REPUBLIC OF PERU

REPORT ON GEOLOGICAL SURVEY

OF

ISCAYCRUZ (OYON) AREA

PHASE I

SEPTEMBER 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Peru, decided to conduct collaborative mineral exploration, that is drilling and tunnelling surveys, in the Iscaycruz (Oyon) area and entrusted its execution to Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ).

Between 12 July, 1982 and 1 July, 1983, Metal Mining Agency of Japan dispatched a survey team headed by Mr. Jinichi Nakamura to conduct the Phase I of the project.

The survey had been accomplished under close cooperation with the Government of the Republic of Peru and its various authorities.

This report is a compilation of the survey of the Phase I, and after the completion of the project the consolidated report will be submitted to the Government of the Republic of Peru.

We wish to express our appreciation to all of the organizations and members who bore the responsibility for the project, the Government of the Republic of Peru, Instituto Geologico, Minero y Metalurgico, and other authorities and the Embassy of Japan in Peru.

July 1983

Keisuke Arita
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan

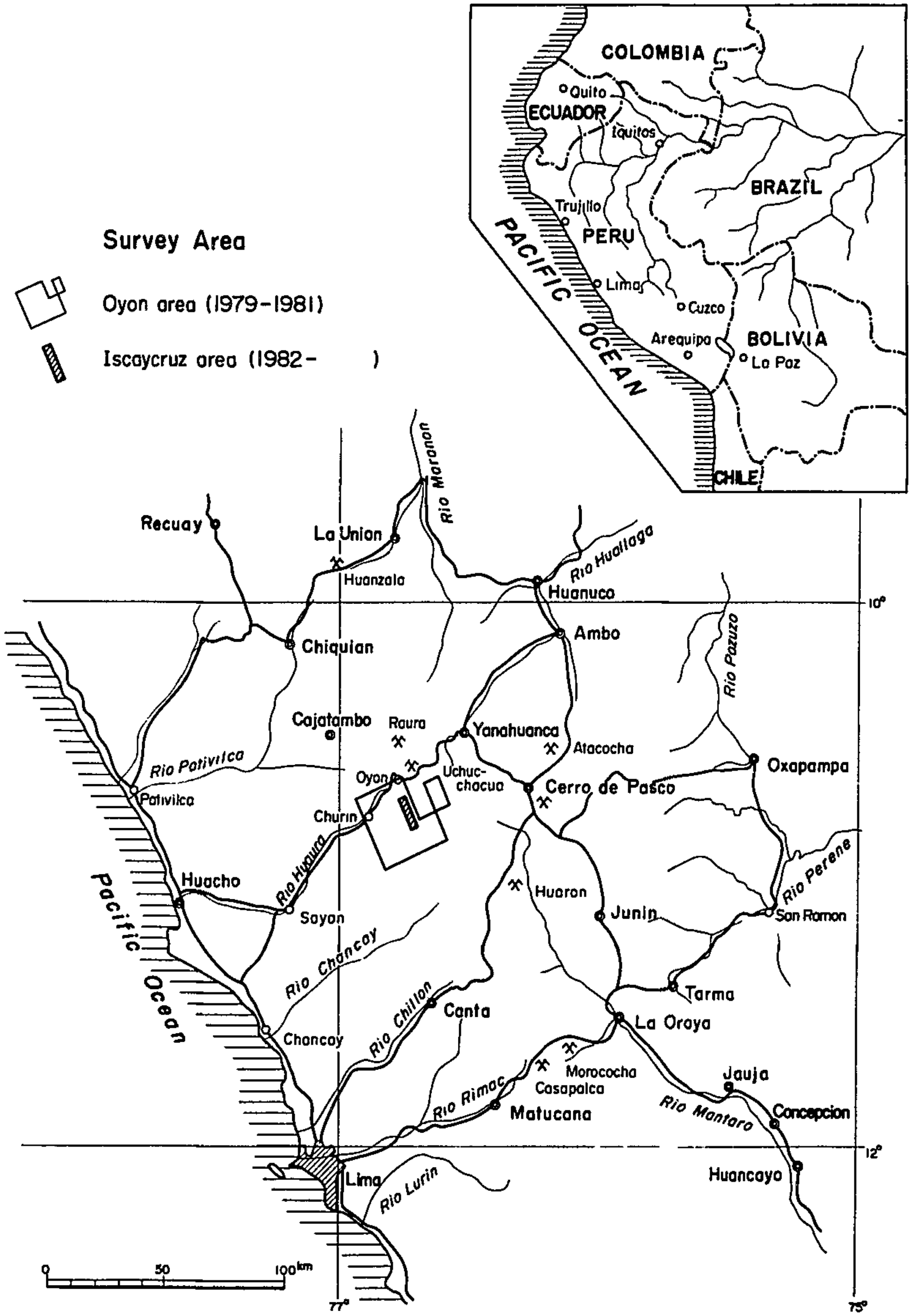


Fig. 1 Index Map

ABSTRACT

This report summarizes results of the first year's work of the Cooperative Basic Geological Survey for Development of Mineral Resources carried out in the Iscaycruz Area, the Republic of Peru.

The purpose of this project is to examine relationship between geological structure and mineralization, and to confirm lateral and vertical continuity of the mineralized zone, by means of drilling exploration and tunnelling exploration in this area.

The Iscaycruz Area had been extracted as a favorable area where economic ore deposits would be expected to be emplaced, by the results of the Cooperative Basic Geological Survey for Development of Mineral Resources in the Oyon Area, which was carreied out during the period of three years from 1979 to 1981.

The Iscaycruz Area is located about 150 km north of Lima, in the backbone range of the West Andes. Geologically, Mesozoic sedimentary rocks are widely distributed in this area, forming remarkable compose folded structure due to tight folding with the axes in the Andean direction, namely NNW-SSE.

The Iscaycruz mineralized zone is located approximately 7 to 19 km south-southeast of Oyon, in the high mountain at the altitude of 4,700 m above sea level. The mineralization occurs in the limestones of the Santa Formation, about 40 to 80 meters in thickness, and continues about 12 km along the strike. In this mineralized zone there are two types of ore deposits; the one is contact metasomatic skarn type ore deposits represented by copper-zinc skarn orebodies and the other is hydrothermal replacement ore deposits represented by copper-lead-zinc massive sulphide orebodies as well as by disseminated orebodies of lead and zinc in the siderite beds.

In this year's program in the Limpe area, where high grade copper-lead-zinc ore deposits would have been expected, diamond drilling of five holes was performed at five localities, the total length of which was 1,300 m, while the tunnelling exploration was carried out at two localities in different two levels, whose total excavated length was 580 m.

By the results of the diamond drilling, the existence of high grade copper ores accompanied by pyrite mass and lead-zinc orebodies have been confirmed in the drill hole IC-2, which is located near Cumbre de Limpe. The copper ores are recognized in two parts of total core length of 24.8 m with the average grades of Ag: 43 g/t and Cu: 4.38 %, while the lead-zinc ores are found in four parts of total core length of 53.3 m with the average grades of Ag: 23 g/t, Pb: 2.81 % and Zn: 15.07 %. By the diamond drillings located to the south of Cumbre de Limpe, it has been confirmed that pyrite and hematite are predominant as ore minerals in this area, partly with heavy concentration of copper minerals in this area.

As for the tunnelling exploration, two tunnels which were worked in this year of the program have not reached the mineralized zone in the Santa Formation. Both of the tunnels, Adit-N (elevation: 4,690 m) and Adit-S (elevation: 4,570 m), were excavated in the quartzite beds in the Chimu Formation.

For future program of the investigation in the Limpe area where the most favorable indications of mineralization warranting further exploration have been confirmed, it is recommended to keep proceeding the exploration by tunnelling and to carry out underground diamond drilling, with the purpose to make clear the details of the figures and the conditions of the mineralized zone geologically, as well as to undertake full examination of the features of the mineralized zone in the deeper part.

INTEGRATED CONTENTS

GENERAL REMARKS

GENERAL REMARKS

CONTENTS

LIST OF FIGURES

LIST OF PLATES

Chapter 1 Introduction

1-1 Purpose of the Survey

The purpose of this survey is, in addition to the comprehension of the geological structure in relation to the mineralization in this Iscaycruz Area, to confirm lateral and vertical continuity of the mineralized zone, by means of drilling and tunnelling explorations and the analysis of the related geology.

The survey works have been completed with the cooperation of the Instituto Geologico, Minero y Metalurgico (INGEMMET).

1-2 Circumstances of the Survey

Cooperative Basic Geological Survey for the Development of the Mineral Resources was carried out for three years from 1979 to 1981 in the Oyon Area (area = 860 km2) including the Iscaycruz Area (approximate area = 40 km2). In addition to geological mapping, geochemical survey and detailed geological survey, the following investigations were carried out in the Iscaycruz Area; geophysical prospecting by IP method (15 survey lines, total length 35.9 km); geophysical prospecting by EM method (10 survey lines, total length 13.0 km); diamond drilling (12 holes at 11 sites, total length of the holes 2,654 m).

By the results of these investigations, it was confirmed that the high grade copper-lead-zinc sulphide ore deposits and skarn ore deposits were emplaced in this Iscaycruz Area and also it was proved that high potentiality of the mineralization would be expected in this area for the development of mineral resources.

On the basis of the above results obtained through the Cooperative Basic Geological Survey in this Oyon Area, more detailed investigations by drilling and tunnelling explorations were recommended in Limpe area and in Tinyag area, where the most high grade lead-zinc ore deposits in the Iscaycruz Area were expected.

The Cooperative Basic Geological Survey for the Development of Mineral Resources in the Iscaycruz Area is scheduled to be carried out in three years' program starting in this year (1982) on the basis of the Scope of Work signatured on May 11, 1982 between the Instituto Geologico, Minero y Metalurgico and the Metal Mining Agency of Japan.

1-3 Outline of the Survey

1) Drilling Exploration

For the analysis of the relation of the geological structure to the mineralization in Limpe area in the Iscaycruz Area, diamond drilling of 4 holes, total hole length of 854 meters, was completed in 1980 and 1981, in the narrow zone of the approximate distance of 750 meters from north to south (refer to Fig.6).

Indications of mineralization were recognized in all of the four holes. In this year, diamond drilling of 5 holes at 5 sites, total hole length of 1,300 meters, was carried out in the midways of the existing drill-holes and in the area south of Cumbre de Limpe.

2) Tunnelling Exploration

The purpose of the Tunnelling exploration is to confirm, along the tunnel wall passing through the orebodies, various factors as figures of orebodies, features and continuity of grade distribution and aspect of combinations of ore minerals, as well as to utilize the tunnel as the base for the underground drilling crosscutting the orebodies, which is the most effective for the confirmation of lateral and vertical continuity of the orebodies and the mineralized zone (refer to Fig.6).

As the excavation and the maintenance of the tunnels were supposed to be difficult according to the results of the diamond drilling which revealed that the walls would be soft and weak in the mineralized zone, the main tunnel was excavated in the hard rock of quartzite of the Chimu Formation, from which the crosscut tunnels into the mineralized zone and underground drill chambers will be excavated.

Total length of tunnel excavated this year is 580 m, Adit-N and Adits-S, 310 m and 280 m, respectively.

As the time for the investigation was limited, two starting points (gates of tunnel) were established for the excavation of the tunnels with the approximate distance of 1,400 meters, so that the two faces could be worked at the same time. The location and the elevation of each gate are as follows.

Adit-N : E = 310,357 N = 8809,085 4689.4 m

Adit-S : E = 310,968 N = 8807,861 4570.1 m

Before starting the excavation of the tunnels, trianglulation was carried out around the Limpe area. Therefore, new coordinate system is employed particularly in the Limpe area. There is approximate 15 meters' difference of elevation between the existing topographical map and the new coordinate system.

1-4 Organization of the Survey Team

Japan Side Planning, Negotiation, and Supervision

Toru	Miura	MMAJ*
Makoto	Ishida	MMAJ
Toshio	Koizumi	MMAJ
Zenji	Kita	MMAJ
Kazuhiko	Uematsu	MMAJ
Hideyuki	Ueda	MMAJ
Hideaki	Mukai	JICA**
Tadaaki	Ezawa	JICA
Takashi	Ono	MITI***

Peru Side Planning and Negotiation

Fracisco	Sotillo	INGEMMET[x]
Gregorio	Flores	INGEMMET
Augusto	Zelaya	INGEMMET

Japanese Survey Team

Jinichi	Nakamura	(Team Leader)	MINDECO[xx]
Nobuhiko	Yamamoto	(Leader of Drilling)	"
Yuji	Katabe	(Drilling)	"
Tetsuo	Yoshida	"	"
Saichi	Ishii	"	"
Shuji	Kurokawa	"	"
Yoriyuki	Kogami	"	"
Tetsuo	Sako	"	"
Hisashi	Shimizu	"	"
Ken	Nakamura	(Leader of Tunnelling)	"
Haruyoshi	Ide	(Tunnelling)	"
Hideo	Morishita	"	"

Peruvian Survey Team

Gregorio	Flores	(Team Leader)	INGEMMET
Cesar	Vilca	(Investigation)	"
Emilio	Rojas	"	"

Coordination in Japan

Ryoichi	Yano	(General)	MINDECO
Mutsuo	Kanbe	(Drilling)	"
Riichi	Tani	(Tunnelling)	"

Coordination in Peru

Katsumasa Tanikawa	(General)	MINDECO

* Metal Mining Agency of Japan

** Japan International Cooperation Agency

*** Ministry of International Trading and Industry

x Instituto Geologico, Minero y Metalurgico

xx Mitsui Mineral Development Engineering Co., Ltd.

Chapter 2 General Circumstances of the Surveyed Area

2-1 Location and Accessibility

The Iscaycruz Area is located about 150 km north of Lima, the capital. Running north along the Pan-American Highway from Lima, about 3 hours' drive will take to Sayan through Chancay or Huachuo. It is 137 km from Lima to Sayan. From Sayan there is a rough and bending road along the valley of Rio Huaura to Churin. It is 61 km and takes 2 hours by vehicle from Sayan to Churin. From Churin to Oyon, it is 32 km and takes a little more than 1 hour by vehicle. To reach Iscaycruz, further 2 hours' drive is necessary. From Oyon to Pampahuay, it is about 10 km and takes 30 minutes. After Pampahuay, passing over a ridge at the approximate altitude of 5,000 meters along the newly constructed transportation road, it is about 20 km, taking one hour and a half to Iscaycruz (refer to Fig.2).

2-2 Topography

The surveyed area lies in the Cordillera Occidental, a main range of the Western Andes, and is situated in the source of Rio Huaura which belongs to the drainage system of the Pacific coast, about 11 km west to the continental divide. The area forms steep mountainous topographical feature.

The sea level ranges from 2,300 m at the lowest part of the valleys to 5,300 m at the summit of the highest mountain, attaining 3,000 m in the difference. Relatively flat plane named the Puna surface is developed from 4,200 m to 4,800 m, and the difference in topography is clearly observed bounded by this plane. The glacial topography consisting of steep peaks is formed above 4,800 m and the plane shows the stage of maturity, being deeply cut by valleys below 4,200 m.

The Iscaycruz Area are located at uplands more than 4,600 m above sea level. All places above 4,800 m near the continental divide are covered by snow and glacier.

The topography and drainage system in this area relfect the geological structure: the Jumasha Formation consisting of massive limestone forms the highest peaks stretching in the NNW-SSE direction, then the Chimu Formation of quartzite forms the mountains of intermediate height, and the Carhuaz Formation composed of shale and sandstone forms lower cols. The drainage systems of NNW-SSE and ENE-WSW directions are well developed and cross to each other. The drainage system of NNW-SSE reflects the folding structure, distribution trend of the formations and thrust faults developing in parallel with the folding axes, while that of NNE-SSW reflects the fracture system.

2-3 Climate and Vegetation

1) Climate

The climate in the highland is so-called Andean highland climate. The temperature variation within a day is conspicuous. It rises over 20°C in the daytime and falls below 0°C at night.

The climate during a year is controlled by the seasonal wind from the Amazon side and is devided into two seasons, that are the dry season from May to September and the rainy season from October to April. In the rainy season rainfall, which turns to snowfall above 4,000 m, attains considerable amounts near the continental divide. As the height decreases toward west, the climate becomes dry and mild.

2) Vegetation

The kinds of plant in this area are limited owing to the dry and cold climate. A kind of cactus, such as Huacro, Chuco, and Viscayna, comes out at an upland from 3,000 m to 4,000 m above sea level. Only special alpine herbage, such as Ichu o Paja, Piriula, and Chapcha, grows at a mountainous place above 4,000 m.

2-4 Inhabitants and Industrids

1) Inhabitants and Their Lives

The area belongs to Provincia Cajatambo in Departamento Lima in the administrative organization. The inhabitants are mainly indio. They have settled villages in the basins along the valleys since Inca time, and are living in selfsuficient by old-fasioned farming and cattel breeding. The transportations between villages depend on horse and foot.

The area is steep in topography and has cold climate in the higher places and dry climate in the lower places, and therefore the lands suitable for farming are restricted. Small scale farming is engaged on the slopes with water channels, which is limited by the elevation of 4,000 m. Grazing is only carried on the plateaus above 4,000 m.

2) Industries

Although there are no operating mines in the Oyon area, mordern metal mines such as Raura mine, Uchucchacua mine, and Chanca mine are operating in the neighboring area. Production rates of these mines are 1,100 t/d, 500 t/d, and 200 t/d, and numbers of employees are 800, 400, and 450 persons, respectively. Each production scale is small and moderate but more than 10,000 people including employees families are depending their lives on these mines.

Developoment of these mines is a core of industrial activity and brings a great impact and the most stable earnings to the communities which are located in the steep mountain range and depend on old-fasioned farming and grazing.

Coal mining has been carried since long time ago, but the scale is small remained a handicraft and the weight in the local economy is not high. There are hot springs at Churín and Chiuchin, and tourism is prospecting at these places as resort zone.

Fig. 2 Location and Access Map

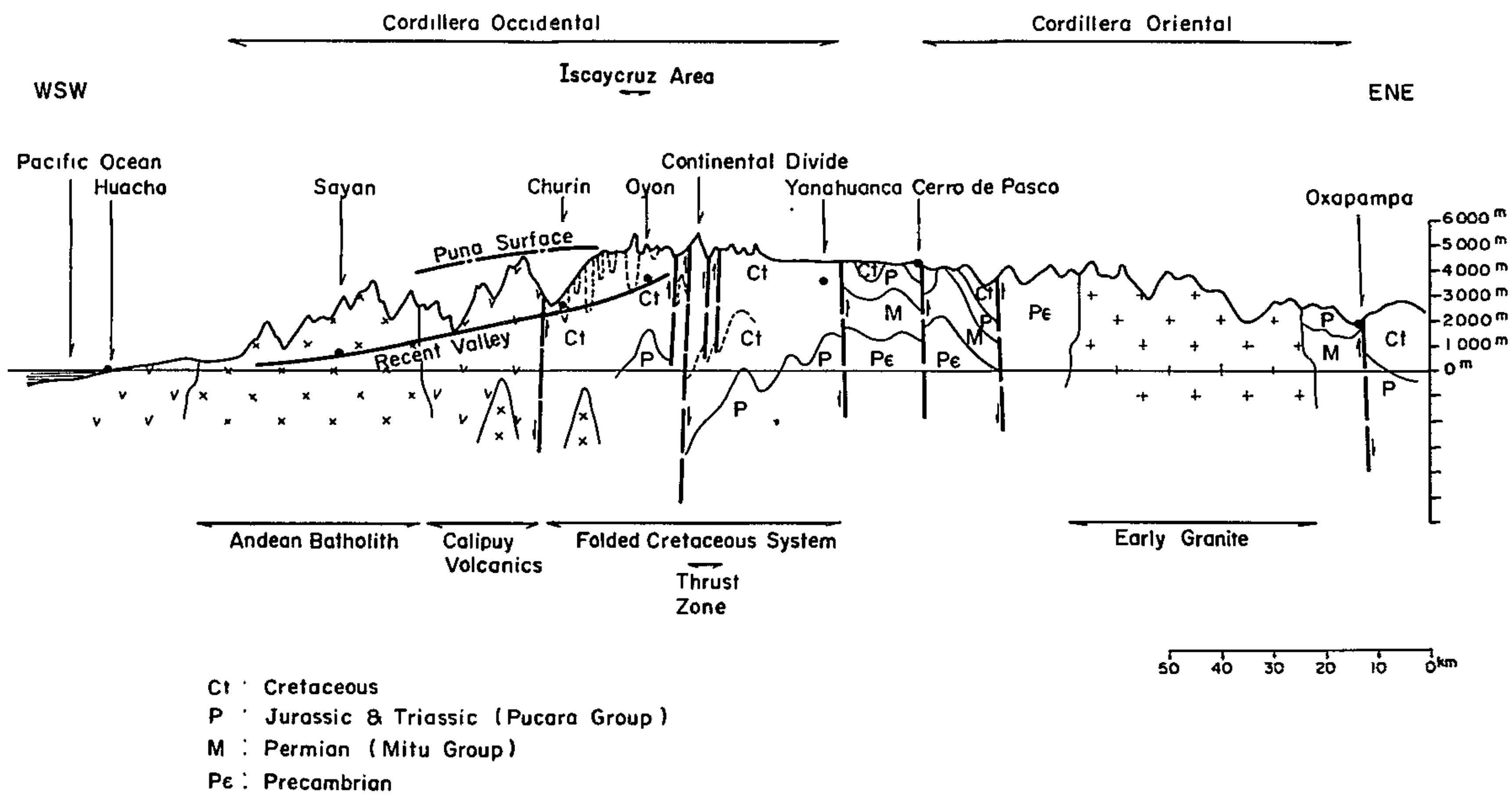


Fig. 3. Schematic Profile of the Central Andes Area

Chapter 3 Situation of Mining Industry in Peru

1) Outline

Peru is a well known country rich in mineral resources such as gold, silver, copper, lead, zinc, iron ores, etc., and the mining has been the main industry in this country.

The proportion of the production by the mining industry to the gross domestic production(GDP) is usually slightly less than 10 %, although it fairly changes according to the variation of the international metal prices and the movement of the consuming countries. The employment of the mining industry is a little less than 2 %. Indeed the proportion of the mining industry in the whole Peurvian economy is pretty low, viewing from such factors as GDP or the employment. However, the mining industry has played a great role in the balance of international payments of this country. Recently the amount of the export of the mineral products occupies as much as 45 % of the total amounts of the exports. If petroleum is included in the mineral products, the figure goes up to as high as 65 %. As the petroleum production is forecasted to be decreasing in future, and there would be no expectation of rapid expansion in the fishing, the agricultural and the manufacturing industries, the mining industry mainly of copper, silver, zinc and lead is thought to play increasingly greater role than ever, occupying heavier weight in the Peruvian economy (refer to the following table).

(1) Trade Balance of Peru and Export-Import by Items (Unit $1 million)

	1974	1975	1976	1977	1978	1979	1980	1981
Export								
Marine products	259	208	201	215	238	331	289	
Agricultural products	350	387	282	337	281	362	258	
Mineral products	723	547	690	901	912	1,458	1,755	
Oil products	28	44	53	52	180	646	810	
Others	165	105	133	221	330	677	751	
Total	1,505	1,291	1,359	1,726	1,941	3,474	3,863	3,255
Import								
Consumption goods	155	199	176	173	104	170	615	
Raw material semiprocessed goods	919	1,172	1,032	1,050	734	894	928	
Capital goods	610	782	675	469	458	744	934	
Others	223	238	217	472	305	283	619	
Total	1,908	2,390	2,100	2,164	1,601	2,091	3,096	3,803
Trade balance	Δ403	Δ1,099	Δ741	Δ438	340	1,383	767	Δ548

(From data of Banco Central de Reserva del Peru)

(2) Quantity of Mineral Products Exported from Peru (Metal content, Unit x 1,000)

		1977	1978	1979	1980	1981
Copper	(MT)	331	344	373	350	325
Iron ore	(LT)	6,122	4,778	5,749	3,730	5,269
Silver	(OZ)	39,910	41,628	41,880	42,000	42,100
Lead	(MT)	172	176	164	154	139
Zinc	(MT)	434	437	418	400	499
Oil	(BL)	4,104	13,775	23,570	22,400	19,900

(3) Export of Mineral Products from Peru (Unit $1 million)

	1974	1975	1976	1977	1978	1979	1980	1981
Copper	301	156	227	392	408	674	752	529
Iron ore	75	52	63	90	74	85	95	93
Lead	57	42	64	173	207	389	139	100
Silver	140	146	145	82	92	145	556	404
Zinc	150	151	191	164	133	171	211	272
Total, mineral products	723	547	690	901	912	1,464	1,753	1,398

(From data of Banco Central de Reserva del Peru)

2) Mineral Production

The mineral production in Peru is shown in the following table. In addition to the Oroya copper-lead-zinc smelter, the recently constructed Iro copper smelter began its full scale operation and in 1981 the Cajamarquilla zinc smelter started its operation. Accordingly, as for the degree of processing, production ratio of finished or semi-finished goods such as ingot metal or blister has been increasing.

The production of copper increased rapidly in 1977, because of the development and the operation of the Cajone mine and the Cerro Verde mine. But the production of other metals has not been expanding. Generally, Peruvian mining industry has been supported by moderate to small scaled mines, except for some large scaled mines employing open pit mining method as are the cases with the Toquepala mine, the Cajone mine and the Cerro Verde mine, which are working porphyry copper type ore deposits, and the Cerro de Pasco mine, which is working lead-zinc massive sulphide ore deposits.

Mineral Production in Peru (Metal content, Unit x 1,000)

		1976	1977	1978	1979	1980 (Ingot/Blist/Conc)	1981 (Ingot/Blist/Conc)
Copper	(MT)	188	336	376	397	367(231/120/ 16)	328(209/95/ 23)
Silver	(Kg)	1,233	1,298	1,337	1,364	1,392(763/ 35/567)	1,460(746/28/615)
Lead	(MT)	178	178	183	184	189(82/ /107)	187(80/ /107)
Zinc	(MT)	462	477	457	491	488(64/ /375)	497(126/ /321)
Iron ore	(MT)	3,138	4,033	3,275	3,622	3,780	4,034
Gold	(G)	3,038	2,993	3,361	4,191	4,074	4,820
Oil	(Bar)	27,965	33,271	55,060	69,952	71,369	70,445

(From La Mineria en el Peru-81)

3) Main Operating Mines in Peru

Recent production (annual production of metal content in 1980 - 1981) from the principal mines is listed in the following table.

