CHAPTER 6 DRILLING SURVEY

DRILLING SURVEY

6-1 Outline of the Drilling Survey

The drilling program was planned to achieve the purpose of evaluation the potential for economic Kuroko type ore deposits, following the study of all results of the geological, geochemical and geophysical surveys done by the first year's program. The La America-Descubridora area was selected as one of the potential areas, and the drilling program was concentrated in the area.

Though three holes totaling 750 meters were initially planned, two holes totaling 600 meters were added to test the extension of the significant hydrothermal alteration zone. Eventually five holes totaling 1,369.70 meters were drilled.

Site location and outline of each hole are shown in Figure 6-1 and Table 6-1.

Table 6-1 Outline of Each Hole

Hole No.	Location			Proposed Depth	Drilled Depth	Period
	X	Y	Above the sea			
MJM-1	9,360	21,410	+1,350 m	250 m	253.3 m	15.10.1985 -31.10.1985
MJM-2	8,250	20,720	+1,320 m	250 m	262.6 m	1.11.1985 -3.12.1985
MJM-3	7,840	19,190	+1,560 m	250 m	250.6 m	4.12.1985 -7.1.1986
MJM-4	8,440	19,320	+1,520 m	300 m	301.6 m	8.1.1986 -28.1.1986
MJM-5	8,540	21,050	+1,320 m	300 m	301.6 m	29.1.1986 -15.2.1986

6-2 Drilling Method and Equipment

A drilling machine, equipment and tools which were used for the initial program were shipped from Japan, July 1985. Diamond bits, rods and casing pipes for the additional holes were procured in Mexico later.

The operation was carried out by the three shifts a day. One crew consisted of one Japanese driller and three Mexican workers.

An adopted drilling method was of wireline system the final bit size BQ-WL. Libonite-bentonite-mudwater was used for drilling.

The principle equipment such as drilling machine, pump, rods, and other supplies and consumables expended in this program are shown in Table 6-2, 6-3, 6-4, 6-5 and 6-6.

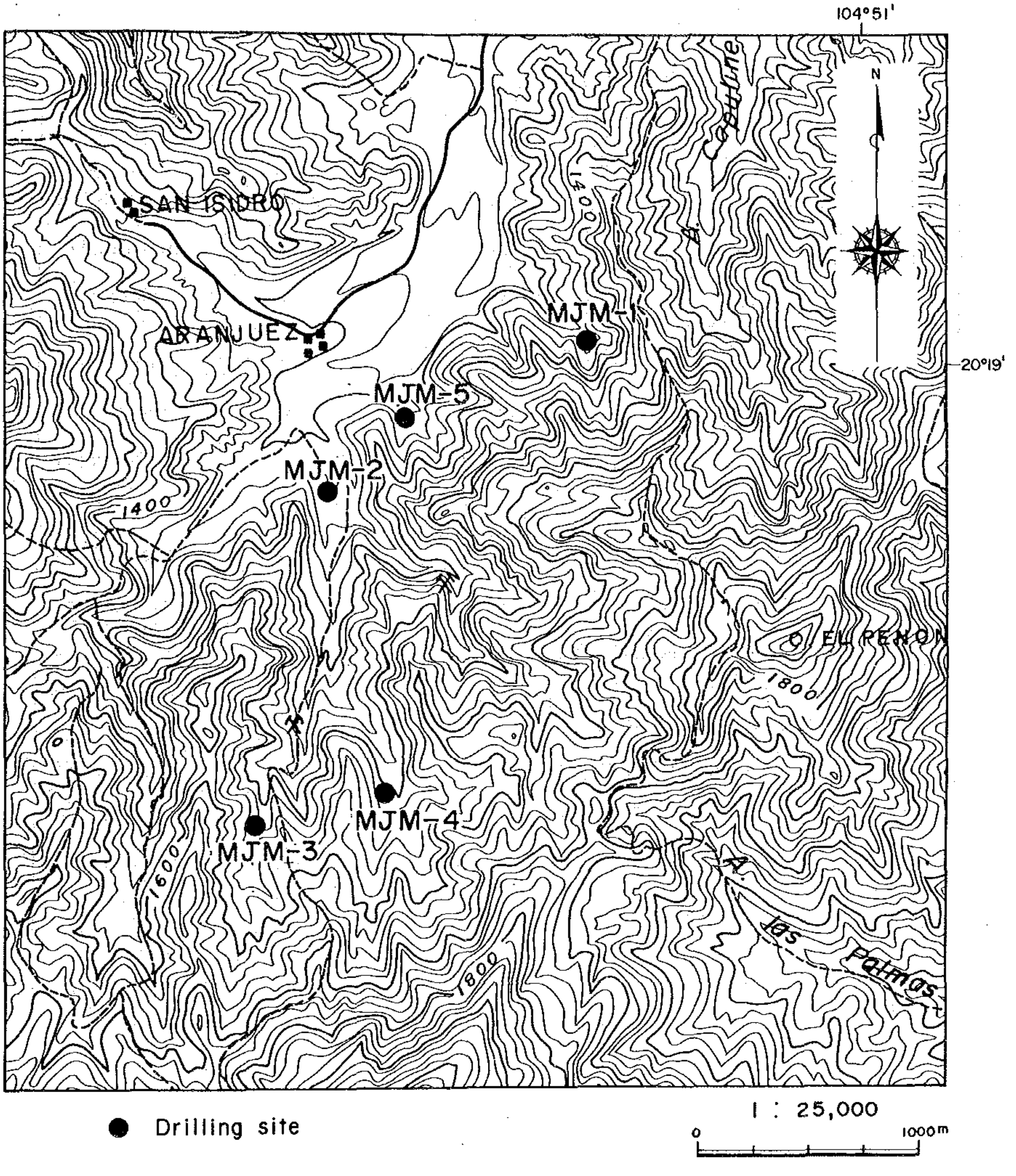


Fig. 6-1 Location Map of Drill Holes

Table 6-2 List of Equipment Used

Item	Type	Maker	Capacity	Quantity
Drilling machine	TGM-3A	TONE Boring	Load Rating 2,200 kg	1
Prime mover	Electric Motor	Mitsubishi	Rating 15 kW	1
Main pump	NAS-3C	TONE Boring	Maxim. Press 70 ksc Maxim. Vol. 130 ℓ/min	1
Prime mover	Electric Motor	Mitsubishi	Rating 7.5 kW	1
Mud mixer	MCE-100	TONE Boring	Maxim. Vol. 100 ℓ	1
Prime mover	Electric Motor	HITACHI	Rating 1.5 kW	1
Generator	DCA-55	DENYO	Rating 55 kVA	1
Prime mover	Engine DA.120	ISUZU	Horse power rating 76.5 ps/1,800 rpm	1
Water supply pump	MS-403	MARUYAMA	Maxim. 40 ksc Maxim. 63ℓ/min	1
Prime mover	GED. 25R	SIBAURA	Horse power rating 5.0 ps/1,800 rpm	1
Mast	NL-2	TONE Boring	Height 7 m	1
Wire line hoist	WHS-600	TONE Boring		1
Wire line rod	NQ	TONE Boring	1.5 m/JOINT	1
"	"	"	3.0 m/JOINT	92
"	BQ	"	1.5 m/JOINT	1
"	"	"	3.0 m/JOINT	120

Table 6-3 List of Supplies and Consumables Spent

Item	Specification	Unit	Quantity
Wireline drill rod	NQ	pcs	82
"	BQ	"	140
Casing tube	NW×3.0m	"	25
"	BW×3.0m	"	105
Inner tube assy	NQ	sets	3
"	BQ	"	3
Outer tube assy	NQ	"	2
"	BQ	"	2
Hoisting wire rope with socket	12.5mm×30.0m	roll	2
Pipe wrench	900mm	pcs	4
"	600mm	"	6
"	450mm	"	4
Diamond bit	101mm	"	3
"	NQ	"	16
"	BQ	"	21
Diamond reamer	101 mm	"	3
"	NQ	"	6
"	BQ	"	5
Casing metal shoe	NW	"	5
"	BW	"	6
Cement		kgs	5,850
Bentonite		"	21,650
Libonite		"	520
C.M.C.		"	290
Tel-stop (P)		"	50
" (G)		"	250
Barite		"	3,300
Soluble cutting oil		liters	520
Gas oil		"	13,510
Gasoline		"	1,590
Mobile oil		"	80
Turbine oil		"	120
Grease		kgs	40
Core box	101 mm	pcs	20
"	NQ	"	200
"	BQ	"	150

Table 6-4 List of Diamond Bits Used for Each Hole

Item	Size	Type	Hole No.					
			MJM-1	MJM-2	MJM-3	MJM-4	MJM-5	Total
Bit	101 m/m	101 SW	1	1	1			3
	NQ	NQ-WL	3	5	3	3	2	16
	BQ	BQ-WL	3	6	2	6	4	21
Reamer	101.5 m/m	101.5 St	1	1	1			3
	NQ	NQ-WL	1	2	1	1	1	6
	BQ	BQ-WL	1	1	1	1	1	5

Table 6-5 List of Diamond Bits Used

Item	Size	Type	Carats	Matrix	W.O.B. (t)	Spindle speed (r.p.m)	Pump pressure	Pieces
Diamond Bit	101 m/m	101 SW	32	E	1 - 2	300	6 - 8 kg/cm^2	3
"	NQ	NQ-WL	30	E	0.5 - 3.0	300 - 700	10 - 15 kg/cm^2	16
"	BQ	BQ-WL	20	E	0.5 - 3.0	300 - 700	18 - 25 kg/cm^2	21
Diamond Reamer	101.5 m/m	101.5 St	10	E				3
"	NQ	NQ-WL	8	E				6
"	BQ	BQ-WL	6	E				5

Table 6-6 Drilling Fluid

Mud materials \ Hole name		MJM-1	MJM-2	MJM-3	MJM-4	MJM-5	Total
Bentonite	kg	1,700	10,600	2,350	4,050	2,950	21,650
C.M.C.	kg	-	70	20	80	120	290
Libonite	kg	130	50	70	270	-	520
Cutting oil	ℓ	-	-	-	200	320	520
Tel-Stop (G)	kg	-	40	150	20	40	250
Tel-Stop (P)	kg	-	50	-	-	-	50
Barite	kg	-	-	3,000	300	-	3,300

6-3 Drilling Operation

6-3-1 Site Preparation

The equipment and tools from Japan landed at Manzanillo in late August were received by the mission on October 12th after long waiting due to custom procedure and the big earthquake contemporary occurred in Mexico City.

After receiving, they were immediately carried to the first drilling site. A base camp for the survey was set up in Talpa de Allende in which a branch office of C.R.M was situated. The crews commuted to the drilling sites, about 15 kilometers from the comp every day.

Construction of total length of 1.5 kilometers access roads for four sites except for MJM-2 were performed. A bulldozer and a payloader were used for the construction. A crane truck was co-operated for rigging up the tripods.

6-3-2 Mobilization

The crane truck and trucks were used for all mobilization works. A helicopter which was hired in C.R.M was used for mobilization from MJM-1 to MJM-2 site in a half day.

6-3-3 Demobilization

After completion of the final holes MJM-5 on February 13th, 1986, all equipment and tools were checked and repaired for maintenance. They were carried to a storage in La Concha where was the nearest village for the next phase program.

6-3-4 Core Recovery and Drilling Fluid

All holes were drilled down about 150 meters by NQ-wireline method, then BW casing pipes were inserted, then rest of deeper parts were drilled by BQ-wireline method.

The average core recovery rate of the five holes was 97.0 percent. The summarized drilling data were shown in Table 6-7, 6-8, 6-9, 6-10 and 6-11.

Libonite-bentonite-mud was used as drilling fluid. General mixing ratio was 7 percent bentonite, 1 percent libonite and 1 percent CMC, but the ratio was adjusted dependent on hole conditions such as lost circulation and gushed water.

6-3-5 Water Supply

The water was pumped up from streams and small rivers nearby the drilling sites. The lengths of water pipes were 50 to 500 meters, and the maximum head high was 150 meters.

6-3-6 Drilling

Progression of the whole operation is shown in Figure 6-2 and the drilling data of each hole are shown in Fig. 6-4, 6-5, 6-6, 6-7 and 6-8, and Table 6-7, 6-8, 6-9, 6-10 and 6-11.

Table 6-7 Summary of Drilling Program (MJM-1)

Classification	Period	Total days	Working days	Day off	Number of workers
Mobilization	15.10.1985 - 17.10.1985	3	3	0	36
Drilling	18.10.1985 - 28.10.1985	11	Drill 11	0	132
			0	0	0
Demobilization	29.10.1985 - 31.10.1985	3	3	0	36
Total	15.10.1985 - 31.10.1985	17	17	0	204

Proposed depth	250.0m	Core length	250.4m
Drilling depth	253.3m	Core recovery	98.86%
Over burden	4.3m		

Drilling	123°00'	46.59%	39.43%
Relative operation	141°00'	53.41%	45.19%
Pipe stuck	0°00'	0.00%	0.00%
Subtotal	264°00'	100.00%	-%
Mobilization	24°00'	- %	7.69%
Demobilization	24°00'	- %	7.69%
Total	312°00'	- %	100.00%

Casing size	Depth (m)	$\frac{B}{A}\times 100$ (%)	Recovery (%)
N.W	6.00	2.37	100
B.W	142.00	56.06	100

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 102.0	102.0m	98.04%	98.04%
102.0 - 200.0	98.0m	99.80%	98.90%
200.0 - 253.3	53.3m	98.69%	98.86%

Efficiency

253.3 m/total period	14.90 m/day
253.3 m/working days	14.90 m/day
253.3 m/drilling days	23.03 m/day
Total workers/253.3 m	0.81 workers/m

Observation

A: Total depth

B: Casing length

Table 6-8 Summary of Drilling Program (MJM-2)

	Classification	Period	Total days	Working days	Day off	Number of workers
Period	Mobilization	1.11.1985 - 3.11.1985	3	3	0	36
	Drilling	4.11.1985 - 1.12.1985	27.5	Drill 24	0	288
				3.5	0	44
	Demobilization	1.12.1985 - 3.12.1985	2.5	2.5	0	28
	Total	1.11.1985 - 3.12.1985	33	33	0	396

Proposed depth	250.0m	Core length	247.1m
Drilling depth	262.6m	Core recovery	94.10%
Over burden	15.5m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 100.6	100.6m	86.08%	86.08%
100.6 - 200.8	100.2m	98.50%	92.28%
200.8 - 262.6	61.8m	100.00%	94.10%

Time distribution	Drilling	152°00'	22.76%	21.17%
	Relative operation	429°00'	64.22%	59.75%
	Pipe stuck	87°00'	13.02%	12.12%
	Subtotal	668°00'	100.00%	- %
	Mobilization	25°00'	- %	3.48%
	Demobilization	25°00'	- %	3.48%
	Total	718°00'	- %	100.00%

Efficiency

262.6 m/total period	7.96 m/day
262.6 m/working days	7.96 m/day
262.6 m/drilling days	10.94 m/day
Total workers/262.6 m	1.51 workers/m

	Casing size	Depth (m)	$\frac{B}{A}\times100$ (%)	Recovery (%)
Casing	N.W	43.00	16.37	65
	B.W	109.00	41.51	100

Observation

A: Total depth

B: Casing length

Table 6-9 Summary of Drilling Program (MJM-3)

	Classification	Period	Total days	Working days	Day off	Number of workers
Period	Mobilization	4.12.1985 - 9.12.1985	5.5	5.5	0	68
	Drilling	9.12.1985 - 5.1.1986	27	Drill 26	1	312
				0	0	0
	Demobilization	5.1.1986 - 7.1.1986	2.5	2.5	0	28
	Total	4.12.1985 - 7.1.1986	35	34	1	408

Proposed depth	250.0m	Core length	246.7m
Drilling depth	250.6m	Core recovery	98.44%
Over burden	7.2m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 101.8	101.8m	98.33%	98.33%
101.8 - 201.0	99.2m	97.78%	98.06%
201.0 - 250.6	49.6m	100.00%	98.44%

Time distribution	Drilling	71°51'	11.09%	9.85%
	Relative operation	576°10'	88.91%	79.04%
	Pipe stuck	0°00'	0.00%	0.00%
	Subtotal	648°00'	100.00%	- %
	Mobilization	57°00'	- %	7.82%
	Demobilization	24°00'	- %	3.29%
	Total	729°00'	- %	100.00%

Efficiency

250.6 m/total period	7.16 m/day
250.6 m/working days	7.37 m/day
250.6 m/drilling days	9.64 m/day
Total workers/250.6 m	1.61 workers/m

	Casing size	Depth (m)	$\frac{B}{A}\times100$ (%)	Recovery (%)
Casing	N.W	10.00	3.99	11
	B.W	168.40	67.20	100

Observation
A: Total depth
B: Casing length

Table 6-10 Summary of Drilling Program (MJM-4)

	Classification	Period	Total days	Working days	Day off	Number of workers
Period	Mobilization	8.1.1986 - 9.1.1986	2	2	0	24
	Drilling	10.1.1986 - 27.1.1986	17.5	Drill 17.5	0	208
				0	0	0
	Demobilization	27.1.1986 - 28.1.1986	1.5	1.5	0	20
	Total	8.1.1986 - 28.1.1986	21	21	0	252

