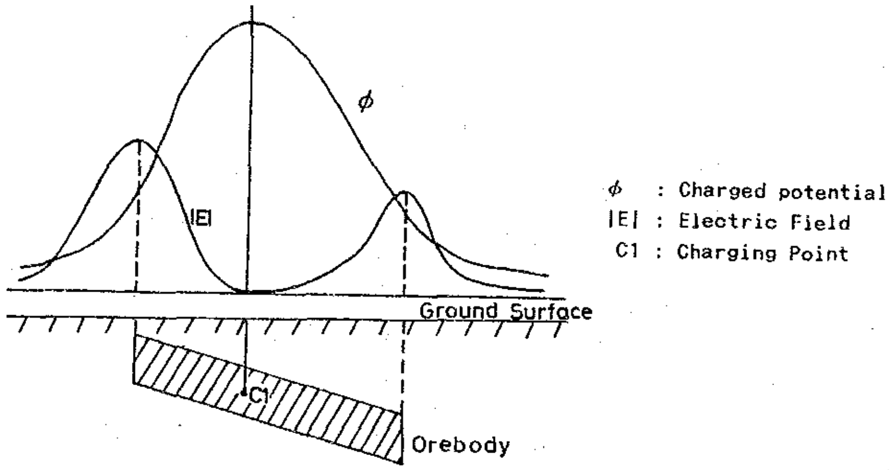


Fig. II-1-16 Model Curve of Charged Potential and Its Electric Field

The intensity and azimuth at each CP station are shown in Appendix 2.

The above two kinds of plan maps are utilized to delineate the distribution of the conductor qualitiatively. On the other hand, the quantitative delineation of the concuctor is done by two-dimensional (2-D) model simulation using 2-D finite element method. The procedure of 2-D model simulation is as follows:

(i) A profile running through the current-introduced drill hole is chosen.

(ii) Taking the results of the drilling survey and the physical property tests into consideration, the 2-D resistivity model structure is constructed.

(iii) Charged potential curve for the 2-D resistivity model is calculated and compared with the observed potential curve.

(iv) If the difference between the observed and calculated curves is a little, the calculation is terminated. If the difference is large, the 2-D model structure is reconstructed and model calculation is repeated until the calculated curve matches the observed curve.

1-3-2 Survey Results

1. Results of Physical Property Test

The 24 samples, in total, of rocks and ores collected in the both areas, Area A and Area B, were used for the physical property tests. Each of samples was collected at the ground surface and/or from drill cores. Sampling locations of rock samples collected at the ground surface are shown in Fig. II-1-12.

Three kinds of physical properties, resistivity, PFE and phase difference, of each rock/ore sample were measured by means of the Spectral IP testing system made by Zonge Engineering and Research Organization Inc. (U.S.A.). The results of the physical property tests are shown in Table II-1-3.

Physical properties in wet condition were tested. Physical properties of rock/ore samples are not necessarily same as those existed in the earth, but they may show similar values.

Average values of physical properties for the geologic units and/or ores are shown in Table II-1-4 in which the resistivity shows the descending order of gossan > Lower Effusives II (LII) > Lower Effusives I (LI) > stockwork ore > massive ore.

Therefore, it is expected that the current charged in the orebody flows in the massive and stockwork orebodies concentratedly because resistivities of those orebodies are extremely lower than those of the surrounding rocks, and the charged potentials show a distribution pattern reflecting the shape of the orebody.

2. Charged Potentials

The plan maps of charged potentials due to two drill holes, HS-14 and HS-7, are shown in Fig. II-1-17 and Fig. II-1-18, respectively.

Table II-1-3 Physical Properties

Sample No.	Area Name	Drill Hole	Depth Sampled (m)	Rock/Ore Name	Resistivity (Ω·m)	PFE (%)	Phase Difference (-mrad)
1	A	MJO-A2	136.00	Pillow Lava (L I)	963	0.3	2
2	B	MJO-B3	133.60	Pillow Lava (L I)	878	10.4	94
3	B	MJO-B3	147.70	Pillow Lava (L I)	545	0.5	3
4	B	MJO-B4	101.20	Pillow Lava (L I)	191	0.2	1
5	B	MJO-B5	107.60	Pillow Lava (L I)	731	6.0	53
6	B	MJO-B5	136.10	Pillow Lava (L I)	1,380	1.2	7
7	B	MJO-B6	85.90	Pillow Lava (L I)	545	0.5	3
8	A	MJO-A1	63.70	Pillow Lava (L II)	366	0.2	1
9	A	MJO-A4	44.20	Basaltic Lava (L II)	580	0.5	2
10	A	------	------	Pillow Lava (L II)	2,450	1.6	10
11	A	------	------	Pillow Lava (L II)	154	0.5	4
12	B	MJO-B2	52.20	Pillow Lava (L II)	4,190	0.9	6
13	B	MJO-B3	55.20	Pillow Lava (L II)	1,810	0.9	5
14	B	MJO-B3	80.10	Pillow Lava (L II)	583	2.7	18
15	A	------	------	Pillow Lava (Me)	957	4.3	19
16	A	MJO-A1	82.60	Stockwork Ore	4.25	62.9	370
17	A	MJO-A1	92.30	Stockwork Ore	14.8	37.3	259
18	A	MJO-A4	89.30	Stockwork Ore	91.4	32.3	216
19	B	MJO-B5	47.70	Stockwork Ore	9.12	33.6	251
20	B	MJO-B5	69.00	Stockwork Ore	5.97	64.6	389
21	A	MJO-A1	78.40	Massive Ore	1.26	4.9	46
22	A	MJO-A4	81.20	Massive Ore	0.97	18.5	159
23	A	------	------	Gossan	1,930	2.5	16
24	A	------	------	Gossan	3,500	0.5	4

Table II-1-4 Average Values of Physical Properties

Rock/Ore Name	Resistivity (Ω·m)	PFE (%)	Phase difference (-mrad)	Number of Samples (pcs)
Pillow Lava (L I)	747	2.7	23	7
Pillow Lava (L II)	1,390	1.5	8	8
Stockwork Ore	25.1	46.1	297	5
Massive Ore	1.12	11.7	10	2
Gossan	2,720	1.5	10	2

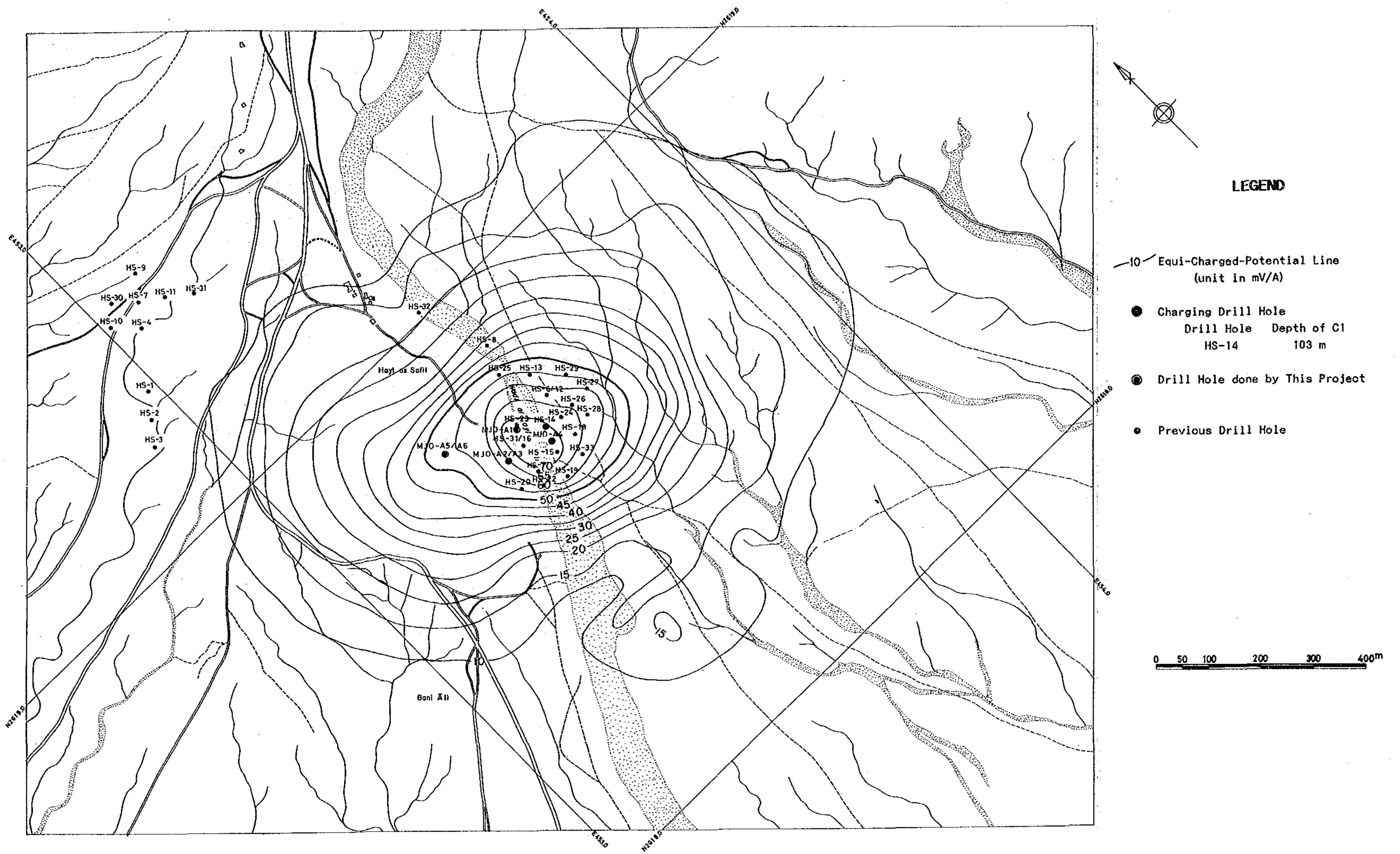


Fig. II-1-17 Charged Potential Map (HS-14)

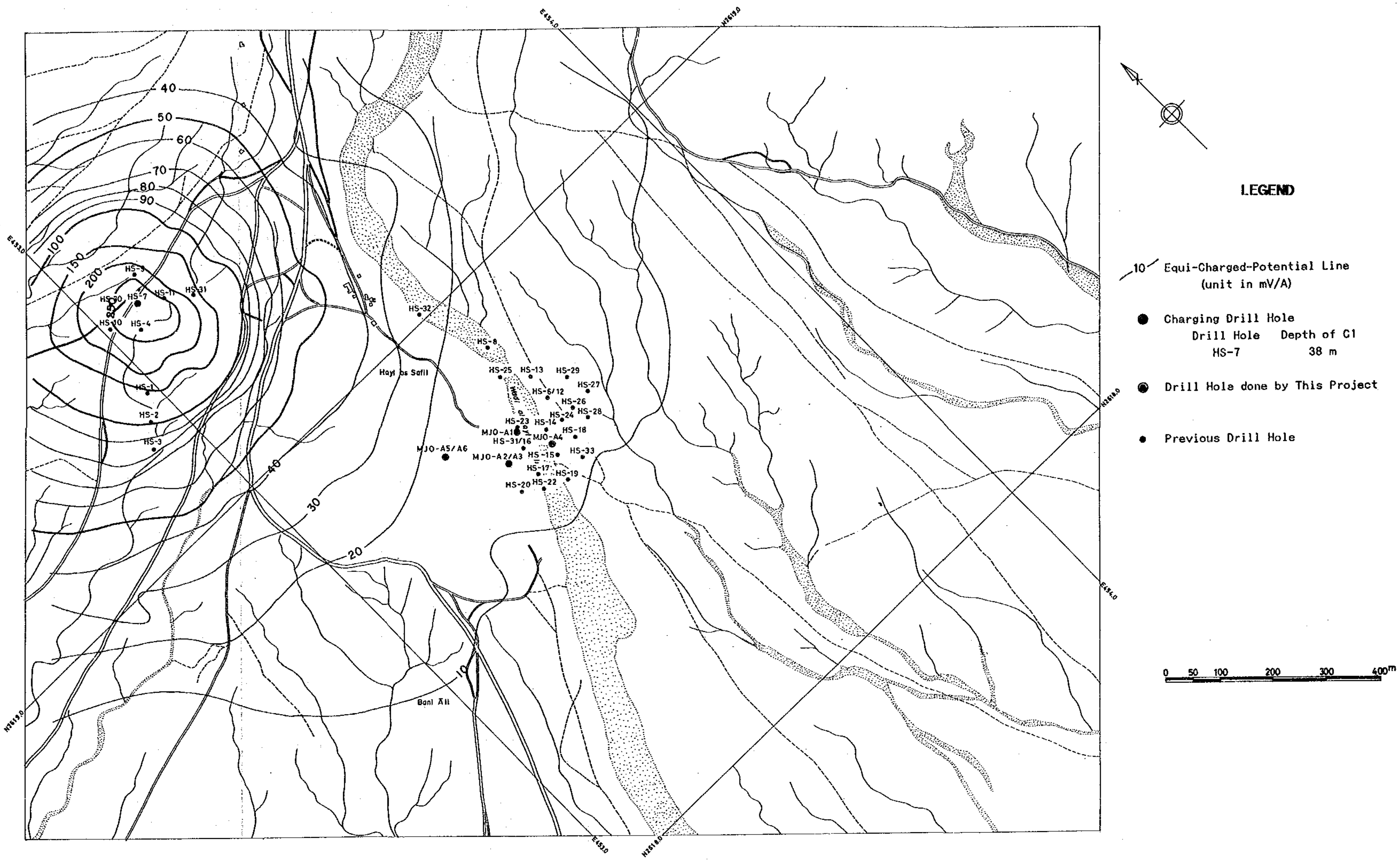


Fig. II-1-18 Charged Potential Map (HS-7)

(1) Charged Potentials due to HS-14 Drill Hole

A charge potential plan map due to charging point placed at the depth of 103 m in the HS-14 drill hole is shown in Fig. II-1-17.

On this plan map, the highest peak of charged potential of 73.5 mV/A is found at the west of HS-14 hole, and the equi-charged potential lines extend towards the west (the south of Main Gossan), the southeast and the northeast. These distribution pattern seem to reflect the distribution of the Hayl as Safil deposit.

The northern and southwestern bounderies of conductor including orebody are presumed at 200 m north and 200 m southwest of HS-14 hole, respectively, where the large gradients of charged potentials are observed.

A distortion of the equi-potential lines extends only up to the southern-half part of Main Gossan toward the west, and does not continue to Small Gossan. Therefore, it is thought that both of the Hayl as Sail and the north orebody are insulated electrically, that is, there is no continuation between both orebodies.

(2) Charged Potentials due to HS-7 Hole

A charged potential plan map due to charging point placed at the depth of 38 m in the HS-7 drill hole is shown in Fig. II-1-18.

On this plan map, a highest peak of charged potential of 592 mV/A is found at 50 m south of HS-7 hole, and charged potentials show a distribution of a little extension in a N-S direction. A higher charged-potential value at the highest peak than that due to HS-14 hole is only due to shallower charging point (C1) and not due to the difference of the sizes of the deposits.

The boundaries of conductors including orebody are presumed around 150 m north, east, south and west of HS-7 hole, respectively, where large gradients of charged potentials are observed. At the south of HS-7 hole, the southern boundary seems to be located at the southern edge of Small Gossan, and the equi-potential lines do not extend toward Main Gossan. Therefore, the both of the Hayl as Safil and the north orebody seem to be insulated on this map also.

3. Electric Fields

As described in 1-3-1, low $|E|$ (intensity of electric field) anomalies are distributed in the distribution area of the conductor including orebody, and high $|E|$ anomalies on the boundary of the conductor. Utilizing the characteristics of $|E|$ distribution, the boundary of conductor including orebody could be estimated. While, low and high $|E|$ anomalies are called when the some point shows relatively low or high $|E|$ comparing with the neighbouring points.

(1) **Elecftric Fields due to HS-14 hole**

The electric fields due to HS-14 hole is shown in Fig. II-1-19.

On this map, several low | E | anomalies are distributed around the HS-14 hole, and are surrounded by notable high | E | anomalies. The boundary of the conductor including orebody seems to be located at 200 m west (100 m west of MJ0-A3 hole at the western bank of wadi), at 200 m north (around HS-8 hole), at 200 m southeast and 100 m south of the HS-14 hole. And the boundary at the northwestern edge near MJ0-A5/A6 holes entends 50 m toward the west.

Moreover, high | E | anomalies extend towards the northwest (the southern-half of Main Gossan), northeast and southeast, and the existence of the conductor is expected at these portions. However, since the | E | are lower than those in above notable anomalies, the conductor in each of these three portions seems to become either thinner or deeper or highly resistive.

In the main part of the conductor as described above, there are found the equi - | E | lines trending in NW-SE, WNW-ESE and N-S directions, which may reflect the directions of the fault structures.

The | E | distribution due to HS-14 hole shows no relation betweeen the Hayl as Safil and north orebody, as shown in the charged potentials (Fig. II-1-17).

(2) **Electric Fields due to HS-7 Hole**

The electric fields due to HS-7 hole is shown in Fig. II-1-20.

On this map, a low | E | anomaly with a center at 50 m west of HS-7 hole, is distributed around the HS-14 hole, and are surrounded by notable high | E | anomalies.

Judging from the distribution of high | E | anomalies, the boundary of the conductor including orebody is located at the southern fringe of Small Gossan, around 100 m east of HS-7 hole, around 100 m north of HS-7 hole and around 150 m west of HS-7 hole. Therefore, it is suggested that there is no continuity between the Hayl as Safil and North deposits.

(3) **Model Simulatoin**

In order to evaluate western and southeastern extensions of equi-potential lines on a charged potential plan map due to HS-14 hole, 2-D (two-dimensional) model calculation by means of 2-D finite element method was applied. Location of 2-D section line, running at the HS-14 hole, is shown in Fig. II-1-21. The section line runs through HS-14 hole in NW-SE direction. At the north of HS-14 hole, the line extends to 30 m east of MJ0-A5 hole and toward the west through MJ0-A5 hole.

The results of the calculation is shown in Fig. II-1-22.

The initial model was constructed on the basis of the results of the drilling survey and the physical property test of the drill holes on and/or near the section line such as HS-14, MJ0-A5, etc. By means of setting each hole as a control point model calculation was repeated by changing the resistivity and thickness of resistivity model structure, until the calculated potential curve matches the observed curve.

Fig. II-1-19 Electric Field Map (HS-14)

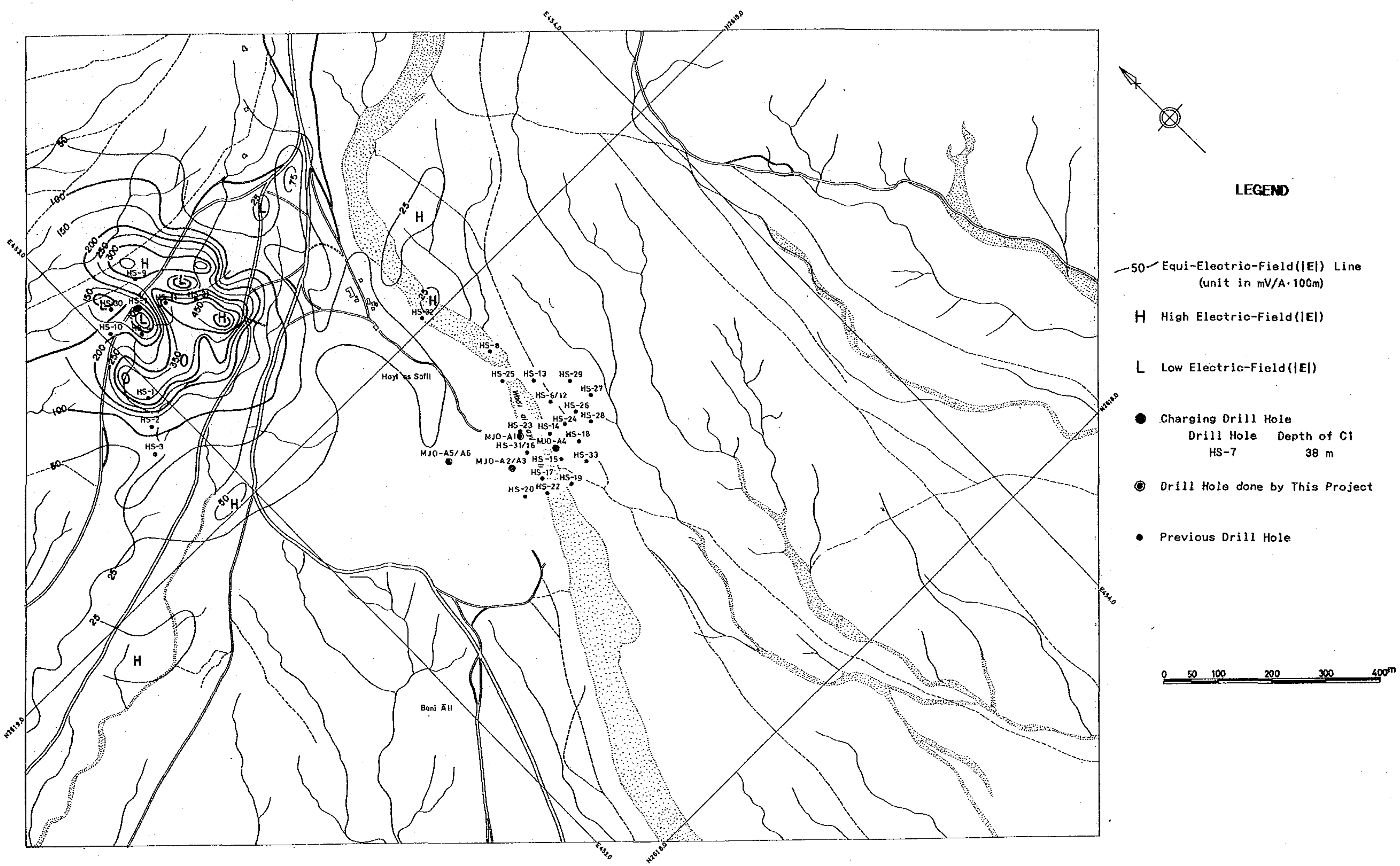


Fig. II-1-20 Electric Field Map (HS-7)

