REPORT ON THE COOPERATIVE MINERAL EXPLORATION IN THE JALISCO AREA THE UNITED MEXICAN STATES

PHASE 3

FEBRUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

At the request of the United Mexican States Government, the Japanese Government planned a mineral exploration program consisting of several survey method to examine the possibility of the existence of mineral deposits in the Jalisco area located in the central part of the country. The Japanese Government entrusted the execution of the general plan to the Japan International Cooperation Agency (JICA), and in turn JICA entrusted the execution of this survey to the Metal Mining Agency of Japan (MMAJ), since this survey was a professional survey program of mineral exploration.

This year's program is the third year's one. MMAJ organized a survey team of four members and dispatched it to the area in a period from May 21, 1986 to January 16, 1987.

The drilling survey was completed as scheduled with the cooperation of the related government agencies of the United Mexican States, especially the Consejo de Recursos Minerales (CRM).

This report is the summary of survey results in the third year and will form a part of a final report.

We would like to express our cordial thanks to the United Mexican States Government Agencies, the Ministry of International Trade and Industry of Japan, the Ministry of Foreign Affairs of Japan, the Japanese Embassy in México and the persons concerned with these agencies.

February, 1987.

Keisuke Arita
President,
Japan International Cooperation Agency

Junichiro Sato
President,
Metal Mining Agency of Japan

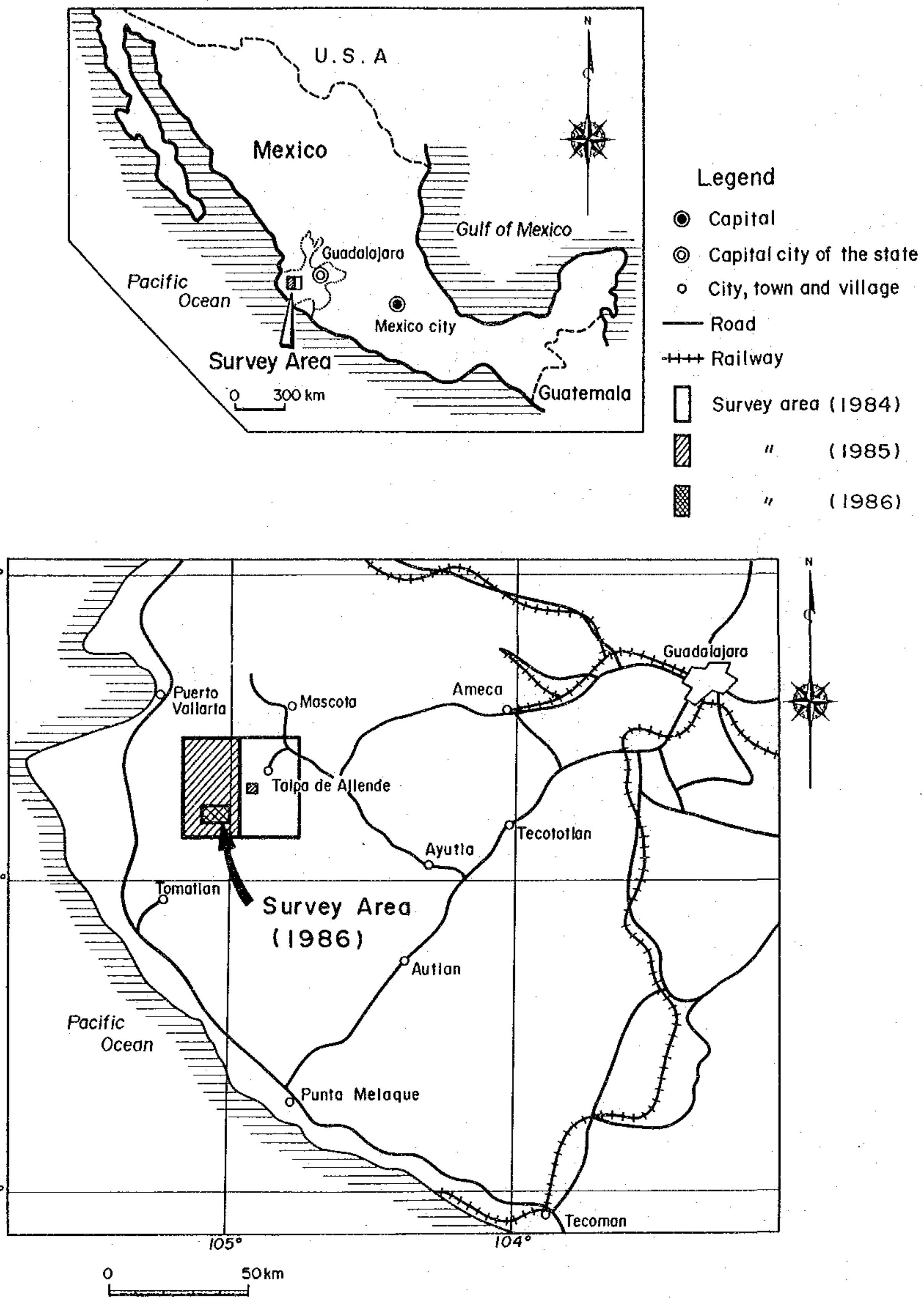

Fig. G-1 Location Map of Jalisco Area

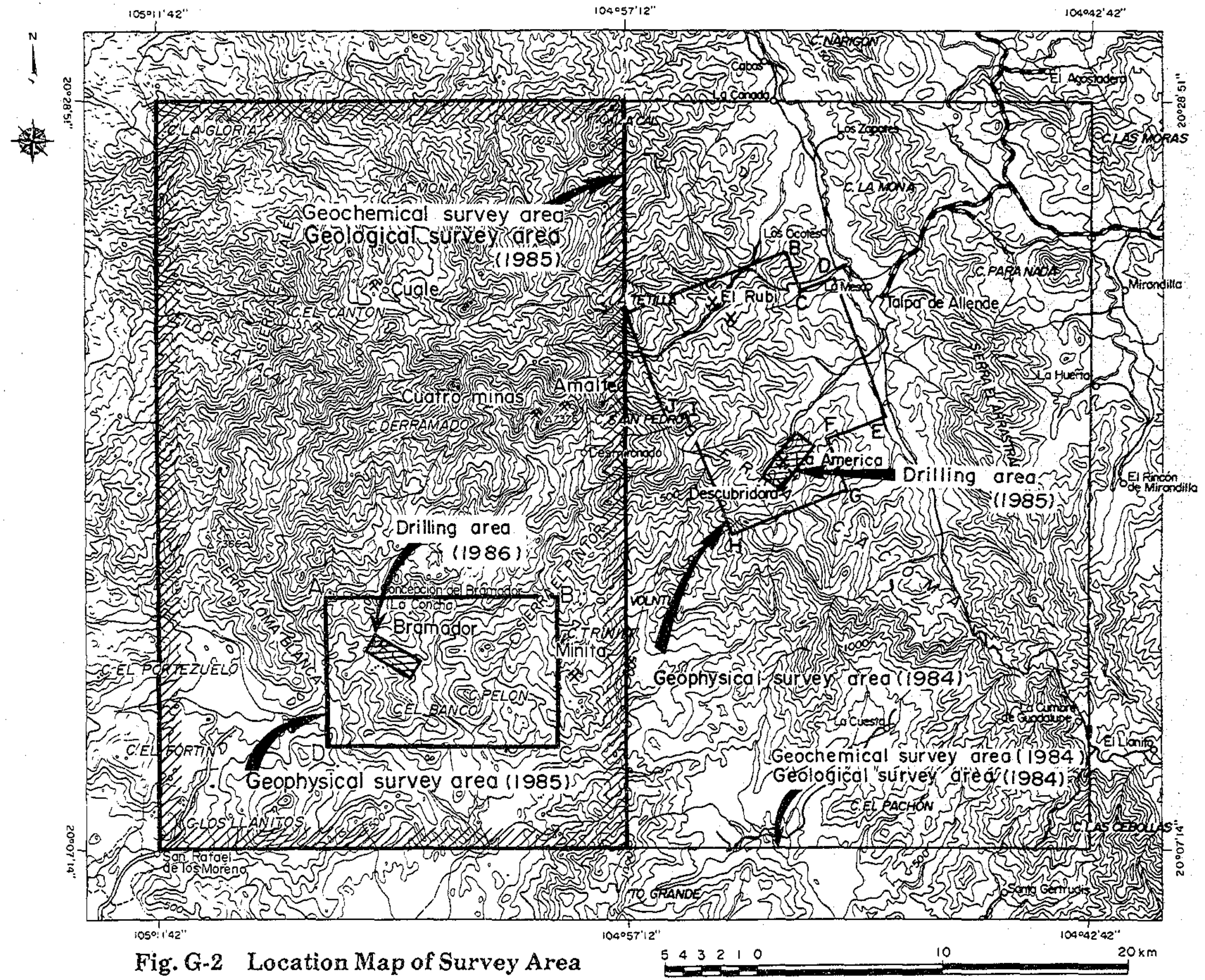

Fig. G-2 Location Map of Survey Area

SUMMARY

Based on the results from geological, geochemical and geophysical (CSAMT method) surveys in the second year of the cooperative mineral exploration survey in Jalisco area in the United Mexican States, drilling survey in a total drilling depth of 2, 296.2 m was carried out at seven sites in the third year of the survey to probe Kuroko type deposits in La Concha - El Bramador area.

As a result of the drilling survey, Kuroko ore (MJM-9) and fine pyrite disseminated zones accompanying gold mineralization (MJM-9) and silver mineralization (MJM-6 and MJM-7) that are related to Kuroko type mineralization were found. The drilling survey has provided us with a lot of data on the history of volcanic activity and geological structures relating to the formation of Kuroko type deposites in the area, which were not obtained from the geological survey, and this has enriched our knowledge on such history and geological structures.

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CHAPTER 1 INTRODUCTION

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1-1 Purpose of Survey

The purpose of the project is to examine the possibility of the existence of mineral deposits in the Jalisco area by means of clarification of the detailed geological setting with the cooperation of the Consejo de Recursos Minerales (CRM).

1-2 Outline of Survey

In the second year, geological and geochemical surveys were conducted in an area of 1,000 Km^2m the west half of the total planned area of 2,000 Km^2. In addition an area of 100 Km^2, which was selected on the preceding survey results, was geophysically surveyed.

Then a drilling program consisting of seven holes, total depth of 2,296.20 meters, which was planned on the basis of the preceding survey results, was conducted in this year.

The outline of this year's survey is as follows:

Table 1-1 Outline of Surveys

Survey Method	Number drill	Contents
Drilling	7	2,296.20 meter

Table 1-2 Laboratory Tests

Kinds of Tests	Number of Samples	Remarks
Microscopic observation of Rock Thin Sections	20	
Microscopic observation of Ore Polished Sections	20	
X-ray Diffraction Test	82	
Ore Analysis	216	Au, Ag, Cu, Pb, Zn
K-Ar Ages Determination	3	

1-3 Members of Mission

The members who were involved in the planning, managing, and drilling survey were as follows:

(1) Planning and Managing

Japanese Members	
Tooru Miura	Metal Mining Agency of Japan
Kouhei Arakawa	Metal Mining Agency of Japan
Akio Hoshino	Metal Mining Agency of Japan
Hideyuki Ueda	Metal Mining Agency of Japan
Yasuo Endo	Metal Mining Agency of Japan
Takashi Kamiki	Metal Mining Agency of Japan
Mexican Members	
Ramón Farias García	General Director of C.R.M.,General
Luis Brizuela Venegas	Technical Director of C.R.M., General
Héctor Rodríguez Medina	Technical Sub-director of C.R.M., General
Gustavo Camacho Ortega	Chief of Special Investigation Department of C.R.M. Charged in Project
César J. Villegas García	Chief of Geophysical Department of C.R.M. Charged in Project
Raùl Cruz Rois	Subchief of Special Investigation Department of C.R.M Charged in Project

(2) Survey Team

Japanese Members	
Fumio Wada	Dowa Engineering Co., Ltd. (Chief of Mission, General, Geological Survey)
Fumio Nakajima	Dowa Engineering Co., Ltd. (Drilling Survey)
Tatsuhiro Aoyama	Dowa Engineering Co., Ltd. (Drilling Survey)
Hisato Kai	Dowa Engineering Co., Ltd. (Drilling Survey)
Mexican Members	
Pánfilo Sánchez Alvarado	Special Investigation Department of C.R.M. (Geological Survey)
Hugo A. Omaña Pulido	Special Investigation Department of C.R.M. (Geological Survey)

CHAPTER 2 GENERAL OUTLINE

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2-1 Location and Transportation

The project area lies in Talpa de Allende area, Jalisco State in the central Mexico. The survey area for the third year is La Concha-El Bramador area, 35 Km southwest of Talpa de Allende.

The traffic by air and land routes from Mexico City, the capital of Mexico, to Guadalajara City is as follows.

(1) Air Route:

The straight line distance between the two cities is about 450 km, and it takes 50 minutes for a jet liner. Many flight services of Aero Mexico and Mexicana de Aviación are available every day.

(2) Land Route:

It is the most convenient to go via the completely paved Pan American Highway (National Highway Route 15) and it takes eight hours to go a distance of 540 km. Further, it takes four hours to get to Talpa de Allende, which was the base of the survey this time, 220 km distant from Guadalajara city. The road of 100 km between Guadalajara city and Ameca town has been well-paved, but the remaining 120 km road consists of a blacktopped part (100 km) and an unpaved part (20 km). The unpaved road which begins at a point 20 km from Talpa de Allende is always in a very bad condition both in rainy and dry seasons. There is one gas station in Talpa de Allende town.

The route from Talpa de Allende town to La Concha - El Bramador area, the drilling survey area for the third year, includes a 25 Km long mountainous road that permits car driving (2 hours and 30 minutes) and the remaining part that requires horse riding or walking. In the rainy season, Swollen dales frequently interrupt the traffic.

2-2 *Topography and Climate*

The topography in the survey area is generally steep with higher elevations in the northwest part and lower ones in the southern part. Ridges and dale are also arranged in the similar direction, and in San Jeronimo, where drilling were practiced, dales run down toward the southeast, joining the Bramador river. El Bramador hamlet is located in the vicinity of the joining site with 330 m elevation and 250 residents in 30 families. The climate is subtropical throughout the year, resulting in luxuriant citrus fruits and palms.

On the other hand, La Concha hamlet is in the north of the survey area, with 910 m elevation, 430 residents in 60 families and a somewhat cooler climate despite clumps of subtropical plants.

There is a clear distinction between the rainy and the arid seasons, the former season covers the period from June through October, to which the annual rainfall of

1,200 mm centers. The highest peak in the area is Cerro El Blanco with 1,020 m elevation.

2-3 Industry

The main industry in La Concha and El Bramador, two major hamlets in the survey area, consists of trifling agriculture and stock raising. Both hamlets lack plains, and most fields are made on slops of mountains by the slash-and-burn methods. Predominant farm produce is corn, with coffee in part of La Concha hamlet.

Only during the arid season, a road to carry out wood is set up from Cabrel hamlet, located in the west edge of the survey area, to La Concha hamlet. Tree-felling narrowly remains in the northern part of La Concha hamlet, with little contribution to the employment of local people.

There are old tunnels scattered in the area, but none of them are in operation.

2-4 Mining Industry

The mining industry of the United Mexican States can be evaluated so that it is making strenuous efforts, while other industries of the nation are gasping due to slump. The industry is, however, under influence from the worldwide recession, because of consecutive withdrawals of foreign enterprises that had continued their exploration activities in this country.

The mining industry accounts for 1.4% of the GNP (1985), and the mining statistics of 1985 shows a marked growth in production of silver when compared with the record for 1984. The growth has not brought by developing new mines, but has come from the increased production at Real de Angel mine. The production of lead in 1986 has also exceeded the mark of 200,000 tons, with a big attention on its growth. An important factor that should not be overlook for contribution to such remarkable growths in the mining industry is the reduction in production cost due to the substantial devaluation of the Mexican peso against the US dollar. According to one view, the underground mining cost in Mexico is the lowest in the world, end if so, it is a strongly favorable competitive factor. As seen in Table 2-1, however, in contrast with such production growths of gold, silver and lead, the production of copper and zinc has been lowering because of their staggering prices at low level in the world market.

Cuale mine, which was in operation in the area at the time of survey, was forced to operate under hard situations because of its diminishing ore reserves and deteriorating grade. On the other hand, a milling plant of C.F.M. (Comisión de Fomento Minero) located in Talpa de Allende was pacticing floation of waste from old mines in the vicinity.

Table 2-1 Mexican Mineral Production

1981-85 (metric tones)

Mineral	1981	1982	1983	1984	1985*
Gold	-	6.104	6.930	7.058	7.260
Silver	1.655	1.549	1.911	1.987	2.160
Lead	157,384	145.844	167.405	183.314	206.000
Zinc	211.629	231.910	257.444	290.230	275.000
Copper	230.466	239.091	206.062	189.111	177.000
Molybdenum	-	5.190	5.866	4.054	3.850
Bismuth	654	606	545	359	395
Cadmium	1.433	1.444	1.341	1.135	1.180
Coke	2.4325.000	2.450.000	2.424.826	2.375.480	2.350.000
Iron (cont. Fe)	5.293.100	5.382.000	5.306.343	5.489.343	5.020.000
Manganese (cont.)	208.193	183.120	133.004	180.940	168.000
Sulphur	2.077.0900	1.815.000	1.602.029	1.825.729	1.997.000
Fluorite	925.000	631.000	556.977	627.433	695.000
Barite	317.738	323.753	357.043	426.095	184.000

After Mining Annual Review-1986

* Preliminary estimate

CHAPTER 3 OUTLINE OF GEOLOGY AND ORE DEPOSITS IN SURVEY AREA

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3-1 Geology

The geology of the survey area consists of Cretaceous, Tertiary and Quaternary System, on the basement of metamorphic rocks that can be regarded as of the Jurassic System (Berrocal & Mendoza, 1986).