Proposed depth	300.0m	Core length	292.4m
Drilling depth	301.6m	Core recovery	96.95%
Over burden	13.2m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 100.2	100.2m	94.21%	94.21%
100.2 - 200.7	100.5m	100.00%	97.11%
200.7 - 301.6	100.9m	96.63%	96.95%

Time distribution	Drilling	123° 40'	29.73%	26.37%
	Relative operation	292° 20'	70.27%	62.33%
	Pipe stuck	0° 00'	0.00%	0.00%
	Subtotal	416° 00'	100.00%	- %
	Mobilization	24° 00'	- %	5.12%
	Demobilization	29° 00'	- %	6.18%
	Total	469° 00'	- %	100.00%

Efficiency	
301.6 m/total period	14.36 m/day
301.6 m/working days	14.36 m/day
301.6 m/drilling days	17.23 m/day
Total workers/301.6m	0.84 workers/m

	Casing size	Depth (m)	$\frac{B}{A}\times100$ (%)	Recovery (%)
Casing	N.W	15.00	4.97	100
	B.W	162.00	53.71	100

Observation

A: Total depth

B: Casing length

Table 6-11 Summary of Drilling Program (MJM-5)

	Classification	Period	Total days	Working days	Day off	Number of workers
Period	Mobilization	29.1.1986 - 31.1.1986	2.5	2.5	0	28
	Drilling	31.1.1986 - 13.2.1986	13	Drill 13	0	156
				0	0	0
	Demobilization	13.2.1986 - 15.2.1986	2.5	2.5	0	32
	Total	29.1.1986 - 15.2.1986	18	18	0	216

Proposed depth	300.0m	Core length	293.2m
Drilling depth	301.6m	Core recovery	97.21%
Over burden	12.5m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 100.0	100.0m	92.90%	92.90%
100.0 - 202.3	102.3m	99.22%	96.09%
202.3 - 301.6	99.3m	99.50%	97.21%

Time distribution	Drilling	94°30'	28.81%	25.00%
	Relative operation	233°30'	71.19%	61.77%
	Pipe stuck	0°00'	0.00%	0.00%
	Subtotal	328°00'	100.00%	- %
	Mobilization	29°00'	- %	7.67%
	Demobilization	21°00'	- %	5.56%
	Total	378°00'	- %	100.00%

Efficiency

301.6 m/total period	16.76 m/day
301.6 m/working days	16.76 m/day
301.6 m/drilling days	23.20 m/day
Total workers/301.6 m	0.72 workers/m

	Casing size	Depth (m)	$\frac{B}{A}\times100$ (%)	Recovery (%)
Casing	N.W	13.00	4.31	100
	B.W	139.00	46.09	100

Observation

A: Total depth

B: Casing length

Fig. 6-2 Progress of Drilling Program

Item		Days	Workers Specialist	Workers Helper	August. 1985	September	October	November	December	January. 1986	February
Roads and drilling sites preparated and repairs		74	102	193	6–11, 19–	–14, 16–24, 29–	–12		4–15		
Mobilization (from Japan to Talpa)		6	18	-		2–7					
Transportation (from Manzanillo to Talpa)		3	9	8			12–14				
MJM-1	Mobilization	3	9	27			15–17				
	Drilling	11	33	99			18–28				
	Demobilization	3	9	27			29–31				
	Total	17	51	153							
MJM-2	Mobilization	3	9	27				1–3			
	Drilling	27.5	83	249				4–	–1		
	Demobilization	2.5	7	21					–3		
	Total	33	99	297							
MJM-3	Mobilization	5.5	17	51					4–9		
	Drilling	27	78	234					9–31	2–5	
	Demobilization	2.5	7	21						5–7	
	Total	35	102	306							
MJM-4	Mobilization	2	6	18						8–9	
	Drilling	17.5	52	156						10–27	
	Demobilization	1.5	5	15						27–28	
	Total	21	63	189							
MJM-5	Mobilization	2.5	7	21						29–31	
	Drilling	13	39	117						31–	–13
	Demobilization	2.5	8	24							13–15
	Total	18	54	162							
Transportation (from Talpa to Concha)		3	9	-							16–18
Equipments repairs (from Talpa to Japan)		4	12	-							19–22
Demobilization		6	18	-							23–28
Total			258	1,308							

