1-4 Drilling

1-4-1 Method and progress

The drilling survey was carried out in two years of Phase I and II (12 holes, 1,740.80 m in total). Six drill holes from MJO-A1 to -A6, 898.70 m in total were completed in the Phase I. In the Phase II, six drill holes of MJO-A7 to MJO-A12 were also completed in Area A.

Drilling work was carried out by the subcontractor of Lalbuksh Contracting and Trading Est. in Oman. Details of the drill holes completed in this survey are listed on Table 1-4. The drill holes completed in this area by MPM and BRGM are shown in Table 1-5. Location of each drill site is decided by means of close traverse surveying method using a portable transit. The drill sites completed in this area are shown in Fig. 1-10.

Two drill machines in Phase I and three drill machines in Phase II were used in this survey. The name and capacity of each drilling machine, and the holes number completed by the machine are as below.

Name of Machine	Capacity	Drill hole
JOY RAMROD II	455m (NX), 650m (BX), 825m (AX)	MJO-A1, A2, A3, A6
VOL 35	205m (NX), 350m (BX), 430m (AX)	MJO-A4, A5, A11
VOL 90	300m (NX), 400m (BX), 500m (AX)	MJO-A7, A9, A10, A12
VOL180	600m (NX), 760m (BX), 980m (AX)	MJO-A8

Among these machines, JOY RAMRODII is manufactured in U.S.A. and VOL35, 90 and 180 are in Indea. Progress of each drill hole is shown in Appendix 7.

Because of loose and thick terrace deposits (20m ~ 30m), and strongly silicified and hard mineralized zone, drilling work consumed more time. The drill holes of MJO-A5 and -A6 in Phase I and MJO-A10 in Phase II encountered the debris zones of siliceous gossan. Because the zones are hard and have cave zones, the holes consumed many diamond bits and drill time, and also the rods were broken in the holes of MJO-A6 and MJO-A10. Therefore, these drill holes of MJO-A5, -A6 and -A10 were reduced the size to BX.

First three meters for most of the holes was drilled with rotary bit and the NW casing was inserted. Then the hole was drilled with wireline method of NX size. Same drill hole was drilled NX in size at first, then interted the NW casing after reaming the hole. If the hole encountered caving zone, the hole was reamed and extended the casing, or cemented the hole.

Geologic logs for these drill holes are given in Appendix 8. The samples collected from the drill cores for laboratorial studies are as follows;

Table 1-4 List of drill holes completed in Area A in this project

Hole number	Coordinates	Elevation (m)	Drill length (m)	Bearing	Inclination	Core length (m)	Core recovery (%)	Period: from to	Casing (m)
MJO-A1	N 2618.737 E 453.434	691.0	200.60	270°	-50°	197.60	98.5	8 Oct.'88 20 Oct.'88	NWC 15.00
MJO-A2	N 2618.698 E 453.373	695.8	151.15	—	Vertical	133.30	88.2	26 Nov.'88 10 Dec.'88	NWC 25.00
MJO-A3	N 2618.698 E 453.371	695.8	143.00	270°	-50°	136.05	96.4*	12 Dec.'88 26 Dec.'88	NWC 3.00
MJO-A4	N 2618.673 E 453.458	695.5	150.75	—	Vertical	136.25	90.4	3 Oct.'88 16 Oct.'88	NWC 3.00
MJO-A5	N 2618.793 E 453.295	704.1	120.10	—	Vertical	98.45	84.3*	1 Dec.'88 23 Dec.'88	NWC 11.50 NX 56.70
MJO-A6	N 2618.794 E 453.294	704.1	133.10	0°	-50°	106.70	81.4*	27 Dec.'88 13 Jan.'89	NWC 27.00 NX 72.65
MJO-A7	N 2618.794 E 453.200	717.3	100.30	—	Vertical	95.20	94.9	14 Aug.'89 21 Aug.'89	NWC 3.00
MJO-A8	N 2618.831 E 453.563	705.8	240.05	—	Vertical	215.90	89.9	28 Jul.'89 31 Aug.'89	HX 27.50
MJO-A9	N 2618.650 E 453.596	696.3	150.20	—	Vertical	139.90	93.1	28 July'89 5 Aug.'89	NWC 6.00
MJO-A10	N 2618.795 E 453.200	717.3	120.55	0°	-50°	106.65	91.1*	22 Aug.'89 5 Sep.'89	NWC 3.00 NX 28.50
MJO-A11	N 2618.794 E 453.241	714.5	100.65	—	Vertical	99.90	99.3	17 Aug.'89 24 Aug.'89	NWC 3.70
MJO-A12	N 2618.690 E 453.637	697.8	130.35	—	Vertical	114.95	88.2	6 Aug.'89 12 Aug.'89	NWC 7.50
Total			1,740.80 m		(Phase I: 898.70 m, Phase II: 842.10 m)				

* : Excluding cave zones.

Table 1-5 List of drill holes completed by MPM and BRGM 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	170.60	-	-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	160.25	-	-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
HS-34	2618.740	453.302	697.8	101.60	-	-90°	29 Jan. '89	8 Feb. '89	MPM
HS-35	2618.797	453.366	698.8	157.65	-	-90°	11 Feb. '89	2 Mar. '89	MPM
HS-36	2618.828	453.419	700.0	200.15	-	-90°	6 Mar. '89	30 Mar. '89	MPM
HS-37	2618.872	453.443	699.2	200.95	-	-90°	3 Apr. '89	29 Apr. '89	MPM
HS-38	2618.697	453.235	697.1	100.20	-	-90°	30 Apr. '89	11 May '89	MPM
HS-39	2618.979	453.183	742.0	200.50	72°	-63°	4 June '89	4 July '89	MPM
HS-40	2618.871	453.378	701.2	147.75	-	-90°	18 June '89	13 July '89	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

Item	Phase I	Phase II	Total	Remarks
Thin section	5 samples	3 samples	8 samples	Table 1-1
Polished section	18 samples	5 samples	13 samples	Table 1-6
EPMA analyses	2 samples	—	2 samples	Table 2-5
Whole rock analyses	6 samples	—	6 samples	Appendix 2
Minor element analyses	7 samples	—	7 samples	Appendix 2
X-ray diffraction analyses	5 samples	6 samples	11 samples	Table 1-7
Ore assaying	132 samples	60 samples	192 samples	Appendix 8
Physical properties	8 samples	—	8 samples	Table 1-3
Sampling for beneficiation test	100 kg	—	100 kg	Volume III

The drill cores of mineralized zone were cut by a drill cutter. A half of the core samples were collected for beneficiation test and a quarter was samples for ore assaying in the Phase I. In the Phase II a quarter sample for mineralized zone was collected for ore assaying. Remaining samples have been stored. Assay samples were basically collected for one meter core section in case of massive ore zone, and two meters section in case of stockwork ore zone. Four elements of Au, Ag, Cu, Pb and Zn were assayed for the samples in the Phase I. Because of extremely low contents of Pb, four elements of Au, Ag, Cu and Zn were assayed in the Phase II. The assay results are given in Appendix 8 together with geologic logs.

1-4-2 Results of survey

(1) Drilling

Four drill holes (MJO-A1 ~ MJO-A4) were planned originally in the Phase I. However, because of encouraging results of these four holes, additional two drill holes (MJO-A5 and -A6) were completed in Phase I. Based on the results of geophysical and drilling surveys, six drill holes (MJO-A7 ~ MJO-A12) were completed in the Phase II. These six holes were planned to confirm the extensions of the ore deposits.

(a) MJO-A1 (Bearing 270°, inclination −50°, drilled length 200.60 m)

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. Results are shown below:

0.00 ~ 23.60 m	Terrace deposits consisting of gravel and sand. Lower 7 m is completely cemented 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 is sheared. 132.30 ~ 133.20 m : stockwork ore.
133.30 ~	200.60 m	*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 shows similar nature and occurrences from the top to the bottom and is intensely brecciated.

Assay results show slightly higher copper contents at the upper and lower parts 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 comparing with the grade of copper.

(b) MJO-A2 (Vertical, drilled length 151.15 m)

This hole was carried out to examine the western extension of stockwork ore zone confirmed by the 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	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 very clearly between the mineralized zone and footwall volcanic rocks.

This hole confirmed thick mineralized zone (D.L. 71.95 m) consisting of rather homogeneous stockwork ore. The assay results excluding the lowermost part gave 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

The siliceous and massive ores at the top show comparatively high contents of Au ranging from 1.1 g/t to 2.9 g/t.

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.

(c) **MJO-A3 (Bearing 270°, inclination −50°, drilled length 143.00 m)**

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.

0.00 ~ 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 ore 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	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 shown 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

Estimated ore grade for the massive ore at the top was not high but the assay results gave extremely high grade (10.94% Cu) possibly due to very fine-grained chalcopyrite.

(d) **MJO-A4 (Vertical, drilled length 150.75 m)**

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 massive ore for beneficiation test. Results of the hole are as follows:

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 ore.
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	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 suggests that the difference of thickness of massive sulfide zone between this hole and previous holes is the fault displacement. Assay results for the mineralized zone are as follows:

80.75 m ~ 93.40 m D.L.: 11.25 m

0.47 g/t Au, 4.1 g/t Ag, 1.49% Cu, 0.01%>Pb, 0.28% Zn

Gold contents are higher in massive ore zone (1.2 ~ 2.2 g/t) than in stockwork ore zone (0.1 ~ 0.4 g/t).

(e) **MJO-A5 (Vertical, drilled length 120.10 m)**

This hole was carried out as the additional hole to examine the mineralization of the Main Gossan and to confirm the relationship between the known ore deposits and the Main Gossan. Location of the drill site is the immediate south of Main Gossan. Results of the hole are given below:

0.00 ~ 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.
48.70 ~	51.70 m	Massive ore 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	Lower Extrusives I. Chloritized pillow and massive lavas . Quartz-calcite stringers. Hematite in matrix.

The stockwork ore zone encountered 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 the 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 mineralized zones in the Main Gossan area affected by weathering from the surface to deeper part comparing 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 shows 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:

34.20 m ~ 90.00 m D.L.: 55.80 m

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

(f) MJO-A6 (Bearing 0°, inclination −50°, drilled length 133.10 m)

The drill hole MJO-A6 was carried out at the same drill site of MJO-A5. Purpose of the hole was to examine the geology and mineralization under the Main Gossan. Results are as follows:

0.00 ~	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	Lower Extrusives I. Chloritized pillow and massive lavas.

The size of the hole was reduced from NX to BX at the depth of 72.65 m due to rod broken. 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 comparing with the results of MJO-A5. Average grades are shown 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 assayed, because no sulfide minerals were found due to intense gossanization.

(g) MJO-A7 (Vertical, drilled length 100.30 m)

This hole was carried out at 95 m west of the drill sites of MJO-A5 and -A6 in order to examine the western extension of the mineralized zone confirmed by the drill holes of MJO-A5 and -A6. Results of this hole are as follows:

0.00 ~	12.80 m	Lower Extrusives II. Pillow lavas. Weathered and weakly argillized. 10.50 ~ 12.80 m: secondary copper minerals.
12.80 ~	22.30 m	Gossan soil with minor argillized pillow lavas.
22.30 ~	27.60 m	Siliceous gossan. Strongly brecciated.
27.60 ~	29.80 m	Gossan soil.
29.80 ~	48.90 m	Pillow lavas. Chloritized and weakly silicified. 29.80 ~ 32.20 m and 34.90 ~ 36.10 m: secondary copper minerals along fractures.
48.90 ~	100.30 m	Lower Extrusives I. Pillow lavas with hematite-quartz veinlets.

The hole was carried out at the western end of the ore deposits. Because the mineralized zone is situated at shallower depth, the zone is completely gossanized and no sulfide minerals can be observed. Assay results gave extremely low grade of Cu and Zn except the top and bottom of the gossan zone where secondary copper minerals were concentrated. The bottom of siliceous gossan shows assay values of 1.5 g/t Au and 5.6 g/t Ag, but Au and Ag are very low other than this zone. The assay results of the top and bottom of the mineralized zone are as follows:

10.50 m ~ 16.80 m D.L. : 6.30 m

Tr Au, Tr Ag, 1.94% Cu, 0.27% Zn

29.80 m ~ 32.20 m D.L. : 2.40 m

Tr Au, Tr Ag, 1.02% Cu, 0.16% Zn

(h) **MJO-A8 (Vertical, drilled length 240.05 m)**

This hole was planned to confirm the northeastern extensions of the known ore deposits. The results are as follows:

0.00 ~	35.10 m	Terrace deposits. Gravel and sand.
35.10 ~	37.50 m	Lower Extrusives II. Massive lavas.
37.50 ~	126.70 m	Lower Extrusives II. Chloritized and weakly brecciated pillow lavas.
126.70 ~	128.10 m	Strongly chloritized and brecciated pillow lavas.
128.10 ~	179.10 m	Lower Extrusives I. Chloritized and hematized pillow lavas.
179.10 ~	183.90 m	Lower Extrusives I. Chloritized, hematized and brecciated pillow lavas.
183.90 ~	184.85 m	Hematite zone.
184.85 ~	209.70 m	Stockwork ore zone.
209.70 ~	210.30 m	Strongly chloritized and sheared zone.
210.30 ~	240.05 m	Lower Extrusives I. Chloritized and hematized pillow lavas.

This hole encountered a stockwork ore zone of 24.85 m in thickness. The hole reduce the thickness of ore zone comparing with the hole HS-25 which was completed at 95 m west of this hole. The upper part of this stockwork zone shows low copper concentration similar to those holes of HS-8 and HS-37 which were completed at the north of this hole. Average assay results excluding low concentrated zone are as follows:

192.85 m ~ 208.85 m D.L. : 16.00 m

0.21 g/t Au, 0.55 g/t Ag, 0.75% Cu, 0.09% Zn

(i) **MJO-A9 (Vertical, drilled length 150.20 m)**

The geophysical survey results in the Phase I suggested further southeastern extension of the known ore deposits. This hole was carried out at the southeast of the known ore deposits to examine the potential. Results of this hole are as follows:

0.00 ~	24.00 m	Terrace deposits. Gravel and sand.
24.00 ~	31.20 m	Lower Extrusives II. Weakly chloritized and hematized massive lavas.
31.20 ~	42.20 m	Lower Extrusives II. Pillow breccia. Matrix: hematized.
42.20 ~	49.10 m	Lower Extrusives II. Weakly epidotized pillow lavas.
49.10 ~	53.10 m	Strongly hematized and weakly chloritized pillow breccia.
53.10 ~	88.70 m	Lower Extrusives II. Brecciated and weakly chloritized pillow lavas.
88.70 ~	89.40 m	Strongly chloritized sheared zone. Pyrite disseminations.
89.40 ~	102.30 m	Lower Extrusives I. Silicified and chloritized pillow lavas with quartz-hematite stockwork veinlets.
102.30 ~	137.70 m	Lower Extrusives I. Chloritized and hematized pillow lavas.
137.70 ~	144.60 m	Lower Extrusives I. Pillow lavas with quartz-hematite stockwork veinlets.

144.60 ~	150.20 m	Chloritized pillow lavas. Lower Extrusives I.

This hole confirmed a pyrite disseminated zone as the mineralized zone at the depth from 88.70 m to 89.40 m (D.L. : 0.70 m). The assay results gave extremely low grades (Tr Au, Tr Ag, 0.06%Cu, 0.21%Zn). The intersected mineralized zone is possibly at the eastern extension of the massive ore zone which is situated at the boundary between Lower Extrusive I and II.

(j) **MJO-A10 (Bearing 0°, inclination −50°, drilled length 120.55 m)**

In order to examine the northern extension of the mineralized zone confirmed by the hole of MJO-A7, this hole was carried out. The bearing is 0° and inclination is −50°. The results of this hole are as follows:

0.00 ~	7.20 m	Lower Extrusives II. Weathered and weakly brecciated pillow lavas.
7.20 ~	9.60 m	Strongly weathered clay zone with limonite and hematite.
9.60 ~	37.90 m	Strongly brecciated siliceous gossan with limonite and hematite. 26.50 ~ 28.50 m and 36.00 ~ 37.50 m: cave zones.
37.90 ~	39.10 m	Argillized and weathered pillow breccia. Lower Extrusives I.
39.10 ~	65.80 m	Lower Extrusives I. Strongly chloritized pillow lavas with many quartz-calcite-hematite veinlets.
65.80 ~	72.00 m	Lower Extrusives I. Chloritized and hematized pillow breccia.
72.00 ~	104.55 m	Lower Extrusives I. Chloritized and hematized pillow lavas.
104.55 ~	120.55 m	Lower Extrusives I. Chloritized, silicified and weakly brecciated pillow lavas.

The encountered mineralized zone is almost completely gossanized as same as MJO-A7 and no sulfide minerals are recognized. The assay results gave comparatively high Au zone (25.60 m ~ 26.50 m : 5.4 g/t Au, 28.50 m ~ 30.50 m : 3.7 g/t Au), but no concentration of Cu and Zn is observed. The average grades for the encountered gossan zone are as follows:

7.20 m ~ 37.90 m D.L.: 30.70 m

0.80 g/t Au, 4.5 g/t Ag, 0.15% Cu, 0.27% Zn

(k) **MJO-A11 (Vertical, drilled length 100.65 m)**

In order to examine the western extension of the mineralized zone, the drill hole MJO-A11 was carried out at the middle between the holes MJO-A5 and MJO-A7. The results of this hole are as follows:

0.00 ~	4.00 m	Lower Extrusives II. Doleritic massive lavas. Weakly brecciated.
4.00 ~	18.95 m	Lower Extrusives II. Brecciated and chloritized pillow lavas.
18.95 ~	24.00 m	Lower Extrusives II. Weakly brecciated massive lavas.
24.00 ~	27.65 m	Lower Extrusives II. Brecciated pillow lavas with copper oxide minerals.
27.65 ~	28.20 m	Aargillized clay zone.
28.20 ~	42.30 m	Strongly brecciated siliceous gossan with limonite, hematite and goethite.

42.30 ~ 53.35 m	Strongly silicified and brecciated stockwork ore zone.
53.35 ~ 53.70 m	Aargillized clay zone with pyrite disseminations.
53.70 ~ 68.00 m	Lower Extrusives I. Chloritized and brecciated pillow lavas.
68.00 ~ 100.65 m	Lower Extrusives I. Weakly brecciated pillow lavas.

The mineralized zones encountered in this hole consist of the copper enriched zone, siliceous gossan and stockwork ore zone from the shallower depth to the deeper depth. The total thickness of the mineralized zone confirmed in this hole is thiner than that of MJO-A5 and thicker than that of MJO-A7. The copper enriched zone shows high concentration of Cu (D.L. 3.65 m, 3.77% Cu) and the siliceous gossan partly shows higher concentration of Au (D.L. 2.00 m, 5.6 g/t Au). Assay results gave following average grades.

Depth	D.L.	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Remarks
24.00 ~ 27.65 m	3.65 m	0.05	0.82	3.77	0.08	Secondary enriched zone
28.20 ~ 42.30 m	14.10 m	1.06	6.52	0.16	0.01	Siliceous gossan
42.30 ~ 53.35 m	11.05 m	0.21	4.74	1.38	0.01	Stockwork ore

(l) **MJO-A12 (Vertical, drilled length 130.35 m)**

The hole was carried out to examine the southeastern extension of the Hayl as Safil deposit where was delineated by the geophysical survey in Phase I. The results are as follows:

0.00 ~ 23.00 m	Terrace deposits. Gravel and sand.
23.00 ~ 52.70 m	Lower Extrusives II. Brecciated pillow lavas with calcite and quartz veinlets.
52.70 ~ 63.20 m	Lower Extrusives II. Brecciated, chloritized and hematized pillow lavas with intercalation of thin metalliferous sediment layers.
63.20 ~ 69.40 m	Lower Extrusives II. Hematized pillow lavas.
69.40 ~ 92.00 m	Lower Extrusives II. Chloritized and weakly hematized pillow lavas.
92.00 ~ 95.30 m	Brecciated massive ore.
95.30 ~ 95.70 m	Lower Extrusives I. Pillow lavas with calcite-quarts stringers.
95.70 ~ 130.35 m	Lower Extrusives I. Pillow lavas with may quarts-hematite veinlets.

The massive ore zone at the southeastern extension of the Hayl as Safil deposit terminated in the vicinity of the drill holes of HS-27 and MJO-A9. But this hole was carried out further southeast of the area and encountered massive ore zone. The occurrences of this massive ore are similar to those of the known massive ore and magnetite which indicates marginal parts of the ore deposits is not found in this massive ore. Average assay for the massive ore is as follows:

92.00 m ~ 95.30 m　　D.L. : 3.30 m

3.60 g/t Au,　31.18 g/t Ag,　4.82% Cu,　1.09% Zn

(2) Observation results of polished section

Ore samples were collected from drill cores in the Hayl as Safil deposit (Area A) for the study of polished section. A total of 15 samples were collected in Phase I and five samples were collected in Phase II for this study. In addition, three samples were collected from the drill hole HS-17 which encountered representative massive ores of the Hayl as Safil deposit. Microscopic observation results for these polished sections are shown in Table 1-6, and photographs are shown in Appendix 14.