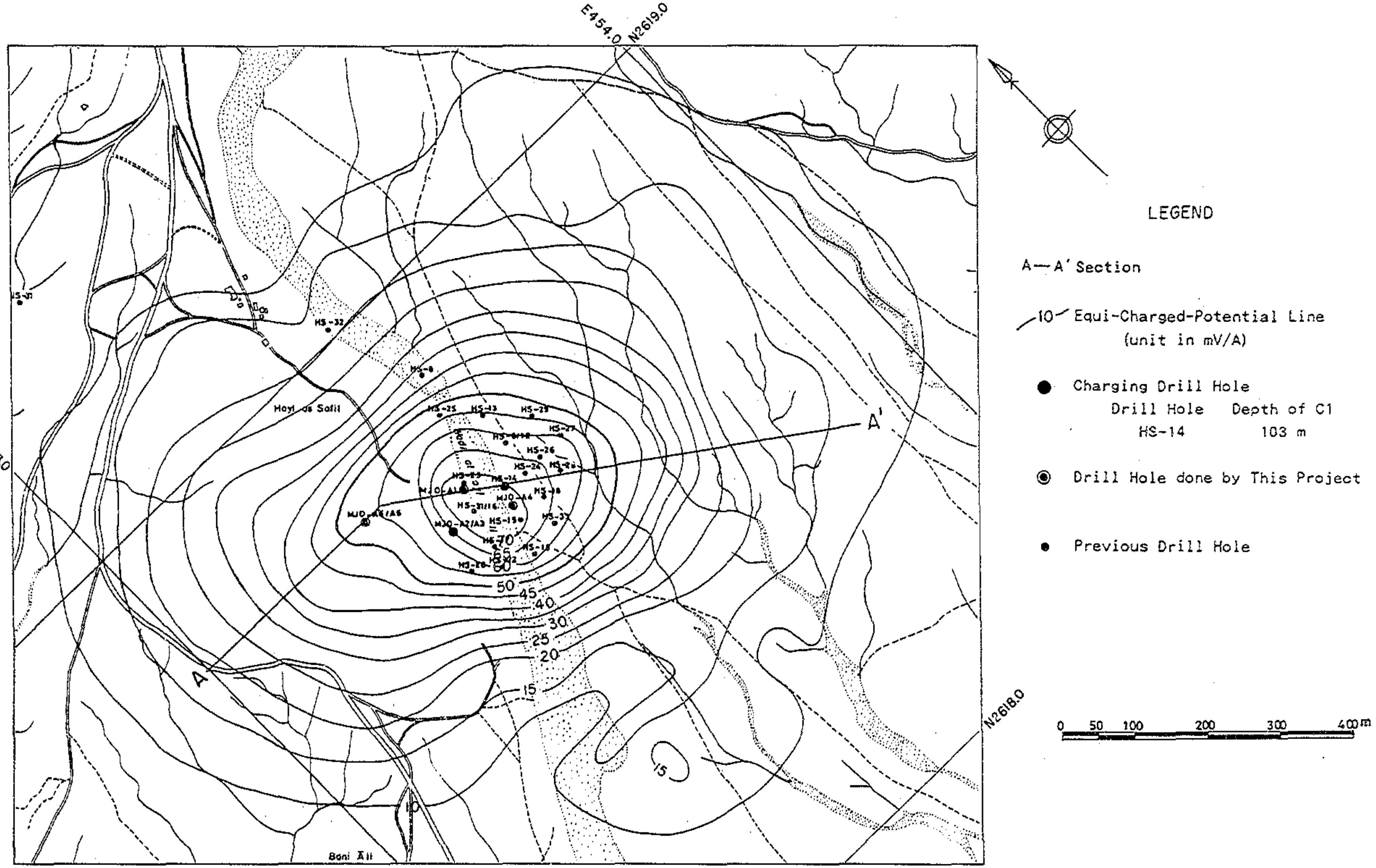
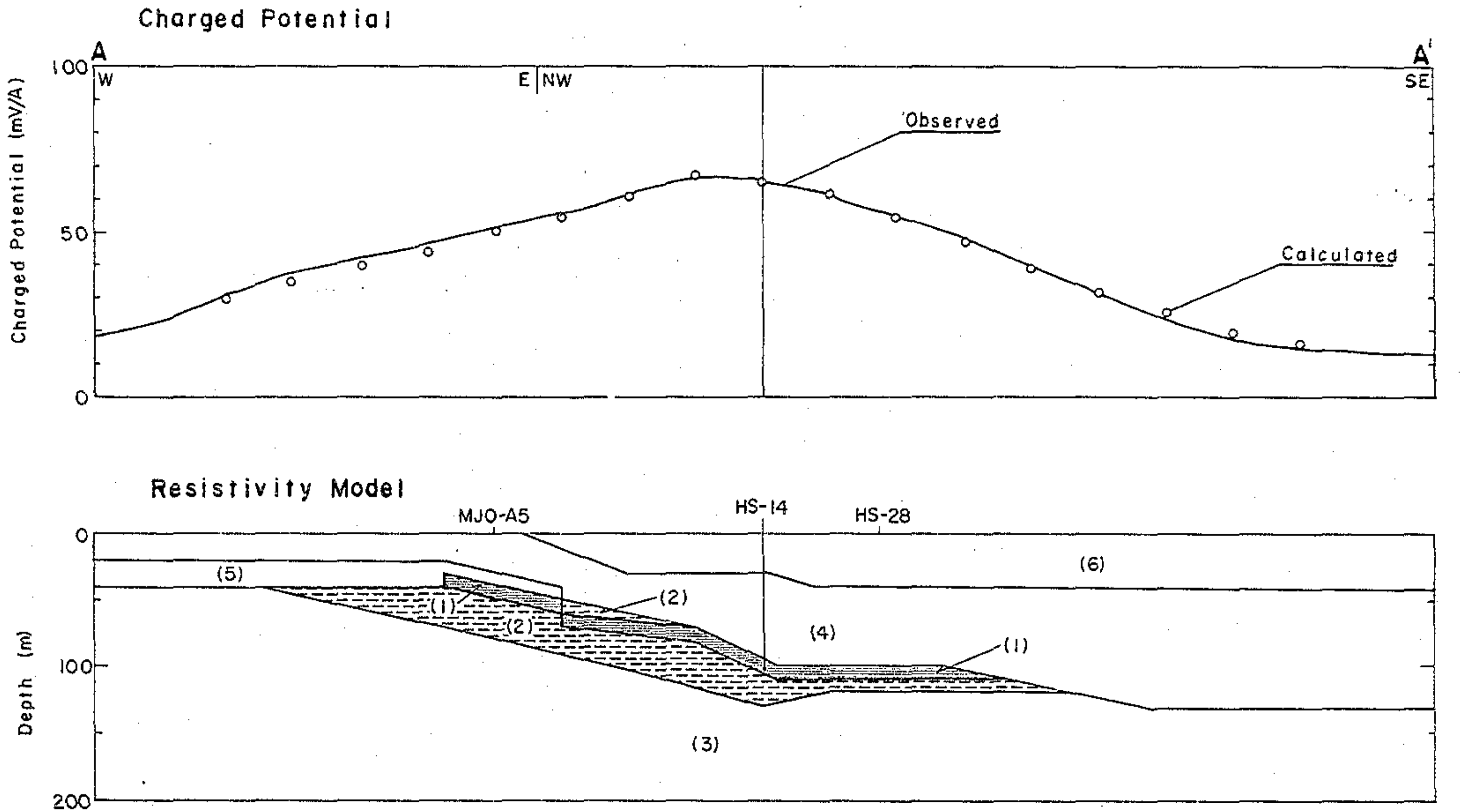


Fig. II-1-21 Location Map of Section



Resistivity Code	Resistivity (Ω·m)	Unit	Resistivity Code	Resistivity (Ω·m)	Unit
(1)	1	Massive Ore	(4)	1,000	Lower Extrusives II
(2)	5	Stockwork Ore	(5)	3,500	Gossan
(3)	900	Lower Extrusives I	(6)	100	Quaternary

0 100 200m

Fig. II-1-22 A-A' Section

Resistivity of each formation and orebody of the final model is 1 Ω · m for massive ore, 5 Ω · m for stockwork ore, 900 Ω · m for Lower Effusives I (LI), 1,000 Ω · m for Lower Effusives II (LII), 3,000 Ω · m for gossan and 100 Ω · m for terrace deposits of Quaternary sediments.

The orebody including massive and stockwork ore zones is distributed at the thickness of 20 m through 50 m, around 200 m southeast of HS-14 hole toward the southeast and around 200 m west of MJ0-A5 hole toward the west, and is diminished at the both ends. Within the orebody, the massive ore zone is distributed between 50 m west of MJ0-A5 hole and 150 m southeast of HS-14 hole at the thickness of about 10 m.

A high resistivity layer of 3,500 Ω · m with the thickness of 10 m to 20 m, corresponding to gossan, is distributed at the west of MJ0-A5 hole, and a resistivity of 100 Ω · m with the thickness of 30 m to 40 m, corresponding to terrace deposits, is also distributed at the surface at the southeast of HS-14 hole.

(4) Summary of Geophysical Survey Results

By means of locating 611 CP stations in total in Area A and placing a charging electrode (C1) at the massive orebody in each of two drill holes, HS-14 and HS-17 holes, the charged potentials were obtained. Moreover, by the electric fields calculated from charged potentials and the 2-D model calculation for the Hayl as Safil deposit, the distribution of the conductor including the massive and stockwork ore zones were evaluated.

A geophysical interpretation map is shown in Fig. II-1-23.

The main part of the Hayl as Sail deposit, evaluated by the geophysical survey results, is distributed with the width of 250 m in N-S and E-W directions each, and extends to 200 m southeast of HS-14 hole. And the bondary of the main part is assumed around 20 m through 60 m west of MJ0-A5/A6 holes at the west bank of the wadi, around 20 m north of HS-8 hole, around 140 m east of HS-14 hole, and around HS-19 hole. At the northwestern edge of the main part, the MJ0-A5/A6 holes were drilled and hit the massive and stockwork orebody successfully, so that this drilling survey results seem to encourage the geophysical survey results.

In this main part, the distribution of the orebody is controlled by the fault structures running in NW-SE and WNW-ESE directions, and the orebody seems to be distributed at relatively large thickness.

According to the geophysical survey results, the orebody extends toward the northwest (the southern-half part of Main Gossan) and to 50 m west of the western edge of the main part, and in these extensions the thickness of the orebody seems to be thin. And also the northeastern extension of the orebody, which is distributed toward 360 m northeast of HS-14 hole, seems to be existed in the depth. The north orebody, which is distributed at the width of 200 m in N-S and E-W directions each and shows a southern edge at southern fringe of Small Gossan, is thought not to continue to the Hayl as Safil deposit.

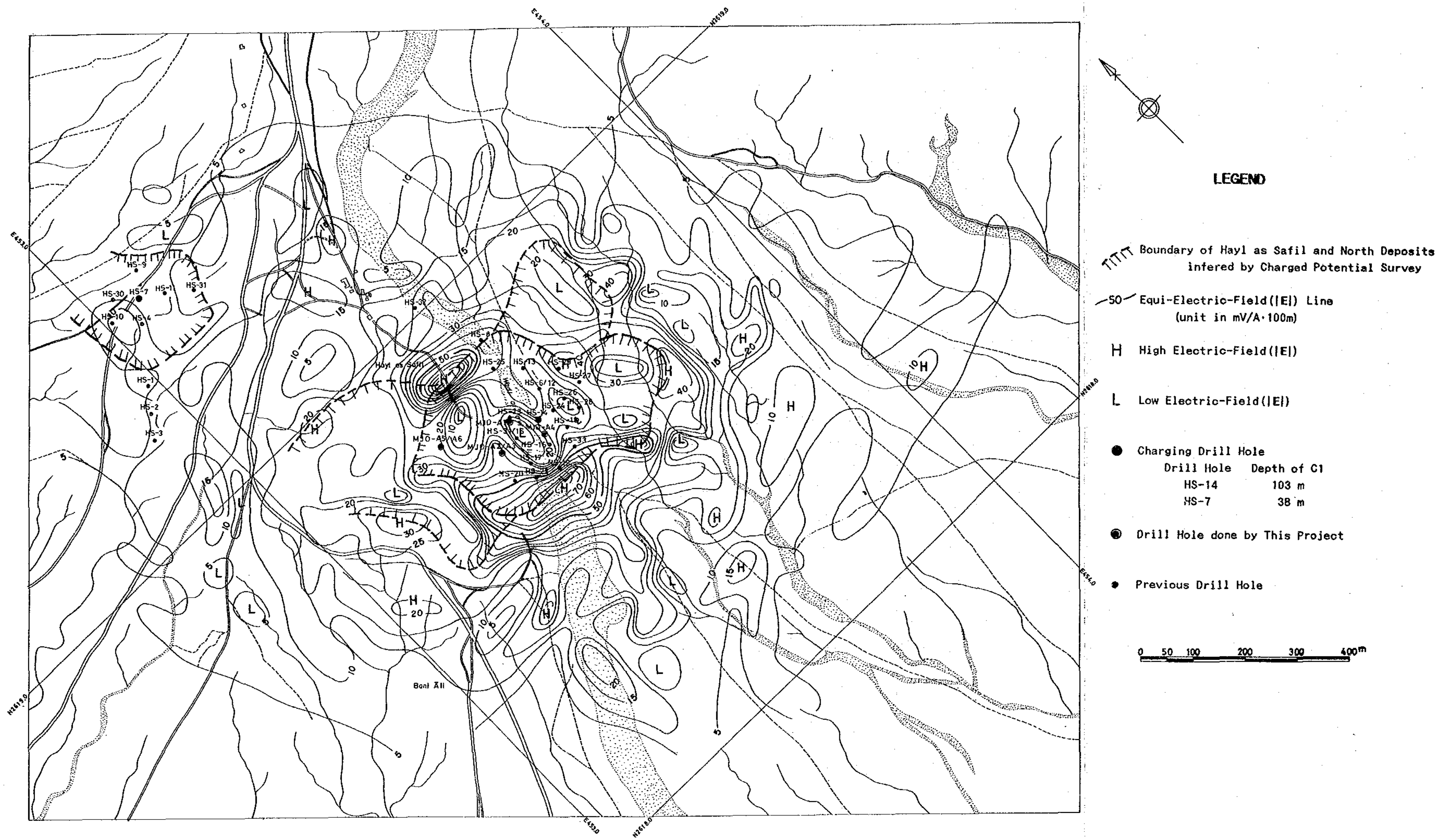


Fig. II-1-23 Geophysical Interpretation Map of Area A

1-4 Drilling

1-4-1 Method and Progress of Drilling

A total of six drill hole of MJO-A1 to MJO-A6 (898.70 m in total) were completed in Area A. Locations of these holes are shown in Fig. II-1-10. Details of each hole are given in Table II-1-5. List of previous drill holes completed in the Hayl as Safil deposit area are shown in Table II-1-6.

Drillinhg work was carried out by subcontrator of Lalbuksh Contracting and Trading Est. in Oman. Two machines were utilized for the drilling and operation was carried out one shift of twelve hours operation. Name the drilling machines and the capacities are as follows:

JOY RAMROD II	VOL 35
NX 455 m	NX 205 m
BX 650 m	BX 350 m
AX 825 m	AX 430 m

JOY RAMROD II is manufactured in U.S.A. and VOL 35 is in Indea. Among six holes, two holes of MJO-A4 and A5 were completed by VOL 35, and remainings were by JOY RAMROD II. Progress of each holes are shown in Appendix 3. Four holes except MJO-A5 and A6, were completed by NX in size.

Because of thick terrace deposits and strongly silicified mineralized zone, drilling consumed more time than that in Area B. Especially, the drill holes MJO-A5 and A6 which were located at southern immediate flank of Main Gossan, drilled siliceous gossan zone and consumed many diamond bits. Because of heavy caving and thick cave zones, these two holes reduced the size from NX to BX at the depth of 56.70 m for MJO-A5 and 72.65 m for MJO-A6.

First three meter was drilled by rotary bit and insert NW casing. Then the hole was drilled by wireline method of NX in size. If the hole encounter caving zone, the hole was reamed and extended the casing, or cemented the hole then re-drilled.

Geologic logs for these drill holes are given in Appendix 4. Samples collected from the drill core are listed in Table II-1-1.

A part of these study results is given in the palagraph "Geologic Survey" and Chapter 3 of Part II.

All six drill holes completed in the Area A encountered mineralized zone. Drill cores were cut by rock cutter. A half of core were sampled for beneficiation test and a quarter were samples for ore assay. Remaining a quarter sample were stored. Following samples were collected from each hole for ore assay:

Table II-1-5 Details of Drill Holes Completed in Area A

Hole Number	MJO-A1	MJO-A2	MJO-A3	MJO-A4	MJO-A5	MJO-A6
Coordinates	N 2618.737 E 453.434	N 2618.698 E 453.373	N 2618.698 E 453.371	N 2618.673 E 453.458	N 2618.793 E 453.295	N 2618.794 E 453.294
Drill Length	200.60 m	151.15 m	143.00 m	150.75 m	120.10 m	133.10 m
Bearing	270°	–	270°	–	–	0°
Inclination	–50°	Vertical	–50°	Vertical	Vertical	–50°
Core Length	197.60 m	133.30 m	136.05 m	136.25 m	98.45 m	106.70 m
Core Recovery	98.5%	88.2%	96.4%*	90.4%	84.3%*	81.4%*
Period: From To	 8 October 1988 20 October 1988	 26 November 1988 10 December 1988	 12 December 1988 26 December 1988	 3 October 1988 16 October 1988	 1 December 1988 23 December 1988	 27 December 1988 13 January 1989
Casing	15.00 m	25.00 m	3.00 m	3.00 m	11.50 m (NW) 56.70 m (NX)	27.00 m (NW) 72.65 m (NX)
Remarks			Terminated at the depth of 143.00m due to heavy caving Cave zone: 1.90m		56.70m~120.10m BX Cave zone: 3.30m	72.65m~133.10m BX Cave zone: 2.00m

* Except cave zone

Table II-1-6 List of Previous Drill Holes in Area A

Hayl as Safil Deposit Area

Hole No.	Coordinates		Elevation (m)	Depth (m)	Bearing	Inclination	Period		Done by
	N	E					Started	Completed	
* HS-5	2618.781	453.451	692.0	105.00	301°	-54°	9 Jan.'86	15 Jan.'86	BRGM
HS-6	2618.737	453.509	703.5	177.60	303°	-50°	17 Feb.'86	28 Feb.'86	BRGM
HS-8	2618.880	453.494	692.8	193.90	–	-90°	8 Mar.'86	25 Mar.'86	BRGM
HS-12	2618.736	453.511	703.5	200.05	–	-90°	27 Jan.'87	19 Feb.'87	MPM
HS-13	2618.787	453.514	704.3	200.10	–	-90°	15 Feb.'87	28 Feb.'87	MPM
HS-14	2618.698	453.468	696.5	200.05	–	-90°	29 Feb.'87	13 Mar.'87	MPM
HS-15	2618.648	453.449	694.0	150.00	–	-90°	16 Mar.'87	1 Apr.'87	MPM
HS-16	2618.698	453.417	690.5	90.00	–	-90°	27 Sep.'87	8 Oct.'87	MPM
HS-17	2618.649	453.398	689.8	90.00	–	-90°	11 Oct.'87	19 Oct.'87	MPM
HS-18	2618.645	453.499	702.9	116.25	–	-90°	21 Oct.'87	2 Nov.'87	MPM
HS-19	2618.601	453.432	694.5	152.10	–	-90°	4 Nov.'87	15 Nov.'87	MPM
HS-20	2618.649	453.356	694.9	120.00	–	-90°	17 Nov.'87	28 Nov.'87	MPM
HS-21	2618.698	453.416	690.5	119.30	280°	-42°	1 Dec.'87	16 Dec.'87	MPM
HS-22	2618.620	453.389	689.2	120.50	–	-90°	19 Dec.'87	26 Dec.'87	MPM
HS-23	2618.739	453.435	691.0	170.50	–	-90°	28 Dec.'87	9 Jan.'88	MPM
HS-24	2618.690	453.501	703.1	150.00	–	-90°	12 Jan.'88	21 Jan.'88	MPM
HS-25	2618.830	453.475	692.6	181.00	–	-90°	25 Jan.'88	5 Feb.'88	MPM
HS-26	2618.690	453.531	702.2	150.25	–	-90°	20 Feb.'88	1 Mar.'88	MPM
HS-27	2618.689	453.571	704.1	168.55	–	-90°	3 Mar.'88	14 Mar.'88	MPM
HS-28	2618.656	453.537	702.2	150.30	–	-90°	16 Mar.'88	25 Mar.'88	MPM
HS-29	2618.737	453.561	704.3	200.15	–	-90°	27 Mar.'88	9 Apr.'88	MPM
HS-32	2619.020	453.445	695.0	170.55	–	-90°	9 Mar.'88	25 May '88	MPM
HS-33	2618.610	453.481	700.8	175.00	–	-90°	27 Mar.'88	9 June '88	MPM

Small Gossan Area

Hole No.	Coordinates		Elevation (m)	Depth (m)	Bearing	Inclination	Period		Done by
	N	E					Started	Completed	
* HS-1	2619.263	452.980	701.5	50.00	–	-90°	24 Dec.'85	27 Dec.'85	BRGM
* HS-2	2619.223	452.948	701.0	50.00	–	-90°	28 Dec.'85	29 Dec.'85	BRGM
* HS-3	2619.182	452.917	701.8	79.00	–	-90°	29 Dec.'85	31 Dec.'85	BRGM
* HS-4	2619.357	453.055	702.8	65.00	–	-90°	2 Jan.'86	6 Jan.'86	BRGM
HS-7	2619.399	453.087	708.5	108.10	–	-90°	3 Mar.'86	6 Mar.'86	BRGM
HS-9	2619.437	453.118	707.0	101.15	–	-90°	1 Dec.'86	16 Dec.'86	MPM
HS-10	2619.399	453.013	707.0	111.50	–	-90°	14 Jan.'87	26 Jan.'87	MPM
HS-11	2619.368	453.127	708.0	116.50	–	-90°	18 Dec.'86	11 Jan.'87	MPM
HS-30	2619.430	453.049	707.8	110.70	–	-90°	21 Apr.'88	28 Apr.'88	MPM
HS-31	2619.337	453.168	706.1	120.20	–	-90°	30 Apr.'88	5 May '88	MPM

* *Percussion drill hole*

Hole number	Depth and thickness of mineralized zone	Sampled length	Number of sample
MJO-A1	77.60 ~ 133.30 m (55.70 m)	53.30 m	28
MJO-A2	30.00 ~ 101.95 m (71.95 m)	66.20 m	34
MJO-A3	31.20 ~ 88.10 m (56.90 m)	47.70 m	25
MJO-A4	80.75 ~ 95.30 m (14.55 m)	9.65 m	6
MJO-A5	24.90 ~ 94.15 m (69.25 m)	54.75 m	26
MJO-A6	15.90 ~ 81.30 m (65.40 m)	27.30 m	13
Total	333.75 m	258.90 m	132

Assay samples were collected for one to two meters core section. Length of the core section was decided based on the type of ore. Assay results are given in Appendix 4.