Fig. 6-3 Progress Record of Diamond Drilling MJM-1

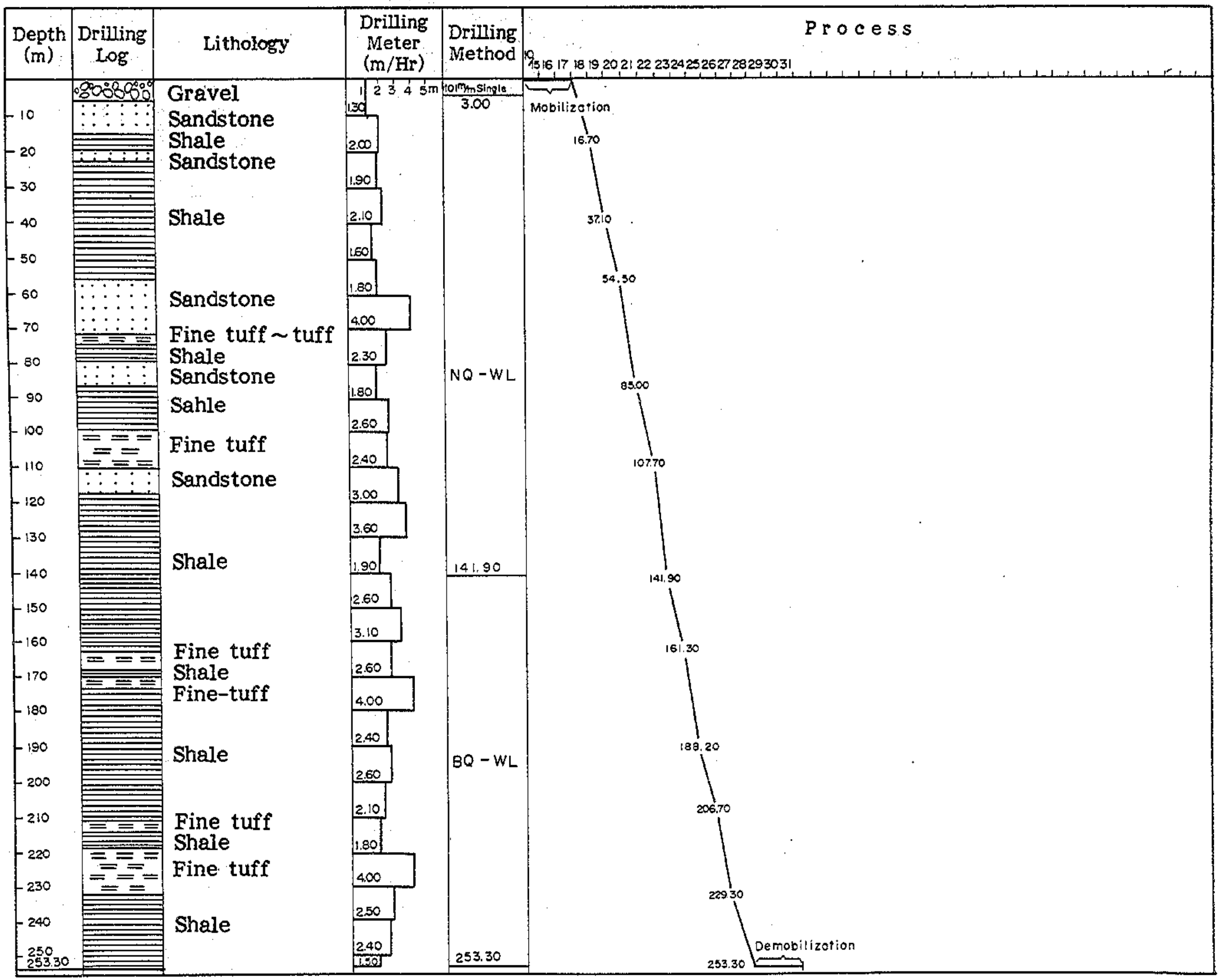


Fig. 6-4 Progress Record of Diamond Drilling MJM-2

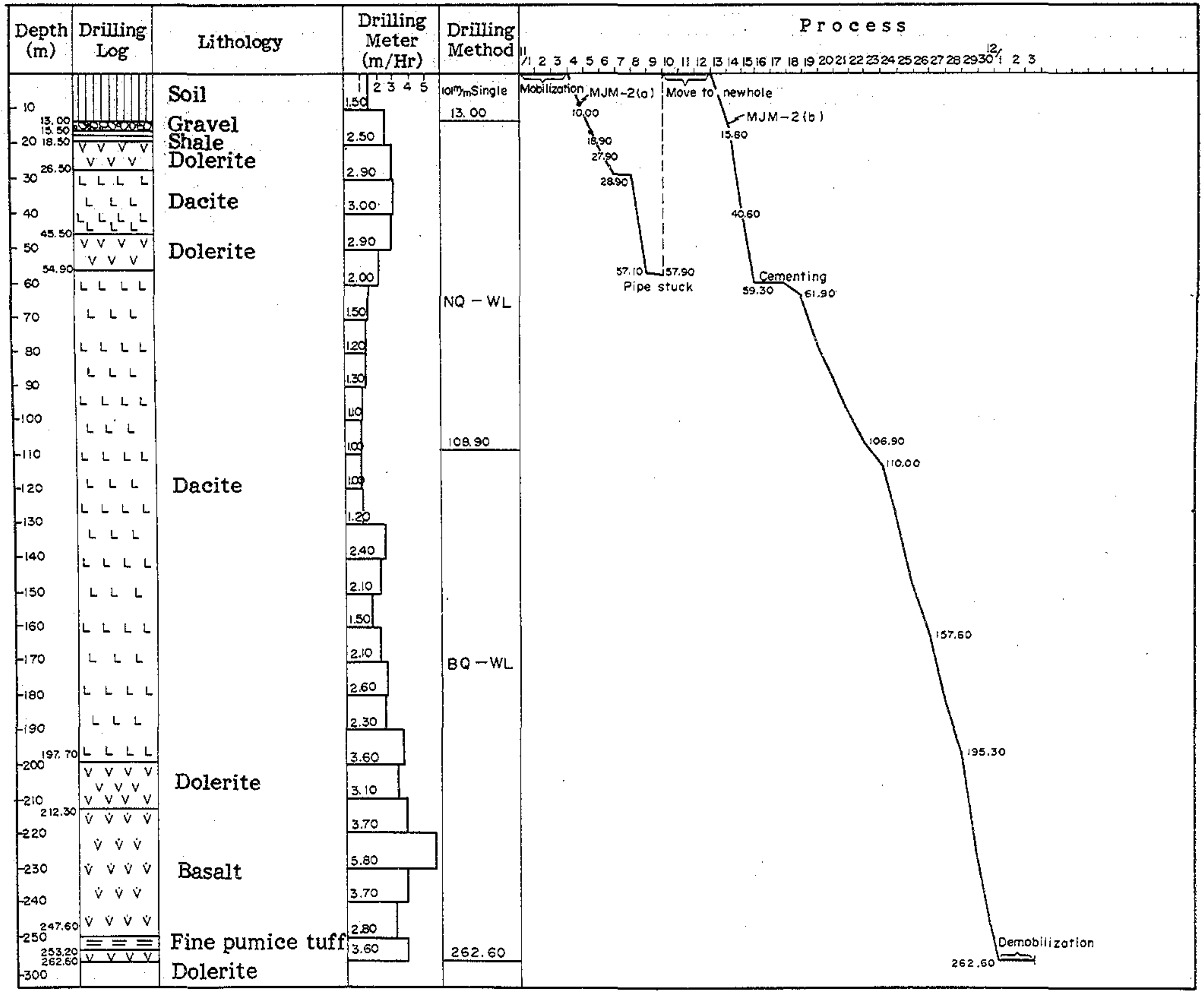


Fig. 6-5 Progress Record of Diamond Drilling MJM-3

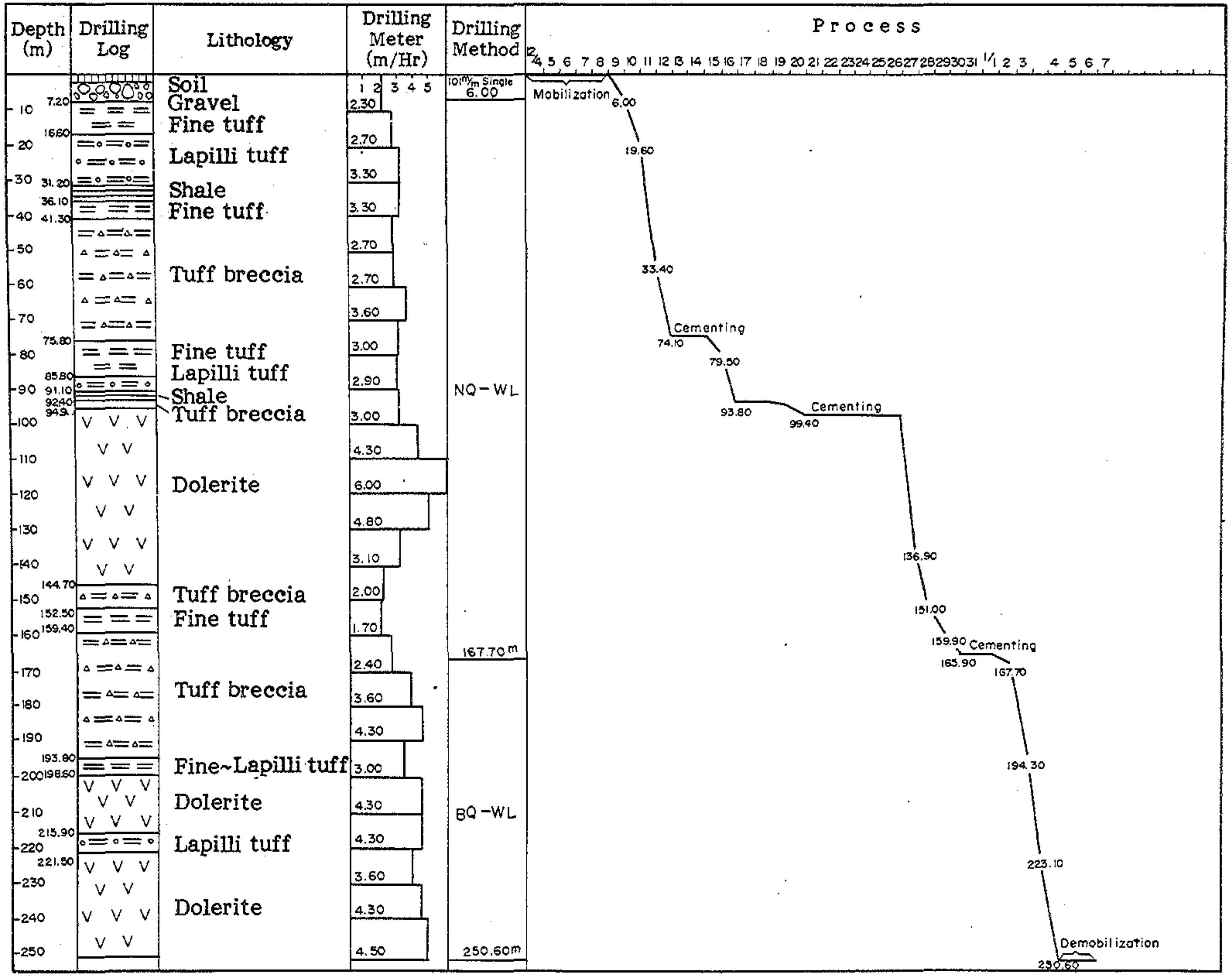


Fig. 6-6 Progress Record of Diamond Drilling MJM-4

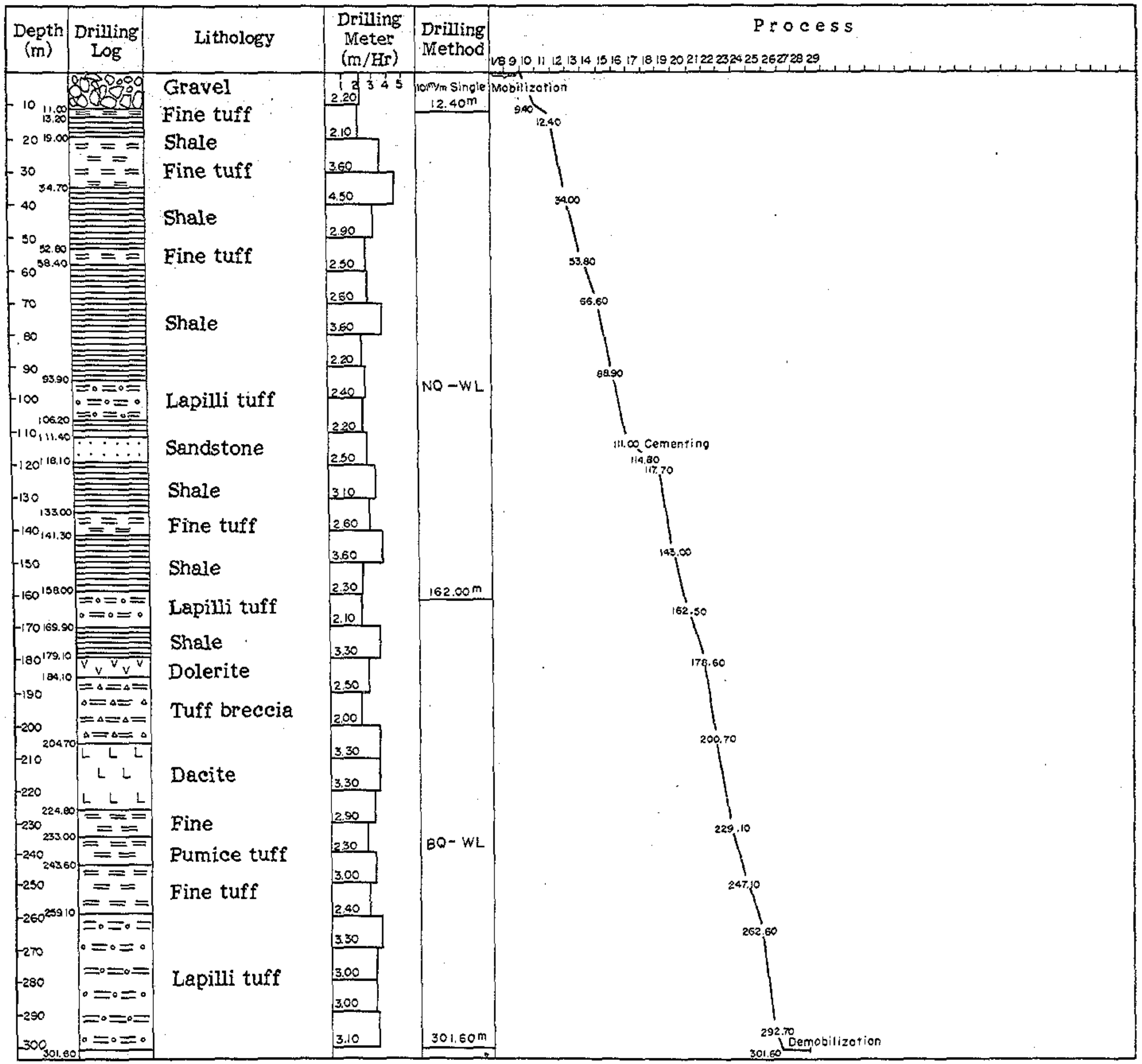


Fig. 6-7 Progress Record of Diamond Drilling MJM-5

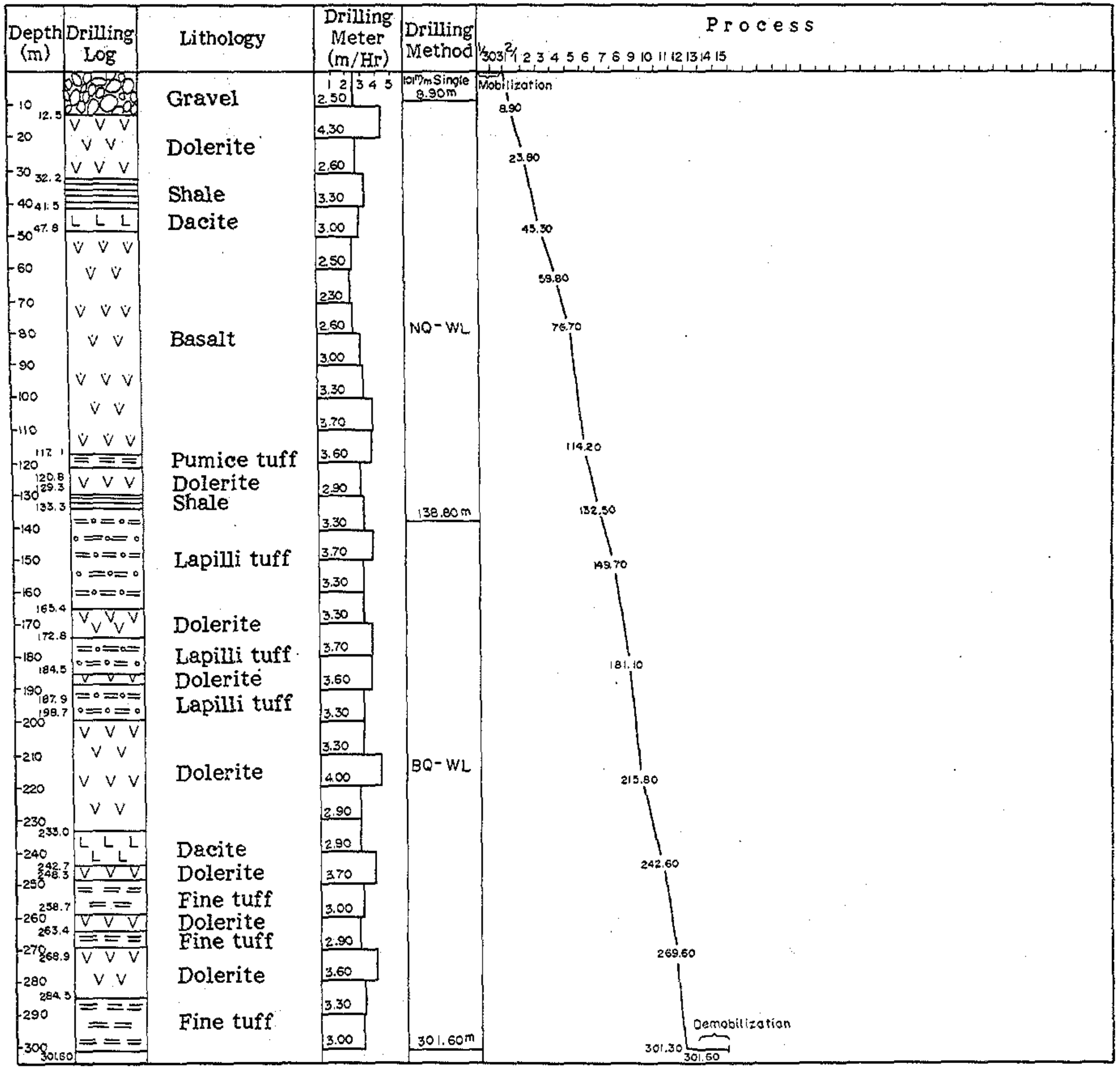
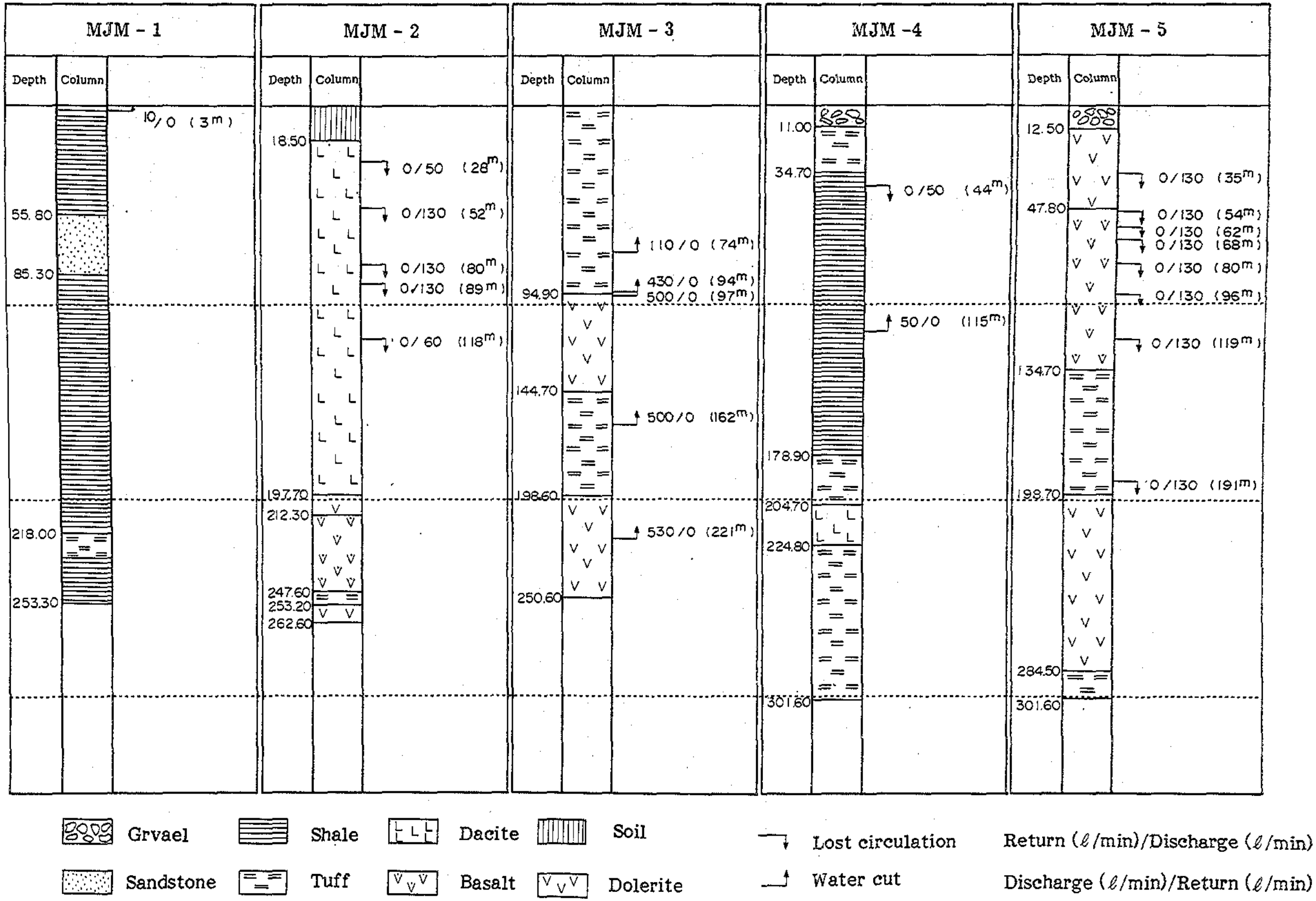


Fig. 6-8 Relation of the Geological Logs and Circulation of the Drilling Water



Summary of the situation for each hole is as follows.

MJM-1: No special trouble happened. Smooth drilling.

MJM-2: The drill hole encounted a sheared zone with lost circulation trouble at depth of 57.9 meters, and the outertube and rods were stuck. After an unsuccessful recovery work for the stuck rods, another hole was spudded four meters apart from the original hole. During the drilling between the depth of 28 meters and 120 meters, all mud water circulation stuck troubles (discharge 130 ℓ /min) were happened four times in the cracked dacite.

Measures to recover the trouble were as follows:

Lost circulation materials such as Telstop (powder and crushed cotton seeds) and CMC were mixed with the mud water. Cementing and extension of casing pipes were done.

These measures effectively worked for the trouble, this hard dacite also made lowering the bit life and the drilling speed rate.

MJM-3: There were five gushed water troubles (110 ~ 530 ℓ /min) between depth of 70 meters and 220 meters. The water was gushed up from sheared zones which were occurred mainly along the boundary of the dolerite and the tuff breccia. The drilling was about to be continued by cement plugging and casing extension to seal off these zones.

MJM-4: No special trouble happened except one small cementing job.

MJM-5: Mud water circulation troubles same as those occurred in MJM-2 were happened seven times in the cracked dacite. The measures to prevent the lost circulation was performed almost same as that done in MJM-2

6-3-7 Measures to Prevent Gashed Water and Lost Circulation Trouble

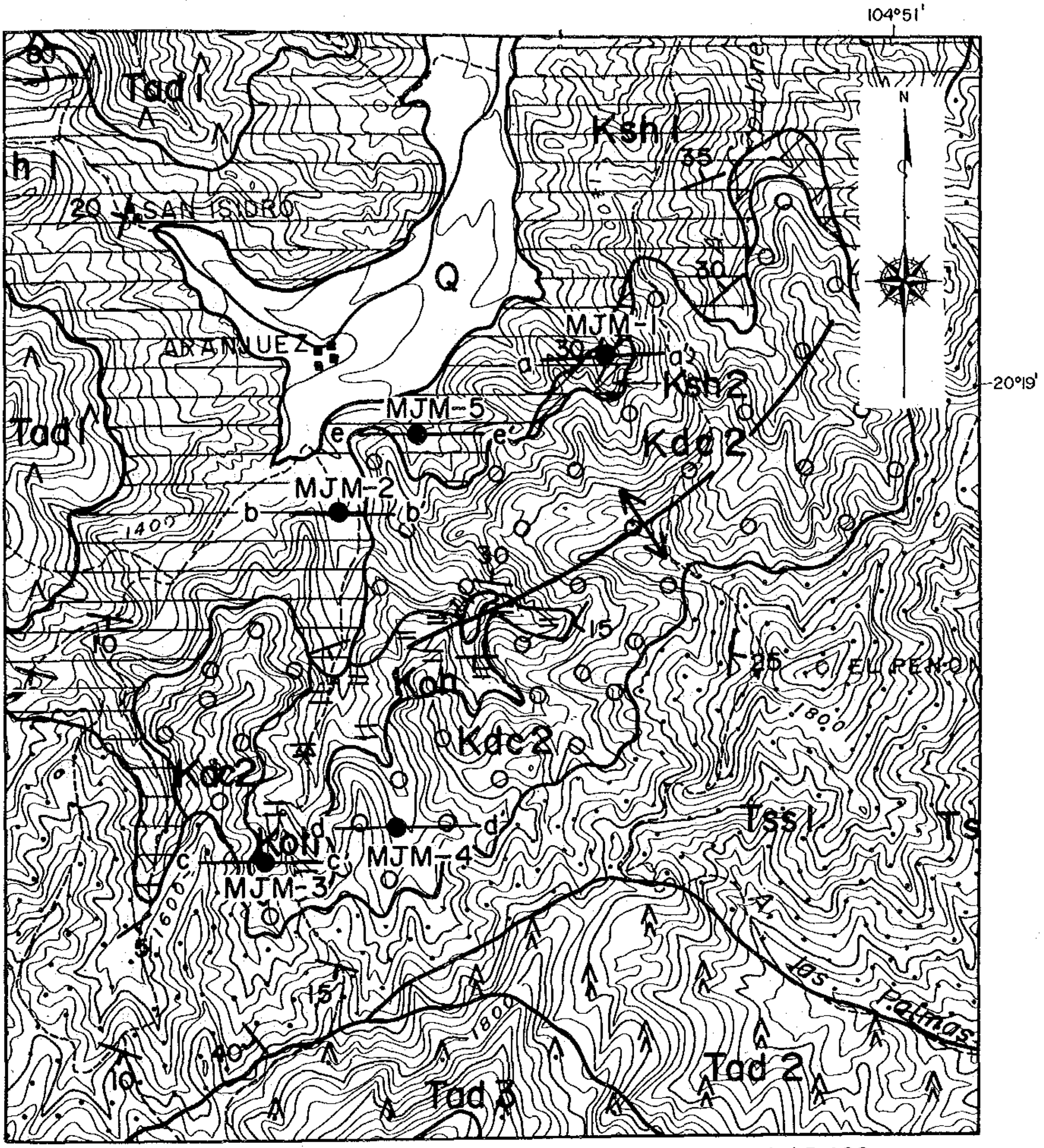
Most lost circulation troubles occurred in the cracked dacite of MJM-2 and -4. Gashed water trouble of MJM-3 seems to take place along and near the dolerite sheet borders.

The prevention measures were mentioned above in Clause 6-3-6. The relation of the geology and drilling water problem are shown in Fig. 6-8.

6-4 Geology of the Holes

6-4-1 Selection of the Drilling Targets

The selection of the drilling targets was done based on the results of the geological, geochemical and geophysical (CSAMT method) surveys conducted in the first year. All the results were integratively interpreted to achieve the purpose to find Kuroko type ores of the project. The following points were considered as important elements for the selection of drilling targets.



1 : 25,000

0 — 1000m

Legend

Q	Alluvium-Diluvium	Kdc2	Hanging wall dacite
Tad3	III-stage andesite	Koh	Ore horizon pyroclastics
Tad2	II-stage andesite	Ksh2	Calcareous shale
Tss I	Sandstone	Ksh I	Shale-sandstone
Tad I	I-stage andesite		

● Drilling site

Fold axis

Strike and dip

a——a' Section line

Fig. 6-9 Geological Map around Drilling Sites

a. Dominant distribution of the Cretaceous acidic volcanics.

b. Strong hydrothermal alteration.

c. Geochemical anomaly of stream sediments, specially geochemical anomaly by multi-element.

d. Low resistivity zone detected by the CSAMT survey.

Reasons of selection for each hole are as follows:

(1) MJM-1:

This position is situated in the northern side of an anticlinal structure, presumably being caused by uplift of dacite domes being related to genesis of Kuroko ores. Furthermore the point is in a geochemical anomaly by multi-element, and in a low resistivity zone (lower than 200 ·m) of Aranjuez East.