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. Some samples show 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.

(3) Results of EPMA analysis

In order to examine the nature of ore minerals, 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 2-4, and the images are shown in Appendix 15.

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 Appendix 2.

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

Table 1-6 Observation results of polished sections for the Hayl as Safil deposit

Hole No.	Depth (m)	Occurrence	Pyrite	Chalcopyrite	Covellite	Chalcosite	Bornite	Sphalerite	Cuprite	Malachite	Gangue and alteration minerals
MJO-A1	78.40	Massive py ore with fragments of jasper.	◎	•	•	•	•	•*			○ with hematite
MJO-A1	82.60	Pyrite disseminations (stockwork ore).	○	•	•	•	•	•*			◎ mostly quartz
MJO-A1	92.30	Py veinlet and disseminations (stockwork ore).	○ partly brecciated	•	•	•	•	•*			◎ mostly quartz
MJO-A2	36.70	Massive pyrite ore.	◎ brecciated, colloform	•	•	•		•			○ mostly quartz with hematite
MJO-A2	39.20	Massive py ore with fragments of jasper.	◎ fractured, brecciated	●	•	•		•*			○
MJO-A2	51.70	Secondary enrichment of disseminated py-cp ore.	○ partly fractured	●	•	●	○	•*			◎ mostly quartz with hematite
MJO-A2	75.10	Py-cp veinlet in chloritized pillow laves (stockwork ore).	◎	●	•	•	•	•*			◎
MJO-A2	93.10	Py-cp veinlet and disseminations (stockwork ore).	●	●	•			•*			◎
MJO-A3	40.80	Secondary enrichment of massive py-cp ore.	◎ fractured, brecciated	●		●	•	•			○
MJO-A3	50.60	Partly brecciated cp-py ore.	◎ fractured, brecciated	○		•	•	•*			○
MJO-A4	81.20	Massive cp-py ore, partly brecciated.	◎ brecciated	○	•	•		•			●
MJO-A4	89.30	Secondary enrichment of disseminated py-cp ore.	○ fractured	●		●	●	•			◎
MJO-A5	34.40	Siliceous pyrite ore.	◎ fractured, colloform	•		•		•*			○ mostly quartz
MJO-A5	49.90	Massive pyrite ore.	◎ fractured	•		•		•*			○ mostly quartz
MJO-A5	52.50	Siliceous py ore with fragments of jasper.	○	•	•	•		•*			◎ mostly quartz
MJO-A8	199.60	Cp-sp-py veinlet (stockwork ore).	○ partly fractured	○				●			◎
MJO-A11	25.90	Cuprite-malachite veinlet in pillow lava (oxidized zone).							○	○	◎
MJO-A11	44.60	Siliceous pyrite ore with jasper.	◎ fractured	●	●	●					◎ mostly quartz with hematite
MJO-A12	92.20	Fine- to medium grained massive py-cp ore.	◎ colloform, framboidal	○							●
MJO-A12	94.10	Massive cp-rich pyrite ore.	◎	◎				•			•
HS-17	61.55	Massive cp-py-sp ore.	○	◎				●*			• with hematite
HS-17	63.10	Massive cp-py ore.	○	◎				•			• with hematite
HS-17	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

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 of the Hayl as Safil deposit were examined by bulk X-ray diffraction analyses in Phase I and II in order to clarify the nature of alteration. Eleven samples were collected from drill cores and the analyses were made at Central Institute of Mitsubishi Metal Corporation. The results are shown in Table 1-7.

Six samples were collected from the Lower Extrusives I (LI) which formed the footwall rocks of the ore deposits. The detected alteration minerals include quartz, chlorite, smectite, chlorite/smectite mixed layer, calcite and zeolites etc. This result suggests the Lower Extrusives I is marked by strong chloritization and silicification. Quartz observed in the thin section is also secondary quartz. However, no quartz was detected for a sample collected from the drill hole MJO-A12 which was carried out at the southeastern end of the Hayl as Safil deposit. This fact suggests that silicification is very weak at the marginal parts of the ore deposits. Smectite was detected for most of the samples of the Lower Extrusives I. Epidote, prehnite and pumpellyite which indicate low-grade metamorphism, are also detected in the Lower Extrusives I.

For samples were collected from the stockwork ore. The detected minerals are quartz, chlorite, smectite, sericite/smectite mixed layer, kaolinite, calcite chalcopyrite and pyrite. Among these minerals, sericite/smectite mixed layer, kaolinite and chalcopyrite were detected from one samples. Augite and plagioclase were detected for the samples collected from the Lower Extrusives I and II, but these mineral were not detected for the samples of stockwork ore due to strong alteration. The sample collected from MJO-A11 contains kaolinite but chlorite is not detected. This fact may suggest that the area nearby MJO-A11 is the strongest altered zone of the Hayl as Safil deposit.

One sample was collected from the Lower Extrusives I. Quartz was not detected in this sample, but plageoclase and chlorite were detected. This fact indicates that the Lower Extrusive II is more weakly altered compare with the Lower Extrusives I. Pumpellyite which indicates low-grade metamorphism was also detected.

Table 1-7 Results of X-ray diffraction analyses in Area A

Hole number	Sampled depth (m)	Geologic unit	Quartz	Plagioclase	Augite	Amphibole	Chlorite	Smectite	Chlorite/smectite	Sericite/smectite	Kaolinite	Epidote	Prehnite	Pumpellyite	Pyrophillite	Sphene	Analcite	Laumontite	Epistilbite	Natroalunite	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
MJO-A8	209.85	LI	◎				◎		△					●		●		●				●				
MJO-A8	193.20	Ore	◎				◎			●											●	△				
MJO-A10	42.90	LI	◎	●	●		○	○	●						●				●					●		
MJO-A10	58.90	LI	○	●	○	●	○	○										●			●			●	△	
MJO-A11	49.40	Ore	◎								△									●	●	○				
MJO-A12	99.90	LI		○*	△		△	●									●	△			○			●	△	*Andesine

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

1-5 Discussion

Geologic, geophysical and drilling surveys were carried out in Area A centering the Hayl as Safil deposit in a period of two years. Details of the survey results are as mentioned before.

These survey results delineated exact nature of the Hayl as Safil deposit and clarified that the Hayl as Safil deposit was one of the biggest copper deposit in the northern Oman Mountains region. Geologic plan maps of 600 and 650 m levels are shown in Fig. 1-26.

According to the survey results in Area A, followings are thought to be very important for further exploration work.

① The Hayl as Safil deposit is situated at the top of the Lower Extrusives I and is overlaid with the Lower Extrusives II. Known copper deposits in the Sohar region occur in the same stratigraphic location of the Hayl as Safil deposit and in the area where the Lower Extrusives II are widely distributed. It is thought that the volcanic activity of the Lower Extrusives II played important role for the formation of this type copper deposits. Therefore, it is important to make attention for the areas where the Lower Extrusives II is developed. These areas may have potential for this type copper deposits.

② The Hayl as Safil deposit is significantly dislocated by the tectonic movement of obduction of the Samail Ophiolite. The ore deposits is also dislocated by the tectonic movement of after abduction. In order to clarify the shape of the ore body, it is very important to analyse the fault movement especially the thrust faults which form in the stage of the obduction. Schematic history of the Hayl as Safil deposit is illustrated in Fig. 1-27.

③ Copper ore deposits in the Sohar region consist of mainly massive sulfide ore. On the other hand, the Hayl as Safil deposit consists mostly of stockwork ore. Because of repeated brecciation of ore zone, it is thought that the ore solution mostly precipitated in the volcanic rock and formed stockwork ore in the Hayl as Safil deposit. Therefore it is very important for the exploration to understand that the nature of ore is depend on the geologic circumstance where the solution precipitates.

④ According to the previous survey results, ore deposits confirmed by drilling survey and mineralized zone which form Main Gossan are interpreted to be different mineralization. Because no significant mineralized zone related to the volcanic activity of the Middle Volcanic Rocks has been found in the Oman Mountains region, it is better to understand that the significant mineralized zones were formed in the same stage of known ore deposits including the Hayl as Safil, Lasail and Bayda deposits.

⑤ Magnetite in the mineralized zone were confirmed in the drill holes completed by MPM at northern and southern ends of the Hayl as Safil deposit. Magnetite in the Lasail deposit is

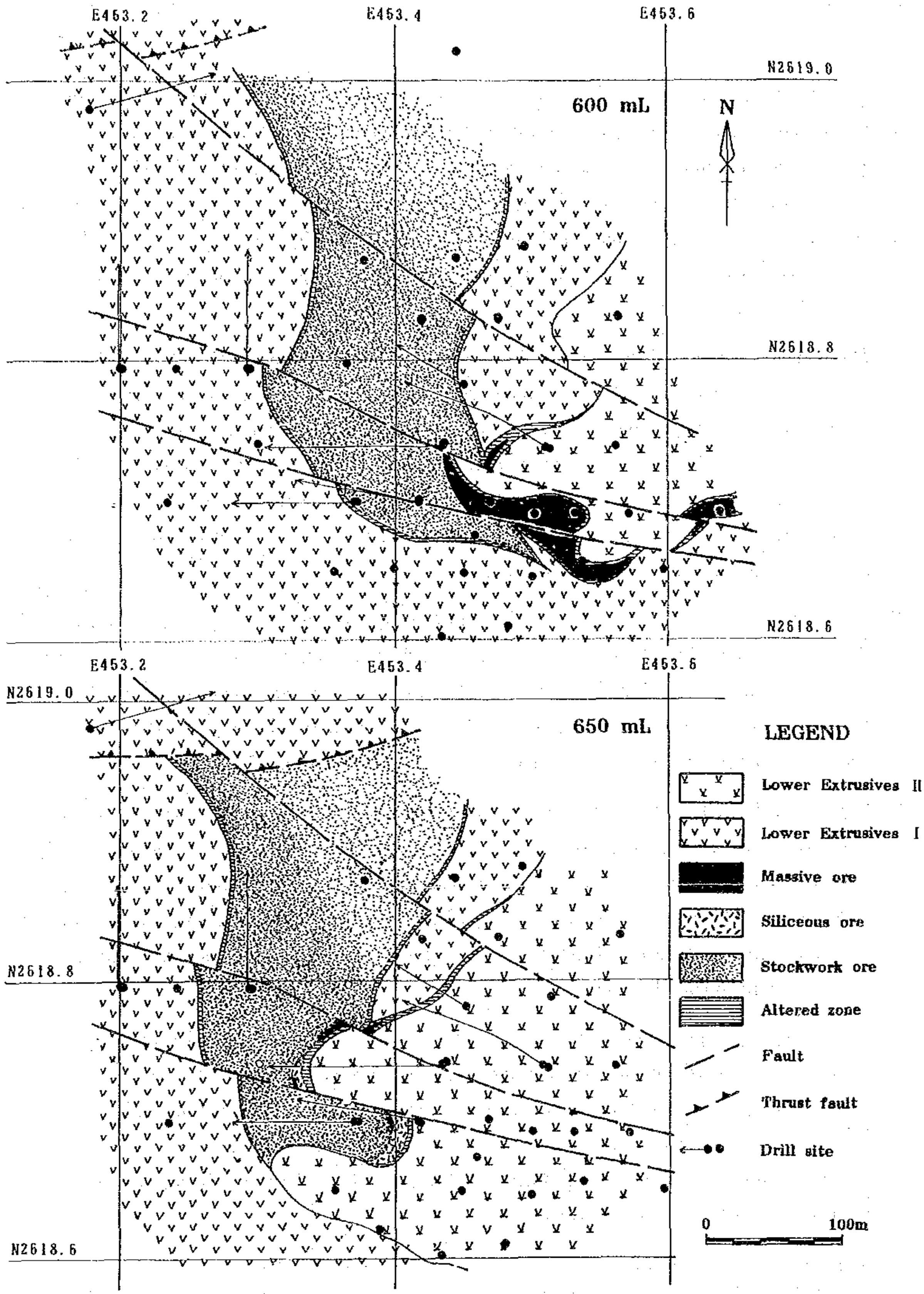


Fig. 1-26 Geologic plan maps of the 600 m and 650 m levels in the Hayl as Safil deposit

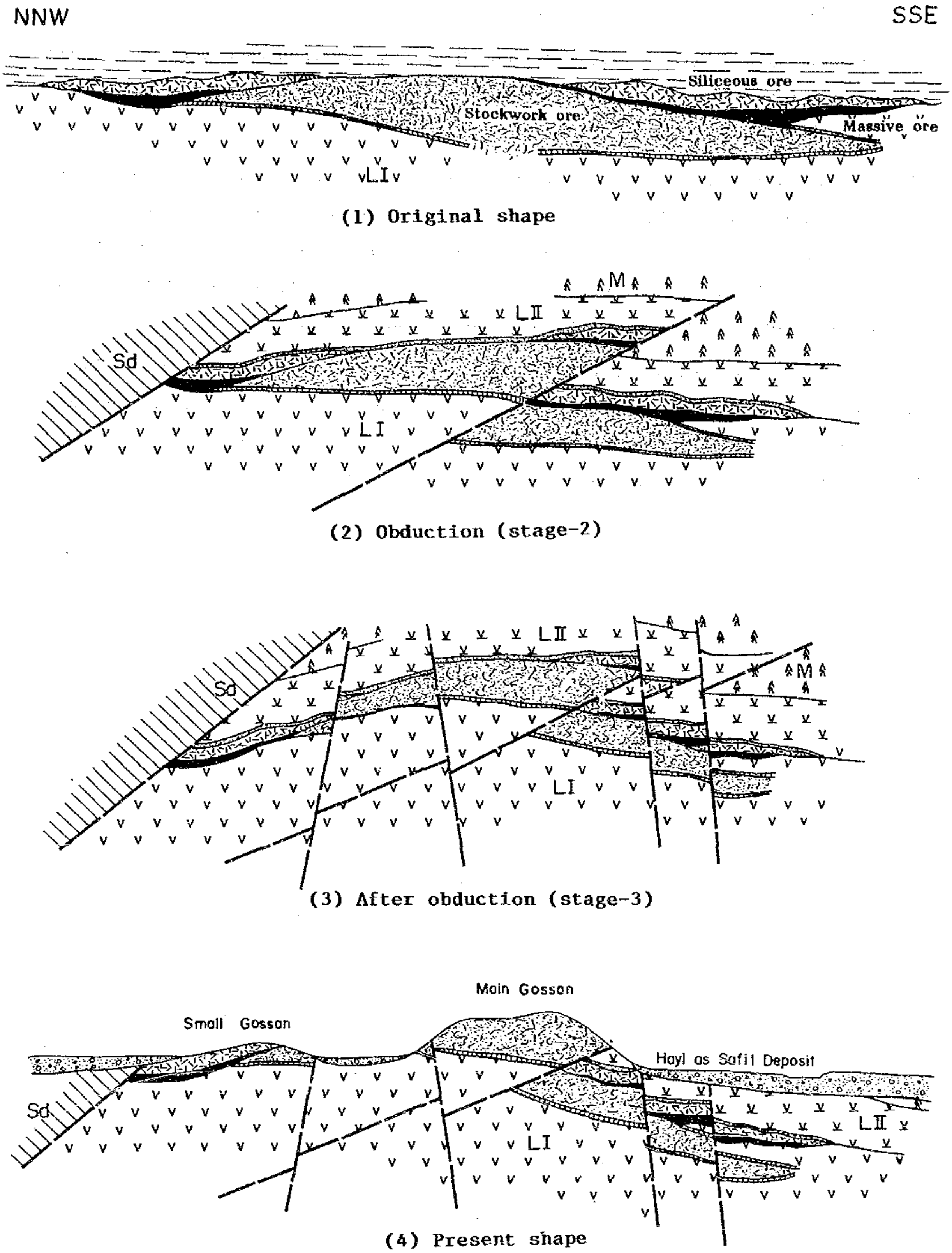


Fig. 1-27 Schematic history of the Hayl as Safil deposit

also recognized at the marginal parts of the deposits. Therefore, magnetite is good indicator to locate the marginal part of the ore deposits.

⑥ Results of the geophysical survey (CP method) outlined the ore deposits very clearly. This method using a electrode in a drill hole which encountered mineralized zone is very efficient method to delineate the mineralized zone.

⑦ Previous drilling was concentrated in the high grade massive sulfide ore zone. However, not only the grade but also the quantity of ore is very important factor for the mine development. It is better to take attention for the quantity even if the ore grade is low. In the early stage of exploration, it is also important to carry out drilling for clarifying to geologic structure and nature of mineralization in order to conduct efficient exploration.

These survey results delineated the Hayl as Safil deposit very clearly except the east and below of Main Gossan due to limited number of drill holes. It is better to carried out some additional drill holes in this area. However, the area of the east and below Main Gossan is possiblely stockwork ore zone and the expected copper grade is low.

Chapter 2 Area B (Rakah deposit)

2-1 General

In order to clarify the potential in Area B, geologic, geophysical (CP method) and drilling surveys were also carried out in the period of two years. The work methods and amounts completed in the Area B are as follows:

Geologic survey:	4 km2, 1:2,000 in scale.
Geophysical survey:	Charged potential (CP) method, 402 stations.
Drilling:	11 holes, 1,583.25 m in total.

These survey results clarified the geology and geologic structure of Area A and the Rakah deposit. The exploration work completed in the Rakah deposit is sufficient and the deposits should go to the mine development stage.

2-2 Geologic survey

2-2-1 Geology

(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 (Fig. 1-1, Fig. 1-2). The Samail Ophiolite is composed of Tectonites, Cumulate Sequence, High-level Gabbro, Sheeted-dyke Complex and Samail Volcanic Rocks in ascending order. The Supra-ophiolite Sediments consists of Suhaylah formation which does not occur in Area A and Olistostrome in ascending order. The Suhaylah formation is sporadically distributed in the vicinity of the Rakah deposit over the volcanic rocks. The geologic map of Area B is shown in Fig. 2-1 and Plate II-2-1. The geologic sections are shown in Plate II-2-2.

The geologic structure (Fig. 2-2) in Area B is also characterized with thrust fault trending from NW-SE to E-W directions. Two major thrust faults at northern part of the area and associated four minor thrust faults are recognized in this area. These thrust faults make imbrication structure and stratigraphically lower units of ophiolite can be observed at the upper part. NW-SE trending fault system is predominant. Anticlinal and synclinal folds are also found in this area.

(2) Stratigraphy

Results of microscopic observation are shown in Table 1-1 and Appendix 1.