The metamorphic rocks of the Jurassic System extensively spread from the west to the northwest of La Concha hamlet in the northern part of the survey area. The major constituent is pelitic schist, but much lesser amounts of psammitic schist or chlorite and sericite schist that are assumed to be originated from volcanic rock are found around Florida dale.

Most part of the survey area is covered by Cretaceous System consisting of footwall dacite lava (K dc 1-b), ore horizon pyroclastics (K oh-b), hangingwall dacitic pyroclastics - shale alternation (K dc-sh) and the black shale (K sh 1). This footwall dacite lava (K dc 1-b) spreads in a half circle form from the west to the north of the survey area, and constitutes the footwall of Kuroko type deposits in the sequence of strata in the area. The lava (K dc 1-b) is pale brown to pale green and is slightly altered, but the field survey did not indicate that the lava contains strongly altered part and disseminated part that suggest the presence of Kuroko type deposits in the neighborhood. Ore horizon pyroclastics (K oh-b) are found inside the half circle of the footwall dacite lava (K dc 1-b), and constitute an ore horizon in a broad sense. The hangingwall dacitic pyroclastics - shale alternation (K dc-sh) and the black shale (K sh 1) are rock strata mainly consisting of shale, and widely sprawl from the south to the east of San Jeronimo dale, where drilling survey were carried out. The former (K dc-sh) features frequent presence of intercalated sandstone that can be seen to be originated from acidic volcanic rock. The latter (K sh 1), on the other hand, covers the northeast in the survey area, mainly consisting of a stratum of several centimeters thick shale, with less frequent presence of intercalated sandstone than the case for the former (K dc-sh), and with development of slaty cleavage in some places. The Cretaceous System unconformably covers basement of metamorphic rocks of the Jurassic System.

The Tertiary System lies in the east of the survey area, consisting of andesites (Tad 1 and Tad 2) and unconformably covering the Cretaceous System.

In addition to the above, mountains of El Blanco and Pelon in the south of the survey area contains andesite (intrusive rock) that suggests activity of the Tertiary period but the precise active period is unknown because of no measurements of the absolute age.

3-2 Geological Structure

Elements for geological structures found in the survey area vary depending on the Jurassic, the Cretaceous and the Tertiary System: vigorous foldings in the former two, but gentle foldings of large wave lengths in the last one.

Detailed geological structures of the Jurassic System are yet unknown because of lack of suitable outcrops for the analysis, but they can be understood so that, similar to the formation found on the road between Cuale mine and El Aguacate in the second year survey, combinations of high order foldings had resulted in gentle low order foldings the half-wavelength of which is 5 Km or more. The schistosity and the bedding plane are in a slight crossing each other.

The Cretaceous System is unconformably covered with I-stage andesites (Tad 1) and II-stage ones (Tad 2), and its geological structure is featured with semi-basin structures which are composed of footwall dacite lava (K dc 1-b), horizon pyroclastics (K oh-b) and hangingwall dacitic pyroclastics - shale alternation (K dc-sh). Inside the semi-basin structure lies a synclinorium structure having a NW-SE axis, and an anticlinal axis of 600 to 700 meters of a half wavelength plunges toward the southeast around San Jeronimo dale. San Jeronimo dale roughly corresponds to the position of the anticlinal axis. The semi-basin structure runs for a little less than 10 Km from the southwest to the southeast, but the length beyond the end is unknown because from there the structure runs into beneath andesites of the Tertiary System.

The Tertiary System in the survey area includes only andesites that unconformably cover the Cretaceous System in the neighborhood of El Pozo (Tad 1 and Tad 2) and that lie in the south of the area (instrusive rock). These andesites form extremely gentle foldings that are not harmonious with the underlying Cretaceous System.

The geological survey has shown that the survey area includes no remarkable dislocation of the formation. The drilling survey, however, has suggested presence of faults that run through the south of San Jeronimo dale in the NW-SE direction and demarcate MJM-10 from other drilling sites. Faults of this system are the most prominent ones throughout the whole survey area with a variety of displacement degrees. Comparison of these degrees with those found in other drilling holes in the vicinity implies that blocks in the southern side have dropped by tens of meters because of these faults.

3-3 Ore Deposits

The survey area includes Kuroko type ore deposits, which have been formed in dacites of Cretaceous System with a close genetical relationship. Direct relationship of Kuroko type deposits with country rock has not been observed because of collapsed tunnels, but ore stored around every tunnel shows typical appearance of massive sulfide ore.

Ores appear of typical Kuroko, mainly consisting of fine pyrite ore (yellow ore) and sphalerite-galena- ore (black ore).

Massive sulphide ores are dominant but some pyrite ores show compositional banding of galena and sphalerite.

The coexistence of yellow ore and black ore in the same ore deposit suggests a zonal arrangement of the ore in this ore deposit, which can be regarded as a "proximal" type ore deposit.

In addition to the above mentioned Kuroko type deposits, the survey area includes distributions of old pits that can be assumed to be used for mining of mineralized zones of precious metals (for example, San José and El Rosario) which have stratigraphically developed in the footwall rock. These ore deposits are distributed along San Jeronimo dale, 2 to 5 km northwest from El Bramador hamlet, and the dales tributaries, in the NW-

SW direction because of the restriction from the folding axis (in the NW-SE direction) in this area. These old pits are scattered in a range over 3 km from La Trozada-E, the northwestern end (elevation: 875 m) to San Pedro ore deposit, the southeastern end (elevation: 500 m), with the following known ore deposits.

ⓐ	La Trozada-E	Mercury
ⓑ	La Castellana	Kuroko type
ⓒ	Los Alpes	Kuroko type
ⓓ	San José	Kuroko type and Gold (?)
ⓔ	Delicias-El Rosario	Kuroko type and Gold (?)
ⓕ	La Colorada	Kuroko type
ⓖ	San Pedro - Rey Negro	Kuroko type

CHAPTER 4 K-Ar AGE DETERMINATION

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4-1 Purpose

In the survey area, generally distributed is an intrusive rock that can be deemed as the same rock as granodiorite that is extensively exposed along the Pacific coast. The rock has not been subjected to the absolute age determination, thus the intrusive age has remained unknown. The survey aims to get better understanding on the igneous activity in the survey area by determining the K-Ar age of the rock.

As to Kuroko type ore deposits in this survey area, the survey in the first year (for the Eastern Area) has concluded that the age of these deposits dates back to the Late Cretaceous (from Campanian Stage to Maastrichtian Stage, 78 to 65 m.y.), based on the judgment on nannoplanktons obtained from the shale (K sh1) in which these Kuroko type ore deposits contain. Accordingly it can be assumed that they have been formed in the Late Cretaceous.

On the other hand, the second year's survey (for the Western Area) has pointed out, based on the judgment on fossils of nannoplanktons and radiolarias found in the same shale (K sh1), that these fossils are generally found in the Lower Cretaceous System, thus the age of the shale might be the Early Cretaceous. This fact has suggested that there might be some difference in the age of formation of the Kuroko type ore deposits between two areas; the Eastern Area and Western Area.

In this survey, to verify this problem, a K-Ar age determination was carried out on samples of country rock, which have been intensively affected by hydrothermal alteration from the Kuroko type mineralization and were taken from typical Kuroko type ore deposits in the two area (La America deposit in the Eastern Area and Los Alpes deposit in the Western Area). Sampling sites are shown in Fig. 4-1.

4-2 Results

Measurements on the K-Ar age were done by use of an analyzer of the Institute Mexicano del Petroleo. Five data were obtained from three samples and results are shown in Table 4-1.

With AE-1-DESM (western part of Desmoronado) sample, the age was measured on hornblend and biotite in massive, compact, rigid and medium grained granodiorite, and data were 71.1 ± 6 m.y. and 71.8 ± 6 m.y. AE-2-AMEC (La America deposit) sample was compact and green sandy tuff, and was measured with the whole rock, and data were 71. 9 ± 6 m.y. AE-3-MIRA (Los Alpes deposit) sample was strongly altered, pale green to grey pumice tuff, and the whole rock and sericite were subjected to measurements, resulting in 86.6 ± 7 m.y. and 89.0 ± 7 m.y. respectively.

Constants used for calculation of the age were: $\lambda_e = 0.581 \times 10^{-10}\ yr^{-1}$, $\lambda_b = 4.962 \times 10^{-10}\ yr^{-1}$, and $^{40}K/K = 1.167 \times 10^{-4}$. $^{40}Ar^R$ was radiogenic argon.

4-3 Consideration

As shown in Table 4-1, measured results of the absolute age can be regarded as of high reliability because they closely resemble one another even if the analyzed minerals were different in the same sample. One exception was AE-1-DESM; air contamination of hornblend was 86.7%, a relatively high figure which casted a question on the reliability of the data, but the age of hornblend was roughly equal to that of biotite, thus the results on the age can be judged as reliable.

Table 4-1 K-Ar Ages of Dated Rocks

Sample NO.	Rock Name	Coordinates		Analyzed Sample	K(%)	$^{40}Ar^{R}/^{40}K$	Air Contamination (%)	Age (m.y.)
		X	Y					
AE-1-DESM	Granodiorite	-3,440	20,450	Hornblend	0.42	0.00422	86.7	71.1 ± 6
				Biotite	6.07	0.00426	27.0	71.8 ± 6
AE-2-AMEC	Sandy Tuff	8,750	20,350	whole rock	2.64	0.00426	23.8	71.9 ± 6
AE-3-MIRA	Pumice Tuff	-13,450	11,650	whole rock	3.61	0.00511	66.4	86.0 ± 7
				Sericite	4.63	0.00529	10.4	89.0 ± 7

As mentioned previously, the suggested formation age for Kuroko type ore deposits based on investigations on mannoplanktons and radiolarias was the Late Cretaceous for the Eastern Area but was the Early Cretaceous for the Western Area. Data obtained in this survey also indicate that Kuroko type ore deposit (Los Alpes deposit) in the Western Area is older than that in the Eastern Area, though the difference is smaller than the obtained from judgment on microfossils. Such difference might be explained by a theory saying that these Kuroko type ore deposits could have been formed by volcanic activities deeply related to global tectonics (Cathles at al., 1983), and by an opinion pointing that there is perceptible marks implying that volcanic fronts at that time moved roughly from the west to the east (Damon et al., 1981).

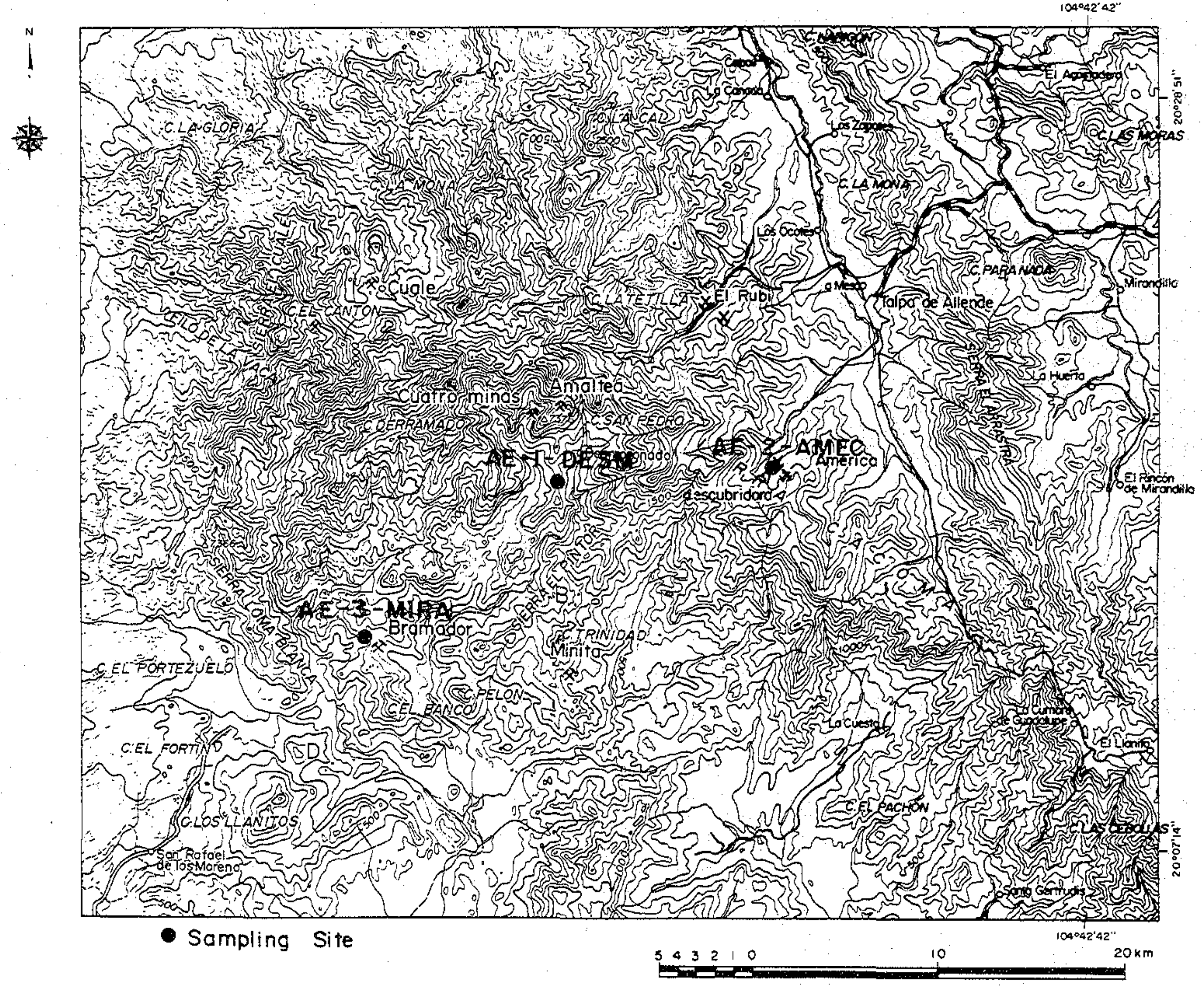

Fig. 4-1 Sampling Localities of Dated Rocks

CHAPTER 5 DRILLING SURVEY

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5-1 Outline of 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 carried out in the second year's program. The La Concha-El Bramador area was selected as one of the potential areas, and the drilling program was concentrated in the area.

Though six holes totaling 1,850 meters were initially planned, one hole of depth 350 meters was added to test the extension of the significant sulphide mineralization and hydrothermal alteration zone. Eventually seven holes totaling 2,296.20 meter were drilled.

Outline and site location of each hole are shown in Table 5-1 and Fig. 5-1.

Table 5-1 Outline of Each Hole

Hole No.	Location		Above the sea	Proposed Depth	Drilled Depth	Period
	X	Y				
MJM-6	13,440	11.880	+820 m	300 m	301.6 m	17.6.1986 28.6.1986
MJM-7	11,780	11,240	+710 m	300 m	316.4 m	19.7.1986 7.8.1986
MJM-8	9,650	9,390	+410 m	300 m	301.6 m	29.8.1986 15.9.1986
MJM-9	11,180	9,750	+470 m	300 m	307.6 m	26.9.1986 7.10.1986
MJM-10	11,890	9,930	+510 m	350 m	358.6 m	28.10.1986 12.11.1986
MJM-11	11,530	10,440	+520 m	300 m	358.2 m	24.11.1986 6.12.1986
MJM-12	12,620	11,380	+670 m	350 m	352.2 m	18.12.1986 1.1.1987

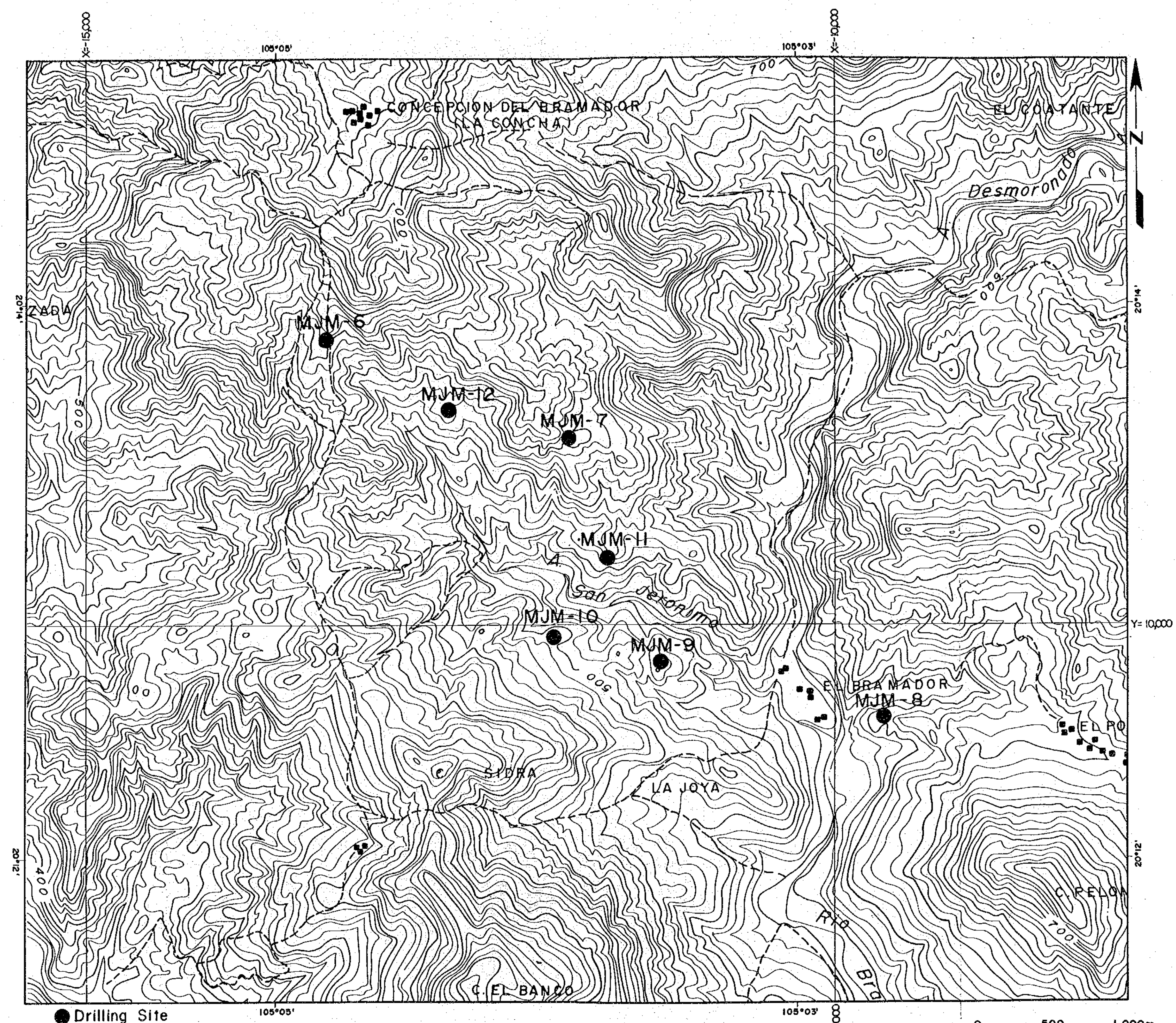

Fig. 5-1 Location Map of Drill Holes

5-2 Drilling Method and Equipment

A drilling machine, equipment and tools which were used for this program were shipped from Japan, July 1985. They were carried to a storage in La Concha. Diamond bits, rods, casing pipes, and mud materials were procured in Mexico.