Following core sections were sampled for beneficiation test:

MJO-A1	76.60 ~ 80.60 m,	91.70 ~ 95.50 m
	108.40 ~ 112.00 m,	114.80 ~ 115.70 m
MJO-A2	38.80 ~ 40.30 m,	46.10 ~ 48.85 m
	49.90 ~ 50.80 m,	53.80 ~ 63.45 m
	86.70 ~ 88.70 m	
MJO-A4	81.10 ~ 82.50 m,	
HS-17	59.50 ~ 60.20 m,	

Because of limitted intersection of high copper grade massive ore, some samples were collected from HS-17 which completed in 1987 by MPM.

1-4-2 Survey Results

1. Drilling Results

(1) MJO-A1

MJO-A1 was carried out at the same location of previous drill hole HS-23 (vertical) to confirm the western extension of the known ore deposits. Bearing of the hole is 270 degree and inclination is minous 50 degree. Results are below:

0 ~ 23.60 m	Terrace deposits consisting of gravel and sand. Lower 7 m is completely comented with calcite.
23.60 ~ 76.70 m	Lower Extrusives II. Pillow lavas with minor massive lavas and pillow breccia. Chloritized. Hematite in matrix of pillows or breccia, and in fractures.
76.70 ~ 77.60 m	Brecciated and strongly argillized pillow lavas.

77.60 ~ 77.75 m	Hematite-clay zone.
77.75 ~ 78.60 m	Massive sulfide zone with minor silicified fragments. Pyrite dominant.
78.60 ~ 85.30 m	Stockwork ore zone with 30 to 80 vol. % sulfides.
85.30 ~ 129.90 m	Stockwork ore zone. Strongly silicified and brecciated zone with sulfides and quartz veinlets. Small angular hematite fragments in places.
129.90 ~ 133.30 m	Strongly chloritized and phyllitic zone. Upper 0.25 m sheared. 132.30 ~ 133.20 m : stockwork ore.
133.30 ~ 200.60 m (bottom)	Lower Extrusives I. Chloritized and hematized pillow lavas. 196.70 ~ 197.30 m : sheared and brecciated zone.

Mineralized zone encountered in the hole are clearly bounded with strongly argillized zone at the top and strongly chloritized zone at the bottom. No sulfide minerals can be observed in the hanging wall and footwall volcanic rocks. Sulfide minerals concentrate at the top and form massive sulfide zone. Stockwork ore zone show similar nature and occurrence from the top to the bottom and is intensely brecciated.

Assay results show slightly higher copper contents at the upper and lower ports of the ore zone. Average grades of the core section from 77.75 m to 130.15 m (D.L. 52.40 m) are as follows:

0.50 g/t Au, 2.2 g/t Ag, 0.60% Cu, 0.39% Zn

Lead grade was less than 0.01%. Gold shows slightly higher value compare with other metals.

(2) MJO-A2

This hole was carried out to examine the western extension of stockwork ore zone confirmed by a previous drill hole HS-21. Results are as follows:

0 ~ 30.00 m	Terrace deposits consisting of gravel and sand. 19.20 ~ 25.30 m : cemented with calcite.
30.00 ~ 30.70 m	Gossan soil.
30.70 ~ 32.45 m	Brecciated siliceous ore. Matrix : coarse-grained pyrite with minor chalcopyrite and hematite.
32.45 ~ 34.80 m	Gossanized siliceous ore zone. Hematite and goethite with angular siliceous fragments.
34.80 ~ 35.50 m	Massive sulfide zone.
35.50 ~ 39.40 m	Gossanized massive sulfides zone.
39.40 ~ 96.20 m	Stockwork ore zone. Strongly silicified and brecciated zone with sulfides and quartz. Hematite in matrix of breccia in places.
96.20 ~ 96.70 m	Clay zone with pyrite disseminations.
96.70 ~ 99.10 m	Strongly chloritized zone with pyrite stringers and disseminations.
99.10 ~ 101.95 m	Mixture of chlorite and hematite bands.
101.95 ~ 151.15 m (bottom)	Lower Extrusives I. Pillow lavas with subordinate massive lavas. Quartz and calcite stringers. Hematite in matrix.

Mineralized zone encountered in this hole is directly covered by terrace deposits. Because, siliceous and massive ores are observed at the upper part of the mineralized zone, erosion for the mineralized zone may be limitted. Strongly chloritized zone is also observed in the hole and the zone bounded between the mineralized zone and footwall volcanic rocks very clearly.

This hole confirmed thick mineralized zone (D.L. 71.95 m) consisting mainly of stockwork ore. Assay results show following results:

30.00 m ~ 93.40 m　D.L. 63.40 m

0.55 g/t Au,　2.7 g/t Ag,　0.87% Cu,　0.19% Zn

Lead grade is less than 0.01%. The best two meters section is between 85.40 m ~ 87.40 m grading 0.6 g/t Au and 4.92% Cu.

(3) MJO-A3

This hole was completed at the same drill site of MJO-A2. Purpose of the hole was to confirm the further western extension of the mineralized zone. Bearing of this hole is 270 degree and inclination is minous 50 degree.

0 ~ 31.20 m	Terrace deposits. Gravel and sand. 15.25 ~ 31.20 m : cemented with calcite
31.20 ~ 33.30 m	Clay zone.
33.30 ~ 34.30 m	Gossan soil
34.30 ~ 35.00 m	Siliceous gossan. Brecciated.
35.00 ~ 36.95 m	Gossan. Possibly massive sulfides.
36.95 ~ 41.10 m	Massive sulfide zone with minor siliceous fragments.
41.10 ~ 43.00 m	Cave.
43.00 ~ 43.70 m	Clay zone with brecciation.
43.70 ~ 85.90 m	Stockwork ore zone. Strongly silicified and argillized. Pyrite-chalcopyrite veinlets and disseminations. Quartz network veins.
85.90 ~ 88.10 m	Chlorite zone with hematite bands.
88.10 ~ 143.00 m (bottom)	Lower Extrusives I. Pillow lavas with hematite in matrix and fractures. 122.10 ~ 122.30 m : strongly argillized and sheared zone. 141.10 ~ 141.70 m : strongly argillized and sheared zone. 142.70 ~ 142.80 m : sheared and fractured.

Mineralized zone encountered in this hole shows similar occurrence to that of the drill hole MJO-A2. However, this hole contains more quantity of sulfides (15 ~ 70 vol %).

The assay results gave encouraging values. Average grades for the intersection are as below:

36.20 m ~ 85.90 m　D.L. 49.70 m

1.09 g/t Au,　9.5 g/t Ag,　2.52% Cu,　0.01% > Pb,　0.13% Zn

The massive ore at the top shows high grade of Cu (10.94% Cu).

(4) MJO-A4

Previous drill holes of HS-14 and HS-15 confirmed thick and high copper grade massive ore zone. This hole was carried out to examine the nature of the massive ore zone, in the middle of the previous two holes and to sample for beneficiation test. Results of the hole are as follow:

0 ~ 22.10 m	Terrace deposits. Gravel and sand. 16.20 ~ 22.15 m : completely cemented with calcite.
22.10 ~ 80.75 m	Lower Extrusives II. Pillow lavas with minor massive lavas and pillow breccia. Quartz, hematite and zeolites stringers.
80.75 ~ 81.15 m	Clay zone with pyrite disseminations.
81.15 ~ 82.30 m	Massive sulfide zone.
82.30 ~ 92.00 m	Siliceous ore with pyrite and chalcopyrite disseminations. 82.50 ~ 82.80 m : clay zone with pyrite.
92.00 ~ 95.30 m	Brecciated, chloritized and weakly silicified zone with pyrite disseminations.
95.30 ~ 150.75 m (bottom)	Lower Extrusives I. Pillow lavas with quartz calcite and hematite veins and veinlets. Hematite in matrix. 101.20 ~ 101.80 m : Strongly chloritized, argillized and sheared zone. 122.40 ~ 122.60 m : Strongly chloritized and sheared zone.

This hole encountered thin but comparatively high copper grade massive sulfide ore (D.L. 1.15m, 1.2 g/t Au, 4.5 g/t Ag, 3.24% Cu, 0.34% Zn). The massive sulfide ore is bounded by thin clay zones at the top and bottom. This fact suggest that the difference of thickness of massive sulfide zone between this hole and previous holes is the fault displacement. Assay result for the mineralized zone are as follow:

Depth (m)	D.L. (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
80.75 ~ 83.20	2.45	1.56	7.1	3.44	<0.01	0.40
83.20 ~ 86.90	3.70	0.25	4.2	1.14	<0.01	0.40
88.50 ~ 92.00	3.50	0.15	4.0	1.17	<0.01	0.18

Average grades of the encountered mineralized zone of 11.25 m core section are 0.47 g/t Au, 4.1 g/t Ag, 1.49% Cu and 0.28% Zn.

(5) MJO-A5

This hole was carried out to examine the mineralization of Main Gossan and to confirm the relationship between the known ore deposits and Main Gossan. Location of the drill site is imadiate southern adjacency of Main Gossan. Results of the hole give below:

0	~	10.90 m	Overburden. Debris of siliceous gossan.
10.90	~	24.90 m	Doleritic massive lavas (Lower Extrusives II). Weakly brecciated and locally hematized. 20.80 ~ 24.90 m : argillized, chloritized and weathered pillow lavas.
24.90	~	25.90 m	Gossan soil. Hematite, limonite and clay.
25.90	~	34.20 m	Siliceous gossan. Brecciated siliceous fragments with clay. Hematite and limonite dominant.
34.20	~	48.70 m	Siliceous ore zone. Brecciated, silicified and argillized with quartz stringers and fragments. Hematite in matrix. Pyrite disseminations. 43.30 ~ 44.30 m : Strongly brecciated and argillized zone.
38.70	~	51.70 m	Massive sulfide zone with minor siliceous fragments.
51.70	~	53.40 m	Siliceous zone. Brecciated and weakly weathered. Pyrite disseminations. Quartz-pyrite veins.
53.40	~	56.70 m	Cave. Reduced the size to BX.
56.70	~	63.95 m	Siliceous gossan. Brecciated and silicified zone. Hematite and limonite in matrix.
63.95	~	92.30 m	Stockwork ore zone. Strongly silicified and brecciated zone with sulfides (15 ~ 35 vol.%). 83.90 ~ 84.90 m : strongly brecciated and chloritized zone.
92.30	~	94.15 m	Hematite and chlorite zone with quartz stringers.
94.15	~	120.10 m (bottom)	Lower Extrusives I. Chloritized pillow and massive lavas . Quartz-calcite stringers. Hematite in matrix.

The stockwork ore zone encounterd in this hole shows similar occurrence and ore mineral assemblage to those of the drill holes MJO-A1, A2 and A3. This fact suggests that the known ore deposits and mineralized zone of Main gossan were formed by same mineralization. The hole intersected gossanized zones up to the depth of 63.95 m. This result shows that the minerlized zoned in the Main Gossan area affected by weathering from the surface to deeper part compare to that of the known ore deposits.

Assay results gave good grade of massive ore (46.20 m ~ 51.70 m, D.L. 5.50 m, 1.66 g/t Au, 7.91% Cu). The stockwork ore zone also show high grades locally (63.95 ~ 68.00 m, D.L. 4.05 m 1.24 g/t Au, 3.47% Cu). Average grades for the mineralized zone are as follows,

1.03 g/t Au, 6.1 g/t Ag, 1.66% Cu, 0.01% > Pb, 0.14% Zn

(6) MJO-A6

The drill hole MJ0-A6 was carried out at the same drill site of MJ0-A5. Bearing of the hole is 0 degree (north) and inclination is minus 50 degree. Purpose of the hole was to examine the geology and mineralization under Main Gossan. Results are as follows:

0	~	8.60 m	Overburden. Debris of siliceous gossan.
8.60	~	15.90 m	Lower Extrusives II. Strongly chloritized massive lavas. Brecciated and sheared.
15.90	~	24.95 m	Gossan soil with siliceous fragments.

24.95 ~	36.70 m	Siliceous gossan. Brecciated. 25.50 ~ 26.00 m : cave (fracture)
36.70 ~	37.70 m	Gossan soil with siliceous fragments.
37.70 ~	43.10 m	Strongly chloritized and brecciated zone.
43.10 ~	45.30 m	Siliceous gossan. 39.20 ~ 40.70 m : cave (fracture)
45.30 ~	48.05 m	Siliceous gossan. Silicified and brecciated. Limonite and hematite.
48.05 ~	78.10 m	Stockwork ore zone. Brecciated chalcopyrite-pyrite disseminated breccia. Pyrite disseminations. 72.65 m : reduced the size to BX.
78.10 ~	81.30 m	Strongly chloritized and brecciated zone with pyrite disseminations.
81.30 ~	133.10 m (bottom)	Lower Extrusives I. Chloritized pillow and massive lavas.

Occurrences of gossan soil zone encountered between 43.10 m ~ 45.30 m suggest that the zone is massive sulfide origin. Nature of the mineralization in this hole is same to that of MJO-A5.

Assay results gave lower grade compare with the results of MJO-A5. Average grades are as below,

52.00 m ~ 79.30 m D.L. 27.30 m

0.27 g/t Au, 1.4 g/t Ag, 0.53% Cu, 0.01% > Pb, 0.18% Zn

Upper part of the mineralized zone was not asseyed, because no sulfide minerals were found due to intense gossanization.

2. Observation Results of Polished Sectoin

A total of 15 samples were collected from drill cores in Area A for the study of polished section. The drill holes completed in Area A are mostly western extensions of the known ore deposits. Therefore, three samples were collected from the previous drill holes completed in the center of the known ore deposits. Microscopic observation results for the polished sections are shown in Table II-1-7.

Ore minerals confirmed are pyrite ($Fe\ S_2$), chalcopyrite ($Cu\ Fe\ S_2$), covellite ($Cu_2\ S$), chalcocite ($Cu\ S$), bornite ($Cu_5\ Fe\ S_4$) and sphalerite ($(Fe, Zn)\ S$). Pyrite and chalcopyrite are the main ore minerals among them. Pyrite is usually brecciated and fractured. Massive and siliceous ores contain colloform pyrite. Chalcopyrite occurs between pyrite crystals, in matrix of brecciated pyrite and along fractures. Sphalerite cuts the pyrite and chalcopyrite, and is found among the crystals of pyrite and chalocopyrite. A core sample collected from HS-17 (61.55 m) shows chalcopyrite disease in sphalerite. Covellite, chalcocite and bornite are found together with chalcopyrite and are thought to be formed by supergene enrichment. These minerals occur from near surface to comparatively deeper part. This occurrence suggests that weathering effected to the deeper part of the Hayl as Safil deposit. No native gold was confirmed under the microscope.

Table II-1-7 Results of Microscopic Observation for Polished Sections in the Hayle as Safil Deposit

Hole No.	Depth (m)	Occurrence	Pyrite	Chalcopyrite	Covellite	Chalcocite	Bonite	Sphalerite	Native gold	Gangue minerals and alteration minerals
MJO-A1	78.40	massive py ore with fragment of jasper	◎	•	•	•	•	•*		○ with hematite (•)
"	82.60	py dissemination	○	•	•	•	•	•*		◎ mostly quartz
"	92.30	py veinlet and dissemination	○ fractured, partly brecciated	•	•	•	•	•*		◎ mostly quartz
MJO-A2	36.70	massive py ore	◎ brecciated fractured colloform dendritic	•	•	•		•		○ mostly quartz with hematite (•)
"	39.20	massive py ore with fragment of jasper	◎ fractured brecciated	●	•	•		•*		○
"	51.70	secondary enrichment of disseminated py-cp ore	○ partly fractured	●	•	●	○	•*		◎ mostly quartz with hematite (•)
"	75.10	py-cp veinlet in chloritized pillow lava (?)	◎	●	•	•	•	•*		◎
"	93.10	py-cp veinlet and py-cp dissemination	●	●	•			•*		◎
MJO-A3	40.80	secondary enrichment of massive py-cp ore	◎ fractured brecciated	●		●	•	•		○
"	50.60	partly brecciated cp-py ore	◎ fractured brecciated	○		•	•	•*		○
MJO-A4	81.20	massive cp-py ore, partly brecciated	◎ brecciated	○	•	•		•		●
"	89.30	secondary enrichment of disseminated py-cp ore	○ fractured	●		●	●	•		◎
MJO-A5	34.40	siliceous py ore	◎ fractured colloform	•		•		•*		○ mostly quartz
"	49.90	massive py ore	◎ fractured	•		•		•*		○ mostly quartz
"	52.50	siliceous py ore with fragment of jasper	○	•	•	•		•*		◎ mostly quartz
HS-17	61.55	massive cp-py-sp ore	○	◎				●*		• with hematite (•)
"	63.10	massive cp-py ore	○	◎				•		• with hematite (•)
"	64.80	disseminated py-cp ore in chloritized pillow lava (?)	○	●				•		◎ with hematite (•)

*: chalcopyrite disease ◎: abundant ○: common ●: rare •: very rare py: pyrite cp: chalcopyrite sp: sphalerite

3. *Results of EPMA Analysis*

An ore sample collected at the depth of 61.55 m of Drill hole HS-17 in Area A was analyzed by EPMA (Electron Probe Micro-analyser) after made polished sections and coating by carbon. The sample is massive ore and consists of mainly pyrite, chalcopyrite and subordinate sphalerite. A quantitive analysis of sphalerite and qualitative analysis of chalcopyrite by EPMA were carried out and the results are shown in Table II-2-4.

Sphalerite is very rich in Zn as much as 1/55 to 1/109 in Fe/Zn ratio. The sphalerite, which has a characteristic of rich in Zn, is also observed in the Lasail deposit in the Sohar area. And it includes 0.6 to 1.4% Cu which is confirmed by microscope that it is replaced by chalcopyrite and is found scattered fine grains of chalcopyrite as a disease feature in the sphalerite.

Chalcopyrite consists Cu, Fe and S and indicates almost pure crystal by qualititive analysis.

4. Results of Minor Elements Analyses

In order to examine the difference between the Lasail deposit in the Sohar area and mineralized zone in Area A geochemically, a sample was collected from Main Gossan and chemical analyses were made for 24 elements. The analytical results are shown in Table II-3-3 (Chapter 3).

The Lasail deposit shows high contents of Mn, Zn and Ba at the marginal part of hanging wall side, and high Co an low Mn and Zn in the stockwork ore zone. The sample collected in this survey is gossanized stockwork ore and shows low contents of Co and Mn. Especially, Co in the Lasail deposit is twenty times more than that in Main Gossan. Because, Co is comparatively immobile, the ore solution formed the Lasail and Hayl as Safil deposits may have some differences.

5. Results of X-ray Diffraction Analyses

Hanging wall and footwall volcanic rocks as well as ore zone were examined by X-ray diffraction analyses in order to clarify the nature of alteration. Bulk X-ray diffraction analyses were made for five samples collected from drill cores. The analyses were made at Central Institute of Mitsubishi Metal Corporation. Results are given in Table II-1-8.

Two samples were collected from the Lower Extrusives I (LI). Main alteration minerals detected are quartz, chlorite and smectite. Prehnite and pumpellyite which indicate low-grade metamorphism, are also detected.

Two samples were collected from the stockwork ore zone and the results indicate strong chloritization and silicification. Smectite was detected in the stockwork ore zone encountered by the drill hole MJ0-A4 which is the margin part of the deposit.

The Lower Extrusives II of hanging wall volcanic rocks show more weak chloritizaion compare with the Lower Extrusives I. Very rare pumpellyite suggests weak low-grade metamorphism.

As the results of this survey smectite was detected. Because, smectite increase the volume when meet water, it is better to make consideration when develope the mine.