(2) MJM-2:

This position is situated in an expected distribution area of the hanging wall dacite, and in a geochemical anomaly by multi-element. Furthermore a strong alteration zone extending northeast to southwest is distributed there, and it intersects the Aranjuez low resistivity zone at this point. These anomalies coexist at this point, therefore it is evaluated that this position is one of very favorable areas for Kuroko exploration.

(3) MJM-3:

This position is situated in an extension zone of a distribution area of the ore horizon pyroclastic (Koh) being subjected to strong alteration, and in a low resistivity zone extending to the west from this point. However, there is another possibility that the low resistivity zone is caused by the Tertiary sandstones (Tss1) judging from the surface geology. No geochemical anomaly was detected there.

(4) MJM-4:

This position is situated in a distribution area of the hanging wall dacite (Kdc2), and distribution of the ore horizon pyroclastics (Koh) being extended from the Descubridora or La America ore deposits is expected there. This point is in a strong alteration zone but in a geochemical anomaly by single element (Zn), and no low resistivity zone was detected there.

(5) MJM-5:

This position is situated in an edge of a potential distribution area of the Cretaceous volcanics, and in a geochemical anomaly by multi-element. Furthermore this point is in the Aranjuez low resistivity zone, therefore it is evaluated that this point is one of favorable areas for Kuroko exploration.

Fig. 6-9 shows the geology around the drilling holes.

6-4-2 Outline of Geology for Each Hole

(1) MJM-1:

Rocks of the hole are hard compact shale and grey to dark grey well sorted sandstone of the Upper Cretaceous (Kshl). They are mainly intercalated by olive to grey acidic fine grained pyroclastics layers, but partly, between depths of 218.00 and 232.40 meters, lapilli tuffs contain pumice patches. Nevertheless no mud balls or other evidences indicating submarine pyroclastic flows are noted in the cores except common existence of fine-grained pyrite and pyrrhotite clastics (smaller than several millimeters diameter) between depths of 218.00 and 232.40 meters, it is presumed that the pyroclastics are of flows. In addition lithofacies of the pyroclastic are similar to those of ore horizon pyroclastics around the La America deposit and old workings. Therefore it is concluded that the rocks of the hole are of the ore horizon formation (Koh). The depth of the pyroclastic in the hole coincides with the postulated depth from the surface geology. From the geological point of view, it is suggested that this position is situated far from volcanic eruption centers, because no lava flow or coarse graind pyroclastic such as volcanic breccia are noted. Therefore to search such volcanic centers is necessary for Kuroko exploration.

(2) MJM-2:

Geology of the hole is much different from that of MJM-1, mainly consisting of volcanics. Therefore, it is presumed that this position is close to a volcanic eruption center. Geology from 21.00 meters to 197.70 meters consists of the hanging wall dacite (Kdc2), pale green to green in fresh parts, generally massive, poor breccated texture. This part is in an extension zone of the dacite in the surface about 600 meters east of the hole.

Well brecciated basalt, dark green to purple, was encountered the depth from 214.00 meters to 247.60 meters. This rock is not exposed in the surface. Submarine small basin structures as paleo-basin are good indication for genesis of Kuroko type ores, and the rock in the hole suggests that such structures existed around there.

The depth from 247.60 meters to 253.30 meters consists of dark green to green, little pumiceous, fine grained pyrite disseminated, fine tuff. The lithofacies of the rocks are similar to those of the ore horizon pyroclastics in the La America deposit, and the position of the rocks coincides with the postulated depth from the surface geology. As mentioned above, geology of the hole is very favorable for potential Kuroko ores.

(3) MJM-3:

Geology of the hole is much different from those of the previously mentioned two holes. Acidic pyroclastics and dolerite are the main constituents, being alternated by thin layers of black shale.

The depth from 7.20 meters to 41.30 meters consists of alternation of olive colored fine tuff, dark green to olive colored lapilli tuff, and black shale. The black shale is intercalated by thin layers of fine tuff, indicating deposition during volcanic activity.

Fig. 6-10 Geological Section of Drilling (MJM-1)

(a – a′)

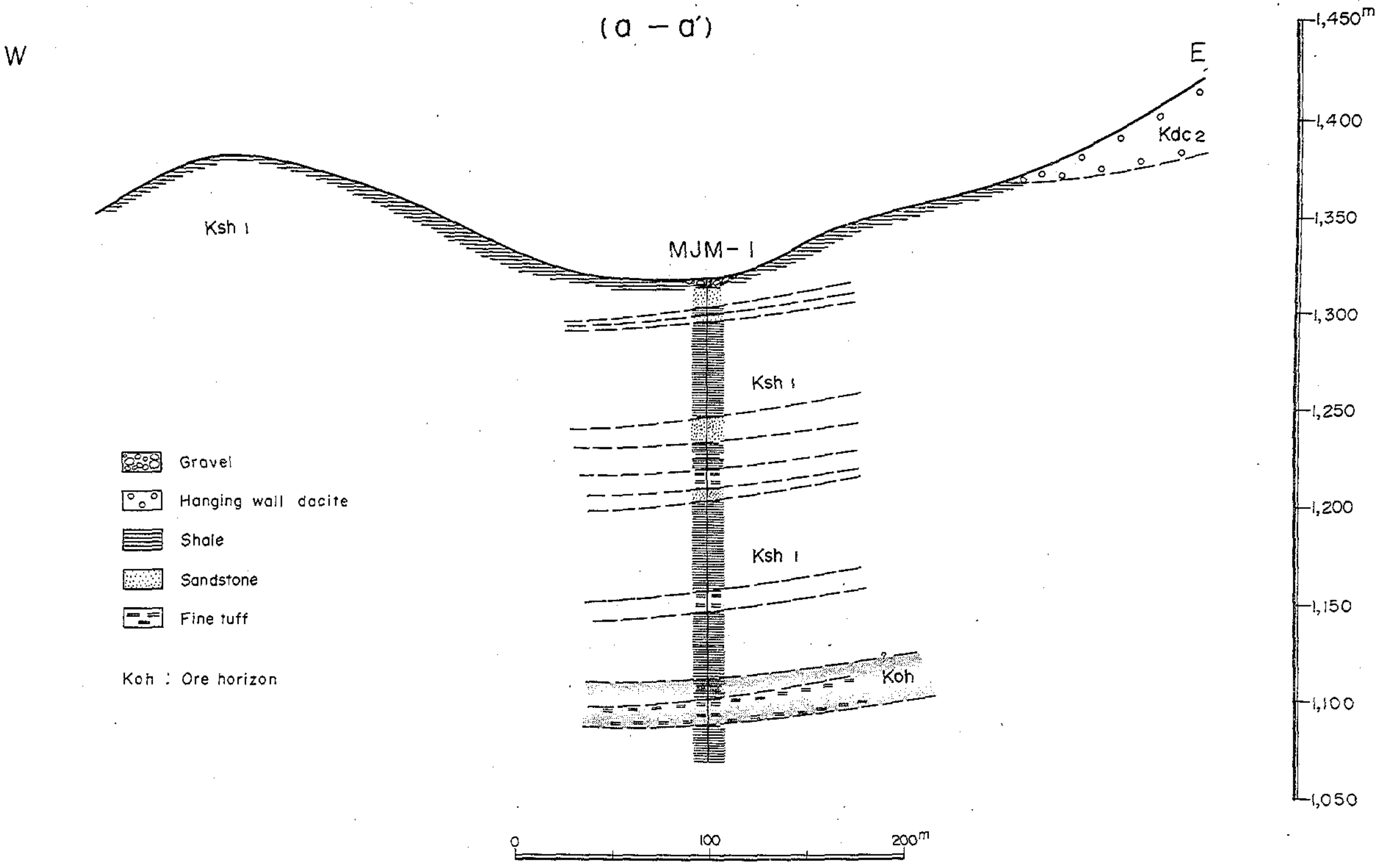


Fig. 6-11 Geological Section of Drilling (MJM-2)

(b — b′)

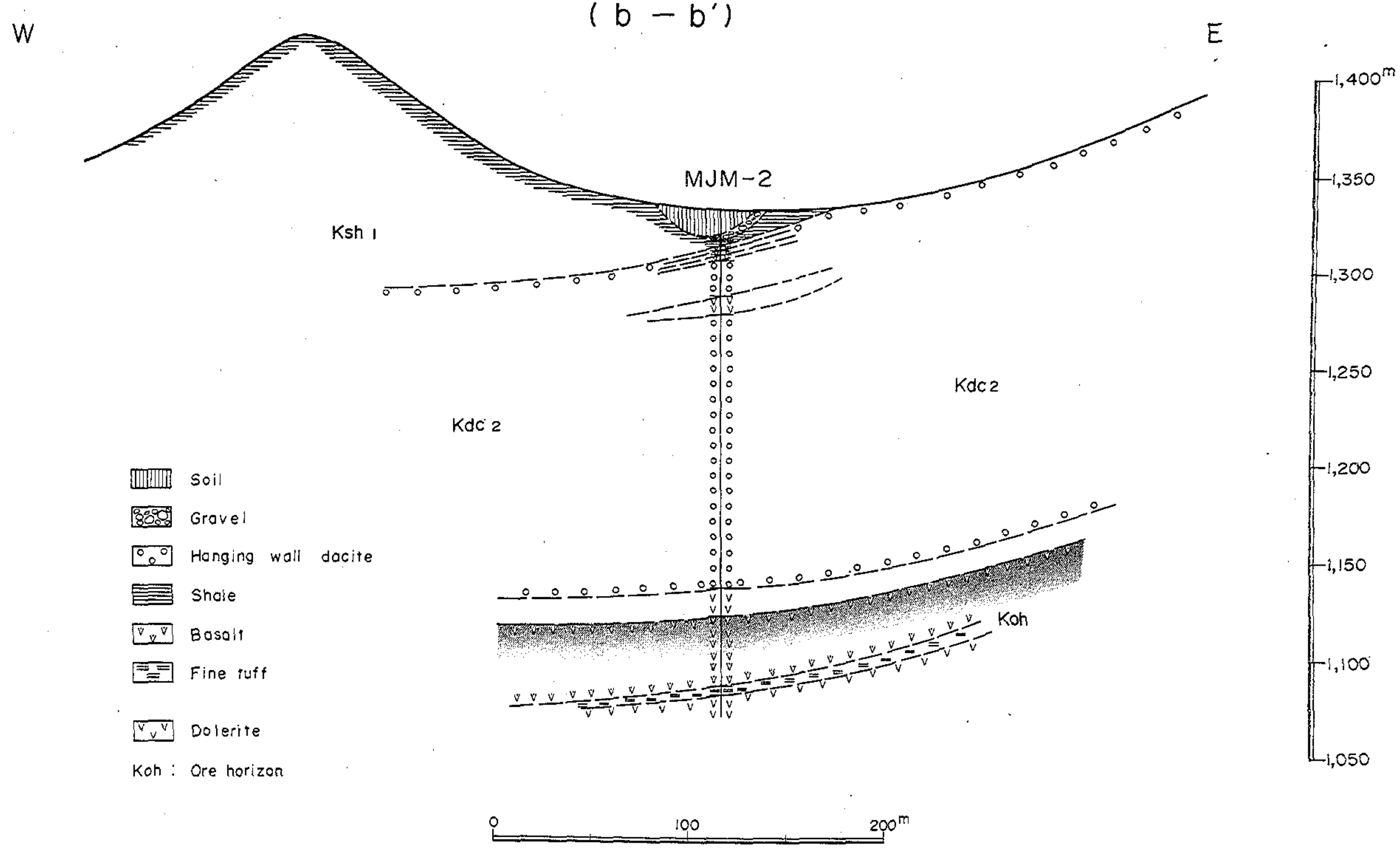
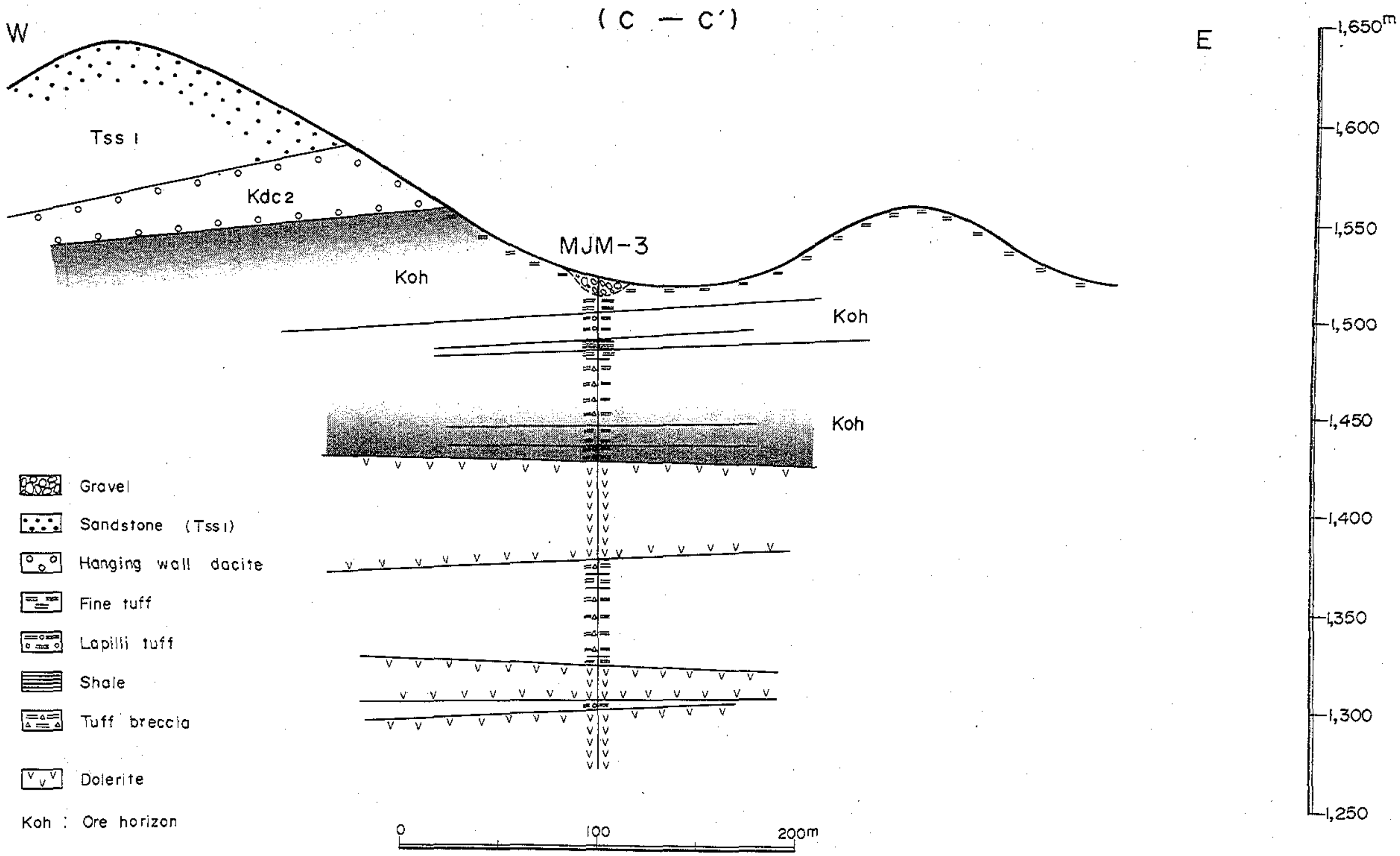


Fig. 6-12 Geological Section of Drilling (MJM-3)

(C — C′)



The depth from 75.80 meters to 159.40 meters consists of alternation of olive colored fine tuff, lapilli taff, black shale, and green tuff breccia, being intruded by a basalt sheet (from 94.90 meters to 144.70 meters).

The depth from 159.40 meters to 250.60 meters consists of tuff breccia, fine tuff, lapilli tuff, and dolerite, dominantly tuff breccia in the upper part (from 159.40 meters to 193.80 meters) and dolerite in the deeper part (from 198.60 meters to 215.90 meters, and from 221.50 meters to 250.60 meters).

(4) MJM-4:

Geology of the hole is separated into two parts, alternation of shale, sandstone and fine tuff in the shallow part (from 11.00 meters to 179.10 meters), tuffs in the deeper part (from 179.10 meters to 301.60 meters). Lithofacies of the pyroclastics appeared in the hole are different from those of MJM-1, -2, and-5, but similar to those of MJM-3, especially the lapilli tuffs and volcanic breccias in the deeper parts of the two holes. MJM-3 and -4 are lithologically same, and it is judged that they are of the same formation.

Judging from the common existence of tuff breccia and dolerite sheet, it is presumed that the position of MJM-3 is situated closer to a volcanic activity center than that of MJM-4. Nevertheless no Kuroko ore is found in the hole, fine grained sulphide dissemination zone commonly associated with Kuroko mineralization are noted in a zone from the surface to the depth of 111.40 meters. Therefore it is judged that this zone is correlated with the ore horizon.

(5) MJM-5:

Main constituent rocks of the hole are volcanics, dominantly basic one down to the depth of 130 meters, then coexistence of basic and acidic ones in the deeper part.