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 and was the final bit size BQ-WL. Bentonita and soluble cutting oil were 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 5-2, Table 5-3, Table 5-4, Table 5-5 and Table 5-6.

5-3 Drilling Operation

5-3-1 Site Preparation

Equipment for drilling, which had been stored in a warehouse constructed in La Concha in February, 1986, was transported by a helicopter to each drilling site and installed. Due to steep and rocky ground conditions and to the rainy season, it was almost impossible to construct access roads over 10 km. Lodings were built near drilling site.

5-3-2 Mobilization

A helicopter which was hired in C.R.M. was used for all mobilization works.

5-3-3 Demobilization

After completion of the final hole MJM-12 on January 1, 1987 all equipment and tools were checked and repaired for maintenance. Then they were carried to a storage in Guachinango where C.R.M. has a store for drilling equipments.

5-3-4 Core Recovery and Drilling Fluid

All holes were drilled down approximately 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 seven holes was 94 percent. The summarized drilling data were shown in Table 5-7, Table 5-8, Table 5-9, Table 5-10, and Table 5-11.

Bentonite and soluble cutting oil were used as drilling fluids. General mixing ratio of bentonite and soluble cutting oil was 7 percent and 0.3 percent, respectively. But the ratio was adjusted depending on hole conditions such as lost circulation and gushed water.

Table 5-2 List of Equipment Used

Item	Type	Maker	Capacity	Quan-tity
Drilling mach-ine	TGM-3A	TONE Boring	Load Reting 2,200 kg	1
Prime mover	Electric Mo-tor	MITSUBISHI	Rating 15 kw	1
Main pump	NAS-3C	TONE Boring	Maxim.Press 70 ksc Maxim.Vol.130 /min	1
Prime mover	Electric Mo-tor	MITSUBISHI	Rating 7.5 kw	1
Mud mixer	MCE-100	TONE Boring	Maxim.Vol.100	1
Prime mover	Electric Mo-tor	HITACHI	Rating.1.5 kw	1
Generator	DCA-55	DENYO	Rating.55kVA	1
Prime mover	Engine - DA.120	ISUZU	Horse power reting 76.5 ps/1,800 rpm	1
Water supply pump	MS-403	MARUYAMA	Maxim.40 ksc Maxim.63 /min	1
Prime mover	GED.25R	SIBAURA	Horse power reting 5.0 ps/1,800 rpm	1
Mast	NL-2	TONE Boring	Height 7m	1
Wire line hoi-st	WHS-600	TONE Boring		1
Wire line rod	NQ	TONE Boling	1.5m/JOINT	1
〃	〃	〃	3.0m/JOINT	95
〃	BQ	〃	1.5m/JOINT	1
〃	〃	〃	3.0m/JOINT	130

Table 5-3 List of Supplies and Consumables Spent

Item	Specification	Unit	Quantity
Wireline drill rod	NQ	pcs	95
〃	BQ	〃	130
Casing tube	NW×3.0m	〃	40
〃	BW×3.0m	〃	110
Inner tube assy	NQ	sets	3
〃	BQ	〃	4
Outer tube assy	NQ	〃	2
〃	BQ	〃	2
Hoisting wire rope with socket	12.5mm×30.0m	roll	3
Pipe wrench	900mm	pcs	6
〃	600mm	〃	8
〃	450mm	〃	6
Diamond bit	101mm	〃	7
〃	NQ	〃	25
〃	BQ	〃	24
Diamond reamer	101mm	〃	7
〃	NQ	〃	8
〃	BQ	〃	7
Casing Diamond shoe	NW	〃	7
〃	BW	〃	7
Cement		kgs	1,850
Bentonite		〃	4,050
Libonite		〃	-
C.M.C.		〃	373
Tel-stop(P)		〃	-
〃 (G)		〃	245
Barite		〃	110
Soluble cutting oil		liters	1,997
Gas oil		〃	13,215
Gasoline		〃	1,010
Mobile oil		〃	130
Turbine oil		〃	180
Grease		kgs	120
Core box	101mm	pcs	20
〃	NQ	〃	270
〃	BQ	〃	250

Table 5-4 List of Diamond Bits Used for Each Hole

Item	Size	Type	Hole No.							
			MJM-6	MJM-7	MJM-8	MJM-9	MJM-10	MJM-11	MJM-12	Total
Bit	101m/m	101 SW	1	1	1	1	1	1	1	7
	NQ	NQ-WL	2	8	3	3	4	2	3	25
	BQ	BQ-WL	2	4	5	3	4	4	2	24
Reamer	101.5m/m	101.5 St	1	1	1	1	1	1	1	7
	NQ	NQ-WL	1	1	1	1	1	1	2	8
	BQ	BQ-WL	1	1	1	1	1	1	1	7

Table 5-5 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	1.0 - 2.0	300	4 - 5 kg / cm²	7
〃	NQ	NQ-WL	30	E	0.7 - 3.0	300 - 700	0 - 16 kg / cm²	25
〃	BQ	BQ-WL	20	E	0.7 - 3.5	300 - 700	0 - 20 kg / cm²	24
Diamond Reamer	101.5 m/m	101.5 ST	10	E				7
〃	NQ	NQ-WL	8	E				8
〃	BQ	BQ-WL	6	E				7

Table 5-6 Drilling Fluid

Hole name / Mud materials		MJM- 6	MJM- 7	MJM- 8	MJM- 9	MJM-10	MJM-11	MJM-12	total
Bentonite	kg	950	850	650	400	550	300	350	4,045
C.M.C.	kg	80	6	60	28	66	60	73	373
Libonite	kg	-	-	-	-	-	-	-	-
Soluble cutting oil		116	383	320	182	373	345	278	1,997
Tel-Stop(G)	kg	5	20	140	10	-	55	15	245
Tel-Stop(P)	kg	-	-	-	-	20	-	-	20
Barite	kg	-	-	100	-	-	-	-	100

5-3-5 Water Supply

The water used for drilling operation was pumped up from streams nearby the drilling sites. The length of water pipes were 300 to 1000 meters, and the maximum head high was 120 meters.

5-3-6 Drilling

Progression of the whole operation is shown in Fig. 5-2; drilling data of each hole in Fig. 5-3, Fig. 5-4, Fig. 5-5, Fig. 5-6, Fig. 5-7, Fig. 5-8 and Fig. 5-9; and drilling records of each hole in Table 5-7, Table 5-8,Table 5-9, Table 5-10, Table 5-11, Table 5-12 and Table 5-13.

The following are special remarks for each hole.

MJM-6: A lot of time was consumed for preparation because of a troubled truck in carrying materials into the site. A lost circulation trouble was encountered between 5.50 m to 167.80 m in depth, which was dealt with Telstop and casing. In drilling through the lost circulation trouble, water for drilling was insufficient partly because of the arid season, which was supplied with trucks. The work required 27 days.

MJM-7: Drilling was obliged to delay due to day after day thunderstorms in the rainy season. A lightning attack troubled the generator, requiring some days for repair. There was a lost circulation trouble between 196.4 m to 280.0 m in depth, which was coped with Telstop and cementing, resulting in 42 days for completion of the operation.

MJM-8: Time was wasted for transportation of materials because of the regular inspection of the helicopter and unsoasonable weather. Another lightning attack troubled the generator. Collapse accompanying lost circulation caused stuck trouble at a depth of 241.0 m, which was dealt with monkey hammering and jack winding. Cementing was also practice at the same depth to prevent lost circulation and collapse. The whole operation needed 38 days.

MJM-9: Lost circulation with collapse occurred between 134.0 m to 140.0 m in depth, which was coped with cementing. Although the generator wasted some time because of repairing its balky condition, the drilling operation progressed smoothly, resulting in 24 day for completion.

MJM-10: Damaged lodgings due to a typhoon and adverse weather conditions asked a longer period for transportation of materials and preparation for the operation. Collapse at a depth of 52 m was treated by cementing. The whole work needed 34 days.

MJM-11: Uncomfortable topography required superfluous time to prepare drilling site, but drilling operation went on favorably without any extraordinary problem with 22 days to finish the operation.

MJM-12: Despite the generator was troubled once, the drilling met no interruption, ending smoothly the operation in 22 days.

Table 5-7 Summary of Drilling Program (MJM-6)

	Classification	Period	Total days	Working days	Day off	Number of workers
Periodo	Mobilization	5. 6.1986 - 16. 6.1986	12	12	0	258
	Drilling	17. 6.1986 - 28. 6.1986	12	Drill 11	1	312
				0	0	0
	Demobilization	29. 6.1986 - 1. 7.1986	3	3	0	78
	Total	5. 6.1986 - 1. 7.1986	27	26	1	648

Proposed depth	300.0 m	Core length	291.3 m
Drilling depth	301.6 m	Core recovery	96.58 %
Over burden	0 m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 99.8	99.8 m	91.88 %	91.88 %
99.8 - 201.6	101.8 m	99.41 %	95.68 %
201.6 - 301.6	100.0 m	99.80 %	96.58 %

Time distribution	Drilling	84° 00′	32.8 %	20.3 %
	Related operation	154° 00′	60.2 %	37.2 %
	Pipe stuck etc.	18° 00′	7.0 %	4.3 %
	Sub total	256° 00′	100.0 %	-
	Mobilization	110° 00′	-	26.6 %
	Demobilization	48° 00′	-	11.6 %
	Total	414° 00′	-	100.0 %

Efficiency	
301.6 m/total period	11.17 m/day
301.6 m/working days	11.60 m/day
301.6 m/drilling days	27.42 m/day
Total workers/301.6 m	2.15 worker/m

	Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
Casing	N.W	18.00	6.0	100.0
	B.W	189.00	62.7	100.0

Observation
A: Total depth
B: Casing length

Table 5-8 Summary of Drilling Program (MJM-7)

	Classification	Period	Total days	Working days	Day off	Number of workers
Periodo	Mobilization	2. 7.1986 - 18. 7.1986	17	17	0	420
	Drilling	19. 7.1986 - 7. 8.1986	20	Drill 20	0	518
				0	0	0
	Demobilization	8. 8.1986 - 12. 8.1986	5	5	0	113
	Total	2. 7.1986 - 12. 8.1986	42	42	0	1051

Proposed depth	300.0 m	Core length	306.7 m
Drilling depth	316.4 m	Core recovery	96.93 %
Over burden	15.0 m		

Time distribution	Drilling	111° 00′	28.9 %	19.1 %
	Related operation	118° 00′	30.7 %	20.3 %
	Pipe stuck etc.	155° 00′	40.4 %	26.7 %
	Sub total	384° 00′	100.0 %	-
	Mobilization	151° 00′	-	26.0 %
	Demobilization	46° 00′	-	7.9 %
	Total	581° 00′	-	100.0 %

	Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
Casing	N.W	27.00	8.5	44.0
	B.W	147.00	46.5	100.0

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 100.1	100.1 m	89.71 %	89.71 %
100.1 - 200.3	100.2 m	99.80 %	94.81 %
200.3 - 316.4	116.1 m	100.00 %	96.93 %

Efficiency	
316.4 m/total period	7.53 m/day
316.4 m/working days	7.53 m/day
316.4 m/drilling days	15.82 m/day
Total workers/ 316.4 m	3.32 worker/m

Observation
A: Total depth
B: Casing length

Table 5-9 Summary of Drilling Program (MJM-8)

Periodo	Classification	Period	Total days	Working days	Day off	Number of workers
	Mobilization	13. 8.1986 - 28. 8.1986	16	16	0	373
	Drilling	29. 8.1986 - 15. 9.1986	18	Drill 18	0	465
				0	0	0
	Demobilization	16. 9.1986 - 19. 9.1986	4	4	0	98
	Total	13. 8.1986 - 19. 9.1986	38	38	0	936

Proposed depth	300.0 m	Core length	274.9 m
Drilling depth	301.6 m	Core recovery	91.15 %
Over burden	9.0 m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 99.9	99.9 m	76.38 %	76.38 %
99.9 - 200.9	101.0 m	96.90 %	86.71 %
200.9 - 301.6	100.7 m	100.00 %	91.15 %

Time distribution				
	Drilling	97° 00′	27.9 %	19.1 %
	Related operation	113° 00′	32.5 %	22.2 %
	Pipe stuck etc.	138° 00′	39.6 %	27.1 %
	Sub total	348° 00′	100.0 %	-
	Mobilization	129° 00′	-	25.3 %
	Demobilization	32° 00′	-	6.3 %
	Total	509° 00′	-	100.0 %

Efficiency	
301.6 m/total period	7.94 m/day
301.6 m/working days	7.94 m/day
301.6 m/drilling days	16.76 m/day
Total workers/ 301.6 m	3.10 worker/m

Casing	Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
	N.W	36.00	11.9	100.0
	B.W	177.00	58.7	100.0

Observation
A: Total depth
B: Casing length

Table 5-10 Summary of Drilling Program (MJM-9)

	Classification	Period	Total days	Working days	Day off	Number of workers
Periodo	Mobilization	20. 9.1986 - 25. 9.1986	6	6	0	146
	Drilling	26. 9.1986 - 7.10.1986	12	Drill 12	0	295
				0	0	0
	Demobilization	8.10.1986 - 13.10.1986	6	6	0	150
	Total	20. 9.1986 - 13.10.1986	24	24	0	591

Proposed depth	300.0 m	Core length	277.3 m
Drilling depth	307.6 m	Core recovery	90.15 %
Over burden	10.0 m		

Time distribution	Drilling	90° 00′	38.6 %	28.0 %
	Related operation	118° 00′	50.7 %	36.8 %
	Pipe stuck etc.	25° 00′	10.7 %	7.8 %
	Sub total	233° 00′	100.0 %	-
	Mobilization	56° 00′	-	17.4 %
	Demobilization	32° 00′	-	10.0 %
	Total	321° 00′	-	100.0 %

	Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
Casing	N.W	51.00	16.9	58.8
	B.W	147.00	47.8	100.0

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 100.0	100.0 m	85.00 %	85.00 %
100.0 - 199.6	99.6 m	84.74 %	84.87 %
199.6 - 307.6	108.0 m	99.91 %	90.15 %

Efficiency	
307.6 m/total period	12.82 m/day
307.6 m/working days	12.82 m/day
307.6 m/drilling days	25.63 m/day
Total workers/ 307.6 m	1.92 worker/m

Observation
A: Total depth
B: Casing length

Table 5-11 Summary of Drilling Program (MJM-10)

Periodo	Classification	Period	Total days	Working days	Day off	Number of workers
	Mobilization	14.10.1986 - 27.10.1986	14	14	0	350
	Drilling	28.10.1986 - 13.11.1986	17	Drill 17	0	439
				0	0	0
	Demobilization	14.11.1986 - 16.11.1986	3	3	0	84
	Total	14.10.1986 - 16.11.1986	34	34	0	873

Proposed depth	300.0 m	Core length	337.0 m
Drilling depth	358.6 m	Core recovery	93.98 %
Over burden	9.0 m		

Time distribution				
Drilling	113° 00′	32.8 %	24.8 %
Related operation	130° 00′	37.8 %	28.5 %
Pipe stuck etc.	101° 00′	29.4 %	22.1 %
Sub total	344° 00′	100.0 %	-
Mobilization	72° 00′	-	15.8 %
Demobilization	40° 00′	-	8.8 %
Total	456° 00′	-	100.0 %

Casing

Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
N.W	24.00	6.7	12.5
B.W	145.00	40.4	100.0

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 99.8	99.8 m	81.96 %	81.96 %
99.8 - 201.7	101.9 m	98.72 %	90.43 %
201.7 - 300.9	99.2 m	98.59 %	93.12 %
300.9 - 358.6	57.7 m	98.44 %	93.98 %

Efficiency

358.6 m/total period	10.55 m/day
358.6 m/working days	10.55 m/day
358.6 m/drilling days	21.09 m/day
Total workers/ 358.6 m	2.43 worker/m