(1) Main Copper Mines (more than 2,500 t/y of Cu metal content)

Cobriza	(18,517-16,841)	Toquepala-Cajone	(227,685-290,806)
Morococha	(3,766- 3,638)	Cerro Verde	(31,471- 32,704)
Yauricocha	(4,900- 5,026)	Aquila	(2,886- 2,586)
Cobre de Chapi	(2,832- 2,525)	Pativilca	(4,536- 5,140)
Condroma	(4,012- 3,760)	Nor-Peru	(2,801- 3,234)
Atalaya	(3,118- 2,156)	Del Madrigal	(2,243- 2,632)

(2) Main Lead Mines (more than 5,000 t/y of Pb metal content)

Cerro de Pasco	(51,578-48,741)	Atacocha	(13,757- 13,324)
Casapalca	(13,104-13,101)	Milpo	(12,616- 10,380)
Yauricocha	(10,350-10,483)	Raura	(7,944- 5,646)
Alianza	(8,174- 8,386)	Huaron	(5,211- 5,784)
Del Madrigal	(5,705- 6,016)	Santa Luisa	(8,038- 7,269)
Rio Pallanga	(5,027- 3,875)		

(3) Main Zinc Mines (more than 15,000 t/y of Zn metal content)

Cerro de Pasco	(151,895-156,588)	Milpo	(24,293- 24,088)
Casapalca	(20,265- 20,550)	S.Ig.de M.	(39,742- 40,136)
M Tunel	(27,232- 29,348)	Santa Luisa	(18.625- 18,298)
Atacocha	(17,189- 18,705)	Santander	(25,915- 26,156)
Gran Bretana	(14,703- 16,361)	Volcan	(15,860- 21,352)

(4) Main Silver Mines (more than 50,000 kg/y of Ag metal content)

Cerro de Pasco	(78,152- 92,760)	Buenaventura	(143,089-)
Casapalca	(113,411-115,978)	Alianza	(60,790-)
Morococha	(48,145- 56,197)	Arcata	(67,250-)
Milpo	(54,586-)	Huaron	(54,784-)

Chapter 4 Outline of Geology and Ore Deposits

4-1 Outline of Geology

1) Regeonal Geological Setting

The Iscaycruz Area and the peripheral area belong stratigraphically to the zone of Cretaceous sedimentary basin (la Zona de la Cuenca Cretacea) by Cobbing (1973), and is structually situated in the folding-thrusting zone (la Zona de Plieques y Sobreescurrimientos) by Wilson (1967).

In this area thick Cretaceous sedimentary rocks are widely distributed. The lower part is composed mainly of clastic rocks such as siliceous sandstone and shale, and the upper part calcareous rocks associated with dolostone and shale, and the uppermost part red formation.

The clastic rocks of the lower part is divided into the Oyon, Chimu, Santa, Carhuaz and Farrat Formations, and the calcareous rocks of the upper part into the Pariahuanca, Chulec, Pariatambo, Jumasha, Celendin and the uppermost red Casapalca Formations in ascending order. These formations are unconformably covered by the Calipuy volcanics in Tertiary and are intruded by tonalites, dacites, granite porphyry and others (Fig.3 and 5).

The Cretaceous sedimentary rocks suffered intensely a structural movement in consequency of the Andean Orogeny to form composite folds with NNW-SSE trend. Anticlines and synclines appear at intervals of 2 to 3 km, sometimes several tens meters, so that the same stratum is repeately exposed at the surface. Usually the folds have acute angle at the axis. In many cases the upper strata are folded in between the lower strata, and the latter are interbedded in the former as plug. At the central part in the orogenic zone thrust faults parallel to the fold axis are developed. The total vertical displacement of the two main faults at intervals of about 2 km attain approximately 1,500 m. The west block thrusts onto the east block, and this part makes a continental divide. To the east of the thrusting fault, the faults belonging to the same system are developed at intervals of 1 to 2 km and make a imbricate structure (Fig.3 and 4).

On the east of this area the Eastern Andes consisting mainly of Paleozoic sedimentary rocks and Pre-Cambrian metamorphosed rocks runs, while on the west Tertiary volcanic rocks are continuously distributed and the Andean batholith intrudes into this volcanic rocks (refer to Fig.3).

2) Outline of the Geology in Iscaycruz Area

The Iscaycruz Area is about 6 km to 18 km south-south-east of Oyon. Canaypata is at the north end of the area and Antapamppa is at the south end (refer to Fig.2).

In the east of this area, an anticline is recognized with the axis running in NNW-SSE direction. The Oyon Formation, the lowest Cretaceous, composed mainly of sandstone and shale with coal measures and the overlying Chimu Formation, 600 to 700 meters thick, composed of quartzite or quartzose sandstone are distributed along the axis of the anticline. They look dark grey to dark brown in color and form irregular rough mountain land. In the west of this area, a syncline is recognized with the axis in NNW-SSE direction, along which is distributed the upper Cretaceous Jumasha Formation composed of massive limestone of the thickness of almost 1,400 meters. The limestone forms steep mountain land, brightly shining in grey color. Between the two mountain lands, topographically lower part has been formed in the area occupied by the Carhuaz Formation composed of the alternation of shale and sandstone, 500 to 700 meters thick.

In a narrow zone between the Chimu Formation and the Carhuaz Formation, the Santa Formation is distributed. The Santa Formation is as thick as 50 to 100 meters, composed of well-stratified bluish grey limestones. This formation constitutes the country rock of the mineralization in the Iscaycruz Area. Between the Carhuaz Formation and the Jumasha

Formation, there are four other formations which are distributed zonally. They are Farrat Formation, about 100 meters in thickness, composed of quartzose sandstone and calcareous sandstone; Pariahuanca Formation, about 100 meters in thickness, composed of dark grey massive limestone; Chulec Formation, about 200 meters in thickness, composed mainly of light grey marlstone; and Pariatambo Formation, about 200 meters in thickness, composed of the alternation of thin layers of shale and dark grey to dark-colored limestone.

The Santa Formation is situated on the wing of the fold structure. The dipping of the strata of this formation is almost vertical, as they constitute parts of the remarkable tight-folds. Reverse structures are observed to be developed in the Limpe area and Tinyag area in the central part of this area.

As for igneons rocks, dacitic porphyry is recognized near the axis of the syncline in the west of Cumbre de Iscaycruz (Iscaycruz pass) and also acidic dyke complex is found to have been active around the anticline axis near Cumbre de Cunsha Punta, in the middle to southern part of this area.

4-2 Outline of the Ore Deposits

1) Outline

According to Bellido et al (1972), the Iscaycruz Area is located geologically in the Sub Provincia Polimetalica del Altiplano in the Provincia Metalogenia Andina Occidental. In the north next to this surveyed area, there are several operating mines as the Raura silver-lead-zinc mine, the Uchucchacua silver mine and the Chanca silver mine. Also, in the vicinity of this surveyed area, are in operation many moderate scaled silver-lead-zinc mines such as the Huanzala mine, the Cerro de Pasco mine, the Atacocha mine, the Milpo mine, the Huaron mine, the Rio Pallanga mine etc.

2) Iscaycruz Mineralized Zone

The Iscaycruz Mineralized zone is found in the limestones of the Santa Formation, and is distribued intermittently along the limestons in a distance of about 12 km from Canaypata, the northern end, to Antapama, the southern end. The indications of mineralization are found as dark-colored gossans bearing lead and zinc, massive pyrite orebodies associated with galena and sphalerite, skarn masses containing chalcopyrite and sphalerite, hematite masses disseminated with chalcopyrite and sphalerite, and disseminations in dolostones with galena and sphalerite. As the Santa Formation is distributed in a narrow zone along the steep cliff of quartzite belonging to the Chimu Formation, talus deposits composed mainly of quartzite breccias and glacier sediments are developed in this area. The above-stated mineral indications are found exposed spottedly like islands in these recent sediments.

The country rocks of the ore deposits are altered by silicification, sericitization, argillization, sideritization, dolomitization and brecciation. The acidic dykes which intruded into the Oyon Formation and the Chimu Formation around Cumbre de Cunsha Punta are thought to have been related to the mineralization. There are more than ten dykes of the acidic rocks in this area. Not only they are remarkably altered, but also the wall rocks are hydrothermally altered severely by brecciation, pyritization, sericitization, silicification, pyrophyllitization, etc., and in some places, breccia structure is observed as breccia dykes. The activity of these dyke rocks is recognized merely scatteringly, but they are distributed in the whole Iscaycruz Area, along the axis of the anticline.

Remarkable fissure systems are recognized distinctly in two directions, WNW-ESE and NNE-SSW, both of which are oblique to the bearing of the folding axes. It has been confirmed that they have dislocated some strata by several to several ten meters. The fissures in these systems are representing shear faults and it is thought they would have some relation to the mineralization. Thrust faults and bedding faults in the direction parallel to the strike of the layers are developed. It is inferred that they have had influences upon the variation of thickness of the country rock of the mineralization, that is, the Santa Formation, as well as upon the continuity of the ore deposits.

Dark-colored gossans exposed widely on the surface are composed mainly of goethite, quartz and kaolinite, associated with manganese oxides and siderite. The assay results of samples of dark-colored gossan collected near the Cumbre de Iscaycruz in the northernpart of the surveyed area reveal Pb : a little less than 1% and Zn : 4-6%. However, most of the metal ingredients in the gossans are thought to be in the form of oxide or carbonate such as chalcophanite and smithsonite. It is inferred that the dark-colored gossans are the oxidation products of manganiferrous siderite.

The Limpe area is in the central part of the surveyed area and is characterized with the large amount of hematite dissemination in the altered quartzitic rocks. In this area, there are several exposures of pyrite masses containing galena and sphalerite. The pyrite masses are associated with pyrrhotite and marcasite. Sphalerite contains spotted small grains of chalcopyrite and exsolution structure is well developed. In the Tinyag area, there are exposure of skarn masses, disseminated with chalcopyrite, sphalerite, pyrite and magnetite. Main skarn minerals are tremolite, garnet, epidote and quartz. In the Cunsha Punta area are distributed pyrite masses associated with sphalerite as is the case in the Limpe area. In the Antapampa area in the southernmost part of the surveyed area, there are exposures of dark-colored gossans.

The mineralized zone in the Iscaycruz Area is in a narrow zone about 12 km in length. The exposures of the mineral indications are intermittent and the features of concentration of the ore minerals are variable. Viewing the whole area at a glance, the skarn ore deposits containing copper and zinc minerals are recognized in the Tinyag area, nearest to the center of the activity of the acidic igneous rocks. It is thought these skarn ore deposits would occupy the area corresponding to the central portion of the mineralization in this area. Both in the Limpe area in the north of this central area, and the Cunsha Punta area in the south of it, massive sulphide ore deposits have been found, in places associated with lead and zinc minerals. In the outermost zone of the Cumbre de Iscaycruz area and the Antapampa area, dissemination type ore deposits of lead and zinc in the manganiferrous siderite layers are recognized. These ore deposits of various types are distributed in zonal arrangement, centered in the acidic igneous rocks, and they are thought to have been formed in a single mineralosphere by a series of mineralization as a whole.

3) Chupa Ore Deposit

The Chupa ore deposit is located approximately 600 meters west of the skarn exposure in the Tinyag area. It is skarn type ore deposit containing zinc mainly, formed by the replacement of part of the limestones belonging to the Pariahuanca Formation. In the past, tunnel exploration was carried out in two levels, and orebodies of the scale of 20 m x 80 m were caught in each level. However, the depth of the orebodies are left unexplored. Skarn minerals are mainly tremolite, hedenbergite, quartz and siderite, with less amount of chlorite, sericite, epidote and lievrite. Ore minerals are mainly sphalerite, pyrite and magnetite, associated with chalcopyrite and pyrrhotite. It is thought that the formation of this ore deposit would have occurred as a part of the mineralization which formed the Iscaycruz mineralized zone, related to the activity of the acidic igneous rocks.

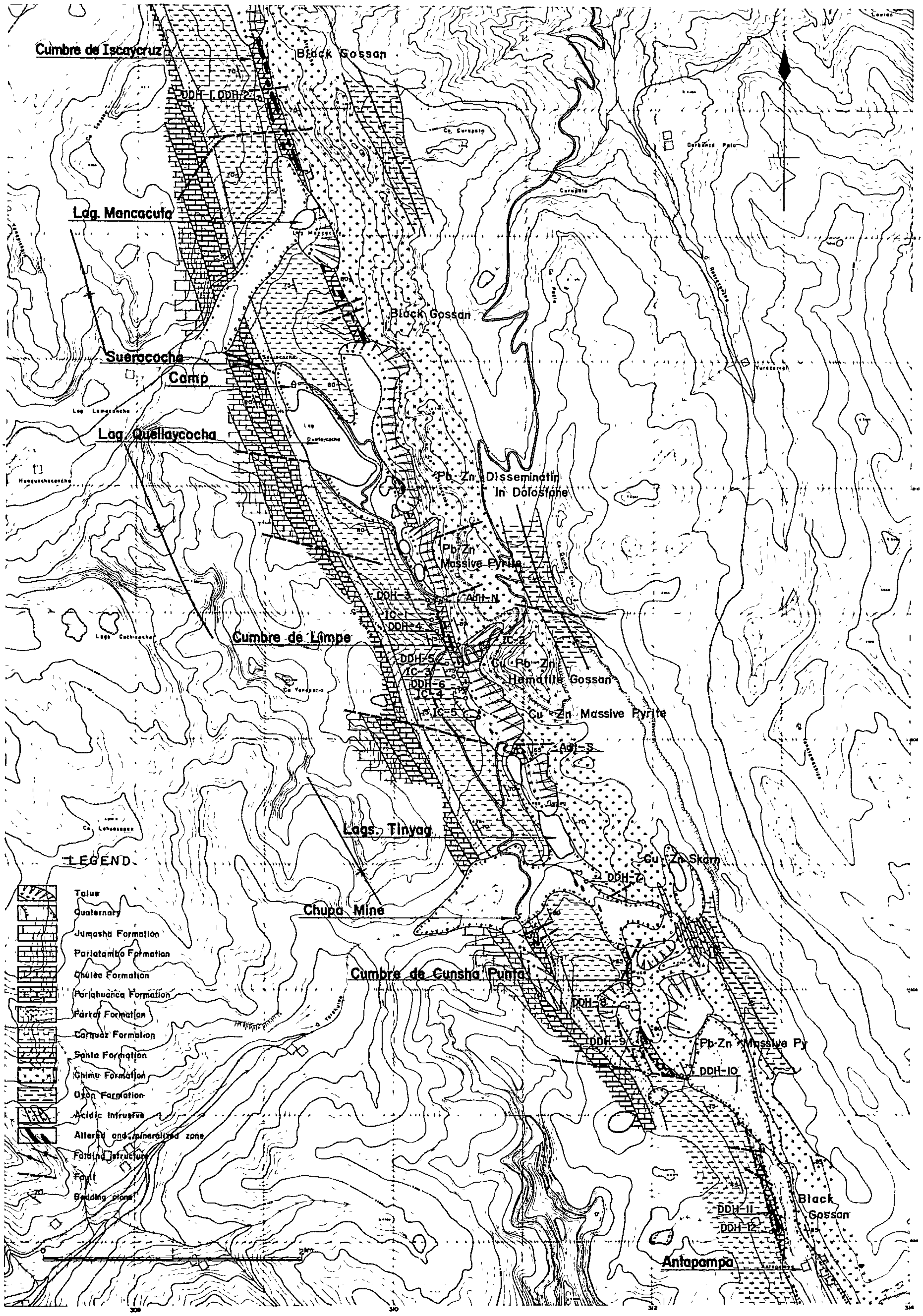


Fig. 4 Geological Map of the Iscaycruz Area

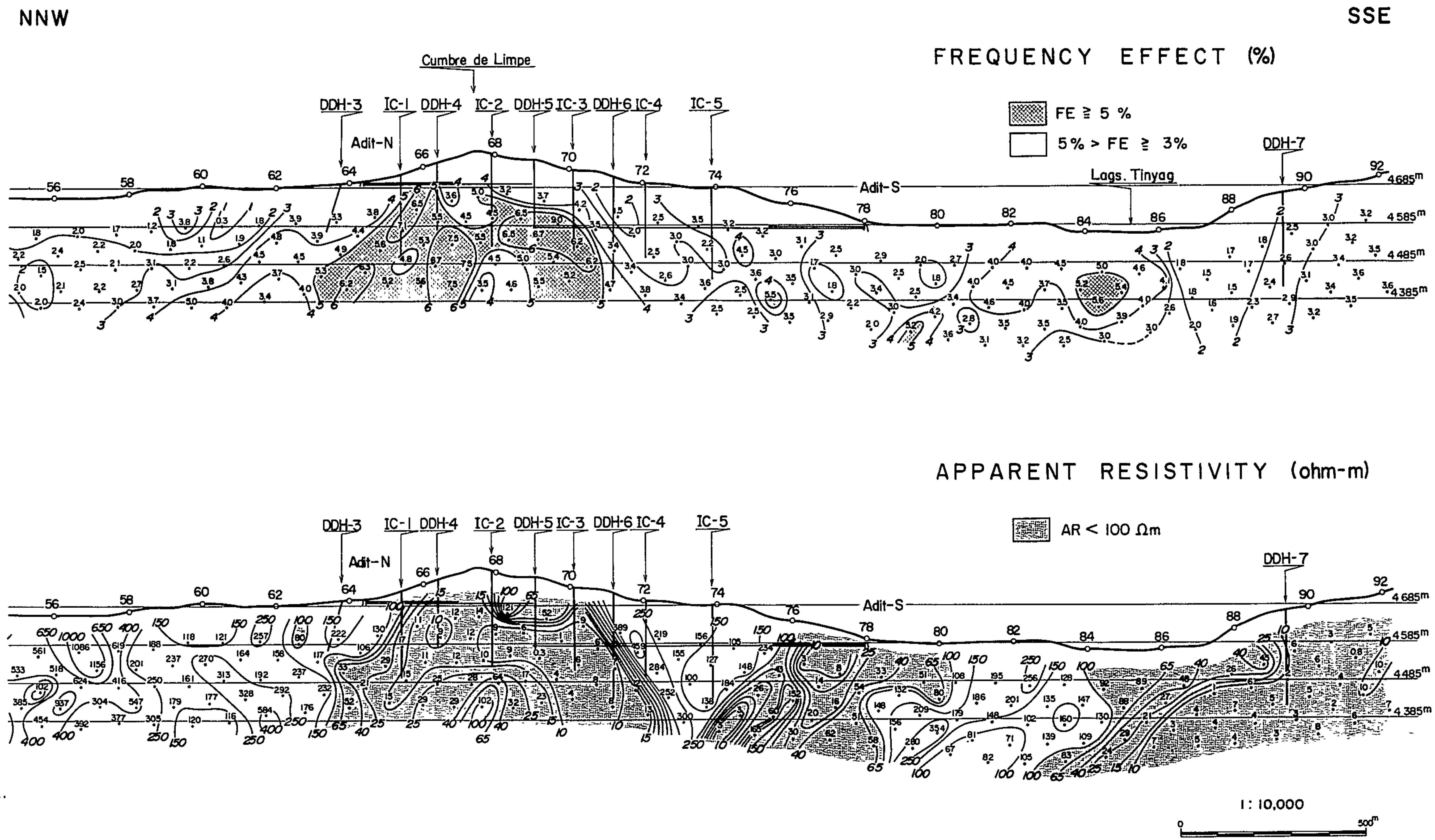


Fig. 5 Geophysical Profile of the Limpe Area

Chapter 5 Outline of the Survey Results

5-1 Drilling Exploration

In this year of the program, diamond drilling of 5 holes was carried out at 5 localities, a hole in the north of Cumbre de Limpe and 4 holes in the southern part of the area, total length of which was 1,304 m.

As the results of the drilling, existence of high grade copper-lead-zinc ores was confirmed widely in the drill hole IC-2, which is located near Cumbre de Limpe. The assay results of the main parts of the orebodies are shown in the following table. As is seen in this table, the ore grade is as high as over 30 %, Pb and Zn combined, in the highest grade ores so far assayed.

	Depth (m) - (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
IC-2	77.6 - 82.1	4.5	2	5	7.10	0.22	0.48
"	82.1 - 88.1	6.0	6	39	0.17	2.69	27.93
"	88.1 - 95.1	7.0	4	10	0.03	1.54	3.63
"	95.1 - 104.7	9.6	9	49	0.06	6.02	15.36
"	104.7 - 126.0	21.3	4	4	0.14	0.16	15.68
"	126.0 - 146.3	20.3*	5	46	3.38	0.03	0.43
"	211.0 - 227.4	16.4	8	25	0.06	4.43	9.39

* includes 5.2 m of core lacking part

In the drill hole IC-1, which is located about 200 m north of Cumbre de Limpe, small quantities of low grade lead-zinc ores were caught (core length:8 m, Pb: 0.76 %, Zn: 3.69 %).

In the drill hole IC-3, IC-4 and IC-5, which are located respectively about 100 m, 470 m and 600 m south of Cumbre de Limpe, considerable amount of pyrite and hematite masses were caught. However, no lead-zinc mineralization has been confirmed so far. Instead, indications of concentration of copper minerals have been recognized in some parts. The assay results of the cores of the high grade copper ores are as follows.

	Depth (m) (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
IC-3	149.0-153.7	4.7	2	5	1.04	0.02	0.12
"	158.2-160.2	2.0	1	-	4.46	0.02	0.05
IC-4	114.0-120.5	6.3	3	32	2.20	0.02	0.29
"	157.4-158.7	1.3	1	24	5.62	0.02	0.05
"	180.8-186.8	6.0	3	-	0.83	0.01	0.05
"	198.0-223.7	25.7	5	2	0.63	0.01	0.03
IC-5	128.8-130.4	1.6	1	4	4.64	0.09	0.20
"	131.8-133.8	2.0	1	4	0.72	0.01	0.10

5-2 Tunnelling Exploration

The tunnelling exploration was carried out in this year by excavating two tunnels, Adit-N of the length of 310 m and Adit-S of the length of 270 m, totalling 580 m.

Cutting across the Santa Formation distributed around the entrances, both of the tunnels were excavated in the beds belonging to the Chimu Formation. They have not reached the mineralized zone in the Santa Formation.

In the Adit-N, it has been confirmed that, neighbouring the Santa Formation, the transitional zone to the Chimu Formation represented by the alternation of dolostone, siliceous sandstone and shale is developed about 35 m in thickness, that by the quartzite beds of the Chimu Formation reverse structure is shown with the strikes of N10°-15°W and the dips of 70°-80°E, and that heavy mineralization and alteration represented by pyritization and silicification are recognized in the quartzite.

In the Adit-S, a remarkable fault of E-W system with the true width of 5 meters was confirmed. The strike of the limestone of the Santa Formation in the entrance area of the Adit-S is N25°W and the dip is 60°E. The strike of the quartzite of the Chimu Formation beyond the fault is N25°W with the dip of 70°E. It is certain that both of them show reverse structure, but that the dip of the beds varies to a certain amount, according to their location bordered by the fault. It is estimated from the geological conditions on the surface as well as those in the underground that these beds have been dislocated by at least ten odd meters.

The quartzite of the Chimu Formation is white, hard and compact. They have been mineralized and severely altered by pyritization, silicification and sericitization.

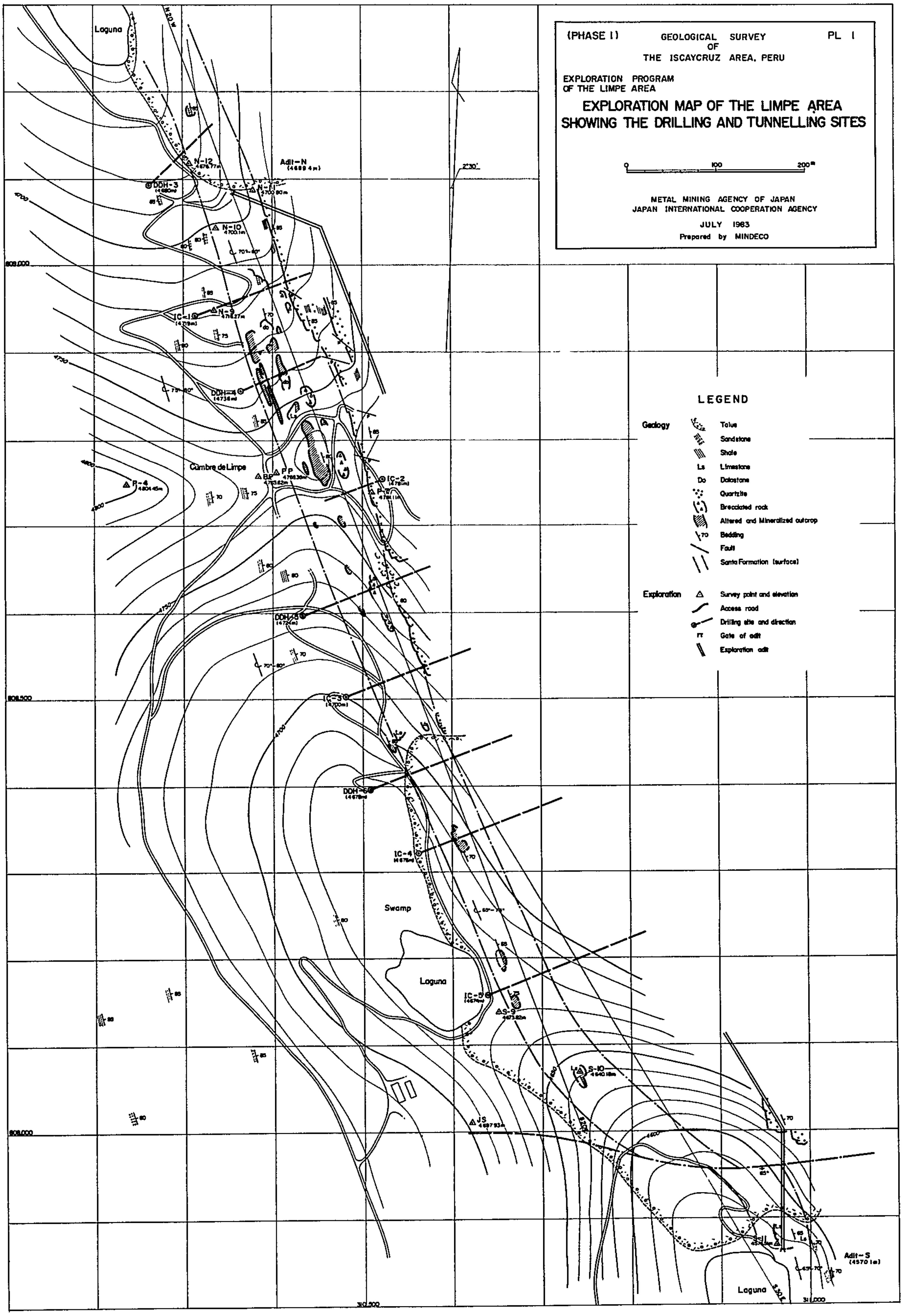


Fig . 6 Exploration Map of the Limpe Area

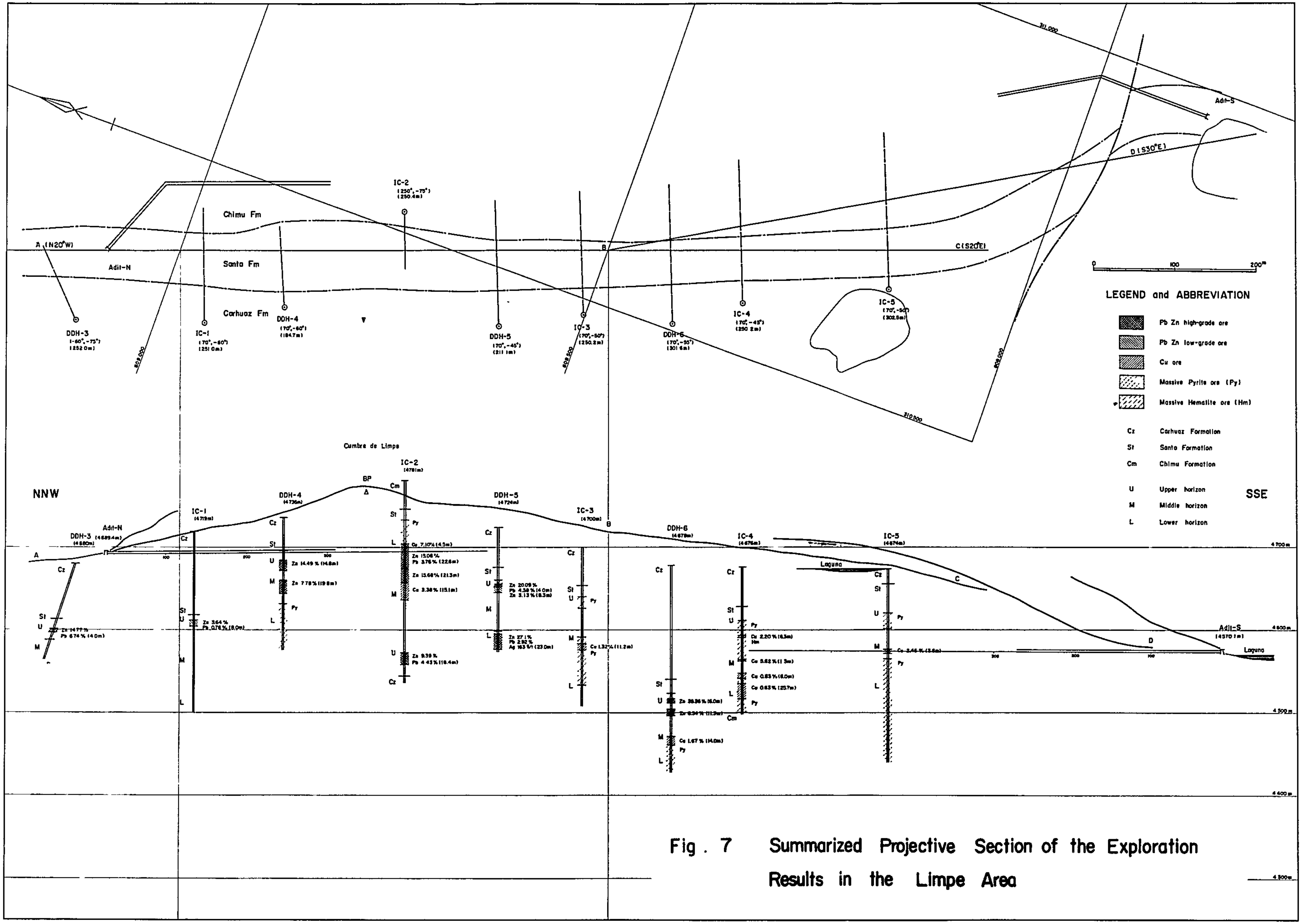


Fig . 7 Summarized Projective Section of the Exploration Results in the Limpe Area

Chapter 6 Conclusion and Future Outlook

6-1 Conclusion

The investigation works carried out in this year were those in the first phase of the three years' program of the exploration for mineral resources in the Iscaycruz Area.