The depth from 32.20 meters to 41.50 meters consists of compact black shale, being intercalated by thin layers (thiner than several centimeters) of fine tuffs accompaning fine grained pyrite dissemination.

The depth from 41.50 meters to 47.80 meters consists of pale green dacite lava, being stratigraphically correlated with the dacite in the upper part of MJM-2, but showing different lithofacies (grain size, amount of plagioclase, etc.) from them. Therefore, its volcanic activity is originally and timely different form that of MJM-2.

The depth from 47.80 meters to 117.10 meters consists of dark green to green typical basalt lava, suggesting possible existence of a paleo-basin there, which is good indication for Kuroko ores as previously mentioned.

The depth from 117.10 meters to 301.60 meters mainly consists of green to gray lapilli tuff and fine tuff except some carboniferous black shale intercalations in the upper part. The rocks are intruded by dolerite sheets. It is presumed that the ore horizon in the hole is in the zone from 32.20 meters to 184.50 meters, judging from the character of mineralization, alteration, and geological setting. It is judged that the volcanics of the hole are originally same as those of MJM-2, and the two holes are situated in the same volcanic activity environment.

Fig. 6-13 Geological Section of Drilling (MJM-4)

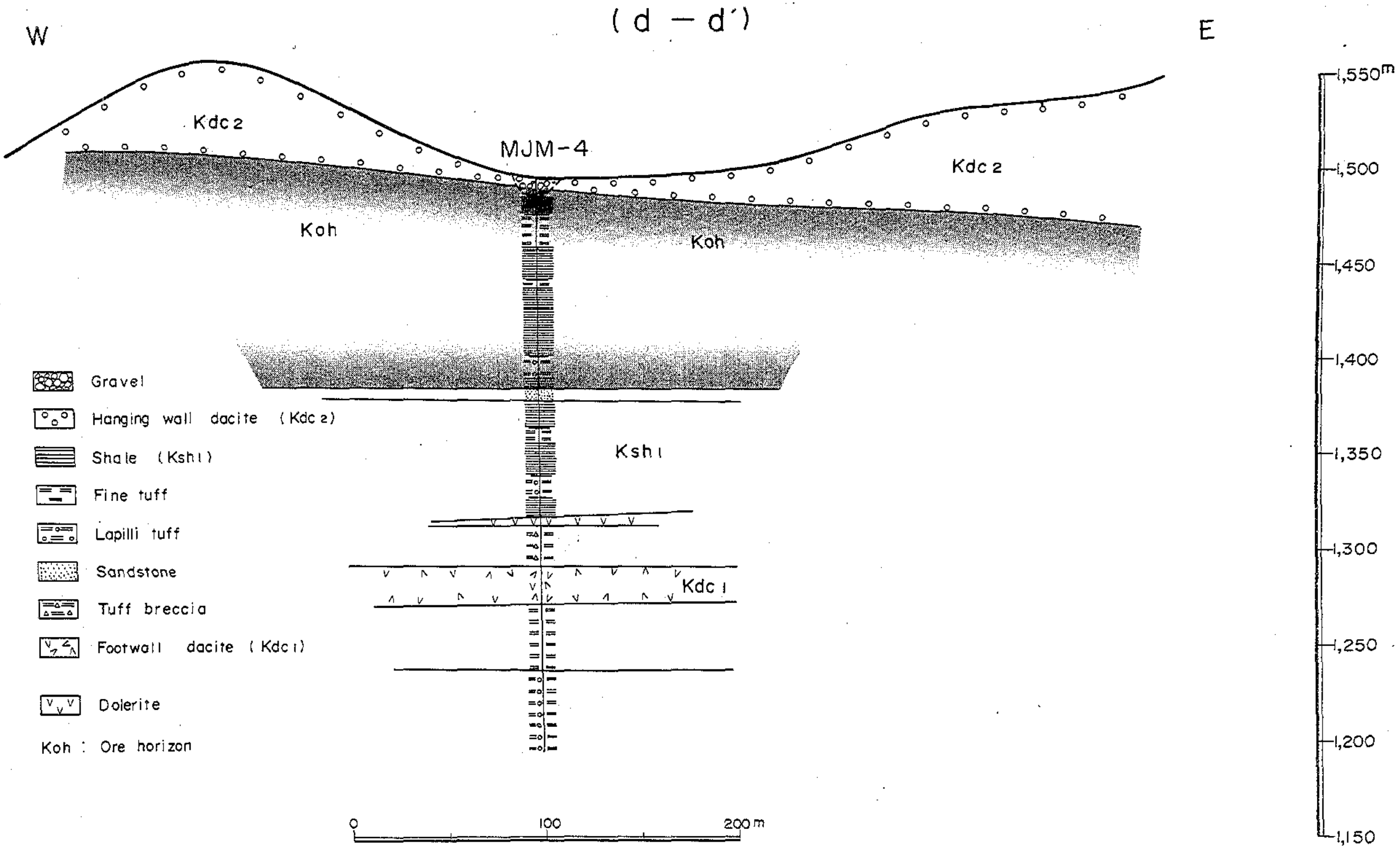


Fig. 6-14 Geological Section of Drilling (MJM-5)

(e — e′)

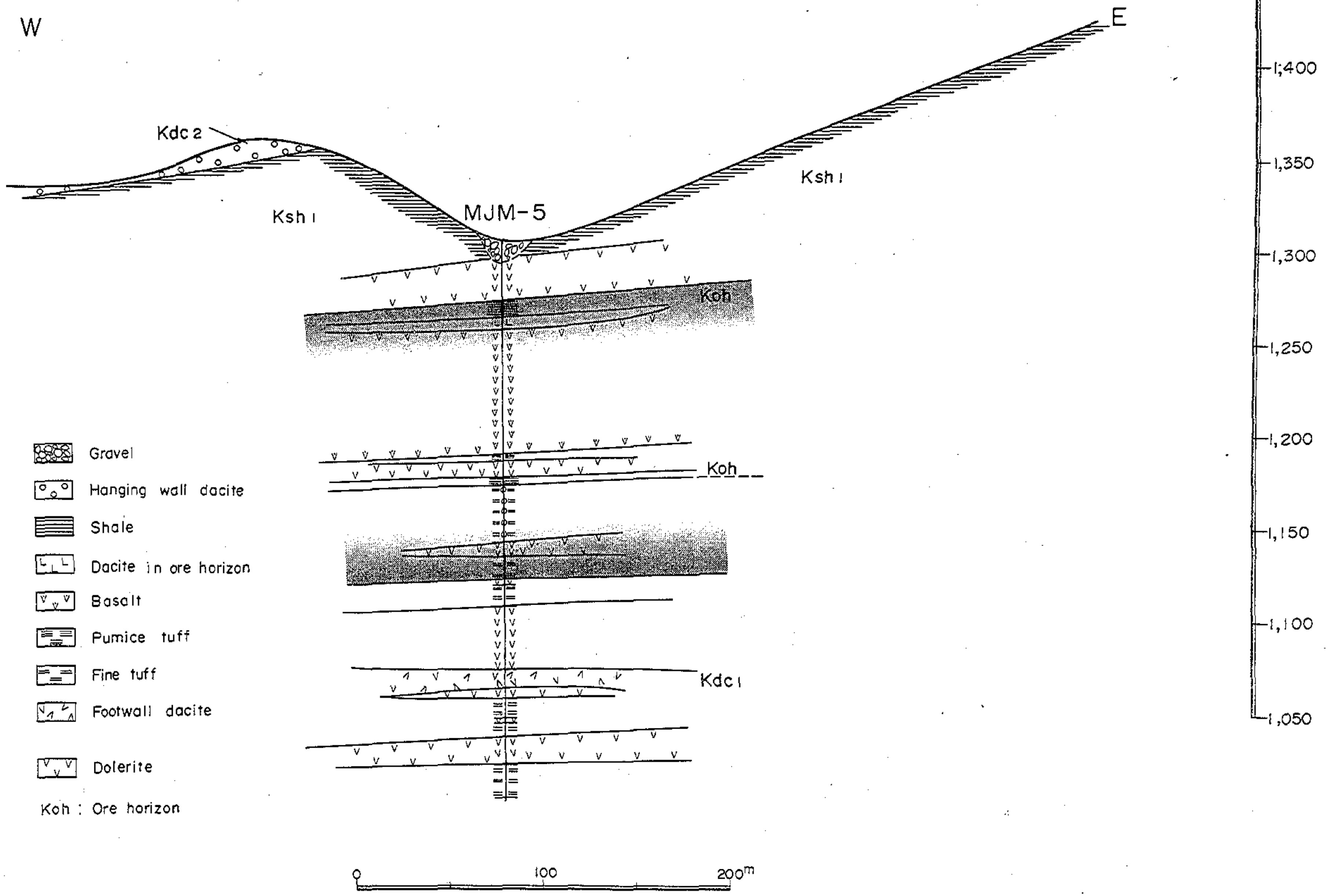
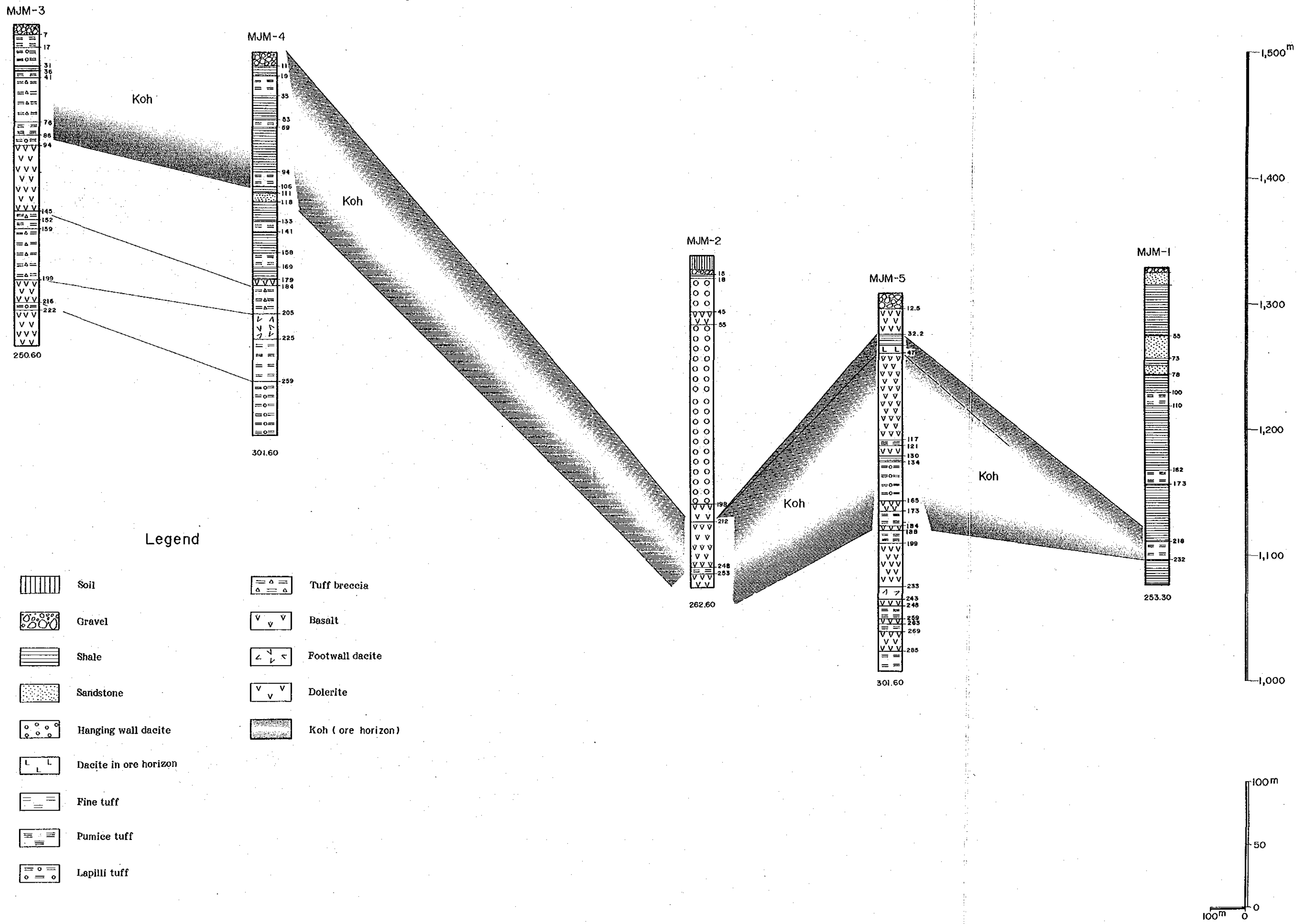


Fig. 6-15 Correlation of Geological Succession of Each Hole



6-4-3 Mineralization and Alteration

(1) MJM-1:

A Mineralized zone found in the hole is of impregnated and veinlet sulphides in the black shale and gray fine tuff between 208.00 meters and 224.50 meters.

Some of impregnated ores contain apparently fine grained sulphide ore fragments consisting of pyrite, pyrrhotite and minor amount of chalcopyrite. Under the microscope, pyrite grains in some cases are surrounded by pyrrhotite as replacement halo. It suggests that some geological events such as decreasing fs_2 occurred there.

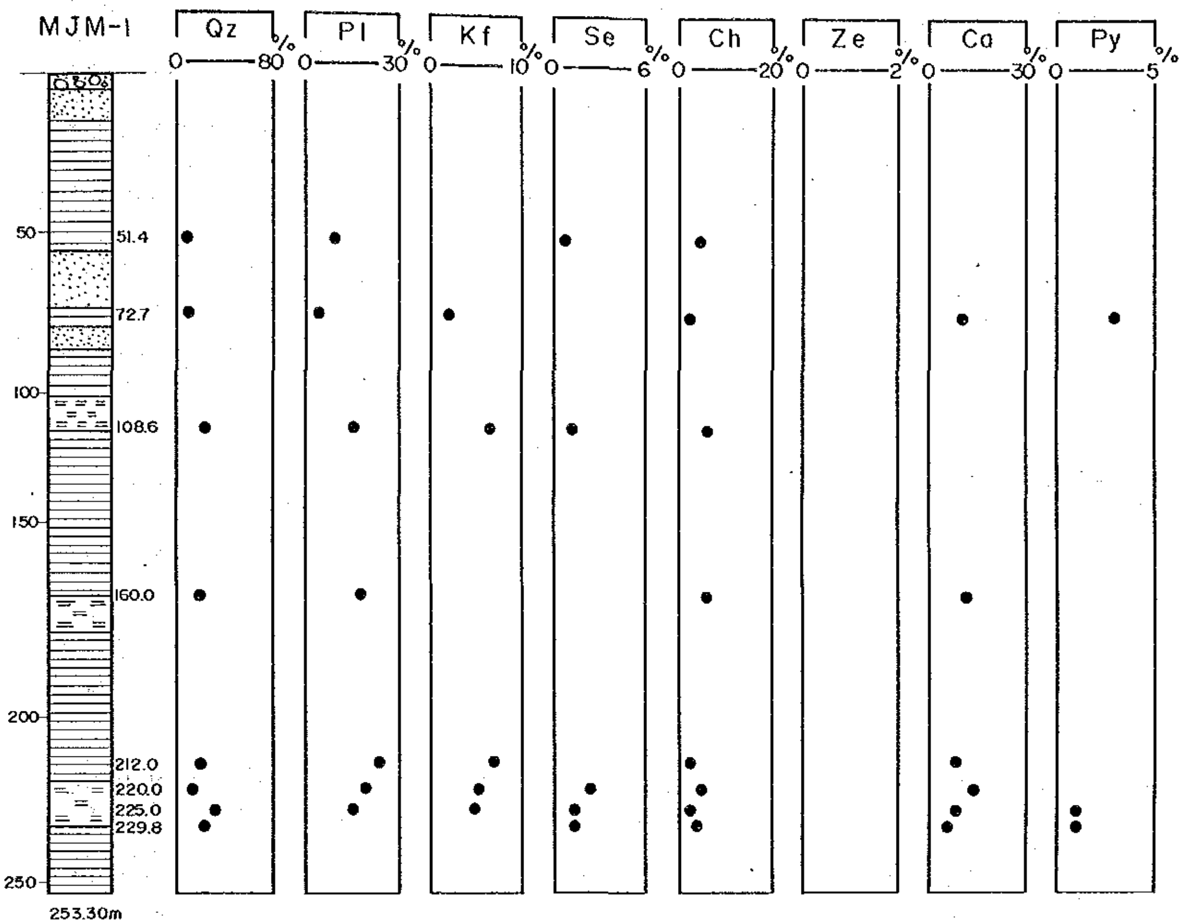
Assay results of the mineralized zone are as follows:

Depth (m)	Sample	Au (g/t)	Ag (g/t)	Cu(%)	Pb(%)	Zn(%)	Remarks
208.00-209.00	A-1	0	3	0.01	0.05	0.15	Py-Po impregnation in shale
209.00-210.00	A-2	0	2	0.01	0.07	0.15	"
-211.00	A-3	0	4	0.01	0.07	0.12	Py-Po impregnation in shale and fine tuff
-212.00	A-4	0	Tr	0.01	0.06	0.12	Py-Po impregnation in fine tuff
219.50-220.50	A-5	0	3	0.01	0.07	0.10	"
222.50-223.50	A-6	0	6	0.01	0.06	0.10	"
-224.50	A-7	0	5	0.01	0.07	0.10	"

Sulphides in the shale and the fine tuff are same, but those in the shale are little smaller than the others. Grades of them are same.