Table II-1-8 Results of X-ray Diffraction Analyses in Area A

Sample No.	Geol. Unit	Quartz	Plagioclase	Augite	Chlorite	Smectite	Prehnite	Pumpellyite	Epidote	Sphene	Analcite	Calcite	Pyrite	Chalcopyrite	Hematite	Titanomagnetite (?)	Remarks
MJO-A1 111.00	ORE	◎			◎								○	○			
MJO-A1 172.00	LI.	◎	△*	○	◎	△	●	○		●						●	*labradorite
MJO-A4 59.20	LII.		◎*		◎			●				○			△	●	*oligoclase
MJO-A4 91.20	ORE	◎			◎	○							△				
MJO-A4 143.70	LI.	●	◎*	◎	○	○			●	●	○	△				△	*labradorite

◎: abundant ○: common △: rare ●: very rare

1-5 Discussion

As mentioned above, work including geologic, geophysical and drilling surveys was completed in Phase I. Based on the results, nature of the mineralization, potential of ore reserves and future exploration work were considered and obtained following conclusions.

1. Nature of Mineralization of the Hayl as Safil Deposit

The Lasail and Bayda deposits in the Oman Mountains region are cupriferous massive sulfide deposit with underlying stockwork zone in the Samil Ophiolite. The ore deposits area situated at the top of Lower Extrusives I and covered with Lower Extrusives II. Volcanic activity of the Lower Extrusives II is thought to have close relation with the mineralization (Bishimetal, 1987).

The mineralized zones in Area A are also found at the top of the Lower Extrusives I. The mineralized zones are aligned intermittently with a direction of NW-SE. These are the Hayl as Safil deposit, Main Gossan, Small Gossan and north of Small Gossan (north orebody) from southeast to northwest. Among the zones, Main Gossan and the Hayl as Safil deposit are large in size and previous worker interpretated that these were formed separately. However, this survey results revealed that both mineralized zones of Main Gossan and Hayl as Safil deposit were formed by same mineralization because the nature of the both zones are similar and extension of the Hayl as Safil deposit reachs under Main Gossan. Geophysical survey results also suggest these are continuous mineralized zone. Judging from the geologic and drilling survey results, mineralized zones found in area A may separated by the tectonic movement as shown in Fig. II-1-24. (1) shows shapd of original ore deposits, (2) is thrust and low angle faults related to the obduction of Samail Nappe. (3) shows fault movement after the obduction and (4) shows the present situation. As show in Fig. II-1-24, Main Gossan and Small Gossan are completely separated. Geophyical survey results also reveal the separation.

Drilling results gave following characteristics for the Hayl as Safil deposit.

(i) Ore zone is composed of stockwork, massive and siliceous ores in ascending order. The stockwork ore is found in the center and is surrounded by massive ore. Massive and stockwork ores have gradational change in the center but Lower Extrusives II is intercalated between them in the marginal part of the ore deposit.

(ii) Thick stockwork ore zone shows intense silicification and repeated brecciation with quartz stockwork veins. Quantz-hematite breccia and hematizaion are observed throughout the stockwork ore zone. The stockwork ore shows similar occurrence from the top to the bottom of the zone.

(iii) The ore zone contacts Lower Extrusives II with clay zone of a few meter thick. Several meters thick chlorite zone with pyrite disseminations is found at the boundary between the ore zone and Lower Extrusives I at the bottom. Boundary between the mineralized zone and the hanging wall and footwall volcanics are very clear, and no sulfide minerals are found in the volcanics.

(iv) Ore minerals observed are pyrite, chalcopyrite and sphalerite. Supergene copper minerals including covellite, chalcocite and bornite are found under microscope. These minerals were confirmed at the shallower part, but a little are found at the deeper part. Siliceous and massive ores are brocciated. Colloform texture is observed in the breccia of pyrite.

The ore deposits align in a NW-SE direction. This trend is similar to the strike of Sheeted-dyke Complex and is also similar to the general trend of Samail Ophiolite. This fact may suggest that formation of the ore deposit is controlled by regional tectonics.

The stockwork ore froming the most part of the deposits is strongly brecciated and the central part of the orebody shows thinner massive sulfide zone compare with the marginal part. This occurrence may suggest that high polocity zone centering the thick stockwork zone, existed throughout the mineralization stage. Because of repeated brecciation of several times, most sulfide minerals were precipitated in the brecciated zone before reaching the sea floor. Quartz-

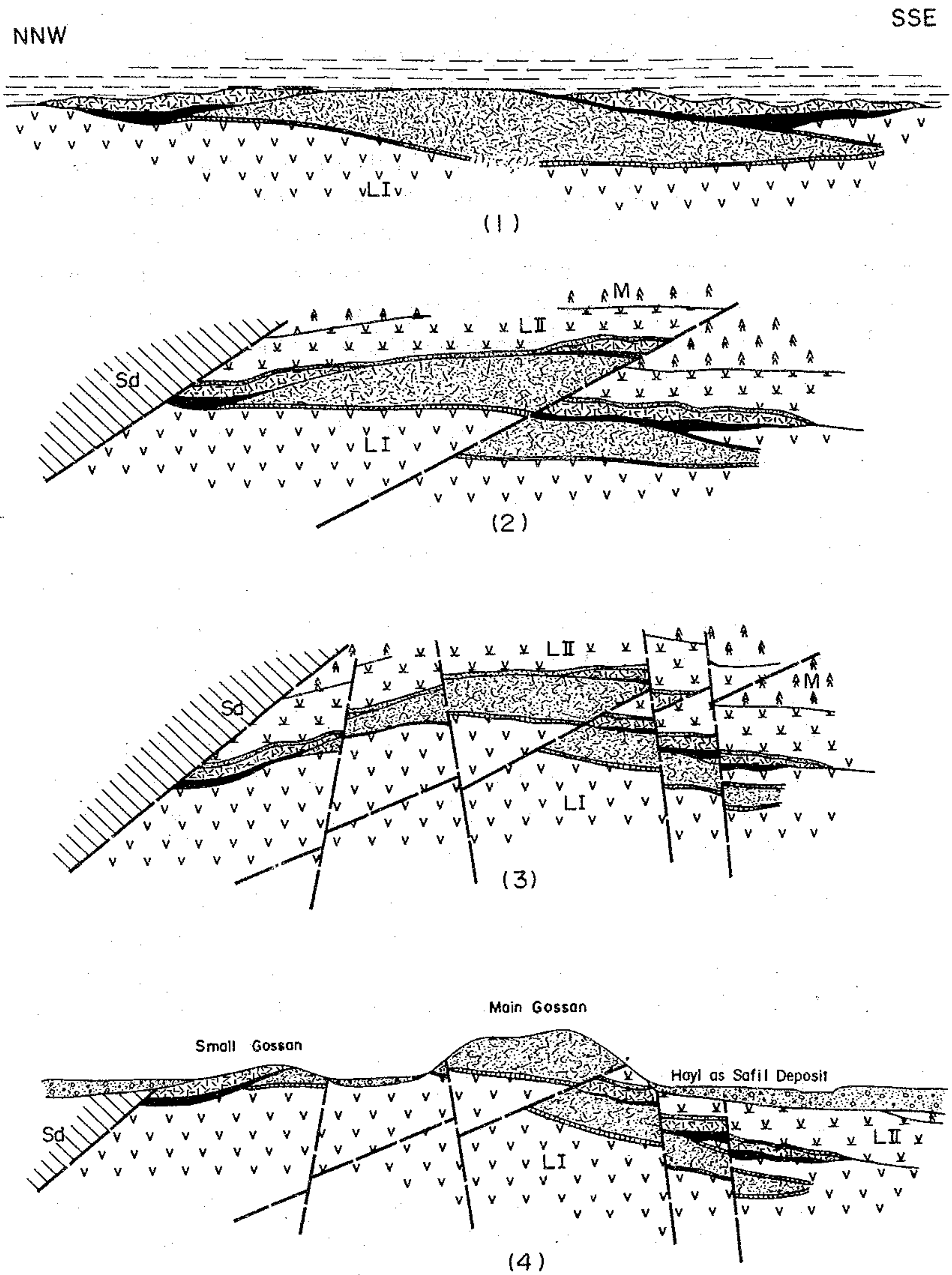


Fig. II-1-24 Schematic History of the Hayl as Safil Deposit hematite ore in the Lasail deposit is found at the marginal part of the hanging wall side, but quartz-hematite breccia is found throughout the stockwork zone in the Hayl as Safil deposit. This fact also suggest the repeated brecciation.

Fig. II-1-25 shows isopach map of mineralized zone in the Hayl as Safil deposit. As shown on this map, the mineralized zone incleases the thickness toward Main Gossan. The thickness of stockwork zone encountered by the drill hole MJO-A2 is 56.80 m, but the hole HS-17 which was completed 50 m south of MJO-A2, encountered mineralized zone with no stockwork zone. This results indicate that the stockwork ore is situated at the limitted zone and no stockwork zone can be expected at the outside of this zone.

2. Potential of Ore Reserves

The drill holes done in this project excluding MJO-A4 were carried out to confirm the western extension of the Hayl as Safil deposit. All these holes confirmed thick stockwork ore zone with thin siliceous and massive ore zone at the top. The stockwork zone gave average thickness of 43.60 m and the grades were as below,

0.73 g/t Au, 4.5 g/t Ag, 1.27% Cu, 0.01% > Pb, 0.20% Zn

Based on the previous drilling results, MPM estimated 2,086 thousand tons grading 0.97 g/t Au, 2.09% Cu before starting this project. In this survey, further western extension of the Hayl as Safil deposit was confirmed. The extension, at this stage, can be expected to cover an area of 150 m by 150 m. Therefore, about 3 Mt of ore can be estimated as the additional ore reserves for the Hayl as Safil deposit. However, insufficient drilling work is completed for the area between the Hayl as Safil deposit and Main Gossan. Additional drilling is required for the area to confirm the grade and thickness of the mineralized zone.

MJO-A5 an A6 completed at immadiate southern adjacency of Main Gossan show that the mineralized zone is gossanized at the deeper part. This result suggests that Main Gossan is completely gossanized and no ore resserves can be estimated for Main Gossan.

3. Potential

The results of surveys completed in this project indicate further outside extensions of the Hayl as Safil deposit. Especially, geophysical survey results show the extension very clearly. Based on these survey results following can be extracted as the potential area for further exploration work.

(i) Southern half of Main Gossan: Extensions of comparatively low grade stockwork ore is expected at the west and east of the ore zone encountered by the drill hole MJO-A6.

(ii) South of Main Gossan: Western extension of the mineralized zone encountered by the drill hole MJO-A5. Because of the marginal part of the ore deposits, high grade zoned is expected.

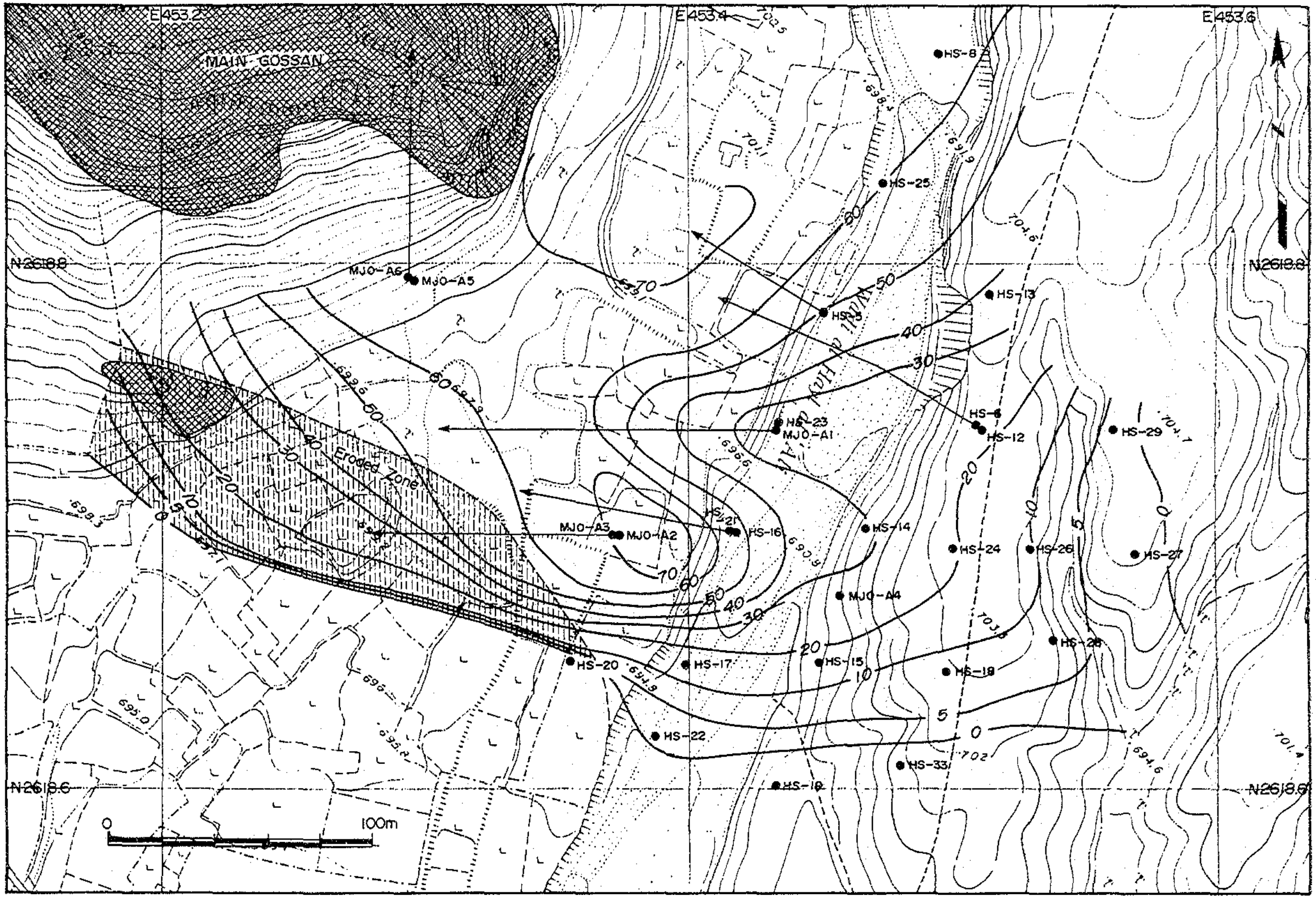


Fig. II-1-25 Distribution Map of Mineralized Zone in the Hayl as Safil Deposit

(iii) Northeast of the Hayl as Safil deposit: East of the drill hole HS-8. Comparatively low grade but thick stockwork ore zone is expected.

(iv) Southeast of the Hayl as Safil deposit: Southeast of the drill hole HS-28. Thin but high grade massive ore zone is expected.

Chapter 2 Area B

2-1 Survey Mmethods

Surveys were carried out in an area of 4 km^2 centering the Rakah ore deposit. The work completed in the area are as below:

Geologic survey:	4 km^2 (1 : 2,000 in scale)
Geophysical survey:	Charged potential method 2 km^2 402 stations
Drilling:	Six holes. 811.45 m in total.

List of samples collected for laboratorial studies are shown in Table II-1-1.

The survey results are given below.

2-2 Geologic Survey

1. General Geology

Area B is also situated in the area of the Samail Nappe and consists of the Samail Ophiolite and Supra-ophiolite Sediments. The Samail Ophiolite is composed of Tectonites, Cumulate Sequence, High-level Gabbro, Sheeted-dyke Complex and Samail Volcanic Rocks in ascending order. Geologic map is shown in Fig. II-2-1 and Plate II-2-1. Geologic sections are shown in Plate II-2-2.

(1) Samail Ophiolite

(a) Tectonites

The Tectonites consists of harzburgite and is found locally in the northeastern and northern edges of the area. The thickness of the Tectonites is estimated to be more than 100 m and the rocks have fault contact with Cumulate Sequence.

Harzburgite is dark brown to dark green and is present visible orthopyroxene ranging in size from 1 mm to 10 mm. Foliation and lineation in the harzburgite are invisible or are very weak. The rocks are strongly serpentinized, particularly along the shear zone of the lower part of the Tectonites. Many magnesite veins with 1 cm to 5 cm wide are found in the Tectonites. Sheared zones with width of 1 m to 5 m are observed along the thrust faults.

(b) Cumulate Sequence

This unit is found locally at the northwestern and northeastern corners of the area, and is also found at north of the Rakah ore deposit. The Cumulate Sequence contacts Tectnites with a thrust

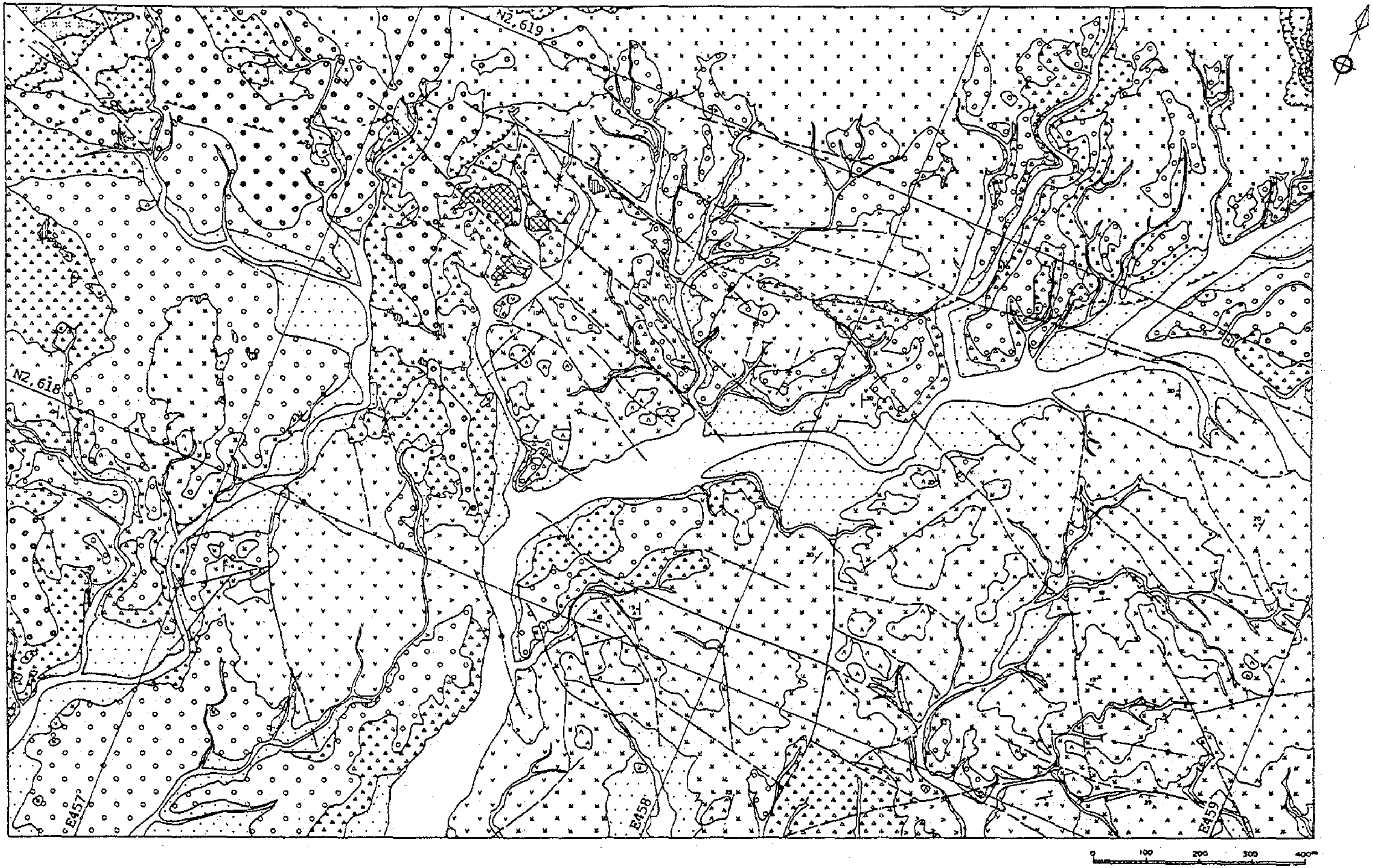


Fig. II-2-1 Geologic Map of Area B

(Legend is same as Fig. II-1-3.)

fault and the upper part changes gradationally to the overlying High-level Gabbro. The unit has thickness more than 50 m.

The unit consists of gabbros with subordinate peridotites. The gabbros consist of clinopyroxene gabbro and minor olivine gabbro and is present rysmical layered structure. the peridotites are classified to wherlite and clinopyroxenite and are interlayered as dark to black bands of 1 cm ~ 20 cm thick in the gabbros. The layered structure strikes N 40° ~ 65° E and dips 60° ~ 80° eastward.

Late dykes cut this unit and gave alteration along the dykes. Microscopic observation for this unit gave following results:

Rock name:	Clinopyroxene gabbro
Sample number:	M017
Texture:	Orthocumulus texture.
Descriptions:	Cumulus phase consists of euhedral to subhedral plagioclase and augite. Augite is 1 to 1.5 m/m in grain size and is slightly altered to amphibole and chlorite. Post-cumulus phase consists of anhedral plagioclase, augite and subordinate olivine, apatite and opaque minerals. Augite exhibites locally poikilitic texture. Plagioclase is altered locally to sericite and calcite. Olivine is decomposed to serpentine and magnetite.

(c) *High-level Gabbro (Hg)*

This unit is found in the northeastern and northwestern parts of the area. The unit gradationally changes to the underlying Cumulate Sequence and the overlying Sheeted-dyke Complex. Thickness of this unit ranges from 50 m to 180 m. Many dolerite and basalt dykes are observed in the unit.

The unit consists of light greenish gray to whitish gray clinopyroxene gabbro and subordinate hornblende gabbro. The upper part of the gabbro show fine grained texture, while the lower part shows medium to coarse-grained and contains gabbroic pegmatite in places.

