REPUBLIC OF PERU

REPORT ON MINERAL EXPLORATION

IN

ISCAYCRUZ (OYON) AREA

PHASE III

SEPTEMBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Peru, decided to conduct the mineral exploration composed of drilling and tunnelling surveys in the Iscaycruz (Oyon) Area in cooperation with Instituto Geologico, Minero, y Metalurgico (INGEMMET), and entrusted its execution to Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ).

Metal Mining Agency of Japan dispatched a survey team headed by Mr. Jinichi Nakamura to conduct the Phase III of the project. The survey had been started on 7 May, 1984 following the Phase II survey and accomplished on 1 June, 1985 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 III 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.

August, 1985

Keisuke Arita
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan

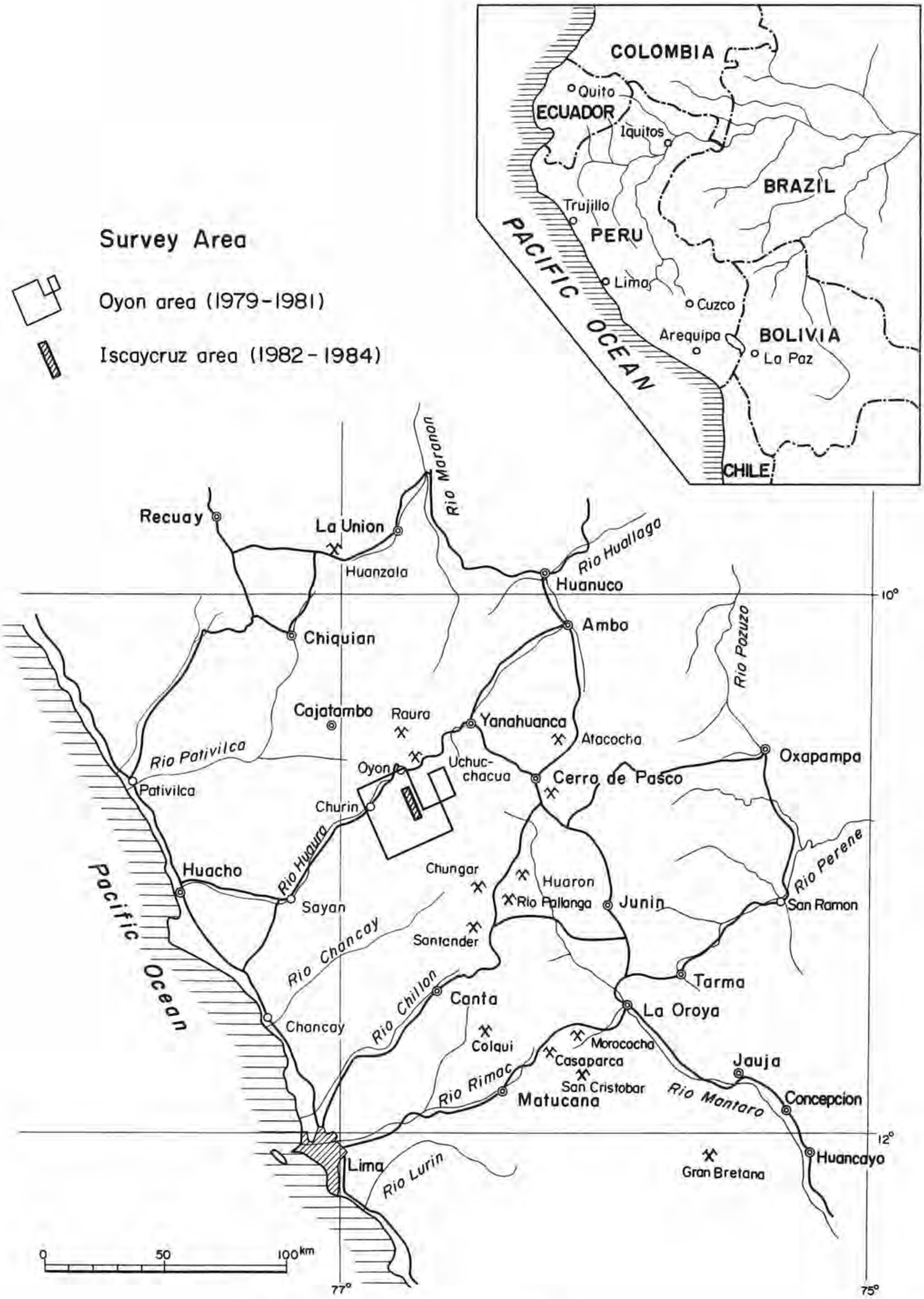

Fig. I Index Map

ABSTRACT

This report summarizes results of the third year's work of the Mineral Exploration by means of drilling and tunnelling explorations carried out in the Iscaycruz Area (40 km^2), 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 Iscaycurz Area had been extracted as a favorable area where economic ore deposits would be expected to be emplaced, by the results of the Mineral Exploration in the Oyon Area (860 km^2), which was carried 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 Western Andes. Geologically, Mesozoic sedimentary rocks are widely distributed in this area, forming remarkable composit folded structure due to tight folding with the axes in the Andean direction, namely NNW-SSE.

The Iscaycruz mineralized zone is located approximately 7 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 50 to 100 m in thickness, and continues about 12 km along the strike. In this mineralized zone, ore deposits are divided roughly into two categories; 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.

The investigations in the present year, following the works in the last year, the tunnelling exploration (crosscut of Adit-N, main tunnel of Adit-S and two crosscuts of Adit-S) total length of which is 748 m, and the drilling (6 drill holes in the underground, 1 drill hole on the surface, total length 1,340 m) were carried out in the Limpe area, in addition to the drilling carried out in the Limpe-South area (3 drill holes on the surface, total length 560 m).

By the results of the drilling, high grade zinc orebodies associated silver, copper and lead minerals (the grade of Cu + Pb + Zn is up to 20%) was confirmed in the 4 holes; 3 holes in the Limpe area and 1 hole in the Limpe-South area. Considering the results of the drilling in this year with the data obtained in the past, the scale of the orebody in the Limpe area is estimated to be about 300 m in horizontal extension, more than 150 m in vertical extension and 10 to 30 m in

thickness. Also, it has been confirmed that there is a fair potentiality of the emplacement of high grade copper-zinc ore deposit in the Limpe-South area.

By the results of the tunnelling exploration, two portions of high grade lead-zinc mineralization have been confirmed in the crosscut of Adit-S. The sizes and the ore grade of these mineralized portions are presumed to be better than those estimated from the data obtained by the drilling.

The exploration works in the Limpe area during the period of these three years have brought about the full comprehension of the existence of fairly large scale of high grade lead-zinc ore deposits in this area and it is thought that the purpose of the investigation has been completed in the subject area.

As to the investigation of the next stage, it is recommended to carry out the survey for the planning of the developmentl including every item in necessary fields for the investment to the development of mineral resources.

GENERAL REMARKS

GENERAL REMARKS

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CHAPER 1 INTRODUCTION

1–1 Purpose of the Survey

The purpose of this survey is, in addition to the comprehension of the geological structure in relaton to the mineralization in the 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 Scope of the Survey

The Mineral Exploration was carried out for three years from 1979 to 1981 in the Oyon Area (860 km^2). By the results of the investigations, it was confirmed that the high grade copper-lead-zinc sulphide ore deposits and skarn ore deposits were emplaced in the Iscaycruz Area (40 km^2) and also it was proved that high potentiality of the mineralization would be expected in this area for the development of mineral resources.

The Limpe area and Limpe-South area, where high grade lead-zinc ore deposits were expected, were selected for the next continuous Mineral Exploration in the Iscaycruz Area, and more detailed investigations by drilling and tunnelling explorations were carried out scheduled in three years program for 1982 to 1984. This year survey (1984) is the third year final plan.

1–3 Outline of the Survey

1) Drilling Exploration

Surface drilling of 4 holes and underground drilling of 6 holes in the Limpe area, totalling 10 holes, 1,900 m was carried out in this year.

	Phase I	Phase II	Phase III	Total
Limpe area; Surface	1300(5)	–	180(1)	1480(6)
Adit–N		440(2)	680(3)	1120(5)
Adit–S		470(2)	480(3)	950(5)
Limpe–S, Surface			560(3)	560(3)
Total	1300(5)	910(4)	1900(10)	4110(19)

(unit: m)

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. 5).

Main tunnels were excavated in the Chimu Formation and crosscut tunnels into the mineralized zones in the Santa Formation.

As the time for the investigation was limited, two starting points were established for the excavation of the tunnels with the approximate distance of 1,400 m, so that the two faces, that are Adit–N and Adit–S, could be worked at the same time. Excavation length in this year was 175 m in Adit–N and 573 m in Adit–S, totalling 748 m.

	Phase I	Phase II	Phase III	Total
Adit–N; Main Tunnel	310	200	–	510
Crosscut–1	–	150	–	150
Crosscut–2	–	–	175	175
Adit–S; Main Tunnel	270	330	346	946
Crosscut–1	–	–	141	141
Crosscut–2	–	–	86	86
Total	580	680	748	2,008

(unit:m)

1–4 Organization of the Survey Team

Japan Side Planning, Negotiation, and Supervision

Toru Miura	MMAJ*
Masao Tsuge	MMAJ
Makoto Ishida	MMAJ
Sumihiro Fure	MMAJ
Takashi Kamiki	MMAJ

Peru side Planning and Negotiation

Francisco Sotillo	INGEMMET**
Gregorio Flores	INGEMMET
Augusto Zelaya	INGEMMET

Japanese Survey Team

Jinichi Nakamura (Team Leader)	MINDECO***
Nobuhiko Yamamoto (Drilling)	MINDECO
Hisashi Shimizu	MINDECO
Tsutomu Aoyama	MINDECO
Tetsuo Yoshida	MINDECO
Kunihiko Tsukanaka (Tunnelling)	MINDECO
Seiichi Furuyado	MINDECO

Peruvian Survey Team

Gregorio Flores (Team Leader)	INGEMMET
Hector Zarate	INGEMMET
Emilio Rojas	INGEMMET
Luis Santalla	INGEMMET

* Metal Mining Agency of Japan

** Instituto Geologico, Minero y Metalurgico

*** Mitsui Mineral Development Engineering Co., Ltd.

CHAPTER 2 OUTLINE OF THE SURVEYED AREA

2–1 The Surveyed Area

The Iscaycruz Area is, on the administrative division, belonging to Provincia Cajatambo of Departamento Lima, and is located about 150 km north of Lima, the capital (see Fig. 1).

To reach the Area from Lima, it is necessary to come to Sayan through Chancay (137 km, about 3 hours by vehicle). From Sayan, running along a rough and bending road along the valley of the Rio Huaura, one can come to Oyon through Churin (93 km, about 3 hours). After passing through Pampahuay, an access road is available to pass over the range at the approximate altitude of 5,000 meters above sea level, to come to the Iscaycruz Area (approximately 30 km, about 2 hours, (see Fig. 2).

The surveyed area lies in the Cordillera Occidental, a main range of the Western Andes, and is situated in the source area 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 mountaneous topographical feature. The elevation of the surveyed area is 4,600 ~ 4,700 meters above sea level.

The climate in this area belongs to what is called Andean highland climate. Daily variation of temperature is in fairly great range, and sometimes the temperature reaches over 20°C in daytime, while it goes down to less than 0°C in night time. To take annual variation of the climate, there are two seasons. The dry season is in the period from May to September, while the wet season is in the period from October to April. In the wet season, snowfall can be seen almost every day in the highland area at the altitude of more than 4,000 meters above sea level.

2–2 Outline of Geology

1) Regional 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 Pliegues y Sobreescurrimientos) by Wilson (1967).

Thick Cretaceous sedimentary rocks are widely distributed in this area. 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.