Observation
A: Total depth
B: Casing length

Table 5-12 Summary of Drilling Program (MJM-11)

Periodo	Classification	Period	Total days	Working days	Day off	Number of workers
	Mobilization	17.11.1986 - 23.11.1986	7	7	0	193
	Drilling	24.11.1986 - 6.12.1986	13	Drill 13	0	347
				0	0	0
	Demobilization	7.12.1986 - 8.12.1986	2	2	0	50
	Total	17.11.1986 - 8.12.1986	22	22	0	590

Proposed depth	300.0 m	Core length	350.8 m
Drilling depth	358.2 m	Core recovery	97.93 %
Over burden	8.8 m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 101.5	101.5 m	92.81 %	92.81 %
101.5 - 201.2	99.7 m	100.00 %	96.37 %
201.2 - 301.6	100.4 m	100.00 %	97.71 %
301.6 - 358.2	56.6 m	100.00 %	97.93 %

Time distribution				
Drilling	103° 00′	33.9 %	26.0 %
Related operation	169° 00′	55.6 %	42.7 %
Pipe stuck etc.	32° 00′	10.5 %	8.1 %
Sub total	304° 00′	100.0 %	-
Mobilization	72° 00′	-	18.2 %
Demobilization	20° 00′	-	5.0 %
Total	396° 00′	-	100.0 %

Efficiency	
358.2 m/total period	16.28 m/day
358.2 m/working days	16.28 m/day
358.2 m/drilling days	27.55 m/day
Total workers/ 358.2 m	1.65 worker/m

Casing

Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
N.W	28.20	7.9	100.0
B.W	130.00	36.3	100.0

Observation
A: Total depth
B: Casing length

Table 5-13 Summary of Drilling Program (MJM-12)

	Classification	Period	Total days	Working days	Day off	Number of workers
Periodo	Mobilization	9.12.1986 - 17.12.1986	9	9	0	225
	Drilling	18.12.1986 - 1. 1.1987	15	Drill 13	2	345
				0	0	0
	Demobilization	2. 1.1987 - 3. 1.1987	2	2	0	50
	Total	9.12.1986 - 3. 1.1987	26	24	2	620

Proposed depth	350.0 m	Core length	329.1 m
Drilling depth	352.2 m	Core recovery	93.44 %
Over burden	0 m		

Core recovery of each 100 m

Depth (m)	Meter drilled	Core recovery	Grand total
0 - 99.8	99.8 m	77.96 %	77.96 %
99.8 - 199.2	99.4 m	99.40 %	88.65 %
199.2 - 300.6	101.4 m	99.51 %	92.32 %
300.6 - 352.2	51.6 m	100.00 %	93.44 %

Time distribution	Drilling	109° 00′	34.7 %	28.8 %
	Related operation	112° 00′	35.7 %	29.6 %
	Pipe stuck etc.	93° 00′	29.6 %	24.6 %
	Sub total	314° 00′	100.0 %	-
	Mobilization	44° 00′	-	11.7 %
	Demobilization	20° 00′	-	5.3 %
	Total	378° 00′	-	100.0 %

Efficiency

352.2 m/total period	13.55 m/day
352.2 m/working days	14.68 m/day
352.2 m/drilling days	27.09 m/day
Total workers/ 352.2 m	1.76 worker/m

	Casing size	Depth (m)	B/A × 100 (%)	recovery (%)
Casing	N.W	39.00	11.1	0
	B.W	172.00	48.8	100.0

Observation
A: Total depth
B: Casing length

Item		Days	Workers		Schedule (May, 1986 – June – July – August – Septomber – October – November – December – January, 1987)
			spe-cialist	Hel-per	
Mobilization (from Japan to La Concha)		5	20	—	21 – 25
Roads and drilling sites Preparation and repairs		10	40	118	26 – 4
MJM-6	Mobilization	12	48	210	5 – 16
	Drilling	12	48	264	17 – 28
	Demobilization	3	12	66	29 – 1
	Total	27	108	540	
MJM-7	Mobilization	17	68	352	2 – 18
	Drilling	20	80	438	19 – 7
	Demobilization	5	20	93	8 – 12
	Total	42	168	883	
MJM-8	Mobilization	16	64	309	13 – 28
	Drilling	18	72	393	29 – 15
	Demobilization	4	16	82	16 – 19
	Total	38	152	784	
MJM-9	Mobilization	6	24	122	20 – 25
	Drilling	12	48	247	26 – 7
	Demobilization	6	24	126	8 – 13
	Total	24	96	495	
MJM-10	Mobilization	14	56	294	14 – 27
	Drilling	17	68	371	28 – 13
	Demobilization	3	12	72	14 – 16
	Total	34	136	737	
MJM-11	Mobilization	7	28	165	17 – 23
	Drilling	13	52	295	24 – 6
	Demobilization	2	8	42	7 – 8
	Total	22	88	502	
MJM-12	Mobilization	9	36	189	9 – 17
	Drilling	15	60	285	18 – 1
	Demobilization	2	8	42	2 – 3
	Total	26	104	516	
Transportation (La Concha to Guachinango)		6	24	113	4 – 9
Demobilization		7	28	12	10 – 16
Total		241	964	4,700	