(d) Sheet-dyke complex

This unit is found north and south of the Rakah ore deposit. The relations between this unit and both of the underlying High-level Gabbro and overlying Samail Volcanic Rocks are gradational change or thrust contacts. The unit is estimated to be more than 80 m, but the uppermost and lowermost parts of the unit are only exposed in the area. The dykes in the complex strike N 30°~70° W and dip 30° to 40° eastward.

The dykes are dark gray and light greenish gray and consist of dolerite and basalt dykes. The complex is composed of dykes of more than 70 volume percents. Individual dykes range in width from 30 cm to 1 m and have chilled margin with several centimeters in width. The matrix of the lower part of the unit is gabbro, while that of the upper part is pillow lavas.

The rocks are chloritized and epidotized. Hydrothermally altered zones are also observed in part of this unit

Microscopic observation results are as follows:

Rock name:	Dolerite (dyke)
Sample number:	M016
Texture:	Glomeroporphyritic texture
Descriptions	The rock is mainly composed of plagioclase, and mafic minerals with minor opaque minerals. Plagioclase is euhedral to subhedral and 0.3 to 1.2 m/m in grain size and shows zoning structure. Mafic minerals are altered completely to chlorite, epidote and calcite. Alteration minerals are epidote, chlorite, calcite and subordinate sphene.

(e) **Samail Volcanic Rocks**

The Samail Volcanic Rocks in this area also classified into the Lower Volcanic Rocks and Middle Volcanic Rocks. The Lower Volcanic Rocks can be subdivided into the Lower Extrusives I and Lower Extrusives II. Columnar sections of the volcanic rocks in this area are shown in Fig. II-2-2. Stratigraphic correlation of volcanic rocks between Area A and Area B is shown in Fig II-1-7.

<u>Lower Extrusives I (LI)</u>

The rocks occur from the southwest to the southeast of the area. The relationship between the Lower Extrusives I and II is conformity or fault contact. The thickness of this unit is estimated to be more than 150 m and the unit gently dips from 10° to 30°.

The rocks consist of pillow lavas with minor massive lavas and metalliferous sedimentary layers. The pillow lavas are light brownish green to dark green basaltic pillow lavas. The pillows have oval shape of 60 cm to 100 cm in diameter. Radial joints are generally observed in the pillow. Vericles are filled with calcite, zeolites, chlorite and epidote. Matrix of the pillow is hyaloclastite of 1 cm to 3 cm in width and minor pillow breccia. Distribution of the massive lavas is limitted at the central and southeastern parts. The lavas are greenish gray to light greenish brown and have a thickness from 2 m to 6 m. Columnar joints are developed in the lava.

Metalliferous sedimantary layers are red to reddish brown and have thickness of several centimeters to 10 cm. The layer is continuous and consist of fine grained muddy metalliferous sediments.

Rock name:	Pillow lava
Sample number:	M032
Texture:	Intersertal texture
Descriptions	The rock is altered completely, so that the original structure is not clear. Phenocrysts consist of plagioclase and mafic minerals. Plagioclase is altered mostly to quartz and epidote. Mafic minerals are

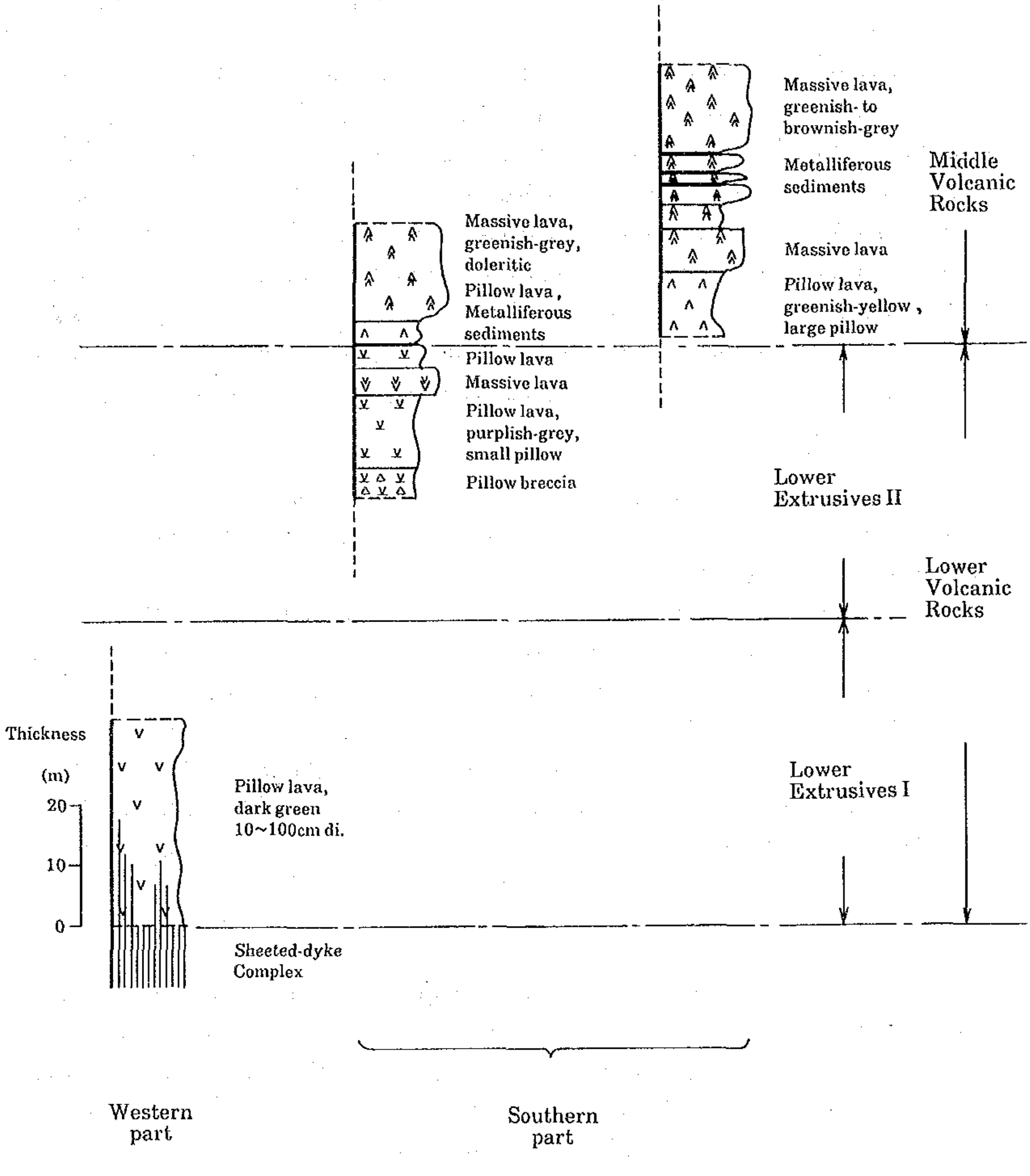


Fig. II-2-2 Columnar Sections of Volcanic Rocks in Area B replaced mostly with smectite, chlorite, epidote calcite and opaque minerals.

Lower Extrusives II (LII)

This Rocks occur widely in the area. The unit dips gently from 5° to 25° and have gently folding structure. The relationship between this unit and overlying the Middle Volcanic rocks is unconformity.

This unit consists of pillow and massive lavas and interbedded metalliferous sedimentary layers. The thickness is estimated to be 50 m to 150 m. The pillow lavas are purplish gray to light greenish gray and the pillows have from 30 cm to 80 cm in diameter. Thin pillow breccia is intercalated in the lavas. Vesicles are filled with zeolites, chlorite calcite and epidote. Hyaloclastite forming the matrix between pillow is thin and is only 1 cm or 2 cm. The massive lavas are light purplish gray or greenish gray and is doleritic lavas. Pyroxene phenocrysts in the lava are mostly chloritized. Thickness of the individual lava flows are from 4 m to 6 m and many columnar joints are observed. The metalliferous sedimentary layers are intermitently found in the upper part of the unit and have a thickness from several centimeter to 30 cm.

Middle Volcanic Rocks (M)

The rocks are found in the southern part and south of the Rakah deposit, and form the top of small hills. The rocks dip gently up to 20° and show gentle folding structure. The thickness of the unit is from 20 m to 50 m in the area.

The rocks consist of massive lavas (Mms) and subordinate pillow lavas (Me). Metalliferous sedimentary and red chert layers are interbedded in the unit. The massive lavas are light greenish brown to greenish gray doleritic lava flows having a thickness from 4 m to 20 m and intercalate pillow lavas and pillow breccia. Matrix of the pillow is hyaloclastite with thickness of 2 cm to 5 cm. Epidotization and chloritization are observed in the chilled margin of the pillows. Metalliferous sediments and red chert layers are intercalated at the lowest part of the unit. The metalliferous sediments are reddish and continuous layers and have 20 cm to 70 m in thickness.

(2) Intrusive Rocks

Dykes found in Area B is divided into dykes and late dykes. The dykes occure the southwest and from north to northeast parts of the aera. These are basaltic to andesitic in composition and are dark green to greenish gray in color. The width ranges from 50 cm to 1.5 m. The dykes strike NW-SE to E-W and dip 35° to 65° northward. The dykes show similar nature to those in Sheeted-dyke Complex and are possibly feeder dykes of the Lower Volcanic Rocks.

The late dykes are found at the northwestern and southeastern parts of the area and are also basaltic to andsitic in composition. The dykes are greenish gray to brownish green in color and strong epidotization and weak hydrothermal alteration are observed in the dykes. The surface of the dykes is weakly gossanized and secondary copper minerals are found in places. The width of dyke ranges from 30 cm to 6 m and can be traced from several meters to 100 m along the strike. The dykes strike NW-SE to ENE-WSW and radial distribution is found locally. These are possibly feader dykes of the Middle Volcanic Rocks because of similar nature is observed.

Microscopic observation results for the late dyke are as below:

Rock name:	Dolerite
Sample number:	M031
Texture:	Ophitic texture
Descriptions	Phenocrysts consist of euhedral plagioclase, 0.2 to 2.0 m/m in grain size, and subhedral augite, 0.4 to 0.6 m/m in grain size. Augite exhibites undulatory extinction. Groundmass is altered intensely and iron minerals and are partly oxidized to hematite.

(3) **Supra-Ophiolite Sediments**

This unit is divided into Suhaylah Formation and Olistostrome in ascending order.

(a) **Suhaylah Formation (Sh)**

This formation is defined by Lippard et. al. (1982) in the northern Oman Mountains.

The formation is found sporadically in the Rakah ore deposit area and the surroundings, and consists of light reddish brown to dark red radiolarian chert. The thickness of the formation is 3 m to 8 m and unconformably overlies the Lower Extrusives II.

(b) **Olistostrome**

The formation is defined by Bishimetal (1987) as the Batinah Olistostrome in the northern Oman Mountains. The formation is found in the western corner and cosists of olistoliths with several meter to several tens meters. It shows chaotic structure and includes red chert (Och), bedded limestone (Ols), dirty limestone and serpentinized harzburgite. Numerous limestone floats, possibly derived from this formation are observed in the northwestern part of the Rakah ore deposit area where the Suhaylah Formation occurs.

(4) **Quaternary**

Quaternary superficial deposits are divided into terrace deposits, debis and wadi sediments.

(a) **Terrace Deposits (Qt)**

Terraces are classified to three terraces including upper, middle and lower terraces.

The upper terrace, found in the western part of the area, is situated in the elevation between 680 m and 720 m. The Upper Terrace Deposits (Qtu) has thickness from 2 m to 5 m and consist of gravel and sand. The gravels are mostly rounded to subangular gabbro and harzburgite with a diameter from 1 cm to 40 cm. The matrix is fine to coarse sand and cemented in places with carbonates. The terrace can be traced up to 780 m and the deposits change to fan deposits.

The middle terrace is situated in the elevation between 650 m and 710 m and occurs from western to noutheastern part of the area. The Middle Terrace Deposits (Qtm) have thickness from 2 m to 8 m and consist of similar gravel and sand to those of the Upper Terrace Deposits (Qtu). The deposits can be traced up to the elevation of 780 m and they change to fan deposits.

The lower terrace is found in the elevation between 650 m and 700 m and occurs along wadis. The Lower Terrace Deposits (Qtl) is from 2 m to 6 m in thickness and cosist of gravel and sand. The gravels are 1 cm to 40 cm in diameter and are comparatively well sorted. Sand beds with thickness up to 10 cm are intercalated and show cross bedding and lamina.

(b) Debris (Qd)

The deposits are observed along the exposures of the harzburgite, Middle Volcanic Rocks and Terrace Deposits and cosist of breccia.

(c) Wadi Sediments (Qw)

Wadi Sediments (Qw) are found along wadis and consist of rounded to subangular gravel and sand.

2-2-2 Geologic Structure

The tectonic history of the Rakah area is mentioned in 1-2-2.

Two major thrust faults are found in the northwestern and northeastern parts of Area B. One is situated between Cumilate Squience to High-level Gabbro and Tectonices on the upper part. The other is between Volcanic Rocks to Suhaylah Formation and High-level Gabbro to Sheeted-dyke Complex on the lower part. Four minor thrust faults are associated with the major thrust faults. These thrust faults strike NW-SE to E-W and dip 0° ~ 40° to the north. Shean zone of the faults is ranging from 1 m to 5 m wide.

Faults consist of three systems, including NW-SE, NE-SW and E-W. NW-SE trending faults are dominated and some of them are right-lateral fault.

Folds trending NW-SE are found in the area, and small antichinal and synclinal folds frending N-S are found in the central part of the area. The tectonic map in the area is shown in Fig. II-2-3.

Fig. II-2-3 Structural Map of Area B

(Legend is same as Fig. II-1-4.)

2-2-3 Mineralization

1. General

The mineralized zone found in Aera B is limitted to the Rakah deposit. Contacts between the Lower Extrusives I and II occur at several places in Area B but no mineralization is observed except the Rakah deposit area.

The Rakah deposit consists of lower and upper mineralized zones and volcanics of the Lower Extrusives I is intercalated between them except the eastern part where these two mineralized zone form one zone. The upper mineralized zone reachs the surface at the western part of the Rakah deposit area and is strongly gossanized.

2. Geology of the Rakah Deposit Area and Gossan Zones

A detailed geologic survey for the Rakah deposit area was completed in this survey. Forty five drill holes were completed previously in the Rakah deposit area and six drill holes were carried out in this survey. Based on these survey results, geologic map and geologic sections were made as shown in Fig. II-2-4 and Fig. II-2-5 respectively.

Geology in the Rakah deposit area consists of High-level Gabbro, Sheeted-dyke Complex, Lower Extrusives II of Lower Volcanic Rocks and gossan. The gossan is possibly mineralized and weathered Lower Extrusives I.

High-level Gabbro is found at the northwestern corner of the area and thrusts onto Sheeted-dyke Complex. The Sheeted-dyke Complex occurs at the north of the area and thrust onto the Lower Volcanic Rocks. Dykes in the Sheeted-dyke Complex trend in a E-W direction. This direction is similar to the trend of the Rakah deposit. The gossan zones trending a NW direction are found at the western part of the area and occur along the anticlinal axis. Lower Extrusives II are found at the both sides of the gossan zones. The Lower Extrusives II occurs widely at the central, eastern and western parts of the area, and weak chloritization and hematizaion are recognized in the rocks. Several quartz veins with secondary copper oxide minerals are found in the Lower Extrusives II at the eastern part of the area. This kind quartz vein is found in the Sohar area and is interpreated to have close relation with the Middle Volcanic Rocks. Suhaylah Formation consisting of chert are locally found at the northern central part of the area. The formation forms a part of Supra-ophiolite sediments. Plenty of slags about 20 thousand tons are found in the area. The slags indicate ancient working for mining and smelting in the area. Gossan dump at that time is found in the vicinity of the gossan zones. The drilling results indicate the old working reached to 38 m depth from the surface.

The gossan zones consist of three main gossan outcrops. Among them the largest occurs at the northwest and form a small hill of 30 m high from the wadi level. The gossan at the northeast shows strange shape because of old mining. The gossan is siliceous and brecciated. Matrix of breccia and fractures are filled with hematite, limonite and goethite, and secondary oxide copper