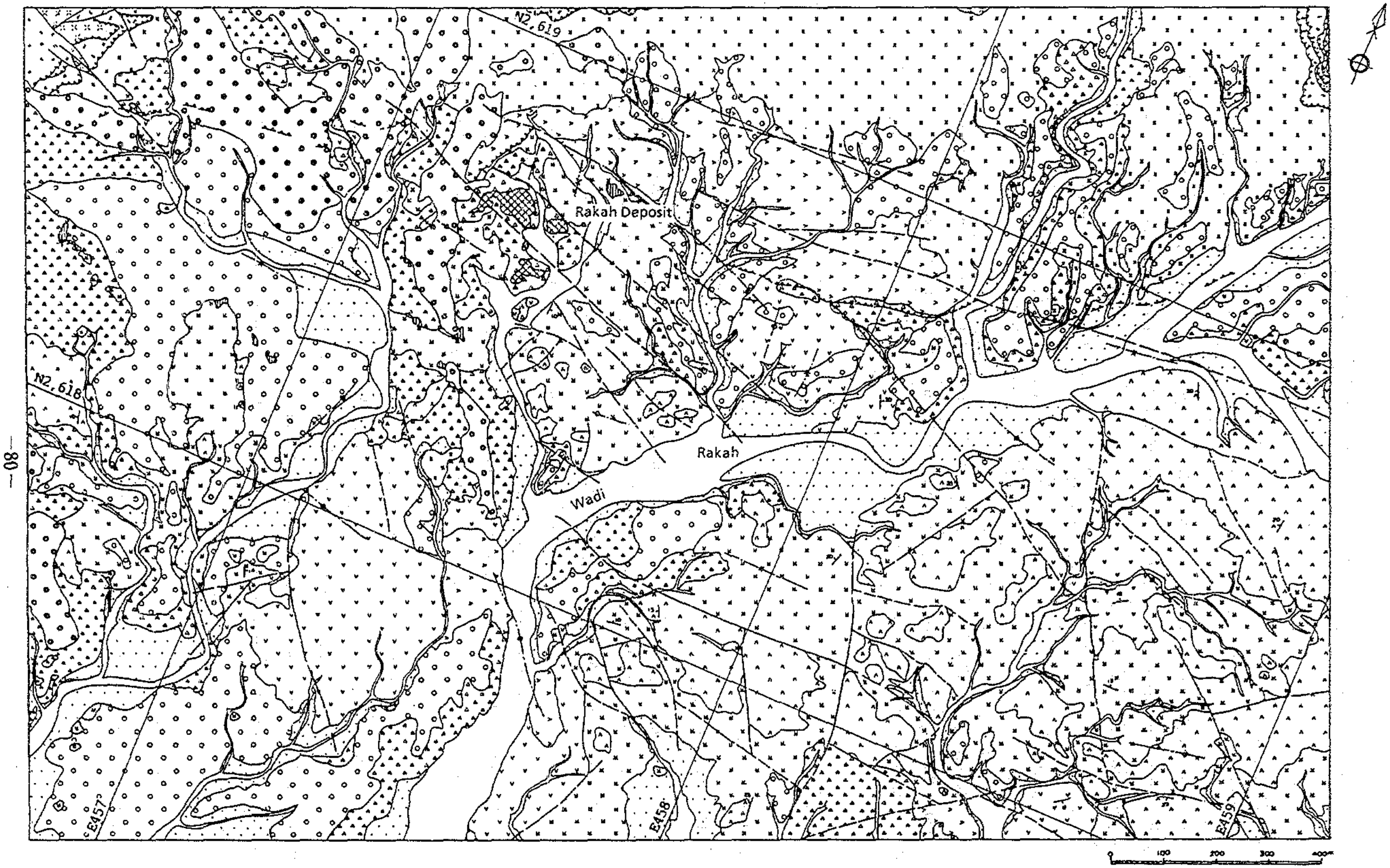


Fig. 2-1 Geologic map of Area B

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

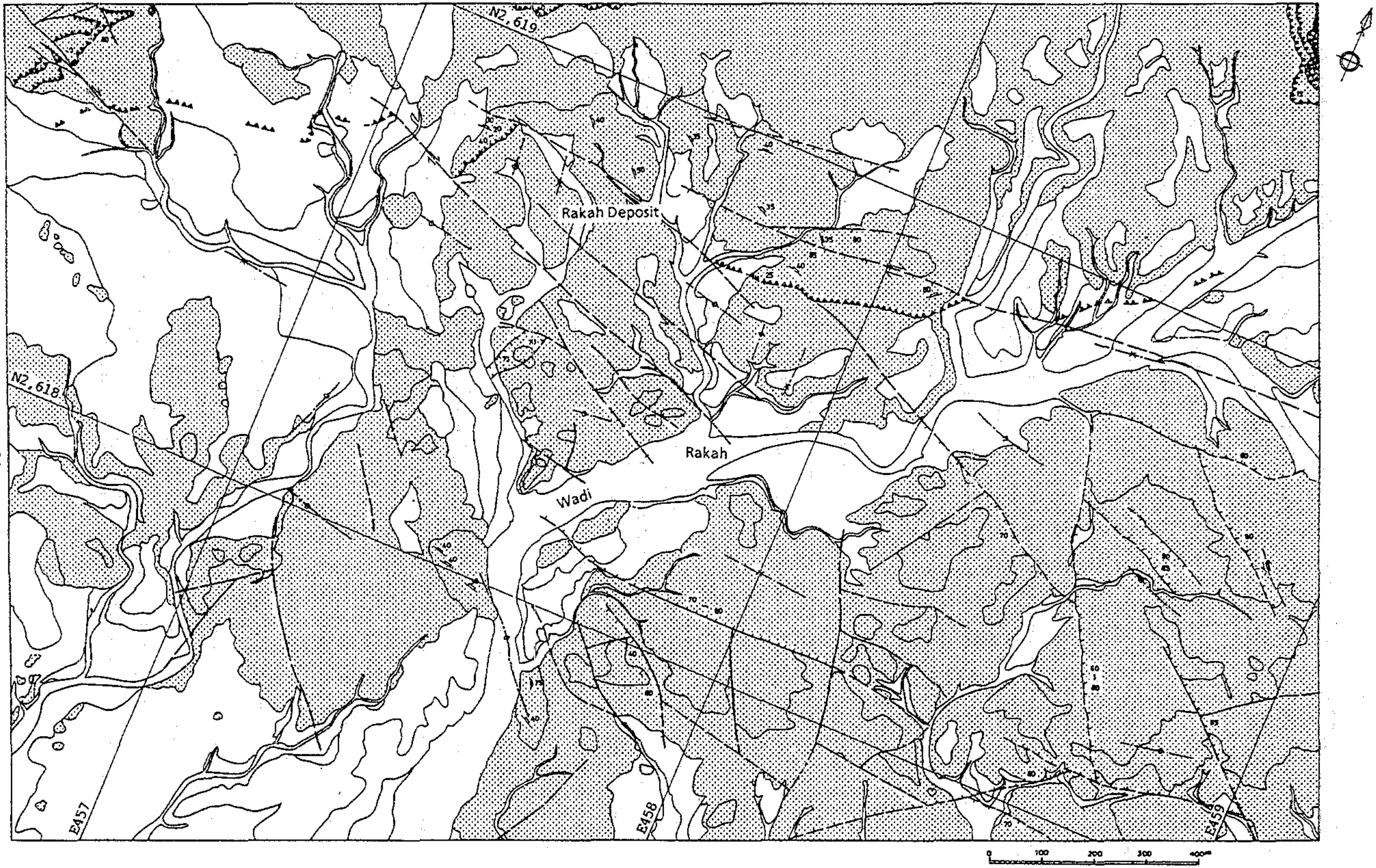


Fig. 2-2 Structural map of Area A (Legend is same as Fig. 1-4.)

(i) **Samail Ophiolite**

The Samail Ophiolite consists of Tectonites, Cumulate Sequence, High-level Gabbro, Sheeted-dyke Complex and Samail Volcanic Rocks in ascending order.

(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 presents 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 Tectonites with a thrust 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 different contents of mafic minerals present rhythmical 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.

(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 this 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) **Sheeted-dyke Complex**

This unit is found in 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.

(e) Samail Volcanic Rocks

The Samail Volcanic Rocks in this area are 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. 2-3. Stratigraphic correlation of volcanic rocks Area A, B and northern Oman mountains region is shown in Fig. 1-7.

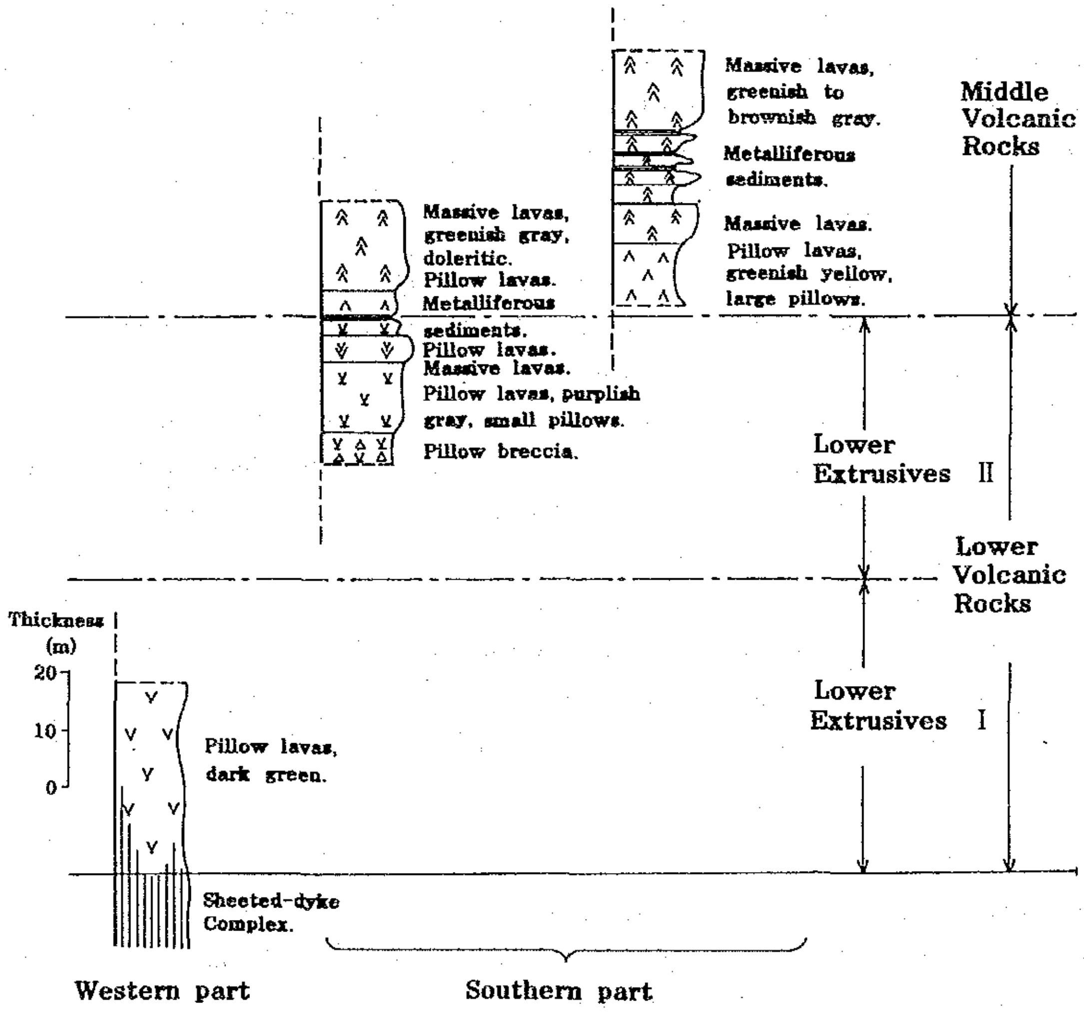


Fig. 2-3 Columnar sections of volcanic rocks in Area B

Lower Extrusives I (LI)

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. Vesicles 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 limited 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. Pillow breccia is scarcely observed on the surface, but drill holes including MJO-B9 on countered comparatively thick pillow breccia at the footwall of the Rakah deposit.

Metalliferous sedimantary layers are red to reddish brown and have thickness of several centimeters to 10 cm. The layer is continuous and consists of fine grained muddy metalliferous sediments. A drill hole, MJO-B10, completed in the southeastern part of the Rakah deposit confirmed five metalliferous sedimentary layers up to 40 cm in thickness in this unit. The layer is reddish brown at the top and bottom, and the middle is dark brown in color.

Lower Extrusives II (LII)

This Rock occurs widely in the area. The unit dips gently from 5° to 25° and has gentle folding structure. The relationship between this unit and overlying Middle Volcanic Rocks is unconformity. The thickness is estimated to be 50 m to 150 m.

This unit consists of pillow and massive lavas and interbedded metalliferous sedimentary layers. 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 cm to 30 cm.

Middle Volcanic Rocks (M)

The rocks are found in the southern part and south of the Rakah deposit in Area B, 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.

(ii) Supra-ophiolite Sediments

This unit is divided into the Suhaylah Formation and Olistostrome in ascending order. The Suhaylah Formation is found in this area, but is not found in Area A.

(a) Suhaylah Formation (Sh)

This formation is defined by Lippard et. al. (1982) in the northern Oman Mountains. The formation yields radio larian fossils dated as Late Cretaceous (Turonian to Campanian) (Bishimetal, 1987).

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 meters to several tens meters. It shows chaotic structure and includes red chert (Och), bedded limestone (Ols), dirty limestone (Ols)and serpentinized harzburgite (Sp). 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.

(iii) Quaternary

Quaternary superficial deposits are divided into terrace deposits, debris 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) have 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) are 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 breccias ranging the diameter from 1 cm to 30 cm.

(c) **Wadi Sediments (Qw)**

Wadi Sediments (Qw) are found along wadis and consist of rounded to subangular gravels ranging 1 cm to 25 cm in diameter and sand.

(iv) **Intrusive Rocks**

Dykes found in Area B is divided into dykes and late dykes. The dykes occur in 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 observed.

2-2-2 Geologic structure

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

Two major thrust faults are found in the northwestern and northeastern parts of Area B (Fig. 2-2). One is situated between Cumulate Sequence to High-level Gabbro and Tectonites 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. Shear 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 anticlinal and synclinal folds trending N-S are found in the central part of the area.

2-2-3 Mineralization

(1) General

The mineralized zone found in Aera B is limited to the Rakah deposit. The mineralized zone at the western part of the deposits is situated at the boundary between the Lower Extrusives I and II and forms massive ore zone where sedimentary rocks are intercalated at the boundary. The stockwork ore zones are found from the central to eastern parts of the deposit area in the Lower Extrusives I. The stockwork ore zone forms two zones of the upper and lower mineralized zones in the central part of the deposits, and volcanics of the Lower Extrusives I are intercalated between these two mineralized zones (Fig. 2-5). At the eastern part of the deposits, the intercalated volcanics thin out and form one mineralized zone with comparatively poor mineralization. Western extension of the upper mineralized zone reached to the surface and the zone was affected with intense gossanization. Contacts between the Lower Extrusives I and II occur at several places in Area B but no mineralized is observed except the Rakah deposit area. The geologic setting of the Rakah deposit is similar to that of the Hayl as Safil deposit. The Rakah deposit is also classified into the Cyprus type massive sulfide deposit.

(a) Geology of the Rakah deposit area and the gossan zones

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 reaches to the surface at the western part of the Rakah deposit area and is strongly gossanized.

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 eleven drill holes were carried out in this survey. Based on these survey results, geologic map and geologic sections were made as shown in Fig. 2-4 and Fig. 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 zones. The gossan zones are 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 Extrusives II. Dykes in the Sheeted-dyke Complex trend in an E-W direction. 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. The Suhaylah Formation consisting mainly 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.

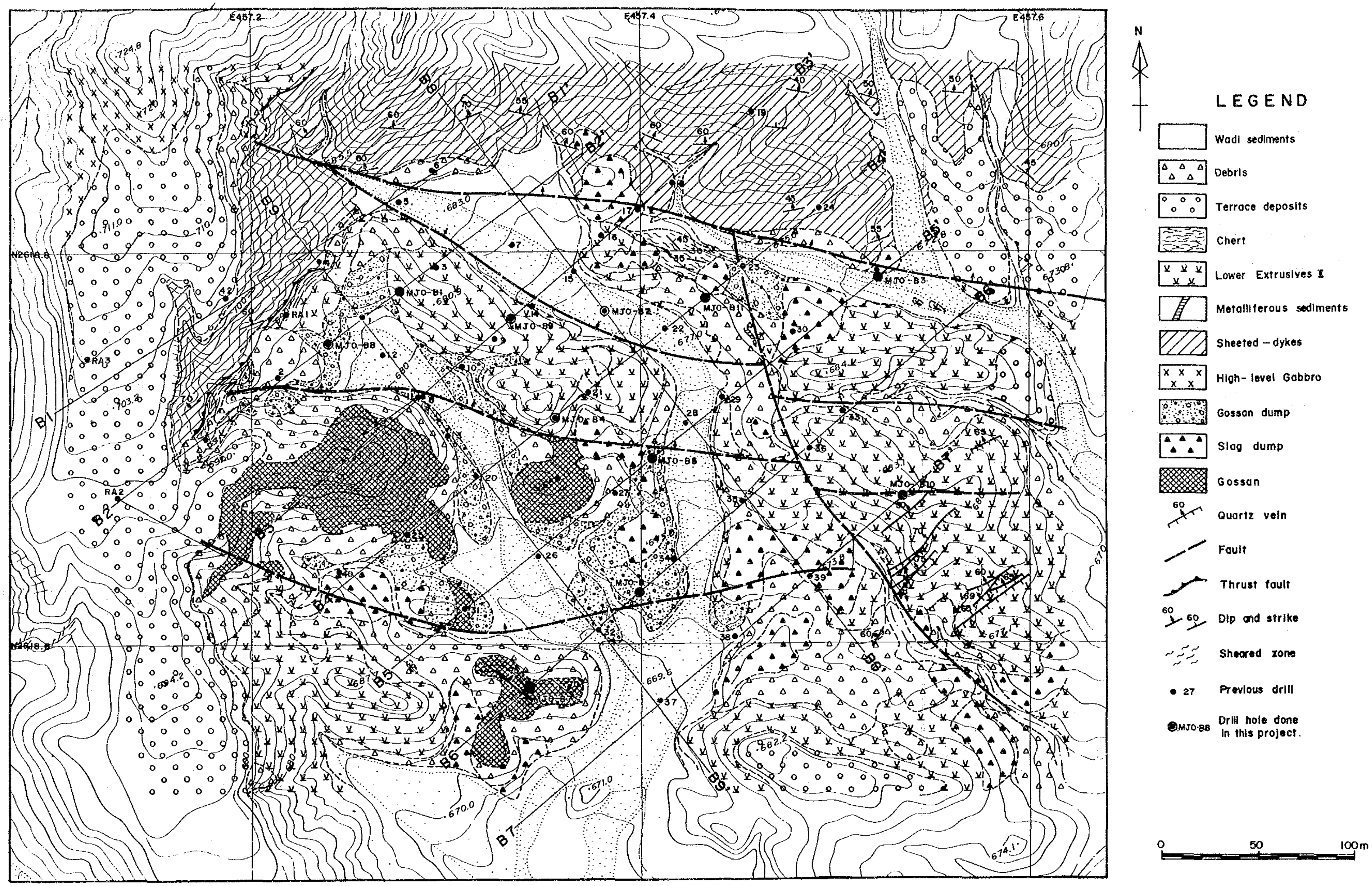


Fig. 2-4 Geologic map of the Rakah deposit area

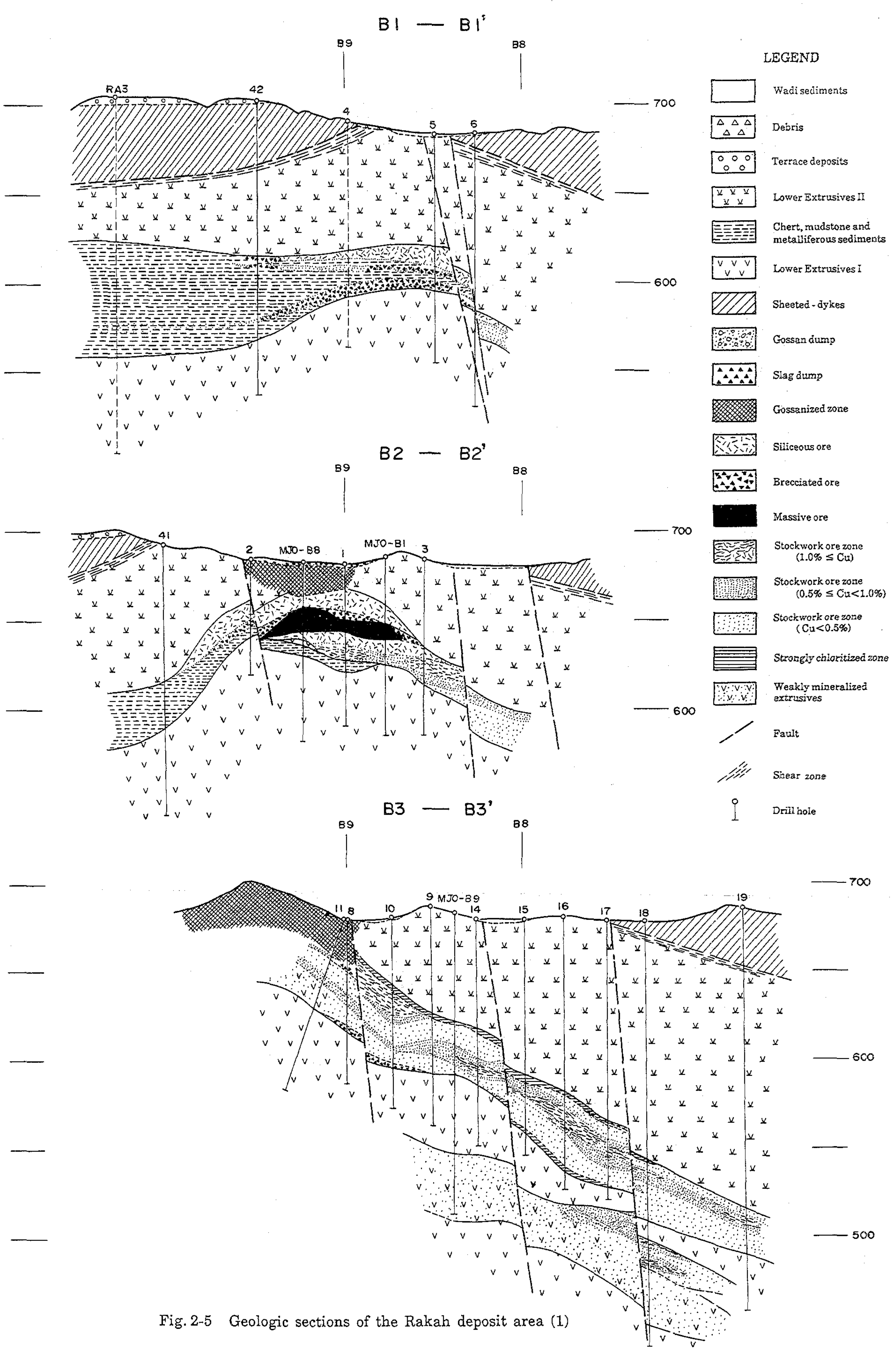


Fig. 2-5 Geologic sections of the Rakah deposit area (1)