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 repeatedly exposed at the surface. At the central part in the orogenic zone thrust faults parallel to the fold axis are developed.

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 (see Fig. 3).

2) Outline of Geology in the 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 Antapampa is at the south end (see 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. Overturned structures are observed to be developed in the Limpe area and Limpe-South area in the central part of this area.

As for igneous 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 (see Fig. 4).

2–3 Outline of 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 Metalogenica Andina Occidental. In the vicinity of the survey area, there are many silver-lead-zinc mines in operation, such as Raura mine (Pb · Zn), Uchucchacua mine (Ag), Atacocha mine (Pb · Zn · Ag), Cerro de Pasco mine (Pb · Zn · Ag), Huaron mine (Pb · Zn · Ag), and Santander mine (Cu · Zn).

2) Iscaycruz Mineralized Zone

The Iscaycruz mineralized zone is found in the limestone of the Santa Formation, and is distributed intermittently along the limestone 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 (see Fig. 4).

Dark-colored gossans exposed widely on the surface are composed mainly of goethite, quartz and kaolinite, associated with manganese oxides and siderite. 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.

Massive pyrite ore deposit, which is composed mainly of pyrite associated with pyrrhotite and marcasite, is occasionally enriched with galena and sphalerite. There occurs a lot of druses in pyrite orebody and hematite in the marginal places. In sphalerite, spotted small grains of chalcopyrite are contained.

Main ore minerals of skarn ore deposit are chalcopyrite, sphalerite, pyrite, and magnetite, and main skarn minerals are tremolite, garnet, epidote, and quartz.

Silicification, sericitization, argillization, sideritization, dolomitization, and brecciation are remarkable alterations in the host rock of the ore deposits. The acidic dykes, which intruded into the Oyon and Chimu Formations around Cumbre de Cunsha Punta, are thought to have been related to the mineralization.

As for the fracture system, shear faults of WNW–ESE and NNE–SSW directions, both of which are oblique to the folding axis, tension fracture of ENE–WSW which shows right angle to the folding axis, and thrust fault and bedding fracture parallel to the folding axis are observed to be developed in this area.

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 Limpe-S 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 igenous rocks, and they are thought to have been formed in a single mineralosphere by a series of mineralization as a whole.

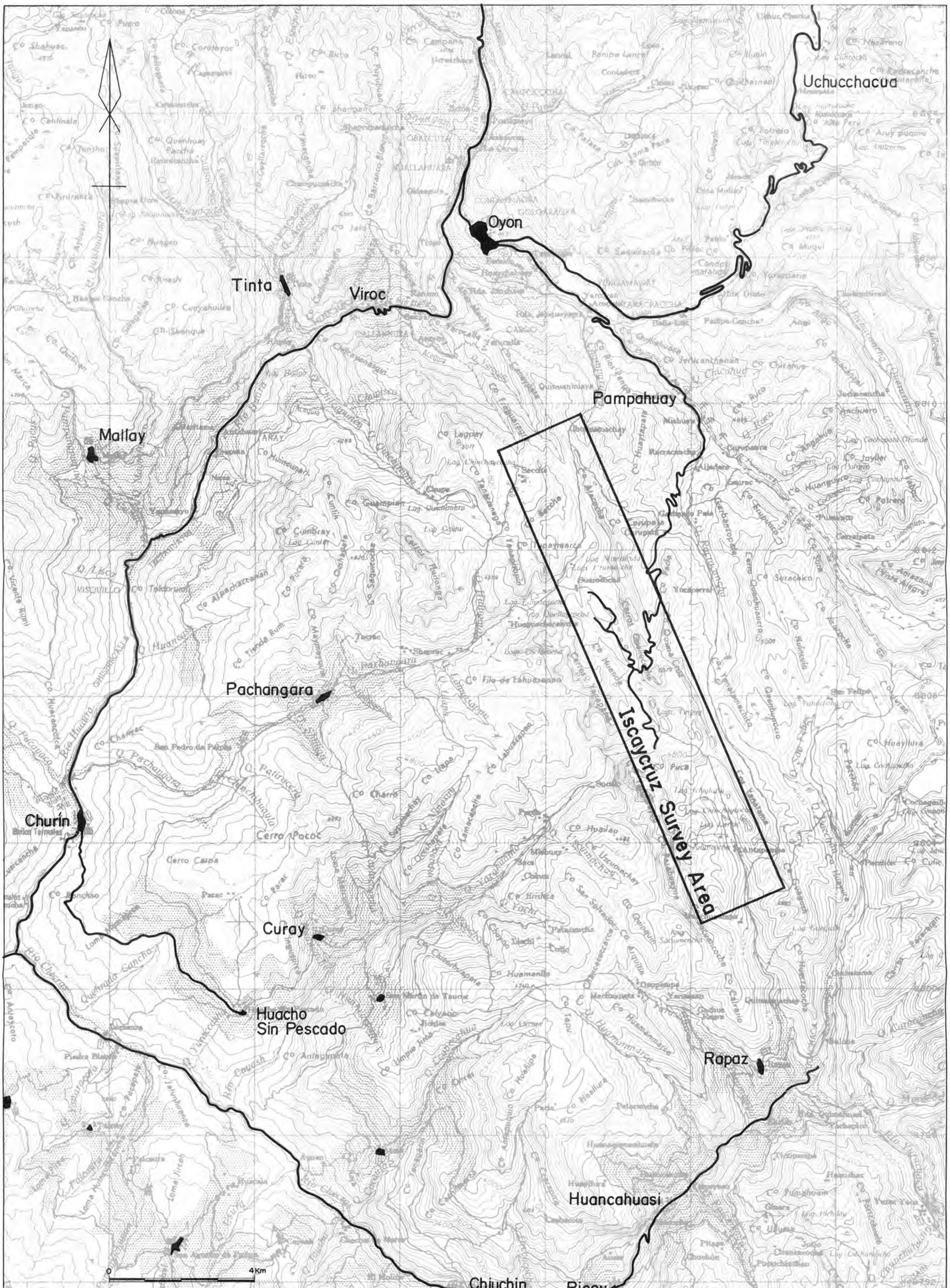
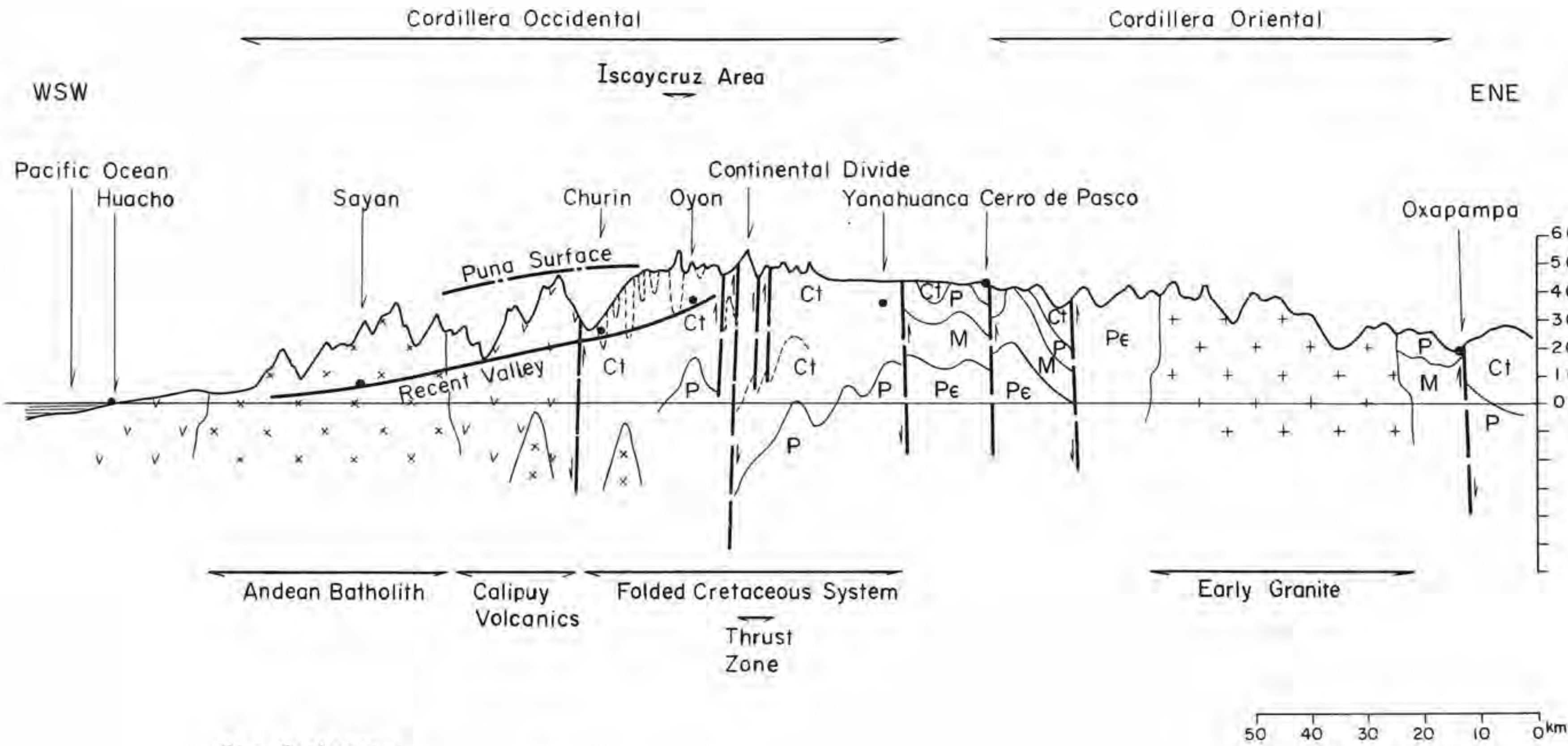


Fig. 2 Location and Access Map



Ct : Cretaceous
P : Jurassic & Triassic (Pucara Group)
M : Permian (Mitu Group)
Pє : Precambrian