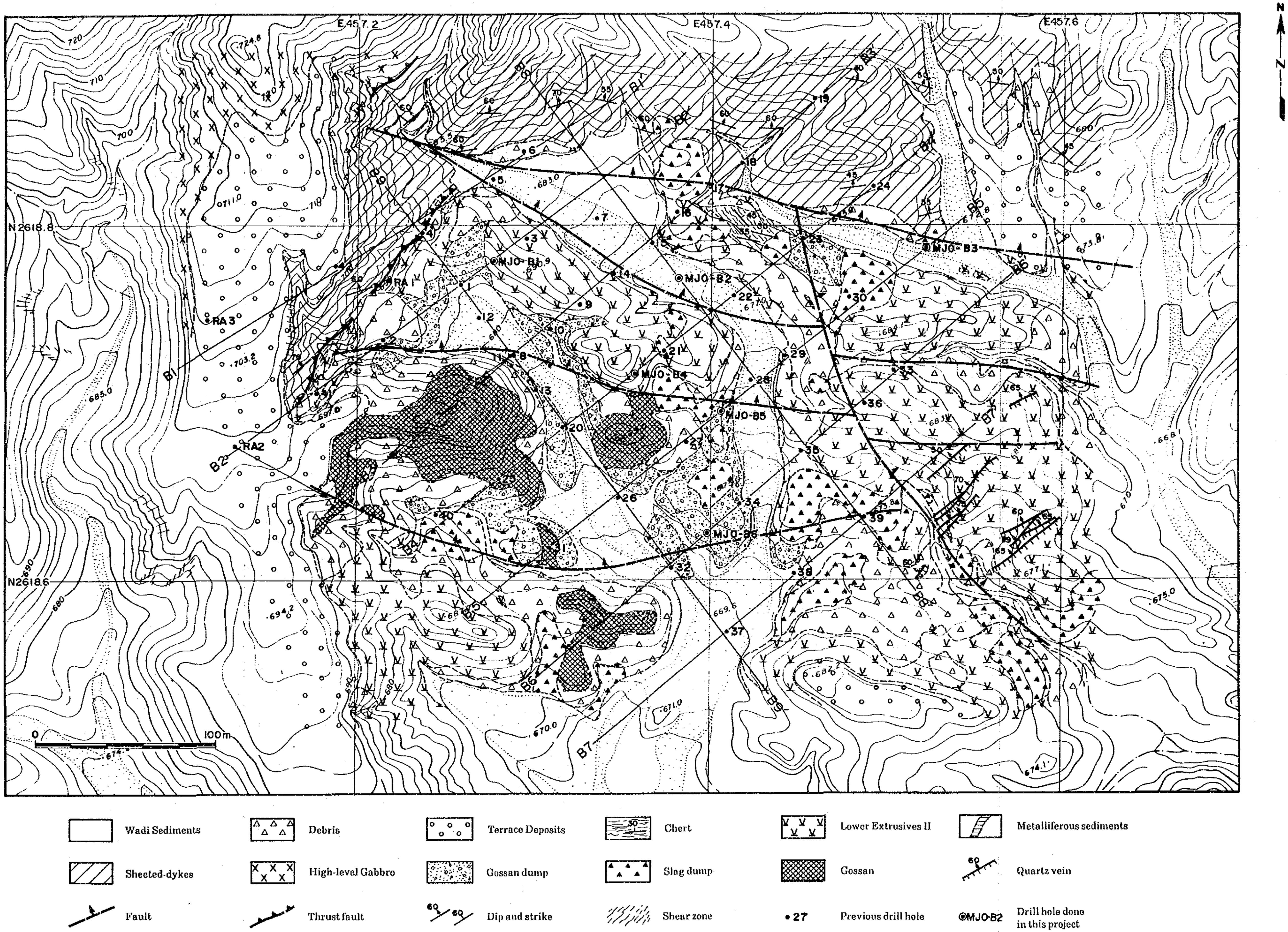


Fig. II-2-4 Geologic Map of the Rakah Deposit Area

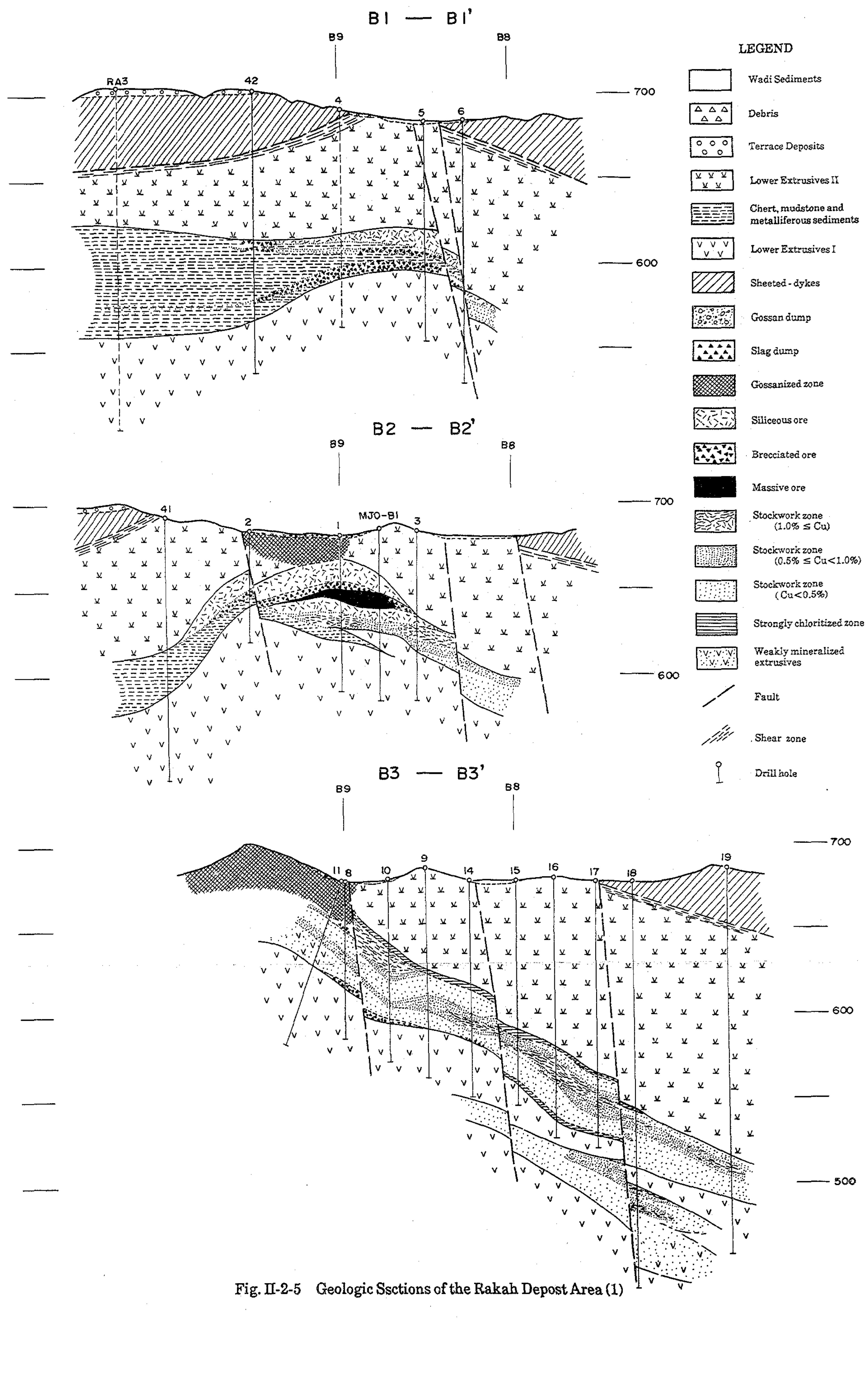
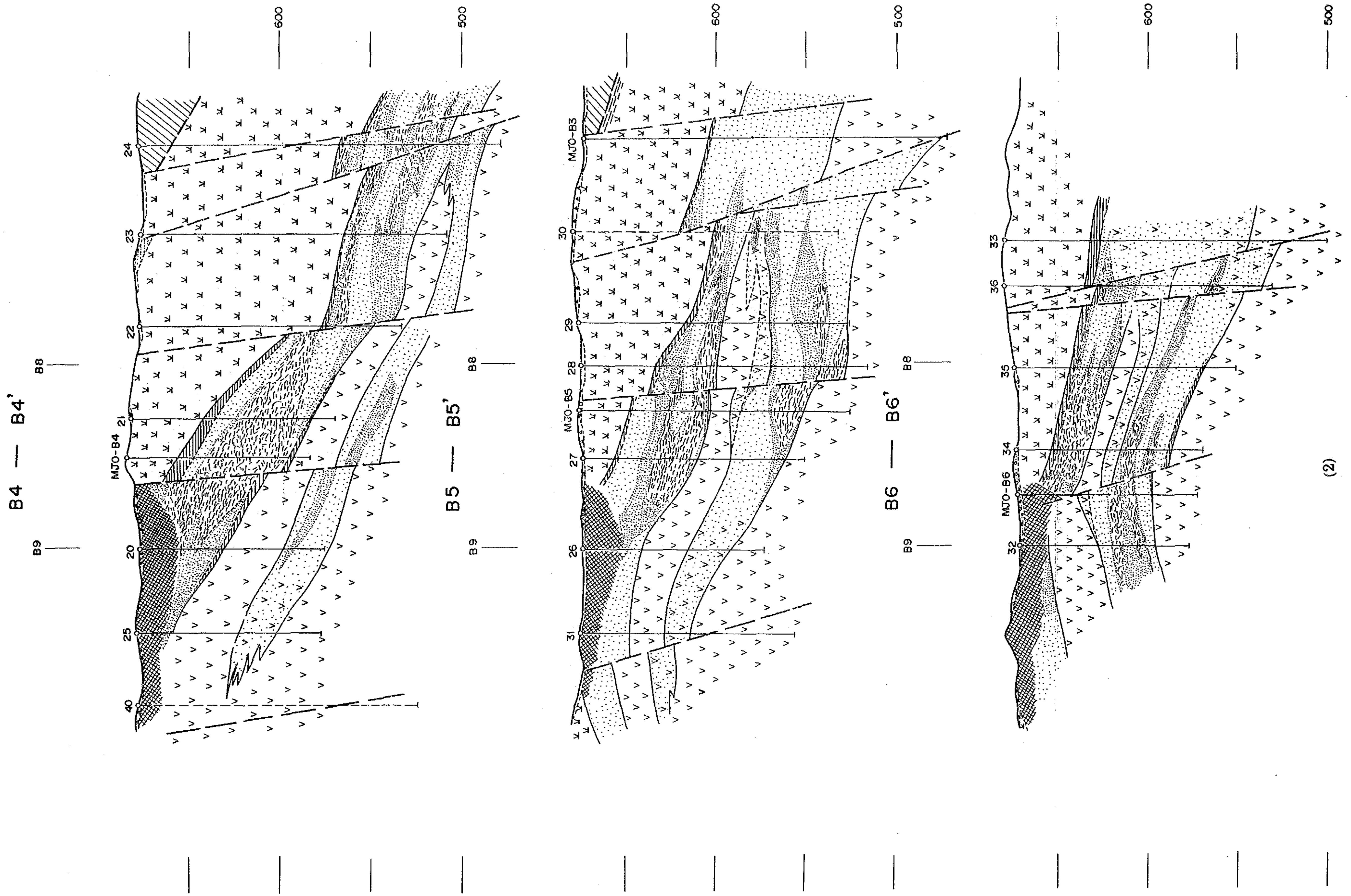
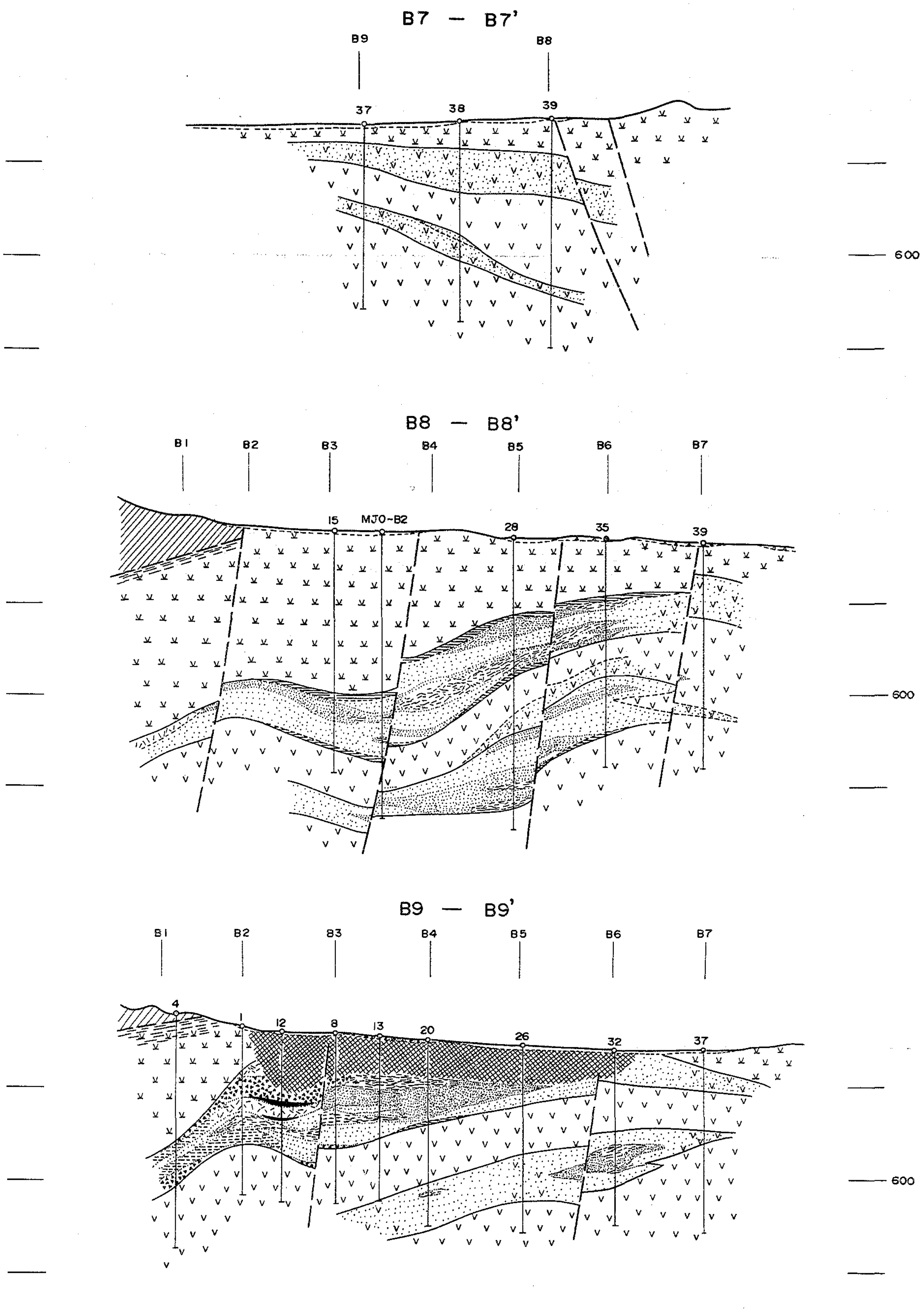


Fig. II-2-5 Geologic Ssctions of the Rakah Depost Area (1)


B4 — B4'
B5 — B5'
B6 — B6'
B8
B9
600
500
MJO-B4
MJO-B5
MJO-B3
MJO-B6
24
23
22
21
20
25
40
30
29
28
27
26
31
33
36
35
34
32
(2)


B7 — B7'
B9
B8
37
38
39
600
B8 — B8'
B1
B2
B3
B4
B5
B6
B7
15
MJO-B2
28
35
39
600
B9 — B9'
B1
B2
B3
B4
B5
B6
B7
4
1
12
8
13
20
26
32
37
600

(3)

mineral are locally found within the gossan.

Based on the surface and drilling survey results, the Rakah deposit is cut by faults trending E-W and NNE-SSW as well as thrust faults at the north. E-W system faults are interpreated to be normal fault diping northward and these fault are recognized on the surface. A NNE-SSW system fault is found at the east and is interpreated to be reverse fault, but no evidence for the fault was found on the surface.

3. Upper Mineralized Zone

The upper mineralized zone is situated between the underlying Lower Extrusives I and overlying Lower Extrusives II. Weak pyrite dissemination is found in the Lower Extrusive I. the disseminated zone is possibly limitted in the area where the Lower mineralized zone occurs beneath the zone. The footwall volcanic rocks disappear at the eastern part, and the upper and lower mineralized zone form one zone. A few meter thick chlorite zone is found at the top of the upper mineralized zone and show very clear boundary between the hanging wall rocks and mineralized zone. Because intensity of alteration is completely different between the footwall volcanics and the mineralized zone, it is easy to distinguish the mineralized zone from the footwall volcanics. The chlorite zones are also observed in places at the bottom of the zone. However, the eastern part of the mineralized zone show no clear boundary due to weak alteration and mineralization.

Ore in the upper mineralized zone consists of massive ore, brecciated ore siliceous ore and stockwork ore. The brecciated ore is brecciated massive sulfides and is a affinity of the massive ore. The massive and brecciated ores were confirmed by drilling completed in the northwestern part of the area. These ore have close relation with sedimentary rocks consisting mainly of chert as shown in the sections of B1 ~ B1' and B2 ~ B2' of Fig. II-2-5. The massive ore is brecciated and the matrix is also filled with sulfide minerals. The massive ore contains pyrite breccia with franboidal and colloform textures. Siliceous ore is possibly mineralized and altered chert and is brecciated. Matrix of the breccia is filled with sulfide minerals. The massive ore zone encounterd by the drill hole MJO-B1 show high concentration of Au and dominant supergene copper minerals.

The host rocks of the stockwork ore are pillow lavas and are strongly chloritized, silicified and brecciated. Plageoclase in the mineralized zone is not detected due to strong alteration except the northeastern and southern parts of the zone where weakly mineralized.

Ore minerals in the zone are pyrite and chalcopyrite with subordinate sphalerite covellite, chalcocite and bornite. The quantity of pyrite is lesser compare with the Hayl as Safil deposit in Area A. Pyrite and chalcopyrite are generally found as dissemination, vein and matrix of the breccia. Quartz veins with sulfide minerals are also found in the zone. High grade of Cu zone in the mineralized zone shows irregular shape. Drill hole MJO-B3 completed in the east of the area shows only weak pyrite disseminations and stringers. The mineralization is very weak.

4. Lower Mineralized Zone

The lower mineralized zone show smaller scale compare with the upper mineralized zone and consists of stockwork ore. Details of the zone is not clear due to insufficent drilling work for the mineralized zone. Geologic sections suggest that the lower mineralized zone may formed centering the enter of the upper mineralized zone.

2-3 Geophysical Survey

In order to delineate an extension of the Rakah deposit and to obtain the guideline of the further drilling survey, Charged Potential (CP) survey of 402 stations in total was conducted in an area of 2 km^2 in Area B.

2-3-1 Methodology

1. Measurement

In Area B, the 402 measuring points in total were settled at 50 m and 100 m apart each in an area of 2 km^2, by means of the open traverse surveying method. The location of CP stations is shown in Fig. II-2-6. Coordinates of each of measuring points in meters was decided by settling the origin (0, 0) at X=N2618.60 and Y=E457.40, and by setting positive directions towards the south and the east, respectively.

The two charging electrode (C1) was placed at the massive ore of the upper mineralized zone of the Rakah deposit in MJ0-B1 hole, and at the stockwork ore of the lower mineralized zone in the MJ0-B5 hole.

The charging electrode (C1) in each drill hole was positioned at the depth of the center of the orebody.

A far current electrode (C2) was placed in the HS-14 hole in the Area A, and a far potential electrode (P2) was settled at the Wadi Rakah, 4 km south of the middle point between Area A and Area B. The location of a far potential electrodes (P2) is shown in Fig. II-1-15.

The depth of each of the current electrode in the drill holes are shown below.

By means of charging an alternative DC (0.1 Hz) current of 2.5 A to 3.0 A between two current electrodes, C1 and C2, charged potential at each CP station (P1) was measured in mV.

The same equipments as used in Area A was adopted in this area.

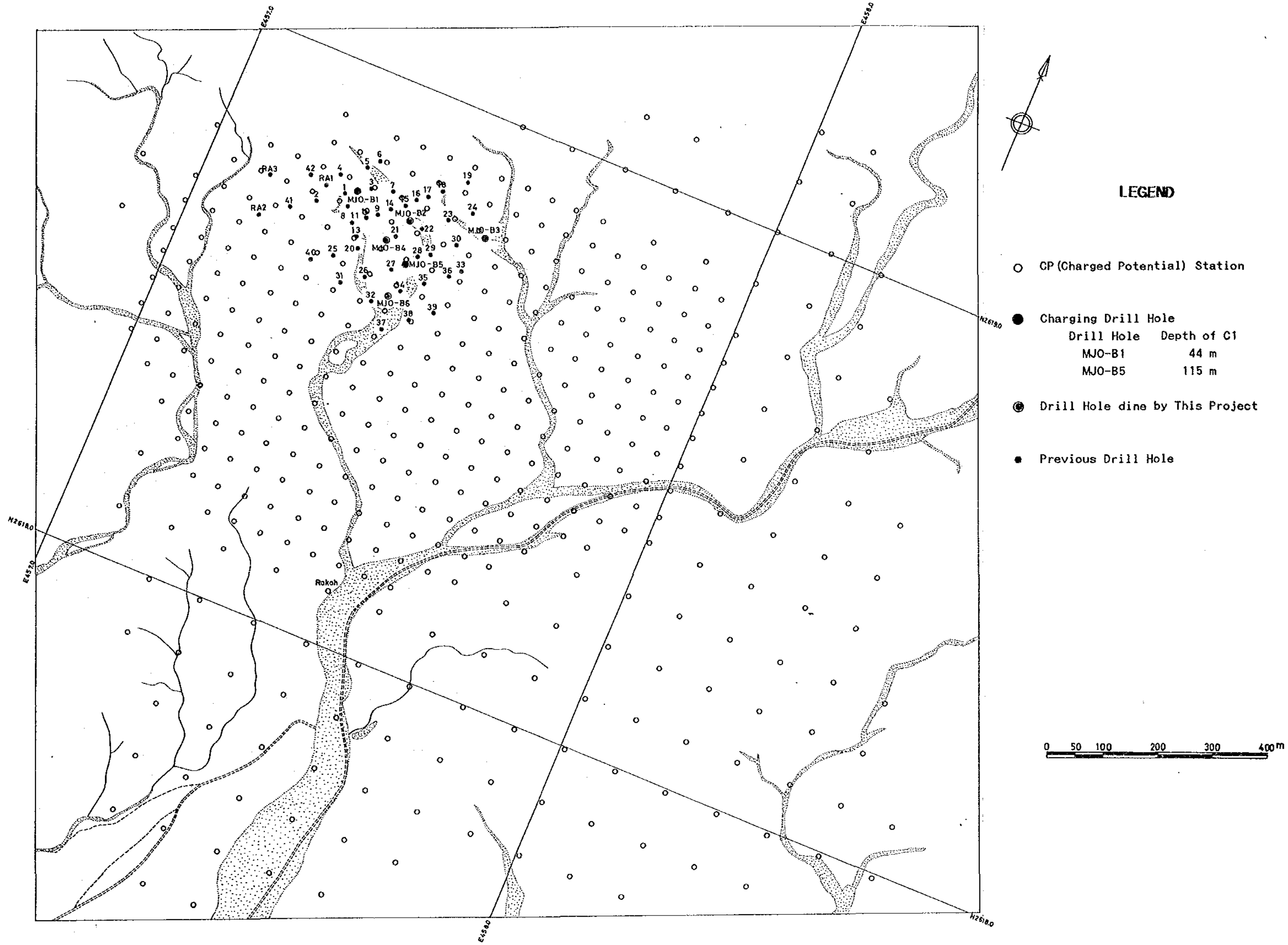


Fig. II-2-6 Location Map of CP Survey Stations in Area B

Current Electrode	Drill Hole	Depth of Electrode	
Charging Point (C1)	MJ0-B1	44 m	(Upper mineralized zone of Rakah deposit)
	MJ0-B5	115 m	(Lower mineralized zone of Rakah deposit)
Far Current Electrode (C2)	HS-14	104 m	(Haly as Safil deposit)

2. Data Arrangement and Analyses

In the same manner as in Area A, the plan maps of the charged potentials and electric fields for each drill hole, MJ0-B1 and MJ0-B5, were made. The charged potentials and electric fields at each CP station are shown in Appendixes 5 and 6.

2-3-2 Survey Results

1. Charged Potentials

The plan maps of charged otentials due to two drill holes, MJ0-B1 and MJ0-B5, are shown in Fig. II-2-7 and Fig. II-2-8, respectively. The charged potentials due to both of two holes, MJ0-B1 and MJ0-B5, show similar distribution patterns extending in NW-SE direction, each together, excepting for the diffdrent patterns in the province of the holes.

(1) Charged Potentials due to MJ-B1 Drill Hole

A charged potential plan map due to charging point placed at the depth of 44 m in the MJ0-B1 hole is shown in Fig. II-2-7.

On this plan map, the highest peak of charged potential of 203 mV/A is observed at the middle point between the MJ0-B1 hole and the gossan zone. The charged potentials show sharp decreases at 50 m northwest, at 50 m west and at 200 m south-west-south of the MJ0-B1 hole, and gradual decreases toward the southeast (MJ0-B5 hole).

Then, the conductor including mineralized zone seems to be limited at the above northwestern and western sharp decreases, and to extend toward the southeast.

Among the three sharp decreases, the former two portions coincide with thrust fault.

1) Charged Potentials due to MJ0-B5 Hole

A charged potential plan map due to charging point placed at the depth of 115 m in the MJ0-B5 drill hole is shown in Fig. II-2-8.

On this plan map, the highest peak of charged potential of 172 mV/A is observed at 50 m south of MJ0-B5 hole, and charged potentials show an extension to the MJ0-B1 hole toward the northwest. And the charged potentials show a similar distribution pattern as that due to the MJ0-B1 hole, excepting for a low gradient zone including the gossan zone.