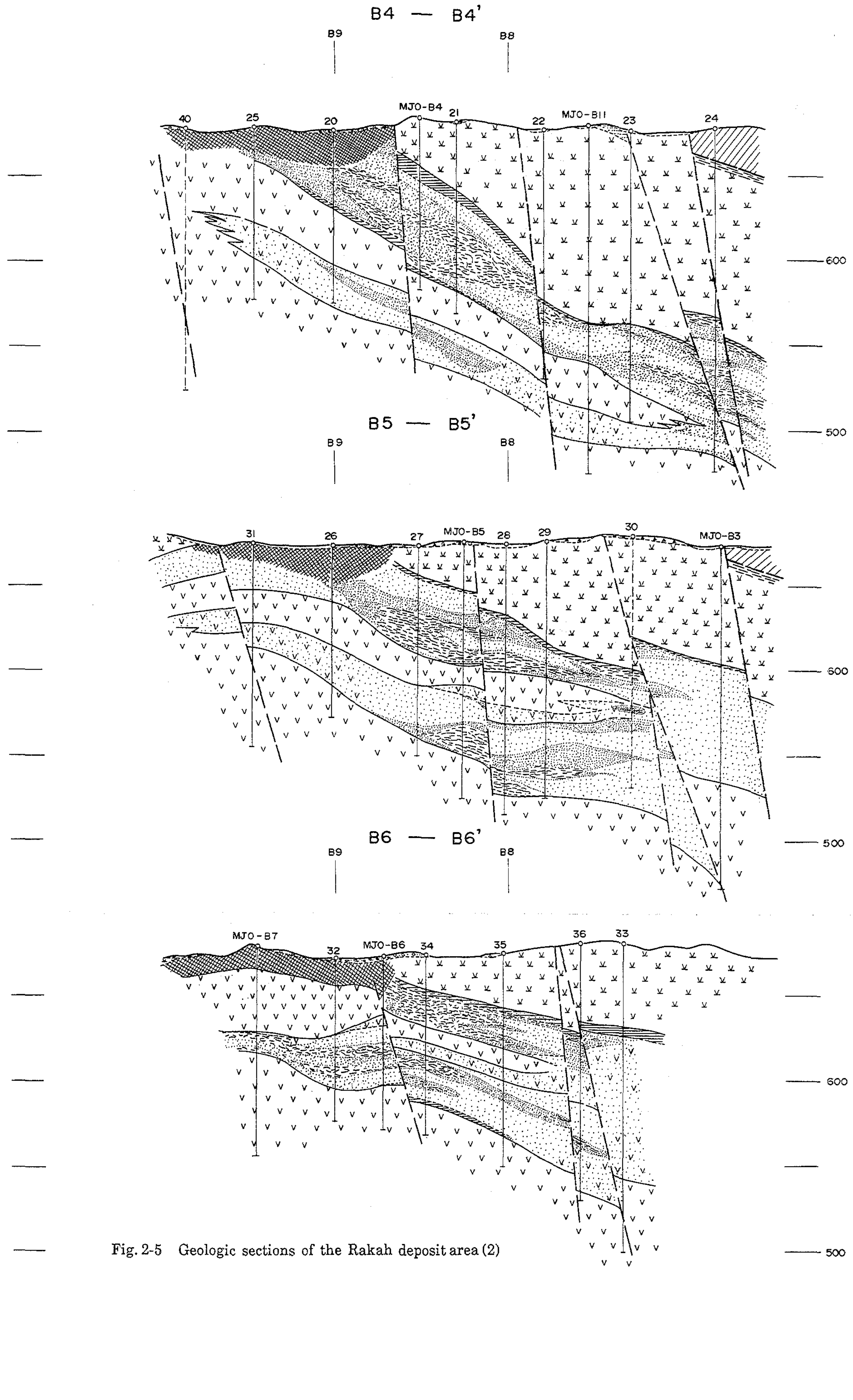


Fig. 2-5 Geologic sections of the Rakah deposit area (2)

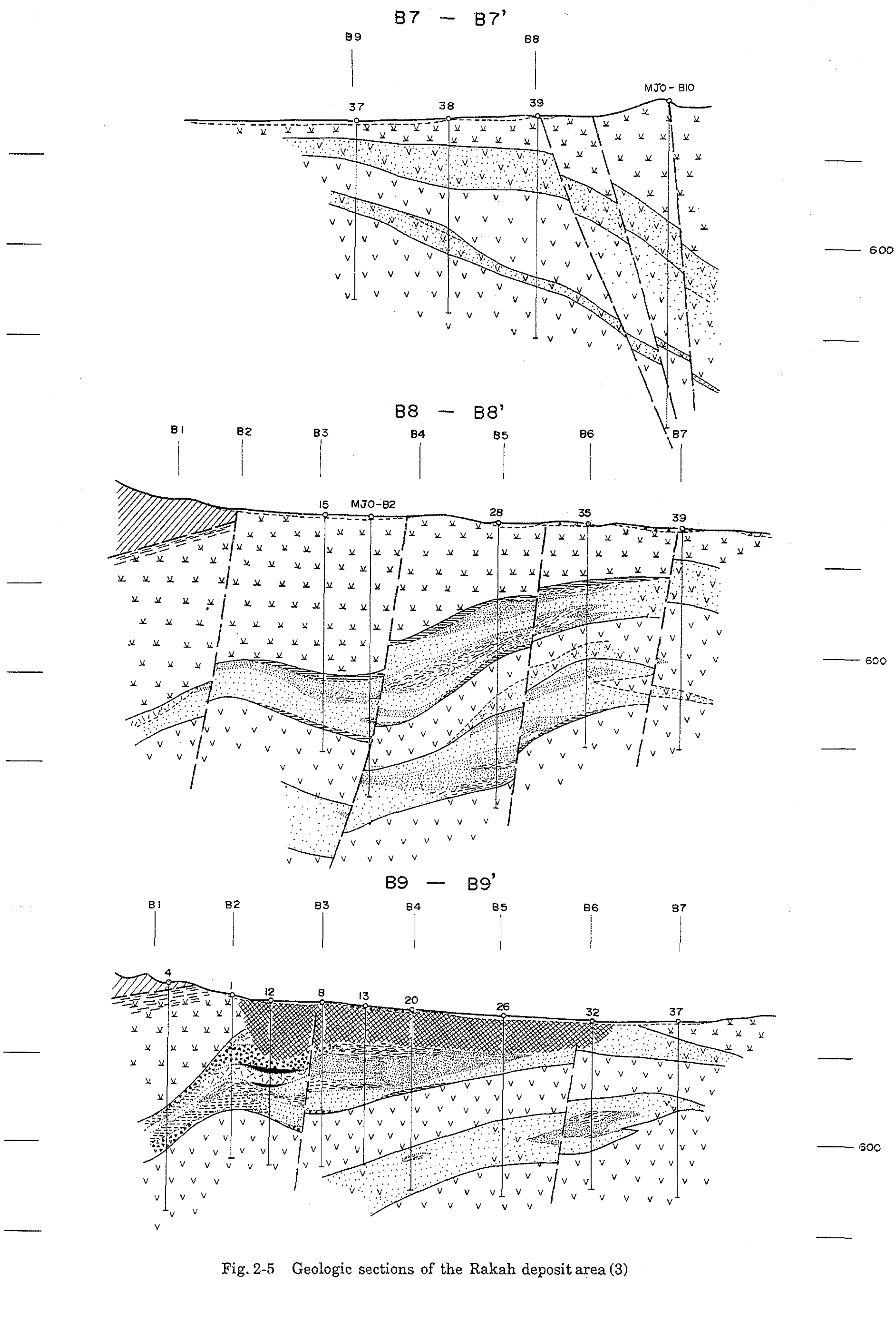


Fig. 2-5 Geologic sections of the Rakah deposit area (3)

The slags indicate ancient working for mining and smelting in the area. Gossan dump 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 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 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 minerals are locally found within the gossan. Several quartz veins with secondary copper oxide minerals are found in the Lower Extrusives II at the eastern part of the area. This kind of quartz vein is found in the Sohar area and is interpreted to have close relation with the Middle Volcanic rocks.

(b) Upper mineralized zone

The footwall rocks of the upper mineralized zone are the Lower Extrusives I. Weak pyrite dissemination is found in the Lower Extrusives I where the Lower mineralized zone occurs beneath the zone. The hanging wall rocks of the upper mineralized zone are the Lower Extrusives I. However, no weathered surface can be observed at the top of the stockwork ore zone, and some parts of the stockwork ore zone may be covered with the Lower Extrusives I. Sedimentary rocks consisting mainly of chert are found at the boundary between the Lower Extrusives I and II in the area where the massive ore occurs. The footwall volcanic rocks thin out at the eastern part of the Rakah deposit area, and the upper and lower mineralized zones form ore mineralized 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 boundary between the footwall rocks and the mineralized zone. However, the eastern part of the mineralized zone shows 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 massive, brecciated and siliceous ores were confirmed 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. 2-5. The massive ore zone consists of pyrite except the top and bottom where minor breccia of siliceous ore occurs. The massive ore is brecciated and the matrix is filled with fine-grained sulfide minerals. Franboidal and colloform textures are found in the pyrite breccia. The brecciated ore was not confirmed in this survey, but geologic logs for previous drill holes suggest that the ore is the intensely brecciated massive ore. The siliceous ore is brecciated siliceous rock originated from chert, and the matrix of breccia is filled with fine-grained sulfide minerals. The massive and siliceous ores confirmed by the drill hole MJO-B1 and -B8 show high concentration of Au and dominant supergene copper minerals.

The stockwork ore zone is hosted with brecciated, silicified and strongly chloritized pillow lavas, and pillow forms are found in the weakly mineralized stockwork zone. Ore minerals in the zone are pyrite, chalcopyrite and subordinate sphalerite. The sulfide minerals, especially pyrite, in this stockwork zone are less than those in the Hayl as Safil deposit. Pyrite and chalcopyrite are generally found as disseminations and veinlets. The matrix of breccia is filled with pyrite and chalcopyrite, and quartz veins with these sulfide minerals are also found in places. Copper concentrated zone in the mineralized zone is mostly found in the central part of the ore deposits, but shows irregular shape. Only weak mineralized and altered zones with weak pyrite disseminations and stringers are found in the eastern and southern extensions of the ore deposits.

(c) Lower mineralized zone

The lower mineralized zone is significant below the central part of the upper mineralized zone, and the scale of the mineralized zone is smaller than the upper mineralized zone. The lower mineralized zone consists of stockwork ore zone and the occurrences of the stockwork zone are similar to that of the upper mineralized zone. The lower mineralized zone forms a mineralized zone together with the upper mineralized zone at the east. But only pyrite disseminations are observed in this zone. Weakly mineralized zone with pyrite disseminations and stringers are also found in the northern, southern and western extensions of the lower mineralized zone.

(3) Gold in gossanized zone and gossan dump

The drill hole MJO-B1 in Phase I encountered Au concentrated massive ore zone (D.L. 18.30m, 8.96 g/t Au, 13.3 gt/ Ag). This fact suggested the existence of Au concentrated zone in the gossanized zone and the gossan dump nearby the gossanized zone. In order to clarify the Au potential in the gossan and gossan dump, sampling from the gossan and gossan dump for ore assaying were carried out in this survey. This survey is also important to confirm whether the gossan and gossan dump should be treated as the Au ore or not when the project goes to mine development stage. Samples collected for this survey are as follows:

MJO-B7 (Gossanized zone)	6 samples
MJO-B8 (Gossanized zone)	9 samples
Grossanized zone on the surface	21 samples
Gossan dump	31 samples
Slags	3 samples

Assay results for the gossan samples of drill holes MJO-B7 and -B8 are shown in geologic logs of Appendix 13. Locations of the sample sites for the gossan, gossan dump and slags are shown in Fig. 2-6 and the assay results are shown in Appendix 9.

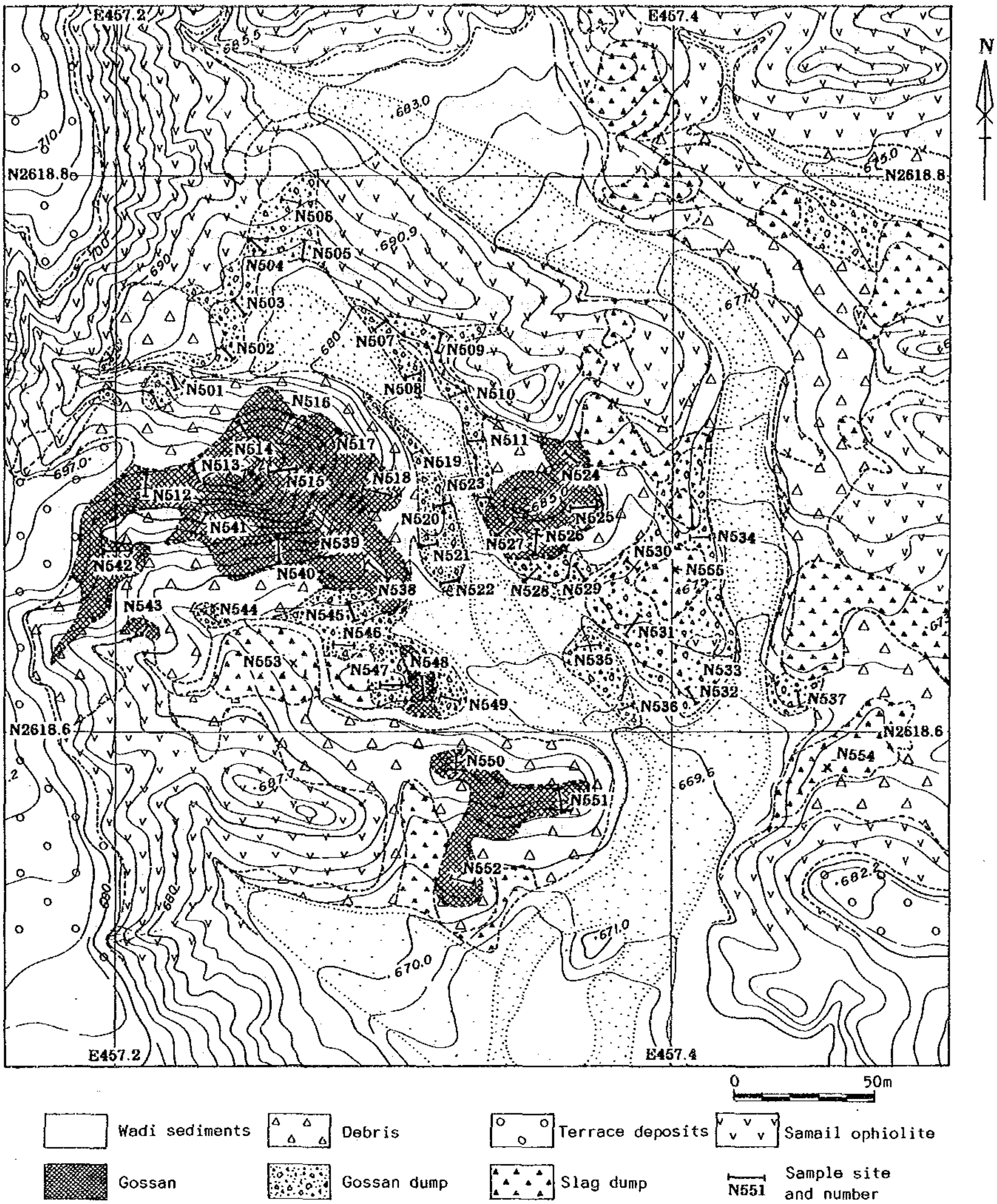


Fig. 2-6 Location map of samples collected from gossan zones for assaying in Area B

A drill hole MJO-B7 was carried out at gossan zone in the south of the Rakah deposit and encountered gossanized zone from the surface to 12.70 m in depth. This hole encountered a high Au gossan zone (7.55 g/t Au, 15.81 g/t Ag) from the surface to 3.80 m in depth. Average assays for the gossanized zone (0.00 ~ 12.70 m) are as follows:

D.L.: 12.70 m, 2.62 g/t Au, 6.00 g/t Ag, 0.16% Cu, 0.01% > Zn

A drill hole MJO-B8 was carried out in the massive and siliceous ores zone at the northwest of the Rakah deposit. This hole encountered the siliceous ore from the depth of 12.70 m and the massive ore from 24.70 m in depth. This siliceous ore shows extreme concentration of Au. The best core section gives 113.4 g/t Au and 182.3 g/t Ag (18.75 ~ 20.25 m in depth). Average assays for the Au concentrated zone (17.40 m ~ 24.70 m) are as follows:

D.L.: 7.30 m, 49.03 g/t Au, 97.71 g/t Ag, 0.10% Cu, 0.01% Zn

The assay results for the gossan and gossan dump delineated a area (200 m × 80 m) along wadi in the center of the gossan zones where containing more than 1.0 g/t Au in the gossan. Average assay values for this area are 3.36 g/t Au and 5.37 g/t Ag. The area of massive and siliceous ores zone tends to show higher concentration of Au and Ag.

Based on these surface and drilling survey results, it is possible to estimate 300 thousand tons for the gossanized zone which possibly contains comparatively high Au and Ag (5.0 g/t Au, 10.0 g/t Au).

2-3 Geophysical survey

2-3-1 Survey method

In order to delineate an extension of the Rakah deposit and to obtain the guideline of the further drilling survey, Charged Potential (CP) survey was conducted in an area of 2 km^2 in Area B. Summary of the CP method is given in paragraph 1-3 of Chapter 1.

(1) Measurement

In Area B, 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. 2-7. Coordinates of each of measuring points in meters was decided by setting 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 MJO-B1 hole, and at the stockwork ore of the lower mineralized zone in the MJO-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 (N2614.7, E455.1) between Area A and Area B.

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

Current electrode	Drill hole	Depth of electrode	Remarks
Charging point (C1)	MJ0-B1	44 m	Upper mineralized zone
	MJ0-B5	115 m	Lower mineralized zone
Far current electrode (C2)	HS-14	104 m	Haly as Safil deposit

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 equipment as used in Area A was adopted in this survey.

(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, MJO-B1 and MJO-B5, were made. In order to clarify the distribution of the Rakah deposit, the quantitative delineation of the conductor is also done by two-dimensional (2-D) model simulation using 2-D finite element method. The charged potentials and electric fields at each CP station are shown in Appendix 10 and 11, respectively. The plan maps of charged potentials due to two drill holes, MJO-B1 and -B5, are shown in Fig. 2-8 and Fig. 2-9, respectively.