Fig. 3. Schematic Profile of the Central Andes Area

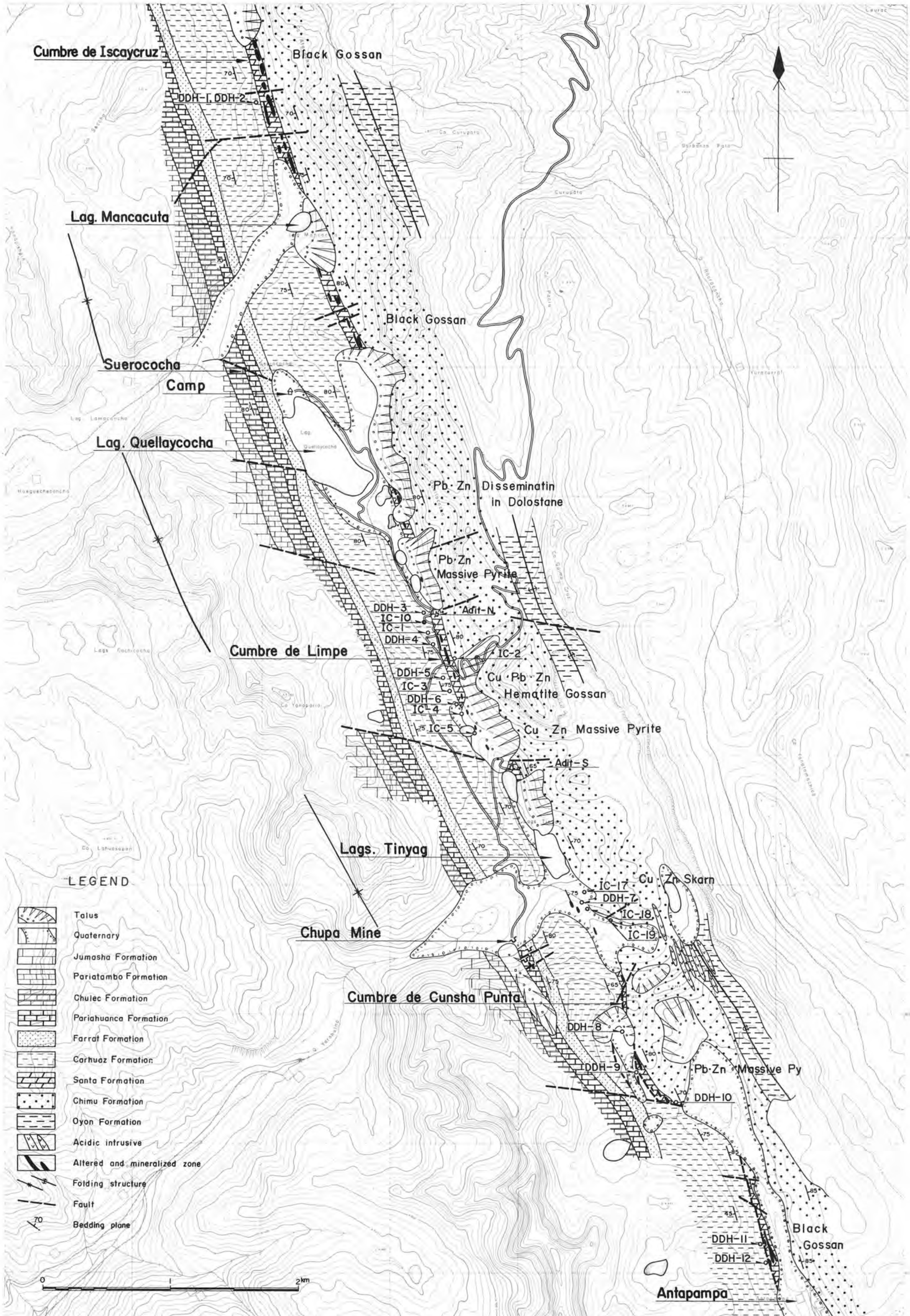


Fig.4 Geological Map of the Iscaycruz Area

CHAPTER 3 OUTLINE OF THE SURVEY RESULTS

3–1 Drilling Exploration

In the present year, under ground diamond drilling of 10 holes, whose total length was 1,900 meters, was carried out in 8 drill sites, 1 site on the surface at Limpe, 2 sites in the underground of Adit-N, 2 sites in the underground of Adit-S and 3 sites on the surface in the Limpe-South (Tinyag) area.

1) IC–10 (on the surface at Limpe)

At the immediate depth of the gate of the Adit-N, the drill hole caught only a weak indecation of lead-zinc-copper mineralization in dolostone, siderite, pyrite and hematite.

2) IC–11, IC–12 and IC–13 (in the underground of Adit-N)

Rich indications of mineralization were caught in the drill holes of IC–11 sited at the 310 m point in the Adit-N and IC–12 sited at the 410 m point in the Adit-N. The ore grade of high grade portion of the indication is as high as more than 40%. The assay results of the samples collected every one meter of the cores are shown in the following table.

Hole	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Horizontal Width (m)
IC–11	107.2–115.4	8.2	5	39	0.05	4.44	7.97	
"	115.4–124.5	9.1	9	47	0.05	1.38	39.16	
"	124.5–133.9	9.4	5	25	0.04	3.94	19.00	
Average	107.2–133.9	26.7	19	38	0.04	3.16	22.69	20.5
IC–12	144.3–161.5	17.2	17	40	0.01	2.11	8.37	
"	161.5–175.5	14.0	14	153	0.48	3.23	44.80	
"	175.5–183.5	8.0	7	32	0.06	2.64	21.59	
Average	144.3–183.5	39.2	38	78	0.19	2.61	24.08	33.2

The levels of the location of the above two indications of mineralization are 4,610 m and 4,570 m respectively, and it is thought that these two indications would form one orebody with the indications formerly caught at 4,680 m level in the drill hole IC–2 and at 4,590 m level in the hole DDH-5. The scale of this orebody is estimated to be more than 250 meters in horizontal extension and over 150 m in vertical extension.

The southern extension of this orebody has been confirmed to be massive pyrite, which was caught in the drill hole IC–13.

3) **IC–14, IC–15 and IC–16 (in the underground of Adit-S)**

In the drill hole IC-14 sited in the underground at the 710 m point of the Adit-S, 4 layers of zinc mineralization has been confirmed around massive pyrite.

Hole	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
IC–14	100.7–102.4	1.7	1	30	0.43	0.02	17.50
IC–14	107.1–113.9	6.8	4	18	0.05	0.04	9.90
IC–14	113.9–123.7	9.8	9	42	0.27	0.19	21.56
IC–14	131.6–133.8	2.2	2	28	0.28	0.06	31.00

The average grade of 16.6 meters of the core between 101.7 m and 123.7 m is Ag 32 g/t, Cu 0.18%, Pb 0.13% and Zn 16.78%, and the horizontal width is estimated to be 13.2 meters. This indication is thought to be connected to the indication caught in the drill hole DDH-6. This fact suggests that the orebodies in the Limpe area has dipping to the south as a whole.

It is confirmed in the drill hole IC–15 located at the same site that the above mineralization is thinning out in the southern extention where the rocks of the Santa Formation have been remarkably pyritized. In the pyrite zone, local dissemination of copper minerals is recognized.

Also, in the drill hole IC–16 located in the underground at the 510 m point in the Adit-S, large scale of massive pyrite and hematite are confirmed, and copper minerals are recognized to be disseminated locally.

4) **IC–17, IC–18 and IC–19 (on the surface at Limpe-South)**

The mineralized and altered Santa Formation was recognized in the core of the length of over 60 meters in the drill hole IC–17, located about 100 meters north of the drill hole DDH-7, in which high grade mineralization was formerly confirmed. However, the mineralization is found not to be magnificent.

Hole	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
IC–17	94.8–99.5	4.7	3	11	1.25	0.00	0.09
IC–17	127.3–127.7	0.4	1	11	9.00	0.00	38.40
IC–17	140.0–141.0	1.0	1	8	0.42	0.00	22.00

In the drill hole IC–18 located about 110 meters southeast of the drill hole DDH-7, high grade mineralization has been confirmed associated with skarn minerals as tremolite in the Santa Formation which is recognized over 45 meters after passing through the fault fractured zone developed along the boundary of the Chimu Formation and the Santa Formation.

Hole	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Horizontal Width (m)
IC–18	96.9–101.8	4.9	3	22	2.86	0.03	21.60	
IC–18	101.8–110.8	9.0	9	9	0.90	0.01	28.89	
IC–18	110.8–125.5	12.7	10	7	0.97	0.01	12.24	
Average	96.9–125.5	28.6	22	8	1.32	0.01	19.79	22.3

In the drill hole IC–19 located about 320 meters southeast of the drill hole DDH-7, skarnized and intensely pyritized rocks belonging to the Santa Formation are confirmed over 38 meters after passing through a large fault fractured zone. However, no other mineralization but local dissemination of zinc and copper minerals has been recognized.

3–2 Tunnelling Exploration

As the tunelling exploration in this year, total 748 meters of tunnel excavation was carried out:

Crosscut-2 of Adit-N	175 m
Adit-S (main tunnel)	346 m
Crosscut-1 of Adit-S	141 m
Crosscut-2 of Adit-S	86 m

The cummulative total length of the excavation of the Adit-N is 835 meters and that of the Adit-S is 1,173 meters.

1) Crosscut-2 of Adit-N

The starting point of this crosscut-2 is at the 460 m point of the Adit-N. The geology along this cross cut is as follows.

0 m – 49 m :	quartzite (Chimu Formation)
49 m – 92 m :	alternation of sandstone, marlstone, mudstone and dolostone (transitional zone of the Chimu Formation)
92 m – 126 m :	massive pyrite (Cu-Zn dissemination, Santa Formation)
126 m – 140 m :	dolostone, pyrite (Cu-Zn dissemination, Santa Formation)
140 m – 170 m :	limestone (Santa Formation)
170 m – 175 m :	shale (Carhuaz Formation)

A fault of NE series is confirmed at around the 57 m point. Faults parallel to the bedding planes are well developed along the boundary zone of the different rocks.

The high grade orebody in the lower horizon caught in the drill holes of IC–2 and IC–12 is recognized to have varied to massive pyrite in the extension while the lead-zinc orebody in the upper horizon has been thinning out.

2) **Adit-S main tunnel**

The Adit-S main tunnel was excavated in the NNW direction, following the works in the last year, in the transitional zone of the Chimu Formation, which is composed of quartzite, marlstone, mudstone and dolostone. Faults parallel to the bedding planes are well developed along the border between the hard rock like quartzite and the soft rocks such as marlstone, and the excavation was fairly difficult. The main tunnel whose direction was changed to the left side at the 835 m point encountered the Santa Formation at the 32 m point and the excavation was carried out in the dolostone toward the proposed position of the opening point of the crosscut-2. At the 94 m point, there is a fault of WNW-ESE series dipping to the south. In the far side beyond this fault, there is a large druse. Dissemination of zinc minerals is recognized in the dolostone.

3) **Crosscut-1 of Adit-S**

Geology of the crosscut-1 is as shown below (the opening of the crosscut-1 is at the 700 m point of Adit-S).

0 m – 46 m :	alternation of sandstone, marlstone, mudstone and dolostone (transitional zone of the Chimu Formation)
46 m – 100 m :	massive pyrite (Santa Formation)
100 m – 120 m :	limestone and dolostone (Santa Formation)
120 m – 130 m :	pyrite (Santa Formation)
130 m – 141 m :	limestone (Santa Formation)

In the far side of the 46 m point along this tunnel, there were several localities where remarkable acidic spring water (pH=1) came out, and the excavation was awfully difficult and had to be stopped. Although a large scaled pyritic orebody was confirmed in this tunnel, no more mineralization than local dissemination of zinc minerals at around the 129 m point has been recognized.

4) **Crosscut-2 of Adit-S**

Two remarkable mineralization zones have been confirmed in the sections between 3 m and 19 m points and between 60 m and 67 m points along this tunnel. The assay results of the samples collected along every 1 meter of the channels on both of the walls are given as below.

	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
D7 North wall	3–21	18	18	161	0.16	4.25	29.80
South wall	5–19	13	13	210	0.16	3.28	30.54
Average		15	31	182	0.16	3.84	30.11
U6 North wall	60–67	7	7	15	0.06	2.84	8.64
South wall	61–66	5	5	33	0.10	2.47	13.97
Average		6	12	26	0.08	2.63	11.75

The above U7 orebody was caught in the drill hole DDH-5 at the almost same locality. According to the data of the hole DDH-5, the horizontal width of this orebody is 11.9 m and the ore grade is Ag 163 g/t, Cu 0.14%, Pb 2.92% and Zn 27.15%. The result of the confirmation of this orebody in the tunnel is better than the result obtained in the drill hole in the viewpoint either of scale or of grade.