By the diamond drilling on the surface, it has been confirmed by catching such indications as high grade copper-lead-zinc ores in the drill hole IC-2 located near Cumbre de Limpe, that there can be considerable mineralization in this area. The total length and the average grades of the representative high grade copper ores and lead-zinc ores confirmed by IC-2 are shown in the following table.

	Numbers of Localities	Total Core Length(m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	True Width(m)
Pb-Zn ores	4	53.3	27	23	0.10	2.81	15.07	24.7
Cu ores	2	24.8	7	43	4.38	0.04	0.44	11.5

The lateral true width of the ores is calculated by the following formula, taking the inclination of drill hole to be 75° and the dip of the beds hosting the ores to be 78°.

$$\text{True width (m)} = (\text{Length along drill hole, m}) \times \sin[180^\circ-(75^\circ+78^\circ)] / \sin 78^\circ$$
$$= (\text{Length along drill hole, m}) \times 0.464$$

In the southern part of Cumbre de Limpe, quite distinguished indications of mineralization represented by pyrite and hematite are recognized partly with heavy concentration of copper minerals, by the diamond drilling on the surface. However, no indications of lead-zinc mineralization has been found so far.

As for the tunnelling exploration, both of Adit-N and Adit-S were excavated mainly in the quartzite beds belonging to the Chimu Formation in this year of the program, and they have not reached the mineralized zone in the Santa Formation.

6-2 Future Outlook

In the Limpe area where high grade copper-lead-zinc ore deposits would be expected to exist as there are quite remarkable indications of mineralization, it is desirable to continue tunnelling exploration and to carry out underground diamond drilling.

As for the Adit-N, it is recommended, by crosscutting the main mineralization zone, to confirm various geological factors as figures of orebodies, features and continuity of grade distribution and aspect of combination of ore minerals, as well as to clarify the conditions of mineralization in the deeper part, by carrying out underground drilling, which is programmed to locate the drill holes with approximate interval of every 100 meters including the drill holes on the surface.

As for the Adit-S, it is recommended to continue excavation of the present tunnel toward that prosperous orebody with the grade as high as over 30 % Pb and Zn combined, which was caught in the drill hole located in the south of Cumbre de Limpe, and also underground diamond drilling is recommended to be applied in order to examine mutual relationship of pyrite masses, hematite masses, copper mineralization and lead-zinc mineralization, and in order to confirm the conditions of mineralization at the deeper level.

REFERENCES

Bellido, B.E. (1969)
Sinopsis de la geologia del Peru.
Serv. Geol. Min., Peru, Bel. 22.

Bellido, B.E., Luis de Montreuil, D. y Girard, P.D. (1956)
Aspectos generales de la metalogenia del Peru.
Serv. Geol. Min., Peru.

Cobbing, J. (1973)
Geologia de los cuadrangulos de Barranca, Ambar, Oyon, Huacho, Huaral y Canta. Ser. Geol. Min., Peru, Bol.26.

Einaudi, M.T. (1977)
Environment of ore deposition at Cerro de Pasco, Peru.
Econ. Geol., v.72, p.893-924.

Fukahori, Y., Aikawa, K. and Kawasaki, M. (1980)
Geology and ore deposit of the Huanzala mine - Mineralogical Study (in Japanese). Min. Geol. Japan, v.30, p.103-118.

Horita, A., Oikawa, J. and Tagami, Y. (1973)
Geological features of the Huanzala ore deposits, Peru (in Japanese). Min. Geol. Japan, v.23, p.265-274.

James, D.E. (1971)
Plate tectonic model for the evolution of the Central Andes.
Geol. Soc. Amer. Bull., v.82, p.3325-3346.

Japan International Cooperation Agency and Metal Mining Agency of Japan (1980-1982), Report on geological survey of the Oyon area.
Phase I., Phase II., Phase III.

Japan International Cooperation Agency and Metal Mining Agency of Japan (1982), Consolidated report on geological survey of the Oyon area.

Jenks, W.F. (1956)
Peru, Handbook of South American Geology.
Geol. Soc. Amer., Memoir, 65, p.215-247.

Jenks W.F. (1979)
Geology of South America, Geology of the World (in Japanese).
Iwanami, Tokyo, p.143-172.

Miyashiro, A. (1979)
Orogenesis based on the plate tectonics, The Trasitional Earth (in Japanese). Iwanami, Tokyo, p.35-144.

Petersen, U. (1965)
Regional geology and major ore deposits of Central Peru.
Econ. Geol., v.60, p.407-475.

Petersen, U. (1970)
Metalogenetic provinces of South America.
Geol. Rundschau, v.59, p.834-897.

Sato, H. and Saito, N. (1977)
Pyrite zones and zonal distribution of Cu-Pb-Zn ores in Huanzala mine, Peru (in Japanese).
Min. Geol. Japan, v.27, p.133-144.

Wilson, J.J. (1963)
Cretaceous stratigraphy of Central Andes of Peru.
Amer. Assoc. Petrol. Geol. Bull., v.47, p.1-34.

PARTICULARS
PART I
DRILLING EXPLORATION

PART I DRILLING EXPLORATION

CONTENTS

LIST OF FIGURES AND TABLE

LIST OF APPENDICES

Chapter 1 Drilling

1-1 General View of the Survey

1) Drilling

Drilling exploration performed this year is 5 holes at 5 sites totalling 1,304 m as shown below.

Name of drill hole	Drilled depth(m)	Core length(m)	Core recovery(%)
IC-1	251.00	233.80	93.6
IC-2	250.40	196.10	78.6
IC-3	250.20	231.60	96.6
IC-4	250.20	209.80	86.6
IC-5	302.50	257.30	87.7
Total	1,304.30	1,128.60	86.5

Note: Talus and surface soil was excluded for the core recovery.

Drilling period was 68 days from August 18 to October 24.

Location (longitude and latitude) and elevation of each drill hole site are listed below.

Name of drill hole	Longitude	Latitude	Elevation
IC-1	310.313E	808.942N	4,717 m
IC-2	310.523E	808.755N	4,781 m
IC-3	310.481E	808.503N	4,700 m
IC-4	310.562E	808.322N	4,676 m
IC-5	310.639E	808.158N	4,674 m

The two machines used were TGM-3C (drilling capacity: NQ 510 m, BQ 660 m) and TGM-5A (drilling capacity: NQ 510 m, BQ 660 m).

2) Core Evaluation and Analysis

All cores taken from drill holes were evaluated with respect to lithology, alteration and mineralization, and the results were compiled on geologic drill logs with a scale of 1/200.

For the mineralized part, one-half or one-quarter cores were sampled, analysis samples were adjusted, and four elements such as copper, lead, zinc, and silver were analyzed.

In addition, thin sections and polished sections of rocks and mineralized part were prepared and observed through a microscope. Also, a portion of samples were subjected to X-ray microanalysis to determine the mineral content.

Main contents and quantities of analysis are listed below.

(1) Microscopic observation of thin sections of rocks: 20 sections

(2) Microscopic observation of polished sections of ores: 30 sections

(3) Analysis of mineralized part(Ag,Cu,Pb,Zn): 115 samples

(4) X-ray microanalysis: 1 sample

1-2 Preparation

1) Bringing in Materials and Equipment

Materials and equipment were transported after customs clearance from a warehouse in Port of Callao to Pampahuay village via Churin and Oyon villages with two 11-ton trucks on August 25, 1982. From there, they were transported with two 1-ton pickup trucks from Pampahuay village to the location of drilling of IC-1 and IC-2 in the Iscaycruz area.

2) Preparatory Work

Preparatory work began from IC-1. At first, the ground was leveled to receive the drilling platform using a bulldozer. For IC-2 and IC-3, an access road about 100 m long was built first with a bulldozer, and then the ground was leveled by manual labor to receive the drilling platform. For IC-4 and IC-5, an access road about 500 m long was built with a bulldozer, and then the ground was leveled by manual labor to receive the drilling platform.

3) Water for Drilling

For IC-1 and IC-2, a pipeline about 400 m long was installed and water was supplied with a lift pump from a lake on the north side of Cumbre de Limpe. For IC-3, IC-4 and IC-5, a pipeline about 300 m long was installed and water was supplied with a lift pump from a lake on the south side of Cumbre de Limpe.

1-3 Drilling

Talus was drilled by using a 116-mm metal crown. After reaching rock, drilling was performed by the HQ wire-line method, casing pipes were sequentially inserted and installed, and BQ was used in final.

1) IC-1

Drilled depth: 251.00 m

Core length: 233.80 m

Core recovery: 93.6%

Drilling started: August 18, 1982

Drilling completed: September 11, 1982

<u>0 m to 3.60 m</u>

Talus was drilled to a depth of 3.60 m using a 116-mm metal crown with bentonite mud water. After the rock became stable, NW casing pipes were inserted to a depth of 3.60 m.

<u>3.60 m to 38.30 m</u>

Layers of shale and marl were drilled to a depth of 38.30 m using HQ wire line and diamond bits as well as bentonite mud water. After the rock became stable, HW casing pipes were inserted to a depth of 38.30 m.

<u>38.30 m to 63.70 m</u>

Layers of shale and fractured shale were drilled to a depth of 63.70 m using NQ wire line diamond bits with bentonite mud water.

In the layer between 50.00 m and 52.80 m, there was a fracture zone of shale interbedded with clay. This zone had considerable swelling, resulting in poor conditions in the drill hole and difficult drilling.

Using an HW casing diamond shoe bit with bentonite mud water, the layer between 3.60 m and 38.30 m was reamed. After this, reaming was performed in the layer between 38.30 m and 63.70 m using an HQ wire-line diamond bit with bentonite mud water. Then, while reaming from 38.30 m to 63.70 m using an HW diamond shoe bit with bentonite mud water, HW casing pipes were inserted down to 63.70 m and drilling was shifted to the HQ wire-line method.

<u>63.70 m to 113.20 m</u>

Using an HQ wire-line diamond bit with bentonite mud water, layers of shale and sandstone were drilled to a depth of 113.20 m. Then, the lithology became stable so that NW casing pipes were inserted down to 113.20 m.

<u>113.20 m to 251.00 m</u>

Using an NQ wire-line diamond bit with bentonite mud water, layers of mudstone, marl and limestone were drilled down to a depth of 251.00 m at which drilling work was stopped since the purpose was achieved.

Mineralized zinc was caught and confirmed in the layer between 121.00 m and 129.00 m.

2) IC-2

Drilled depth: 250.40 m

Core length: 196.10 m

Core recovery: 78.6%

Drilling started: September 19, 1982

Drilling completed: October 5, 1982

<u>0 m to 1.00 m</u>

Talus was drilled down to a depth of 1.00 m using an 116-mm metal crown with bentonite mud water. After the rock condition became stable, HW casing pipes were inserted down to 1.00 m.

<u>1.00 m to 15.40 m</u>

The sandstone layer was drilled down to a depth of 15.40 m using an HQ wire-line diamond bit with bentonite mud water. After the rock became stable, NW casing pipes were inserted down to a depth of 15.4 m.

<u>15.00 m to 63.00 m</u>

Layers of sandstone, marl and sulfide ore were drilled down to a depth of 63.00 m using an NQ wire-line diamond bit with bentonite mud water. In this case, the layer between 53.00 m and 60.00 m was a fracture zone of sulfide ore interbedded with clay, in which significant lost circulation occurred, and subsequent conditions in the drill hole became very poor. While reaming with an NW casing diamond shoe bit, NW casing pipes were inserted down to a depth of 63.00 m.

63.00 m to 173.10 m

Layers of mineralized sulfide and zinc ores and altered rock were drilled down to a depth of 173.10 m using an NQ wire-line diamond bit with bentonite mud water. After the lithology became stable, BW casing pipes were inserted to a depth of 173.10 m.

In this interval, zinc ores was caught and confirmed in two layers between 79.40 m and 88.00 m and between 95.00 m and 126.00 m.

173.10 m to 250.40 m

Layers of altered rocks, shale and dolostone and mineralized parts of sulfide and zinc ores were drilled down to a depth of 250.40 m using a BQ wire-line diamond bit with bentonite mud water, thereby achieving the purpose and drilling terminated.

In this interval, zinc ore was caught and confirmed from 211.00 m to 227.40 m.

3) IC-3

Drilled depth: 250.20 m

Core length: 231.60 m

Core recovery: 96.6%

Drilling started: October 11, 1982

Drilling completed: October 19, 1982

0 m to 8.50 m

Talus was drilled down to a depth of 8.5 m using an HQ wire-line diamond bit with bentonite mud water. After the rock became stable, HW casing pipes were inserted down to a depth of 8.50 m.

8.50 m to 102.20 m

Layers of shale, sandstone, altered rocks, limestone and sulfide ore were drilled with an HQ wire-line diamond bit with bentonite mud water down to a depth of 102.20 m.

After the lithology became stable, NW casing pipes were inserted down to a depth of 102.20 m.

102.20 m to 183.70 m

Layers of limestone, marl, altered rocks and sulfide ore were drilled to a depth of 183.70 m with an NQ wire-line diamond bit with bentonite mud water. After the lithology became stable, BW casing pipes were inserted down to a depth of 183.70 m.

183.70 m to 250.20 m

Layers of sulfide ore, altered rocks, sandstone and dolostone were drilled down to a depth of 250.20 m with a BQ wire-line diamond bit with bentonite mud water, thereby achieving the purpose and drilling terminated.

4) IC-4

Drilled depth: 250.20 m

Core length: 209.80 m

Core recovery: 86.6%

Drilling started: September 1, 1982

Drilling completed: September 26, 1982

0 m to 12.00 m

Talus and layer of limestone were drilled down to a depth of 12.00 m with an 116-mm metal crown with bentonite mud water. Then, the rock condition became stable and so, 112-mm casing pipes were inserted to a depth of 12.00 m.

12.00 m to 109.10 m

Layers of limestone, sandstone, marl and shale and sulfide ore were drilled to a depth of 109.10 m with an HQ-wire line diamond bit with bentonite mud water.

In this case, in the fracture zone of sulfide ore interbedded with clay between 89.10 m and 109.10 m, significant swelling occurred and conditions in the drill hole became poor, so that NW casing pipes were inserted down to a depth of 109.10 m.

<u>109.10 m to 113.60 m</u>

The layer of a fracture zone of sulfide ore interbedded with clay was drilled down to a depth of 113.60 m with an NQ wire-line diamond bit with bentonite mud water. Significant swelling occurred in the fracture zone, and the conditions in the bore hole became poor. Thus, while reaming with NW casing diamond shoe bits, NW casing pipes were inserted to a depth of 113.60 m.

<u>113.60 m to 132.80 m</u>

Layers of shale and fracture zone of sulfide ore interbedded with clay were drilled to a depth of 132.80 m with an NQ wire-line diamond bit with bentonite mud water. Because of the lithology of the fracture zone of clayed sulfide ore, significant swelling occurred and conditions in the drill hole became poor. Thus, while reaming with an NW casing diamond shoe bit, NW casing pipes were inserted to a depth of 132.80 m.

<u>132.80 m to 196.10 m</u>

Layers of dolostone, altered rocks and sulfide ore interbedded with clay were drilled to a depth of 196.10 m with an NQ wire-line diamond bit with bentonite mud water. In this case, because of the lithology of the fracture zone of sulfide ore interbedded with clay, significant swelling occurred, resulting in poor conditions inside the drill hole and jamming at a depth of 196.10 m. Two days were needed for recovery from the jamming accident.

After recovery, BW casing pipes were inserted to a depth of 196.10 m.

196.10 m to 250.20 m

The facture zone of sulfide ore interbedded with clay and layer of shale was drilled to a depth of 250.20 m with a BQ wire-line diamond bit with bentonite mud water, thereby achieving the purpose and drilling terminated.

5) IC-5

Drilled depth: 302.50 m

Core length: 257.30 m

Core recovery: 87.7%

Drilling started: October 7, 1982

Drilling completed: October 24, 1982

0 m to 9.50 m

Talus was drilled down to a depth of 9.50 m with a metal crown with bentonite mud water. Since the rock condition became stable, HW casing pipes were inserted to a depth of 9.50 m.

9.50 m to 120.50 m

Layers of shale, marl, limestone, fracture zone of sulfide ore, and sulfide ore were drilled to a depth of 120.50 m with an HQ wire-line diamond bit with bentonite mud water. In this case, significant swelling occurred in the fracture zone of sulfide ore interbedded with clay and conditions in the drill hole became poor, so that NW casing pipes were inserted to a depth of 120.50 m.

120.50 m to 158.60 m

Layers of marl and fracture zone of sulfide ore interbedded with clay were drilled down to a depth of 158.60 m with an NQ wire-line diamond bit with bentonite mud water.

In this case, conditions in the bore hole became poor because of the fracture zone containing pebble interbedded with clay in the layer between 133.80 m and 143.10 m. While reaming with an NW casing metal shoe bit, NW casing pipes were inserted to a depth of 158.60 m.

158.60 m to 194.00 m

The layer of the fracture zone of sulfide ore interbedded with clay was drilled to a depth of 194.00 m with an NQ wire-line diamond bit with bentonite mud water. Because of the lithology of the fracture zone of sulfide ore interbedded with clay, considerable swelling and lost circulation occurred resulting in poor conditions inside the bore hole, so that BW casing pipes were inserted to a depth of 194.00 m.

194.00 m to 302.50 m

Layers of sulfide ore, and fracture zone of sulfide ore interbedded with clay were drilled down to a depth of 302.50 m with a BQ wire-line diamond bit with bentonite mud water, thereby achieving the purpose and drilling terminated.

1-4 Transporation

1) Moving Work

IC-2, IC-3, IC-4 and IC-5 are located about 8 km to the south of IC-1. For moving and preparatory work up to the start of drilling for each bore hole, about 7 to 19 days were needed.

2) Removal Work

During removal work for IC-3 and IC-5, the weather was very bad, and access road conditions became poor. Therefore, materials and equipment were transported to the camp while the poor access road was repaired by 15 workers and then sorted out and stored in camp.

1-5 Drilling Record

1) Working Efficiency

As indicated in A. I-9, the drilled depth per shift of drilling work for a 1,304.00-m drill hole was 3.15 m/shift, and the drilled depth per shift of actual drilling work was 4.48 m/shift.

Drilling speed and bit speed were as indicated below.

	Drilling speed	Bit speed
Hard rock	1.0 to 1.5 cm/min.	450 to 600 rpm
Medium hard rock	1.5 to 2.5 cm/min.	350 to 450 rpm
Soft rock	2.5 to 3.0 cm/min.	250 to 350 rpm

2) Core Recovery

As indicated in A. I-9, cores of 1,128.60 m were taken for the total drilled depth of 1,304.30 m except talus. Thus, the average core recovery was 86.5%.