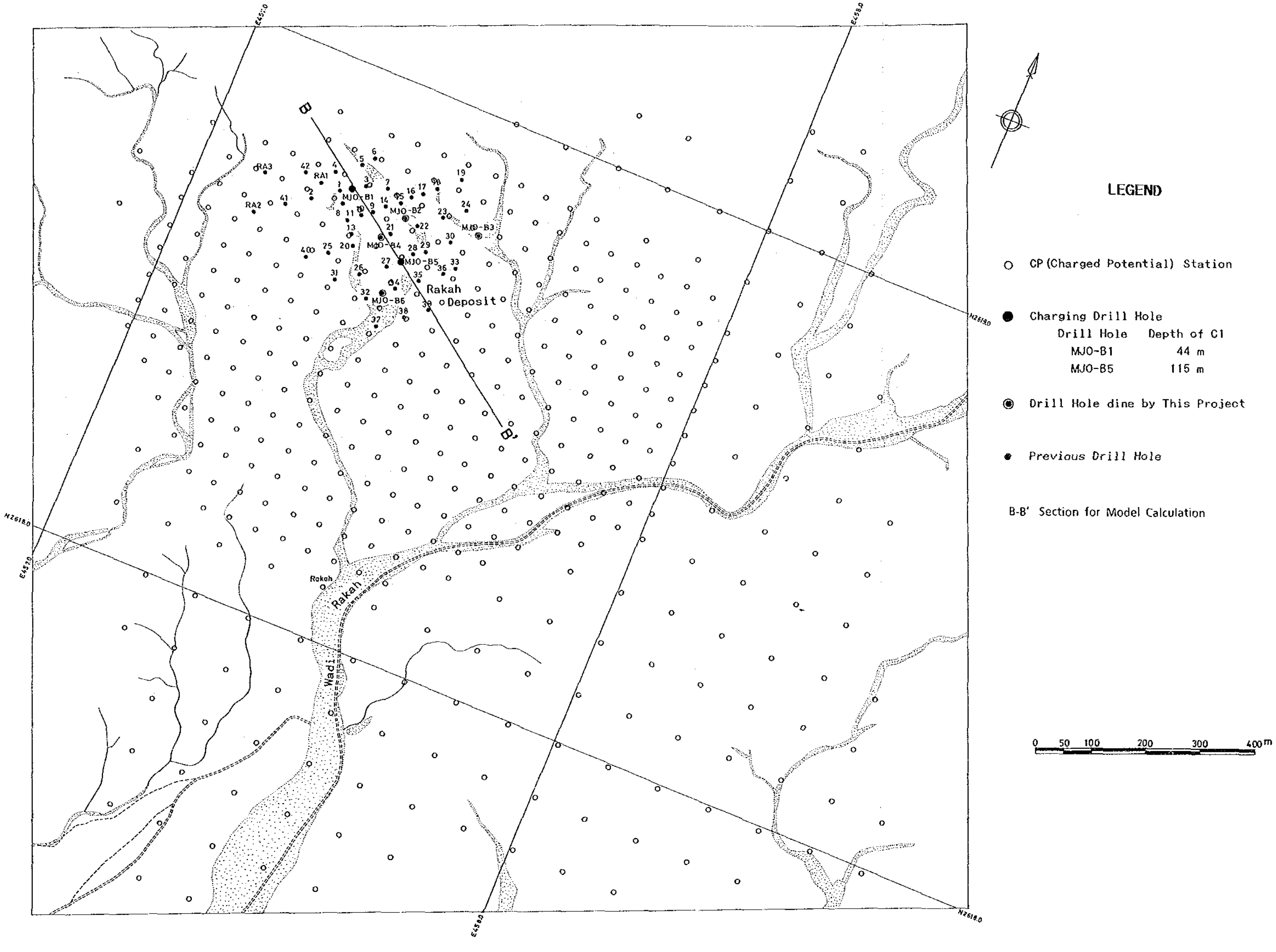


Fig. 2-7 Location map of CP survey stations in Area B

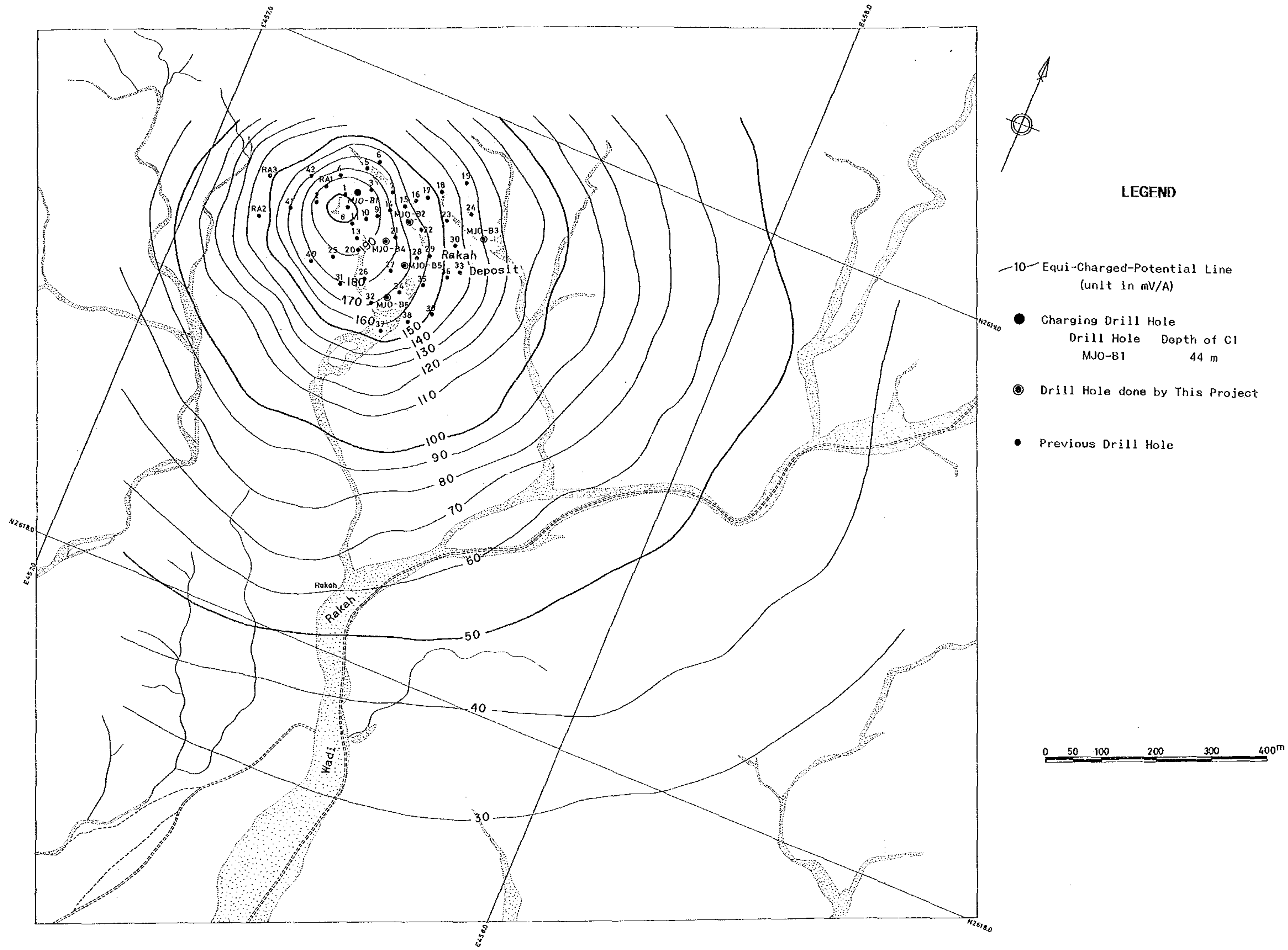


Fig. 2-8 Charged potential map for the drill hole MJO-B1

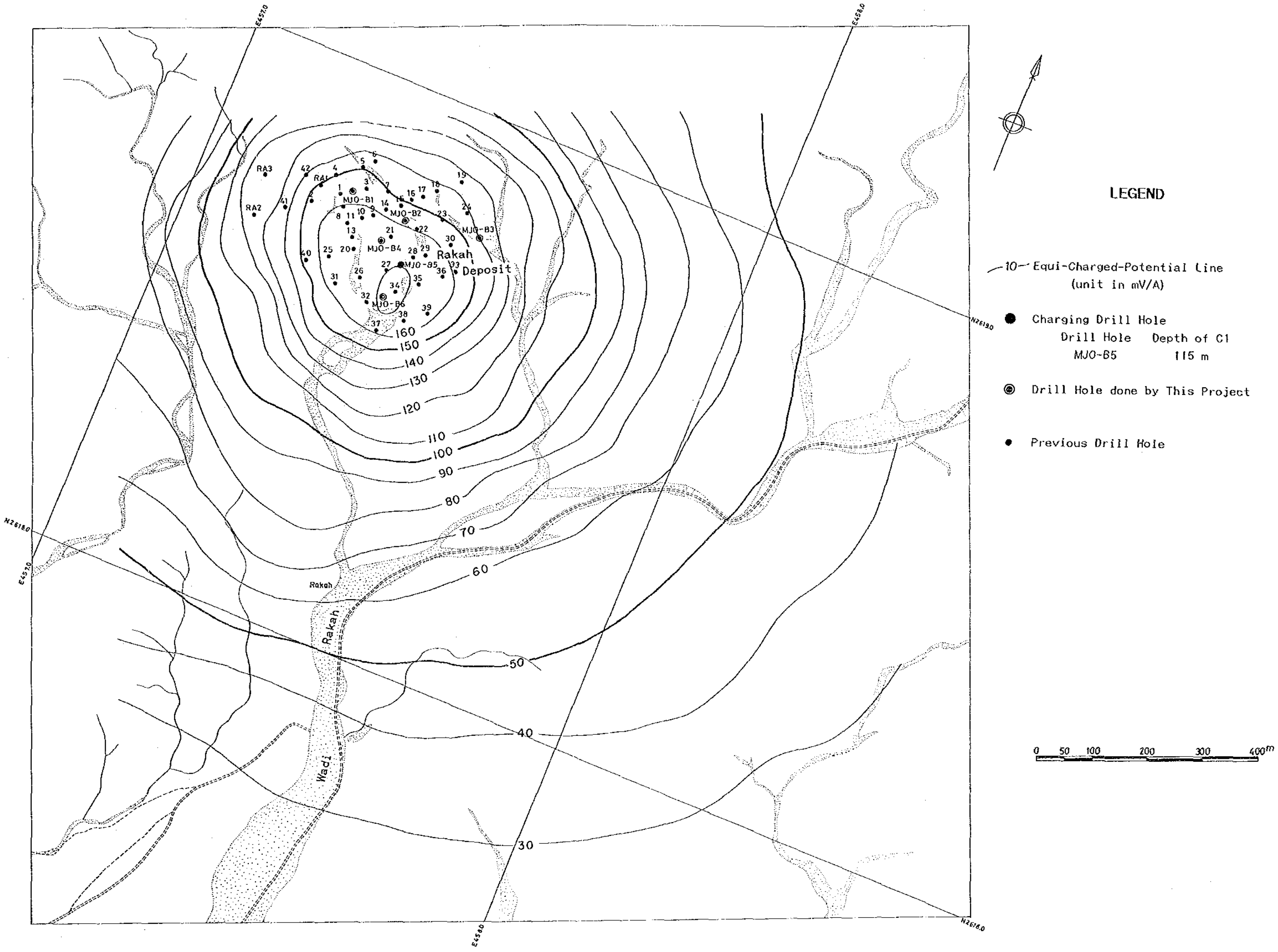


Fig. 2-9 Charged potential map for the drill hole MJO-B5

The plan maps of electric fields due to these two holes, MJO-B1 and -B5, are shown in Fig. 2-10 and Fig. 2-11, respectively.

2-3-2 Results of survey

(1) *Charged potentials*

The charged potentials due to both of two holes, MJO-B1 and MJO-B5, show similar distribution patterns extending in NW-SE direction, each together, excepting for the different patterns in the province of the holes.

(a) Charged potentials due to MJO-B1

A charged potential plan map due to charging point placed at the depth of 44 m in the MJO-B1 hole is shown in Fig. 2-8.

On this plan map, the highest peak of charged potential of 203 mV/A is observed at the middle point between the MJO-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 MJO-B1 hole, and gradual decreases toward the southeast (MJO-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.

(b) Charged potentials due to MJO-B5

A charged potential plan map due to charging point placed at the depth of 115 m in the MJO-B5 drill hole is shown in Fig. 2-9.

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

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 MJO-B1 hole and in the lower mineralized zone in the MJO-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 continue 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

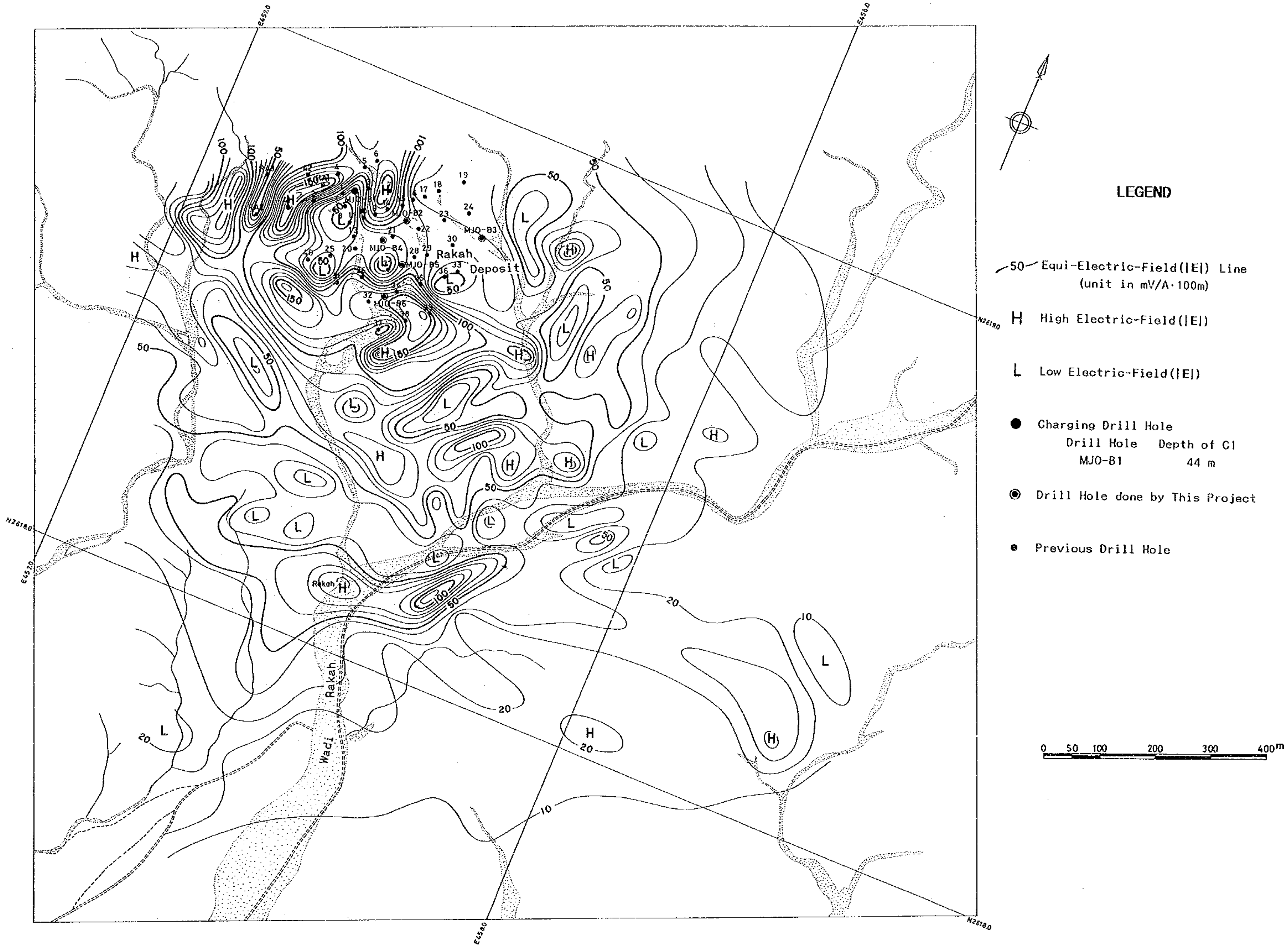


Fig. 2-10 Electric field map for the drill hole MJO-B1

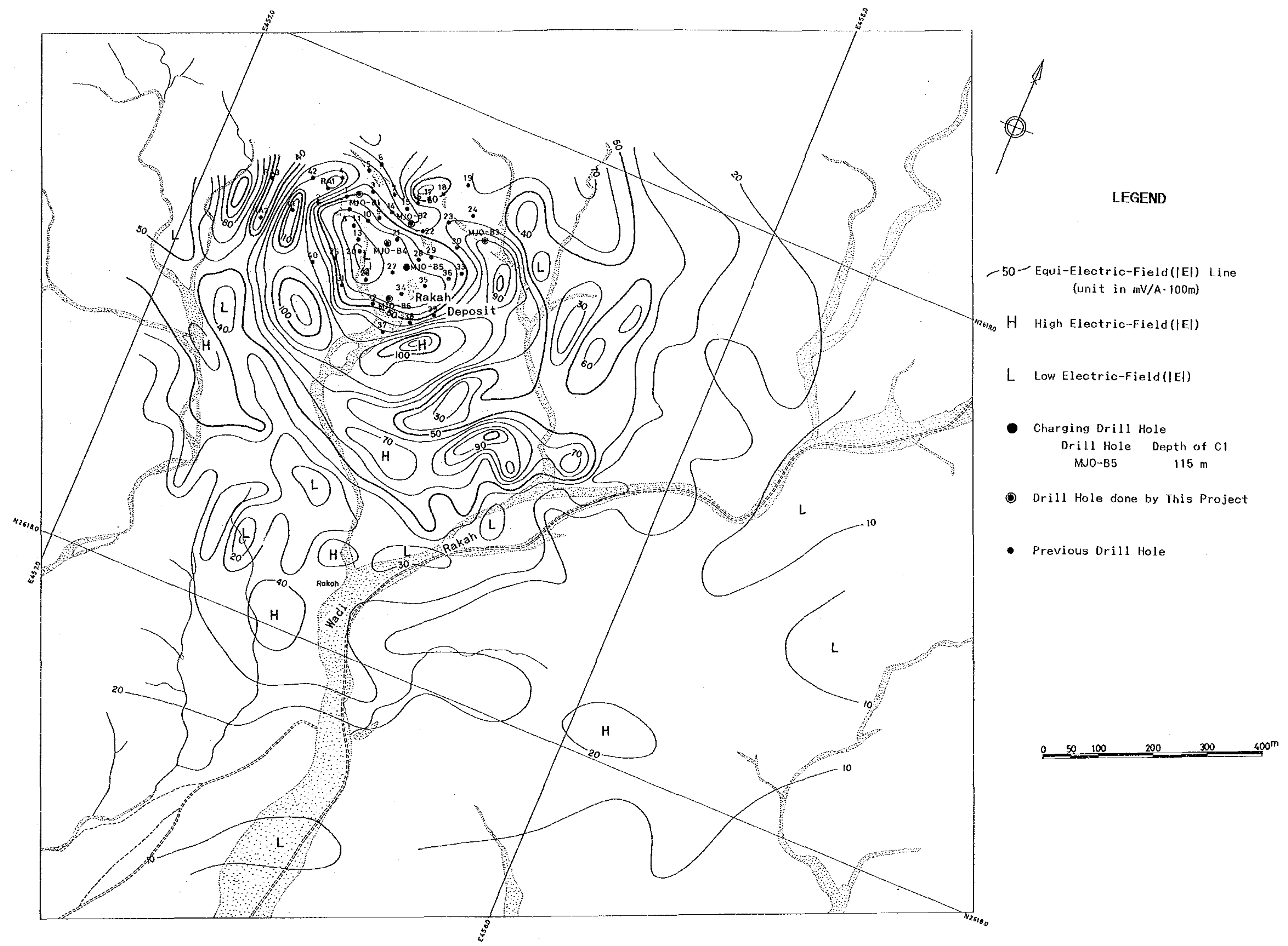


Fig. 2-11 Electric field map for the drill hole MJO-B5

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 MJO-B1 hole, like the plan map of the MJO-B1 hole (Fig. 2-7), and also at 100 m southeast of the MJO-B5 hole. And the boundaries of the conductor including ore deposits seem to be located at these sharp gradient portions.

(2) Electric fields

Comparing with the distribution patterns of | E | (intensity of electric field) for the holes, MJO-B1 and -B5, the high and low | E | anomalies due to the MJO-B1 are small and complicated. And arrangement of the high and low | E | anomalies show some directions. The high and low | E | anomalies due to the MJO-B5, on the other hand, show large and simple distribution patterns. However, no significant differences are found for these two distribution patterns in general.

(a) Electric fields due to MJO-B1

The electric fields due to MJO-B1 hole is shown in Fig. 2-10. On this map, the MJO-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 MJO-B5 hole. This complicated 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 in 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 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.

(b) Electric fields due to MJO-B5

The electric fields due to MJO-B5 hole is shown in Fig. 2-11.

This map shows a smoothed distribution pattern on the plan map of the MJO-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.

The distribution area of the Rakah deposit inferred by the results of the charged potential survey shows 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 MJO-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. 2-7. The results of the calculation are shown in Fig. 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 MJO-B1, MJO-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.