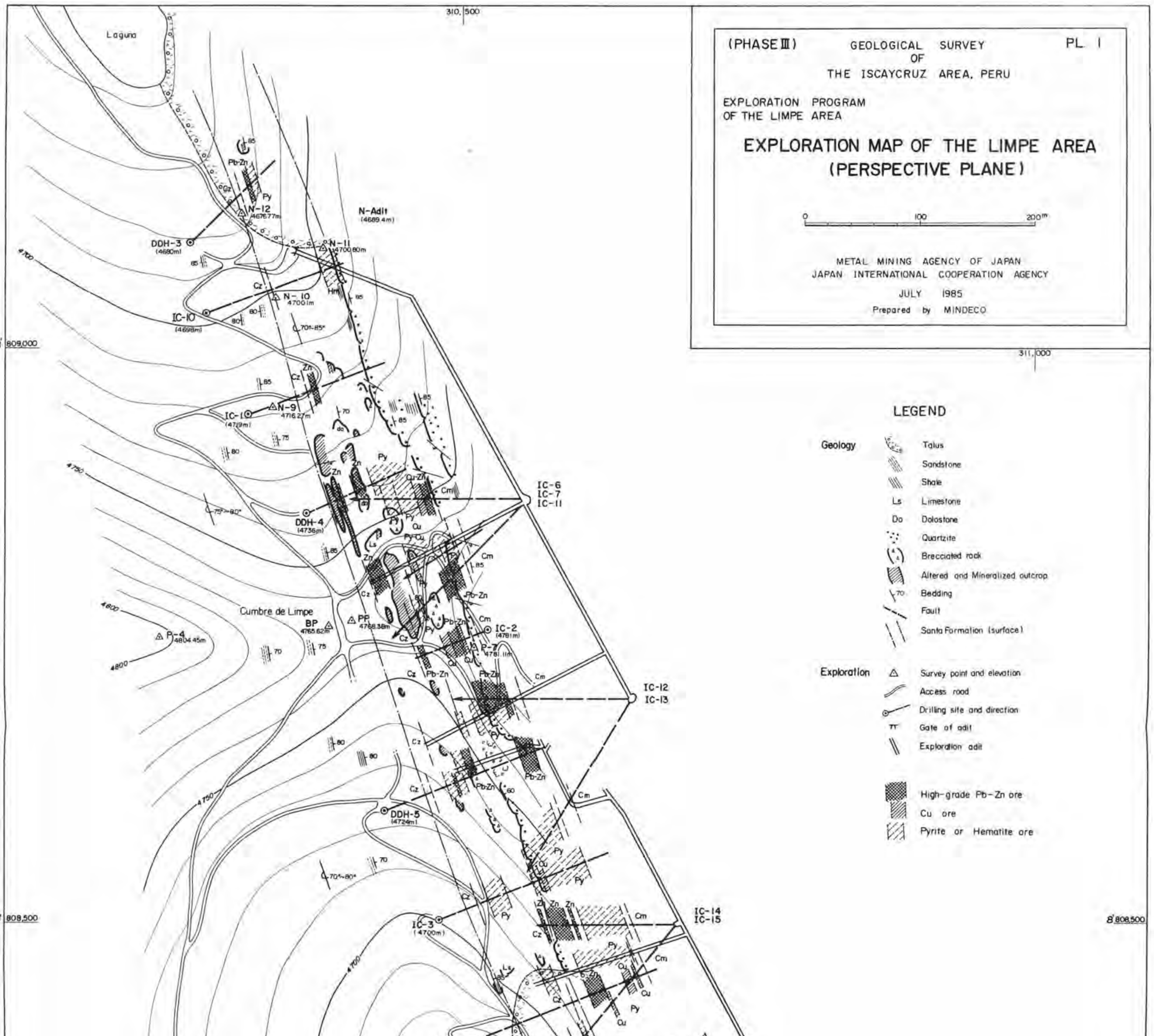


Fig. 5 Exploration Map of the Limpe Area

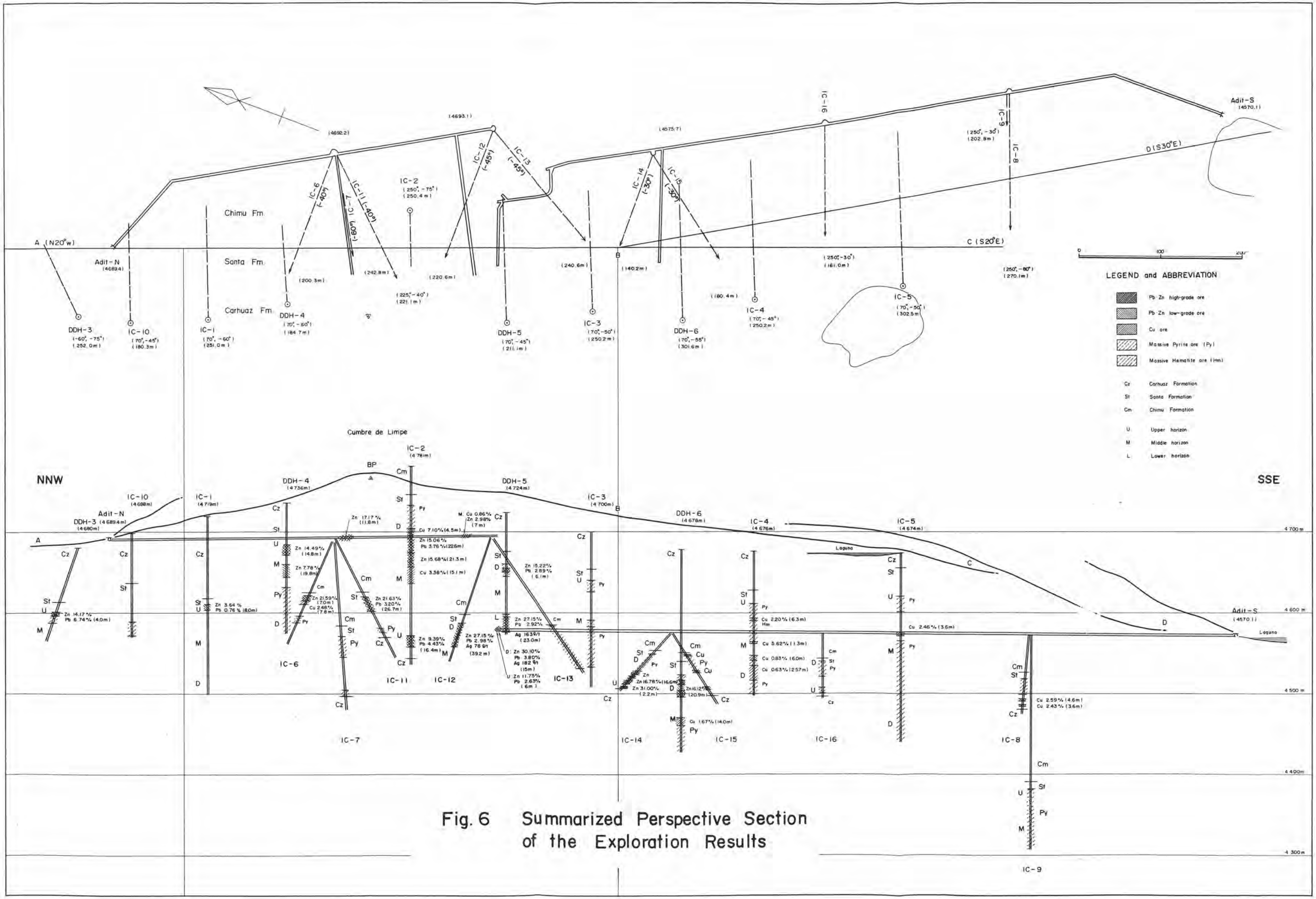


Fig. 6 Summarized Perspective Section of the Exploration Results

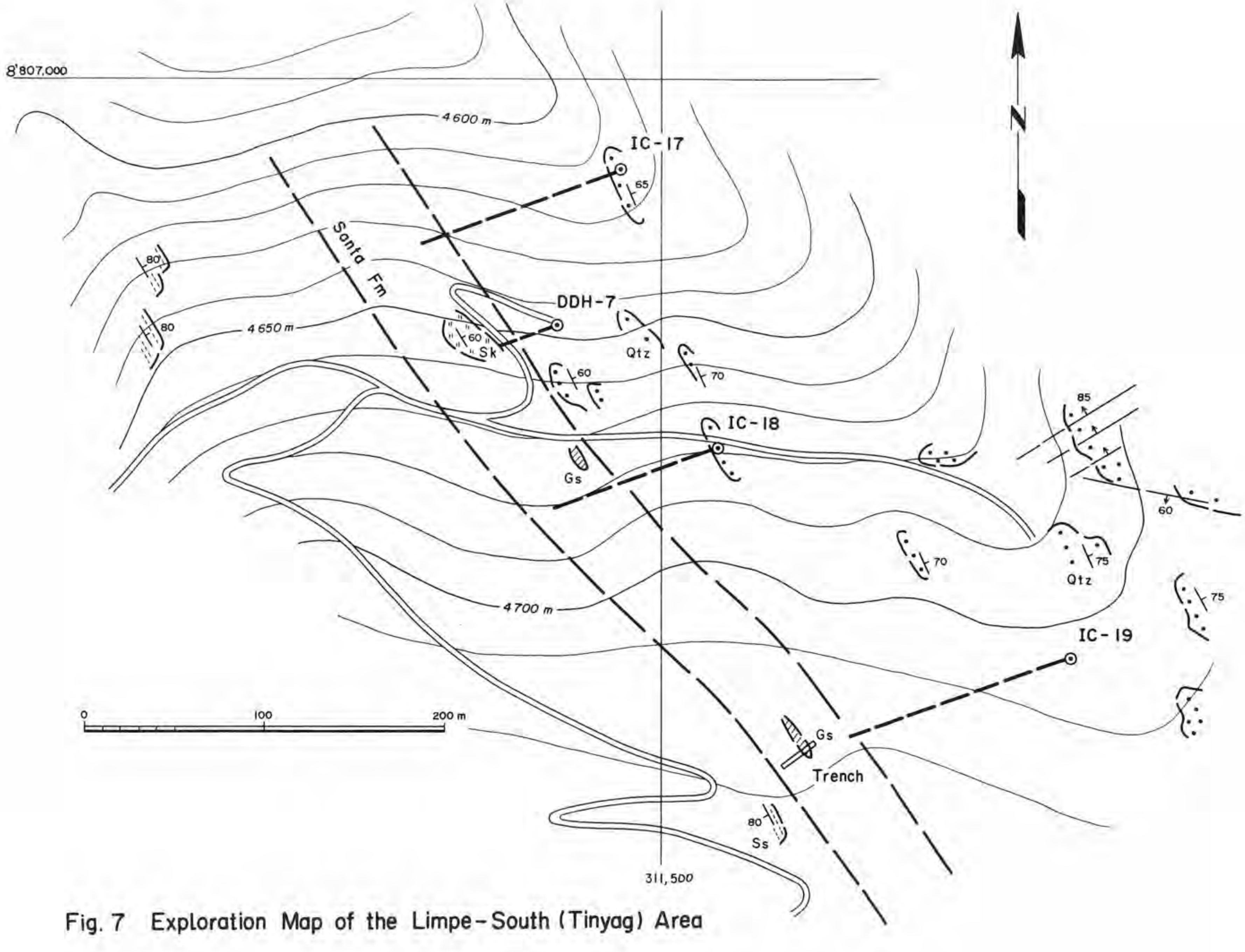


Fig. 7 Exploration Map of the Limpe-South (Tinyag) Area

CHAPTER 4 ORE RESERVE ESTIMATION (TENTATIVE CALCULATION)

4–1 Methods of Calculation

The mineralization in the Limpe area, which is the main object of the surveys, is represented by irregular massive ore deposits formed by the replacement of limestones. Viewing from the survey results, it seems that the shapes and the sizes of the orebodies might have variation to a considerable extent and that the distribution of ore grades might be inhomogeneous. For such undeterminable orebodies, it is impossible to insist that the exploration works carried out by this stage would have been enough in amount for the delineation of precise properties of the orebodies by this stage, because only four crosscut tunnels have been excavated within such a distance of 1,400 meters and the drilling exploration has been done merely with the spacing of every 100 meters. It is not appropriate to say that now is the right stage when ore reserve estimation by any means expecting certain accuracy could be possible.