Fig. 5-2 Progress of Drilling Program

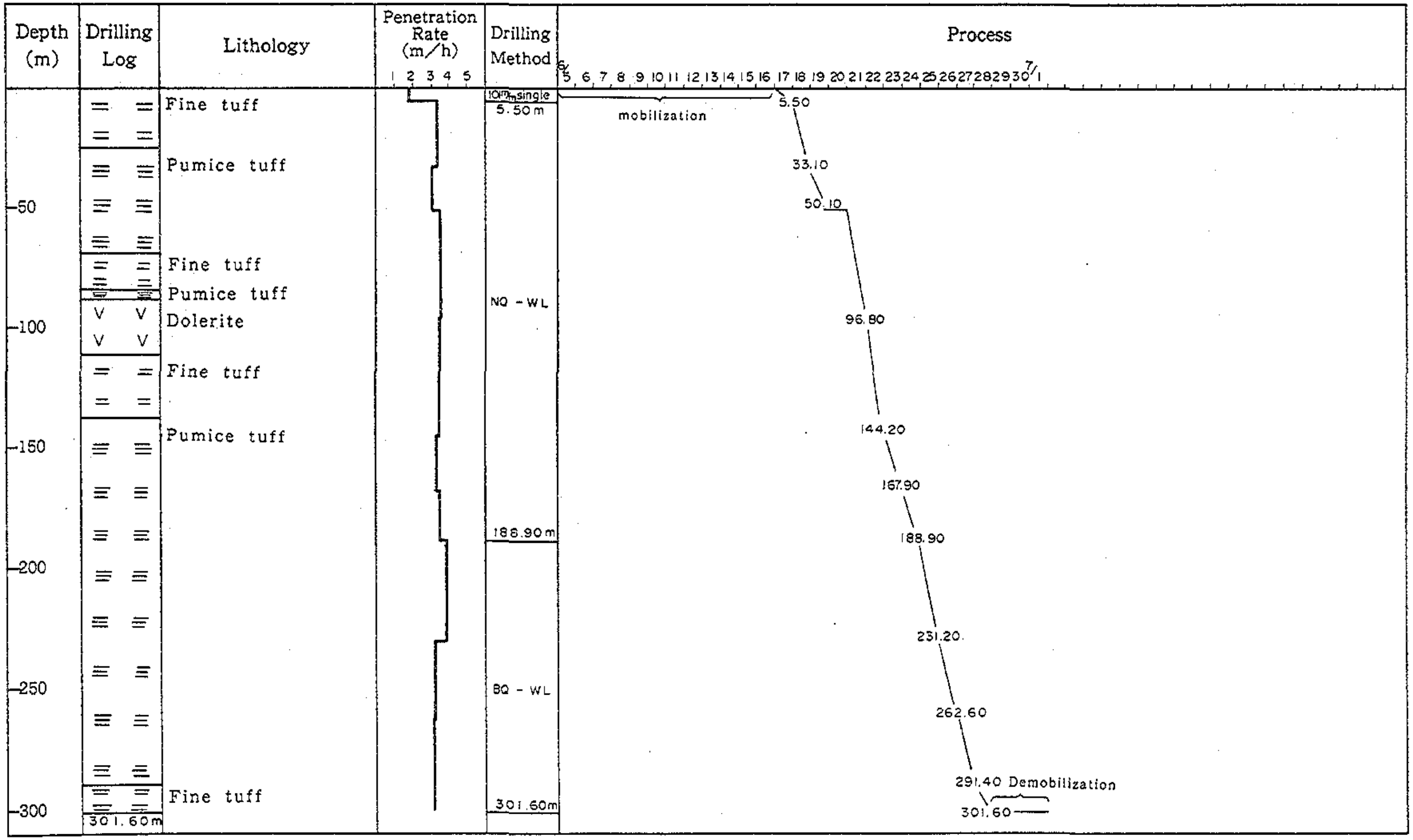

Fig. 5-3 Progress Record of Diamond Drilling MJM-6

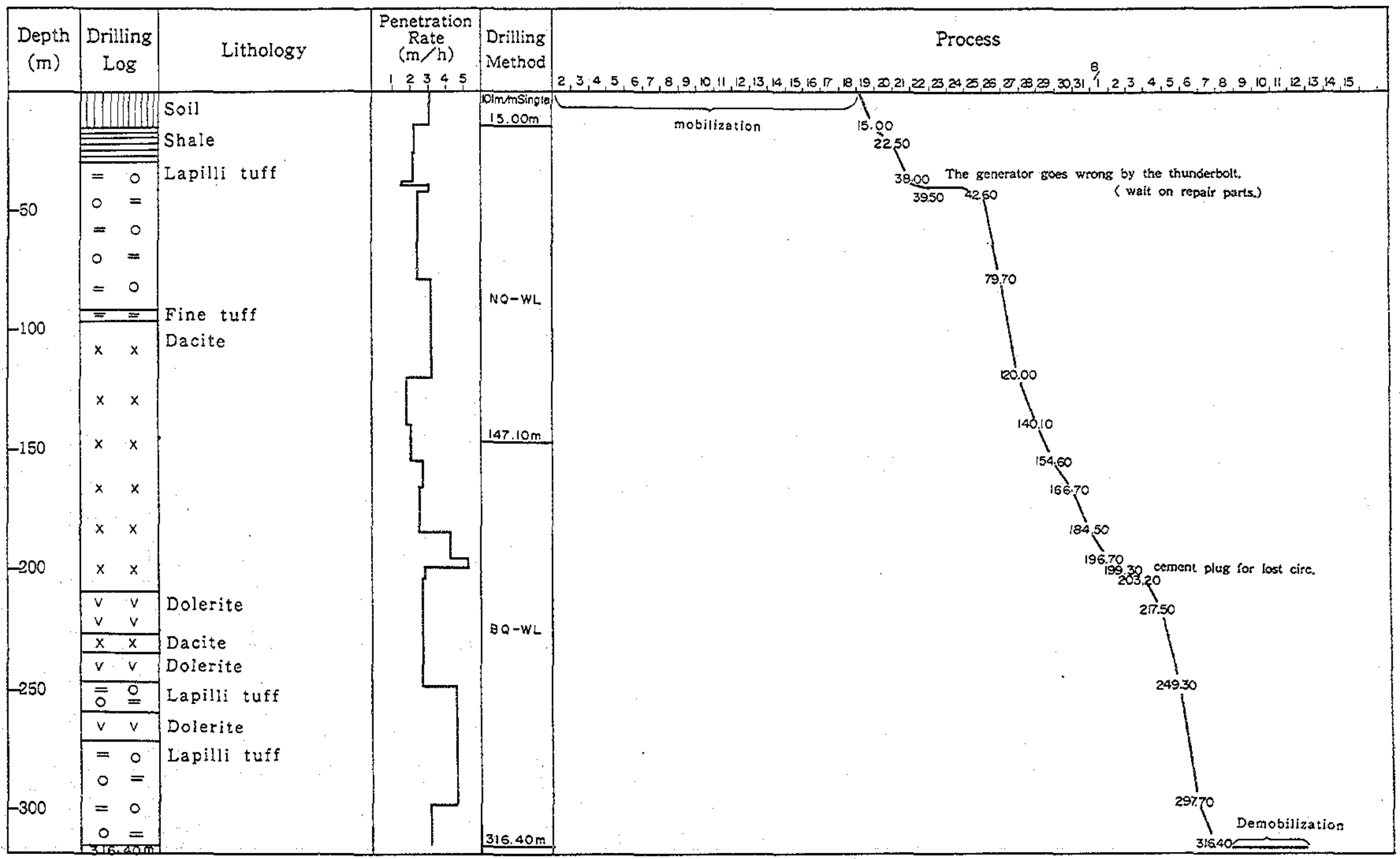

Fig. 5-4 Progress Record of Diamond Drilling MJM-7

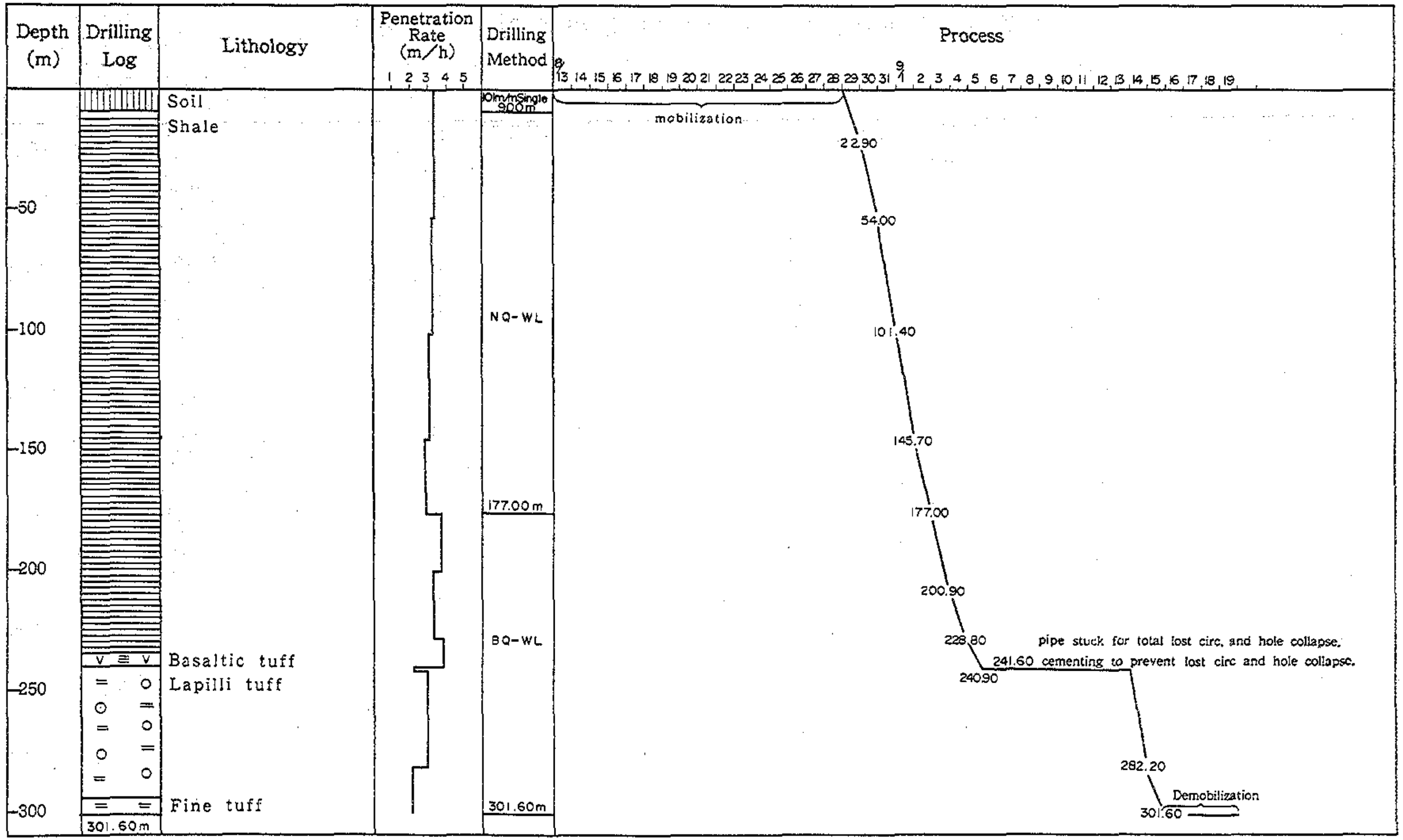

Fig. 5-5 Progress Record of Diamond Drilling MJM-8

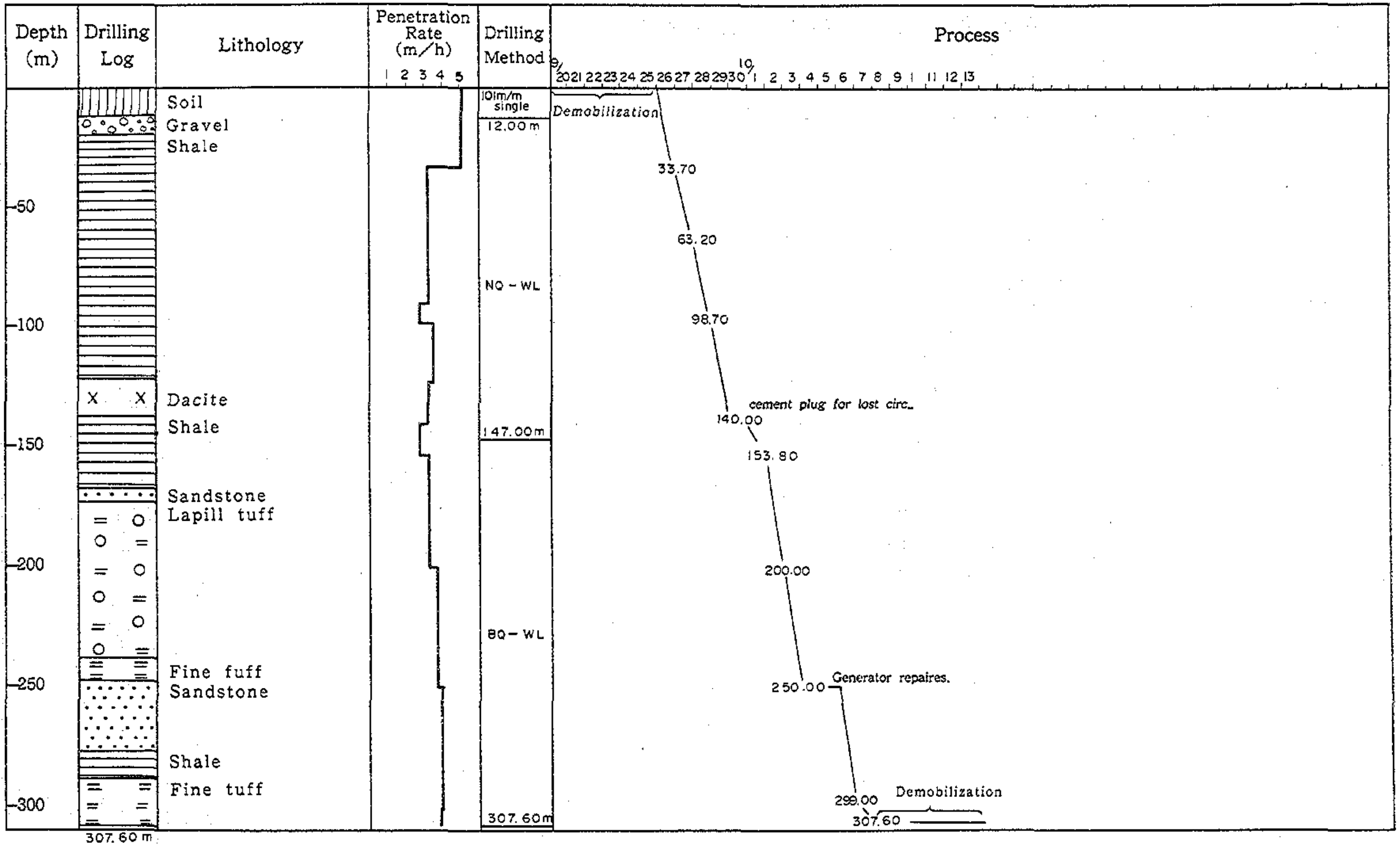

Fig. 5-6 Progress Record of Diamond Drilling MJM-9

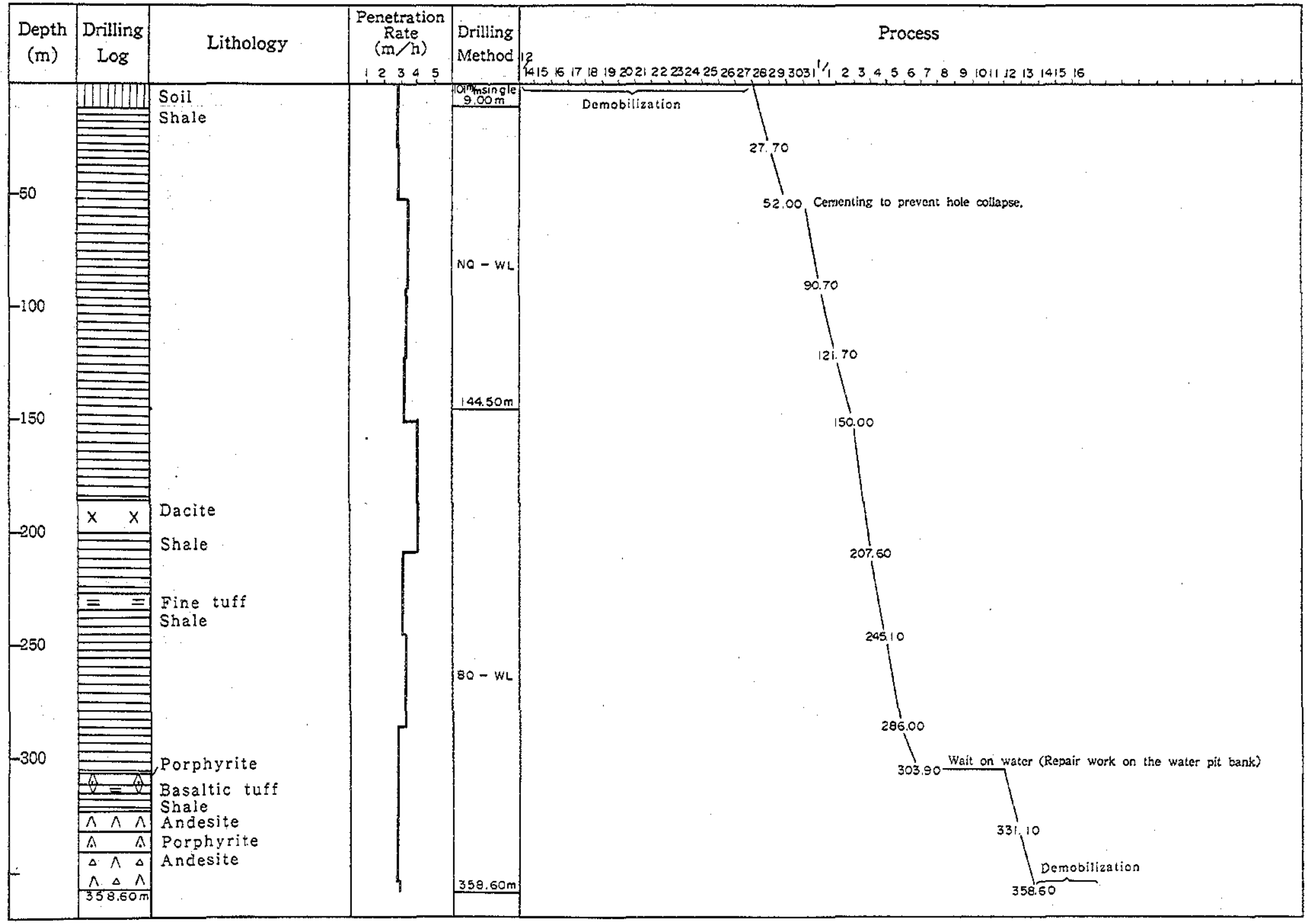

Fig. 5-7 Progress Record of Diamond Drilling MJM-10

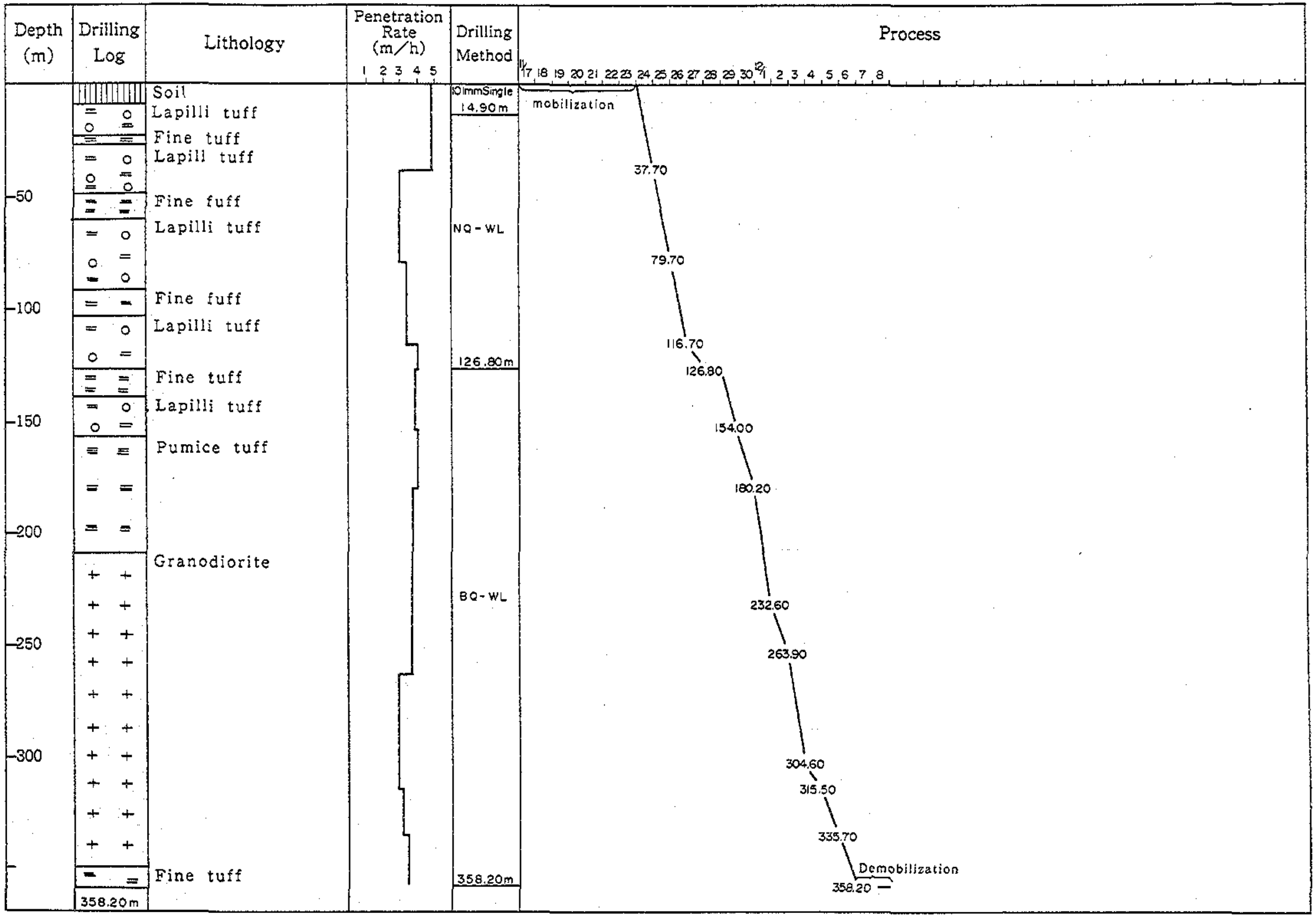

Fig. 5-8 Progress Record of Diamond Drilling MJM-11

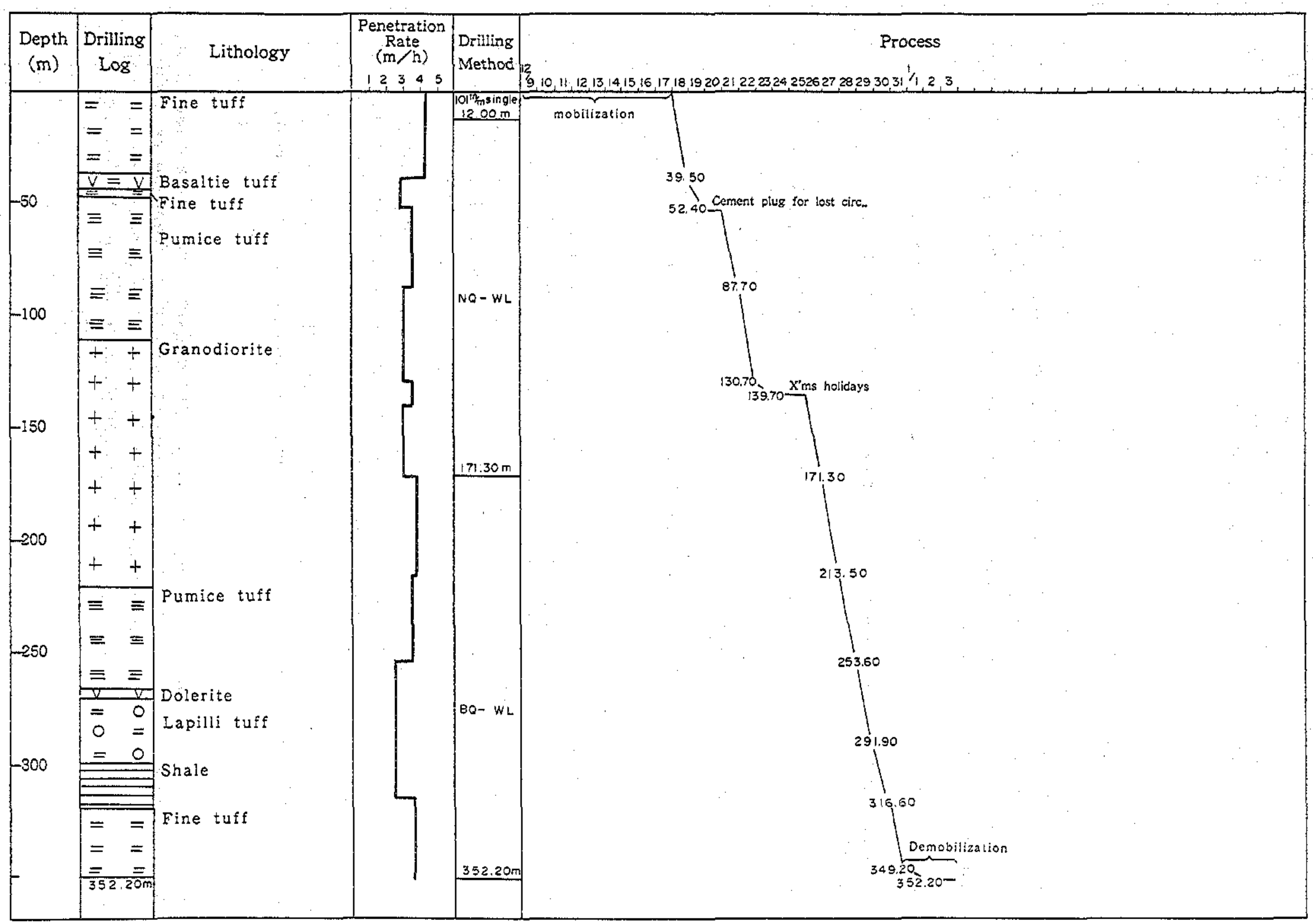

Fig. 5-9 Progress Record of Diamond Drilling MJM-12

5-3-7 Measures to Prevent Gashed Water and Lost Circulation Trouble

The survey has found no gashed water trouble but lost circulation trouble in every hole (water supply: 130 ℓ/min). Such lost circulation trouble was counteracted by mixing C.M.C or Telstop into mud water and inserting casing. Pressurized cement slurry was injected in parallel with them where collapse was accompanied. Relationship of geology with lost circulation trouble in each hole is shown in Fig. 5-10.

5-4 Geology of Holes

5-4-1 Selection of Drilling Targets

The drilling targets for the current year's survey were determined by selecting the sites where the Kuroko type deposits were considered most likely to occur upon comprehensive review of the second year's geological, geochemical and geophysical (CSAMT method) survey results. In determining the drilling sites, the following factors were primarily taken into account:

a. Areas where the Cretaceous acidic volcanic rocks are dominant.

b. Places subjected to strong hydrothermal alteration in the above-mentioned areas.

c. Geochemical anomalies on stream sediments, particularly anomaly indicated by multi-elements.

d. Low resistivity zones detected by the CSAMT method.

The reasons for selection of drill holes are summarized as follows:

(1) MJM-6

Ore horizon pyroclastic rocks (K oh-b) are distributed in this area and some small scale disturbed part is also observed on the surface. This phenomenon may be attributable to the doming up of footwall dacite in view of the CSAMT survey results which located a medium resistivity zone suggesting the existence of a dome of dacite. The existence of the ore horizon is also considered highly possible as the continuation from the Los Alpes and Delicias mineralized zones.

Also, this site is included in the geochemically anomalous zone indicated by the multi-elements of Ag-Pb. Such indication is common in the areas where the Kuroko type deposits occur in the survey area.

The alteration survey results also reveal that this site belongs to the zone of quartz (K-feldspar) - sericite - (chlorite), subjected to hydrothermal alteration.