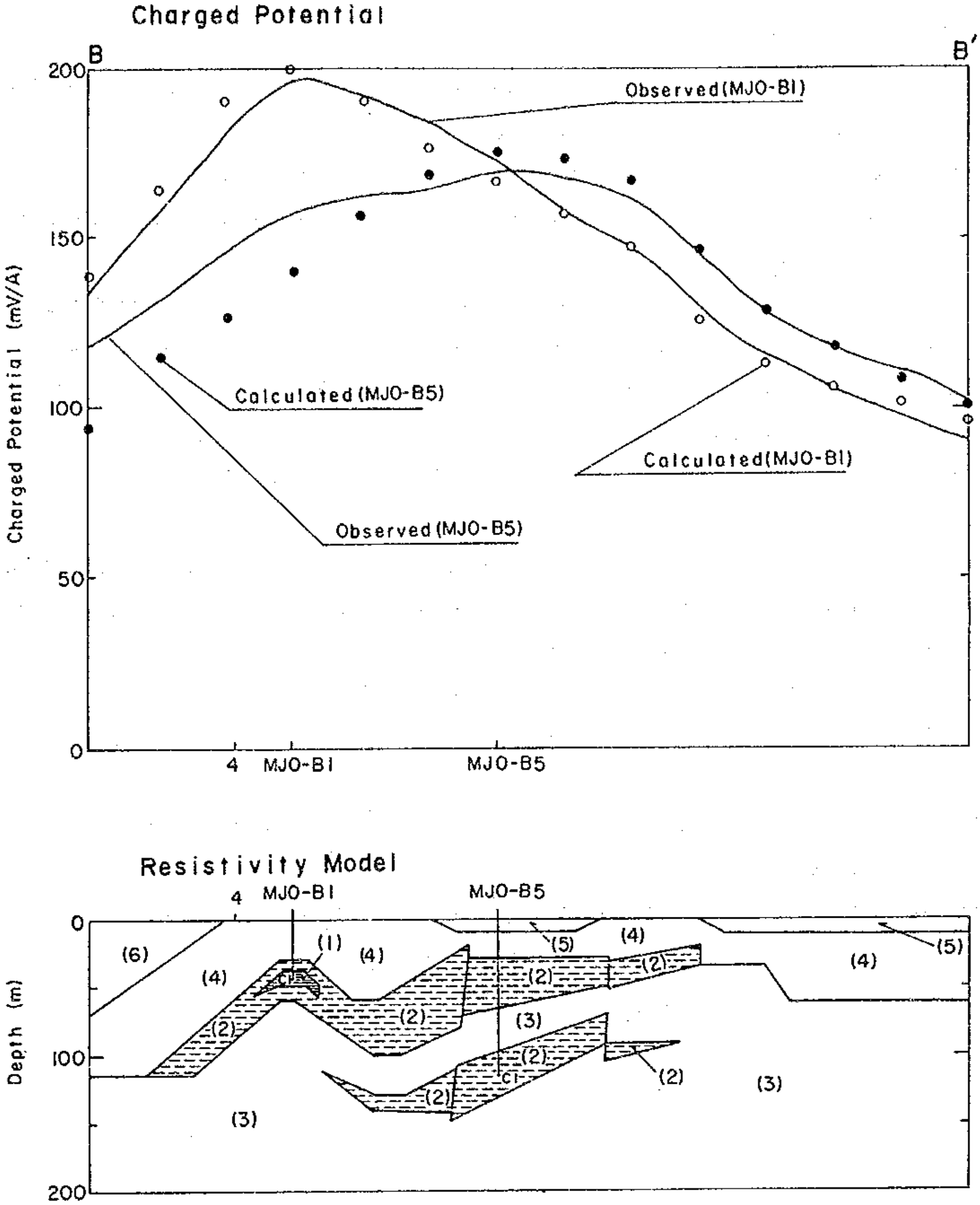
Resistivity of each formation and each mineralized zone of the final model is 1 Ω · m for massive ore, 5 Ω · m for stockwork ore, 1,000 Ω · m for Quaternary sediments, and 20Ω · m for Lower Extrusives II, 100Ω · m for Lower Extrusives I, 1,400 Ω · m for sedimentary rocks.

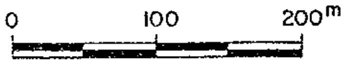
The both of the upper mineralized zone (massive ore; 1 Ω · m and stockwork ore; 5 Ω · m) and the lower mineralized zone (stockwork ore; 5 Ω · m) decrease those thickness with being cut by fault structures from the center towards the both ends.

The upper mineralized zone is distributed from 100 m northwest of the MJO-B1 hole to 150 m southeast of the MJO-B5 hole, and its maximum thickness is about 50 m. While, the lower mineralized zone is distributed from 50 m southeast of the MJO-B1 hole to 150 m southeast of the MJO-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 Extrusives 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 MJO-B5 hole, and when the distribution area of the lower mineralized zone increased at the northwest of the MJO-B5 hole.





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

Fig. 2-12 Results of model calculation and its resistivity structure for the Rakah deposit

(4) Summary of geophysical survey results

A geophysical interpretation map is shown in Fig. 2-13. A distribution of the Rakah deposit inferred 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 MJO-B5 hole, shows width of 400 m in E-W and of 300 m in N-S. The Rakah deposit is distributed in an 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 thrust 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 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 succeeds 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.

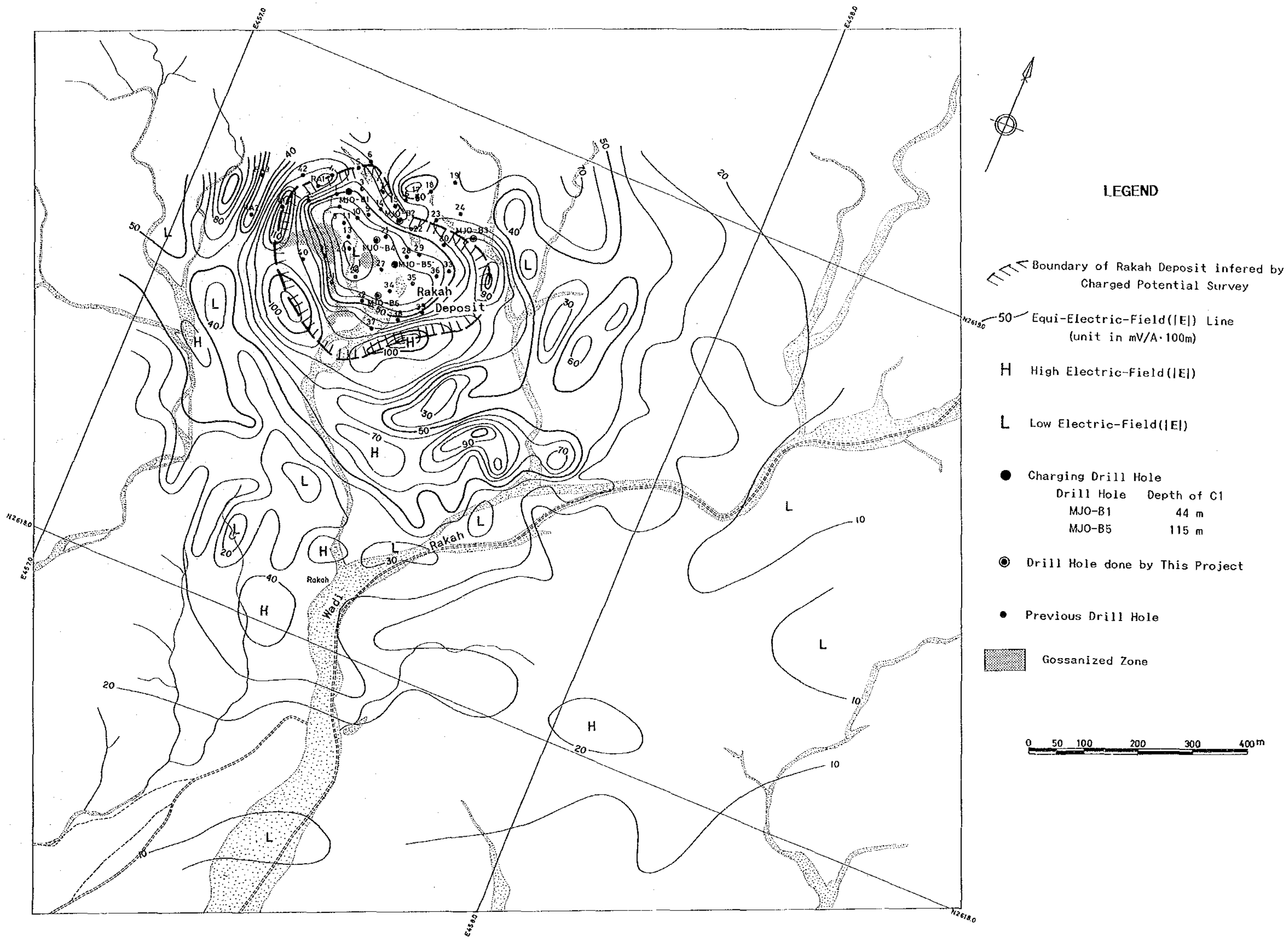


Fig. 2-13 Geophysical interpretation map of Area B

2-4 Drilling

2-4-1 Method and progress

The drilling survey in Area B was also carried out for two years of Phase I and II. A total of six drill holes from MJO-B1 to MJO-B6 (811.45 m in total) were completed in the Phase I. In the Phase II, final year, additional five holes from MJO-B7 to MJO-B11 (771.80 m in total) were completed in Area B. The drilling survey completed in this area is eleven holes totaling 1,583.25 m.

Details of drill holes completed in this survey are shown in Table 2-1. A total of 45 holes (5,938.32 m in total) were completed previously in the Rakah ore deposit area, and the list of these holes are shown in Table 2-2. In order to decide the locations of the previous drill holes, fourteen drill sites which were confirmed on the surface, were surveyed by means of the close traverse surveying method with a portable transit. Based on these surveyed hole and existing data, locations for other drill sites were estimated. The locations of all the drill sites are shown in Fig. 2-4.

Two drill machines and three drill machines were utilized for the survey in the Phase I and II, respectively. The name of machines and the drill holes completed by these machines are as follows.

Name of machine	Drill hole
JOY RAMROD II	MJO-B1, -B3, -B4, -B6 (0.00~31.30 m: re-drilled)
VOL 35	MJO-B2, -B5, -B6, -B7, -B8, -B9
VOL 90	MJO-B10, -B11 (135.45~201.00 m)
VOL 180	MJO-B11 (0.00~135.45 M)

Progress of each drill hole is shown in Appendix 12.

The drill holes of MJO-B1, -B6 and -B8 encountered soft gossanized zones, possibly old working. Because of caving in these holes, the drilling consumed more time comparing with other holes. The MJO-B6 encountered soft gossanized zones. Because of poor core recovery for the zone, re-drilling work was carried out from the surface to 31.30 m in depth using bentonite. The drill machine used for the MJO-A11 was broken at the depth of 135.45 m, and remaining hole was carried out by the different drill machine.

Drilling was carried out by means of the wireline method. In order to collect ore samples for beneficiation test, drill holes were completed mostly by NX in size at the bottom in Phase I. Drilling work in Phase II was mostly carried out with BX in size at the bottom. In case the hole encountered caving zone, the hole was reamed and then extended casing, or the hole was cemented and re-drilled.

Table 2-1 List of drill holes completed in Area B in this project

Hole number	Coordinates	Elevation (m)	Drill length (m)	Bearing	Inclination	Core length (m)	Core recovery (%)	Period: from to	Casing (m)
MJO-B1	N 2618.780 E 457.276	687.0	100.35	—	Vertical	85.85	85.5	15 Nov.'88 20 Nov.'88	NWC 26.50
MJO-B2	N 2618.770 E 457.381	677.1	157.25	—	Vertical	154.15	98.1	13 Nov.'88 23 Nov.'88	NWC 3.00
MJO-B3	N 2618.787 E 457.522	672.6	201.70	—	Vertical	198.00	98.2	22 Oct.'88 30 Oct.'88	NWC 3.00
MJO-B4	N 2618.717 E 457.356	685.0	101.30	—	Vertical	98.30	97.0	31 Oct.'88 4 Nov.'88	NWC 3.00
MJO-B5	N 2618.695 E 457.406	675.0	150.00	—	Vertical	142.90	95.3	18 Oct.'88 31 Oct.'88	NWC 12.00
MJO-B6	N 2618.627 E 457.398	672.8	100.85	—	Vertical	87.35	86.6	3 Nov.'88 23 Nov.'88	NWC 12.75
MJO-B7	N 2618.579 E 457.342	678.0	120.80	—	Vertical	115.40	95.5	4 Oct.'89 13 Oct.'89	NWC 13.00 NX 60.90
MJO-B8	N 2618.754 E 457.239	684.0	100.85	—	Vertical	82.30	83.0*	21 Sep.'89 1 Oct.'89	NWC 15.00 NX 24.70
MJO-B9	N 2618.765 E 457.334	682.8	167.75	—	Vertical	167.55	99.9	2 Sep.'89 14 Sep.'89	NWC 3.00 NX 58.80
MJO-B10	N 2618.677 E 457.536	682.0	181.40	—	Vertical	179.95	99.2	17 Sep.'89 26 Sep.'89	NWC 3.65 NX 80.00
MJO-B11	N 2618.776 E 457.432	679.5	201.00	—	Vertical	199.00	99.0	7 Sep.'89 5 Oct.'89	NWC 3.00 NX 136.55
Total	1,583.25 m (Phase I: 811.45 m, Phase II: 771.80 m)								

* : Excluding cave zone.

Table 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

Geologic core logs for each hole are shown in Appendix 13. The number of samples collected for laboratorial studies are as follows:

Item	Phase I	Phase II	Total	Remarks
Thin section	9 sampels	3 samples	12 samples	Table 1-1
Polished section	20 samples	11 sampels	31 sampels	Table 2-3
EPMA analyses	10 sampels	—	10 sampels	Table 2-4
Whole rock analyses	8 sampels	—	8 sampels	Appendix 2
Minor element analyses	9 sampels	—	9 sampels	Appendix 2
X-ray diffraction analyses	6 sampels	4 sampels	10 sampels	Table 2-5
Ore assaying	133 sampels	68 sampels	201 sampels	Appendix 13
Physical properties	11 sampels	—	11 sampels	Table 1-3
Sampling for beneficiation test	100 kg	—	100 kg	Volume III

The cores of mineralized zones were treated and sampled as the same manner of the cores in Area A. The samples for assaying were collected one meter core section for the massive ore zone and two meters core section for the stockwork ore zone in general. The elements for assaying were five elements of Au, Ag, Cu, Pb and Zn in the Phase I, and four elements of Au, Ag, Cu and Zn in the Phase II, as same as in Area A.

2-4-2 Results of survey

(1) Drilling

In order to clarify the nature of mineralization in the Rakah deposit, five holes in the Phase I were mostly carried out in the central part of the deposits. Based on the results of geologic, geophysical and drilling surveys in the Phase I, five holes were planned in the Phase II to examine the horizontal and vertical extensions of the deposits.

(a) MJO-B1 (Vertical, drilled length 100.35 m)

The drill hole MJO-B1 was carried out to examine the nature of massive sulfide ore which had been confirmed by previous drilling at the northwestern part of the Rakah ore deposit area. Results of the hole are shown below:

0.00 ~	3.00 m	Casing. No recovery.
3.00 ~	3.80 m	Gossan soil.
3.80 ~	10.00 m	Weathered and argillized zone with oxide copper minerals.
10.00 ~	21.40 m	Lower Extrusives II. Weathered and argillized pillow lavas.

21.40 ~	22.00 m	Gossan soil.
22.00 ~	26.60 m	Siliceous gossan. Old working?
26.60 ~	37.80 m	Siliceous ore. Strongly silicified and brecciated. More sulfides in Lower part.
37.80 ~	46.90 m	Massive sulfide ore with minor siliceous fragments.
46.90 ~	55.20 m	Siliceous ore with satin -spar veinlets.
55.20 ~	56.10 m	Brecciated clay zone with pyrite disseminations.
56.10 ~	58.00 m	Strongly chloritized zone. Phyllitic.
58.00 ~	100.35 m	Lower Extrusives I. Chloritized pillow lavas with hematite and quartz.

This hole encountered heavy caving zones up to the depth of 33 m and core recovery was poor at the part. Old working is reported in core logs of a previous drill hole from the surface to the depth of 38 m. This hole is 22 m away for southwest from MJO-B1 and confirmed a massive sulfide zone. Therefore, the massive ore zones including the intersection of MJO-B1 were mined in places at ancient time.

Assay results give high values of Au and Cu in the massive ore. Pb also give slightly higher values comparing with other holes. Average grades of the intersection give following values.

26.00 m ~ 55.20 m	D.L.: 28.60 m			
5.94 g/t Au,	10.3 g/t Ag,	1.37% Cu,	0.03% Pb,	0.16% Zn

The massive ore shows high grade and Au is concentrated between 34.60 m and 52.90 m. This 18.30 m section shows high concentration of Au and Ag and gave 8.96 g/t Au and 13.3 g/t Ag. Because the massive ore zone is situated at shallower depth, the zone was weathered and supergene copper minerals were observed under the microscope throughout the mineralized zone. This massive ore zone contains chalcanthite ($Cu SO_4 \cdot 5 H_2O$) along fractures. Detailed sketch for this mineralized zone is shown in Fig. 2-14.

(b) MJO-B2 (Vertical, drilled length 157.25 m)

This hole was carried out to clarify the nature and ore grade of the mineralized zones at the northern middle of the known deposits area. Results of the hole are summarized below:

0.00 ~	88.80 m	Lower Extrusives II. Chloritized pillow lavas and pillow breccia. Calcite stringers, and hematite in fractures and matrix.
88.80 ~	91.10 m	Strongly chloritized zone. Brecciated and sheared.
91.10 ~	122.20 m	Chloritized, silicified and brecciated zone with stockwork mineralization. Upper mineralized zone. Pyrite disseminations. Pyrite-chalcopyrite stringers and veinlets.
122.20 ~	124.60 m	Silicified and strongly chloritized zone with pyrite and chalcopyrite disseminations and stringers.
124.60 ~	139.50 m	Lower Extrusives I. Chloritized and weakly silicified pillow lavas.
139.50 ~	140.90 m	Strongly chloritized and brecciated zone.