By the tunnelling and drilling explorations, more than ten indications of high grade mineralization have been confirmed. It is thought that they are related intimately to the pyritization and to the brecciation, and it is estimated that they have continuity to some extent, being controlled by the structure of the limestone. Therefore, it would be possible only on such basis to execute tentative ore reserve estimation for rough assumption of the ore reserve and the ore grade.

As to the method of calculation Polygon Method was employed, which is thought to be the most simple and objective way of ore reserve estimation.

4–2 Process and Basis of Calculation

(1) The indications involved in the estimation are those having thickness of more than 2 meters and having grade of more than 10 % of Pb+Zn. In case of copper ore, indications having grade of more than 2 % of Cu are employed. However, any indications which are composed of only one sample satisfying the above conditions have been excluded.

(2) Center points of each of the indications caught are projected on a perspective section, which is established parallel to the extension of the mineralization zone (N20°W–S20°E).

(3) After real thickness of each of the indications is obtained based on the angle between the direction of the drill hole and the boundary plane of the wall rocks and the ore deposit or the plane structure of the ore deposit, its width on the horizontal plane is calculated according to the inclination of the ore deposit or the wall rocks (see Table 1).

(4) The area of the calculation in both strike and vertical directions is taken not to exceed five times of the horizontal width of the indications and is limited to be less than 50 meters at the maximum.

(5) The area down to the depth of 30 meters below surface is not included in the ore reserve estimation due to the possibilities of oxidized and/or leached zone.

(6) In case the distance between any two center points of the indications is within 5 times of the total of the two horizontal width of the indications, and the continuity of the mineralization is expected geologically, they are regarded to be within one single orebody.

(7) In case there are more than two points of the indications within a single orebody, polygons are established with each of the points of the indications to be the centers. Boundaries of the polygons are taken so that any neighbouring two points could have equal distance to the boundary between them. Unmineralized points in the mineralized horizon are also considered to decrease ore reserve tonnage. Tetragon is drawn with such orebody with only one point.

(8) After area and volume of each of the polygons are obtained, the ore reserves and the ore grade are calculated. Specific gravity is decided to be 3.4, considering the amount of 12 % of the porosity of the orebodies over 3.83, the measured value of the specific gravity.

(9) It is the known tendency of the polygon method that the ore reserve would be estimated excessively especially along the margin of each polygon when the density of the survey elements is rough or when the variation of thickness and shapes of the orebody is fairly big. Considering such characteristics of the polygon method, in addition to the fact that the figures of the horizontal widths of the orebodies are obtained only as the estimated values, it may be safer to infer actual ore tonnage, if an assesment factor of around 90 % to 75 % was adopted.

(10) As for ore grade calculation, a safety factor of 95 % is adopted.

4–3 Sampling and Analysis

1) Sampling Methods of the Drill Cores

(1) High grade ore

Sampling interval is 1 meter as a rule. Core is cut squally into two half pieces along the axis by diamond cutter and the half of the core is further cut into two equal pieces in the same way. Thus, one fourth of the core is employed as a sample.

(2) Moderate grade ore

Sampling interval is 2 meters as a rule. With core splitter core is split into two pieces to employ half of the core as a sample. On necessity, cores are broken in site and are reduced to make one sample by sample reducer.

(3) Low grade ore

Sampling interval is free up to 10 meters in maximum. With hammer, one sample is prepared by collecting small pieces continuously.

2) **Sampling Methods in the Tunnels**

(1) **High grade ore**

Continuous channel sampling on both walls with the interval of every 1 meter at a level of 1 meter above the bottom of the tunnel.

(2) **Moderate grade ore**

Channel sampling of the length of 1 meter with the interval of every 2 meters either in zig-zag way on both walls or along a wall on one side.

(3) **Low grade ore**

Channel sampling of the length of 1 meter with the interval of 4 meters on a wall.

3) **Analysis**

(1) **Analysis of Ore Samples**

The analysis of ore samples were carried out at the laboratory of INGEMMET as a rule, but some of the samples were sent to the Plenge Laboratory for the analysis. The ingredients for the analysis are Ag, Cu, Pb and Zn.

The laboratory of INGEMMET employs the Atomic Absorption Spectrochemical Analysis. In the third year, some samples show very high grade more than 40% up to 50% in zinc. The Wet Chemical Analysis is more suitable method to such high grade ore samples. Therefore, all samples of high grade ore more than 30% of zinc content were sent to the Plenge Laboratory and re-analysed by the Wet Chemical Analysis, and the assay values of the Plenge Laboratory were adopted for the ore reserves calculation (refer to Fig. 9 and A. III–1).

(2) **Analysis of Composit Samples**

Three composit samples were analysed for the contents of minor elements, and the results of the analysis are shown as follows.

	Length (m)	Depth (m)	Cu (%)	Pb (%)	Zn (%)	Bi (%)	Cd (g/t)	Sn (%)	W (%)
IC–11	26.7	107.2–133.9	0.05	2.92	18.17	0.10	270	0.32	Nd
IC–12	29.1	151.4–180.5	0.51	1.82	20.39	0.23	15	0.35	Nd
IC–14	9.8	113.9–123.7	0.19	0.02	17.90	0.13	54	0.38	Nd

	Sb (%)	Hg (%)	Fe (%)	As (%)	S (%)	Au (g/t)	Ag (g/t)
IC–11	0.09	0.01	21.30	0.43	27.46	Nd	32
IC–12	0.09	0.14	24.62	0.10	28.36	Nd	58
IC–14	0.09	0.03	29.16	0.11	34.72	Tr	52

4) Measurement of Specific Gravity

Apparent specific gravity was measured with 37 samples, collected in the main mineralized parts of the drill cores. The samples for the measurement of specific gravity had been dried in the temperature of 60°C in 24 hours before measurement and the surface of the samples were coated with paraffine. The results of the measurement are shown in Table 2. The average value of the specific gravity measured with 26 samples of pyritized ore in the Limpe area is 3.83, while the average value measured with 7 samples of skarnized ore in the Limpe-South area is 3.61. As druses or other hollow parts are developed in the actual orebodies in situ, it is necessary to give consideration on the porosity of ore for the specific gravity in situ. Assuming the value of such porosity to be 12% with the pyritized ore and to be 6% with the skarnized ore, the apparent specific gravity in situ common to both types of ore is calculated to be 3.4.

4–4 Calculation Result

1) Limpe Area

The perspective sections for ore reserve estimation are shown in the Fig. 8 and the calculation table is shown in the Table 3. The result of the ore reserve calculation by the polygon method in the mineralization zone in the Limpe area is as follows.

Type of Ore	Ore Reserve (1,000 ts)	Grade of Ore			
		Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
Pb-Zn ore	3,250	48	0.13	1.95	18.99
Cu ore	100	32	2.84	0.03	0.39

2) Limpe-South Area

The exploration is at the preliminary stage where mineralization has been confirmed in only two drill holes spaced about 100 m each other. If the horizontal width of the orebody is taken to be 19.1 m, horizontal extension to be 200 m, vertical extention to be 150 m, specific gravity to be 3.4 and the index of existence of the orebodies to be 75%, total 1,460 thousand tons of ore reserves are expected according to the following calculation.

19.1 m x 200 m x 150 m x 3.4 x 0.75 = 1,461,150 t

The weighted average of the ore grade of the orebodies confirmed in the two drill holes is Ag 10 g/t, Cu 1.85%, Pb 0.01% and Zn 19.59%.