(2) MJM-7

This site is involved in the hanging wall dacite·pyroclastic rock - shale alternation zone (K dc-sh). From its position, a continuity of ore horizon from the Valenciana deposit is highly likely. This site is included in the zone of geochemical anomaly by a single element (Pb). Since the geochemical anomalies in the Kuroko type

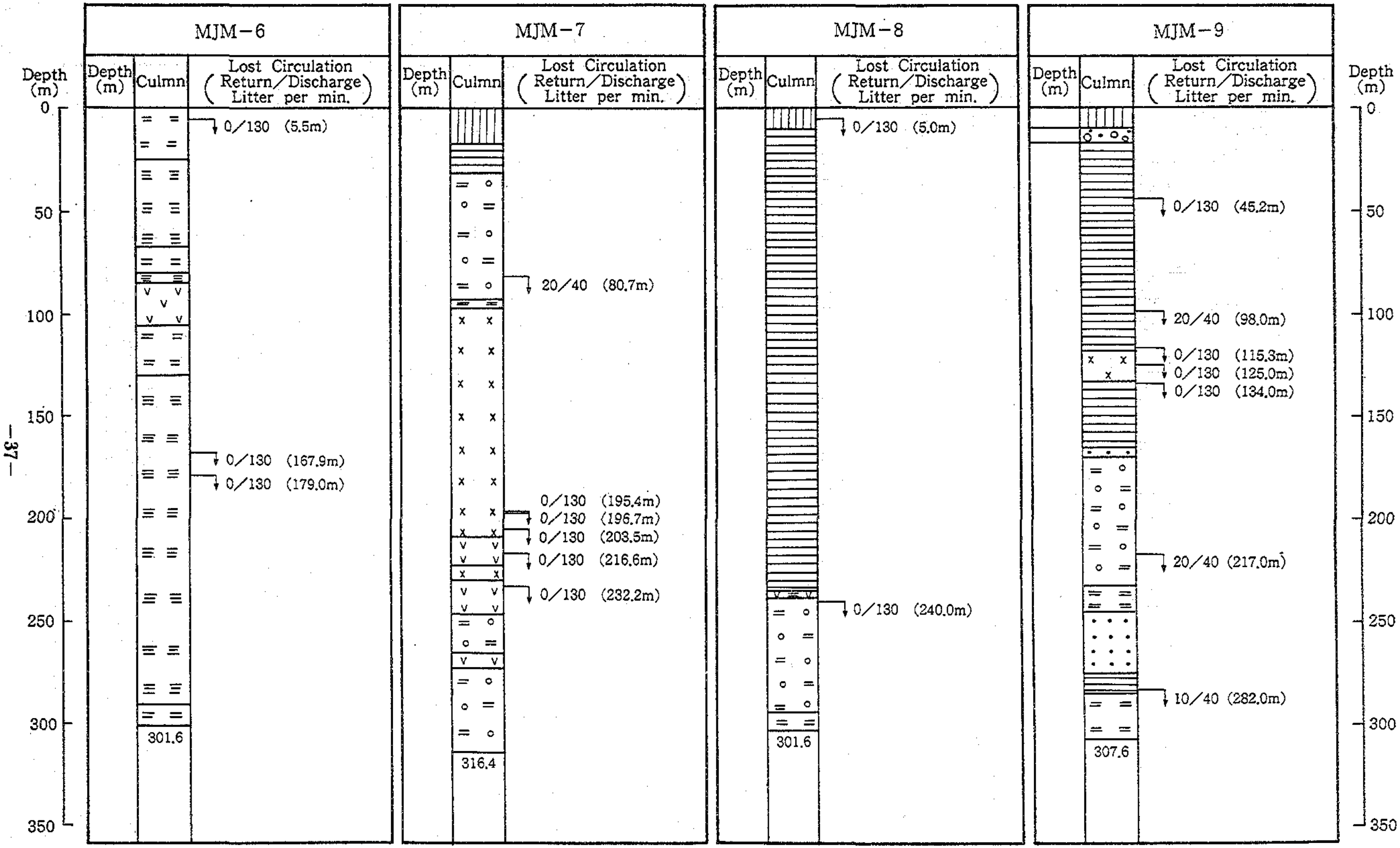

Fig. 5-10 Relation of the Geological Logs and Circulation of the Drilling Water (1)

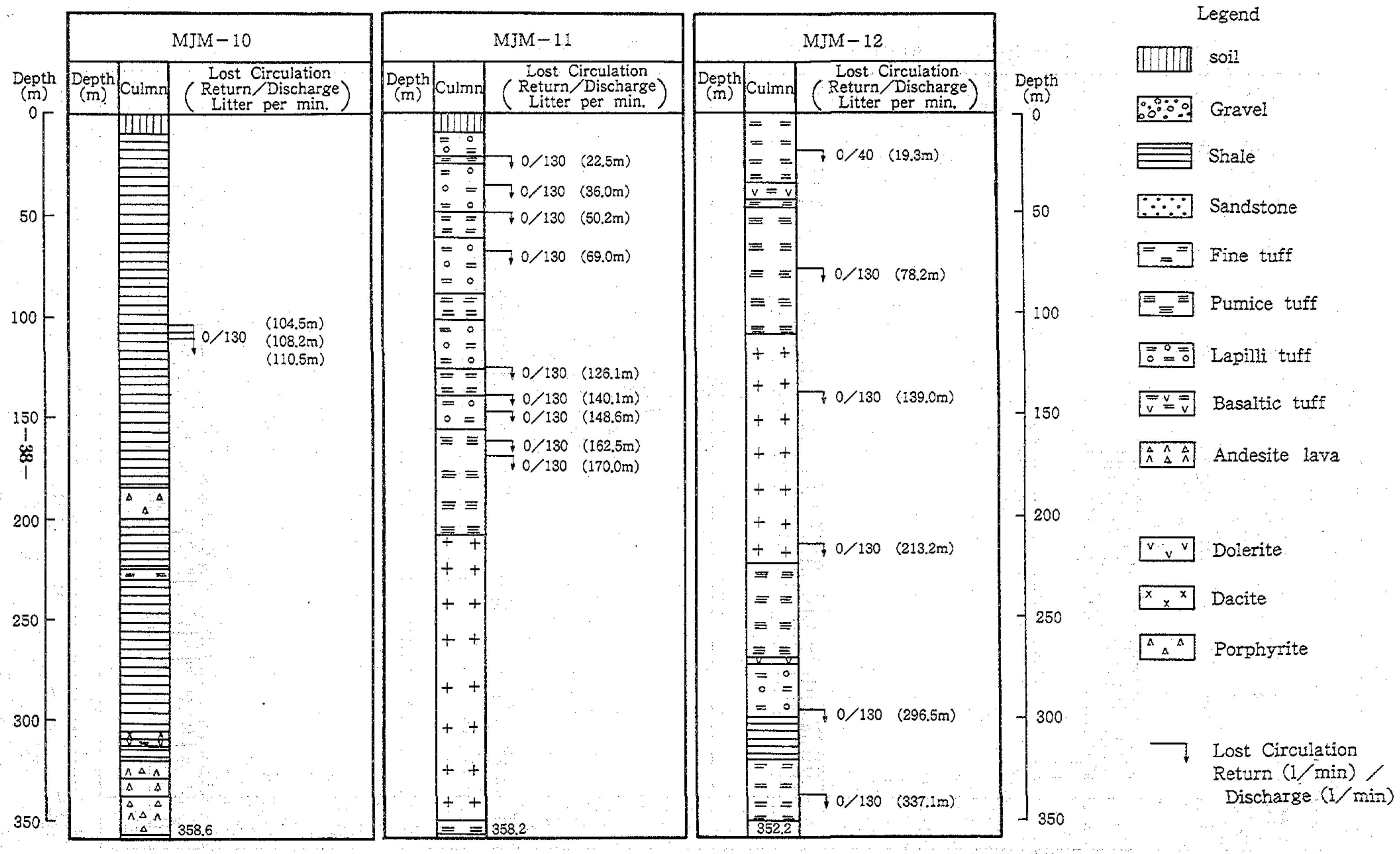

Fig. 5-10 Relation of the Geological Logs and Circulation of the Drilling Water (2)

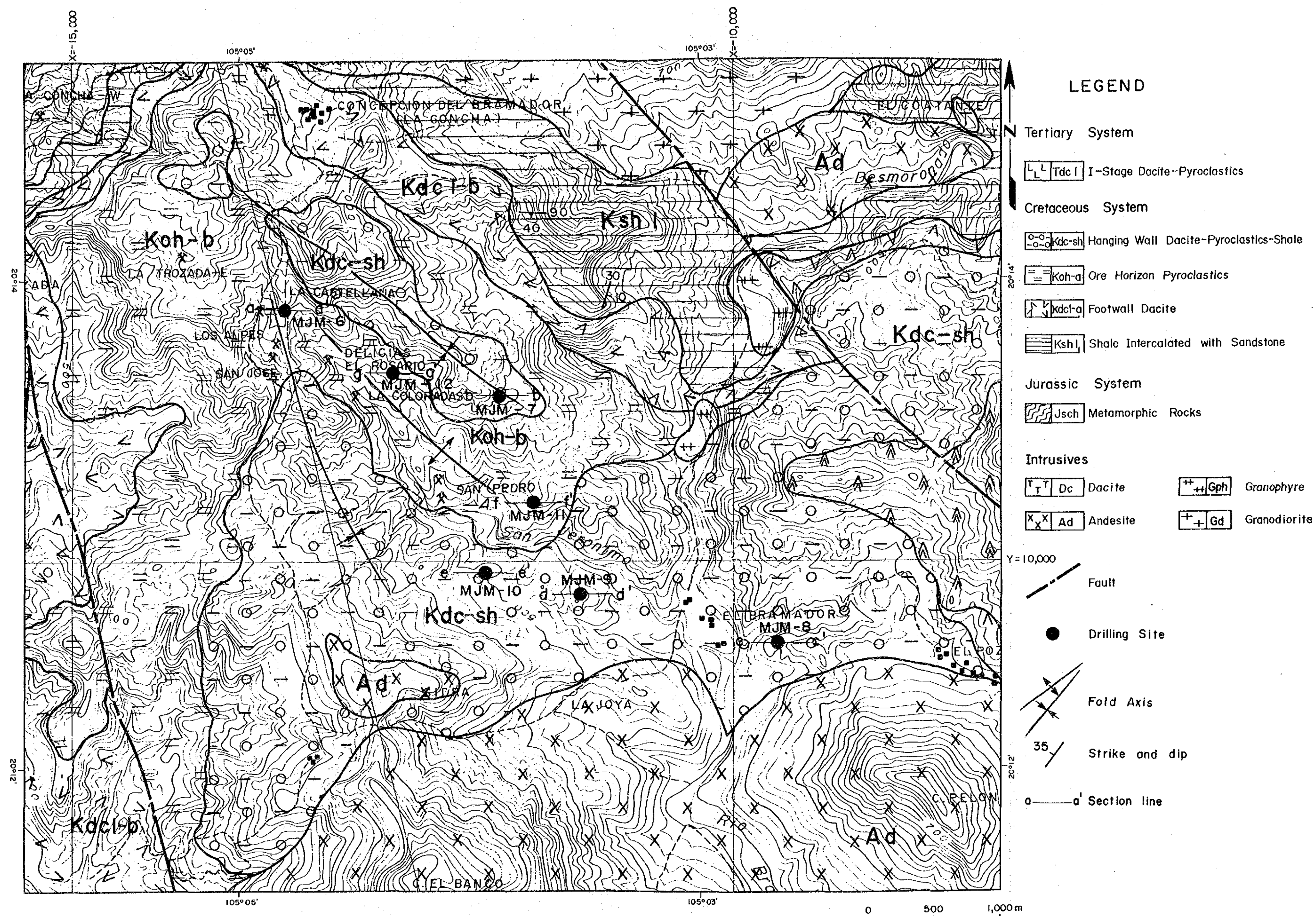

Fig. 5-11 Geological Map around Drilling Sites

deposits are characterized by the multi-element indication, the rating of this site is a little low. However, in the classification by alteration, it belongs to the zone of quartz - (K-feldspar) - sericite - (chlorite), subjected to strong hydrothermal alteration.

In addition, the CSAMT survey results reveal that a medium resistivity zone is distributed upto 100 m depth from the surface and a thick low resistivity zone (100 Ω·m) develops beneath. It is noticeable that this corresponds geologically with the ore horizon and anticipated distribution of footwall dacite. However, the lateral extension of the low resistivity zone does not appear to be so wide.

(3) MJM-8

This site is stratigraphically located in the hanging wall dacite·pyroclastic rock - shale alternation (K dc-sh), but there is a clear tendency of volcanic rock decreasing in quantity in this area compared with the holes MJM-6 and MJM-7 which are located in the northwest. However, this site is situated at the extension of the strike of Kuroko type deposits distributed along the San Jeronimo dale with gossan and argillization observed in the neighborhood.

Although this site is not included in the geochemical anomaly zones, detailed analysis of the geochemical survey results in this area indicates semi-anomaly by Ag-Zn. Furthermore, this site is involved in the altered zone with kaolin formation of different type from Kuroko type alteration. According to the CSAMT survey results, this site can be rated as the first-class low resistivity zone in terms of both resistivity and scale. However, since this low resistivity zone develops from the surface, it is considered from stratigraphical viewpoint that the upper portion of the low resistivity zone is not traceable to any Kuroko type deposit.

(4) MJM-9

This site is also located in the hanging wall dacite·pyroclastic rock-shale alternation (K dc-sh). At this site, acidic volcanic rocks develop predominantly and also the development of ore horizon from the Santa Edwiges and Valenciana deposits can be expected. Moreover, this area is in the geochemical anomaly zone indicated by the multi-elements of Ag-Cu-Pb-Zn.

The alteration survey results suggest that this is the area subjected to strong hydrothermal alteration, belonging to the quartz - (K-feldspar) - sericite - (chlorite) zone.

According to the CSAMT survey results, the resistivity structure at this site is three-layered and the second layer's low resistivity zone in particular corresponds with the ore horizon in geological structure, with the resistivity suggesting the possibility of existence of a highly sulphide disseminated zone or a combination of the disseminated zone and massive sulphide deposit.

(5) MJM-10

This hole was drilled at 750 m west-northwest of MJM-9 to explore the extension of Kuroko ore and the gold mineralized zone encountered by the drilling at MJM-9. This point is included geologically in the hanging wall dacite·pyroclastic rock - shale alternation (K dc-sh). This site is situated in a geochemical anomaly zone indicated by the single element of Pb. The alteration survey results suggest that this is the area subjected to strong hydrothermal alteration, belonging to the quartz - (K-feldspar) - sericite - (chlorite) zone, but the CSAMT survey did not locate any special low or medium resistivity zone in and around this point.

(6) MJM-11

This hole situated at 800 m northwest of MJM-9, was drilled also to ascertain the extension of Kuroko ore and the gold mineralized zone found by the drilling at MJM-9. This point is geologically included in the area of ore horizon pyroclastic rocks (K oh-b) and is also situated in a geochemical anomaly zone indicated by the single element of Pb as in the case of MJM-10. Neither alteration survey nor CSAMT survey gave any promising results at this point. This hole was also aimed at ascertaining the southern extension of the silver mineralization found by the drilling at MJM-7.

(7) MJM-12

This hole was drilled to ascertain the southeastern and west-northwestern extension of the silver mineralization located by the drilling at MJM-6 and MJM-7 and also to explore the massive Kuroko type deposit expected to occur at the central part of the paleo-basin (a promising place for the formation of Kuroko type deposit) based on the results of drilling of the other two holes. Although this point is the area of ore horizon pyroclastic rocks (K oh-b), no promising indications were available from the geochemical, alteration and CSAMT surveys. However, this site is surrounded by the highly altered zone of quartz - (K-feldspar) - sericite - (chlorite) and also by the zone of geochemical anomaly indicated by multi-elements of Ag-Cu-Pb-Zn.

5-4-2 Outline of Geology for Each Hole

(1) MJM-6

This hole is composed primarily of the Cretaceous volcanic rocks (pyroclastic rocks in particular) with some sedimentary rocks observed only locally. From the surface to the depth of 81.60 m are fine tuff, pumice tuff containing mud-balls (26.10 m ~ 66.10 m), shale, etc. Dolerite (sheet) is observed between the depth of 81.60 m and 107.30 m followed by pumice tuff underneath (down to 301.66 m).

The ore horizon (in a narrow sense) is considered to start from right below dolerite. Starting from this vicinity, dissemination of fine pyrite peculiar to *Kuroko type mineralization is observed all over the pumice tuff zone.* As regards alteration, medium degree of silicification is macroscopically more dominant than sericitization and chloritization.

In this hole, lapilli tuff of ore horizon (in a narrow sense) emerges starting from the depth of 107.30 m and the dissemination of fine pyrites peculiar to Kuroko type mineralization is noticed over the length of more than 170 m from the depth of about 110 m to around 280 m. The scale of dissemination is extraordinary, suggesting occurrence of a massive Kuroko type deposit in the neighborhood of this hole. Although lava or coarse grained pyroclastic rocks noticeable at the

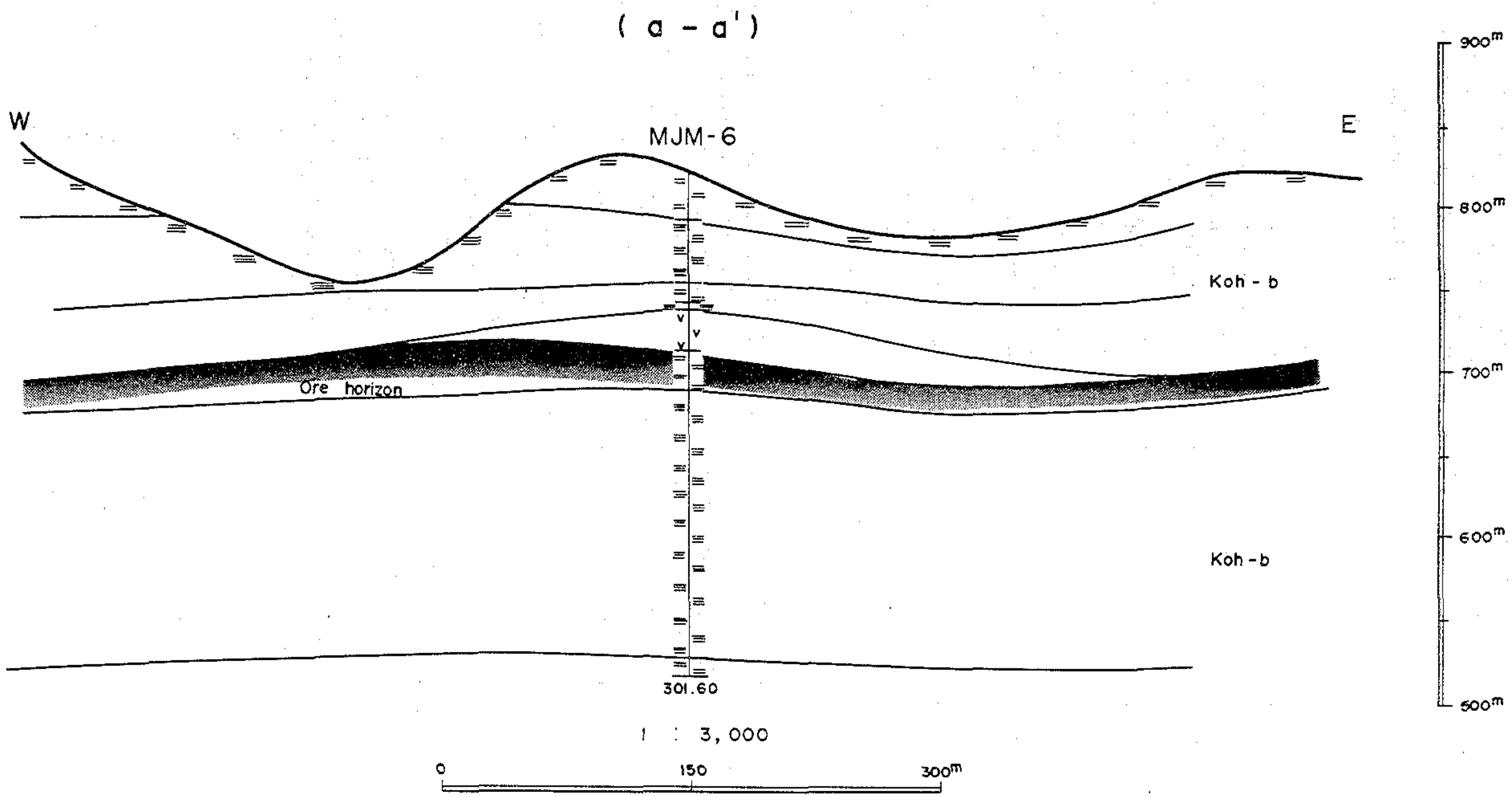

Fig. 5-12 Geological Section of Drilling (MJM-6)

volcanic eruptive center are not found in this hole, suggesting some distance from the eruptive center, the distance from the eruptive center of hydrothermal ore solution is presumed to be not so long in view of the above-mentioned conditions.