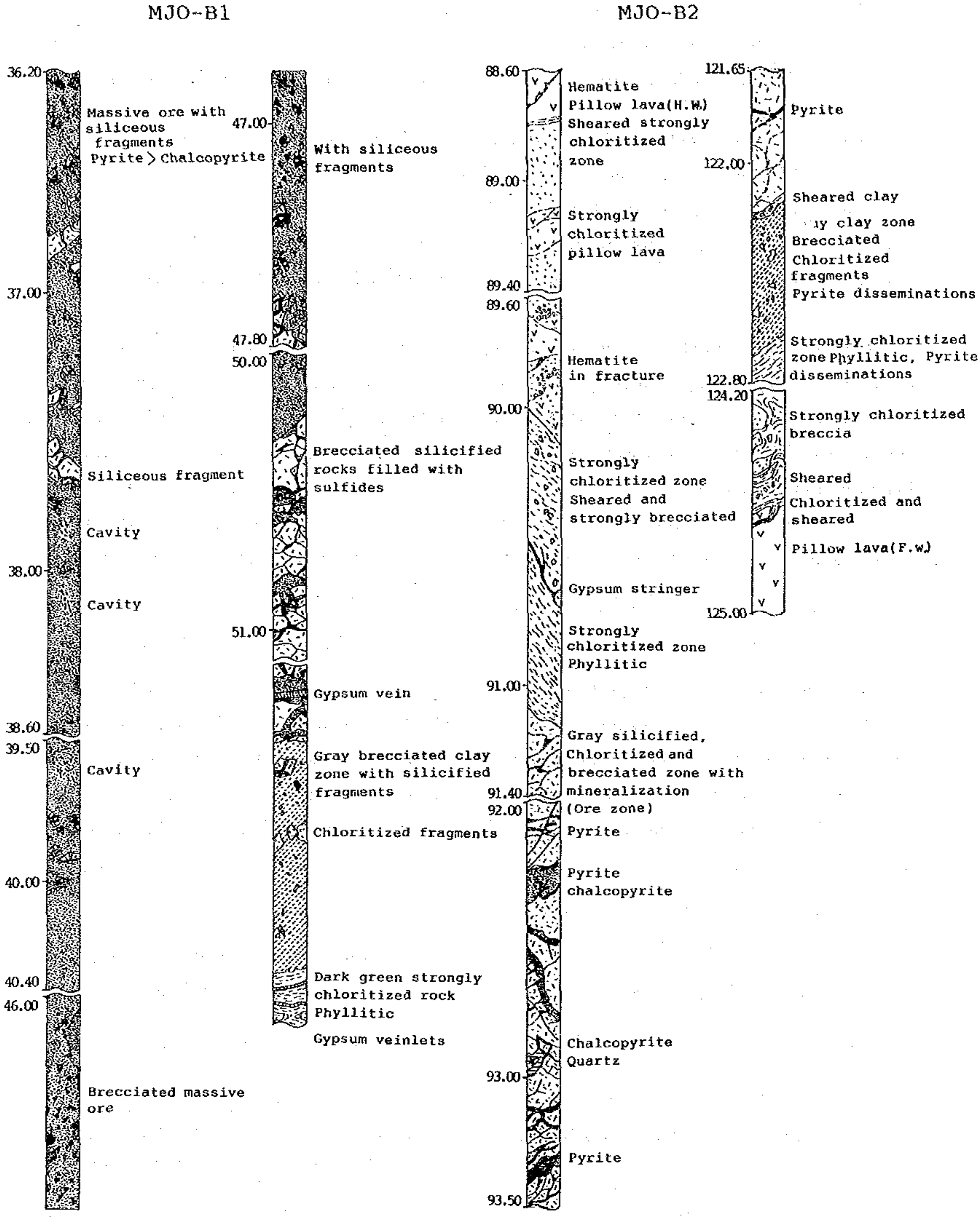
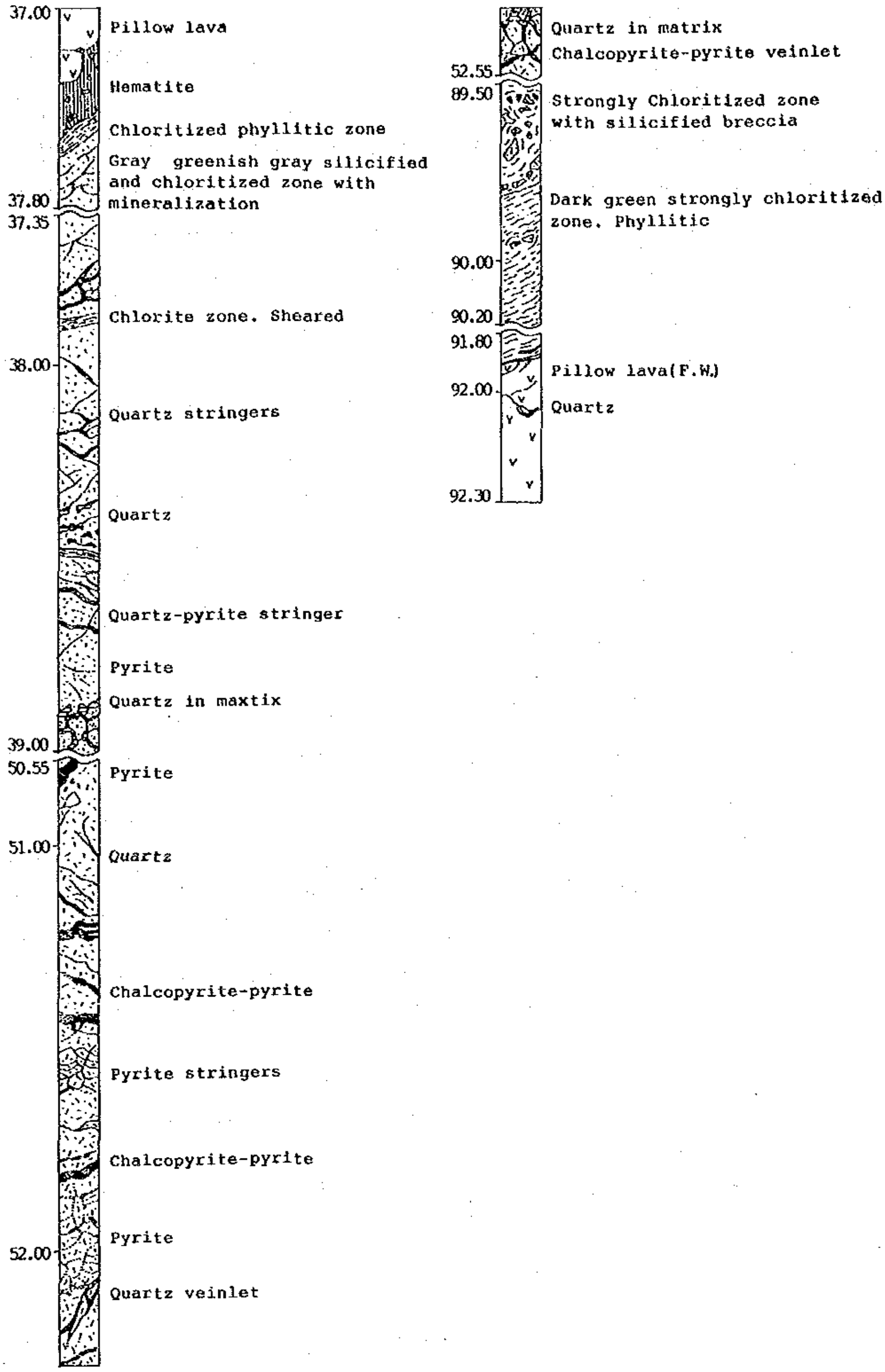


Fig. 2-14 Sketch of core sections for mineralized zone in the Rakah deposit

MJO-B4


37.00
Pillow lava
Hematite
Chloritized phyllitic zone
Gray greenish gray silicified and chloritized zone with mineralization
37.80
37.35
Chlorite zone. Sheared
38.00
Quartz stringers
Quartz
Quartz-pyrite stringer
Pyrite
Quartz in maxtix
39.00
50.55
Pyrite
51.00
Quartz
Chalcopyrite-pyrite
Pyrite stringers
Chalcopyrite-pyrite
Pyrite
52.00
Quartz veinlet
Quartz in matrix
Chalcopyrite-pyrite veinlet
52.55
89.50
Strongly Chloritized zone with silicified breccia
Dark green strongly chloritized zone. Phyllitic
90.00
90.20
91.80
Pillow lava(F.W.)
92.00
Quartz
92.30

140.90 ~ 154.20 m	Silicified and chloritized zone with stockwork mineralization. Lower mineralized zone. Pyrite and chalcopyrite disseminations and stockwork veinlets.
154.20 ~ 157.25 m	Lower Extrusives I. Chloritized pillow lavas with quartz-hematite veins.

This hole confirmed two mineralized zones of the upper and lower mineralized zones. These two mineralized zones show similar occurrences, mineral assemblage and alteration. Host rocks of the both mineralized zones are strongly chloritized and silicified pillow lavas.

Assay results show no extreme Cu concentration for both the lower and upper mineralized zones, and give low Cu grades. The average grades for the encountered mineralized zones are as follows:

Assay results of encountered mineralized zones are summarized below:

Upper mineralized zone 93.10 m ~ 117.10 m D.L.: 24.00 m

0.28 g/t Au, 0.7 g/t Ag, 0.51% Cu, 0.01% > Pb, 0.16% Zn

Lower mineralized zone 140.90 m ~ 150.90 m D.L.: 10.00 m

0.16 g/t Au, 0.2 g/t Ag, 0.59% Cu, 0.01% > Pb, 0.05% Zn

Sketch for the mineralized zone in this hole is shown in Fig. 2-14.

(c) MJO-B3 (Vertical, drilled length 201.70 m)

Drill hole MJO-B3 was carried out to examine the eastern extension of the Rakah ore deposit. The results are summarized as follows:

0.00 ~ 68.90 m	Lower Extrusives II. Chloritized pillow lavas with subordinate massive lavas and pillow breccia. Calcite stringers and hematite in matrix.
68.90 ~ 69.20 m	Hematite-quartz zone; weakly sheared.
69.20 ~ 137.20 m	Silicified, chloritized and brecciated zone with stockwork mineralization. Pyrite-quartz-calcite stockwork and pyrite disseminations. Poor chalcopyrite.
137.20 ~ 198.70 m	Lower Extrusives I. Weakly chloritized and hematized.
198.70 ~ 199.90 m	Silicified, brecciated and strongly chloritized zone with stockwork mineralization. Sheared at the top and bottom.
199.90 ~ 200.30 m	Lower Extrusives I. Brecciated and chloritized pillow lavas.
200.30 ~ 200.60 m	Same as 198.70 ~ 199.90 m.
200.60 ~ 201.70 m	Same as 199.90 ~ 200.30 m.

This hole confirmed a thick mineralized zone. But the mineralization and alteration are very weak, and only pyrite and minor sphalerite are observed.

Pyrite concentrated zones were assayed but the results are disappointing. The best intersection of two meters section was 0.04% Cu and 0.45% Zn.

The thin mineralized zone encountered at the bottom of the hole can be interpreted on the geologic section that upper thick mineralized zone and the lower thin mineralized zone are originally same zone and a reverse fault dislocated the zone.

(d) MJO-B4 (Vertical, drilled length 101.30 m)

This hole was completed at the center of the ore deposits and is situated about 10 m north of a significant gossan zone. Results are summarized below:

0.00 ~ 27.60 m	Lower Extrusives II. Chloritized and weakly brecciated pillow lavas.
27.60 ~ 37.70 m	Strongly chloritized and weakly sheared pillow lavas. Brecciated.
37.70 ~ 89.80 m	Silicified, chloritized and brecciated zone with stockwork mineralization. Pyrite (chalcopyrite) stringers and disseminations.
89.80 ~ 91.90 m	Strongly chloritized zone with pyrite disseminations.
91.90 ~ 101.30 m	Lower Extrusives I. Silicified and chloritized pillow lavas with weak pyrite disseminations and quartz-hematite stringers.

The upper mineralized zone confirmed in the hole is comparatively thick and chalcopyrite is observed throughout the mineralized zone. The Lower Extrusives I encountered from the depth of 91.90 m is possibly the hanging wall volcanics of the lower mineralized zone.

Following average assay values were obtained for the mineralized zone except the top of the zone which shows low values.

Upper mineralized zone 41.70 m ~ 89.90 m D.L.: 48.10 m

0.43 g/t Au, 1.6 g/t Ag, 0.85% Cu, 0.01% > Pb, 0.28% Zn

The best intersection is between 63.70 m and 65.70 m. This two meters section give 0.9 g/t Au and 2.27% Cu. Sketch for the stockwork zone is shown in Fig. 2-14.

(e) MJO-B5 (Vertical, drilled length 150.00 m)

This drill hole was carried out at the center of the known ore deposits and 30 m east of the gossan zone. Results are as follows:

0.00 ~ 28.30 m	Lower Extrusives II. Chloritized pillow lavas. Upper part is argillized and weathered.
28.30 ~ 28.70 m	Strongly chloritized sheared zone.
28.70 ~ 71.00 m	Chloritized, weakly silicified and brecciated zone with stockwork *mineralization (upper mineralized zone). Pyrite-chalcopyrite stringers* and pyrite disseminations.
71.00 ~ 72.90 m	Strongly chloritized sheared zone.
72.90 ~ 84.10 m	Lower Extrusives I. Weakly chloritized pillow lavas with very weak pyrite disseminations.
84.10 ~ 84.20 m	Brecciated zone with quartz-hematite vein.
84.20 ~ 124.60 m	Brecciated, silicified and chloritized zone with stockwork mineralization (lower mineralized zone). Pyrite-chalcopyrite veins and veinlets.
124.60 ~ 150.00 m	Lower Extrusives I. Chloritized pillow lavas with hematite in matrix.

This hole also confirmed two zones of the upper and lower mineralized zones. A lower half of each mineralized zone shows more concentration of copper.

Assay results for the copper concentrated zones are as follows:

Upper mineralized zone	47.40 m ~ 71.00 m		D.L.: 23.60 m	
0.23 g/t Au,	1.0 g/t Ag,	1.15% Cu,	0.01% > Pb,	0.09% Zn
Lower mineralized zone	106.30 m ~ 124.60 m		D.L.: 18.30 m	
0.24 g/t Au,	0.4 g/t Ag,	1.09% Cu,	0.01% > Pb,	0.04% Zn

The best two meters section for the upper mineralized zone is 62.90 m ~ 64.90 m with 0.7 g/t Au, 3.54% Cu, and the best section for the Lower mineralized zone is 110.30 m ~ 112.30 m grading 1.0 g/t Au, 1.91% Cu.

(f) MJO-B6 (Vertical, drilled length 100.85 m)

This drill hole was carried out in southern middle part of the Rakah deposit area. Results are summarized as follows:

0.00 ~ 11.20 m	Gossan and gossan dump.
11.20 ~ 25.30 m	Argillized, chloritized and brecciated zone with stockwork mineralization (upper mineralized zone). Pyrite-chalcopyrite disseminations and stringers.
25.30 ~ 31.50 m	Clay zone. Possibly old working. 27.00 m : wooden chips.
31.50 ~ 37.00 m	Lower Extrusives II. Chloritized and silicified pillow lavas. Weak pyrite disseminations.
37.00 ~ 39.35 m	Strongly chloritized zone. Bottom : Sheared and argillized zone.
39.35 ~ 75.90 m	Chloritized, silicified and brecciated zone with stockwork mineralization (lower mineralized zone). Chalcopyrite pyrite stringers and disseminations. Minor sphalerite stringers.
75.90 ~ 100.85 m	Lower Extrusives I. Chloritized and weakly brecciated pillow lavas. Hematite in matrix and fractures.

Judging from progress of the hole, the clay zone encountered from 25.30 m to 31.50 m is thought to be old working. The gossanized zone confirmed in this hole at the top is the upper mineralized zone. This hole encountered both the lower and upper mineralized zones and the assay results are as follows:

Upper mineralized zone	11.20 m ~ 25.30 m		D.L.: 14.10 m	
0.52 g/t Au,	2.2 g/t Ag,	3.51% Cu,	0.01% > Pb,	0.15% Zn
Lower mineralized zone	49.35 m ~ 67.35 m		D.L.: 18.00 m	
0.18 g/t Au,	0.4 g/t Ag,	0.98% Cu,	0.01% > Pb,	0.04% Zn

The upper mineralized zone shows high grade, but this high grade zone may be formed by secondary enrichment.

(g) MJO-B7 (Vertical, drilled length 120.80 m)

The geophysical survey completed in Phase I suggested the southern extension of the Rakah deposit. In order to examine the southern extension, this drill hole was carried out in the area where gossanized zone outcrops. Results are summarized as follows:

0.00 ~ 8.70 m	Siliceous gossan. Argillized in parts with dominant limonite.
8.70 ~ 12.70 m	Gossanized and argillized zone. Pyrite disseminations.
12.70 ~ 34.20 m	Lower Extrusives I. Brecciated, strongly chloritized and weakly hematized pillow lavas. Pyrite disseminations. Upper art: gossanized.
34.20 ~ 37.10 m	Strongly chloritized sheared zone. Weakly weathered. Pyrite disseminations.
37.10 ~ 49.60 m	Lower Extrusives I. Brecciated and strongly chloritized pillow lavas. Pyrite disseminations. 45.50 m ~ 46.50 m: Brecciated shared zone.
49.60 ~ 50.65 m	Strongly brecciated sheared zone. Strong pyrite disseminations.
50.65 ~ 60.40 m	Lower mineralized zone. Stockwork ore. Strongly chloritized and brecciated with chalcopyrite-pyrite stringers and disseminations.
60.40 ~ 68.60 m	Lower Extrusives I. Chloritized and hematized pillow breccia and pillow lavas.
68.60 ~ 120.80 m	Lower Extrusives I. Chloritized, hematized and brecciated pillow breccia and pillow lavas with dominant quarts-hematite veinlets.

The siliceous gossan encountered in this hole at the top is the gossanized zone of the upper mineralized zone. The Lower Extrusives I encountered in this hole is characterized by dominant pillow breccia.

Assay results for the gossanized upper mineralized zone gave low Cu grade ranging 0.08% to 0.26% Cu. The upper part of the gossanized zone shows comparatively high Au concentration (0.00 m ~ 3.80 m, 7.55 g/t Au, 15.8 g/t Ag). Assay results for the lower mineralized zone is low and the average grades are as follows:

50.65 m ~ 60.40 m D.L.: 9.75 m

0.23 g/t Au, 2.3 g/t Ag, 0.41% Cu, 0.42% Zn

The results of this hole suggest that the southern margin of the Rakah deposit is nearby this hole.

(h) MJO-B8 (Vertical, drilled length 100.85 m)

A drill hole MJO-B1 completed in Phase I confirmed massive sulfide orebody with high Au concentration. In order to examine the western extension of this massive orebody, this hole was carried out at 46 m southwest of the MJO-B1. Results are as follows:

0.00 ~ 11.50 m	Lower Extrusives II. Hematized and weathered. Brecciated in part.
11.50 ~ 14.70 m	Clay zone. Old working?
14.70 ~ 15.90 m	Siliceous ore. Gossanized and brecciated.

15.90 ~	18.75 m	Clay zone with siliceous breccia. Old working?
18.75 ~	24.70 m	Gossanized siliceous ore with cave zones.
24.70 ~	38.60 m	Massive ore with minor siliceous breccia. Fine-grained pyrite and bornite.
38.60 ~	43.80 m	Strongly argillized and brecciated zone with pyrite disseminations.
43.80 ~	45.45 m	Lower Extrusives I. Argillized and strongly brecciated pillow lavas with gypsum veinlets.
45.45 ~	52.35 m	Coarse-grained sandstone and conglomerate. Material: Volcanics and jasper.
53.35 ~	100.85 m	Lower Extrusives I. Brecciated, hematized and strongly chloritized pillow lavas with intercalation of minor pillow breccia.

The clay zones encountered above and below the massive ore body are thought to be old working, judging from the progress of drilling. The siliceous ore above the massive ore zone is possibly sedimentary origin. The sedimentary rocks encountered below the massive ore zone trace to the west and the rocks inclease the thickness westward.

Assay results indicate the highest Au and Ag concentrated zone in the siliceous ore. Average assay of this zone is as follows:

18.75 m ~ 24.70 m D.L.: 5.95 m

62.91 g/t Au, 124.9 g/t Ag, 0.12% Cu, 0.01% Zn

Assays for the massive ore zone also gave high Cu grade, because of the secondary enrichment of Cu.. Average grades for the massive ore zone are as follows:

24.70 m ~ 38.60 m D.L.: 13.90 m

6.25 g/t Au, 14.8 g/t Ag, 2.93% Cu, 0.08% Zn

The clay zone encountered below the massive ore zone shows good assays (D.L.: 4.05 m, 2.05 g/t Au, 6.10% Cu). this zone is also secondary enriched zone of Cu.

(i) MJO-B9 (Vertical, drilled length 167.75 m)

The drill hole MJO-B2 completed in Phase I confirmed the lower mineralized zone in addition to the upper mineralized zone. In order to examine the western extension of the lower mineralized zone, this hole was carried out at 48 m west of MJO-B2. Results of this hole are summarized below:

0.00 ~	60.70 m	Lower Extrusives II. Hematized, chloritized and brecciated pillow lavas with calcite stringers.
60.70 ~	62.20 m	Strongly argillized and chloritized zone with pyrite disseminations.
62.20 ~	90.10 m	Upper mineralized zone. Stockwork ore. Chloritized, silicified and brecciated. Chalcopyrite-pyrite stockwork veinlets and disseminations.
90.10 ~	99.10 m	Lower Extrusives I. Chloritized and weakly silicified pillow breccia.
99.10 ~	135.50 m	Lower Extrusives I. Hematized, chloritized and weakly brecciated pillow lavas with intercalation of pillow breccia.

135.50 ~ 167.75 m	Chloritized and brecciated pillow lavas with pyrite disseminations and stringers (lower mineralized zone).

The lower mineralized zone was confirmed at the expected depth, but the zone was very weakly mineralized and only pyrite disseminations were observed. This result suggests that the lower mineralized zone encountered by the drill hole MJO-A2 does not extend to the west. Assay results for the upper mineralized excluding low grade zone are as follows:

66.20 m ~ 88.50 m D.L. : 22.30 m

0.17 g/t Au, 1.2 g/t Ag, 1.15% Cu, 0.13% Zn

(j) **MJO-B10 (Vertical, drilled length 181.40 m)**

The geophysical survey results in Phase I suggested the eastern extension of the Rakah deposit. In order to examine the eastern extension, a drill hole, MJO-B10, was carried out at eastern outside of the known Rakah deposit area. Results of this hole are summarized as follows:

0.00 ~ 4.10 m	Lower Extrusives II. Brecciated and epidotized pillow lavas.
4.10 ~ 10.35 m	Lower Extrusives II. Massive lavas.
10.35 ~ 87.50 m	Lower Extrusives II. Chloritized and weakly hematized pillow lavas with minor pillow breccia.
10.35 ~ 87.50 m	Lower Extrusives II. Chloritized and weakly hematized pillow lavas with minor pillow breccia.
87.50 ~ 89.35 m	Strongly brecciated zone with pyrite disseminations.
89.35 ~ 94.30 m	Pillow breccia. 91.00 m ~ 91.30 m: metalliferous sediments.
94.30 ~ 110.70 m	Lower Extrusives I. Chloritized and hematized pillow lavas with weak pyrite disseminations. 98.70 m ~ 99.10 m: metalliferous sediments.
110.70 ~ 117.35 m	Lower Extrusives I. Massive lavas. 117.00 m ~ 117.34 m: metalliferous sediments.
117.35 ~ 137.10 m	Lower Extrusives I. Chloritized and weakly brecciated pillow lavas.
137.10 ~ 137.40 m	Metalliferous sediments.
137.40 ~ 138.80 m	Chloritized and weakly brecciated pillow lavas with pyrite disseminations.
138.80 ~ 181.40 m	Lower Extrusives I. Chloritized pillow lavas.