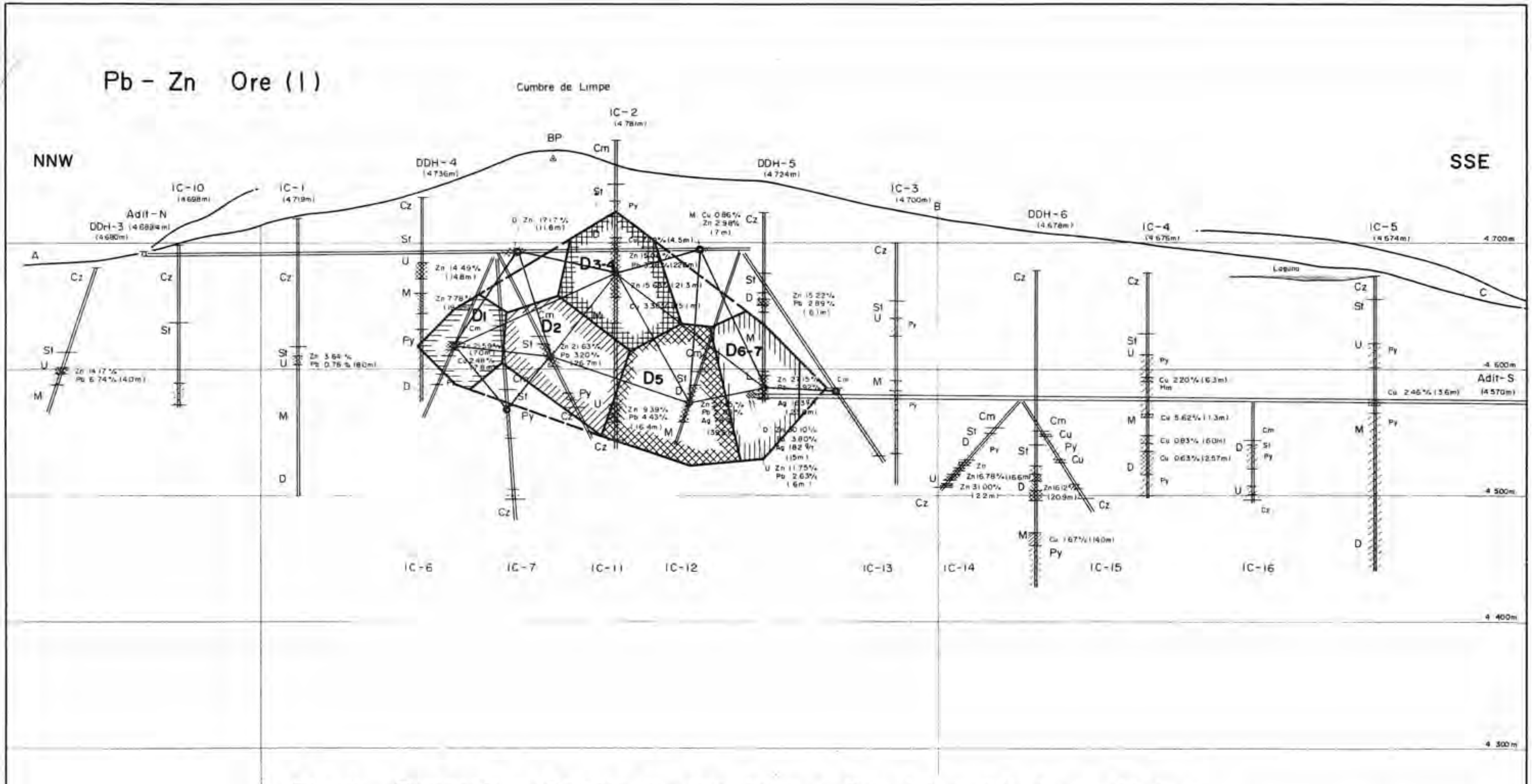


Fig. 8 Perspective Section for Ore Reserve Calculation (I) Lower Horizon

0 100 200m

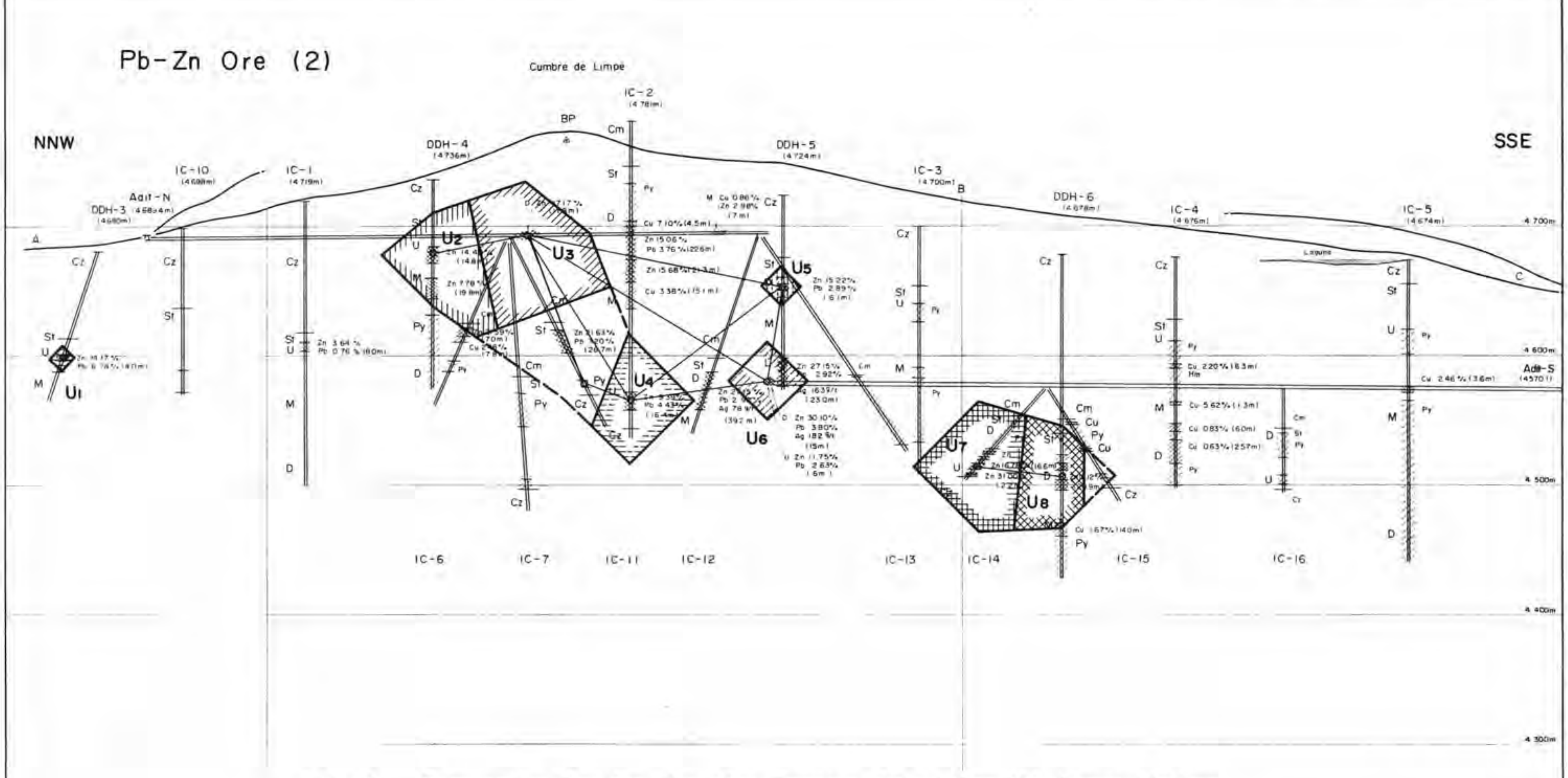


Fig. 8 Perspective Section for Ore Reserve Calculation (2) Upper Horizon

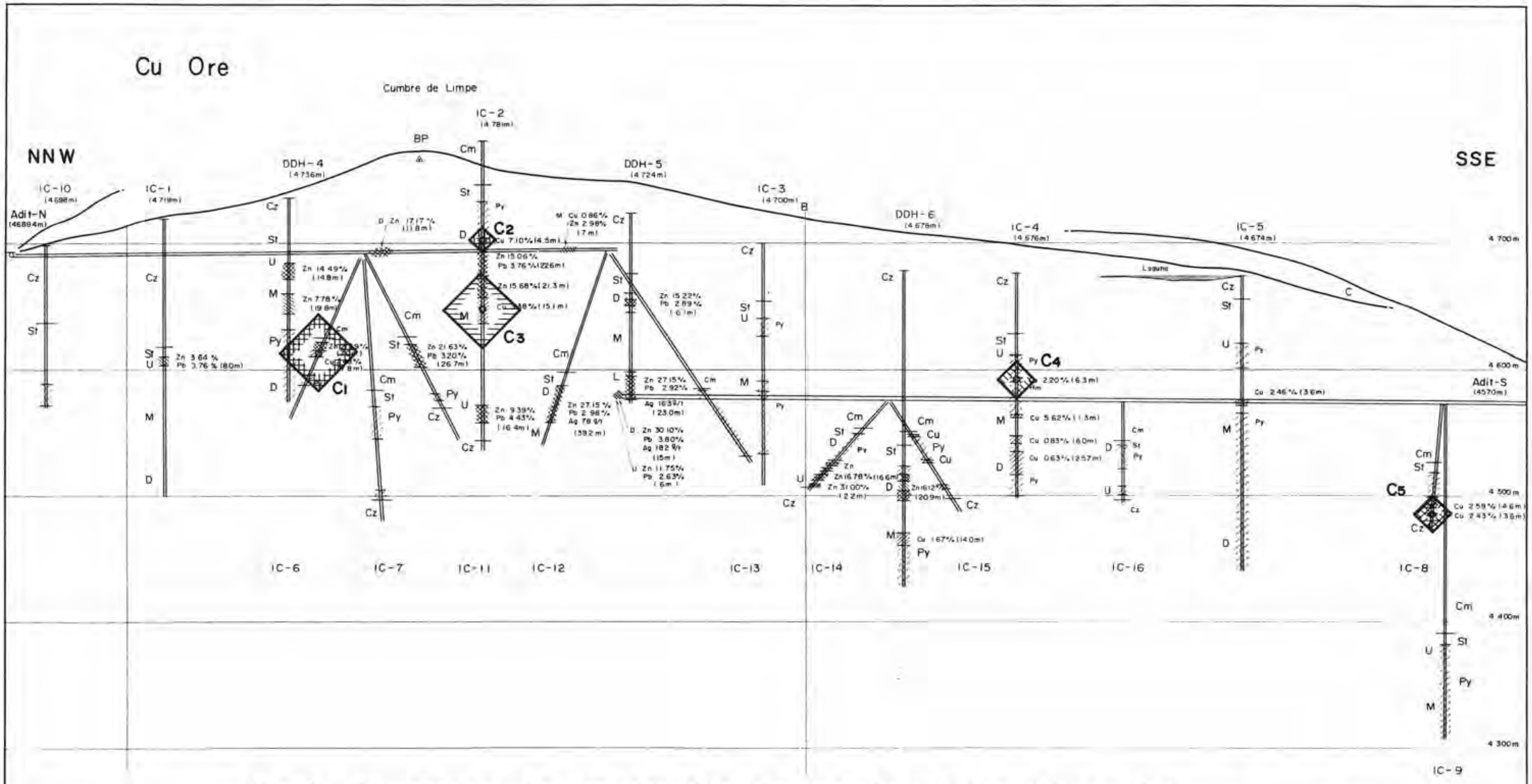


Fig. 8 Perspective Section for Ore Reserve Calculation (3) Cu Ore

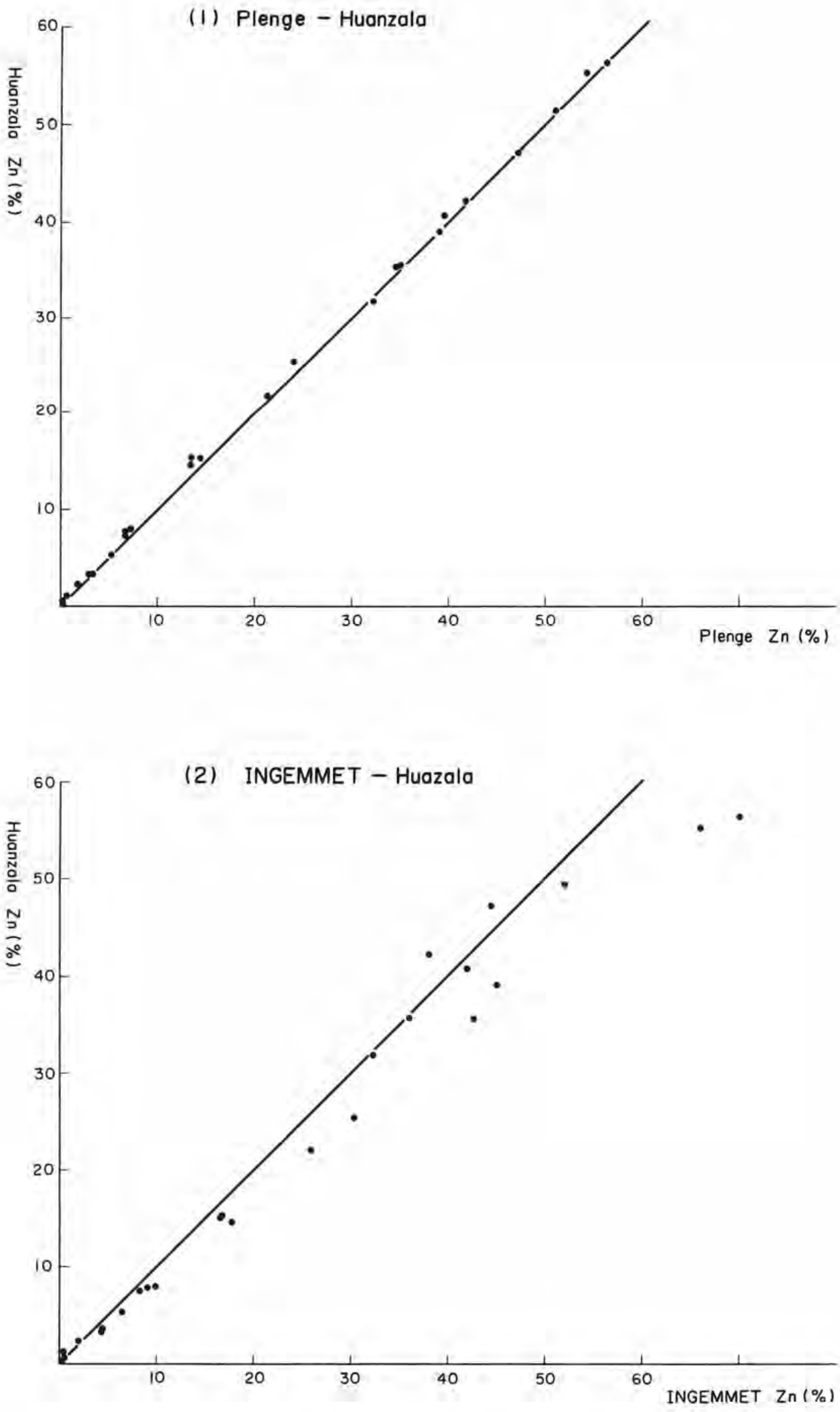


Fig. 9 Correlation Diagram of Check Assays

Table I List of the Confirmed High Grade Mineralized Parts

Area	DDH	Depth m	Interval m	No. of Sample	Ag g/t	Cu %	Pb %	Zn %	Angle (Comp.)	Inc.	Real Thick m	Horiz. Width m	Orebody
Limpe	DDH-3	104.6-108.6	4.0	4	89	0.03	6.74	14.17	55°	90°	2.29	2.3	U_1
	DDH-3	108.6-118.9	10.3	10	32	0.03	1.26	4.56	55°	90°			
	IC-10												
	IC-1	121.0-129.0	8.0	4	4	0.07	0.76	3.64	40°	90°			
	DDH-4	61.3- 76.1	14.8	15	13	0.07	0.04	14.49	50°	90°	9.51	9.5	U_2
	DDH-4	84.9-104.7	19.8	16	10	0.10	0.30	7.78	55°	90°			
	IC-6	96.8-101.0	4.2	4	4	0.03	0.85	5.27	40°	85°			
	IC-6	108.0-115.0	7.0	5	15	0.32	0.02	21.59	30°	85°	6.06	6.1	D_1
	IC-6	115.0-122.8	7.8	4	23	2.48	0.02	0.46	30°	85°	6.75	6.8	C_1
	IC-7												
	NX-1		6.0	6	17	1.42	0.04	0.30	10°				
	NX-1		12.0	24	8	0.10	0.07	17.13	10°			11.8	U_3
	IC-11	107.2-133.9	26.7	19	38	0.04	3.16	22.69	40°	85°	20.45	20.5	D_2
	IC-2	77.6- 82.1	4.5	2	5	7.10	0.22	0.48	50°	80°	2.89	2.9	C_2
	IC-2	82.1-104.7	22.6	19	34	0.08	3.75	15.06	60°	75°	11.30	11.7	D_3
	IC-2	104.7-126.0	21.3	4	4	0.14	0.16	15.68	60°	75°	10.65	11.0	D_4
	IC-2	126.0-146.3	15.3+	5	46	3.43	0.03	0.43	60°	80°	7.65	7.8	C_3
	IC-2	211.0-227.4	16.4	8	25	0.06	4.53	9.39	45°	80°	11.60	11.8	U_4
	NX-2		7	8	32	0.86	0.31	2.98	10°				
	IC-12	144.3-183.5	39.2	38	78	0.19	2.61	24.08	35°	75°	32.11	33.2	D_5
	DDH-5	95.6-101.7	6.1	5	35	1.10	2.89	15.22	55°	80°	3.50	3.6	U_5
	DDH-5	181.0-204.0	23.0	23	163	0.14	2.92	27.15	60°	75°	11.50	11.9	D_6
	SX-2		15.0	31	182	0.16	3.80	30.10	0°			15.0	D_7
	SX-2		6.0	12	26	0.08	2.63	11.75	0°			6.0	U_6
	IC-13												
	IC-3												
	IC-14	107.1-123.7	16.6	13	32	0.18	0.13	16.78	40°	75°	12.72	13.2	U_7
	IC-14	131.6-133.8	2.2	2	28	0.28	0.06	31.00	45°	75°	1.56	1.6	
	SX-1												
	DDH-6	194.4-215.3	20.9	18	22	0.18	0.20	16.04	65°	85°	8.83	8.9	U_8
	DDH-6	248.2-262.2	14.0	7	13	1.67	0.03	0.10	60°	85°			
	IC-4	114.0-120.5	6.3	3	32	2.20	0.02	0.29	60°	80°	3.15	3.2	C_4
	IC-16												
	IC-5												
	IC-8	174.5-178.1	3.6	3	23	2.43	0.11	0.11	10°	65°	3.55	3.9	C_5
Tinyag	DDH-7	56.0- 63.0	7.0	5	5	0.21	0.01	19.71	60°	65°	3.50	3.9	T_1
	DDH-7	81.0- 99.0	18.0	18	4	0.11	0.05	5.34	60°	65°			
	DDH-7	116.0-135.0	19.0	15	9	3.18	-	19.53	55°	65°	10.90	12.0	T_2
	IC-18	96.9-125.5	28.6	22	8	1.32	0.01	19.79	45°	65°	20.22	22.3	T_3

* In principle, listed up ore parts above 5% in Pb+Zn and above 1.5% in Cu averaging more than 2 samples.

+ Excluded of non-core part.

NX and SX marks show Tunnels.

$$\text{Real Thickness (m)} = \text{Interval (m)} \times \sin(90° - \text{Angle})$$

$$\text{Horiz. Width (m)} = \text{Real Thickness (m)} \times \frac{1}{\cos(90° - \text{Inc.})}$$

Table 2 Measurement Results of Specific Gravity

Sample No.	Type of Ore	Wa (g)	Wp (g)	Ww (g)	D
BC-03-107	Gl-Sp-Py ore	70.40	71.70	53.25	4.13
BC-04-064	Sp-Py ore	182.15	185.45	138.90	4.24
BC-04-068	Sp-Py ore	115.90	117.50	88.15	4.19
BC-04-076	Sp-Py ore	141.50	143.50	107.30	4.16
BC-04-087	Sp-Py ore	124.95	126.90	96.00	4.34
BC-04-104	Sp-Py ore	79.30	80.60	59.80	4.08
BC-05-099	Gl-Sp-Py ore	65.45	66.50	48.60	3.90
BC-05-183	Sp-Py ore	62.40	63.70	47.40	4.19
BC-05-190	Sp-Py ore	61.05	62.30	45.30	3.90
BC-05-192	Sp-Py ore	64.25	65.45	47.00	3.74
BC-05-195	Sp-py ore	75.50	77.00	56.35	3.97
BC-05-199	Gl-Sp-Py ore	71.05	72.90	52.90	3.95
IC-02-083	Sp-Py ore	131.0	133.2	96.5	3.81
IC-02-089	Sp diss ore	67.6	69.2	44.9	2.99
IC-02-099	Gl-Sp-Py ore	133.6	136.3	98.6	3.84
IC-02-103	Sp-Py ore	145.5	148.2	108.3	3.93
IC-02-118	Sp diss ore	100.6	102.7	64.2	2.77
IC-02-225	Sp-Py ore	75.6	77.2	55.1	3.71
IC-11-119	Sp-Py ore	87.2	89.5	64.3	3.84
IC-11-123	Sp ore	112.6	114.7	83.3	3.86
IC-12-164	Gl-Sp ore	114.4	116.7	82.6	3.62
IC-12-172	Sp ore	159.8	163.0	122.5	4.32
IC-12-175	Sp ore	98.2	100.3	72.6	3.86
IC-12-183	Sp ore	72.0	73.8	45.5	2.73