Fig. I – I

PROGRESSIVE RECORD OF DIAMOND DRILLING. IC- I

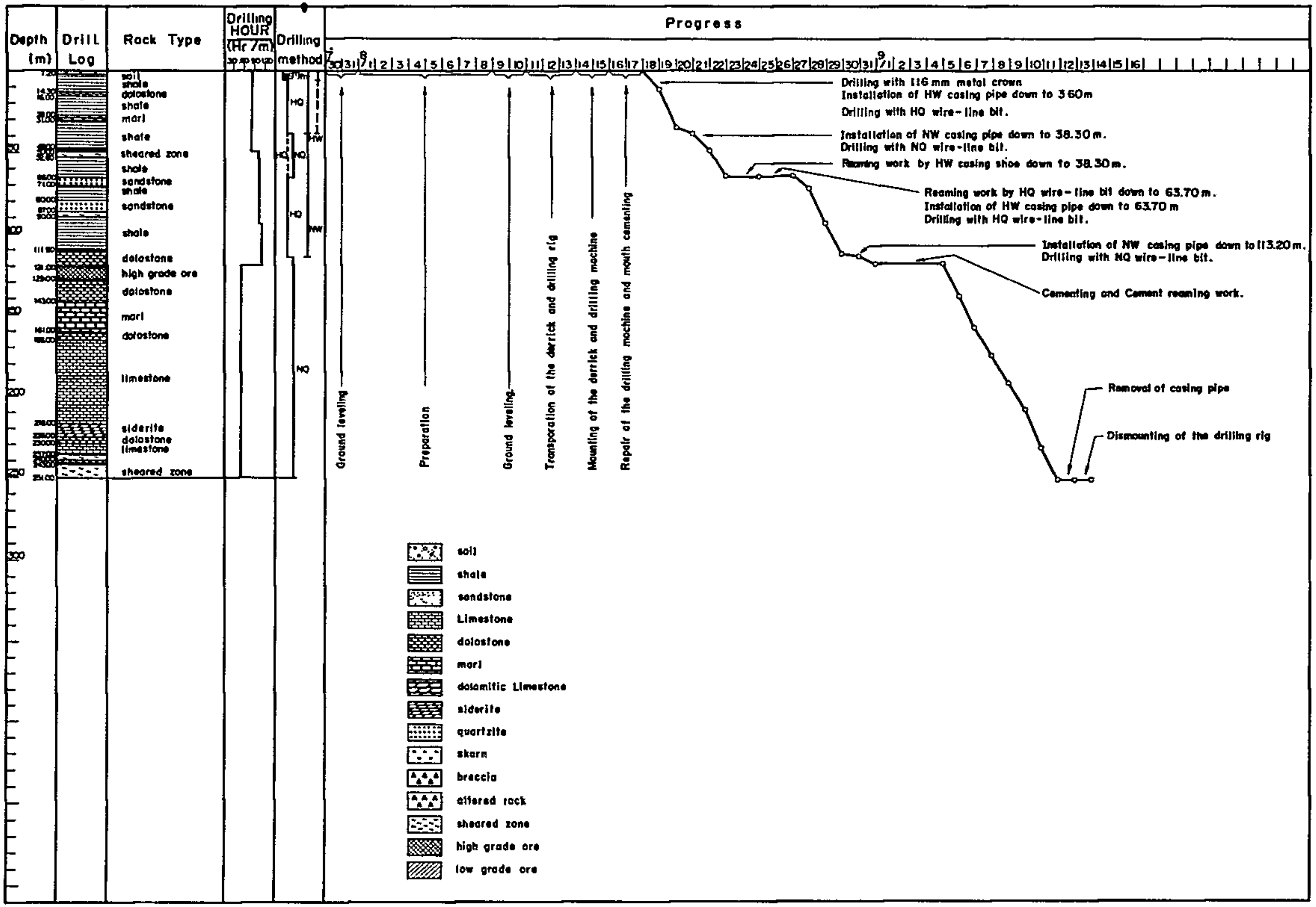


Fig. I − 2 PROGRESSIVE RECORD OF DIAMOND DRILLING, IC-2

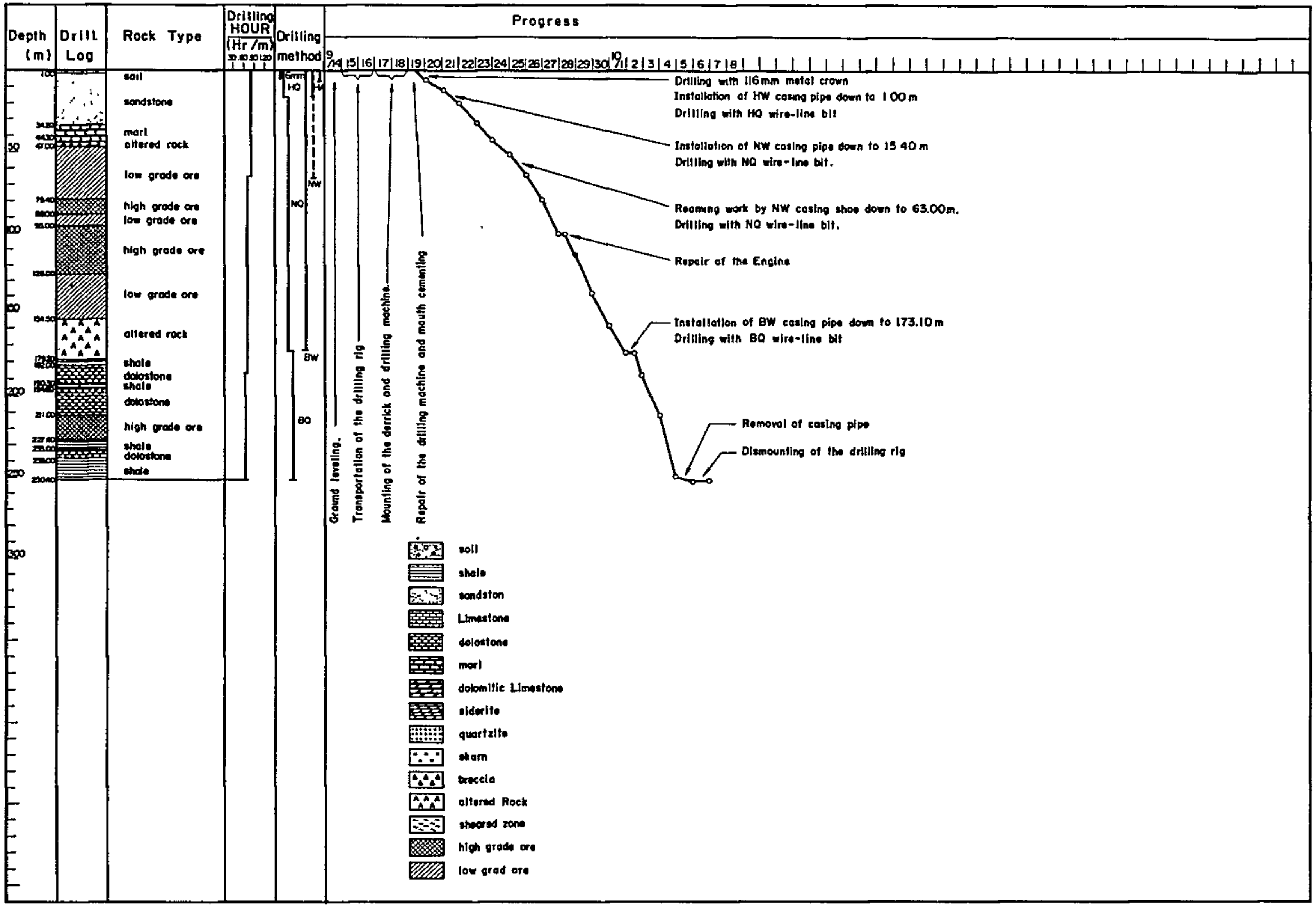


Fig. I - 3

PROGRESSIVE RECORD OF DIAMOND DRILLING, IC-3

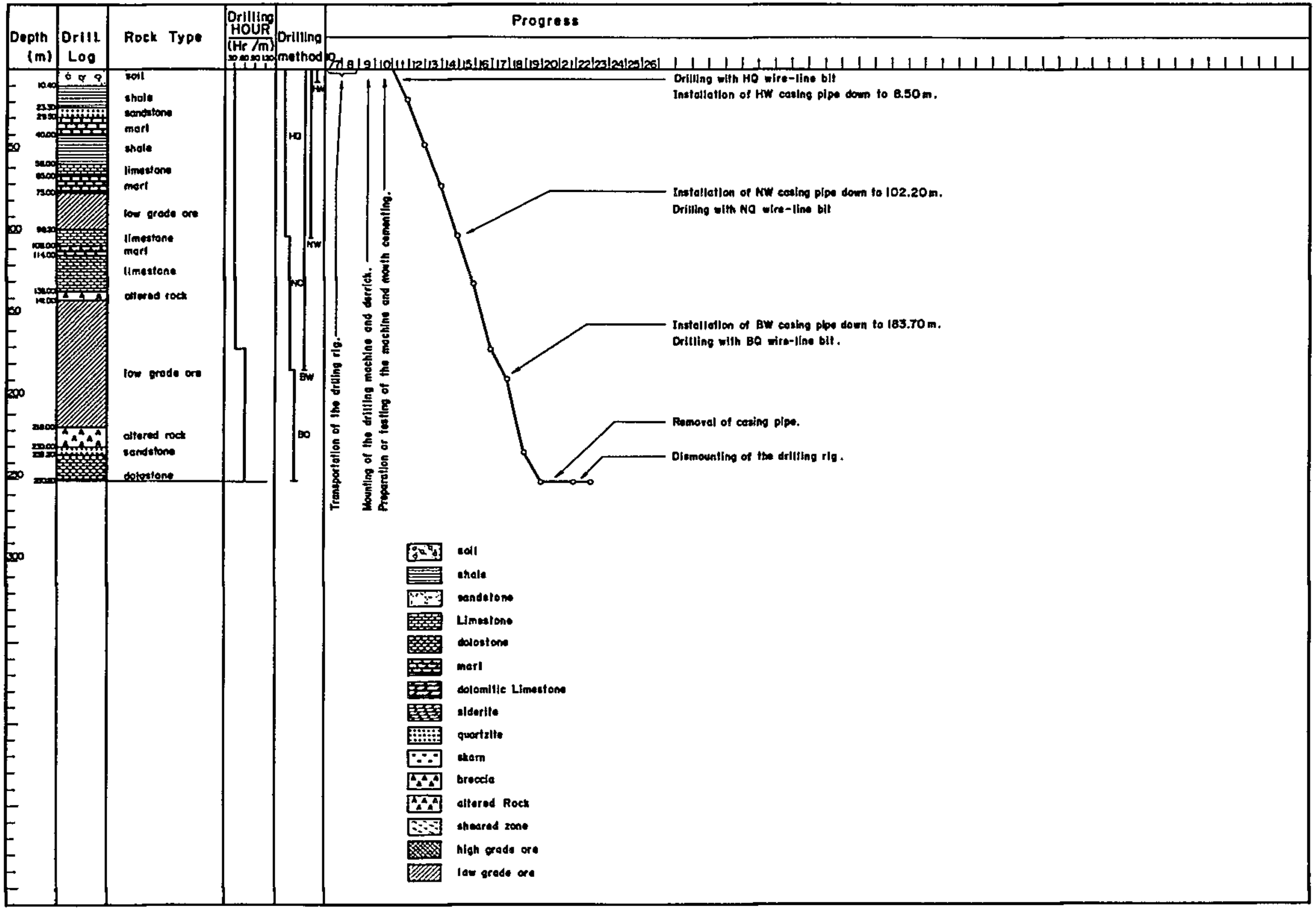


Fig I - 4

PROGRESSIVE RECORD OF DIAMOND DRILLING, IC-4

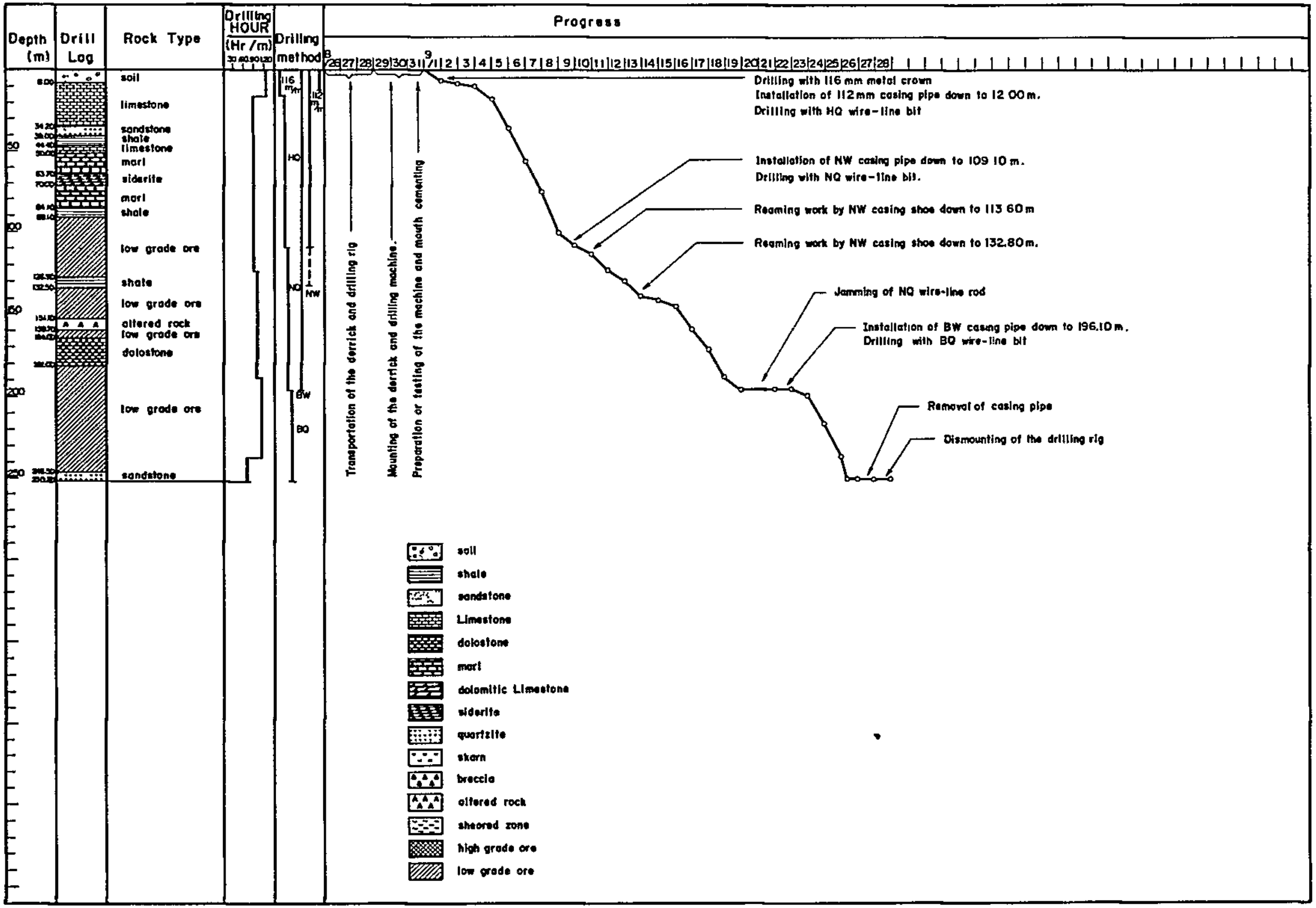
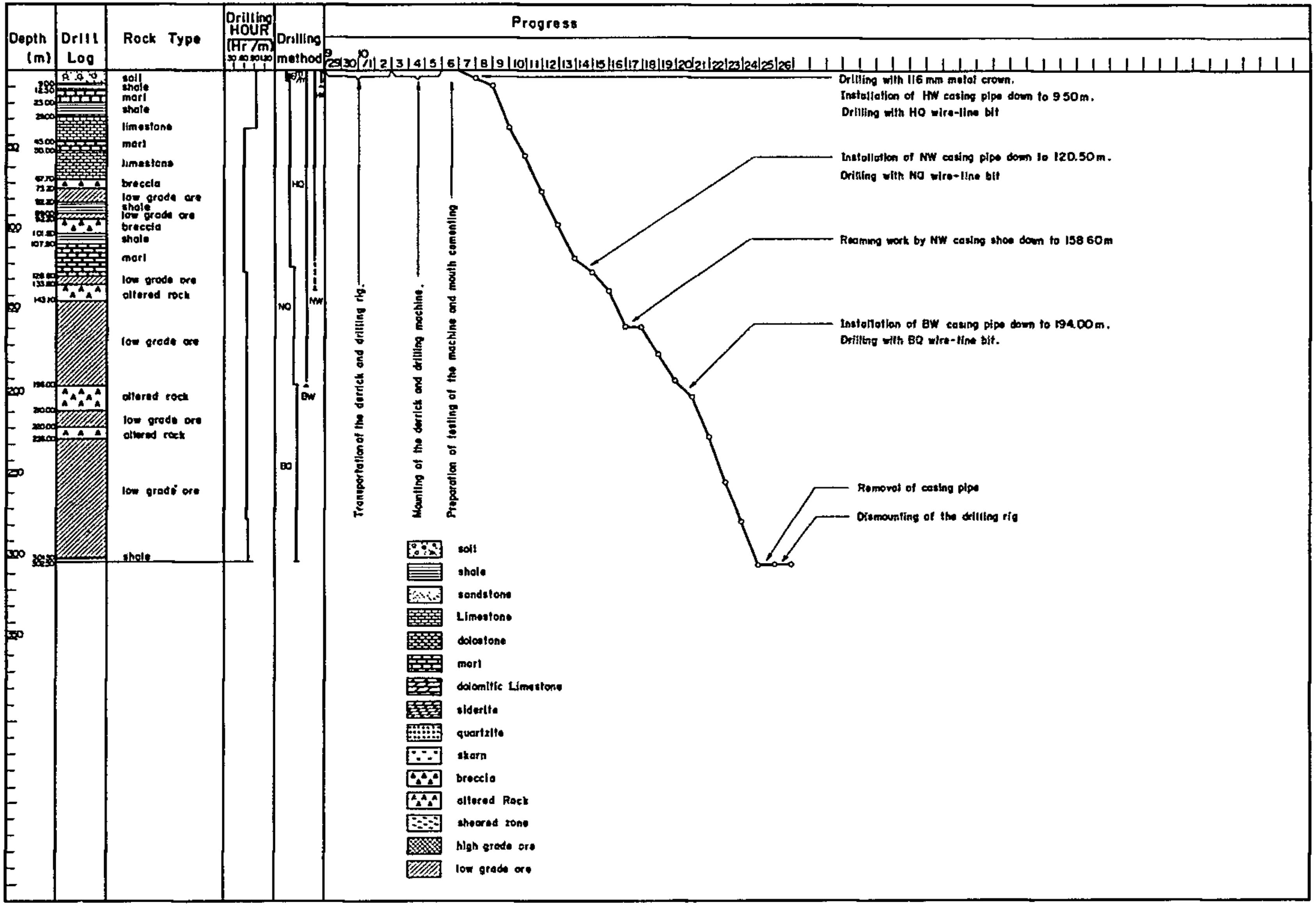


Fig. I – 5 PROGRESSIVE RECORD OF DIAMOND DRILLING, IC-5



Chapter 2 Geology and Mineralization of the Drill Holes

2-1 IC-1

(1) Purpose : Drilling of the hole IC-1 was carried out to examine the area along the northern margin of the geophysical anomaly of high FE with low AR, which corresponds to the northern extension of the gossaneous mineral indications outdropped in Cumbre de Limpe.

(2) Location : The area is located approximately 200 m north of Cumbre de Limpe. The altitude is as high as 4,719 m above sea level according to the new coordinate system. The bearing of the drill hole is 70° and the inclination is -60°. The depth of the bottom of the hole is 251.0 m (Refer to Fig. I-6).

(3) Lithology : Reached the base rock at the depth of 1.0 m, from where to the depth of 111.9 m are found the rocks belonging to the Carhuaz Formation, which is composed mainly of shale with thin layers of dolostone, marlstone, calcareous sandstone, etc. Calcareous sandstone beds are recognized in two layers at the depth between 66.0 m and 87.8 m. The cores between the depth of 111.9 m and the bottom of the hole are composed mainly of limestone with thin layers of shale. They belong to the Santa Formation. The limestone is generally dolomitized and sideritized. Fine-grained sphalerite and pyrite are disseminated in it. Intense mineralization is recognized at the depth between 121.0 m and 129.0 m, where pyrite and sphalerite are concentrated. Fractured zones are found at around the depth of 50 m and 90 m, as well as around the bottom of the hole.

(4) Mineralization and grade : The samples collected continuously in the mineralized portion of the cores are not revealing prominent assay results, which are shown below.

Depth (m)	Length (m)	No. of samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
121.0 - 129.0	8.0	4	4	0.07	0.76	3.46

Under microscope, dissemination of fine-grained electrum is recognized in small veinlets contained in the dolostone at the approximate depth of 137 m.

(5) Consideration : The above-mentioned mineralized portion is correlated to the mineralized horizon of the upper part of the Santa Formation. Indications of the same horizon have been caught in the drill hole DDH-4 located in the south of this hole, and in the hole DDH-3 in the north of the hole. The grade is lower in this hole compared to that of these two holes. The pyritic orebody along the lower horizon of the Formation, as caught in the drill hole DDH-4, is not recognized in this hole. The portion corresponding to the pyritic orebody is occupied by dolostone and siderite.

2-2 IC-2

(1) Purpose : Drilling of the hole IC-2 was carried out to examine the area showing geophysical anomaly of high FE with low AR, detected in and around Cumbre de Limpe.

(2) Location : The drill hole is located approximately 190 m southeast of the drill hole DDH-4 and about 180 m northeast of the hole DDH-5. The altitude is 4,781 m above sea level. The hole starts with the Chimu Formation, which occupies east side of the area where the Santa Formation is distributed. The direction of the drill hole is 250° and the inclination is -60°. The depth of the bottom of the drill hole is 250.4 m (Refer to Fig. I-7).

(3) Lithology : Siliceous sandstone or quartzite of the Chimu Formation is found down to the depth of 34.2 m. The Santa Formation is recognized at the depth between 34.2 m and 239.7 m, below the depth of which is the Carhuaz Formation composed mainly of shale. The Santa Formation is intensely altered and mineralized, and it extensively contains high grade Cu-Pb-Zn orebodies associated with pyrite. The wall rocks are principally silicified, argillized, sericitized, chloritized and carbonatized. In and around the mineralized portion, brecciation is remarkable. In the following, the details are given as for the principal mineralization and alteration.

47.0 m - 77.6 m : Pyritic orebody.

77.6 m - 104.7 m : High grade Pb-Zn orebody. Matrix is brown sphalerite containing galena and pyrite spottedly.

104.7 m - 126.0 m : Fine-grained sphalerite is disseminated in altered leucocratic rocks, argillized and silicified.

126.0 m - 146.3 m : Down to the depth of 135.2 m, chalcopyrite is disseminated in the pyritic orebodies, while chalcopyrite dissemination is recognized in the porous siliceously altered rocks, at the depth between 135.2 m and 146.3 m, where the core recovery is poor.

146.3 m - 177.2 m : Core recovery is pretty low, as the rocks are soft and weak, argillaceously altered.

211.1 m - 227.4 m : Pb-Zn orebody, pyritized.

(4) Mineralization and grade : The assay results of the remarkably mineralized portions are as follows. There are high grade parts of more than 30%, Pb and Zn combined.

Depth (m)	Length (m)	No. of samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
77.6 - 82.1	4.5	2	5	7.10	0.22	0.48
82.1 - 88.1	6.0	6	39	0.17	2.69	27.93
88.1 - 95.1	7.0	4	10	0.03	1.54	3.63
95.1 - 104.7	9.6	9	49	0.06	6.02	15.36
104.7 - 126.0	21.3	4	4	0.14	0.16	15.68
126.0 - 146.3	20.3*	5	46	3.38	0.03	0.43
211.0 - 227.4	16.4	8	25	0.06	4.43	9.39

* includes 5.2 m of core lacking part

Under microscope, small fractions of wall rocks and fine grains of galena as well as pyrite grains are contained in the sphalerite crystals. The country rocks are almost competely replaced. Often sphalerite is recognized to be developed along the margins of pyrite grains (IC-2-116), to fill up small fractures in the pyrite grains and to form lattice-like pattern (IC-2-87). Sphalerite contains spotted small grains of chalcopyrite, forming exolution lamelae (IC-2-190). Galena contains small grains of arsenopyrite, pyrite and pyrrohtite. Parts of pyrite have been altered to marcasite. Gratonite ($Pb_9As_4S_{15}$) is recognized in galena partly (IC-2-94).

(5) Consideration : The mineralized portion found continuously in the core length of 68.7 m at the depth between 77.6 m and 146.3 m is thought to correspond to the extension both of the pyritic orebody caught in the drill hole DDH-4 in the north of this hole and of the high grade Pb-Zn orebody recognized in the drill hole DDH-5 located in the south of this hole.

It is characteristic that the variation of grade is remarkably recognized in the mineralized portions caught in this drill hole, and that it contains copper ore minerals. The average grade of the mineralized portion of the core length of 43.9 m at the depth between 82.1 m and 126.0 m is Ag 20 g/t, Cu 0.11 %, Pb 2.01 % and Zn 15.36 %. The pyritic Pb-Zn orebody caught in the core length of 16.4 m at the depth between 211.0 m and 227.4 m is correlated to the ore zone in the upper horizon (though apparently it is along the lower horizon) recognized in the drill holes of DDH-4 and DDH-5.

2-3 IC-3

(1) Purpose : The drilling of the hole IC-3 was carried out to examine the southern marginal zone of the geophysical anomaly of high FE with low AR, detected in and around Cumbre de Limpe.

(2) Location : The drill hole is located approximately 100 m south of the drill hole DDH-5 and about 110 m north of the hole DDH-6. The altitude is 4,700 m above sea level.

The direction of the hole is 70° and the inclination is -50°. The depth of the bottom of the hole is 250.2 m. This drill hole was completed as a part of the 100 m grid drilling program in the southern half of the Limpe area (Refer to Fig. I-8).

(3) Lithology : Reached the base rock at the depth of 2.0 m. from where to the depth of 58.0 m the cores are composed mainly of shale with insertion of thin layers of marlstone, limestone, and sandstone, belonging to the Carhuaz Formation.

Below the depth of 58.0 m, the Santa Formation, composed of limestone and marlstone with insertion of thin layers of shale, is recognized.

The Santa Formation is intensely pyritized, and massive pyritic orebodies are found emplaced in the core length of 19.6 m at the depth between 74.8 m and 94.4 m and in the length of 76.8 m at the depth between 141.0 m and

217.8 m.

Copper concentration is recognized in parts of the pyritic orebodies, especially along their margins, represented by chalcopyrite, chalcocite etc.

(4) Mineralization and grade : The assay results of the cores of the principal mineralization are as follows.

Depth (m)	Length (m)	No. of samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
149.0 - 153.7	4.7	2	5	1.04	0.02	0.12
158.2 - 160.2	2.0	1	-	4.46	0.02	0.05

Under microscope, main copper mineral is chalcopyrite, while chalcocite and covellite are recognized to be developed along cracks and margins in chalcopyrite grains (IC-3-71). It is noted that fine dot-like grains of sphalerite are contained in pyrite grains (IC-3-91).

(5) Consideration : In this hole small scaled copper bearing pyritic orebody is found in the portion correlated to the high grade Pb-Zn orebodies in the lower horizon, caught in the drill hole DDH-5. Also in the portion of cores correlated to the Pb-Zn orebody in the upper horizon found in the drill holes DDH-5 and DDH-6, there is nothing more than pyritic orebody bearing slight copper dissemination in this drill hole. It is necessary to investigate the relation of these pyritic orebodies to the Pb-Zn orebodies stereographically.

Below the depth of 230 m of this hole, alternation of sandstone, delostone and shale is recognized. They are thought to indicate the series to be close to the Chimu Formation.

2-4 IC-4

(1) Purpose : Drilling of the hole IC-4 was carried out as a part of the 100 m grid drilling program in the southern half of the Limpe mineralization area. The hole is situated in the outer shell of the geophysical anomaly of high FE with low AR, revealing the values of FE < 3 (%) and AR > 250 (Ωm).

(2) Location : The hole is located approximately 90 m south of the hole DDH-6. The altitude is 4,676 m above sea level. The bearing of the hole is 70° and the inclination is -45°. The depth of the bottom of the hole is 250.2 m (Refer to Fig. I-9).

(3) Lithology : Talus deposits are to the depth of 8.0 m, below which the sediments of the Carhuaz Formation are found down to the depth of 66.4 m. The Curhuaz Formation is composed of alternation of shale, marlstone and limestone, with the insertion of sandstone layer at the depth between 34.2 m and 39.0 m.

The Santa Formation is recognized below the depth of 66.4 m. There are leucocratically altered rocks and argillaceous silicified rocks below the depth of 246.5 m down to the bottom, which are thought to be correlated to the border zone between the Santa Formation and the Chimu Formation.

The sediments of the Santa Formation are intensely hematitized and pyritized. Copper dissemination is recognized in time. Massive pyritic orebodies are recognized at the depth between 89.1 m and 114.0 m and between 220.0 m and 246.5 m, total length of which is 51.4 m. Massive hematitic orebodies are found at the depth between 114.0 m and 165.2 m and between 180.8 m and 218.8 m, total length of which is 89.2 m. The hematite masses are usually chacoal brown to dark colored, while they become reddish brown in color, soft, weak and clayey, after swelled by absorption of moisture once transported on to the surface.

As for the wall rock alteration, silicification and sericitization are found in the orebodies, while carbonitization, chloritization and argillization are remarkable in the surrounding area of the orebodies.

(4) Mineralization and grade : The assay results of the cores of the principal copper mineralization are as follows.

Depth (m)	Length (m)	No. of samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
114.0 - 120.5	6.3	3	32	2.20	0.02	0.29
157.4 - 158.7	1.3	1	24	5.62	0.02	0.05
180.8 - 186.8	6.0	3	-	0.83	0.01	0.05
198.0 - 223.7	25.7	5	2	0.63	0.01	0.03

The mineralization recognized in this drill hole is different from those found in the other holes, as it is represented mainly by hematite associated with pyrite and chalcopyrite.

By the microscopic examination, hematite is usually euhedrally crystallized in lamella, maximum 0.5 mm long so far recognized.

Hematite is disseminated homogeneously in parts and irregularly in other parts in the wall rocks, while it forms radial or spherical aggregates partly. Rarely is accompanied sphalerite, in which covellite is recognized along cracks (IC-4-114).

(5) Consideration : According to the results of the geophysical prospecting, this drill hole is located in the bay of relatively low FE zone projected into the high FE anomaly. It has become evident, by the examination of the cores of this drill hole, that the low FE anomaly would have been caused by the results of decrease of pyrite and increase of hematite.

It is also clarified that the hematite is not associated with lead and zinc ore minerals, but that it is intimately associated with copper ore minerals.

2-5 IC-5

(1) Purpose : Drilling of the hole IC-5 was carried out in order to prospect the depth of the pyritic orebody which exposes in the area where talus deposits are distributed about 660 m south of Cumbre de Limpe.

(2) Location : The drill hole is located on the east bank of the small lake, approximately 180 m south of the drill hole IC-4. The altitude is 4,674 m above sea level. The bearing of the hole is 70° and the inclination is -50°. The depth of the bottom of the hole is 302.5 m (Refer to Fig. I-10).

(3) Lithology : The hole starts with talus deposits. It reached the Carhuaz Formation at the depth of 9.0 m, which is composed of shale, marlstone, and limestone. Below the depth of 28.4 m, the Santa Formation mainly of limestone is found continued down to the bottom of the hole.
The Santa Formation is severaly pyritized and pyritic orebodies are recognized emplaced at the depth between 73.2 m and 82.2 m and between 143.1 m and 301.5 m. Along the marginal zone of the pyritic orebodies, alterations such as silicification, argillization and chloritization are remarkable, and in some cases hematite and copper ore minerals are concentrated.
Brecciation is also recognized. Druses are developed in the cores of the depth between 147 m and 171 m and between 191 m and 198 m, where, as the matrix is argillaceous, easily collapsed and smashed, core recovery is poor.

(4) Mineralization and grade : The assay results of the portions of high grade copper mineralization are as follows.

Depth (m)	Length (m)	No. of samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
128.8 - 130.4	1.6	1	4	4.64	0.09	0.20
131.8 - 133.8	2.0	1	4	0.72	0.01	0.10

Under microscope, fluorite is recognized as a gangue mineral with hematite associated with copper minerals. The mineral assemblage of chlorite - quartz - fluorite (IC-5-130) and quartz - clay minerals (IC-S-132) are remarkable, representing alteration minerals, in addition to that of quartz - sericite found in the hole IC-4. Hematite is associated intimately with pyrite and chalcopyrite (IC-5-132), and it often forms spherical aggregates around small grains of pyrite and chalcopyrite (IC-5-132).