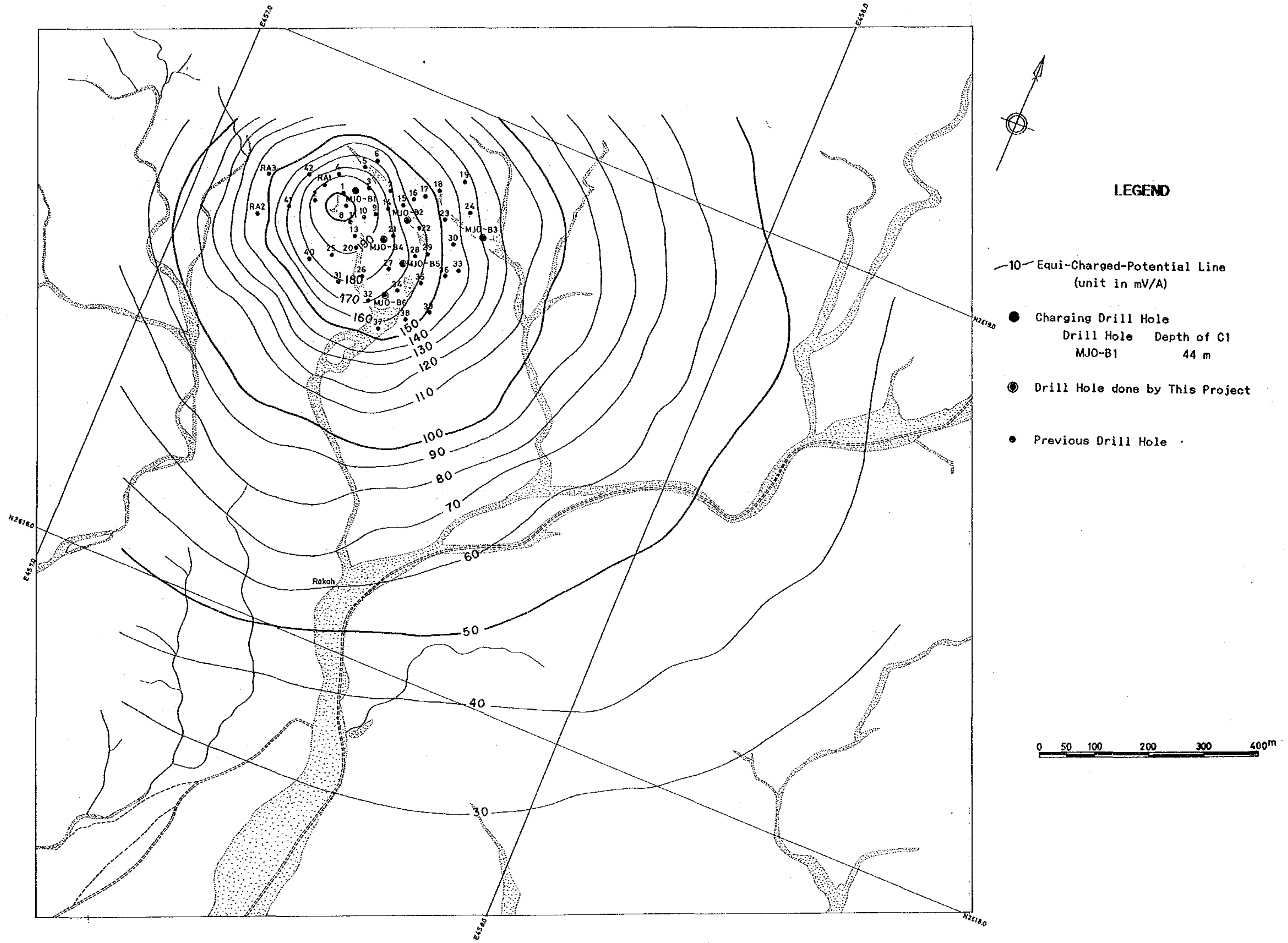


Fig. II-2-7 Charged Potential Map (MJ0-B1)

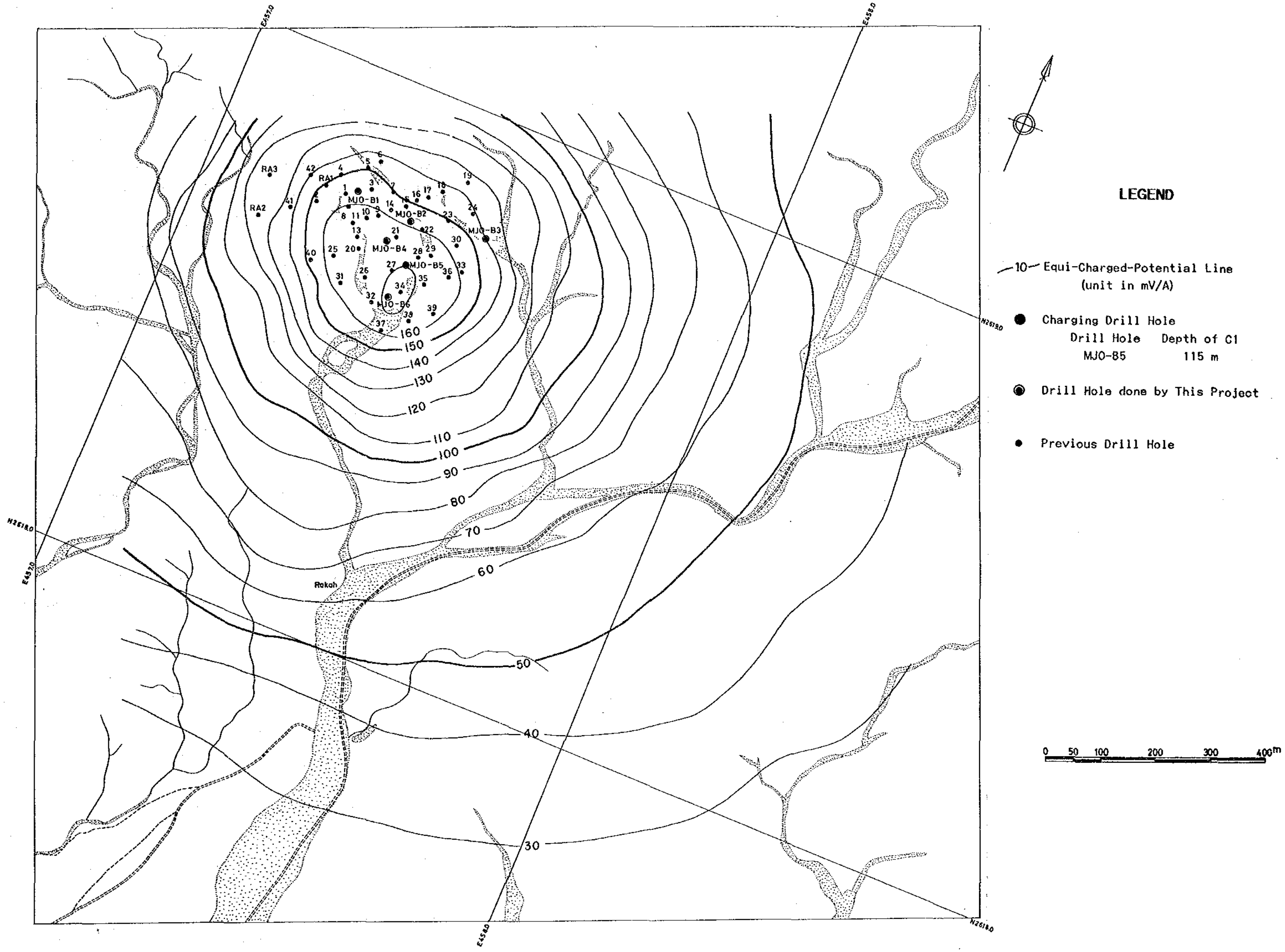


Fig. II-2-8 Charged Potential Map (MJ0-B5)

The difference of highest charged potential values between the MJO-B1 and MJO-B5 holes, is due to the difference of the charging depth in each hole only.

Although the charging point in each hole is in the upper mineralized zone in the MJ0-B1 hole and in the lower mineralized zone in the MJ0-B5 hole, the charged potentials due to both holes show a similar distribution pattern each together. This similarity in the charged potential distribution suggests either that the both of the lower and upper mineralized zones continues electrically, or that the both mineralized zones are distributed in the same area. Since the pyrite dissemination zone, being of low resistivity, is distributed in the effusives between the both mineralized zones, according to the geological and drilling survey results, current charged in each mineralized zone seems to flow in other mineralized zone through the pyrite dissemination zone. Then it is suggested that the similarity is due to the electrical continuity mainly and due to the similar distribution area of the both mineralized zones.

The sharp gradients of charged potentials are observed at 50 m northwest, at 50 m west and at 200 m south-southwest of the MJ0-B1 hole, like the plan map of the MJ0-B1 hole (Fig. II-2-7), and also at 100 m southeast of the MJ0-B5 hole. And the boundaries of the conductor including ore deposits seem to be located at these sharp gradient portions.

(2) Electric Fields

As described in 1-3-1 (1), low | E | (intensity of electric field) anomalies are distributed in the distribution area of the conductor including ore deposits, and high | E | anomalies on the boundary of the conductor. Utilizing the characteristics of | E | distribution, the boundary of the conductor including ore deposits could be estimated. While, low and high | E | anomalies are called when the | E | at some point is relatively low or high comparing with the | E | of the neighbouring points.

1) Electric fields due to MJ0-B1 Hole

The electric fields due to MJ0-B1 hole is shown in Fig. II-2-9.

On this map, the MJ0-B1 hole is located at the northern fringe of low | E | anomaly. Several low | E | anomalies are distributed at and near the gossan zone, and surrounded by high | E | anomalies.

This plan map shows more complicated distribution pattern than that due to the MJ0-B5 hole, as mentioned above. This omplicated feature seems to reflect the shallower resistivity structure because the current flows in the upper mineralized zone mainly and a part of the current flows the lower mineralized zone.

Arrangement of high and low | E | anomalies in E-W and NW-SE ~ NNW-SSE directions and equi - | E | lines in the same directions, suggest the existence of electrical discontinuities-fault structures in those directions.

Judging from the continuities of high | E | anomalies, the distribution area of the Rakah deposit is suggested as follows:

In the western part of the distribution area of the conductor including the ore deposits, the

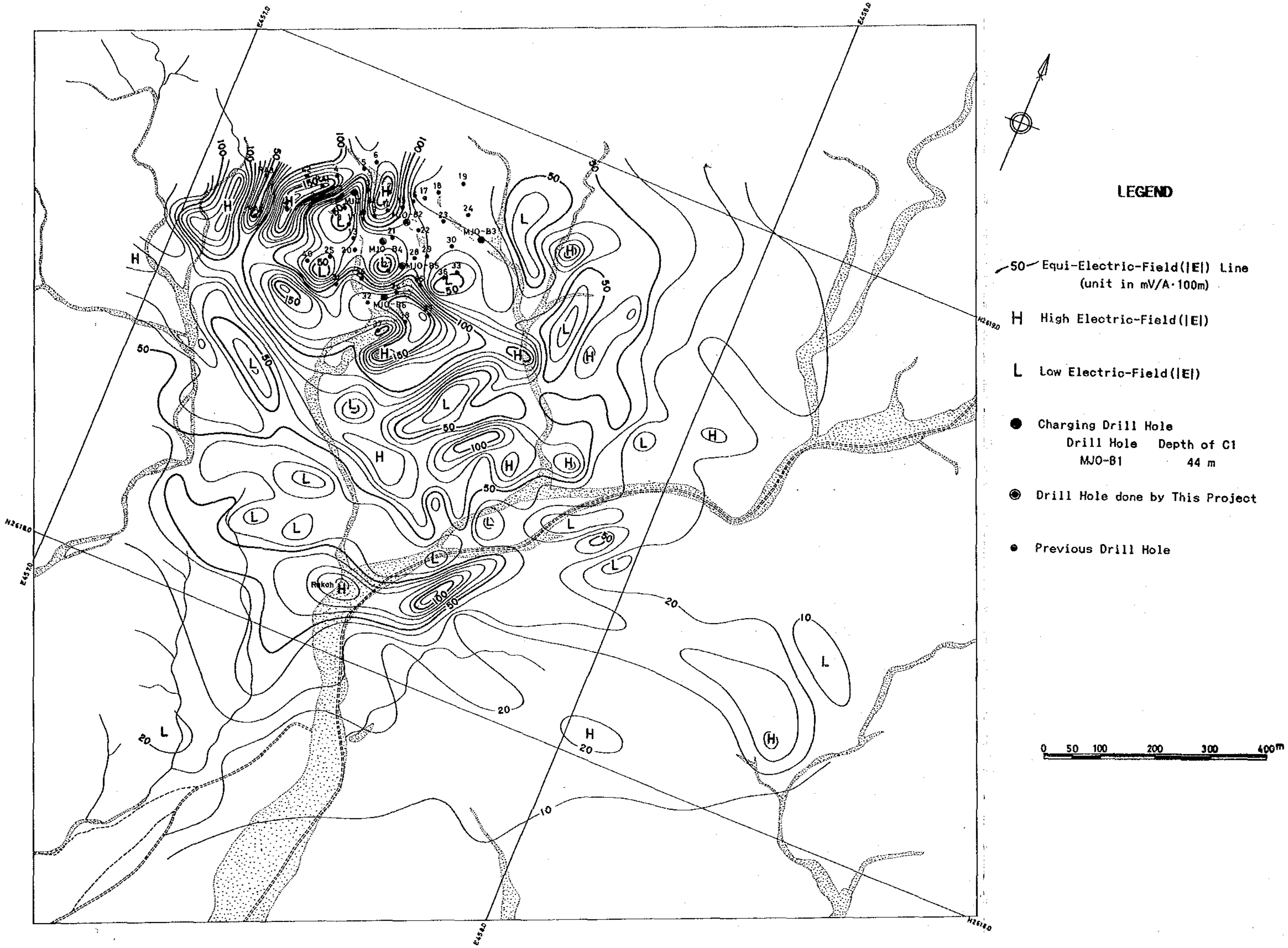


Fig. II-2-9 Electric Field Map (MJ0-B1)

conductor is distributed over the gossan zone, and its northwestern and western edges are limited by the notable high | E | anomalies running in NE-SW and N-S directions, respectively. While, in the eastern part, the conductor extends toward 100 m east of the hole 36. The above high | E | anomaly trending in NE-SW direction may coincide to the thrust fault running in the same direction, and the conductor seems not to be distributed to the west from this thrust fault.

2) **Electric Fields due to MJ0-B5 Hole**

The electric fields due to MJ0-B5 hole is shown in Fig. II-2-10.

This map shows a smoothed distribution pattern on the plan map of the MJ0-B1 hole. A combined large-scale anomaly of low | E |, centering around the hole 20, is distributed at the gossan zone, and surrounded by high | E | anomalies.

This smoothed and relatively simple feature of | E | seems to reflect the deeper resistivity structure, because the current charged in the lower mineralized zone flows in the lower mineralized zone mainly and a part of the current flows in the upper mineralized zone.

Equi - | E | lines trending in E-W and NW-SE directions are predominantly distributed, and these diections seem to reflect the trend of the deeper resistivity structure.

The distribution area of the Rakah deposit infered by the results of the charged potential survey show the same shape as that mentioned above except for the unevenness partly, and is of 400 m in E-W and 300 m in N-S.

(3) **Model Simulation**

In order to evaluate the NW-SE trending distribution on charged potential plan maps due to the MJ0-B1 and MJ-B5 holes, 2-D (two-dimensional) model calculation by means of 2-D finite element method was applied. Location of 2-D profile is shown in Fig. II-2-11. The profile line runs through the MJ0-B1 and MJ0-B5 holes in NW-SE direction.

The results of the calculation is shown in Fig. II-2-12.

The initial model was constructed on the basis of the results of the drilling survey and the physical property test of the drill holes on and/or near the profile such as MJ0-B1, MJ0-B5, etc. By means of setting each hole as a control point, model calculation was repeated by changing the resistivity and thickness of resistivity model structure, until the calculated potential curve matches the observed curve.

Resistivity of each formation and each mineralized zone of the final model is 1 Ω · m for massive ore, 5 Ω · m for stockwork ore, 1,000 Ω · m for Quaternary sediments, and 20Ω · m for Lower Effusives II, 100Ω · m for Lower Effusives I, 1,400 Ω · m for sedimentary rocks.

The both of the upper mineralized zone (massive ore; 1 Ω · m and stockwork ore; 5 Ω · m) and the lower mineralized zone (stockwork ore; 5 Ω · m) decrease those thickness with being cut by fault structures from the center towards the both ends.

The upper mineralized zone is distributed from 100 m northwest of the MJ0-B1 hole to 150 m southeast of the MJ0-B5 hole, and its maximum thickness is about 50 m. While, the lower mineralized zone is distributed from 50 m southeast of the MJ0-B1 hole to 150 m southeast of the

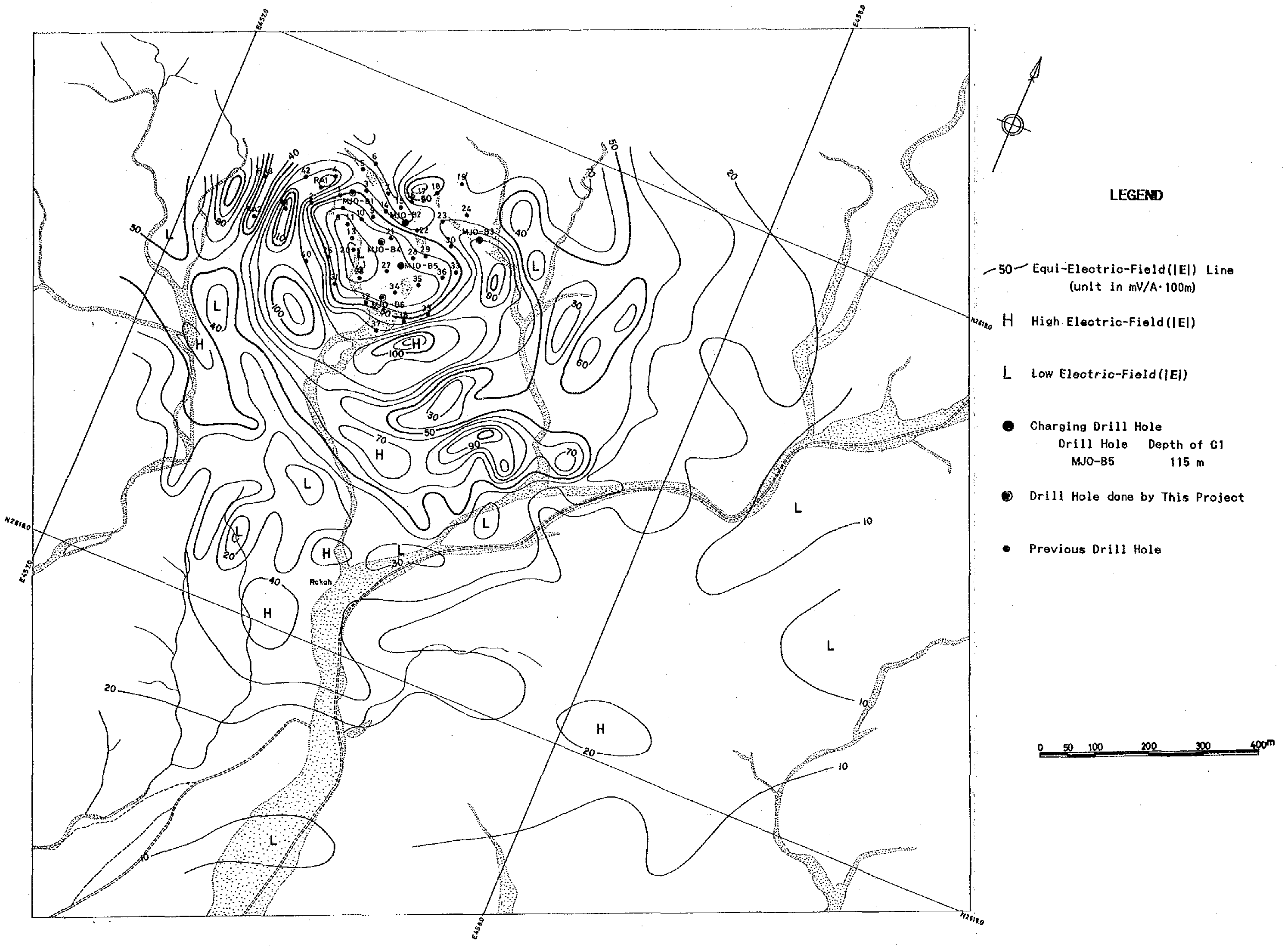
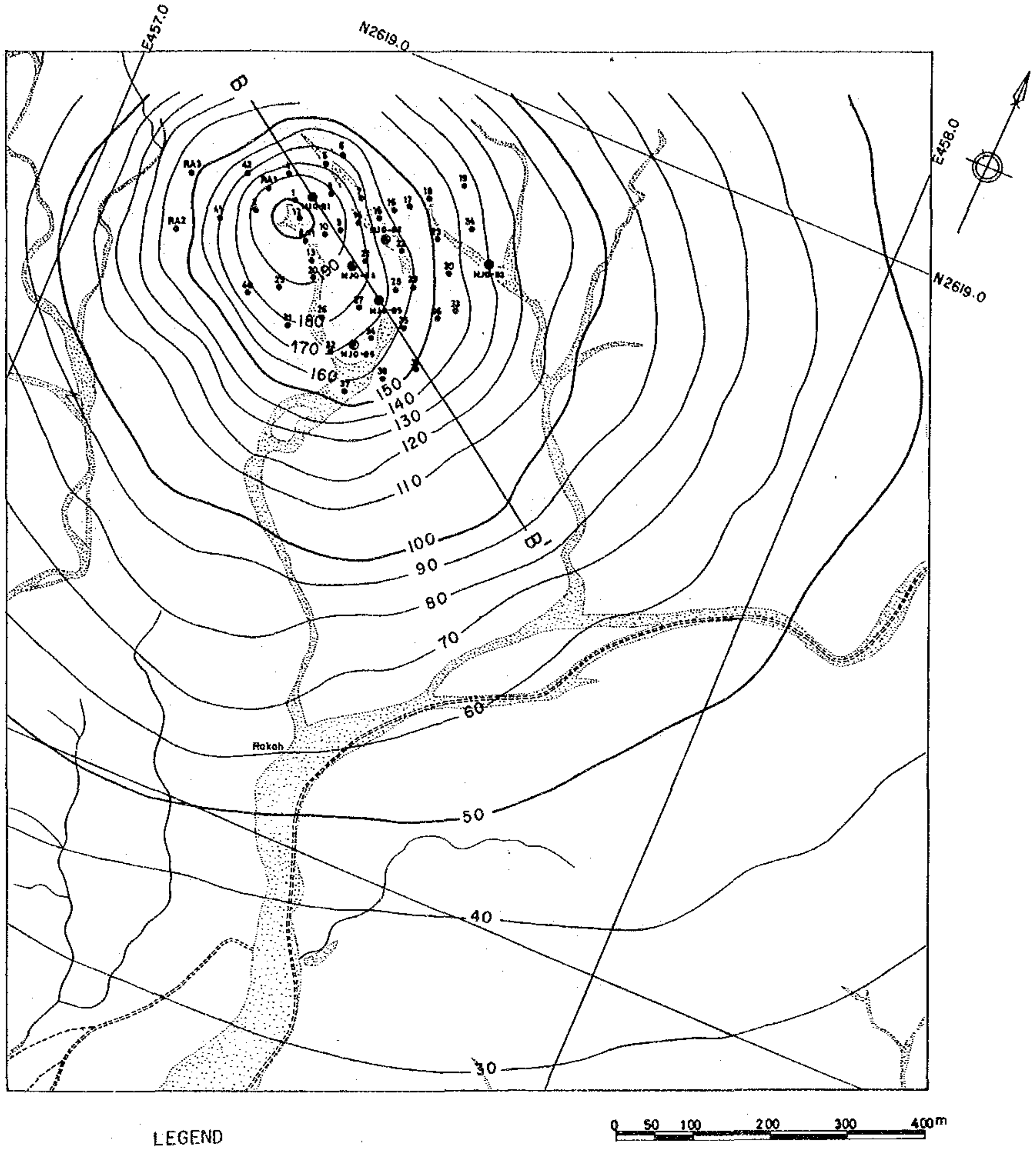