Rocks in the hole are subjected to hydrothermal alteration, specially chlorite is observed throughout the hole.
But amount of the chlorite is not large, less than 10 per cent of Quartz Index numbers. On the contrary, frequency and relative amount ratio of sericite is less than those of chlorite, but sericite commonly appears in the ore horizon of fine tuffs. It means that alteration intensity of the ore horizon rocks is stronger than those of other formations. Potash feldspar also commonly appears in the hole, but as far as seeing its mineral assemblage, it is possibly subjected to diagenesis, not to strong hydrothermal alteration. Plagioclase also appears through the hole indicating weak alteration.

Fig. 6-16 Alteration of Drilling Core (MJM-1)



Legend

Soil	Pumice tuff
Gravel	Lapilli tuff
Shale	Tuff breccia
Sandstone	Basalt
Hanging wall dacite	Footwall dacite
Dacite in ore horizon	Dolerite
Fine tuff	18% : Quartz index

Abbreviation

Qz : Quartz
Pl : Plagioclase
Kf : K-feldspar
Se : Sericite
Ch : Chlorite
Ze : Zeolite
Ca : Calcite
Py : Pyrite

(2) MJM-2:

A mineralized zone found in the hole is of fine grained pyrite impregnation and veinlets in the ore horizon fine tuff. In the mineralized zone, pyrites are concentrated around rims of pumice fragments. Under the microscope, pyrites are classified into large grain one (0.1 to 0.2 millimeters diameter) and small grain one (smaller than 0.01 millimeters diameter), and the latter is dustily scattered in the fine tuff matrix. No other sulphide mineral is noted in the rocks, but a minor amount of hematite altered from pyrrhotite is seen there. Assay results of the mineralized zone are as follows:

Depth (m)	Sample	Au (g/t)	Ag (g/t)	Cu(%)	Pb(%)	Zn(%)	Remarks
247.60~248.60	A-8	0	Tr	0.02	0.08	0.12	Py impregnation in fine tuff
-249.60	A-9	0	2	0.02	0.08	0.12	〃
-250.60	A-10	0	Tr	0.01	0.07	0.10	〃
-251.60	A-11	0	5	0.01	0.10	0.10	〃
-252.60	A-12	0	Tr	0.01	0.08	0.10	〃
-253.60	A-13	0	Tr	0.02	0.08	0.12	〃

Though this zone is of fine grained pyrite impregnation which is characteristic for Kuroko mineralization, no significant return from the assay was obtained.

However, as geologically mentioned in 6-4-2, this position is situated in a very favorable environment for Kuroko ores, therefore there is still some potential for hiden ore deposits nearby the hole.
Rocks of the hole is also subjected to weak hydrothermal alteration throughout the hole as shown in Fig. 6-17. Chlorite commonly occurs throughout the hole, but small amount. Sericite is less amount and more scarce than chlorite. Potash feldspar appears more commonly similar to the case of MJM-1, and it is not products of strong alteration judging from its mineral assemblage. Plagioclase remains throughout the hole, varing its amount. Laumontite, a product of diagenesis, is seen in the hanging wall dacite (Kdc2).

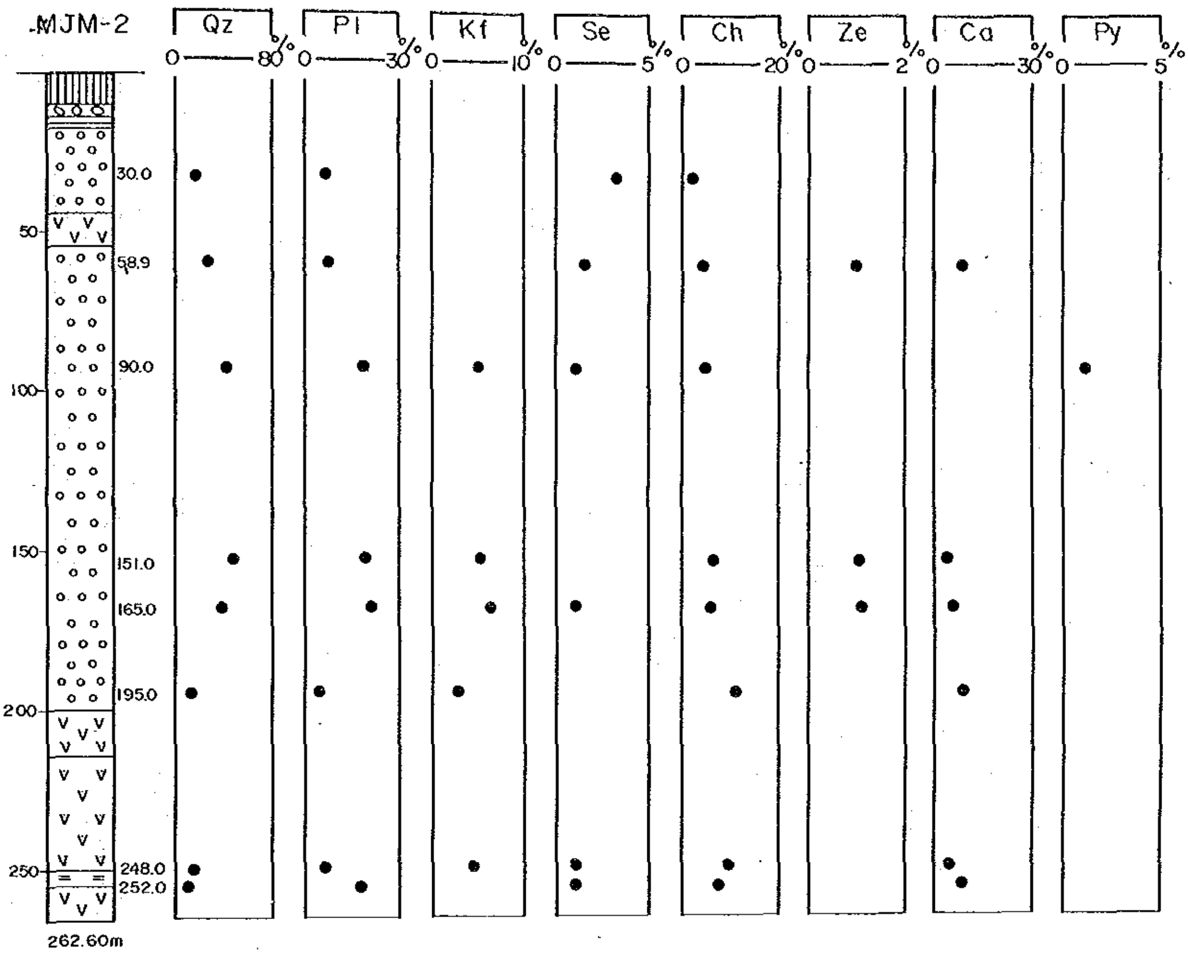
(3) MJM-3:

A mineralized zone found in the hole is of pyrite impregnation, from 91.40 meters to 93.40 meters in black shale and tuff breccia. A minor amount of sphalerite and chalcopyrite, other than pyrite, occur as impregnated zones and veinlets.

In other parts, from 58.30 meters to 91.40 meters and from 159.40 meters to 193.80 meters, same kind of pyrite impregnated zones are observed in tuff breccia, fine tuff, lapilli tuff, but its grade is less.

Assay results of the mineralized zone are as follows.

Fig. 6-17 Alteration of Drilling Core (MJM-2)



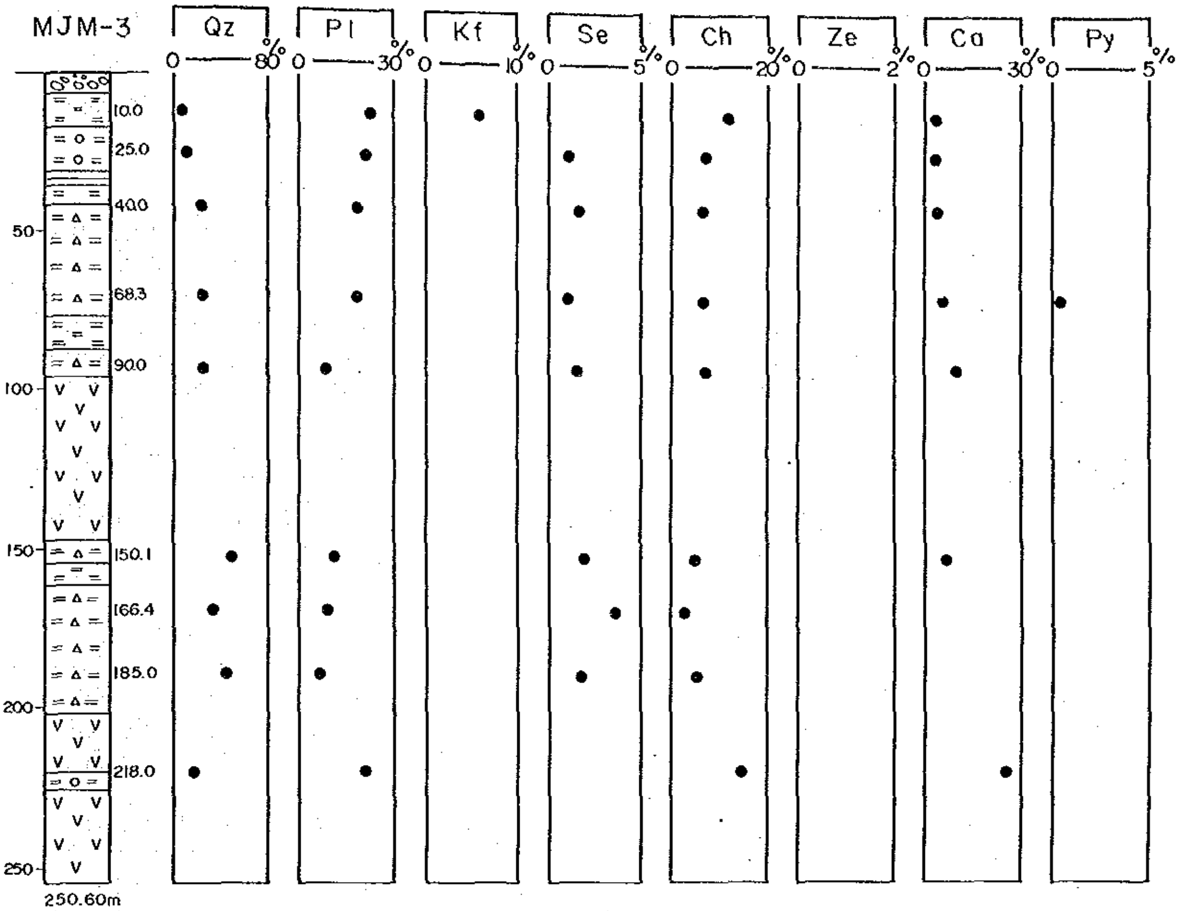
Legend

- Soil
- Gravel
- Shale
- Sandstone
- Hanging wall dacite
- Dacite in ore horizon
- Fine tuff
- Pumice tuff
- Lapilli tuff
- Tuff breccia
- Basalt
- Footwall dacite
- Dolerite
- 18%: Quartz index

Abbreviation

Qz : Quartz
Pl : Plagioclase
Kf : K-feldspar
Se : Sericite
Ch : Chlorite
Ze : Zeolite
Ca : Calcite
Py : Pyrite

Fig. 6-18 Alteration of Drilling Core (MJM-3)



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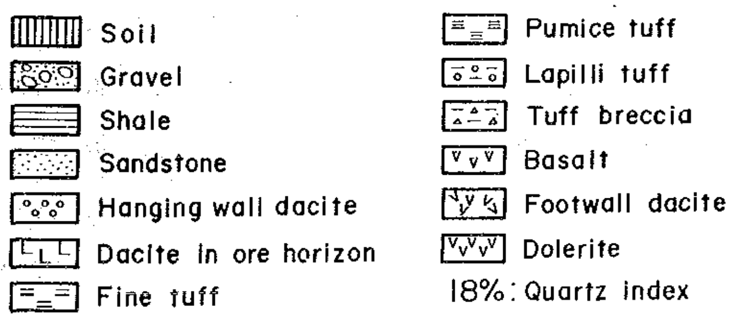


Abbreviation

Qz : Quartz
Pl : Plagioclase
Kf : K-feldspar
Se : Sericite
Ch : Chlorite
Ze : Zeolite
Ca : Calcite
Py : Pyrite

Depth (m)	Sample	Au (g/t)	Ag (g/t)	Cu(%)	Pb(%)	Zn(%)	Remarks
91.40-92.40	A-14	0	22	0.01	0.10	0.15	Py-Sph veinlets in shale
-93.40	A-15	0	Tr	0.01	0.08	0.75	Py-Sph veinlets in shale and tuff breccia

No significant return from the assay was obtained, but Ag in A-14 and Zn in A-15 are slightly higher than those of other cases.

Alteration of the rocks in the hole is similar to those of previously mentioned holes, as long as chlorite is concerned. However, more common appearances of sericite and disappearance of potash feldspar are characteristics.

Accordingly on one side it seems that hydrothermal alteration around the hole is slightly stronger than those of other holes, but on the other side, there is no difference judging from their remained amount of plagioclase (Fig. 6-18).

(4) MJM-4:

A minerized zone found in the hole is of pyrrhotite, pyrite, sphalerite impregnation from 70.60 meter to 101.60 meter. Pyrrhotite is of xenomorphic fine grained, smaller than 0.1 millimeters, in shale. Pyrite is of idomorphic medium grained, smaller than 0.2 millimeters, and minor amount. Sphalerite is of fine grained, smaller than 0.05 millimeters, and also minor amount.

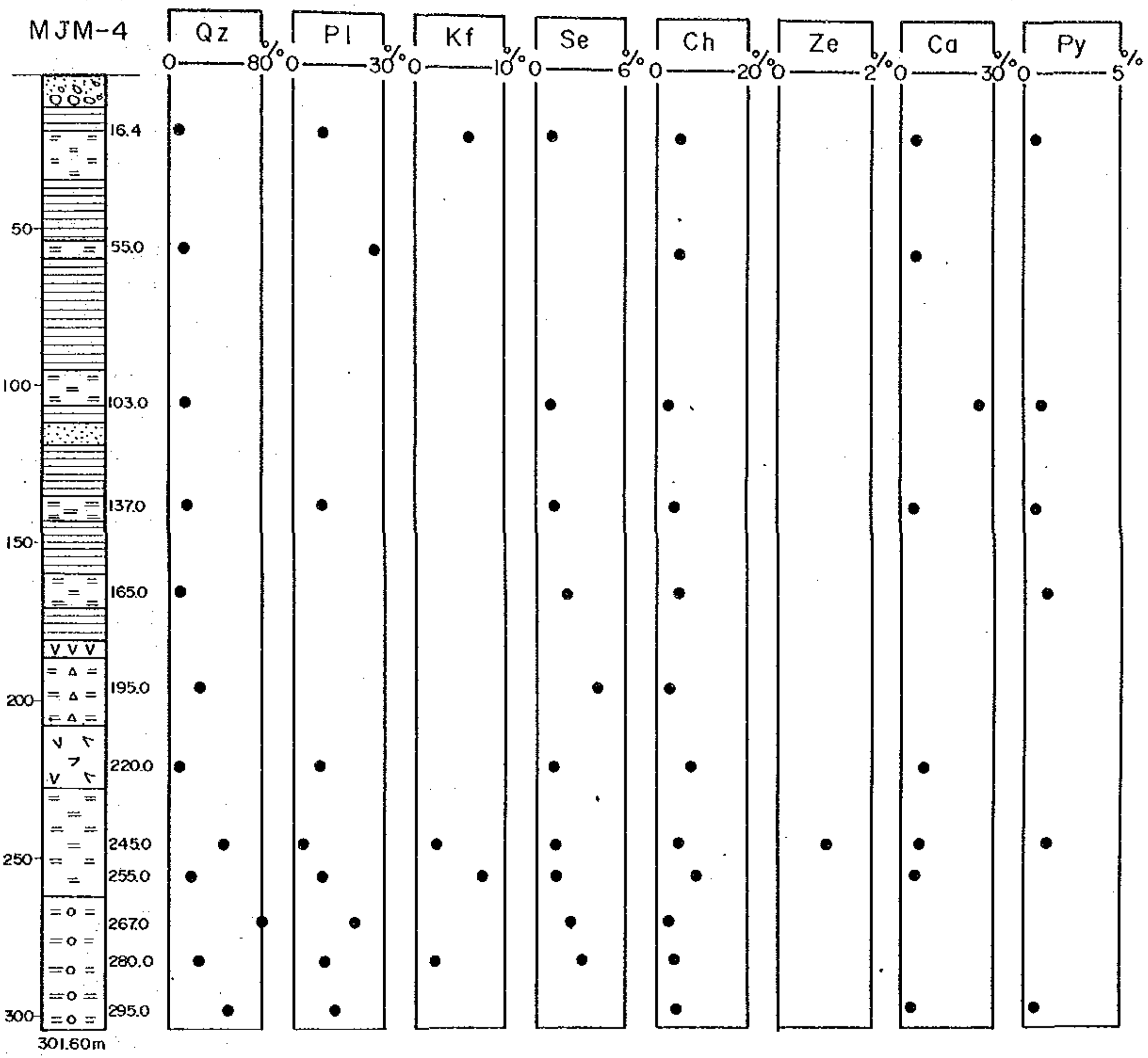
It seems that the impregnation is of in situ, therefore a reduction environment, which acceralates precipitation of sulphides, used to be dominant there.
This kind of environment is very important for genesis of Kuroko type ores. Assay results of the mineralized zone are as follows:

Depth (m)	Sample	Au (g/t)	Ag (g/t)	Cu(%)	Pb(%)	Zn(%)	Remarks
70.60-71.60	A-16	0	14	0.01	0.07	0.15	Po-(Py)-(Sph) impregnation in shale
-72.60	A-17	0	15	0.01	0.08	0.10	"
-73.60	A-18	0	12	0.01	0.09	0.10	"
-74.60	A-19	0	8	0.01	0.08	0.10	"
-75.60	A-20	0	12	0.01	0.08	0.12	"
-76.60	A-21	0	5	0.01	0.08	0.15	"
-77.60	A-22	0	7	0.01	0.07	0.15	"
-78.60	A-23	0	10	0.01	0.07	0.15	"

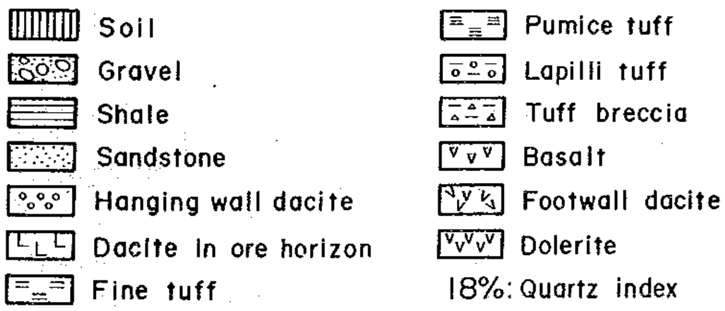
-79.60	A-24	0	12	0.01	0.07	0.15	"
-80.60	A-25	0	10	0.01	0.07	0.12	"
-81.60	A-26	0	12	0.01	0.07	0.12	"
-82.60	A-27	0	2	0.01	0.08	0.12	"
-83.60	A-28	0	5	0.01	0.08	0.10	"
-84.60	A-29	0	5	0.01	0.07	0.12	"
-85.60	A-30	0	Tr	0.01	0.08	0.10	"
-86.60	A-31	0	Tr	0.01	0.07	0.10	"
-87.60	A-32	0	9	0.01	0.07	0.10	"
-88.60	A-33	0	Tr	0.02	0.08	0.10	"
91.60-92.60	A-34	0	41	0.02	0.10	0.15	"
-93.60	A-35	0	7	0.10	0.10	0.15	"
-94.60	A-36	0	17	0.02	0.10	0.15	Po-Py-Sph impregnation in shale and lapilli tuff
-95.60	A-37	0	7	0.05	0.08	0.10	Po-Py-Sph impregnation in lapilli tuff
-96.60	A-38	0	8	0.15	0.07	0.12	"
-97.60	A-39	0	32	0.03	0.10	0.15	"
-98.60	A-40	0	Tr	0.03	0.08	0.10	Po-Py-Sph impregnation in shale and fine tuff
-99.60	A-41	0	Tr	0.03	0.07	0.10	Po-Py-Sph impregnation in shale
-100.60	A-42	0	57	0.02	0.07	0.15	Po-Py-Sph impregnation in shale and lapilli tuff
-101.60	A-43	0	14	0.02	0.07	0.15	Po-Py-Sph impregnation in lapilli tuff

Some samples show several ten grams per ton assay returns of Ag, but no other economical value is shown.
Alteration of the rocks in the hole is similar to those of previously mentioned holes, being subjected to weak hydrothermal alteration (Fig. 6-19).

Fig. 6-19 Alteration of Drilling Core (MJM-4)



Legend



Abbreviation

Qz : Quartz
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Kf : K-feldspar
Se : Sericite
Ch : Chlorite
Ze : Zeolite
Ca : Calcite
Py : Pyrite

(5) MJM-5:

Main mneralized zones found in the hole is of impregnation, veinlets, thin layers (1 to 2 millimeters) of pyrite, sphalerite, chalcopyrite, and very scarcely tetrahedrite in shale, from 32.30 meters to 40.30 meters and from 129.80 meters to 132.80 meters.

Parts containing tetrahedrite show higher Ag contents than others. Pyrite is of very fine grained, smaller than 0.05 millimeters, idiomorphic, showing framboidal texture.

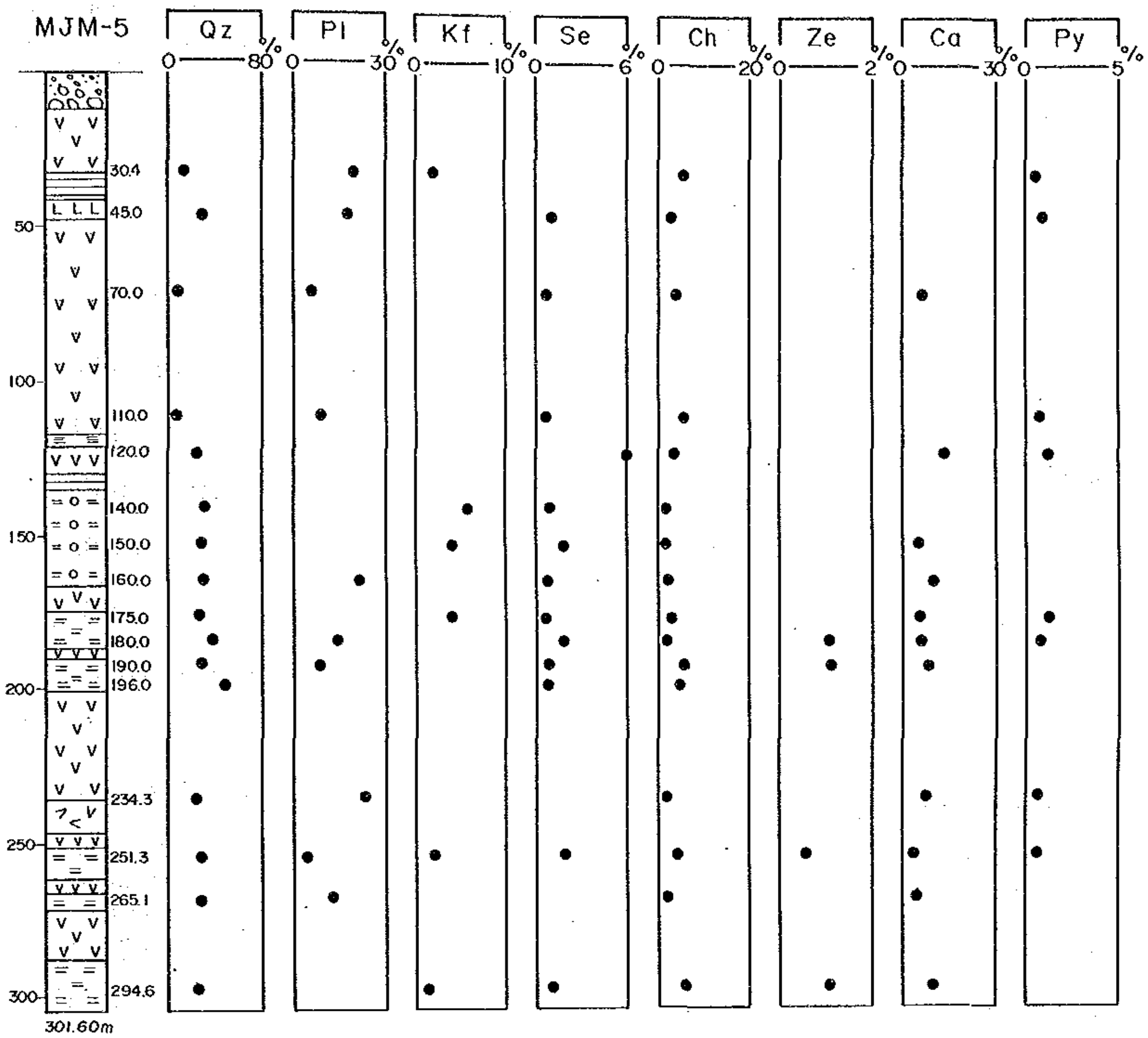
Sphalerite and chalcopyrite are xenomorphic, impregnated in the rocks, but some cases in quartz-calcite veins. It is no clear, whether or not the mineralization stage of such quartz-calcite veins and impregnation is same, but kinds of minerals and their sizes are similar.
Assay results of the mineralized zones are as follows:

Depth (m)	Sample	Au (g/t)	Ag (g/t)	Cu(%)	Pb(%)	Zn(%)	Remarks
32.30-33.30	A-44	0	34	0.17	0.07	0.25	Py-Sph-Cp veinlets in shale
-34.30	A-45	0	4	0.22	0.08	0.15	"
-35.30	A-46	0	3	0.11	0.08	0.15	"
-36.30	A-47	0	51	0.12	0.07	0.20	"
-37.30	A-48	0	31	0.18	0.08	0.15	"
-38.30	A-49	0	5	0.13	0.07	0.15	"
-39.30	A-50	0	45	0.27	0.08	0.15	"
-40.30	A-51	0	71	0.02	0.08	0.15	"
129.80-130.80	A-52	0	103	0.22	0.07	0.30	Py-Sph-Cp impregnation in shale
-131.80	A-53	0	27	0.10	0.07	0.20	"
-132.80	A-54	0	93	0.20	0.08	0.20	"

Under the microscope, veinlets accompanying tetrahedrite is observed in a polished section of A-52, showing high Ag contents. In the volcanic rocks, impregnation and veinlets of pyrite, and sphalerite are observed, but its amount is less.

Alteration of the rocks of the hole is similar to those of other holes, but its intensity is weaker judging from appearance of laumontite and mordenite. Chlorite is of small amount, but much appearance. Sericite is more common but small amount (Fig. 6-20).

Fig. 6-20 Alteration of Drilling Core (MJM-5)



Legend

- Soil
- Gravel
- Shale
- Sandstone
- Hanging wall dacite
- Dacite in ore horizon
- Fine tuff
- Pumice tuff
- Lapilli tuff
- Tuff breccia
- Basalt
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- 18%: Quartz index

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6-4-4 Correlation between Results of Drilling and Geophysical Surveys

Three holes, MJM-1, -2 and-3, out of the five holes drilled were selected based on the result of the CSAMT survey. Fig. 6-21 shows correlation between results of drilling and geophysical surveys.

Resistivity values of each rock types determined by the laboratory test is as follows:

		Resistivity (Ω·m)
Sandstone	(Tss1)	300
I-stage andesite	(Tad1)	3,500
Fine grained tuff	(Koh)	850
Shale-sandstone	(Ksh1)	6,500
Granophyre	(Gph)	8,300
Black ore	(Bo)	66
Pyrite ore	(Py)	6

Summary of the correlation is as follows:

(1) MJM-1

The hole is located in the central part of a low resistivity zone of Aranjuez East.

The drill site is at the survey station 105, showing 100 Ω ·m down to 40 meters from the surface, then 40 Ω ·m down to 250 meters. These resistivity values represent figures obtained by one dimensional simulation to accord values around the points.

Sheared zones are distributed in the hole down to 40 meters from the surface, and its water content possibly caused such low resistivity zone.

The value of 40 Ω ·m corresponds to that of Kuroko ores. However rocks between 40 meters and 250 meters are compact and hard black shale, sandstone, and fine tuff, partially disseminated by sulphides. No sheared zone or clay zone are seen there.

These geological facts don't explain such low resistivity.

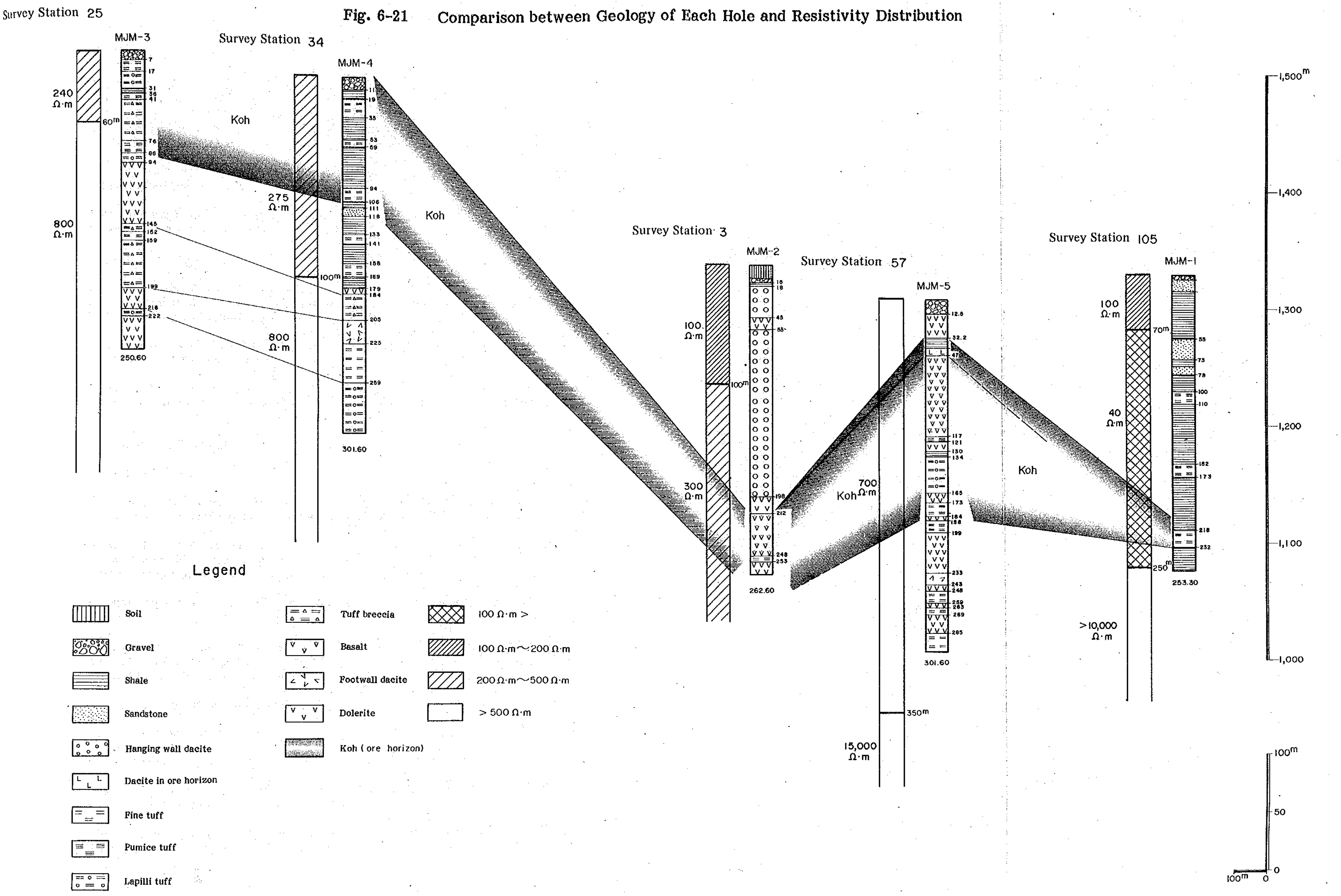
Accordingly it is presumed that geology surrounding the hole is main reason caused such low resistivity.

(2) MJM-2

The hole is in the Aranjuez low resistivity zone.

The drilling site is at the survey station 3, showing about 100 Ω ·m.

Fig. 6-21 Comparison between Geology of Each Hole and Resistivity Distribution



Rocks of the hole are mainly volcanic rocks, but their physical poperties are different between the upper and deeper parts. Sheared zones and partial clay zones are dominant in the upper part of the hole down to 100 meters, and caused lost circulation in the drilling. Therefore such geology well explains the low resistivity, and no mineralized zone is expected there.

On the ohter hand, volcanic rocks are massive in the deeper than 100 meters, appearing no sheared zone.

This fact explains such slightly higher resistivity, even though zones of sulphide dissemination are encountered in some cases.

(3) MJM-3

The hole is located in the western edge of the Descubridora West low resistivity zone. The drilling site is 200 meters northeast of the survey station 25, showing 240Ω·m down to 60 meters, 800Ω·m in the deeper part.

Rocks down to 60 meters are fine grained to medium grained pyroclastics, compact and hard, but accompanied by sheared zones.

Rocks in the deeper part are massive volcanics, accompanied by local sheared zones and fine grained pyrite dissemination zones from 159.40 meters to 193.80 meters.

The geology of the hole well explains the resistivity structure.