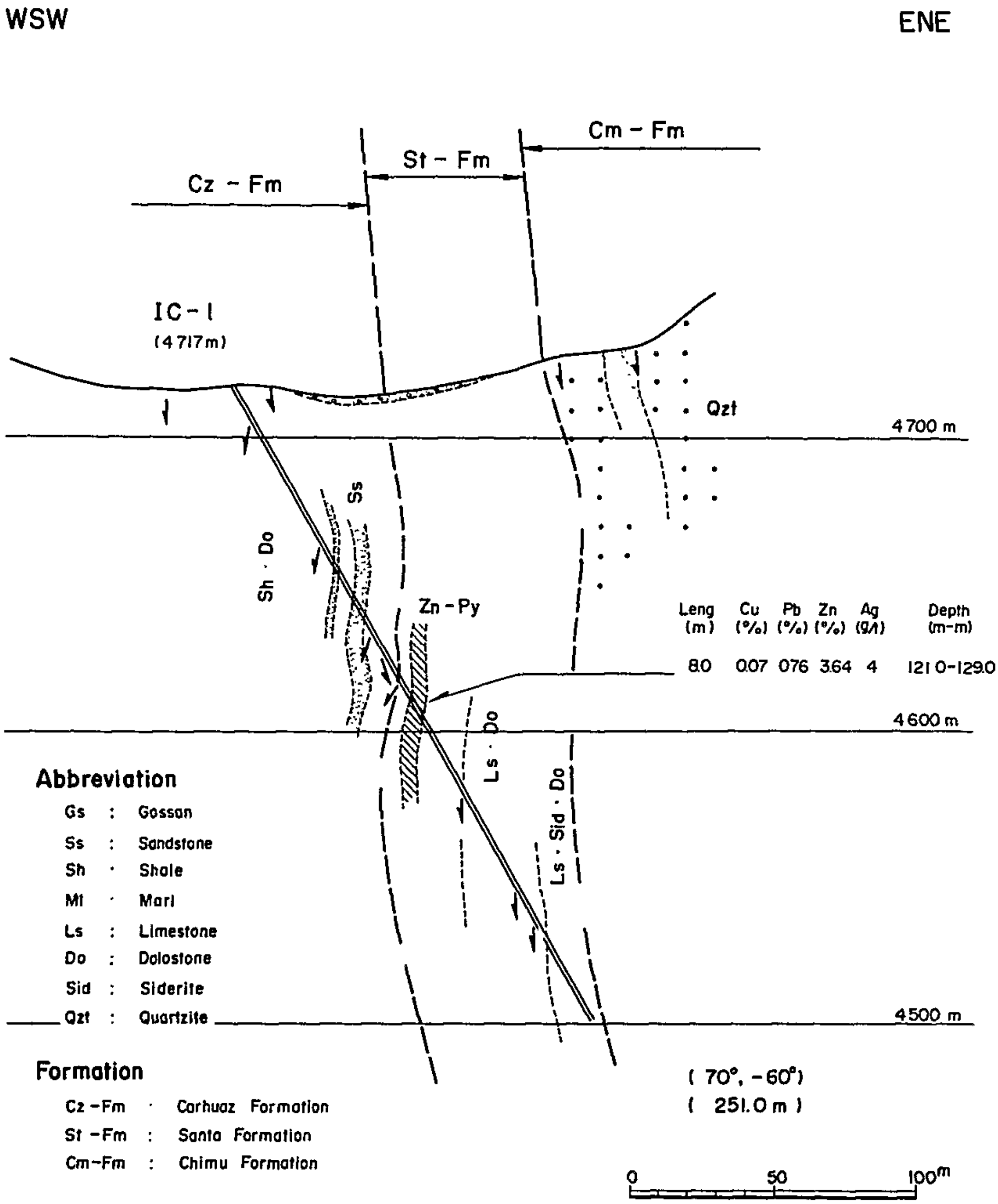
(5) Consideration : As for the mutual relation of hematite, pyrite and chalcopyrite, it is thought, through the results of the microscopic examination, that the hematite would have been formed in the latest stage, because the euhedral crystals of hematite are recognized to be developed in pyrite and chalcopyrite grains, while no pseudomorphs of hematite are found contained in them (IC-4-181, IC-5-74, IC-5-132).

It is thought that most of the hematite would have been formed in the oxidizing environment in the outer shell of the mineralized zone.

Table I-1 List of Drillings in the Limpe Area

DDH No.	Coordinate		Elevation	Direction	Inclination	Depth
	N	E	(m)			(m)
DDH - 3	809,093	310,262	4,680	60°	- 75°	252.0
IC - 1	808,942	310,313	4,719	70°	- 60°	251.0
DDH - 4	808,856	310,364	4,736	70°	- 60°	184.7
IC - 2	808,755	310,523	4,781	250°	- 75°	250.4
DDH - 5	808,597	310,433	4,724	70°	- 45°	211.1
IC - 3	808,503	310,481	4,700	70°	- 50°	250.2
DDH - 6	808,396	310,508	4,678	70°	- 55°	301.6
IC - 4	808,322	310,562	4,676	70°	- 45°	250.2
IC - 5	808,158	310,639	4,674	70°	- 50°	302.5

Coordinate and elevation are adjusted by the triangulation result.



Abbreviation

Gs	:	Gossan
Ss	:	Sandstone
Sh	:	Shale
Ml	:	Marl
Ls	:	Limestone
Do	:	Dolostone
Sid	:	Siderite
Qzt	:	Quartzite

Formation

Cz-Fm	:	Carhuaz Formation
St-Fm	:	Santa Formation
Cm-Fm	:	Chimu Formation

Fig. I - 6 Geological Section for IC - I

(S70°W - N 70°E)

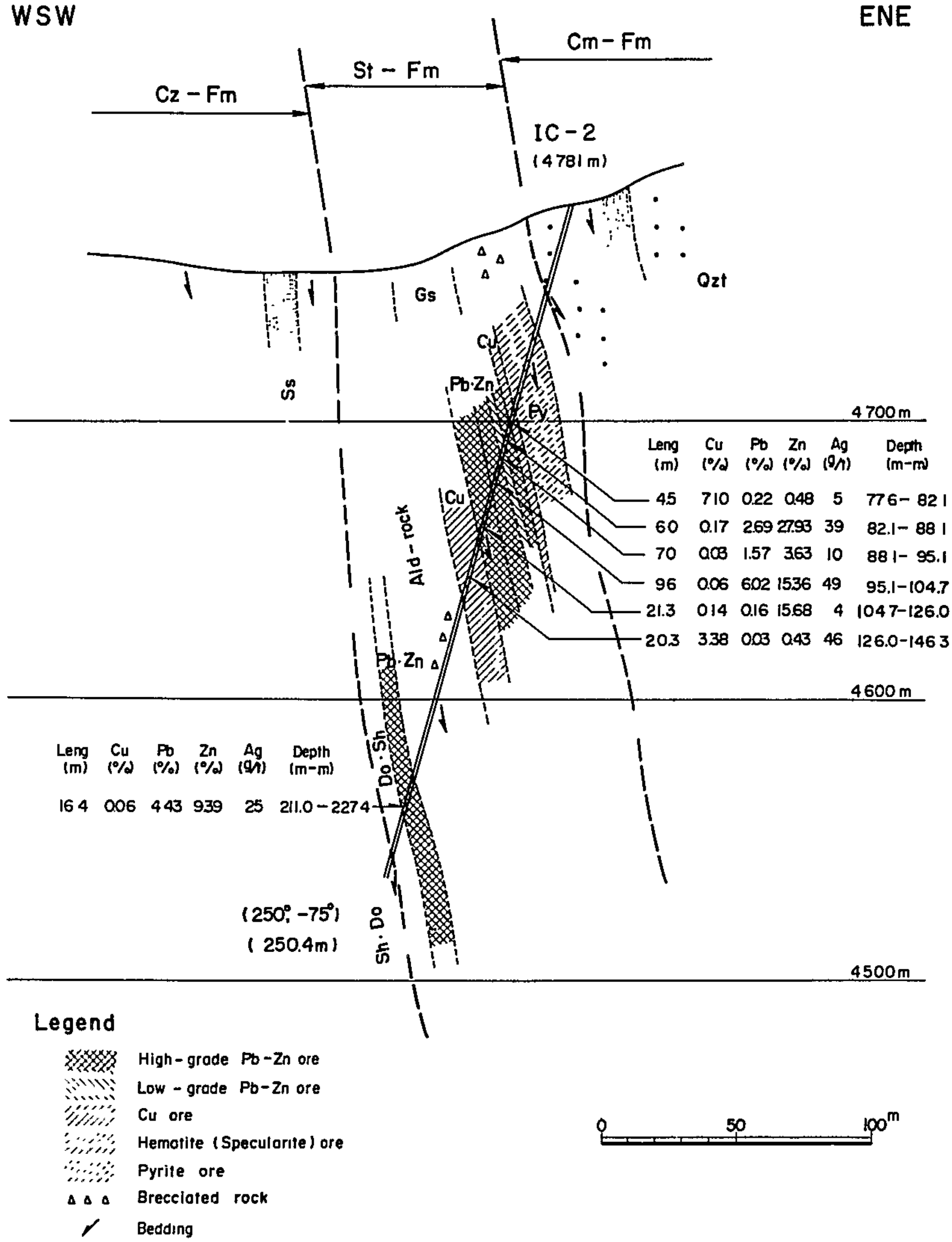


Fig. I - 7 Geological Section for IC-2

(S70°W - N70°E)

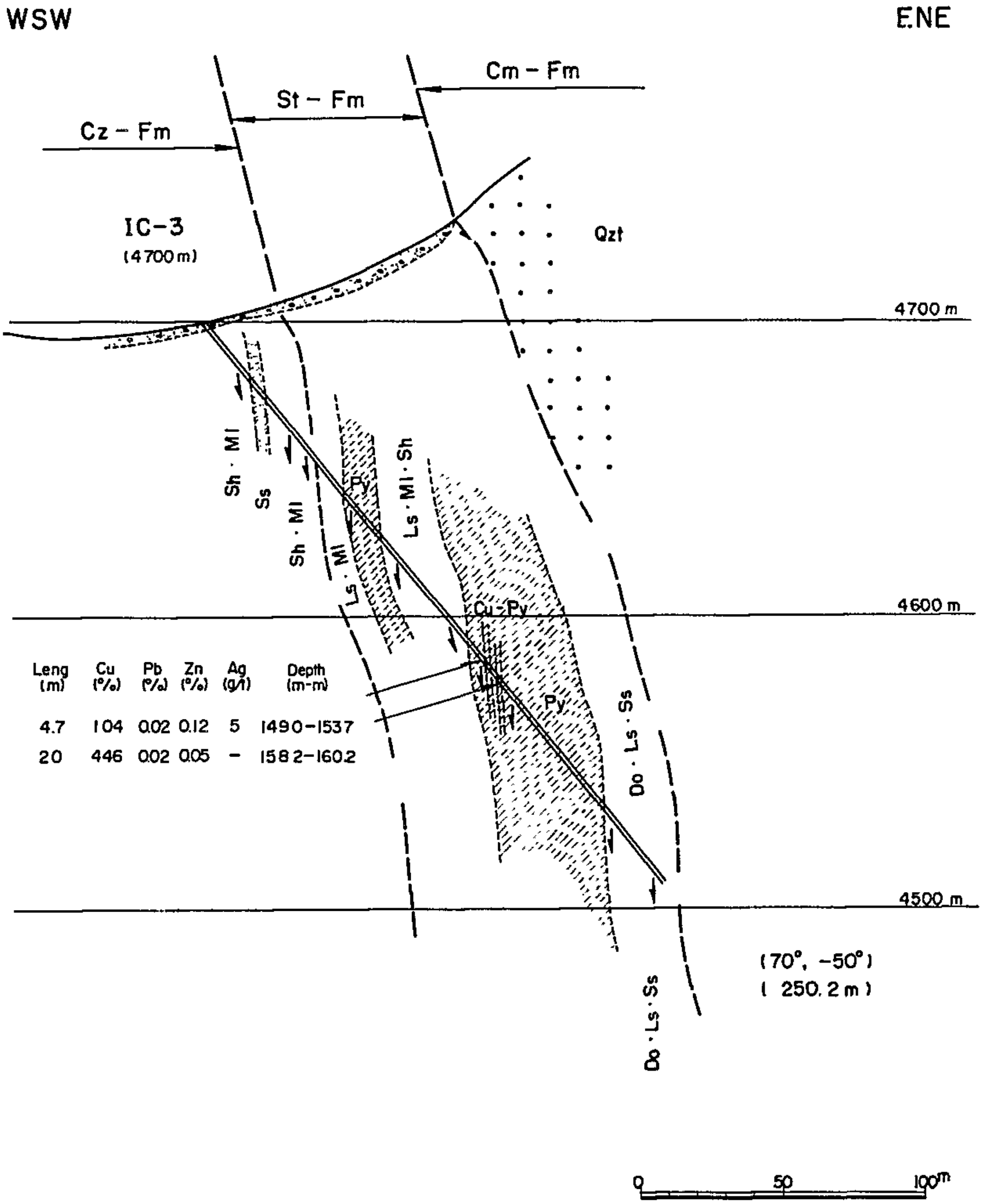


Fig. I – 8 Geological Section for IC-3

(S70°W – N70°E)

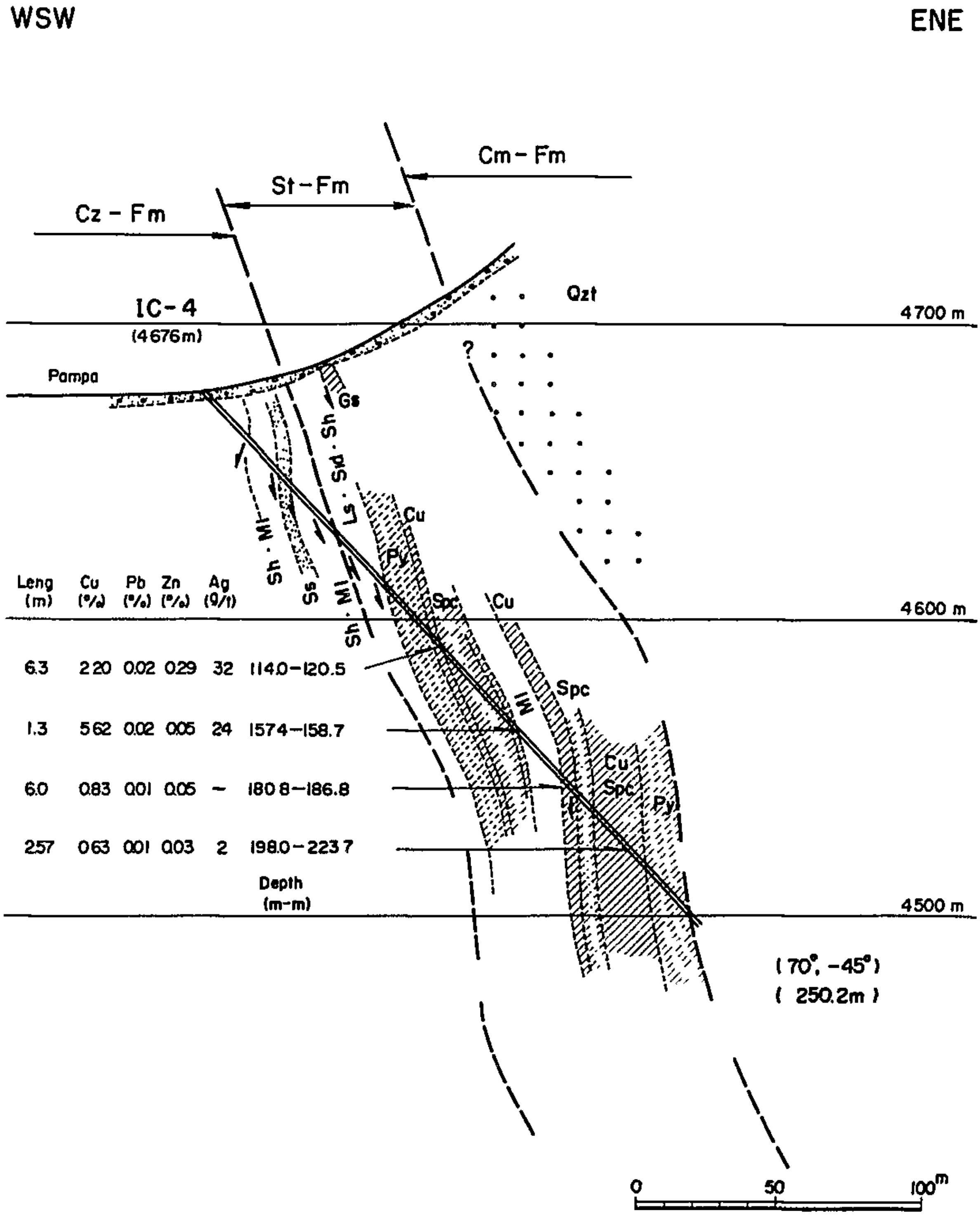


Fig. I - 9 Geological Section for IC - 4

(S70°W - N70°E)

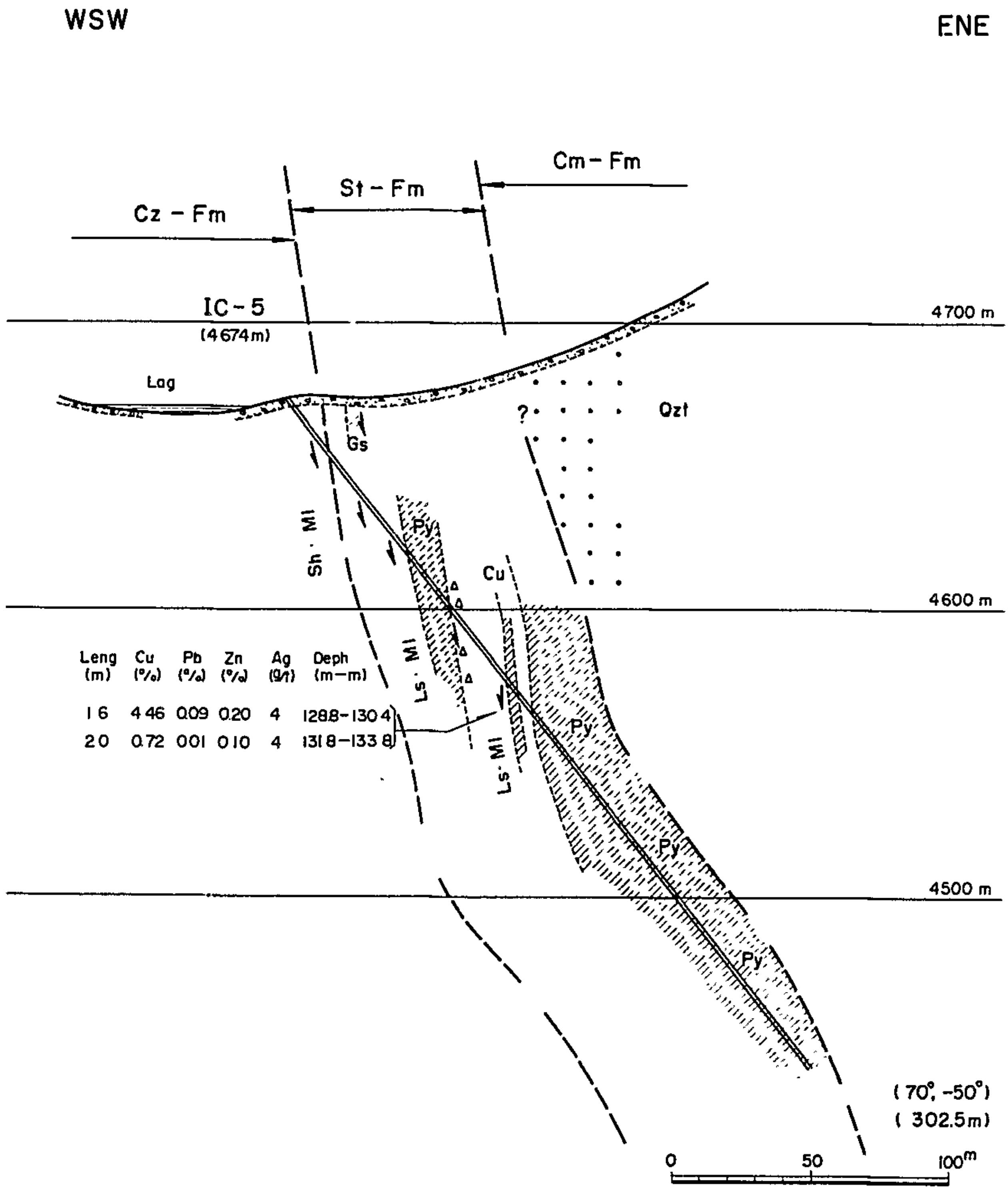


Fig. I - 10 Geological Section for IC-5

(S70°W - N70°E)

PARTICULARS
PART Ⅱ
TUNNELLING EXPLORATION

PART II TUNNELLLING EXPLORATION

CONTENTS

LIST OF APPENDICES

Chapter 1 Tunnelling Exploration

1-1 General View of the Survey

Two tunnels were excavated from the both eside of Cumbre de Limpe (means Limpe Pass), of Limpe area. They are named as Adit-N and Adit-S of which gates are 350 m north and 1050 m south-southeast, respectively of Cumbre de Limpe. The tunnels were expected to cut ore deposits which previous survey, geological, geophysical, and drilling survey had promissed (see Fig. 6).

The length and specifications of the tunnels and duration and other working conditions of excavation work are as follows:

(1) Length of the Tunnels

Name	Planned Length (m)	Excavated Length (m)
Adit-N	310	310.4
Adit-S	270	270.1
Total	580	580.5

(2) Specifications of the Tunnels

Effective Section		2.6m x 2.5m
Inclination		1/100 to 1/200
Elevation of Gate	Adit-N	4,689.37m
	Adit-S	4,570.14m

Direction of Tunnels

Name	Direction	Length
Adit-N	110 degrees	100.0m
	160 degrees	210.4m
Adit-S	0 degree	138.0m
	330 degrees	132.1m

(3) Term of Exploration

Total days spent for excavation and its related work are 352 days from July 12, 1982 until June 27, 1983, as shown in Table A II-1.

During the first few months of this period, road construction, construction of camp and storage buildings, and transportation of machinaries and materials were carried on until October 9. Excavation began on September 26, with 23 days shutdown due to flood damage in April, 1983.

(4) Working System

Road construction and camp construction were carried out for eight hours per one shift and one shift per day and tunnel excavation was carried out for eight hours per shift and three shift per day.

(5) Number of Workers

Personnel worked for tunnel excavation including road and camp construction are as follows:

1. Japanese engineers	2 men per day
2. Peruvian engineers	6 men per day
3. Excavation laborers (incl. waste carrier and track builder)	34 men per day
4. Surface laborers (storekeeper, mechanics and compressor operator)	6 men per day
5. Other laborers (camp and road construction)	11 men per day
6. Chauffers of Jeep and pock-up truck	3 men per day
7. Cook	8 men per day

(6) Topographic Survey

Table A.II-9 shows the results of survey in the tunnels and PL. II-1 and PL. II-2 are maps of the tunnels.

(7) Geological Survey in Tunnels

The tunnels were geologically surveyed on the scale of 1 to 200 with stress laid on clarifying lithology, geological structure, mineralization and dislocation by faults.

1-2 Road Construction

Of the 16 km road section between the starting point of the construction about 0.6 km north of Pampahuay and Iscaycruz, one 7.7 km was newly constructed, a 3.7 km section was widened and other part were repaired. The construction was carried out by two bulldozers (DC-6) and manual labor.

1-3 Camp Construction

A lodging house (194 m^2) with a galvanized sheet iron roofing and a dining room-kitchen-warehouse building (80 m^2) were built in the vicinity of the gate of Adit-S. A galvanized sheet plated house with a floor space of about 190 square meters was built about 1 km from the gate of Adit-N for a engineers housing (166 m^2) and for an office space (24 m^2). Two buildings with galvanized iron roofing were built for a compressor housing (18 m^2) and for a fuel storage (18 m^2) in the vicinity of the gate of Adit-N and Adit-S. A storage house (18 m^2) was built in the vicinity of the gate Adit-N. An underground magazine and a storage for detonators were constructed 500 m from the gate of Adit-N.

Major machinary, and major buildings constructed are listed in table A II-4.

1-4 Excavation

Personnel and working hours of excavation are as follows:

(1) Engineers

Adit-N	Ken Nakamura
	Hoover Ilave
	Borja Cardenas
	Maximo Gonzales
Adit-S	Harukichi Ide
	Hideo Morishita
	Hector Villanueva
	Jorge Lopez
	Juan Torre

(2) Personnel

Excavation personnel for each Adit is one Japanese engineer, three Peruvian engineers and twenty laborers. Excavation was carried out by one engineer and seven laborers per shift on three shift per day.

(3) Working House

The first shift	from 7:00 to 15:00
The second shift	from 15:00 to 23:00
The third shift	from 23:00 to 7:00

1-5 Adit-N Excavation

<u>Gate to 31.0 m:</u>

The tunnel was excavated with timbers after removing surface soil as the first few meters with a bulldozer. The rocks were very brittle consisting of altered marlstone and sandy rocks. Therefore this part was needed to be totally timbered (22 pieces).

31.0 m to 110 m:

The rocks between 31.0 m and 60 m are alternation of dolostone and shale and the rocks after 60.0 m are very hard quartzite. Timber was not needed in this section, but excavation was very difficult. At around 80 m, 14 timbers were installed because of many fractures with NNW direction with pyrite.

110 m to 270 m:

Excavation was disturbed by many NNW fractures developing in the quartzite.

270 m to 310.4 m:

Excavation was diffucult because of joints and fractures developing in the quartzite.

The excavating rate per one actual working day is 1.634 m and a total of 36 timbers was installed.

1-6 Adit-S Excavation

Gate to 190 m

A total of 15 timbers and later timber were installed in the section between the gate and 80 m because of many cracks in the limestone.

At the section between 80 m and 88 m, the rocks are fractured with clay and installation of 3 timbers were required and track building was also very difficult.

Excavation was slowed down between 88 m and 130 m because of many fractures in the quartzite and shale.

At approximately 138 m from the gate, the direction of the tunnel was changed from 0 degree to 330 degrees.

The rocks after 130 m are hard quartzite and shale. At 190 m the fault is encountered and after the fault the rocks is ultra-hard quartzite which kept excavation still difficult but without any timber.

190 m to 270.1 m

Hard quartzite of Chimu Formation continues to this section. Average drilling rate was 15 cm per minute and 45 to 49 drill holes were required for one blasting. Therefore the excavation was very slow and consumption of drilling bit became very heavy.

The excavating rate per actual working day is 1.422 m and a total of 15 timbers was installed.

Chapter 2 Geology of the Exploration Tunnels

2-1 Adit-N

The direction of the Adit-N is 112° to the point as far as 100 m from the entrance (the 100 m point, hereafter). Soft and weak argillaceous rocks are recognized to occupy the wall of the tunnel to the 35 m point (true thickness: 27 m). There are dark-colored part and leucocratic part in the rocks. The dark part is thought to be the weathered product of dolostone while the leucocratic part is inferred to represent alteration and weathering of shale and marlstone. The strike of the beds is N20°W, and the dip is 80°-85°E. As a whole, dissemination of pyrite is recognized. These beds are correlated to the lower part of the Santa Formation.