IC-14-117	Sp-Py ore	124.7	127.2	91.3	3.76
IC-14-133	Sp-Py ore	114.8	117.1	82.9	3.62
Av. of Massive Sp-Py ore					3.83
BC-07-085(A)	Sk ore	152.35	154.30	107.90	3.43
BC-07-085(B)	Sk ore	108.50	110.30	73.35	3.10
BC-07-123	Sp Sk ore	104.50	105.85	78.65	4.05
BC-07-126	Sp Sk ore	104.60	106.40	70.50	3.08
BC-07-127	Sp-Mt Sk ore	80.30	81.50	59.70	3.91
IC-18-121	Sp Sk ore	58.7	59.9	41.0	3.33
IC-18-125	Sp-Py ore	128.4	130.7	98.9	4.38
Av. of Skarn ore					3.61

$$D = \frac{Wa \times Dw}{Wp - Ww - (Wp - Wa)/Dp}$$

D : Apparent specific gravity
Wa: Weight of dried sample in the air
Wp: Weight of paraffin coated sample in the air
Ww: Weight of paraffin coated sample in the water
Dp: Specific gravity of paraffin (=0.9)
Dw: Specific gravity of water (=0.997)

Table 3 Table for Ore Reserves Calculation

Zone	Body	Area (m^2)	Wid. (m)	Volume (m^3)	Tonnage* (t)	Grade Ag g/t	Cu %	Pb %	Zn %	Metal Value Ag kg	Cu t	Pb t	Zn t
D	D_1	3,200	6.1	19,520	66,300	15	0.32	0.02	21.59	994	212	13	14314
	D_2	6,500	20.5	133,250	453,000	38	0.04	3.16	22.69	17214	181	14314	102785
	D_{3-4}	6,600	22.7	149,820	509,300	20	0.11	2.01	15.36	10186	560	10236	78228
	D_5	8,400	33.2	278,880	948,100	78	0.19	2.61	24.08	73951	1801	24745	228302
	D_{6-7}	5,500	13.4	73,700	250,500	172	0.15	3.36	28.62	43086	375	8416	71693
	Subtotal				2,227,200	65	0.14	2.59	22.24	145431	3129	57724	495322
U	U_1	200	2.3	460	1,500	89	0.03	6.74	14.17	133	0	101	212
	U_2	5,000	9.5	47,500	161,500	13	0.07	0.04	14.49	2099	113	64	23401
	U_3	7,600	11.8	89,680	304,900	8	0.10	0.07	17.13	2439	304	213	52229
	U_4	3,900	11.8	46,020	156,400	25	0.06	4.53	9.39	3910	93	7084	14685
	U_5	450	3.6	1,620	5,500	35	1.10	2.89	15.22	192	60	158	837
	U_6	1,800	6.0	10,800	36,700	26	0.08	2.63	11.75	954	29	965	4312
	U_7	5,600	13.2	73,920	251,300	32	0.18	0.13	16.78	8041	452	326	42168
	U_8	3,700	8.9	32,930	111,900	22	0.18	0.20	16.04	2461	201	223	17948
	Subtotal				1,029,700	19	0.12	0.89	15.15	20229	1252	9134	156036
	Zn-Pb Ore Total				3,256,900	51	0.13	2.05	19.99	165660	4381	66858	651114
	Adjusted Total**				3,256,900	48	0.13	1.95	18.99	157377	4161	63515	618558
Cu	C_1	1,800	6.8	12,240	41,600	23	2.48	0:02	0.46	956	1031	8	191
	C_2	200	2.9	580	1,900	5	7.10	0.22	0.48	9	134	4	9
	C_3	1,800	7.8	14,040	47,700	46	3.43	0.03	0.43	2194	1636	14	205
	C_4	450	3.2	1,440	4,800	32	2.20	0.02	0.29	153	105	0	13
	C_5	450	3.9	1,755	5,900	23	2.43	0.11	0.11	135	143	6	6
	Cu Ore Total				101,900	34	2.99	0.03	0.42	3447	3049	32	424
	Adjusted Total**				101,900	32	2.84	0.03	0.39	3274	2896	30	402

* Specific gravity in situ : 3.4

** Safety factor of ore grade : 0.95

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5–1 Conclusion

1) The Results of the Survey in the Third Year (1984)

The investigation works carried out in the present year were those in the final phase of the three years' program of the Mineral Exploration by means of drilling and tunnelling explorations in the Iscaycruz Area.

Following the last year's investigation, the diamond drilling of the 10 holes was carried out, totalling 1900 m, and the tunnelling exploration of the Adit-N and the Adit-S was carried out, the total length of which is 748 m.

As for the drilling, all the holes excavated in this year caught indications of mineralization. Among those indications, high grade lead zinc orebodies are confirmed in four drill holes; IC–11 and IC–17 located in the underground in Adit-N, and IC–14 located in the underground in Adit-S in the Limpe area, and IC–18 located on the surface in the Limpe-South (Tinyag) area. The scale and the ore grade of the indications of high grade mineralization caught in the survey are given in the following table.

Hole No.	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	True Width (m)	Horizontal Width (m)
IC–11	107.2–133.9	26.7	19	38	0.04	3.16	22.69	20.5	20.5
IC–12	144.3–185.5	39.2	38	78	0.19	2.61	24.08	32.1	33.2
IC–14	107.1–123.7	16.6	13	32	0.18	0.13	16.78	12.7	13.2
IC–18	96.9–125.5	28.6	22	8	1.32	0.01	19.79	20.22	22.3

As for the tunnelling exploration, two layers of lead zinc orebodies have been confirmed in the crosscut-2 of Adit-S. The scale and the ore grade of the indications of mineralization thus caught are given in the following table.