(4) MJM-4, MJM-5

The holes were selected based on other reasons rather than geophysical results, but several characteristics are found between geology and resistivity.

In MJM-4, a medium resistivity zone (275Ω·m) in the shallow part (down to 100 meters) coincides with a black shale dominant part, and a high resistivity zone (800Ω·m) in the deeper part coincides with volcanics.

On the other hand, MJM-5 mainly consists of volcanics showing high resistivity (700Ω·m).

No significant sheared zone or clay zone is found in the both holes. Pyrite and pyrrhotite dissemination is found in the shale in the upper part of MJM-5 (from 60 meters to 100 meters), but no change is found in resistivity.

Followings are the summary of the results.

- Black shale dominant parts show about 300Ω·m, unless accompanied by sheared or clay zones.
  In cases accompanied by them, they show lower than 100Ω·m.
- Volcanic rocks mainly composed by pyroclastics show 700 to 800Ω·m, unless accompanied by sheared or clay zones.
- These values are generally lower than those determined in the laboratory test. This fact is noticeable in CSAMT surveys.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

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7-1 Conclusion

In the second year's program, geological, geochemical, and geophysical surveys in the Western Jalisco area were conducted to select favorable zones for Kuroko type ores, and a drilling program consisting of five holes was conducted to examine the possibility of the existence of mineralized zones in the Eastern Jalisco area, based on the results of the first year's program.

Conclusions are as follows:

1. Geological Survey

[Jurassic System]

The Jurassic System is distributed in the western area, being unconformably covered by the Cretaceous and Tertiary Systems, and intruded by grandiorite bodies.

Main constituent rock is pelitic schist, being intercalated by psammitic schist and chlorite and sericite schist originated from volcanics.

Schistosity of those rocks are almost parallel to bedding planes, striking north-south. Folding is common in the distribution area in various degrees.

No significant mineralized zone was found in the rocks. However geochemical anomalous zone by a multi-element was detected in the El Filo de la Vaca Valley, north of El Aguacate.

[Cretaceous System]

The Cretaceous System is distributed in various parts of the area (about 10 percent of the area), being unconformably covered by the Tertiary System. Main constituent rocks are black shale (Kshl) and dacites (Kdcl-a, -b, Koh-a, -b, Kdc-sh, etc).

No geological occurrence indicating depositional time gaps in the System was observed.

Dacites are distributed in the Cuale, Amaltea, and La Concha-El Bramador districts, where known Kuroko type deposits are distributed, being closely related with genesis of Kuroko type ores.

The ore horizon pyroclastics (Koh-a, -b) or hanging wall dacites (Kdc-sh) are distributed in those districts, suggesting some indications for ore forming environments.

From the determination of radiolarias and nannoplanktons found in the black shales of the footwall and hanging wall formations, it is presumed that the System is of early Cretaceous.

[Tertiary System]

The Tertiary System is very extensively distributed in the highland area of the survey area, consisting mainly of andesites and dacites.

However, sandstone (Tss1) is very locally distributed. Activity stage of the volcanics is not clear yet, because no age determination has been conducted yet on the rocks. The andesites (Tad1-Tad4) unconformably overlie the Cretaceous System. No significant time gaps exisit among andesites. Geological environment of the IV-stage activity was possibly transformed from submarine to terrestrial at that time judging from the existence of welded tuff in the andesites in the northern area. The Tertiary System in the area covers topographic highland with gentle dipping.

[Intrusives]

Intrusive rocks in the area are granodiorite (Gd), granophyre (Gph), andesite (Ad), and dacite (Dc). Intrusion time of this granodiorite is of Laramide orogeny (older than 45 m.y.) judging from geological environment around there. That of the others are possibly of Tertiary age.

[Geological Structure]

Geological structure in the area is different in every geological unit, the Jurassic, Cretaceous, and Tertiary Systems.

It seems that the Jurassic System is controlled by folding, an open folding of a half wave length of 5 kilometers consisting higher order foldings of a half wave length of 120 to 200 meters and the axis of the folding gently planges to the south.

Distribution of the Cretaceous System is controlled by a northwest-southeast trending tectonic line. Judging from the distribution of the dacites relating to genesis of Kuroko ores, the northwestern area was uplifted more than the southeastern area.

In the La Concha-El Bramador district, a semi-basin structure about 10 kilometers diameter north to south, is noted. In the basin, northwest to southeast trending synclinal and anticlinal axes plunge to the southeast, separating about 600 meters.

Kuroko ore horizons of the El Bramador, and Cuale and Amaltea districts are in a same stratigraphical formation in the northern wing and the southern wing of the anticlinal structure southwest of Desmoronado.

Faults in the area are of, from the older,

1. south to north and north-northeast to south-southwest trends,
2. east to west trend,
3. northwest to southeast.

[Mineralization]

Kuroko type ore deposits are located in the area, with time and space relation in acidic volcanics of the Cretaceous.

Known ore deposits are located, in the Cuale, Amaltea, and La Concha-El Bramador districts, in which the hanging wall and footwall dacites are distributed.

Judging from mode of occurrence of the ore horizon pyroclastics (Koh-a, -b) and overlying pyroclastics-shale alternation formation (Kdc-sh), it is presumed that the deposits were formed in areas of paleo-basinal topography.

It is thought that these ore deposits are in a nearly same stratigraphic horizon, judging from the hanging wall and footwall geology and geological structure.

In the alteration survey on the dacites located nearby Kuroko ores, a strong extensive alteration zone was detected in the La Concha-El Bramador district. It is evaluated that this zone is favourable for Kuroko exploration.

Other type of mineralization noted in the area is of Grandeza type (Au-Ag), appearing in an area southeast of the Cuale deposits group.

2. Geochemical Survey

As the result of the geochemical survey used stream sediments, it is clarified that areas of Kuroko type ores are generally in multi-element geochemical anomalous zones, and areas of other types are in single element anomalous zones.

Many of the Kuroko type ores in the area are of subterranean. Therefor anomalous zones do not directly indicate Kuroko type ore, rather do post-Kuroko minerallization following to Kuroko type main mineralization. Thus it has been made clear that such type of geochemical survey can be evaluated to be effective for exploration of Kuroko type ores, though in an indirect way.

A whole rock chemical analysis for acidic volcanics located in Kuroko ore areas was carried out to study its relations to Kuroko ores, using alkali alteration index, principal component, and cluster analyses. As a result of the study, it was made clear that there is a possibility to classify rocks relating to Kuroko ores from those of non ores from lithogeochemical point of view.

In cases to apply alkali alteration index for regional exploration program, it is concluded that higher density of sampling is required.

3. Geoplysical Survey

Low resistivity zones (lower than 200 Ω ·m) favourable for potential Kuroko ores were detected in the La Concha-El Bramador district, especially around the San Jeronimo valley. Although resistivity zone located south of La Concha shows moderately low values, its resistivity structure, slightly low resistivity in its overlying zone and moderate resistivity zone probably indicating sulphide disseminated footwall dacite in its underlying zone, is favourable for Kuroko ores. In addition, this zone is in an area closely connected with the Los Alpes and Delicias mineralized zones, therefore it is evaluated that this zone is one of the most promising areas for Kuroko ores.

Low resistivity zones located around the San Jeronimo valley are correlated with depth of a distribution area of the ore horizon pyroclastics (Koh-b) and footwall dacite (Kdc1-b). Therefore this is worthy to note.

It is possible that low resistivity zones located in areas southwest of Cerro de Sidra and southwest of Palmas Viejas were possibly caused by surface clay zones. therefore, the appraisal point for those zones is low.

4. Drilling Survey

A drilling program, consisting of five holes, total depth of 1,369.70 meters, was conducted in this year. Even no significant Kuroko ores were encountered, some new valuable information for Kuroko exploration was obtained from it.

As a result of the drilling survey in the La America-Descubridora district, it was made clear that two areas, the northeastern area (includes MJM-1, -2, -5) and the southwestern area (includes MJM-3, -4), are in different volcanic activity environments. MJM-1 is situated far from a volcanic eruption center, but MJM-2 and-5 are in paleo-basin of submarine, which are favourable site for formation of Kuroko ores. As the ore horizon rocks disseminated by sulphides are found in MJM-2 and -5, it is judged that extension zones of the ore horizon of these holes are favourable for Kuroko ores.

No extension of the volcanic rocks from the northeastern area is expected in the southwestern area, and no other evidence indicating paleo-basin structure was seen there. However, black shale disseminated by fine pyrrhotite and pyrite, which indicates reduction environment, was found in MJM-4, and this fact is very important for sulphide precipitation, in regard to volcanic eruption centers relating with formation of Kuroko ores.

No dacite lava was found in this zone, therefore this zone is situated in a remote area from such centers.

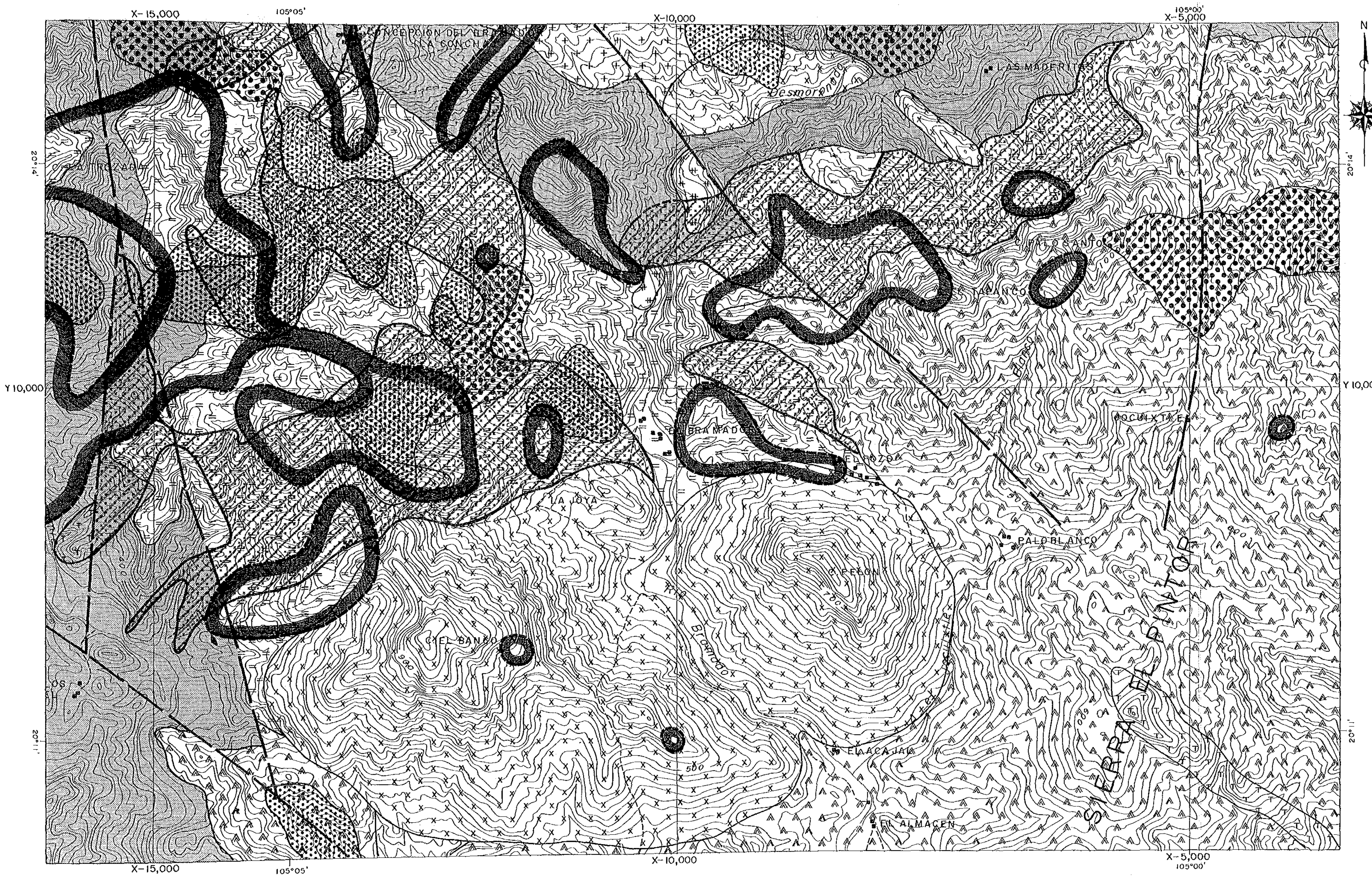
Clay minerals (chlorite, sericite) as products of hydrothermal alteration are observed in the all holes, fluctuating their amounts. It suggest that the whole area is subjected to "pervasive" type alteration. No significant alteration zone was found in the holes.

As a conclusion, area around MJM-2 and MJM-5 are favourable for further exploration activity.

7-2 Recommendation

Based on the results and conclusions of the phase 2 surveys, following surveys are proposed for the phase 3 program. Because favourable low resistivity zones for Kuroko ores was found around the San Jeronimo valley and also acid volcanics genetically having intimate relation with Kuroko ores are commonly found in the area. Geophysical surveys (IP and SIP method) which are more effective to detect sulphide mineralization are recommended to carry out on the above mentioned favourable low resistivity zones.

Drilling should be conducted at the most promising sites on the basis of an integrated interpretation on all results from geophysical, geological, geochemical and alteration surveys.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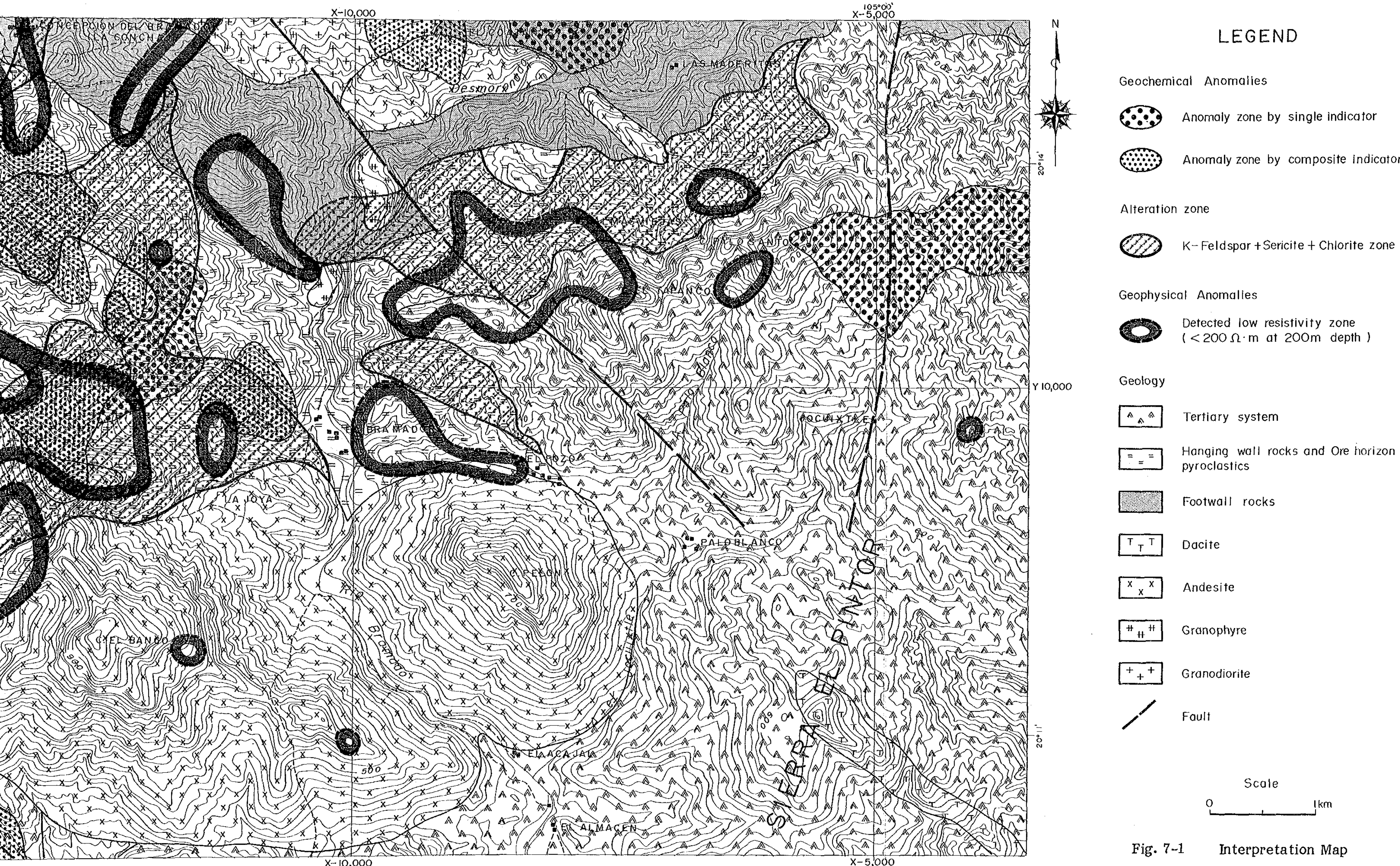

Fig. 7-1 Interpretation Map

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