Quartzitic sandstone is found in the width of 3 m from the 35 m point, from where the alternation of dolostone, quartzitic sandstone, shale and marlstone is observed to the 78 m point (true thickness: 32 m). Quartzitic sandstone is grey, compact and hard, composed mostly of quartz. Dolostone is dark-colored, medium-grained, crystalline and comparatively soft. Shale is grey and apparently brecciated. Innumerable joints are developed in the shale, parallel to the bedding plane. Marlstone is light grey in color and soft in properties. This alteration zone represents the transitional zone to the Chimu Formation, which is developed in the neighbouring area to the Santa Formation. Along the boundaries of the hard and the soft rocks, faults and brecciation zones parallel to the bedding planes are developed. Dissemination of pyrite is recognized.

Dark to light grey quartzite (true thickness: 8 m) of the Chimu Formation is found from the 78 m point to that of 90 m, and the dark-colored dolomitic shale (true thickness: 7 m) occurs between the points of 90 m and 100 m. The quartzite appears again and continues in the farther part of the tunnel than the 100 m point.

The direction of the tunnel is changed at about 100 m point, by turning 42° to the right, roughly in the direction along the strike of the beds. Now that the tunnel runs in the direction of 160° (S20°E) and the strikes of the beds are N10°-15°W, the tunnel and the strikes of the beds are crossing in so small angles as 5° to 10°, hence the deeper in the tunnel, the closer it comes to the lower parts of the Chimu Formation.

The quartzite is compact, hard and light to pale grey in color, composed mostly of quartz. Beds of shale are observed to be inserted with the approximate width of 1 m at the 150 m point, that of 1 m again at the 175 m point and that of a little less than 3 m at the 220 m point. Also, bedding joints are well developed regularly in the quartzite with the interval of 1 meter or around. In such joints, thin layers of shale are found inserted frequently with the thickness of several milimeters to several centimeters. The quartzite is continuous to the 310 m point, the farthest point of the tunnel so far excavated in this year's program. The general trend of the quartzite is N15°W and the dip is 80°E. No remarkable faults are found in the deeper part of the tunnel than the 100 m point, but steep angled joints of the trend of N70°E, which intersect the bedding joints with almost right angle, are numerously developed, dislocating the beds in small amount. Dissemination of pyrite is recognized along the joints.

2-2 Adit-S

The entrance of the Adit-S is in the area occupied by the limestone belonging to the Santa Formation. The tunnel was excavated in the direction of 0°. In the tunnel, dark grey limestones are found from the entrance to the 62 m point, from where the alternation of limestone, marlstone and shale is recognized to the 70 m point. These limestones and the alternated beds belong to the Santa Formation.

The trend of the limestones is N25°W and the dip is 60°-65°E. Regular joints parallel to the bedding planes are well developed with the interval of several centimeters to several ten centimeters. Along the joint planes, thin layers of shale are frequently inserted, where shale layers are usually brecciated. In some places in the limestones, networks of calcite veinlets are recognized and dissemination of pyrite is observed locally.

A small falt is found at the 70 m point, 20-40 cm wide, with the strike of N60°W and the dip of 65°S. In the deeper part of the tunnel off this fault, there appears the alternation of dolostone and siliceous sandstone, which represents the transitional zone to the Chimu Formation. The dolostone is dark in color, fine to medium-grained, and crystalline. Veinlets of dolomite are found in white stringers. Quartzitic sandstone is light grey, compact and hard, composed mostly of quartz.

From the 85 m point to that of 90 m, a fractured fault zone is recognized with the true width of 5 meters. Fault clay is observed over whole width of 5 meters. It is inferred that the strike of the fault is E-W with the dip of 60°-70°S. The north block of the fault has been dislocated toward the west or the south block toward the east. The amount of dislocation is estimated to be at least several ten meters.

Bounded by the E-W fault, the quartzite of the Chimu Formation appears in the tunnel. The quartzite in the neighbourhood of the fault is heavily brecciated. It has been crushed into as small blocks as ten odd centimeters, each of which has some brecciated structure and is disseminated with limonite. Although an insertion of shale bed is found between the points of 106 m and 115 m (true thickness: 7 m), the tunnel wall is occupied by the quartzite. Near the 125 m point, gentle dipping fractures are developed in this quartzite. The strike of the quartzite beds is N25°W and the dip of them is 70°E, which shows the dipping becomes slightly steeper beyond the fault.

At about 140 m point, the direction of the tunnel is changed by turning 30° to the left. Now the tunnel runs in the direction of 330° and the strikes of the beds in this area are N20°-25°W, it is taken that the orientation of the tunnel is toward the upper portion of the Chimu Formation or toward the Santa Formation, the deeper the tunnel goes.

Beyond the turning point of the tunnel, the quartzite beds disseminated with pyrite and limonite are seen appearing to as deep point as 165 m, from where there is a shale bed to the 188 m point. This shale bed is thought to be another part of the same shale bed as seen at the 106 m point. The true thickness of this shale is about 5 meters, but if the alternation of the shale and the sandstone would be included, it becomes as much as about 7 meters. The shale bed has been dislocated to the right by a small fault of the strike of N60°W with the dip of 70°S, found at the 188 m point. The quartzite is observed to appear again from this point to the 280 m point, the farthest point of the tunnel, so far excavated as the work in this year's program.

The quartzite is white in color, medium-grained, siliceous, hard and compact. By heavy silicification, it is composed of recrystallized quartz, partly associated with sericite. The strikes of the quartzite beds are N20°-25°W and their dips are 70°-80°E. Bedding joints parallel to the bedding plane of the quartzite are developed, and also steeply dipping joints of ENE-WSW system, corssing the bedding joints with almost right angle are well developed regularly. Near the 200 m point, a small fault of E-W system is recognized. Dissemination of pyrite along these joints and the fractures are remarkable.

APPENDICES
PART I
DATA OF DRILLING

LIST OF APPENDICES

A. I-1 List of the Used Equipment for Drilling

Item	Model	Quantity	Capacity, Type, and Specification
Drilling Machine	TCM-3C	1	Capacity NQ 510m, BQ 660m Inner Diameter of Spindle 93mm Weight (except engine) 2,300kg
Drilling Machine	TCM-5A	1	Capacity NQ 510m, BQ 660m Inner Diameter of Spindle 93mm Weight (except engine) 1,500kg
Engine for Drill	F4L-912	1	Diesel Engine 1,800 rpm/55 PS~1,500 rpm/41 PS
Engine for Drill	F6L-912	1	Diesel Engine 1,800 rpm/78 PS~1,500 rpm/65 PS
Pump	NAS-3C	2	Piston ϕ75 mm Capacity 130, 72, 39, 22 ℓ/min Pressure 26 ~40 Kg/cm^2
"	NAS-3B	2	Piston ϕ75 mm Capacity 130, 72, 39, 22 ℓ/min Pressure 26 ~40 Kg/cm^2
"	MS-303	1	Piston ϕ25 mm Capacity 25 ~41 ℓ /min Pressure 35 Kg/cm^2
Engine for pump	2T-90L	1	Diesel Engine 1,800 rpm/20 PS
"	NS-130C	2	Diesel Engine 1,800 rpm/8.5 PS
"	NS-110C	2	Diesel Engine 1,800 rpm/8.5 PS
"	NS-65C	4	Diesel Engine 1,800 rpm/5.5 PS
Generator	YSG-3.5	4	3.5KVA, 220V, 60c/s
Engine for Generator	NS-65C	4	Diesel Engine 1,800 rpm/5.5 PS
Mud Mixer	MCE-200A	2	Volume 200ℓ, 800 ~1,000 rpm/min
"	MCE-100A	1	Volume 100ℓ, 800 ~1,000 rpm/min
Derrick	DCP9-6A	1	Steel structural derrick (Vertical, inclination) Weight 2.4 ton Lifting 9 m height
"	DCP9-9	1	Steel structural derrick (Vertical, inclination) Weight 2.4 ton Lifting 9 m height
Rod Holder	RH-85	3	Hand Type
Drill Rods	HQ-WL	68	3.00 m/PC
Drill Rods	HQ-WL	2	1.50 m/PC
"	NQ-WL	170	3.00 m/PC
"	"	2	1.50 m/PC
"	BQ-WL	197	3.00 m/PC
"	"	2	1.50 m/PC
Casing Pipes	112 m/m	5	3.00 m/PC
"	"	2	1.00 m/PC
"	"	2	0.50 m/PC
"	HW	25	3.00 m/PC
"	"	11	1.00 m/PC
"	"	5	0.50 m/PC
"	NW	60	3.00 m/PC
"	"	2	1.00 m/PC
"	"	4	0.50 m/PC
"	BW	120	3.00 m/PC
"	"	2	1.00 m/PC
"	"	3	0.50 m/PC

A. I-2 Articles of Consumption and Drilling Parts

Item	Specification	Unit	Quantity				
			IC-1	IC-2	IC-3	IC-4	IC-5
Light oil		ℓ	5,686	5,012	5,090	6,100	6,510
Gasoline		ℓ	249	181	180	175	227
Mobil oil		ℓ	228	284	215	205	380
Hydraulic oil		ℓ	20	-	10	20	5
Grease		kg	17	-	35	70	40
Bentonite	50kg/bag	kg	149	174	158	283	268
Libonite		kg	82	127	125	129	155
Tel-cellose		kg	22.5	28	26	28	32
Tel-stop		kg	85	76	126	99	152
Emale 20C		ℓ	-	-	-	-	-
Cement	40kg/bag	Bag	35	10	14	10	20
Metal crown	116mm	Pc	1	1	-	2	2
Single core tube	114mm x 0.5m	Set	-	-	1	-	1
Wire line core barrel	HQ x 1.50m	"	-	-	1	-	-
" "	NQ x 1.50m	"	-	-	-	-	1
" "	BQ x 1.50m	"	-	-	-	1	-
Inner tube assembly	HQ x 1.50m	"	-	-	-	-	1
" "	NQ x 1.50m	"	-	-	1	-	-
" "	BQ x 1.50m	"	-	-	-	-	1
Outer tube	HQ x 1.50m	PC	-	-	-	-	-
"	NQ x 1.50m	"	-	-	-	-	-
"	BQ x 1.50m	"	-	-	1	-	-
Inner tube	HQ x 1.50m	"	-	-	-	-	-
"	NQ x 1.50m	"	-	-	-	-	1
"	BQ x 1.50m	"	-	-	-	1	-
Casing metal shoe	114mm	"	-	-	-	1	1
"	HW	"	1	1	1	-	1
"	NW	"	1	1	1	1	1
"	BW	"	1	1	1	1	1
Guide pipe	HQ	"	-	1	-	-	-
"	NQ	"	-	-	-	1	-
"	BQ	"	-	-	-	-	1
Guide coupling	HQ	"	-	-	-	1	-
"	NQ	"	-	1	-	-	-
"	BQ	"	-	-	-	-	1
Core lifter case	HQ	"	1	1	2	2	3
"	NQ	"	2	3	3	1	2
"	BQ	"	-	4	2	2	3
Core lifter	HQ	"	2	1	4	4	6
"	NQ	"	4	6	6	2	4
"	BQ	"	-	8	4	4	6
Water swivel packing		"	-	3	-	3	3
Water swivel spindle		"	-	1	-	1	-
Suction hose	50mm x 4.5m	"	-	1	-	-	1
Piston rod		"	4	-	-	4	-

Item	Specification	Unit	Quantity				
			IC-1	IC-2	IC-3	IC-4	IC-5
Valve steel ball	38.1 φ	Pc	8	-	8	8	-
Pump packing		"	8	-	8	8	8
V-belt	TGM-3CxF4L912	Set	-	1	-	-	-
"	TGM-5AxF6L912	"	-	-	-	1	-
"	NAS-3Cx2T-90L	"	-	1	-	-	-
"	NAS-3BxNS-130C	"	-	-	1	1	-
"	YSG-3.5xNS-65C	"	-	1	-	1	1
Core box	HQ	Pc	15	8	35	35	35
"	NQ	"	55	30	25	20	15
"	BQ	"	-	10	15	15	20
Wire	10#	kg	10	15	18	10	12
"	12#	"	8	6	10	8	5
Nail		"	10	10	5	5	10
Wire rope	6mm x 550m	Roll	0.5	-	-	0.5	-
"	12mm x 40m	"	1	-	-	1	-
Manila rope	18mm x 30m	"	1	-	-	1	-
Vinyl rope	8mm x 100m	"	1	-	-	1	-
Rag		kg	10	15	5	10	5

A. I-3 Preparation and Removal Records

Item / Hole No.		IC - 1		IC - 2		IC - 3		IC - 4		IC - 5							
Preparation and removal	In	30th Jul.'82		14th Sep.'82		7th Oct.'82		26th Aug.'82		29th Sep.'82							
		17th Aug.'82		18th Sep.'82		10th Oct.'82		31th Aug.'82		6th Oct.'82							
	Out	12th Sep.'82		5th Oct.'82		20th Oct.'82		26th Sep.'82		25th Oct.'82							
		13th Sep.'82		6th Oct.'82		22th Oct.'82		28th Sep.'82		26th Oct.'82							
		Days	Man-shifts	Days	Man-shifts	Days	Man-shifts	Days	Man-shifts	Days	Man-shifts	Days	Man-shifts	Days	Man-shifts	Days	Man-shifts
Preparation	Access road	2	35	-	-	-	-	-	-	1	7						
	Haulage	4	68	2	34	1.5	39	2	44	2	45						
	Installation	3	51	2	44	1.5	25	3	31	4	99						
	Water pipe	1.5	17	0.5	17	0.5	10	0.5	10	0.5	7						
	Test run, etc.	8.5	49	0.5	10	0.5	10	0.5	17	0.5	10						
	Total	19	220	5	105	4	84	6	102	8	168						
Removal	Dismantling	1	25	0.5	13	1	27	1	25	1	25						
	Pipe removal	0.5	7	-	-	1	21	1	17	0.5	10						
	Haulage	0.5	10	0.5	8	1	17	0.5	10	0.5	7						
	Road rein-statement	-	-	-	-	-	-	-	-	-	-						
	Others	-	-	-	-	-	-	-	-	-	-						
	Total	2	42	1	21	3	65	2.5	52	2	42						
Grand Total		21	262	6	126	7	149	8.5	154	10	210						

A. I-4 Operation Results of Drill Hole, IC-1

Working Period		Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
	Preparation	30th Jul.'82~17th Aug.'82	19	19	-	220
	Drilling	18th Aug.'82~11th Sep.'82	25	25	-	478
	Removing	12th Sep.'82~13th Sep.'82	2	2	-	42
	Total	30th Jul.'82~13th Sep.'82	46	46	-	740

Drilling Length				
	Planned Length	250.00 m	Over-burden	1.20 m
	Increase or Decrease in Length	m	Core Length	233.80 m
	Length Drilled	251.00 m	Core Recovery	93.6 %

Working Time				
	Drilling	189°00'	29.1 %	26.4 %
	Hoisting & Lowering Rod	27°30'	4.2 %	3.9 %
	Hoisting & Lowering I.T.	97°00'	14.9 %	13.6 %
	Miscellaneous	266°30'	41.0 %	37.3 %
	Repairing	16°00'	2.5 %	2.2 %
	Others	54°00'	8.3 %	7.6 %
	Total	650°00'	100 %	91.0 %
Removing	Preparation	40°00'	-	5.6 %
Removing	Moving	24°00'	-	3.4 %
	G. Total	714°00'	-	100 %

Casing Pipe Inserted	Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
	HW 38.30 m	15.2 %	100 %
	NW 113.20 m	45.0 %	100 %
	m	%	%

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0~100 m	93.9 %	93.9 %
100~200 m	97.7 %	95.9 %
200~251 m	84.3 %	93.6 %
m	%	%
m	%	%
m	%	%

Efficiency of Drilling

251.00 m/Working Period	5.45 m/day
251.00 m/Working Days	5.45 m/day
251.00 m/Drilling Period	10.04 m/day
251.00 m/Net Drilling Days	10.04 m/day
Total workers/ 251.00 m	2.94 Man/m
Total Drilling Workers/ 251.00 m	1.90 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
22 Times	292 Times

Remarks

G : Grand

I.T.: Inner Tube

A. I-5 Operation Results of Drill Hole, IC-2

Working Period		Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
	Preparation	14th Sep.'82 ~18th Sep.'82	5	5	-	105
	Drilling	19th Sep.'82 ~ 5th Oct.'82	17	17	-	355
	Removing	5th Oct.'82 ~ 6th Oct.'82	1	1	-	21
	Total	14th Sep.'82 ~ 6th Oct.'82	23	23	-	481

Drilling Length				
	Planned Length	250.00 m	Over-burden	1.00 m
	Increase or Decrease in Length	m	Core Length	196.10 m
	Length Drilled	250.40 m	Core Recovery	78.6 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0~100 m	89.5 %	89.5 %
100~200 m	58.5 %	73.8 %
200~250.40 m	97.4 %	78.6 %
m	%	%
m	%	%
m	%	%

Working Time				
	Drilling	158°30'	38.8 %	34.5 %
	Hoisting & Lowering Rod	25°00'	6.1 %	5.4 %
	Hoisting & Lowering I.T.	92°00'	22.6 %	20.0 %
	Miscellaneous	108°30'	26.7 %	23.6 %
	Repairing	12°00'	2.9 %	2.6 %
	Others	12°00'	2.9 %	2.6 %
	Total	408°00'	100 %	88.7 %
	Removing: Preparation	24°00'	-	5.2 %
	Removing: Moving	28°00'	-	6.1 %
	G. Total	460°00'	-	100 %

Efficiency of Drilling

250.40 m/Working Period	10.88 m/day
250.40 m/Working Days	10.88 m/day
250.40 m/Drilling Period	14.72 m/day
250.40 m/Net Drilling Days	14.72 m/day
Total workers/ 250.40 m	1.92 Man/m
Total Drilling Workers/ 250.40 m	1.41 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
20 Times	263 Times

Casing Pipe Inserted	Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
	HW 1.00 m	0.4 %	100 %
	NW 63.00 m	25.1 %	100 %
	BW 173.10 m	69.1 %	100 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-6 Operation Results of Drill Hole, IC-3

Working Period	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	7th Oct.'82 ~10th Oct.'82	4	4	-	84
Drilling	11th Oct.'82 ~19th Oct.'82	9	9	-	187
Removing	20th Oct.'82 ~22th Oct.'82	3	3	-	65
Total	7th Oct.'82 ~22th Oct.'82	16	16	-	336

Drilling Length			
Planned Length	250.00 m	Over-burden	10.40 m
Increase or Decrease in Length	m	Core Length	231.60 m
Length Drilled	250.20 m	Core Recovery	96.6 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0~100 m	95.5 %	95.5 %
100~200 m	98.7 %	97.2 %
200~250.20 m	94.3 %	96.6 %
m	%	%
m	%	%
m	%	%

Working Time				
Drilling		104°00'	40.0 %	34.7 %
Hoisting & Lowering Rod		7°30'	2.9 %	2.5 %
Hoisting & Lowering I.T.		80°30'	31.0 %	26.8 %
Miscellaneous		68°00'	26.1 %	22.7 %
Repairing		-	- %	- %
Others		-	- %	- %
Total		260°00'	100 %	86.7 %
Removing	Preparation	16°00'	-	5.3 %
	Moving	24°00'	-	8.0 %
G. Total		300°00'	-	100 %

Efficiency of Drilling

250.20 m/Working Period	15.6 m/day
250.20 m/Working Days	15.6 m/day
250.20 m/Drilling Period	27.8 m/day
250.20 m/Net Drilling Days	27.8 m/day
Total workers/ 250.20 m	1.34 Man/m
Total Drilling Workers/ 250.20 m	0.74 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
6 Times	209 Times

Casing Pipe Inserted: Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 8.50 m	3.4 %	100 %
NW 102.20 m	40.8 %	100 %
BW 183.70 m	73.4 %	69 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-7 Operation Results of Drill Hole, IC-4

Working Period	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	26th Aug.'82 ~ 31th Aug.'82	6	6	-	102
Drilling	1st Sep.'82 ~ 26th Sep.'82	25.5	25.5	-	504
Removing	26th Sep.'82 ~ 28th Sep.'82	2.5	2.5	-	52
Total	26th Aug.'82 ~ 28th Sep.'82	34	34	-	658

Drilling Length			
Planned Length	250.00 m	Over-burden	8.00 m
Increase or Decrease in Length	m	Core Length	209.80 m
Length Drilled	250.20 m	Core Recovery	86.6 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0~100 m	99.8 %	99.8 %
100~200 m	74.7 %	87.0 %
200~250.20 m	85.1 %	86.6 %
m	%	%
m	%	%
m	%	%

Working Time			
Drilling	239°00'	40.9 %	37.1 %
Hoisting & Lowering Rod	45°30'	7.8 %	7.1 %
Hoisting & Lowering I.T.	85°30'	14.6 %	13.3 %
Miscellaneous	154°00'	26.4 %	23.9 %
Repairing	12°00'	2.1 %	1.8 %
Others	48°00'	8.2 %	7.5 %
Total	584°00'	100 %	90.7 %
Removing: Preparation	24°00'	-	3.7 %
Removing: Moving	36°00'	-	5.6 %
G. Total	644°00'	-	100 %

Efficiency of Drilling

250.20 m/Working Period	7.35 m/day
250.20 m/Working Days	7.35 m/day
250.20 m/Drilling Period	9.81 m/day
250.20 m/Net Drilling Days	9.81 m/day
Total workers/ 250.20 m	2.62 Man/m
Total Drilling Workers/ 250.20 m	2.01 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
39 Times	285 Times

Casing Pipe Inserted: Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
112mm 12.0 m	4.8 %	100 %
NW 132.8 m	53.1 %	95 %
BW 196.1 m	78.4 %	66 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-8 Operation Results of Drill Hole, IC-5

Working Period		Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
	Preparation	29th Sep.'82 ~ 6th Oct.'82	8	8	-	168
	Drilling	7th Oct.'82 ~ 24th Oct.'82	18	18	-	378
	Removing	25th Oct.'82 ~ 26th Oct.'82	2	2	-	42
	Total	29th Sep.'82 ~ 26th Oct.'82	28	28	-	588

Drilling Length				
Planned Length	250.00 m	Over-burden	9.00 m
Increase or Decrease in Length	m	Core Length	257.30 m
Length Drilled	302.50 m	Core Recovery	87.7 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0~100 m	96.1 %	96.1 %
100~200 m	76.0 %	85.5 %
200~302.50 m	91.8 %	87.7 %
m	%	%
m	%	%
m	%	%

Working Time				
Drilling	210°00'	47.7 %	41.0 %
Hoisting & Lowering Rod	26°30'	6.0 %	5.2 %
Hoisting & Lowering I.T.	93°30'	21.3 %	18.3 %
Miscellaneous	110°00'	25.0 %	21.5 %
Repairing	-	- %	- %
Others	-	- %	- %
Total	440°00'	100 %	86.0 %
Removing: Preparation	32°00'	-	6.2 %
Removing: Moving	40°00'	-	7.8 %
G. Total	512°00'	-	100 %

Efficiency of Drilling

302.50 m/Working Period	10.8 m/day
302.50 m/Working Days	10.8 m/day
302.50 m/Drilling Period	16.8 m/day
302.50 m/Net Drilling Days	16.8 m/day
Total workers/ 302.50 m	1.94 Man/m
Total Drilling Workers/ 302.50 m	1.24 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
21 Times	312 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 9.50 m	3.1 %	100 %
NW 158.60 m	52.4 %	78 %
BW 194.00 m	64.1 %	100 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-9 Summarized Operational Data of Each Drill Hole

Drill hole No.	Type of machine	Drilling period	Drilling length	Core		No. of drilling shift			Drilling speed		Remarks
				Length	Recovery	Drilling	Casing etc.	Total	* m/shift	** m/shift	
IC - 1	TGM-3C	18th Aug.'82 ~11th Sep.'82	251.00 m	233.80 m	93.6 %	61	51	112	4.11	2.24	
IC - 2	TGM-3C	19th Sep.'82 ~5th Oct.'82	250.40	196.10	78.6	59	15	74	4.24	3.38	
IC - 3	TGM-3C	11th Oct.'82 ~19th Oct.'82	250.20	231.60	96.6	34	9	43	7.35	5.81	
IC - 4	TGM-5A	1st Sep.'82 ~26th Sep.'82	250.20	209.80	86.6	72	31	103	3.47	2.42	
IC - 5	TGM-5A	7th Oct.'82 ~24th Oct.'82	302.50	257.30	87.7	65	17	82	4.65	3.68	
Total			1,304.30	1,128.60	86.5	291	123	414	4.48	3.15	

* Drilled per one shift covering net drilling operations.
** Drilled per one shift covering total works conducted.