Therefore, this hole's drilling results are very important for selection of the locations of future drill holes.

(2) MJM-7

The upper portion of this hole consists of black shale with intercalation of thin layered fine tuff, lapilli tuff (27.00 m ~ 85.00 m) and fine tuff. Between the depths of 94.00 m and 208.20 m is light green, compact and hard dacite (intrusive), which is underlaid with two sheets of intrusive dolerite. The ore horizon (in a narrow sense) is presumed to start from lapilli tuff (246.50 m) underlying the dolerite. In the lapilli tuff, silicification, sericitization and chloritization are visible in addition to the dissemination of fine pyrite.

This hole, although the scale of disseminated zone is appearantly smaller than that of MJM-6, can be rated as high as for MJM-6 in view of the geological conditions, e.g., strong alteration and dissemination and also intrusion of dolerite is noticeable at places.

Although the massive Kuroko type deposit was not encountered, a part of the disseminated zone developed underneath the deposit is considered to have been located by this drill hole. Therefore, the occurrence of a massive Kuroko type deposit is not so distant from this hole.

(3) MJM-8

This hole consists of shale and sandstone alternation from the surface to the depth of 237.80 m. Shale is generally dominant in its ratio to sandstone and the proportion of sandstone become larger a little in the lower portion. Noticeable between the depths of 237.80 m and 240 50 m is dark green, fine grained basaltic tuff, and the ore horizon (in a narrow sense) starts from the underlying lapilli tuff. This lapilli tuff is partly associated with weak dissemination of fine pyrite, but the degree of dissemination is much inferior to that of the foregoing two holes.

Moreover, a disseminated zone of pyrite and pyrrhotite was found in the shale and sandstone alternation between the depths of 31.50 m and 145.00 m.

Unlike the foregoing two holes, the continuity of lapilli tuff forming the ore horizon (in a narrow sense) is observable, but the Kuroko type mineralization becomes weak. However, the existence of basaltic tuff overlying the ore horizon suggests the past existence of a paleo-basin in this vicinity that is one of favourable environment for the formation of the Kuroko type deposit. It is considered, however, that this hole is located relatively farther from the eruptive center of hydrothermal ore solution compared with the foregoing two holes or that the mineralization itself was weak in this area.

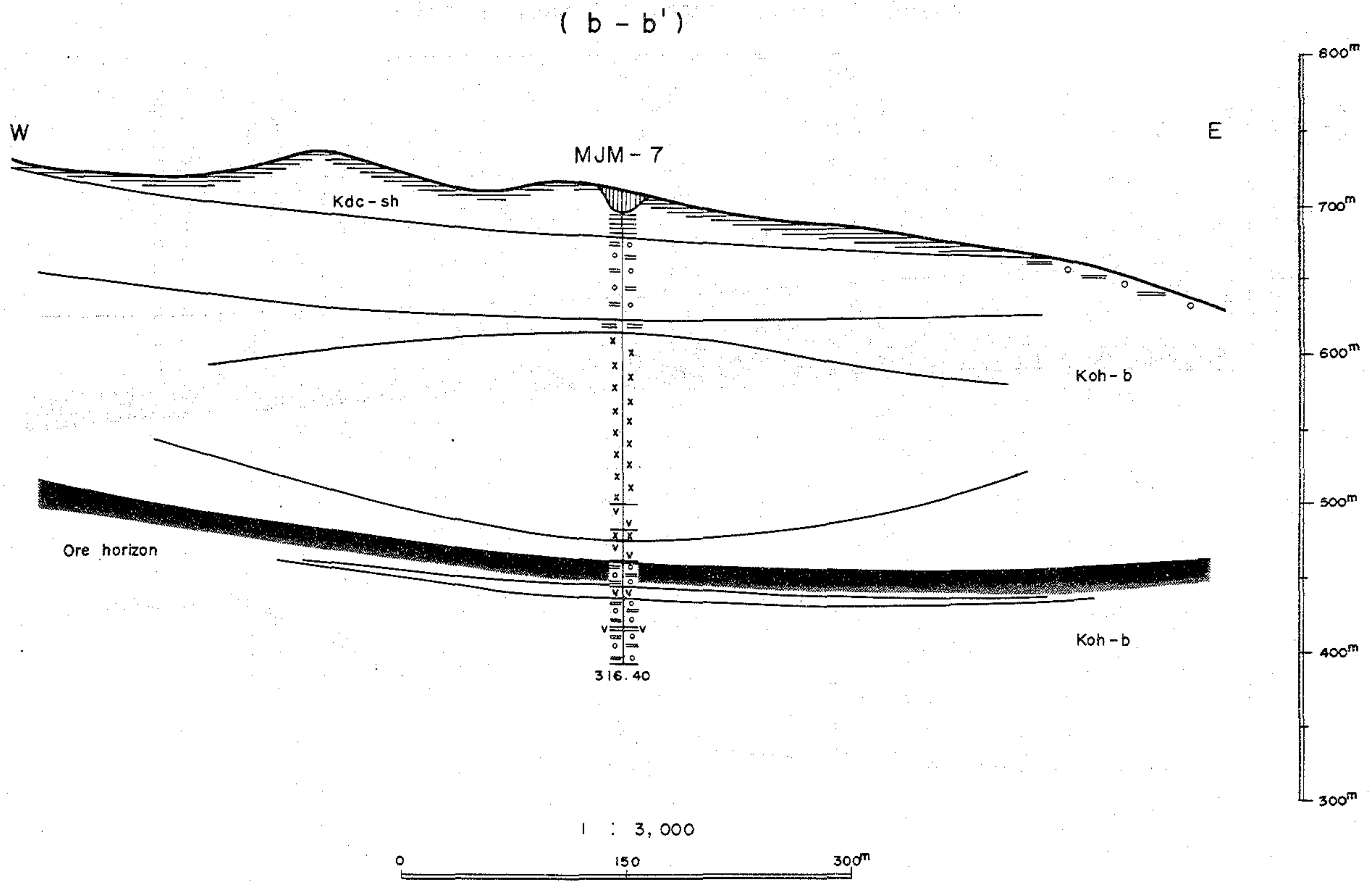

Fig. 5-13 Geological Section of Drilling (MJM-7)

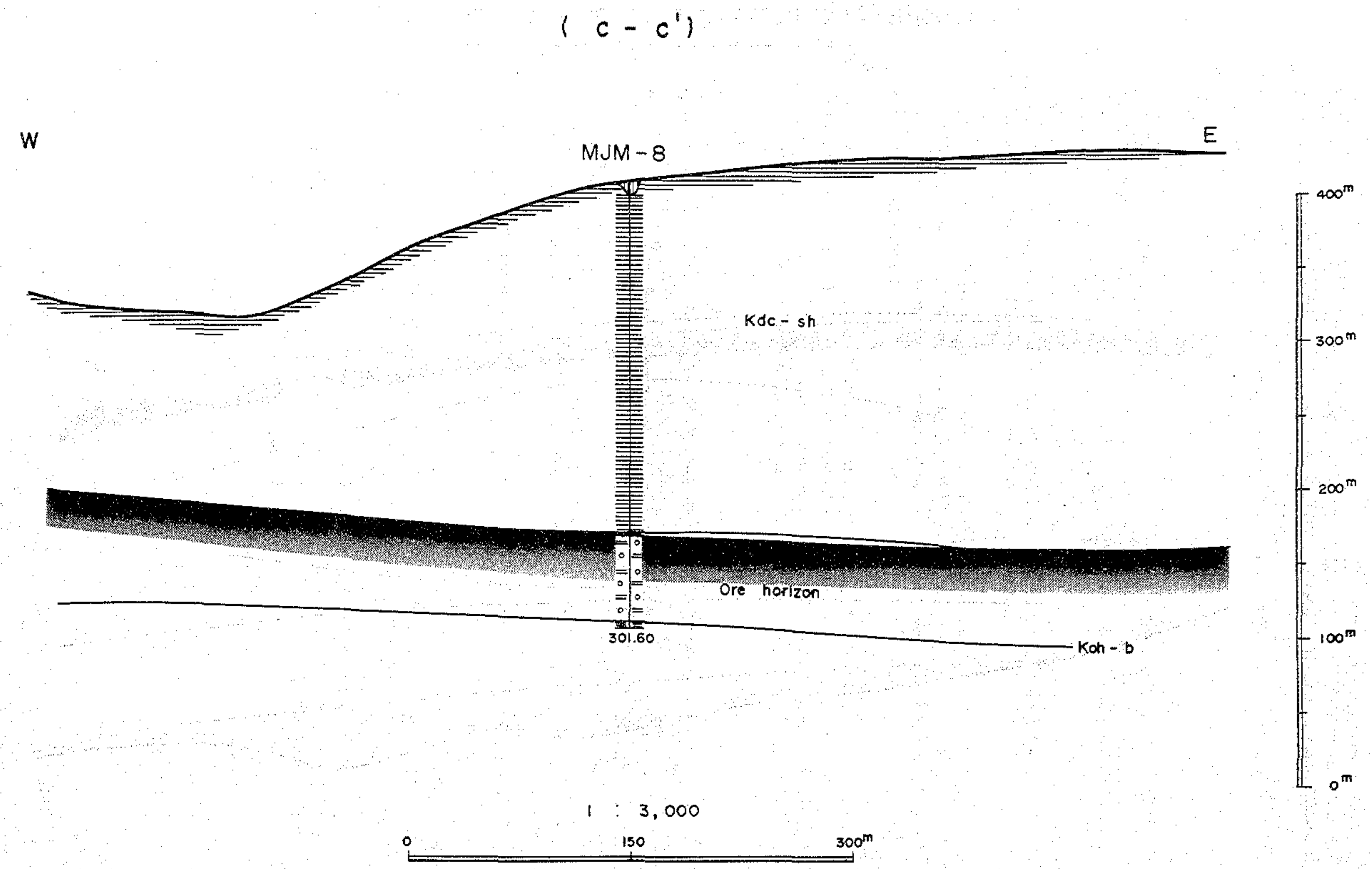

Fig. 5-14 Geological Section of Drilling (MJM-8)

(4) MJM-9

This hole shows a great geological difference between the upper and lower portions; that is, the upper portion to the depth of about 170 m is composed of black shale with intercalation of sandstone while the lower portion consists primarily of lapilli tuff and fine tuff.

The ore horizon starts from the depth of 281. 77 m, just below the black shale containing carbon matter, and strong dissemination of fine pyrite generally associated with the Kuroko type mineralization is observable in fine tuff. This dissemination continues down to the bottom of the hole (307. 60 m deep) with the tendency of mineralization getting stronger in the upper portion and weaker in the lower portion. The strongly disseminated portion assume a dark grey color.

Furthermore, dense black ore consisting of fine sulphides with thickness of 15 cm was encountered at the depth of 293.45 m.

In this hole, black shale containing carbon matter suggests the existence of a paleo-basin that is one of the elements required for occurrence of the Kuroko type deposit, evidencing that this area was forming a suitable environment for precipitation of sulphides from hydrothermal ore solution on the sea botton. The strong dissemination of fine pyrite suggests relative proximity of this point to the eruptive center of ore solution on the sea botton, and the same conclusion is also derived from the degree of alteration noticed in this hole. The discovery of black ore in this hole means confirmation of a part of massive Kuroko type deposit occurring in the vicinity of this hole and expections are placed on the results of future follow up survey.

The tendency of gold and silver concentrating in the upper portion of ore horizon is one of the characteristics of mineralization in the open system of the sea bottom.

(5) MJM-10

This hole consists mainly of sedimentary rocks. Therefore, its geological features are substantially different from those of holes MJM-6, MJM-7, MJM-11 and MJM-12, indicating differences in geological environment. In this hole, black shale includes acidic fine tuff between the depths of 32.30 m ~ 37.30 m and 228.70 m ~ 235.30 m. Also, basaltic tuff exists between the depths of 312.00 m ~ 314.20 m, which is considered to correspond with the basaltic group in the hanging wall of ore horizon generally noticed in the survey area.

Between the depths of 324.80 m ~ 358. 60 m (the bottom of the hole) is andesite lava with weak brecciated structure, in which coarse grained portions exist partly and porphyrite is noticed microscopically in these portions. The andesite lava is considered as the product of volcanic activity which took place in advance of bimodal volcanism related to the formation of Kuroko type deposits existing in the survey area, and it may represent the first product of the Cretaceous volcanism in this area.

In addition to the above, dacite and porphyrite sheet are noticed between the depths of 188.60 m ~ 201.00 m and 306.60 m ~ 312.00 m, respectively.

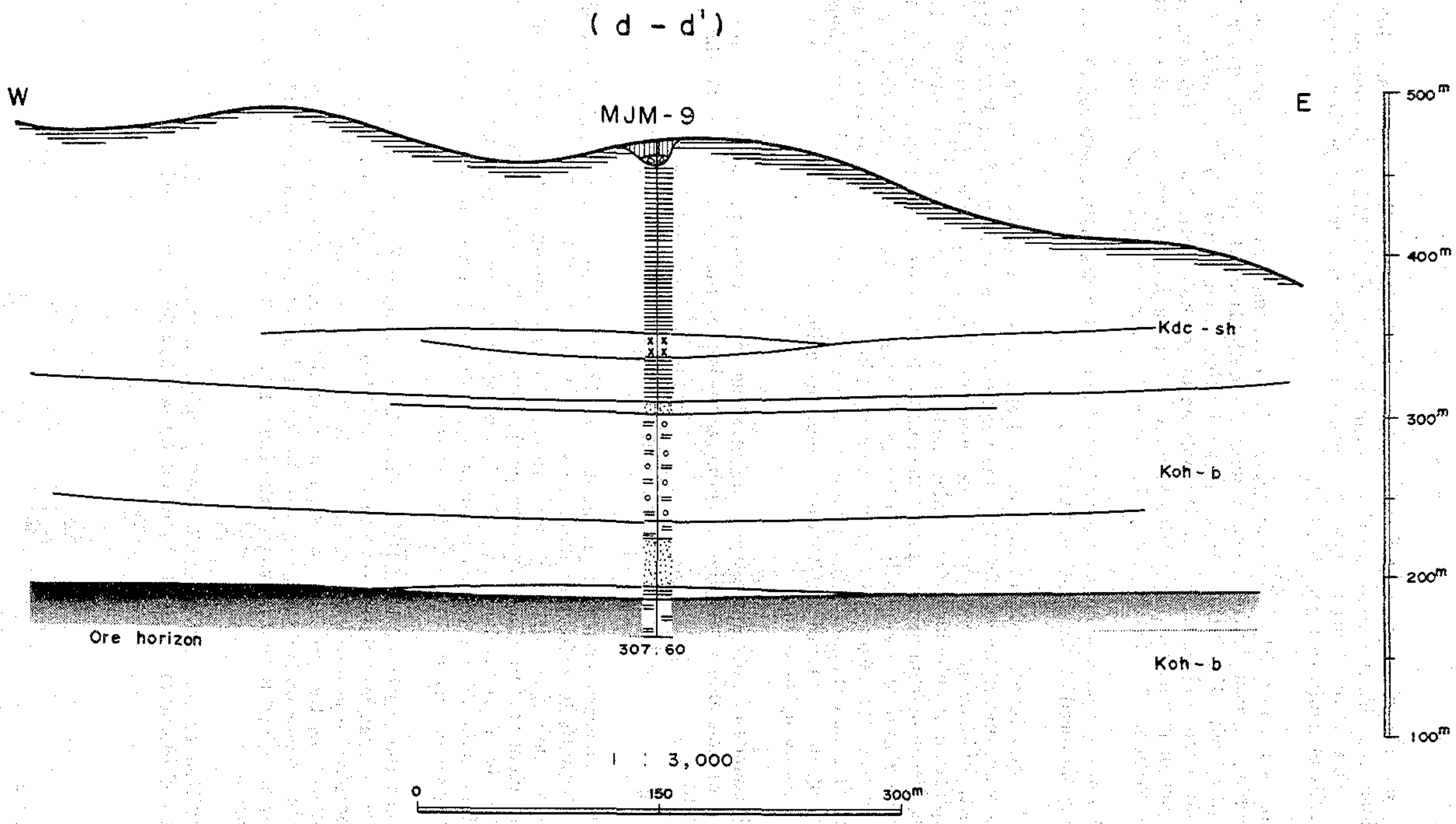

Fig. 5-15 Geological Section of Drilling (MJM-9)