Fig. II-2-10 Electric Field Map (MJ0-B5)



LEGEND

B——B' Section

—10— Equi-Charged-Potential Line
(unit in mV/A)

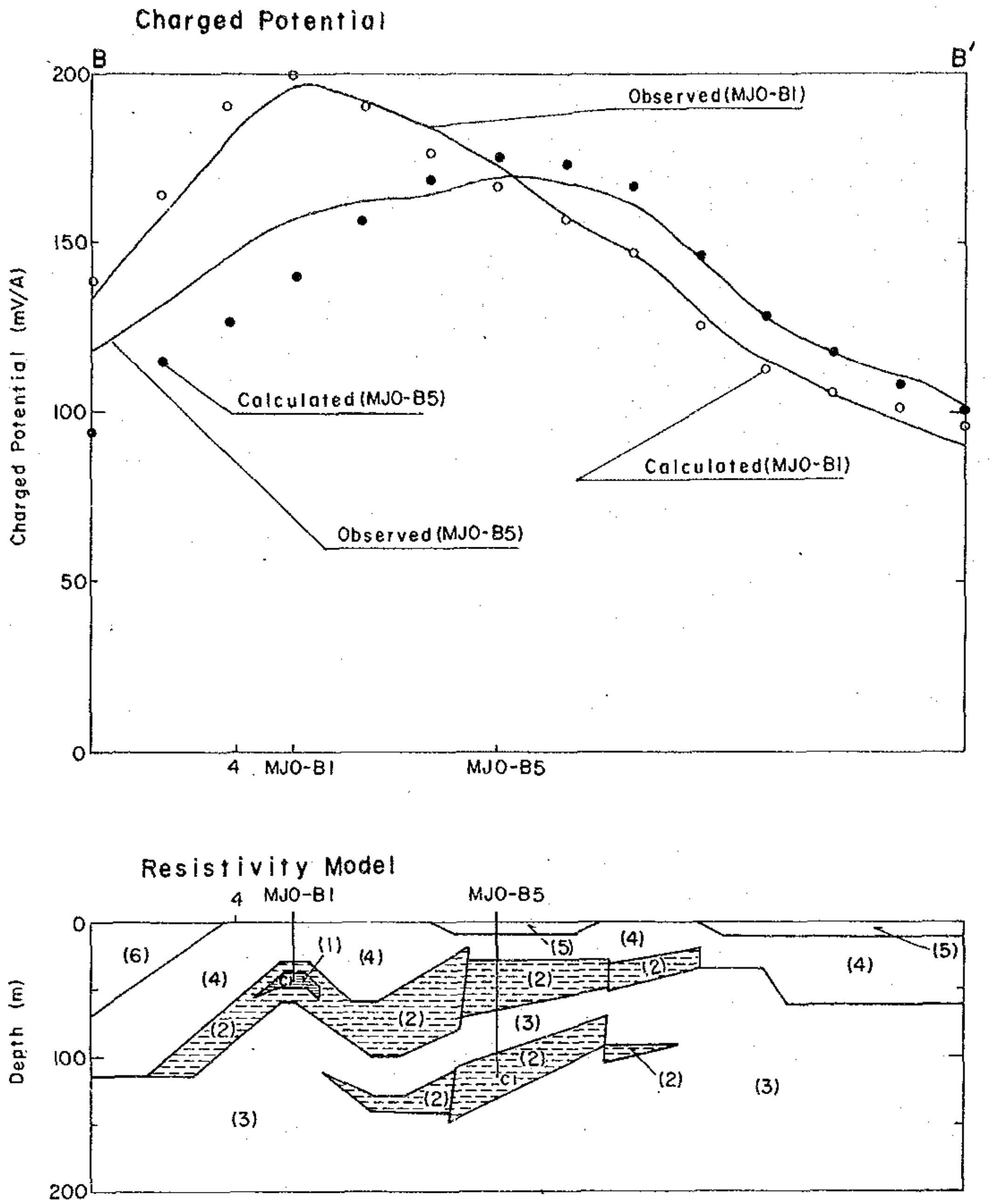
● Charging Drill Hole

Drill Hole	Depth of C1
MJO-B1	44 m
MJO-B5	115 m

◉ Drill Hole done by This Project

• Previous Drill Hole

Fig. II-2-11 Location Map of Section



Resistivity Code	Resistivity (Ω·m)	Unit
(1)	1	Massive Ore
(2)	5	Stockwork Ore
(3)	900	Lower Extrusives I
(4)	1,400	Lower Extrusives II
(5)	100	Quaternary
(6)	20	Sedimentary Rocks

0 100 200m

Fig. II-2-12 B-B' Section

MJ0-B5 hole, and its thickness at the central part is about 30 m.

A resistivity layer of 20 Ω · m corresponding to sedimentary rocks is placed at the northwestern edge. The boundary between this resistivity layer and the Lower Effusives II (1,400 Ω · m) corresponds to the thrust fault.

There is a great difference between the observed and calculated curves at the northwestern part of the MJO-B5 hole. Since it is thought that the current charged in the MJO-B5 hole may not flow enough in the upper mineralized zone corresponding to the fault structures are placed at the both sides of the MJ0-B5 hole, and when the distribution area of the lower mineralized zone increased at the northwest of the MJ0-B5 hole.

(4) Summary of Geophysical Survey Results

By means of locating 402 CP stations in total in Area B and placing a charging electrode (C1) at the orebody in each of two drill holes, MJ0-B1 and MJ0-B5 holes, the charged potentials were obtained. Moreover, by the electric fields calculated from charged potentials and the 2-D model calculation for the Rakah deposit, the distribution of the conductor including the masssive and stockwork ore bodies were evaluated.

A geophysical interpretation map is shown in Fig. II-2-13.

A distribution of the Rakah deposit infered by the results of the geophysical survey is as follows:

The both of the upper and lower mineralized zones of the Rakah deposit are continued electrically, and those show same distribution area each other. Each of those distribution areas, centering the MJ0-B5 hole, shows width of 400 m in E-W and of 300 m in N-S.

The Rakah deposit is distributed in a E-W direction wholly and in a NW-SE direction at the western part, including the gossan zone, and the northwestern edge is limited by the trust fault running in a NE-SW direction. While, its eastern fringe is located at 100 m east of the hole 36.

The | E | (internsity of electric field) distribution suggests the existence of the electrical discontinuities-fault sturctures-trending in E-W, NW-SE and NE-SW directions, which control the distribution of the Rakah deposit.

Although BRGM has been conducted the charged potential method using the RA-1 and RA-2 holes in this area, BRGM could not obtain the charged potential distribution like this survey results, which suggests the whole distribution of the Rakah deposit. The reason may be that a far potential electrode (P2) was placed very near the charging point (C1) by BRGM. In general, a far potential is positioned at a great distance away from a charging point in a such manner as in this survey.

When the drilling survey succeed to hit the orebody, in order to delineate its distribution, it will be recommended to carry out the charged potential survey. And it is the best for clarification of its whole dirstibution to place the charging electrode (C1) at the center of the orebody in the hole.

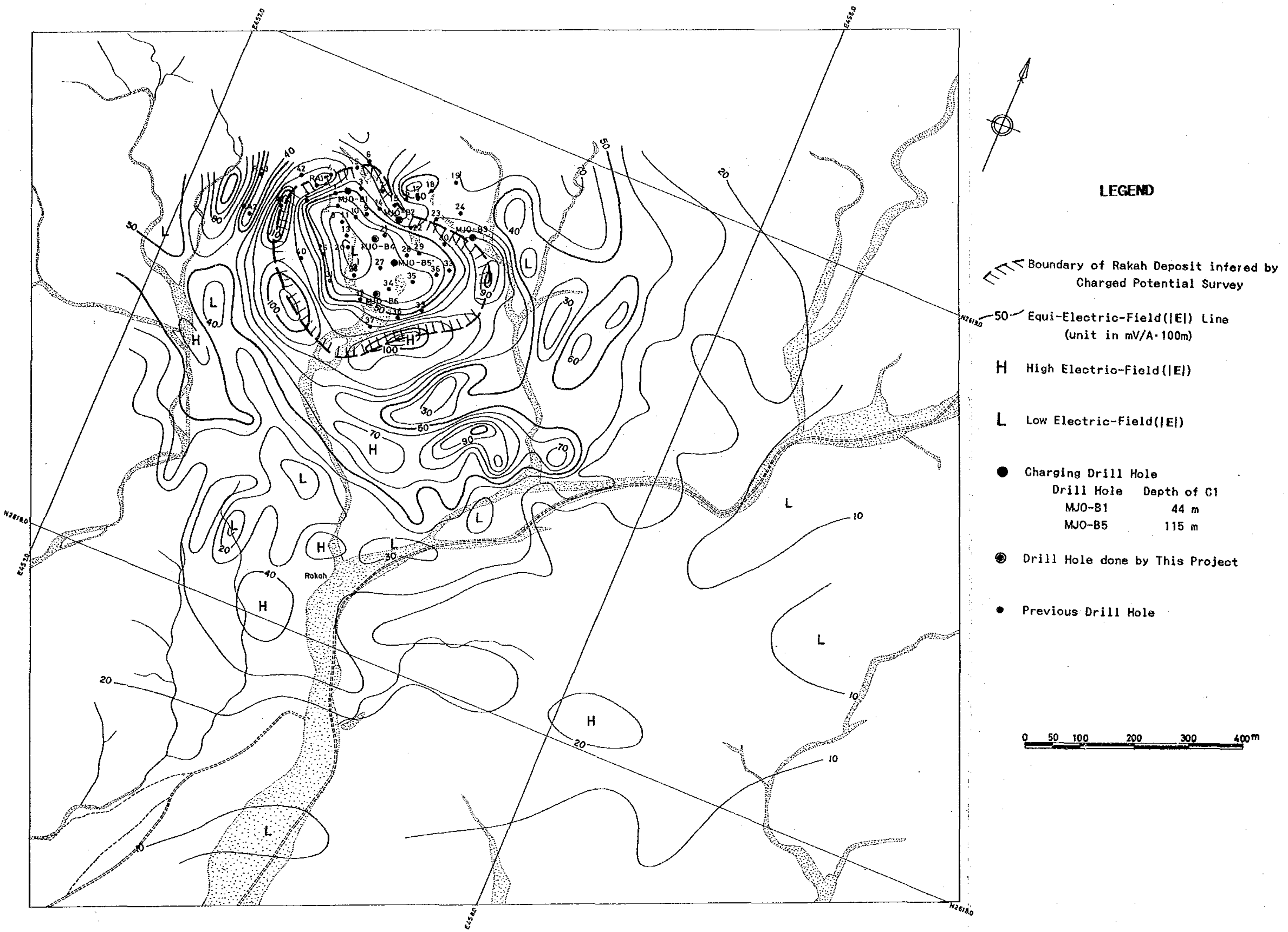


Fig. II-2-13 Geophysical Interpretatoin Map

2-4 Drilling

2-4-1 Method and Progress of Drilling

A total of six drill hole from MJO-B1 to MJO-B6 (811.45 m in total) were completed in Area B. Location of each hole are shown in Fig. II-2-4 and details of each hole are given in Table II-2-1. A total of 45 holes (5,938.32 m in total) were completed previously in the Rakah ore deposit area. List of these holes are shown in Table II-2-2.

Same two drilling machines were utilized for the survey in this area. Drill holes MJO-B1, B3 and B4 were completed by JOY RAMROD II and remaining three holes (MJO-B2, B5 and B6) were completed by VOL 35 drilling machine. Progress of each hole is shown in Appendix 7.

Drilling work was carried out very smoothly except two drill holes of MJO-B1 and B6. Both drill holes of MJO-B1 and B6 encountered old working and took more time for drilling due to soft rock and caving in the hole. Because of poor core recovery for MJO-B6 re-drilled the hole from surface to 31.30 m in depth.

Drilling was made NX wireline method. In case the hole encountered caving zone, reamed the hole, then extended NW casing or cemented the hole.

Geologic core logs are shown in Appendix 8. The number of samples collected for loboratorial studies are shown in Table I-1-1.

All drill holes completed in Area B encountered mineralized zones. Drill cores were treated by similar manner to those of Area A and samples were collected for ore assay and beneficiation test. Encountered mineralized zones and assayed samples for each hole are as follow:

Hole number	Depth and thickness of mineralized zone	Sampled length	Number of sample
MJO-B1	(U) 21.40 ~ 58.00 m (36.60 m)	32.70 m	21
MJO-B2	(U) 88.80 ~ 124.60 m (35.80 m) (L) 139.50 ~ 154.20 m (14.70 m)	46.80 m	24
MJO-B3	68.90 ~ 137.20 m (68.30 m)	17.10 m	8
MJO-B4	(U) 27.60 ~ 91.90 m (64.30 m)	52.10 m	26
MJO-B5	(U) 28.30 ~ 72.90 m (44.60 m) (L) 84.10 ~ 124.60 m (40.50 m)	55.90 m	28
MJO-B6	(U) 21.40 ~ 58.00 m (36.60 m) (L) 88.80 ~ 124.60 m (35.80 m)	52.15 m	26
Total	(375.20 m)	256.75 m	133

U : Upper mineralized zone, L : Lower mineralized zone

Table II-2-1 Details of Drill Holes Completed in Area B

Hole Number	MJO-B1	MJO-B2	MJO-B3	MJO-B4	MJO-B5	MJO-B6
Coordinates	N 2618.780 E 457.276	N 2618.770 E 457.381	N 2618.787 E 457.522	N 2618.717 E 457.356	N 2618.695 E 457.406	N 2618.627 E 457.398
Drill Length	100.35 m	157.25 m	201.70 m	101.30 m	150.00 m	100.85 m
Bearing	–	–	–	–	–	–
Inclination	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Core Length	85.85 m	154.15 m	198.00 m	98.30 m	142.90 m	87.35 m
Core Recovery	85.5%	98.1%	98.2%	97.0%	95.3%	86.6%
Period: From To	 15 November 1988 20 November 1988	 13 November 1988 23 November 1988	 22 October 1988 30 October 1988	 31 October 1988 4 November 1988	 18 October 1988 31 October 1988	 3 November 1988 23 November 1988
Casing	26.50 m	3.00 m	3.00 m	3.00 m	12.00 m	12.75 m
Remarks	Encountered old working					Re-drilling 0.00m~31.30m due to low core recovery Encountered old working

Table II-2-2 List of Previous Drill Holes in Area B

Hole No.	Coordinates		Elevation (m)	Depth (m)	Bearing	Inclination	Period		Done by
	N	E					Started	Completed	
29 - 1	2618.767	457.256	683.0	91.44	–	-90°	5 Apr. '76	9 Apr. '76	Prospection Ltd.
29 - 2	2618.736	457.214	685.9	64.92	–	-90°	9 Apr. '76	11 Apr. '76	Prospection Ltd.
29 - 3	2618.793	457.295	685.0	98.76	–	-90°	12 Apr. '76	14 Apr. '76	Prospection Ltd.
29 - 4	2618.796	457.236	690.8	126.80	–	-90°	14 Apr. '76	20 Apr. '76	Prospection Ltd.
29 - 5	2618.826	457.275	683.8	128.93	–	-90°	21 Apr. '76	26 Apr. '76	Prospection Ltd.
29 - 6	2618.841	457.292	684.7	154.23	–	-90°	26 Apr. '76	30 Apr. '76	Prospection Ltd.
29 - 7	2618.804	457.335	678.8	107.59	–	-90°	30 Apr. '76	2 May '76	Prospection Ltd.
29 - 8	2618.727	457.287	679.0	92.05	–	-90°	2 May '76	5 May '76	Prospection Ltd.
29 - 9	2618.756	457.325	686.7	123.14	–	-90°	5 May '76	8 May '76	Prospection Ltd.
29 - 10	2618.741	457.309	680.1	106.98	–	-90°	8 May '76	9 May '76	Prospection Ltd.
29 - 11	2618.727	457.286	679.0	101.19	235°	-70°	10 May '76	11 May '76	Prospection Ltd.
29 - 12	2618.749	457.268	681.0	91.44	–	-90°	12 May '76	14 May '76	Prospection Ltd.
29 - 13	2618.707	457.302	677.9	89.00	–	-90°	14 May '78	15 May '76	Prospection Ltd.
29 - 14	2618.773	457.344	679.9	126.79	–	-90°	15 May '76	17 May '76	Prospection Ltd.
29 - 15	2618.790	457.366	679.6	131.98	–	-90°	17 May '76	19 May '76	Prospection Ltd.
29 - 16	2618.808	457.380	681.4	152.40	–	-90°	19 May '76	21 May '76	Prospection Ltd.
29 - 17	2618.822	457.399	679.8	156.36	–	-90°	21 May '76	24 May '76	Prospection Ltd.
29 - 18	2618.836	457.417	678.3	238.96	–	-90°	24 May '76	26 May '76	Prospection Ltd.
29 - 19	2618.871	457.457	685.8	226.47	–	-90°	29 May '76	1 June '76	Prospection Ltd.
29 - 20	2618.686	457.316	676.3	101.19	–	-90°	2 June '76	3 June '76	Prospection Ltd.
29 - 21	2618.729	457.373	682.5	113.39	–	-90°	3 June '76	5 June '76	Prospection Ltd.
29 - 22	2618.760	457.413	677.4	144.17	–	-90°	5 June '76	7 June '76	Prospection Ltd.
29 - 23	2618.792	457.452	677.8	168.55	–	-90°	7 June '76	10 June '76	Prospection Ltd.
29 - 24	2618.822	457.492	679.0	198.72	–	-90°	10 June '76	13 June '76	Prospection Ltd.
29 - 25	2618.657	457.280	678.2	101.49	–	-90°	13 June '76	15 June '76	Prospection Ltd.
29 - 26	2618.646	457.347	673.1	101.49	–	-90°	15 June '76	16 June '76	Prospection Ltd.
29 - 27	2618.677	457.386	673.7	122.83	–	-90°	16 June '76	18 June '76	Prospection Ltd.
29 - 28	2618.712	457.422	675.2	159.11	–	-90°	18 June '76	20 June '76	Prospection Ltd.
29 - 29	2618.725	457.442	676.2	151.18	–	-90°	20 June '76	22 June '76	Prospection Ltd.
29 - 30	2618.759	457.478	679.0	147.22	–	-90°	22 June '76	24 June '76	Prospection Ltd.
29 - 31	2618.618	457.310	674.9	119.48	–	-90°	24 June '76	26 June '76	Prospection Ltd.
29 - 32	2618.606	457.378	670.8	94.79	–	-90°	26 June '76	27 June '76	Prospection Ltd.
29 - 33	2618.718	457.505	680.6	180.44	–	-90°	27 June '76	30 June '76	Prospection Ltd.
29 - 34	2618.643	457.417	673.7	104.54	–	-90°	30 June '76	2 July '76	Prospection Ltd.
29 - 35	2618.673	457.452	674.8	124.05	–	-90°	2 July '76	4 July '76	Prospection Ltd.
29 - 36	2618.700	457.487	680.9	150.26	–	-90°	4 July '76	6 July '76	Prospection Ltd.
29 - 37	2618.571	457.409	669.7	98.45	–	-90°	6 July '76	8 July '76	Prospection Ltd.
29 - 38	2618.603	457.448	671.4	107.59	–	-90°	8 July '76	9 July '76	Prospection Ltd.
29 - 39	2618.634	457.486	673.5	122.83	–	-90°	9 July '76	11 July '76	Prospection Ltd.
29 - 40	2618.637	457.244	677.3	153.31	–	-90°	20 Oct. '77	24 Oct. '77	Prospection Ltd.
29 - 41	2618.707	457.176	692.6	153.31	–	-90°	25 Oct. '77	27 Oct. '77	Prospection Ltd.
29 - 42	2618.777	457.187	703.7	165.50	–	-90°	28 Oct. '77	31 Oct. '77	Prospection Ltd.
RA - 1	2618.770	457.218	690.0	130.00	–	-90°	25 Dec. '85	4 Jan. '86	BRGM
RA - 2	2618.676	457.136	699.2	115.00	118°	-60°	5 Jan. '86	15 Jan. '86	BRGM
RA - 3	2618.746	457.115	706.1	200.00	–	-90°	31 Jan. '86	14 Feb. '86	BRGM