A. I-10 Working Time of Each Drill Hole

Drill hole No.	Drilling	Hoisting & lowering rod & I.T.		Miscellaneous			Repairs	Others	Moving operation	Total
		Rod	Inner tube	Casing insertion	Hole reaming	Others				
IC - 1	189°00'	27°30'	97°00'	31°00'	76°00'	159°30'	16°00'	54°00'	64°00'	714°00'
IC - 2	158°30'	25°00'	92°00'	15°00'	47°00'	46°30'	12°00'	12°00'	52°00'	460°00'
IC - 3	104°00'	7°30'	80°30'	13°00'	6°00'	49°00'	-	-	40°00'	300°00'
IC - 4	239°00'	45°30'	85°30'	39°00'	43°00'	72°00'	12°00'	48°00'	60°00'	644°00"
IC - 5	210°00'	26°30'	93°30'	30°00'	44°00'	36°00'	-	-	72°00'	512°00'
Total	900°30'	132°00'	448°30'	128°00'	216°00'	363°00'	40°00'	114°00'	288°00'	2,630°00'
				707°00'						

A. I-11 Drilling Meterage of Diamond Bits

Item	Size	Type	Bit No.	Drilling mrterage by drill hole. Unite meter					Total
				IC-1	IC-2	IC-3	IC-4	IC-5	
				m	m	m	m	m	m
Bit	HX	HQ-WL	M-9707	29.50					29.50
			M-9708	26.20					26.20
			M-9711	28.50					28.50
			M-9714				46.50		46.50
			N- 549				46.60		46.60
			N- 550		14.40				14.40
			N- 551					58.10	58.10
			N- 552					56.40	56.40
			N- 553			32.10			32.10
			N- 554			35.20			35.20
			N- 555			34.90			34.90
			Total	84.20	14.40	102.20	93.10	114.50	408.40
	NX	NQ-WL	N- 33	41.50					41.50
			N- 34	40.20					40.20
			N- 35				29.50		29.50
			N- 36				28.90		28.90
			N- 37	39.80					39.80
			N- 38	41.70					41.70
			N- 557				28.60		28.60
			N- 558		30.20				30.20
			M-11229		15.60				15.60
			M-11230		26.80				26.80
			11402					42.20	42.20
			11403					31.30	31.30
			11404		16.80				16.80
			11405		25.60				25.60
			11406		22.10				22.10
			11407		20.60				20.60
			11408			19.60			19.60
			11409			20.10			20.10
			11410			21.20			21.20
			11411			20.60			20.60
			Total	163.20	157.70	81.50	87.00	73.50	562.90

Item	Size	Type	Bit No.	Drilling meterage by drill hole. Unite meter					Total
				IC-1	IC-2	IC-3	IC-4	IC-5	
				m	m	m	m	m	m
Bit	BX	BQ-WL	N- 556				20.10		20.10
			N- 557				18.10		18.10
			N- 558		26.20				26.20
			N- 559		25.10				25.10
			N- 560				15.90		15.90
			M-11231		26.00				26.00
			M-11232					40.20	40.20
			M-11233					32.60	32.60
			11418			23.50			23.50
			11419			21.90			21.90
			11420					35.70	35.70
			11421			21.10			21.10
			Total	-	77.30	66.50	54.10	108.50	306.40

A. I-12 Specifications of Diamond Bits

Size	Type	Carats per bit	Matrix	Stones per carat	Water way	Number	Remark
HX	HQ-WL	40	Z	1/30	6	M-9707	Reset
		40	Z	1/30	6	M-9708	"
		40	Z	1/30	6	M-9711	"
		40	Z	1/30	6	M-9714	"
		40	X	1/30	6	N- 549	"
		40	X	1/30	6	N- 550	"
		40	Z	1/30	6	N- 551	"
		40	Z	1/30	6	N- 552	"
		40	Z	1/30	6	N- 553	"
		40	Z	1/30	6	N- 554	"
		40	Z	1/30	6	N- 555	"
NX	NQ-WL	30	Z	1/30	4	N- 33	Reset
		30	Z	1/30	4	N- 34	"
		30	Z	1/30	4	N- 35	"
		30	Z	1/30	4	N- 36	"
		30	Z	1/30	4	N- 37	"
		30	Z	1/30	4	N- 38	"
		30	X	1/30	4	N- 557	"
		30	X	1/30	4	N- 558	"
		32	Z	1/30	4	M-11229	"
		32	Z	1/30	4	M-11230	"
		30	T_1	1/30	4	11402	"
		30	T_1	1/30	4	11403	"
		30	T_1	1/30	4	11404	Reset
		30	T_1	1/30	4	11405	"
		30	T_1	1/30	4	11406	"
		30	T_1	1/30	4	11407	"
		30	T_1	1/30	4	11408	"
		30	T_1	1/30	4	11409	"
		30	T_1	1/30	4	11410	"
		30	T_1	1/30	4	11411	"
	BQ-WL	20	Y	1/30	4	N- 556	Reset
		20	Y	1/30	4	N- 557	"
BX	BQ-WL	20	Z	1/30	4	N- 558	"
		20	Z	1/30	4	N- 559	"
		20	Z	1/30	4	N- 560	"
		21	Z	1/30	4	M-11231	"
		21	Z	1/30	4	M-11232	"
		21	Z	1/30	4	M-11233	"
		20	T_1	1/30	4	11418	"
		20	T_1	1/30	4	11419	"
		20	T_1	1/30	4	11420	"
		20	T_1	1/30	4	11421	"

A. I-13 Assay Results of the Drilling Core

(1)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
1	IC-1-122	121.0-123.0	2	Ore	0.08	0.24	5.75	12	
2	IC-1-124	123.0-125.0	2	Ore	0.06	0.33	1.65	4	
3	IC-1-126	125.0-127.0	2	Ore	0.06	0.91	2.95	tr	
4	IC-1-128	127.0-129.0	2	Ore	0.06	1.55	4.20	tr	
5	IC-1-222	220.5-225.7	5.2	Sid	0.04	0.02	0.60	tr	
6	IC-1-228	226.3-230.0	4.7	Do	0.06	1.67	0.60	tr	
7	IC-2-048	47.0- 52.0	5.0	Py	0.15	0.03	0.10	12	
8	IC-2-053	52.0- 60.0	8.0	Py	0.10	0.04	0.15	8	
9	IC-2-061	60.0- 68.0	8.0	Py	0.16	tr	0.05	20	
10	IC-2-069	68.0- 73.0	5.0	Py	0.10	0.12	0.25	52	
11	IC-2-074	73.0- 77.6	4.6	Ald	0.12	0.02	0.10	32	
12	IC-2-078	77.6- 79.4	1.8	Py	1.48	tr	0.15	12	
13	IC-2-080	79.4- 82.1	2.7	Ore	10.84	0.37	0.70	nd	
14	IC-2-083	82.1- 83.1	1	Ore	0.46	0.02	18.31	20	
15	IC-2-084	83.1- 84.1	1	Ore	0.18	0.20	37.13	48	
16	IC-2-085	84.1- 85.1	1	Ore	0.10	0.02	30.62	56	
17	IC-2-086	85.1- 86.1	1	Ore	0.13	3.76	42.58	64	
18	IC-2-087	86.1- 87.1	1	Ore	0.06	4.59	27.52	8	
19	IC-2-088	87.1- 88.1	1	Ore	0.10	7.56	11.41	40	
20	IC-2-089	88.1- 89.1	1	Ore	0.06	1.55	4.85	28	
21	IC-2-090	89.1- 91.1	2	Ore	0.02	1.64	4.13	20	
22	IC-2-092	91.1- 93.1	2	Ore	0.03	0.02	2.12	nd	
23	IC-2-094	93.1- 95.1	2	Ore	0.04	2.96	4.03	tr	
24	IC-2-096	95.1- 96.5	1.4	Ore	0.04	1.61	11.59	tr	
25	IC-2-097	96.5- 97.5	1	Ore	0.04	8.70	22.58	100	
26	IC-2-098	97.5- 98.5	1	Ore	0.05	17.28	20.56	140	
27	IC-2-099	98.5- 99.5	1	Ore	0.06	9.52	21.17	56	
28	IC-2-100	99.5-100.5	1	Ore	0.08	9.45	17.04	84	
29	IC-2-101	100.5-101.5	1	Ore	0.03	4.20	7.56	nd	
30	IC-2-102	101.5-102.5	1	Ore	0.10	4.79	10.08	16	
31	IC-2-103	102.5-103.5	1	Ore	0.09	1.52	17.24	60	
32	IC-2-104	103.5-104.7	1.2	Ore	0.07	0.02	12.50	12	
33	IC-2-105	104.7-109.0	4.3	Ald	0.06	0.04	14.72	4	
34	IC-2-110	109.0-114.0	5.0	Ald	0.07	0.02	14.11	4	
35	IC-2-115	114.0-119.0	5.0	Ald	0.04	0.58	14.21	4	
36	IC-2-120	119.0-126.0	7.0	Do	0.32	0.03	18.45	4	
37	IC-2-127	126.0-130.6	4.6	Ore	1.46	0.02	0.50	12	
38	IC-2-132	130.6-135.2	4.6	Ore	4.24	0.03	0.50	84	
39	IC-2-137	135.2-141.3	6.1	Ore	5.92	0.02	0.40	48	
40	IC-2-142	141.3-144.3	3.0	Ore	1.86	0.02	0.40	36	
41	IC-2-145	144.3-146.3	2.0	Ore	7.28	0.08	0.15	48	
42	IC-2-191	190.3-191.3	1.0	Ore	0.06	5.96	11.16	4	
43	IC-2-210	209.0-211.0	2	Do	0.03	0.33	1.65	tr	
44	IC-2-212	211.0-213.0	2	Ore	0.04	3.04	11.21	40	
45	IC-2-214	213.0-215.0	2	Ore	0.04	4.21	11.11	30	
46	IC-2-216	215.0-217.0	2	Ore	0.06	4.56	10.81	28	
47	IC-2-218	217.0-219.0	2	Ore	0.10	1.37	2.00	8	
48	IC-2-220	219.0-221.0	2	Ore	0.06	5.26	8.21	16	
49	IC-2-222	221.0-223.0	2	Ore	0.10	8.44	17.96	48	
50	IC-2-224	223.0-225.0	2	Ore	0.05	6.75	8.56	12	
51	IC-2-226	225.0-227.4	2.4	Ore	0.06	2.95	5.95	16	
52	IC-2-234	232.9-237.0	4.1	Do	0.06	0.55	0.90	8	
53	IC-2-238	237.0-238.1	1.1	Ore	0.06	0.25	4.00	4	

(2)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
54	IC-3-061	60.9- 61.6	0.7	Do	0.04	0.06	15.01	tr	
55	IC-3-072	71.5- 73.0	1.5	Ml	0.46	0.02	0.17	nd	
56	IC-3-074	73.0- 74.8	1.8	Ml	0.74	0.02	0.03	4	
57	IC-3-077	74.8- 78.8	4.0	Py	0.20	0.01	0.03	40	
58	IC-3-081	78.8- 83.8	4.0	Py	0.11	0.02	0.05	nd	
59	IC-3-085	83.8- 87.2	4.4	Py	0.28	0.02	0.00	tr	
60	IC-3-098	97.0- 98.2	1.2	Spc	0.20	0.02	0.50	tr	
61	IC-3-120	119.5-121.9	1.9	Ls	0.18	0.01	0.05	nd	
62	IC-3-142	141.0-145.0	4.0	Py	0.16	0.02	0.00	4	
63	IC-3-146	145.0-149.0	4.0	Py	0.16	0.02	0.00	nd	
64	IC-3-150	149.0-150.6	1.6	Ore	1.46	0.01	0.25	nd	
65	IC-3-152	150.6-153.7	3.1	Ore	0.82	0.02	0.05	8	
66	IC-3-156	153.7-158.2	4.5	Py	0.24	0.01	0.05	nd	
67	IC-3-159	158.2-160.2	2.0	Ore	4.46	0.02	0.05	nd	
68	IC-3-162	160.2-164.2	4.0	Py	0.48	0.02	0.05	4	
69	IC-3-210	207.5-211.5	4.0	Py	0.20	0.02	0.30	tr	
70	IC-3-215	211.5-217.5	6.3	Py	0.58	0.06	0.10	4	
71	IC-3-220	217.8-221.4	3.6	Ald	0.38	0.08	0.15	8	
72	IC-3-225	221.4-226.8	5.4	Ald	0.03	0.02	0.25	nd	
73	IC-4-090	89.1- 99.1	10.0	Py	0.22	0.02	0.05	8	
74	IC-4-100	99.1-109.1	10.0	Py	0.12	0.02	0.05	nd	
75	IC-4-110	109.1-114.0	4.9	Py	0.20	0.01	0.10	8	
76	IC-4-115	114.0-115.6	1.6	Ore	2.56	0.02	0.40	4	
77	IC-4-117	115.6-117.4	1.8	Ore	1.88	0.02	0.15	60	
78	IC-4-119	117.4-120.5	3.1	Ore	2.18	0.02	0.30	32	
79	IC-4-121	120.5-123.1	2.6	Spc	0.37	0.02	0.05	nd	
80	IC-4-124	123.1-125.6	2.5	Spc	0.11	0.01	0.05	nd	
81	IC-4-135	133.6-140.6	6.4	Py	0.20	0.02	0.50	nd	
82	IC-4-140	140.0-145.0	5.0	Spc	0.20	0.01	0.05	nd	
83	IC-4-158	157.4-158.7	1.3	Ore	5.62	0.02	0.05	24	
84	IC-4-160	158.7-161.4	2.7	Py	0.50	0.02	0.00	tr	
85	IC-4-182	180.8-182.8	2	Ore	0.90	0.02	0.05	nd	
86	IC-4-184	182.8-184.8	2	Ore	0.88	0.01	0.05	nd	
87	IC-4-186	184.8-186.8	2	Ore	0.70	0.01	0.05	nd	
88	IC-4-190	189.4-192.0	2.6	Spc	0.08	0.01	0.05	nd	
89	IC-4-193	192.0-198.0	6	Spc	0.05	0.01	0.05	nd	
90	IC-4-199	198.0-204.0	6	Spc	0.78	0.01	0.05	nd	
91	IC-4-205	204.0-210.0	6	Spc	0.40	0.01	0.05	nd	
92	IC-4-211	210.0-215.4	5.4	Spc	0.94	0.01	0.00	4	
93	IC-4-217	215.4-218.8	3.4	Spc	0.36	0.01	0.00	nd	
94	IC-4-220	218.8-223.7	5.8	Py	0.56	0.01	0.05	8	
95	IC-5-040	40.3- 40.8	0.7	Do	0.08	0.02	15.83	16	
96	IC-5-074	73.2- 76.2	3	Py	0.06	0.01	0.10	8	
97	IC-5-077	76.2- 79.2	3	Py	0.06	0.01	0.00	nd	
98	IC-5-080	79.2- 82.2	3	Py	0.04	0.01	0.05	28	
99	IC-5-084	83.8- 86.2	2.4	Sid	0.05	0.01	0.15	4	
100	IC-5-087	86.2- 88.8	2.6	Sh	0.03	0.01	0.25	4	
101	IC-5-090	88.8- 92.2	3.4	Spc	0.08	0.01	0.30	tr	
102	IC-5-129	128.8-130.4	1.6	Ore	4.64	0.09	0.20	4	
103	IC-5-132	131.8-133.8	2.0	Ore	0.72	0.01	0.10	4	
104	IC-5-144	143.1-147.4	4.3	Py	0.20	0.01	0.10	nd	
105	IC-5-151	150.3-154.0	3.7	Py	0.05	0.01	0.00	nd	
106	IC-5-190	188.0-196.3	7.4	Py	0.10	0.01	0.00	4	

(3)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
107	IC-5-210	210.0-220.0	10	Py	0.13	0.01	0.20	nd	
108	IC-5-220	220.0-230.0	10	Py	0.16	0.01	0.05	4	
109	IC-5-230	230.0-240.0	10	Py	0.08	0.01	0.05	tr	
110	IC-5-240	240.0-250.0	10	Py	0.06	0.01	0.00	8	
111	IC-5-250	250.0-260.0	10	Py	0.08	0.01	0.05	4	
112	IC-5-260	260.0-270.0	10	Py	0.10	0.01	0.05	nd	
113	IC-5-270	270.0-280.0	10	Py	0.03	0.01	0.05	tr	
114	IC-5-280	280.0-290.0	10	Py	0.14	0.01	0.05	4	
115	IC-5-290	290.0-300.0	10	Py	0.12	0.01	0.05	4	

Ore : Cu-Pb-Zn ore
Py : Pyrite ore
Spc : Specularite (Hematite) ore

Sh : Shale
Ls : Limestone
Ml : Marl
Do : Dolostone
Sid : Siderite
Ald : Altered (Brecciated) rock

A. I-14 Microscopic Observation (1) Thin Section

(1)

Sample No.	Rock Type	Microscopic Observation
IC-1-069	Calcareous sandstone	This rock shows clastic texture. Fragmental quartz, showing subangular, 0.2 mm in average size, is cemented by carbonate minerals. Sericite occurs in part. Zircon is observed rarely.
IC-1-136	Brecciated rock	Clastic texture is observed. Breccias are contained in a carbonate matrix. Maximum size of breccia is 10 mm × 7 mm and its material is shaly and/or carbonaceous. (See photograph)
IC-1-137	Siderite	Oolitic texture is seen in part. Main constituent mineral is carbonates with minor amounts of quartz and clay minerals Two types of carbonate, the finer-grained and the coarser-grained, are recognized. (See photograph)
IC-1-221	Siderite	The rock is composed mostly of euhedral to subhedral carbonates with minor amounts of quartz and clay minerals. Two grain sizes of carbonate, the finer and the coarser, less than 0.03 mm and more than 0.1 mm in size, respectively, are recognized.
IC-2-087	Brecciated Zn ore	Main ore minerals are sphalerite and quartz. Matrix is mainly of quartz and shows cataclastic texture. Sphalerite is pale yellowish brown and usually fine-grained, more or less 0 04 mm in size, forming aggregates. Quartz occurs commonly as mosaic aggregate. Spherulitic texture in chalcedonic quartz is observed in part.
IC-2-094	Brecciated Zn ore	The rock is strongly brecciated and silicified and shows cataclastic texture. The matrix is composed mainly of two types of quartz, finer than 0.01 mm and about 0.03 mm in size. Main ore minerals are sphalerite and galena which occur as dissemination and as veinlets. Fluorite is observed in vein.
IC-2-116	Zn-Py dissemination ore	Sphalerite and pyrite are disseminated in fine-grained matrix which is composed mainly of microcrystalline quartz and a minor amount of carbonates. Silicification is remarkable. A few rutile is observed.
IC-2-135	Altered rock (green)	The rock is composed mainly of quartz and chlorite with minor amounts of sericite and carbonate. Banding strucutre caused by alternation of quartz-rich and chlorite-rich layers is observed clearly. Carbonate bearing hematite-pyrite veins and veinlets are developed.
IC-2-190	Zn-Py dissemination ore	Main alteration minerals are quartz and chlorite with subordinate amounts of clay minerals and carbonates. Quartz in matrix is commonly very fine-grained less than 0.1 mm. Sphalerite and pyrite are commonly seen as ore minerals.
IC-2-234	Dolomite and siderite	The rock is composed mainly carbonates accompanied by quartz and chlorite. Carbonate matrix is cut by white carbonate veins. As for ore minerals, sphalerite and pyrite are observed. Sphalerite occurring vein-like is reddish brown. Sphalerite disseminated in the matrix shows yellowish brown color.
IC-3-061	Siderite	Main constituent mineral is euhedral to subhedral granular carbonates. The grain size is generaly from 0.01 mm to 0.04 mm and 0.4 mm in maximum. Anhedral quartz occurs scarcely.
IC-3-071	Altered rock (green)	Chloritization is remarkable Main constituents of the matrix are chlorite and quartz with a minor amount of sericite Two layers, chlorite-rich and sericite-rich, are recognized. Rutile is scarcely seen.
IC-3-091	Altered rock (white)	This rock is completely replaced by quartz and sericite. Mosaic aggregates of quartz and sericite are developed and pyrite is desseminated widely. Maximum grain size of quartz is up to 0.3 mm. Rulile is found as an accessary mineral. (See photograph)
IC-3- 98	Carbonate rock	Oolitic texture appears in this rock. Main constituent is carbonates with a minor amount of quartz. Carbonates shows fine-grained less than 0.01 mm and/or coarse-grained more than 0.2 mm. Fluorite occurs in veinlet. Disseminated sphalerite is scarcely observed.

(2)

Sample No.	Rock Type	Microscopic Observation
IC-4-184	Specularite ore	Alteration of the host rock is characterized by sericitization and silicification. A large amount of specularite (hematite) is disseminated in the host rock composed of fine-grained quartz and sericite. Grain size of quartz is usually 0.02 mm to 0.03 mm. Sericite occurs filling the interspaces among quartz grains and cavities. Hematite is acicular forming aggregates and/or coating pyrite grains in part.
IC-5-040	Altered rock	The rock is composed mainly of quartz with minor amounts of carbonates and sericite. Quartz grains are euhedral to subhedral and comparatively coarse-grained about 0.5 mm to 1.0 mm in size. Carbonates and sphalerite veins cut the matrix of quartz.
IC-5-084	Altered rock	Alteration minerals are sericite, quartz and carbonates. Ore minerals are mainly specularite (hematite) and pyrite. Specularite shows aggregates of acicular crystals. (See photograph)
IC-5-099	Carbonate rock	This rock is mainly of fine-grained carbonate minerals with a minor amount of quartz. It contains accidental subangular breccias. Sericite occurs filling cavities in part.
IC-5-130	Cu-Spc ore	As for alteration minerals, chlorite (Mg-rich type), quartz and fluorite are abundant. Sellaite ($Mg F_2$) is detected. Main ore minerals are lath-shape specularite scattering in the matrix and a minor amount of chalcopyrite. (See photograph)
IC-5-132	Cu-Spc ore	Argillization and hematitization are remarkable. Matrix is mainly of clay minerals, and quartz and fluorite occur in it. Large acicular and tabular crystals of specularite up to 0.3 mm are generated in the matrix minerals. (See photograph)

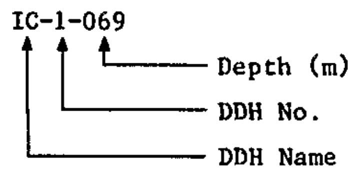
A. I-14 Microscopic Observation (2) Polished Section (1)

Sample No.	Rock Type	Microscopic Observation
IC-1-137	Pyrite disseminated siderite	Pyrite is disseminated in veinlets. Two small grains of electrum, 50μ m to 80 μm in size are confirmed. (See photograph)
IC-1-221	Pyrite disseminated brecciated siderite	Pyrite and sphalerite are disseminated in veinlets. Pyrite shows euhedral form, from 20 μm to 100 μm, and aggregates of very fine grains, 1 μm to 5 μm.
IC-2-083	Zn ore	Sphalerite is dominant. Small amounts of pyrite and galena are seen included in sphalerite. Chalcopyrite is found as exsolution dots in sphalerite.
IC-2-085	Pb-Zn ore	Sphalerite, galena and pyrite are main constituent ore minerals. Various size grains of pyrite, euhedral to anhedral, interstitially lie in sphalerite and galena. (See photograph)
IC-2-087	Brecciated Zn ore	Sphalerite and pyrite are main ore minerals. A subordinate amount of galena is found in sphalerite and pyrite. Both of galena and sphalerite interstitially lie in pyrite grains. (See photograph)
IC-2-094	Brecciated Zn ore	As ore minerals, pyrite, sphalerite, galena, pyrrhotite, marcasite and arsenopyrite are found in order of abundance. Galena is observed around pyrite and in sphalerite. Pyrrhotite and arsenopyrite, diameter of several tens μm, are present in pyrite. A trace amount of gratonite ($Pb_9 As_4 S_{15}$) is presumed by EPMA analysis occurring in veinlets in galena.
IC-2-097	Pb-Zn ore	Sphalerite is dominant. Pyrite, galena and a trace amount of pyrrhotite are found. Inclusion dots in sphalerite are rarely observed.
IC-2-099	Pb-Zn ore	The constituents are sphalerite, galena and pyrite, as accessories pyrrhotite, arsenopyrite and marcasite. Inclusion dots are rarely found in sphalerite. Galena coexists closely with sphalerite. Pyrite in euhedral to anhedral form is found in sphalerite and galena. Pyrrhotite is found in sphalerite and galena showing round form. Arsenopyrite, showing anhedral form, is found in sphalerite and galena. It seems that marcasite occurs replacing a part of pyrite included in galena. (See photograph)
IC-2-100	Pb-Zn-Pyrite ore	Pyrite, sphalerite and galena are main ore minerals. Pyrrhotite in a trace amount is found. Pyrite shows euhedral to anhedral form. Sphalerite is present interstitally in pyrite. Galena occurs coexisting with sphalerite. Pyrrhotite, several tens of μm in size, is found in pyrite grains.
IC-2-116	Zn-Pyrite dissemination ore	Ore minerals consist of pyrite and sphalerite with a trace amounts of pyrrhotite and galena. Pyrite shows euhedral to anhedral form. Sphalerite occurs in disseminated form around pyrite and in gangue minerals irregularly. (See photograph)
IC-2-135	Altered rock	Hematite and pyrite occur in veinlets. Hematite shows euhedral acicular form and pyrite shows euhedral to anhedral form. It is presumed that hematite crystalization is after pyrite.
IC-2-145	Cu ore	Chalcopyrite is main ore mineral. Others are a small amount of pyrite and a trace amount of hematite.
IC-2-190	Zn-Pyrite ore	A lot of sphalerite and pyrite with a subordinate amount of galena are found as ore minerals. Small amounts of chalcopyrite and pyrrhotite are also found. Chalcopyrite exsolution dots are included in sphalerite. Pyrrhotite dots, several tens μm in size, are seen both in sphalerite and galena. (See photograph)
IC-2-213	Pb-Zn-Pyrite ore	The constituents are pyrite, sphalerite and galena with a small amount of phyrrhotite. In addition to coarse-grained pyrite, fine-grained pyrite, less than 20 μm in diameter are found in sphalerite. Fine-grained pyrrhotite is found in sphalerite, galena and pyrite.

Sample No.	Rock Type	Microscopic Observation
IC-2-222	Pb-Zn-Pyrite ore	The constituents are sphalerite, pyrite and galena. Small grains of pyrrhotite are found in sphalerite and galena.
IC-2-234	Zn-Pyrite dissemination ore	Sphalerite and pyrite are main constituent ore minerals As accessories, galena and chalcopyrite are found. In massive sphalerite, small grains of pyrite and quartz are included. Galena is found in gangue minerals and also in sphalerite as disseminated form. Fine-grained chalcopyrite is found in sphalerite.
IC-3-061	Siderite	As disseminated ore minerals, small amounts pyrrhotite, marcasite, limonite, pyrite and sphalerite are found in the host rock. A part of pyrrhotite especially in the margin is replaced by marcasite.
IC-3-071	Altered rock	Disseminated ore minerals are mainly pyrite, chalcopyrite, covelline and sphalerite. A part of chalcopyrite, along the margin and crack, is replaced by covelline.
IC-3-091	Altered rock	The main ore mineral is pyrite with minor amounts of sphalerite and chalcopyrite.
IC-3-098	Carbonate rock	Sphalerite is found as ore mineral disseminated in the host rock. Small dots of exsolution chalcopyrite is seen in sphalerite.
IC-4-114	Pyrite ore	Pyrite is most dominant. Subordinate amounts of sphalerite and chalcopyrite are found with trace amounts of covelline and stannite. Covelline is seen in the margin of chalcopyrite grains and along cracks in sphalerite. Stannite is found in sphalerite. (See photograph)
IC-4-120	Py-Spc ore	Pyrite and hematite are disseminated in the host rock. Pyrite shows euhedral form and hematite shows acicular form. A trace amount of chalcopyrite is also disseminated and a part of chalcopyrite is replaced by covelline.
IC-4-181	Cu-Spc ore	Hematite is dominant, followed by pyrite and chalcopyrite. Hematite shows euhedral acicular form. Pyrite is subhedral. Chalcopyrite occupies interspaces of hematite and pyrite.
IC-4-184	Py-Spc ore	Acicular hematite and subhedral pyrite are dominant.
IC-5-040	Altered rock	Sphalerite is disseminated in the host rock. Small amounts of galena, chalcopyrite, pyrrhotite and marcasite are observed mainly in sphalerite.
IC-5-074	Py-Spc ore	Hematite and pyrite are main constituent. Acicular hematite occurs cutting subhedral pyrite grains. (See photograph)
IC-5-084	Altered rock	Main disseminated ore minerals are pyrite and hematite pyrite shows fine to medium-grained, less than 0.1 mm to about 0.3 mm. Hematite shows acicular form.
IC-5-130	Cu-Spc ore	The constituents are hematite and chalcopyrite. Large tabular hematite crystals, 0.05 mm x 1 mm in size, are seen. Chalcopyrite shows anhedral form and occupies interspaces of hematite. A small amount of chalcocite is observed along cracks in chalcopyrite. (See photograph)
IC-5-132	Cu-Spc ore	Hematite is dominant. Chalcopyrite and pyrite are found in less abundance. Acicular hematite forms aggregates of pellet form. At the center of hematite pellets, chalcopyrite, pyrite and gangue minerals are found. (See photograph)
IC-5-237	Pyrite ore	The constituent is pyrite. A trace amount of sphalerite occurs at the border of pyrite masses as spotted form.