This hole confirmed only weakly pyrite disseminated zones. Based on this survey result, the eastern margin of the Rakah deposit is possibly nearly this hole. Metalliferous sedimentary layers which are not found in the central part of the Rakah deposit are conspicuous in this hole.

(k) **MJO-B11 (Vertical, drilled length 201.00 m)**

In order to clarify the eastern extension of the lower mineralized zone which was confirmed by the drill hole MJO-B2 in Phase I, this hole was carried out at 50 m east of MJO-B2. Results are summarized as follows:

0.00 ~ 14.90 m	Lower Extrusives II. Brecciated pillow lavas with calcite veinlets.

14.90 ~ 27.20 m	Lower Extrusives II. Brecciated massive lavas with calcite and quartz veinlets.
27.20 ~ 115.90 m	Lower Extrusives II. Hematized, chloritized and brecciated pillow lavas with intercalation of pillow breccia.
115.90 ~ 116.20 m	Strongly chloritized zone with weak pyrite disseminations.
116.20 ~ 137.90 m	Upper mineralized zone. Chloritized, silicified and brecciated. Pyrite-chalcopyrite stockwork veinlets and disseminations with minor sphalerite-pyrite veinlets.
137.90 ~ 138.20 m	Brecciated sheared zone.
138.20 ~ 163.60 m	Lower Extrusives I. Silicified and chloritized pillow lavas with very weak pyrite disseminations.
163.60 ~ 183.75 m	Chloritized and strongly silicified pillow lavas with pyrite disseminations (lower mineralized zone).
183.75 ~ 201.00 m	Chloritized and brecciated pillow lavas. Dominant quartz-hematite veinlets.

This hole confirmed both the mineralized zones of lower and upper mineralized zones, but only pyrite disseminations were found for the lower mineralized zone. This result suggests that the good ore zone of the lower mineralized zone is limited in the vicinity of the drill hole MJO-B2.

Average assays for the upper mineralized zone are as follows:

116.20 m ~ 137.90 m D.L.: 21.70 m

0.35 g/t Au, 0.7 g/t Ag, 0.40% Cu, 0.32% Zn

(2) Observation results of polished section

Core samples were collected from the drill holes completed in the Rakah deposit and prepared the polished sections for microscopical observation. A total of 31 samples, 20 samples in Phase I and 11 samples in Phase II, were collected and observed. Among 11 samples in Phase II, five samples were collected from the massive ore encountered by the hole MJO-B1 in Phase I in order to clarify the occurrences of gold. Because the massive ore contains high gold, but it was difficult to separate the gold at the beneficiation test as shown in Volume III. The results of microscopic observation are shown in Table 2-3, and the photographs of polished sections are shown in Appendix 14.

Ore minerals consist of pyrite, chalcopyrite, covellite, bornite, chalcocite and sphalerite, which are similar to the constituent ore minerals of Hayl as Safil deposit in Area A, as well as native gold. In particular, native gold is found in one sample of MJO-B6 drill hole (57.60 m in depth).

Eighteen samples were collected from the stockwork ore zone. The ore minerals of the stockwork ore consist of mostly chalcopyrite and pyrite. Covellite and chalcocite are found in the stockwork ore but are very limited. The chalcocite is thought to be primary mineral because veinlet of chalcocite cuts chalcopyrite. And chalcopyrite disease in the sphalerite is present in

Table 2-3 Observation results of polished sections for the Rakah deposit

Hole No.	Depth (m)	Occurrence	Pyrite	Chalcopyrite	Covellite	Chalcosite	Bornite	Sphalerite	Native gold	Gangue and alteration minerals
MJO-B1	34.70	Secondary enrichment of massive py-(cp) ore.	◎	•	●	○		•		●
MJO-B1	37.50	Secondary enrichment of massive py-(cp) ore.	◎colloform, brecciated	•	●	•	•	•*		●
MJO-B1	38.90	Massive pyrite ore.	◎	•				•*		●
MJO-B1	39.50	Massive pyrite ore.	◎colloform, fractured	•	●	●	•	●*		●
MJO-B1	41.10	Massive pyrite ore.	◎colloform, framboidal	•	•		•	•*		●
MJO-B1	42.40	Massive py ore with matrix of fine-grained py.	◎	●	●	●				●
MJO-B1	45.30	Massive py ore with matrix of fine-grained py.	◎	•	●	•				●
MJO-B1	48.00	Massive py ore with siliceous fragments.	◎colloform, framboidal	•	•	•	•	•*		○
MJO-B1	48.90	Massive pyrite ore.	◎	●	●	•	•			●
MJO-B1	51.15	Massive pyrite ore.	◎	•	•			•		●
MJO-B2	97.70	Py veinlet in chloritized pillow lava (stockwork ore).	●	•				•		◎
MJO-B2	101.45	Py-cp veinlet in chloritized pillow lava (stockwork ore).	◎	○		•		•		•
MJO-B2	111.90	Py veinlet in chloritized pillow lava (stockwork ore).	○brecciated, fractured	●				•		◎ with calcite
MJO-B2	145.60	Lenticular ore (py-cp) in chloritized pillow lava.	○	○				•		◎
MJO-B3	80.10	Quartz-calcite veinlet and py diss. in chloritized pillow lava.	• partly brecciated	•				•		◎ quartz calcite
MJO-B3	133.60	Py veinlet and disseminations in chloritized pillow lava.	● partly brecciated	•				•		◎
MJO-B4	43.70	Py-cp veinlet and disseminations (stockwork ore).	○	●				•		◎
MJO-B4	56.00	Cp-sp-py veinlet.	•	○				●*		◎
MJO-B4	77.40	Py-cp-sp veinlet in chloritized pillow lava (stockwork ore).	◎partly brecciated	●	•			●*		●
MJO-B4	85.10	Py-cp veinlet (stockwork ore).	●	●	•			•*		◎
MJO-B5	47.70	Cp-py veinlet in chloritized pillow lava (stockwork ore).	●	○				•*		◎
MJO-B5	107.60	Cp-py veinlet and disseminations (stockwork ore).	○	◎				•		◎
MJO-B6	42.10	Cp-sp-py-quartz-calcite veinlet in chloritized pillow lava.	•	●				●*		◎ quartz calcite
MJO-B6	57.60	Cp-py veinlet (Au bearing veinlet) (stockwork ore).	○	◎				•	•	○
MJO-B6	71.30	Cp-py veinlet in chloritized pillow lava.	●	●				•*		◎
MJO-B8	28.10	Medium-grained massive pyrite ore.	◎colloform, fractured	•	●					•
MJO. ı	31.90	Fine-grained massive pyrite ore.	◎	•	●	●				•
MJO-B8	36.60	Fine-grained massive py-(cp) ore with fragments of coarse-py.	◎	○	●	•	•			●
MJO-B9	138.00	Pyrite in silicified rock.	○Colloform, framboidal	•				•		◎ mostly quartz
MJO-B11	125.50	Fragment of cp-py ore (stockwork ore).	○	○				•		◎
MJO-B11	134.50	Sp-cp-py-quartz veinlet.	◎	○				◎*		◎

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

several samples. Sulfide veinlets display an occurrence in the order of crystallization from pyrite, chalcopyrite to sphalerite. The native gold, 9 micrometer in diameter, is found in chalcopyrite of stockwork ore.

Thirteen samples were collected from the massive ore which confirmed by the drill holes MJO-B1 and -B8. The ore minerals of the massive ore consist of pyrite, chalcopyrite, covellite, chalcocite, bornite and sphalerite, and ore mostly fine-grained pyrite. Pyrite is marked intensive brecciation and the breccia shows locally colloform and framboidal textures. Copper minerals in the massive ore comprise mainly covellite and chalcocite with subordinate chalcopyrite. The occurrence of covellite and chalcocite suggests to have been formed by secondary enrichment. Chalcopyrite disease in sphalerite is also found in the massive ore. Assay results gave high contents of Au in the massive ore, but no native gold was observed under the microscope. The gold may may be included in pyrite.

(3) **Results of EPMA analysis**

In order to clarify the nature of ore minerals including native gold, sphalerite and chalcopyrite, the EPMA analyses were carried out for the ore samples in the Rakah deposit.

Four samples collected from drilling cores in the Area B were analyzed by EPMA after making polished sections and carbon coating. Analyses methods are area and quantitative analyses for native gold, quantitative analysis of Zn, Fe and Cu for sphalerite and quantitative analysis of Cu, Fe and Zn and qualitative analysis for chalcopyrite. The results of them are shown in Table 2-4, and the images are shown in Appendix 15.

A grain of native gold is observed in the stockwork ore zone at the drill hole MJO-B6 (57.60 m) and it shows triangle shape of 4 × 9 μ wide. Ag content (3.56 ~ 3.76%) is very low and Ag/Au ratio is 1/25 to 26 resulting from the quantitative analysis. The distribution of Ag is inferred to be scattered equally in the native gold without zonal structure based on the area analyses.

Sphalerite in stockwork ore shows the Fe/Zn ratio from 1/5 to 1/18. The contents of Fe in sphalerite of the Rakah deposit is higher than that of the Hayl as Safil deposit.

Most of chalcopyrite is composed qualitatively of Cu, Fe and S. The quantitative analyses show chalcopyrite from MJO-B6 (57.60 m) which contains 0.17 to 0.22% Zn. Small quantity of Zn suggests disseminations of sphalerite, because a small amount of fine grained sphalerite in the chalcopyrite is observed around the analyzed point of EPMA in the polished section.

(4) **Results of minor elements analyses**

A sample taken from MJO-B1 drill hole (40.80 m in depth) was chemically analysed for 24 minor elements in order to clarify the geochemical nature of the ore comparing with the nature of ore in the Sohar area. The results of chemical analyses are shown in Appendix 2.

Mn is marked by high value (1,914 ppm). Highly concentrated zones of Zn in the Lasail

Table 2-4 Results of EPMA analyses

Sample location			Minerals	Analyzed point No.	Analysis method	Analyzed elements	Results						SEM image*1 photo No.	Remarks
Area	Drill Hole No.	Depth (m)												
A	HS-17	61.55	sphalerite	1	quantitive	Zn, Fe, Cu	Point	Zn	Fe	Cu	(%)	Fe/Zn ratio	(1)	massive ore
							1	63.26	1.09	1.19		1/58		
							2	65.04	0.60	0.66		1/108		
							3	63.54	1.16	1.47		1/55		
			chalcopyrite	2	qualitaitive	B ~U	Cu, Fe, S						(2)	
B	MJO-B4	56.00	sphalerite	3	qualitative	Zn, Fe, Cu	Point	Zn	Fe	Cu	(%)	Fe/Zn ratio	(3)	stockwork ore
							1	57.66	3.23	3.98		1/18		
							2	59.16	3.29	3.59		1/18		
							3	57.87	3.75	3.98		1/15		
			chalcopyrite	4	qualitative	B ~U	Cu, Fe, S						(4)	
		77.40	sphalerite	5	qualitative	Zn, Fe, Cu	Point	Zn	Fe	Cu	(%)	Fe/Zn ratio	(4)	stockwork ore
							1	52.36	6.28	6.68		1/8		
							2	56.01	4.46	5.30		2/13		
							3	53.87	5.50	5.96		3/10		
			chalcopyrite	6	qualitative		Cu, Fe, S						(6)	
	MJO-B6	42.10	sphalerite	7	qualitative	Zn, Fe, Cu	Point	Zn	Fe	Cu	(%)	Fe/Zn ratio	(7)	stockwork ore
							1	43.96	9.49	10.67		1/5		
							2	45.07	9.44	10.30		1/5		
							3	46.89	9.13	9.88		1/5		
		57.60	native gold	8	area	Au, Ag							Au, Ag *2 (8) (9) (10)	stockwork ore
				9	qualitative	Zn, Fe, Cu	Point	Au	Ag	Cu	(%)	Fe/Zn ratio		
							1	92.99	3.76	1.68		1/25		
							2	93.40	3.56	1.44		1/26		
			chalcopyrite	10	qualitative	Zn, Fe, Cu	Point	Zn	Fe	Cu	(%)	Fe/Zn ratio	(11)	
							1	32.90	30.60	0.19		1/58		
							2	32.32	30.85	0.17				
							3	31.88	30.68	0.22				
				11	qualitative	B ~U	Cu, Fe, Zn, S							
				12	qualitative	B ~U	Cu, Fe, S						(12)	

*1 SEM images are shown in Appendices.

*2 SEM image of native gold and Microprobe images of Au and Ag are shown Photographs 8, 9 and 10, respectively.

deposit are found in the marginal part of the deposits Bishimetal, 1987. The massive ore which shows high content of Mn is also situated at the marginal part of the Rakah deposit.

(5) Results of X-ray diffraction analyses

Hanging wall and footwall volcanic rocks as well as ore zone were also examined by X-ray diffraction analyses in Phase I and II in order to clarify the nature of alteration. Bulk X-ray diffraction analyses were made for 10 samples collected from drill cores. The results are shown in Table 2-5.

Four samples were collected from the Lower Extrusives I of the footwall volcanics. Among these samples, two samples (MJO-B5: 79.20 m and MJO-B9: 50.00 m) were collected from the volcanic rocks between the lower and upper mineralized zones. The analytical results together with the observation results of thin sections indicate that the Lower Extrusives I is marked with silicification, chloritization and hematization. In addition to these alteration, the volcanics between the lower and upper mineralized zones are characterized with smectite and chlorite/smectite mixed layer. Pumpellyite and epidote are also detected and indicate low-grade metamorphism.

Four samples were collected from the stockwork ore. Quartz and chlorite are detected which indicate silicification and chloritization. Smectite are also found in two samples. Plageoclase and augite which are not found in the ore of the Hayl as Safil deposit are detected in these samples and indicate more weak alteration compare with the Hayl as Safil deposit.

Two samples were collected from the Lower Extrusives II of the hanging wall rocks. The results show chloritization and weak silicification of the Lower Extrusives II. Pumpellyite indicating low-grade metamorphism is also detected.

Table 2-5 Results of X-ray diffraction analyses in Area B

Hole number	Sampled depth (m)	Geologic unit	Quartz	Plagioclase	Augite	Amphibole	Chlorite	Smectite	Chlorite/smectite	Kaolinite	Epidote	Prehnite	Pumpellyite	Sphene	Analcite	Laumontite	Calcite	Pyrite	Chalcopyrite	Hematite	Titanomagnetite	Remarks
MJO-B3	125.90	Ore	○	◎*			◎	△						•			○	△				*Labradorite
MJO-B4	62.30	Ore	◎	•*			◎											○	△			*Oligoclase
MJO-B5	23.50	LII	○	◎*	○		○	○									○	△			△	*Labradolite
MJO-B5	69.00	Ore	○				◎												○			
MJO-B5	79.20	LI	△	△*	○		○	○					•		◎					•	△	*Labradorite
MJO-B5	136.10	LI	○	◎*	○		○				•		•	•						•	•	*Andesine
MJO-B9	14.30	LII		◎*	△	•	○	•					•								•	*Andesine
MJO-B9	50.00	LI	○	◎*	△		○		•				•			•	○				•	*Oligoclase
MJO-B9	120.00	LI	○	◎*	△		○						•								△	*Andesine
MJO-B10	88.90	Ore	◎	◎*			○	•						•		△	△	•				*Andesine

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

2-5 Discussion

Geologic, geophysical (CP method) and drilling surveys were also carried in Area B in a period of two years. Details of the survey results are as mentioned before.

The surveys including previous drilling clearly delineated the Rakah deposit (Fig. 2-15) and necessary exploration work is completed for this deposit. The survey results suggest that the Rakah deposit was formed in the same geologic condition and same age of the Hayl as Safil deposit. In order to carried out the exploration work for this type copper deposits in the Oman Mountains region, following guidelines are thought to be very important.

① This type ore deposits are situated in the area where the Lower Extrusives II is widespread.

② The orebodies dislocated largely by the obduction of the Samail Ophiolite. Tectonic movement after the obduction also dislocate the orebodies.

③ Nature of ores depend on the geologic environment where the ores are formed.

The Rakah deposit has following characteristics compared with the Hayl as Safil deposit.

① The massive ore in the Rakah deposit shows three to four times more enrichment of Au compared with the Hayl as Safil deposit.

② The stockwork ore of the Hayl as Safil deposit is characterized by intense silicification. But the Rakah deposit is characterized by strong chloritization.

③ The mineralized zone of the Hayl as Safil deposit is clearly bounded with the hanging wall and footwall volcanics. But the mineralized zone of the Rakah deposit gradually change to no mineralized zone at the marginal parts of the deposits.

Higher Au concentration was reported by the previous survey results, because previous assays were obtained for the samples collected in the area of the massive ore and its surroundings. The survey results show similar Au contents for both the Hayl as Safil and Rakah deposits.

Gossan and gossan dump on the surface of the Rakah deposit area contain about 5.0 g/t Au. Therefore a survey for these higher Au contents zone is necessary in the stage of mine development.

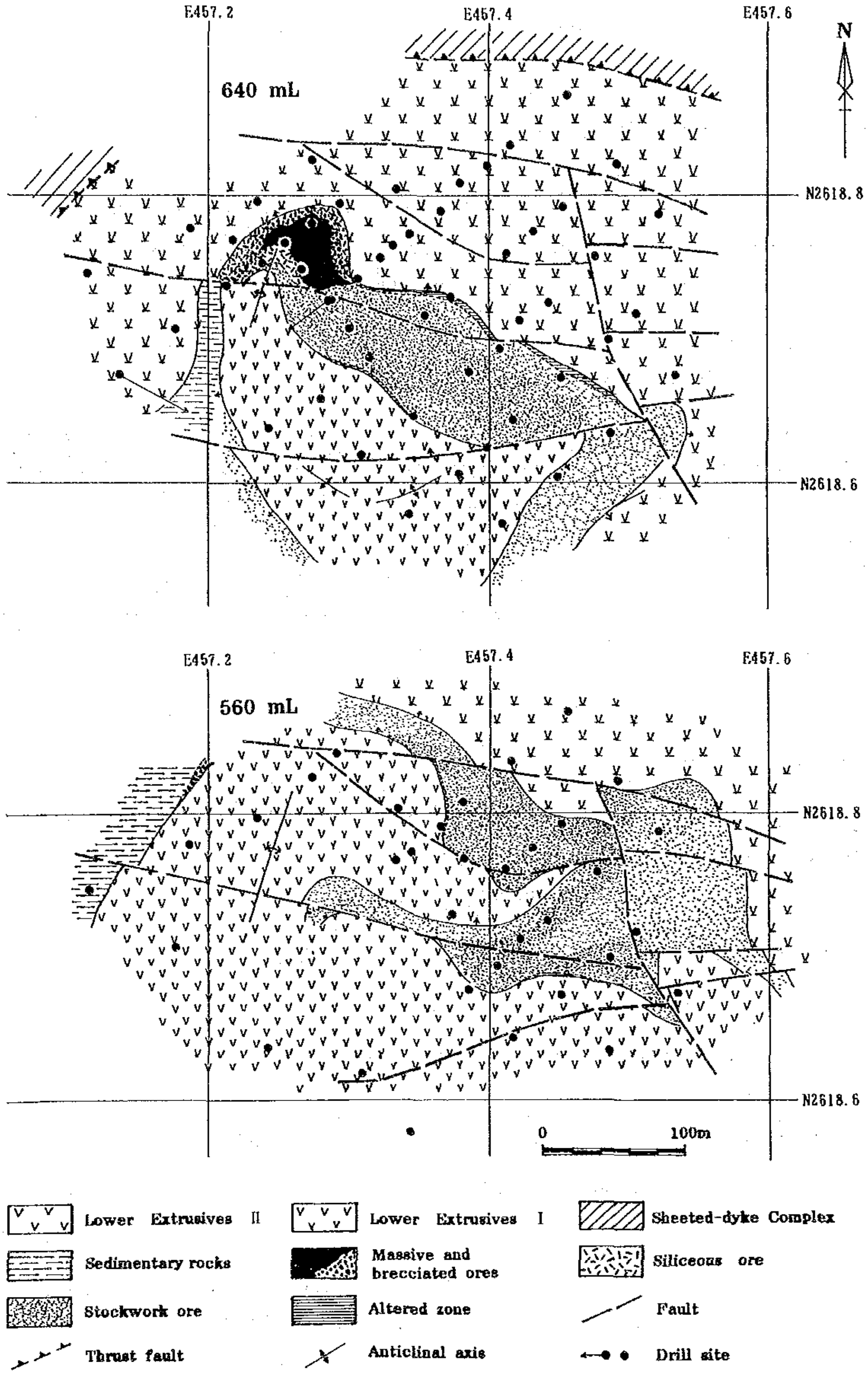


Fig. 2-15 Geologic plan maps of the 560 m and 640 m levels in the Rakah deposit