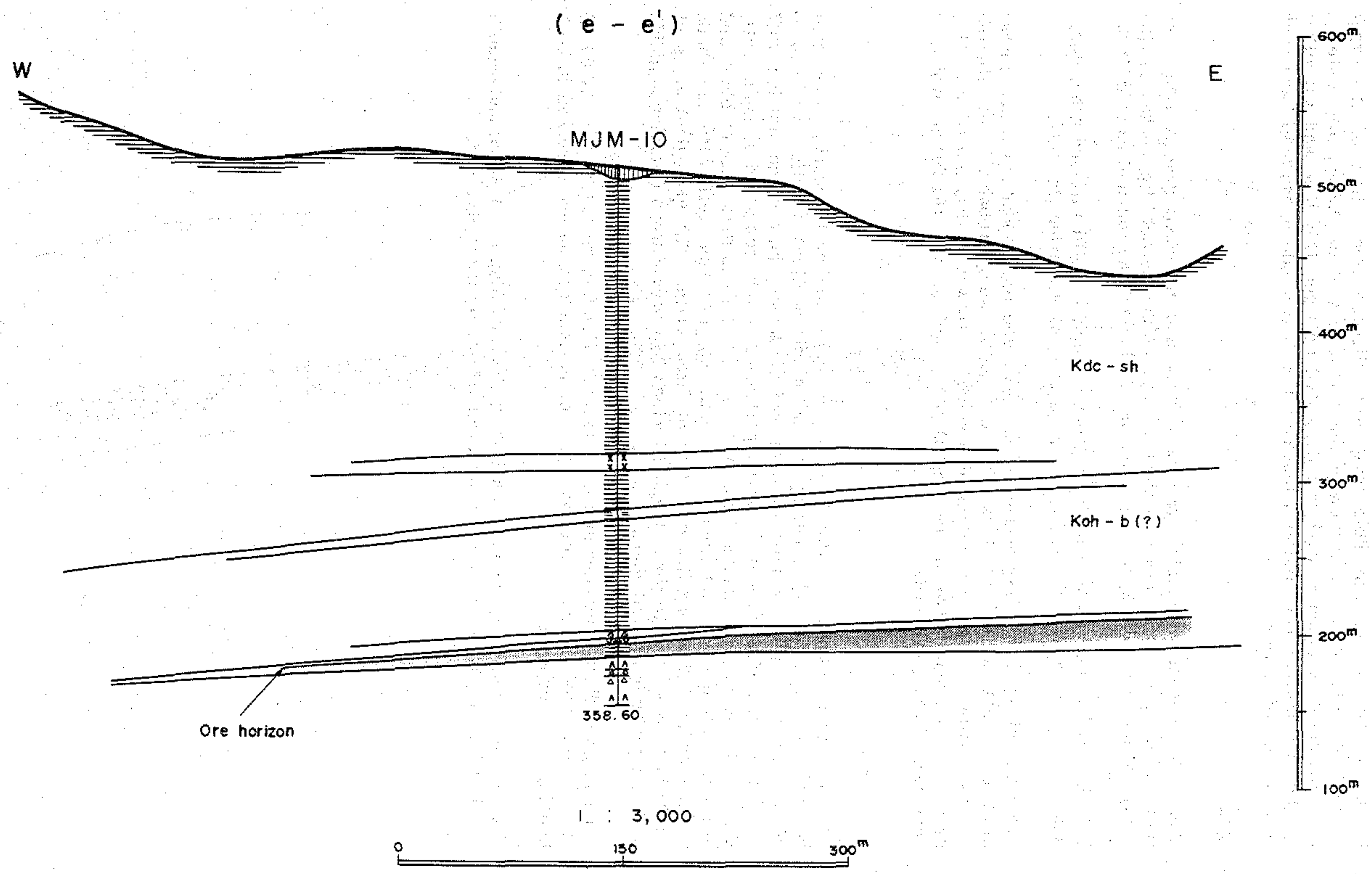

Fig. 5-16 Geological Section of Drilling (MJM-10)

Since the geology of this hole is greatly different from that of the other neighboring holes, and also in view of the results of surface survey, the existence of a northwest-southeast fault is anticipated between this hole and the other neighboring holes. The southern block of this hole's side appears to have sunk several tens of meters.

(6) MJM-11

This hole consists of acidic pyroclastic rock and intrusive granodiorite. No sedimentary rock is observed. Most of the acidic pyroclastic rocks are the continuation from MJM-6, forming the same geological environment as in MJM-6.

Principal component rocks are bluish green, compact lapilli tuff and grey, dense and hard pumice tuff, with the former frequently intercalating fine tuff.

From the viewpoint of exploration of Kuroko type ore deposits, neither coarse grained pyroclastic rock nor lava are found in this hole, probably being situated far away from the eruptive center of a volcano. However, dissemination of fine pyrite is observed between the depths of 129.60 m and 161.20 m, which is considered to be a ore horizon.

(7) MJM-12

The geological features of this hole are basically similar to nearby other drill holes (MJM-6 and MJM-7). The upper and middle portions (depth: 49.40 m ~ 265.50 m) are mainly composed of massive, dense, dark green pumice tuff continuing from MJM-6, and the lower portion is mainly composed of lapilli tuff, shale and fine tuff continuing from MJM-7. The shale is dark gray or black and has been silicified. Underneath the shale is gray fine tuff with mud-balls accompanying the strong dissemination of fine pyrite. The geological mode of occurrence is similar to that of MJM-9 which captures Kuroko (massive sulphide ore) and gold mineralized zones.

Massive granodiorite intrudes into the middle portion (depth: 111.30 m ~ 220.00 m) of this hole, but no significant indication of metamorphism are observed in both hanging and foot walls.

The Kuroko ore horizon seems to start at pumice tuff (depth: 49.40 m) underneath basaltic tuff, below which the dissemination of fine pyrite is observed.

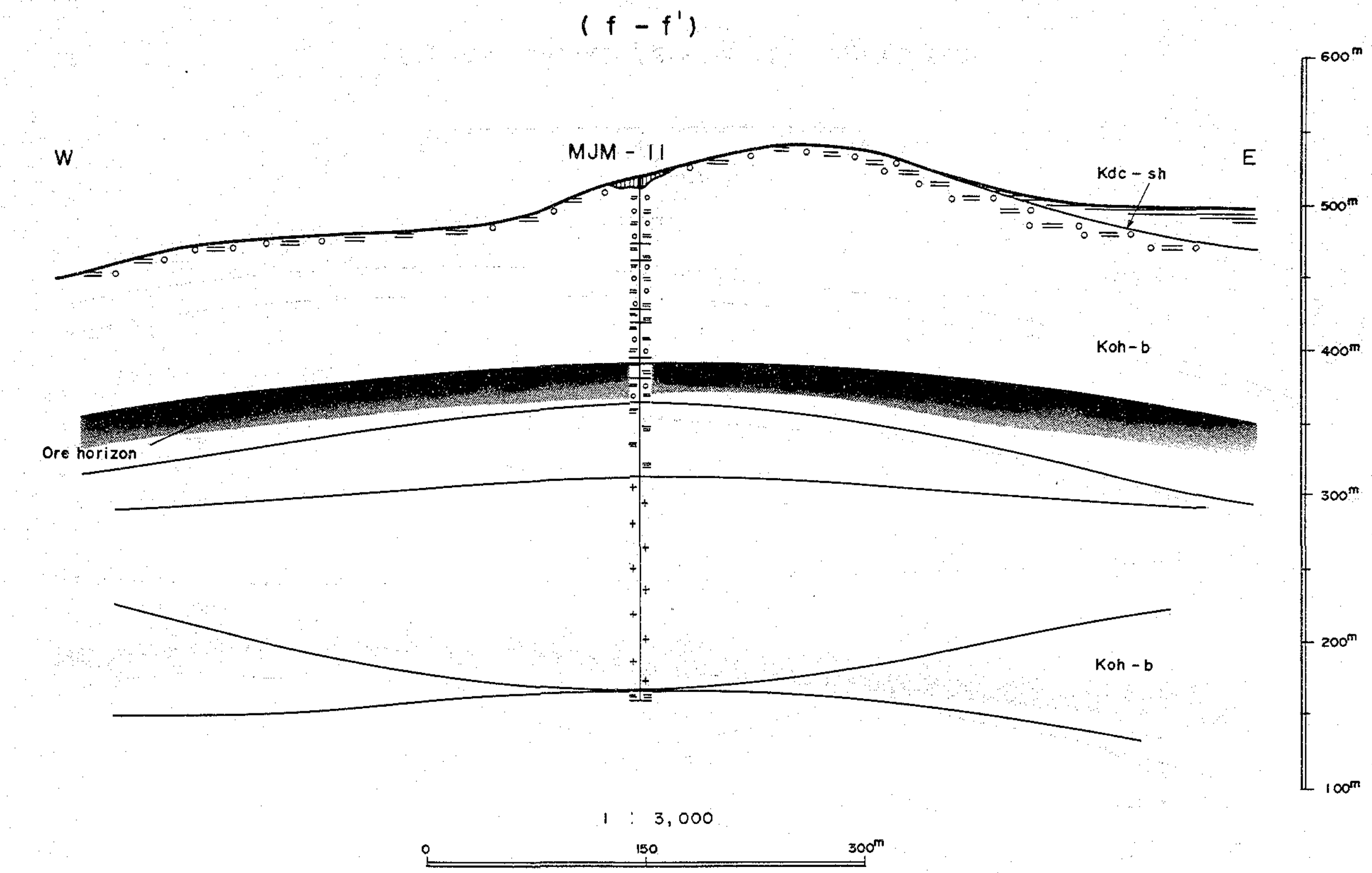

Fig. 5-17 Geological Section of Drilling (MJM-11)

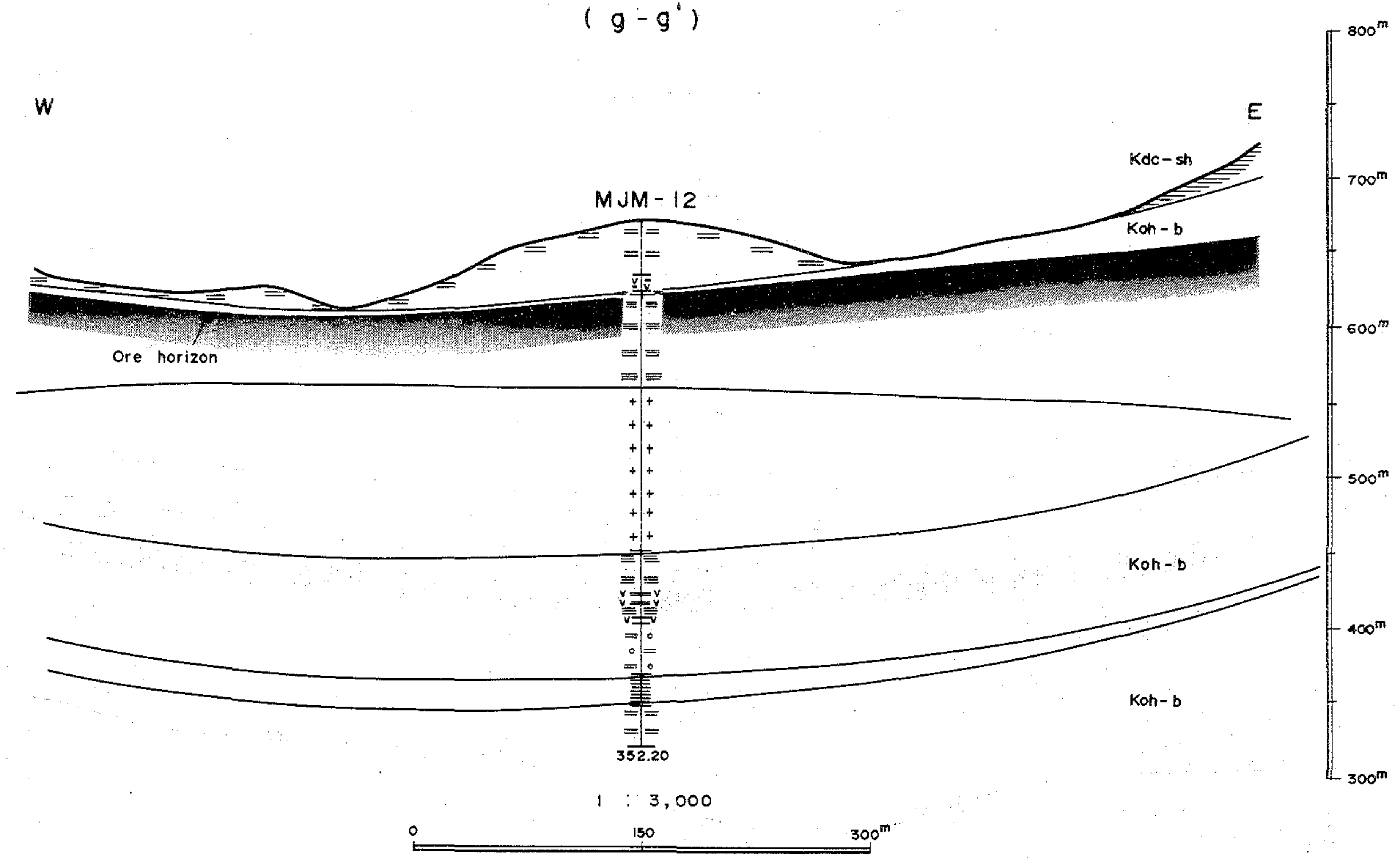

Fig. 5-18 Geological Section of Drilling (MJM-12)

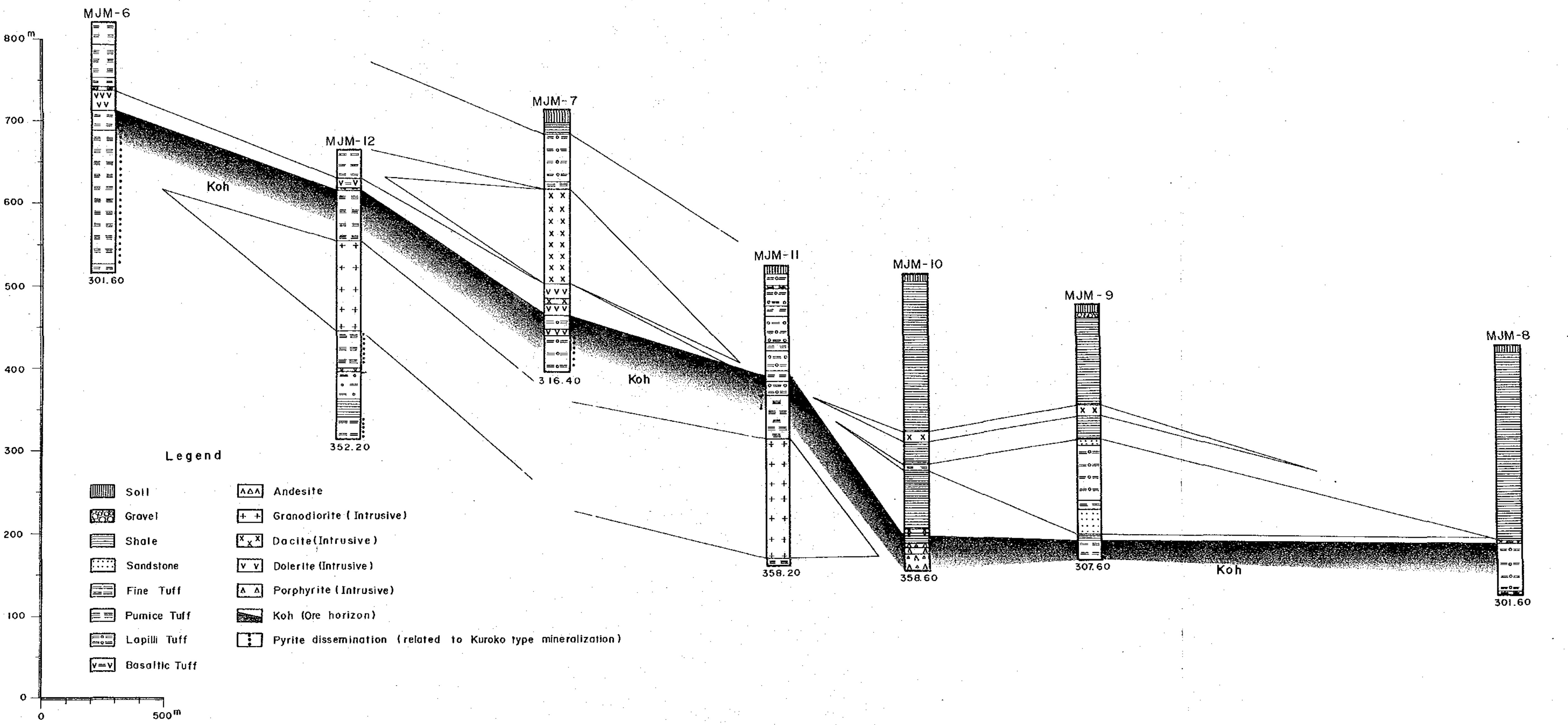

Fig. 5-19 Correlation of Geological Succession of Each Hole