A. I-15 Photomicrographs (I) Thin Section

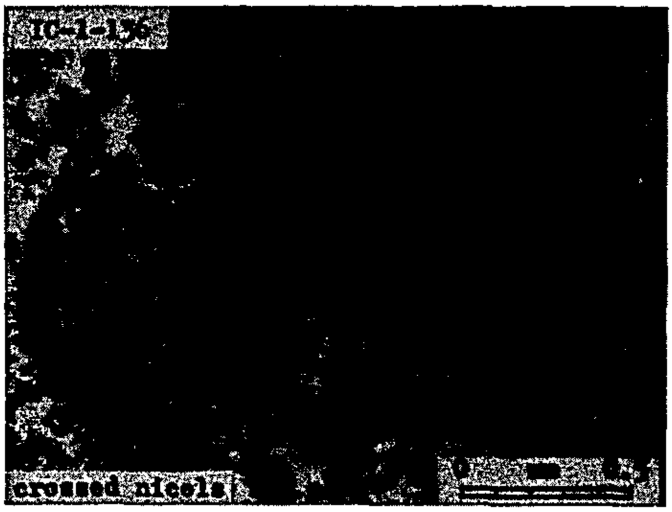
Sample No.	Rock Type
IC-1-069	Calcareous sandstone
IC-1-136	Brecciated rock
IC-1-137	Siderite
IC-2-094	Brecciated Zn ore
IC-2-135	Altered rock
IC-3-091	Altered rock
IC-5-084	Altered rock
IC-5-130	Cu-Spc ore
IC-5-132	Cu-Spc ore



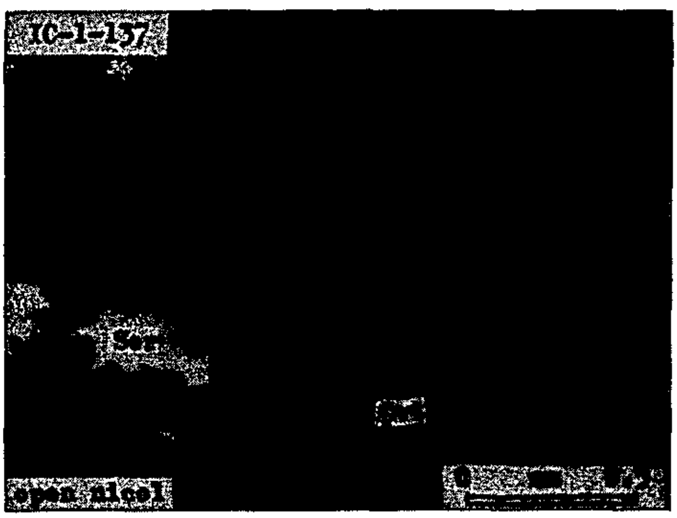
Abbreviations

Qt:	Quartz	Rf:	Rock fragments
Crb:	Carbonates	Sp:	Sphalerite
Ser:	Sericite	Py:	Pyrite
Chl:	Chlorite	Hm:	Hematite
Fl:	Fluorite	Opq:	Opaque minerals
Cly:	Clay minerals	Cut:	Cavity

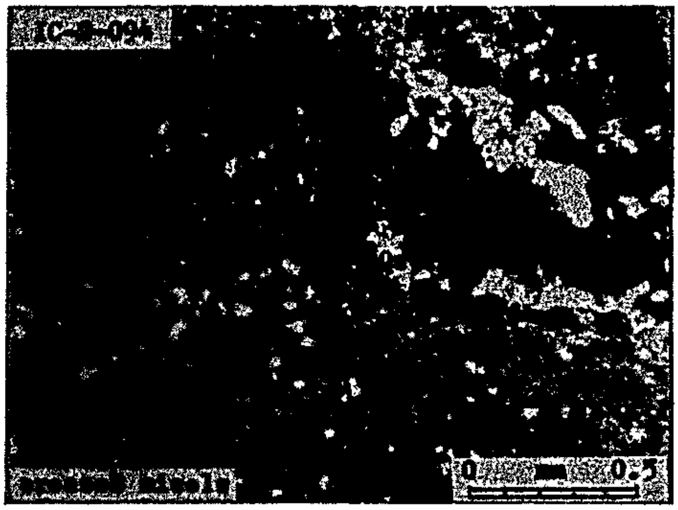
Sample No. IC-1-069
Rock Type : Calcareous sandstone



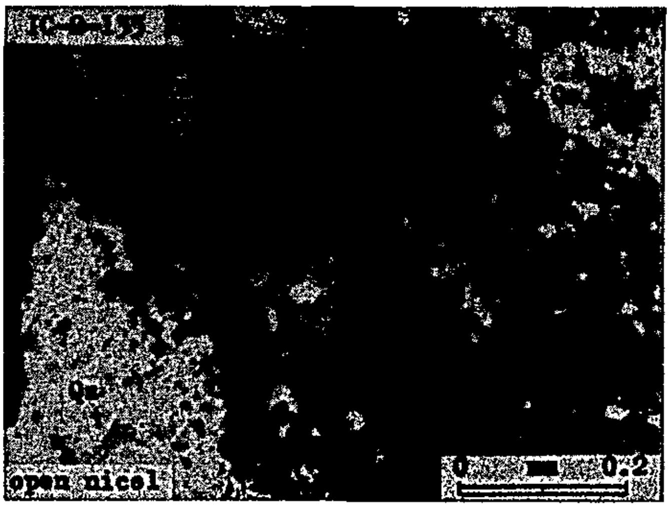
Sample No. IC-1-136
Rock Type : Brecciated rock



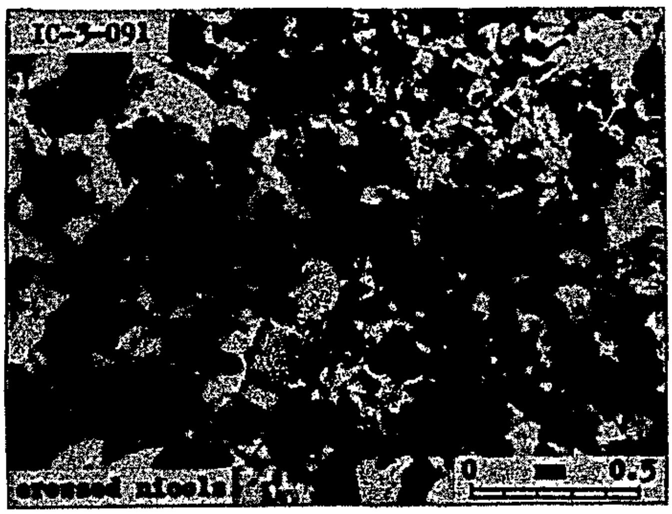
Sample No. IC-1-137
Rock Type : Siderite



Sample No. : IC-2-094
Rock Type : Brecciated Zn ore



Sample No. : IC-2-135
Rock Type : Altered rock



Sample No. : IC-3-091
Rock Type : Altered rock

Sample No. IC-5-084
Rock Type : Altered rock

Sample No. IC-5-130
Rock Type : Cu-Spc ore

Sample No. IC-5-132
Rock Type : Cu-Spc ore

A. I-15 Photomicrographs (2) Polished Section

Sample No.	Rock Type
IC-1-137	Pyrite disseminated siderite
IC-2-085	Pb-Zn ore
IC-2-087	Brecciated Zn ore
IC-2-099	Pb-Zn ore
IC-2-116	Zn-Pyrite dissemination ore
IC-2-190	Zn-Pyrite ore
IC-3-071	Altered rock
IC-4-114	Pyrite ore
IC-5-074	Py-Spc ore
IC-5-130	Cu-Spc ore
IC-5-132	Cu-Spc ore
IC-5-132	Cu-Spc ore

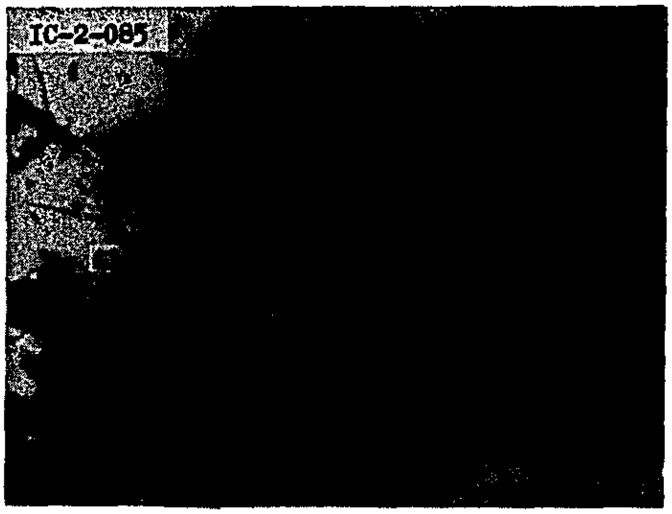
IC-1-137

- 137 — Depth (m)
- 1 — DDH No.
- IC — DDH Name

Abbreviations

Sp:	Sphalerite	Hm:	Hematite
Gl:	Galena	Spc:	Specularite
Cp:	Chalcopyrite	Cc:	Chalcocite
Py:	Pyrite	Cv:	Covellite
Po:	Pyrrhotite	El:	Electrum
Asp:	Arsenopyrite	Qz:	Quartz
Mar:	Marcasite	Crb:	Carbonates
Grat:	Gratonite	G:	Gangue minerals

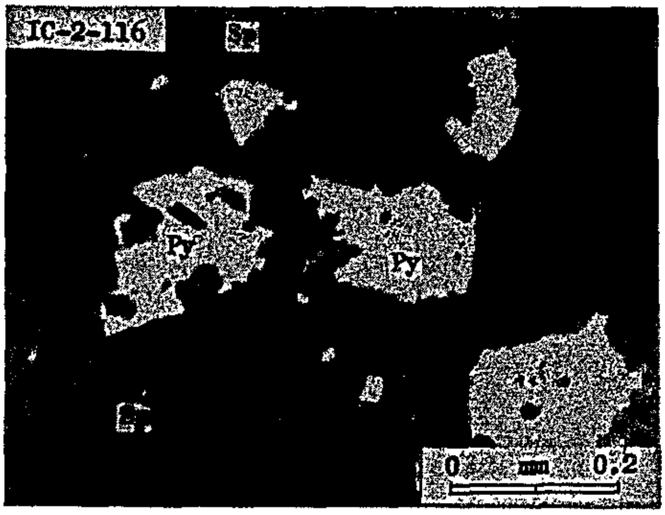
Sample No. IC-1-137
Rock Type : Pyrite disseminated siderite



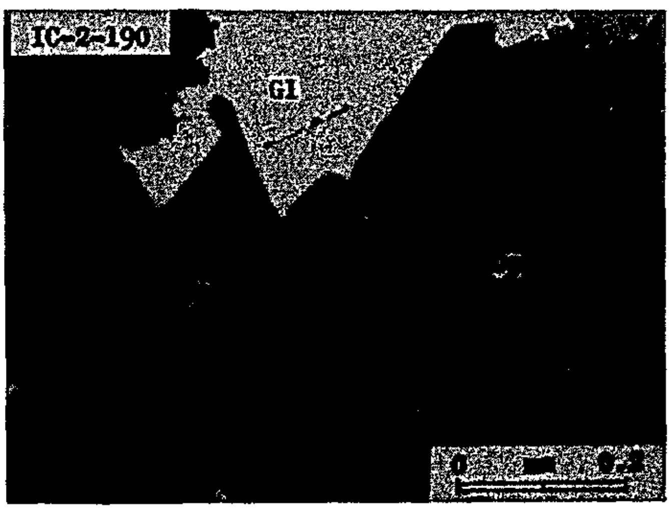
Sample No. IC-2-085
Rock Type : Pb-Zn ore

Sample No. IC-2-087
Rock Type : Brecciated Zn ore

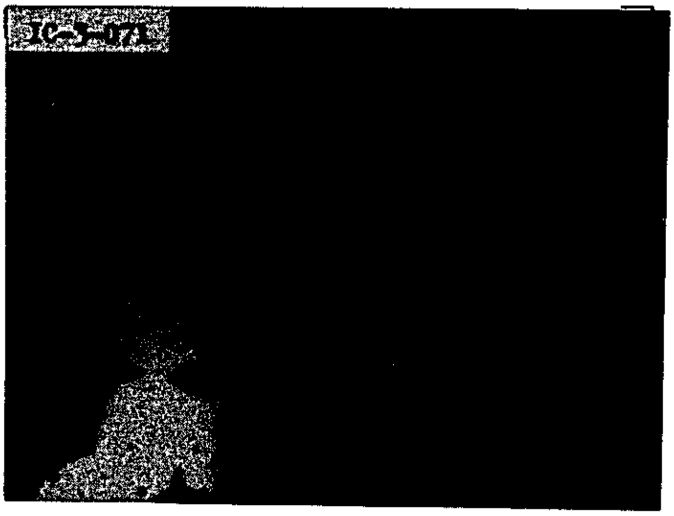
Sample No. IC-2-099
Rock Type : Pb-Zn ore



Sample No. IC-2-116
Rock Type : Zn-Pyrite dissemination ore

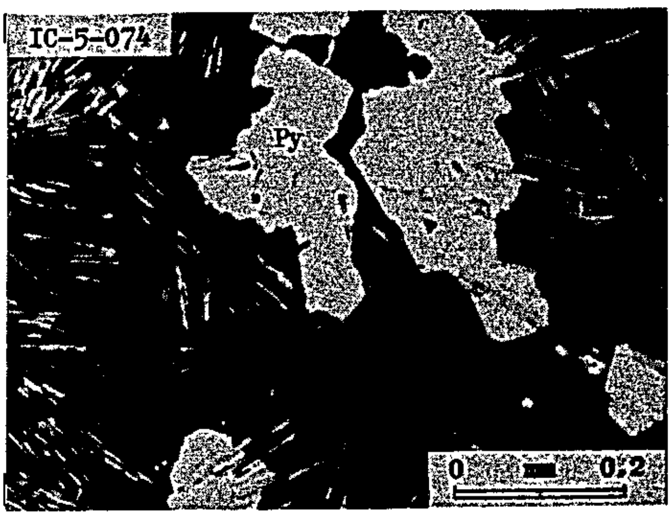


Sample No. IC-2-190
Rock Type : Zn-Pyrite ore



Sample No. IC-3-071
Rock Type : Altered rock

Sample No. IC-4-114
Rock Type : Pyrite ore



Sample No. IC-5-074
Rock Type : Py-Spc ore

Sample No. IC-5-130
Rock Type : Cu-Spc ore

Sample No. IC-5-132
Rock Type : Cu-Spc ore

Sample No. IC-5-132
Rock Type : Cu-Spc ore

APPENDICES
PART Ⅱ
DATA OF TUNNELLING

LIST OF APPENDICES

A. II-1 Summary of Program

Item	1982 Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	1983 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
1 Mobilization (Tokyo ∿ Lima ∿ Site)	12 17	2 17											
2 Road Construction													
Restoration	19	5											
Construction		6		9									
Repair				10								18	
3 Equipment Moving in Provisional Works (with housing)		8		9	14 27								
4 Advance													
Adit-N 310.4 m			26							7	1	12	
Adit-S 270.1 m			26 28	9								18	
5 Equipment Moving out												17 20	
6 Demobilization (Site ∿ Lima ∿ Tokyo)												21 27	
7 Preparation of Report												28	30

A. II-2 Details of Employed Days for Advance

Adit Name	Moving in Moving out	Period of Advancing Work							Details of Working Period		Principal Accessory Works				
		Camping	No.of Days	Advance	No.of Days	Break up	No.of Days	Total	Working Days	Suspended Days	Construction Repair of Road	No.of Days	Moving in Provision	No.of Days	Total No.of Days
	Accessory Works (Date) 19,Jul,82 18,Jun,83	(Date)	day	(Date)	day	(Date)	day	day	days	days	(Date) 19,Jul,82 18,Jun,83	day 335	(Date) 8,Aug,82 27,Sep,83	day 73	day 408
Adit-N		11,Aug,82 12,Aug,82	2	26,Sep,82 12,Jun,83	235	17,Jun,83 18,Jun,83	2	239	226	13					
Adit-S		13,Aug,82 14,Aug.82	2	26,Sep,82 18,Jun,83	256	19,Jun,83 20,Jun,83	2	260	237	23					
	Moving out 21,Jun,83 27,Jun,83														
Total No. of Days			4		491		4	499	463	36		335		73	408

Note: No. of days of each term signifies the No. of days in working term.

A. II-3 Summary of Performance

Adit Name	Moving in Moving out	No. of Working Shift		No. of Man-shift		No. of Hours for Each Work							
		No.of Shift of Advance	Total No. of Shift	Engineer	Worker	Advance	Support	Besides Advance	Sub-Total	Camping Break up	Equipment Moving out	Others	Total
(Accessory Works)		(shift)	(shift)	(man-shift)	(man-shift)	(hrs.)	(hrs.)	(hrs.)	(hrs.)	(hrs.)	(hrs.)	(hrs.)	(hrs.)
	Road Restor.	0	18	24	52	0	-	-	0	-	-	58	58
	" Constr.	14	65	122	1,040	165	-	-	165	-	-	592	757
	" Repair	0	235	302	2,450	0	-	-	0	-	-	2,061	2,061
	Provision	10	89	143	396	25	-	-	25	445	118	40	628
Adit-N		479	636	632	4,749	3,353	479	499	4,331	97	-	-	4,428
Adit-S		510	643	671	4,703	3,542	191	639	4,372	235	-	-	4,607
	Equipment Moving out	-	4	8	49	-	-	-	-	-	32	-	32
Total		1,013	1,690	1,902	13,439	7,085	670	1,138	8,893	777	150	2,751	12,571

Note: Provisional works contain equipment moving in and camping etc.

A. II-4 Principal Equipment and Apparatus

Name of Equipment	Type and Specification	No., Quantity	Remarks
Compressor	ATLAS COPCO PR-700	2	1 for N. 1 for S
	JOY D 450S	2	1 for N. 1 for S
Loader	EIMCO 24B	1	for N
	GARDNER DENVER M64	1	for S
Drifter	ATLAS COPCO BBC-16W	4	2 for N. 2 for S
	MONTABERT T-28	4	2 for N. 2 for S
Tub	Side Dump Type, Hand Handling. 1.0m³	4	2 for N. 2 for S
Bit Grinder	ATLAS COPCO LSD-61	1	
Generator	YAMMER YSG-35N	1	
Vehicle	TOYOTA LAND CRUISER	1	
	HIGH LOOKS	1	
Bulldozer	DC-6	2	
House	Storied House, Galvanized Iron 94m²	1	Camp House
	Storied House, Galvanized Iron 80m²	1	Kitchen, Dinning Room
	Storied House, Galvanized Iron 190m²	1	Camp House, Office
	Storied House, Galvanized Iron 18m²	1	Warehouse
	Storied House, Galvanized Iron 18m²	2	Compressor Chamber 1 for N, 1 for S
	Storied House, Galvanized Iron 18m	2	Fuel Storage 1 for N. 1 for S
Powder Magazine	Subterranean Type Powder Magazine	1	
	Subterranean Type Blasting Supplies		

A. II-5 Summary of Advance Works, Adit-N

Construction Period		
Construction Period	Date of Starting Work	19, July, 1982
	Date of Starting Advance	26, Sept, 1982
	Date of Terminating Advance	12, Jun, 1983
	Date of Finishing Work	18, Jun, 1983

No. of Necessary Days			Until 12-Jun-1983			Until 18-Jun-1983			Remarks
			No. of Days	Per cent (%)		No. of Days	Per cent (%)		
	Working Days	Advance	190 days	84.8	80.2	190 days	84.1	79.5	Days Excluded 7, Apr, 1983-1, May, 1983. Suspended Advance Work for inundation. 13-16, Jun, 1983 Stand by for termination of advance. 12-13, Aug, 1982 Housing.
		Housing	2 "	0.9	0.8	2 "	0.9	0.8	
		Others	32 "	14.3	13.5	34 "	15.0	14.2	
	Sub-Total		224 "	100.0	94.5	226 "	100.0	94.5	
	Suspended Days		13 "	–	5.5	13 "	–	5.5	
	Total		237 "	–	100.0	239 "	–	100.0	

No. of Necessary Workers			Perforation	Preparation of Advance, Housing	Accessory Other Works	Remarks
	Staff	Interior	617 men	– men	1 men	1 man=8 hrs/Shift Period of Advance 26, Sept, 1982-12, Jun, 1983. Housing, 11-12, Aug, 1987. Accessory Works (Equipment Moving in) 17-18, Jun, 1983.
		Surface	15	4	3	
	Worker	Interior	4,667	–	6	
		Surface	82	10	20	
	Sub-Total	Interior	5,284	–	7	
		Surface	97	14	23	
	Total		5,381	14	30	G. Total 5,425 men

Efficiency		Until 12, Jun, 1983 (310.4 m)	Until 18, Jun, 1983 (310.4 m)	Remarks
	Advance m per 1 working day	1.386 m	1.373 m	
	Advance m per 1 actual Working day	1.634 m	1.634 m	
	Advance m per 1 necessary day	1.310 m	1.299 m	
	Advance m per 1 necessary worker	0.058 m	0.057 m	

Support				
Support	No. of Support	36 sets		
	Timbering Length (%)	40.6 m (13.1 %)		

A. II-6 Summary of Advance Works, Adit-S

Construction Period	Date of Starting Work	19, July, 1982
	Date of Starting Advance	26, Sept, 1982
	Date of Terminating Advance	18, Jun, 1983
	Date of Finishing Work	20, Jun, 1983

No. of Necessary Days		Until 18-Jun-1983			Until 20-Jun-1983			Remarks
		No. of Days	Per cent (%)		No. of Days	Per cent (%)		
Working Days	Advance	190 days	80.8	73.6	190 days	80.2	73.1	Days Excluded 28-30, Sept, 1982 Suspended for provisional Work 3-9, Oct, 1982 13-14, Aug, 1982 Housing.
Working Days	Housing	2 "	0.9	0.9	2 "	0.8	0.8	
Working Days	Others	43 "	18.3	16.9	45 "	19.0	17.3	
Sub-Total		235 "	100.0		237 "	100.0	91.2	
Suspended Days		23 "	–	8.9	23 "	–	8.8	
Total		258 "	–		260 "	–	100.0	

No. of Necessary Workers		Perforation	Preparation of Advance, Housing	Accessory Other Works	Remarks
Staff	Interior	641 men	– men	1 men	1 man=8 hrs/Shift Period of Advance 26, Sept, 1982-18, Jun, 1983 Housing, 13-14, Aug, 1982. Accessory Works (Equipment Moving in) 19-20, Jun, 1983.
Staff	Surface	30	4	3	
Worker	Interior	4,552	–	3	
Worker	Surface	151	10	20	
Sub-Total	Interior	5,193	–	4	
Sub-Total	Surface	181	14	23	
Total		5,374	14	27	G. Total 5,415 men

Efficiency		Until 18, Jun, 1983 (270.1 m)	Until 20, Jun, 1983 (270.1 m)	Remarks
	Advance m per 1 working day	1.149 m	1.140 m	
	Advance m per 1 actual working day	1.422 m	1.422 m	
	Advance m per 1 necessary day	1.047 m	1.039 m	
	Advance m per 1 necessary worker	0.050 m	0.050 m	
Support	No. of Support	15 sets		
	Timbering Length (%)	14.9 m (5.5 %)		

A. II-7 Summary of Material Consumption

Name	Specification	Q'ty	Remarks
Petroleum		113,659 ℓ	
Gasoline		1,475 ℓ	
Drifter Oil		4,321.8 ℓ	
Loader Oil		555 ℓ	
Grease		60 kg	
Mission Oil		250 ℓ	
Engine Oil		785 ℓ	
Compressor Oil		270 ℓ	
Kerosene		2245 ℓ	
Dynamite	SEMEX SA. 7/8"×7"	11,107.25 kg	
Detonator	FULMESA No.6	23,660 nos	
Fuse	FULMESA	141,960 ft	
Insert Bit	COROMANT 22m/m Hex. Gauge 38m/m 1.8m	581 nos	
Carbide		146 kg	
Timbering Wood		22.5m^3	No includes Materials for Housing.
Board		2.15m^3	
Sleeper		899 nos	
Supports		44 set	

Note: Includes road construction etc,.

A. II-8 Details of Material Consumption

Name	Specification	Q'ty		Remarks
		Adit-N	Adit-S	
Petroleum		51,479 ℓ	47,280 ℓ	
Gasoline		755 ℓ	720 ℓ	
Drifter Oil		2,203 ℓ	2,077 ℓ	
Loader Oil		290 ℓ	265 ℓ	
Grease		30 kg	30 kg	
Mission Oil		130 ℓ	120 ℓ	
Engine Oil		259 ℓ	285 ℓ	
Compressor Oil		140 ℓ	130 ℓ	
Kerosene		1,040 ℓ	1,205 ℓ	
Dynamite	SEMEX SA 7/8"×7"	5,411 kg	5,075 kg	
Detonator	FULMESA No.6	11,841 nos	10,339 nos	
Fuse	FULMESA	71,046 ft	62,034 ft	
Insert Bit	COROMANT 22m/m Hex. Gauge 38m/m 1.8m	275 nos	274 nos	
Carbide		48 kg	56 kg	
Tinbering Wood	φ0.05 × 3.0m φ0.10 × 3.0m φ0.15 × 3.0m φ0.20 × 3.0m φ0.25 × 3.0m φ0.30 × 3.0m	15.4 m^3	7.1 m^3	
Board	0.3m×0.05m×3.0m	1.08 m^3	1.07 m^3	
Sleeper	0.15m×0.15m×1.2m	458 nos	441 nos	
Supports		30 set	14 set	

A. II-9 Surveying Result, Adit-N

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
N_1	-	-	310,344.28	8,809,084.30	4,689.37
N1 - N2	111°40'03"	20.329	310,376.21	8,809,077.06	4,689.73
N2 - N3	112°31'41"	33.641	310,407.28	8,809,064.17	4,690.29
N3 - N4	112°38'18"	22.963	310,428.47	8,809,055.33	4,690.49
N4 - N5	112°29'21"	22.632	310,449.38	8,809,046.68	4,690.54
N5 - N6	128°31'16"	10.849	310,457.87	8,809,039.92	4,690.62
N6 - N7	158°21'26"	4.961	310,459.70	8,809,035.31	4,690.74
N7 - N8	173°29'56"	6.526	310,460.44	8,809,028.82	4,690.84
N8 - N9	159°56'06"	23.839	310,468.62	8,809,006.43	4,691.00
N9 - N10	159°59'31"	21.000	310,475.80	8,808,986.70	4,691.28
N10 - N11	159°57'01"	26.255	310,484.803	8,808,962.037	4,691.578
N11 - N12	159°54'11"	37.265	310,497.607	8,808,927.041	4,691.724
N12 - N13	159°48'36"	23.576	310,505.743	8,808,904.914	4,691.719
N13 - N14	159°44'56"	31.690	310,516.712	8,808,875.183	4,692.080
N14	-	24.874	-	-	-

A. II-10 Surveying Result, Adit-S

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
S1	-	-	310,968.25	8,807,260.34	4,570.14
S1 - S2	359°30'37"	20.421	310,968.08	8,807,881.36	4,570.20
S2 - S3	1°04'22"	31.541	310,968.67	8,807,912.90	4,570.44
S3 - S4	1°01'47"	24.693	310,969.11	8,807,937.59	4,570.76
S4 - S5	0°46'37"	19.689	310,969.377	8,807,957.273	4,570.91
S5 - S6	359°10'47"	33.582	310,968.90	8,807,990.85	4,571.21
S6 - S7	357°24'32"	8.190	310,968.53	8,807,999.03	4,571.33
S7 - S8	327°31'22"	26.245	310,954.44	8,808,021.17	4,571.572
S8 - S9	327°10'12"	21.519	310,942.769	8,808,039.254	4,571.852
S9 - S10	329°56'32"	29.518	310,927.985	8,808,064.802	4,572.241
S10 - S11	330°53'42"	29.832	310,913.475	8,808,090.867	4,572.398
S11	-	24.870	-	-	-