Tunnel	Orebody	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Horizontal Width (m)
XS-2	D_7	3– 21	15	31	182	0.16	3.84	30.11	15
XS-2	U_5	60– 67	6	12	26	0.08	2.63	11.75	6
(DDH-5)	D_6	181–204	23	23	163	0.14	2.92	27.15	11.9

The above D_7 orebody has been caught at almost same locality in the drill hole of DDH-5 carried out on the surface (D_6 as is listed in the above table). The scale and the ore grade confirmed in the underground are better than those estimated from the results of the drilling.

2) Mineralization Zone in the Limpe Area

The amount of the drilling survey carried out in the Limpe area in the Iscaycruz Area by this year is 4,390 m of total length in 20 holes; 10 holes on the surface and another 10 holes in the underground. The amount of the tunnelling exploration is 2,008 m of the total length of Adit-N and Adit-S.

By the drilling, high grade lead zinc orebodies have been confirmed in 9 holes, while high grade orebodies are recognized at 3 localities in the tunnel exploration.

Through these exploration works, the following points have been clarified as to the mineralization in the Limpe area.

(1) The ore deposit is massive sulphide ore deposit formed by the replacement of limestone of the Santa Formation. The ore minerals are mainly sphalerite and pyrite associated with galena and chalcopyrite.

(2) Remarkable mineralization is found stratigraphically in the horizons situated in the lower portion and in the upper portion of the Santa Formation.

(3) The mineralization is intimately related to the brecciation and the fractuation of the wall rocks.

(4) The copper-lead-zinc mineralization is closely related to the pyritization, and the ore deposits are located around massive pyrite zone and in such portions as remarkably brecciated in pyrite zone.

(5) Scale of the main orebodies is about 300 m in horizontal extension, more than 150 m in vertical extension (lower extension has not been confirmed) and the thickness is 10 to 30 m.

3) Mineralization Zone in the Limpe-South Area

In the Limpe-South area, the drilling of the total length of 770 m of 4 holes including 3 holes completed in this year was carried out on the surface. High grade copper zinc mineralization has been caught in two of the drill holes. In this mineralization zone, there have been confirmed such ore deposits composed mainly of chalcopyrite, sphalerite, magnetite and pyrite associated with skarn minerals. The high grade zone shows 1% to 3% of Cu and about 19% of Zn, and the horizontal width is estimated to be 10 m – 20 m. The ore reserve more than one million tons is expected in the Limpe-South area.

4) Tentative Estimation of the Ore Reserves

Based on the survey results, the ore reserves are estimated tentatively by the polygon method as to the grade and the amount of the ore which is estimated to be emplaced in the mineralization zone in the Limpe area. The result of the ore reserve estimation is as follows.

Type of Ore	Ore Reserve (1,000 ts)	Grade of Ore			
		Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
Pb–Zn ore	3,250	48	0.13	1.95	18.99
Cu ore	100	32	2.84	0.03	0.39

It is noted that there is possibility for the above-estimated ore reserves to be increased through further detailed exploration works and especially through the investigation at the depth of the orebodies.

As the figures and the grade distribution of the orebodies are fairly complicated, it would be necessary to conduct further detailed exploration works such as drifting exploration at the main levels, shafting exploration partly serving for ventilation, short hole drilling in the underground, as well as to carry out investigation for possible extension at the depth of the ore deposits by long hole drilling.

5–2 Recommendation

For the potentiality of the emplacement of mineral ore deposits in the Iscaycruz Area, there has been carried out stage by stage various investigations such as geological survey, geochemical exploration, geophysical prospecting, surface drilling, tunnelling exploration and underground drilling, for these six years.

In the Limpe area, extracted as the most favorable area for the investigation of mineral resources, tunnelling exploration and drilling exploration either on the surface or in the underground were conducted, and the existence of high grade lead zinc orebodies have been confirmed. In the Limpe-South area, surface drilling was carried out and the emplacement of high grade copper zinc ore mineralization has been clarified. It is noted that there are other potential area warranting further investigation for mineral resources as Limpe-North area and Kunsha Punta area.

It is recommended as the investigation of the next stage to carry out the survey for the planning of the development including every item in necessary fields for the investment to the development of mineral resources.

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PARTICULARS
PART I
DRILLING EXPLORATION

PART 1 DRILLING EXPLORATION

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CHAPTER 1 DRILLING EXPLORATION

1–1 Outline of the Exploration

1) Drilling Exploration

The drilling exploration in the present year was carried out in the underground and on the surface. The total length of the drill holes was 1,908.50 m, of 10 holes.

Site	Hole	Bearing	Inclin.	Depth(m)	Core length(m)	Recovery(%)
Surface	IC–10	70°	–45°	180.30	146.45	81.2
Adit–N	IC–11	225°	–40°	221.10	178.80	80.9
Adit–N	IC–12	280°	–45°	220.60	215.80	97.8
Adit–N	IC–13	210°	–45°	240.60	213.10	88.6
Adit–S	IC–14	270°	–30°	140.20	126.20	90.0
Adit–S	IC–15	210°	–30°	180.40	168.30	93.3
Adit–S	IC–16	250°	–30°	161.00	139.90	86.9
Surface	IC–17	250°	–45°	160.20	147.50	92.0
Surface	IC–18	250°	–60°	200.50	162.90	81.2
Surface	IC–19	250°	–50°	203.60	152.40	74.9
TOTAL				1,908.50	1,651.35	86.5

This drilling exploration in the underground and on the surface was performed in the period of 242 days from June 6, 1984 to February 3, 1985.

The drill machine employed was TGM–3C (drilling capacity: NQ 510 m, BQ 660 m) and TGM–5A (drilling capacity: NQ 400 m, BQ 550 m).

Location (grid coordinate) and altitude of each drill hole are as follows.

Site	Hole	Longitude	Latitude	Elevation(m)
Surface	IC–10	310,280E	809,020N	4,698
Adit–N	IC–11	310,550E	808,860N	4,692
Adit–N	IC–12	310,650E	808,690N	4,693
Adit–N	IC–13	310,650E	808,690N	4,693
Adit–S	IC–14	310,690E	808,500N	4,576
Adit–S	IC–15	310,690E	808,500N	4,576
Adit–S	IC–16	310,800E	808,320N	4,574
Surface	IC–17	311,480E	806,960N	4,620
Surface	IC–18	311,500E	806,800N	4,680
Surface	IC–19	311,630E	806,740N	4,700

2) Core logging and analysis works

All the cores of the drill holes were logged with regard to lithology and mineralization. The results of the logging were described in the geological logs of the scale of 1 to 200.

As for the mineralized parts of the cores, half-split pieces or quarterly-split pieces were collected to prepare samples for chemical analysis for such elements as silver, copper, lead and zinc.

Also, as to the parts of the cores where mineralization and indications of mineralization were recognized polished sections were prepared for microscopic observation. Some of the samples were provided for the identification of minerals by X–ray diffraction analysis.

The main content and number analyses are given as follows.

(1) Chemical analysis of the mineralized parts of the cores (Ag, Cu, Pb, Zn) ——210 samples

(2) Microscopic observation of the polished sections or ore —— 10 pieces

(3) X–ray diffraction analysis —— 5 samples

1–2 Works of Preparation

1) Transportation of materials and equipments

After the customs clearance at the Callao port, the materials and the equipments were transported on the 11 t trucks to the Pampahuay on July 22, 1984, through Churin and Oyon. On the way from Pampahuay to Iscarcruz, the transportation was done by two 1 t pick up trucks.

2) Preparation of Drill Sites

Four drill sites were prepared on the surface. In the underground, two drill chambers each along the Adit–N and along the Adit–S, that is, total 4 underground drill chambers, were prepared by excavating walls of the tunnels.

3) Water Supply for Drilling

For the drill holes of IC–10, IC–11, IC–12, and IC–13, approximate 800 meters of pipe-line was established and the necessary water was supplied by pumping, from the lake located north of the Cumbre de Limpe.

For the drill holes of IC–14, IC–15, and IC–16, approximate 1000 meters of pipe-line was established and the necessary water was supplied by natural flowing from the lake located south of the Cumbre de Limpe.

For the drill holes of IC–17, IC–18, and IC–19, approximate 1100 meters of pipe-line was established and the necessary water was supplied by natural flowing from the lake located at the Cumbre de Cunsha Punta.

4) Preparation Period

Total 46 days were needed for the preparation works including transportation of materials and equipment, construction of electric cable and establishment of pipe-line.

1–3 Drilling Operations

HQ wire line method was employed for the drilling. Casing pipes were sunk on necessity so that the final diameter of the hole should be BQ–size. Usually, bentonite mud water was used all the time.

1) IC–10

Hole length	:	180.30 m
Core length	:	146.45 m
Core recovery	:	81.2 %
Date commenced	:	June 6, 1984
Date completed	:	June 15, 1984

* 0 m – 6.00 m : By 116 mm metal crown, using bentonite mud water, the hole was excavated in the talus sediments down to the depth of 6.00 m. As the wall was recognized to be stable there, HW casing pipes were sunk to the depth of 6.00 m.

* 6.00 m – 101.00 m : By HQ wire-line diamond bits, using bentonite mud water, the hole was excavated in quartzite, sandstone, shale and dolostone to the depth of 101.00 m. As the wall was recognized to be stable there, NW casing pipes were sunk to the depth of 101.00 m. At the depth between 86.80 m and 88.00 m, zinc mineralization was confirmed.

* 101.00 m – 180.30 m : By NQ wire-line diamond bits, using bentonite mud water, the hole was excavated in dolostone, clay fracture zone, limestone, sandy sulphide zone, and shale, to the depth of 180.30 m, where the excavation was stopped as the purpose of the hole was thought to have been completed.

2) IC–11

Hole length	:	221.10 m
Core length	:	178.80 m
Core recovery	:	80.9 %
Date commenced	:	August 15, 1984
Date completed	:	August 31, 1984

* 0 m – 1.50 m : By 101 mm diamond bit, the hole was excavated in quartzite and HW casing pipes were sunk to the depth of 1.50 m.

* 1.50 m – 111.40 m : By HQ wire-line diamond bits, the hole was excavated in quartzite, sandstone, shale, marlstone, and dolostone, and NW casing pipes were sunk to the depth of 111.40 m.

* 111.40 m – 194.80 m : By NQ wire-line diamond bits, the hole was excavated in dolostone, zinc-mineralized zone, clay fracture zone of shale, sulphide ore zone and shale zone to the depth of 194.80 m. As the wall was recognized to be stable there, BW casing-pipes were sunk to the depth of 194.80 m. In the portion of the depth between 107.20 m and 133.90 m as well as between 164.80 m and 167.70 m, were recognized and confirmed zinc-lead mineralized zones.

* 194.80 m – 221.10 m : By BQ wire-line diamond bits, the hole was excavated in shale and in sandstone to the depth of 221.10 m, where the excavation was stopped as the purpose of the hole was thought to have been completed.

3) IC–12

Hole length	:	220.60 m
Core length	:	215.80 m
Core recovery	:	97.8 %
Date commenced	:	September 30, 1984
Date completed	:	October 9, 1984

* 0 m – 2.50 m ; By 116 mm bit, the hole was excavated in quartzite and HW casing-pipes were sunk to the depth of 2.50 m.

* 2.50 m – 60.50 m : By HQ wire-line bits, quartzite and shale were drilled and NW casing pipes were set to the depth of 60.50 m.

* 60.50 m – 220.60 m : By NQ bits, shale, quartzite, marlstone, dolostone, zinc mineralized zone, pyrite zone, and limestone were drilled to the depth of 220.60 m, and the drilling was completed after hight grade zinc mineralized zone was confirmed between 145.50 m and 183.50 m.

4) IC–13

Hole length	:	240.60 m
Core length	:	213.10 m
Core recovery	:	88.6 %
Date commenced	:	September 9, 1984
Date completed	:	September 22, 1984

* 0 m – 1.50 m : By 116 mm bit, quartzite was drilled and HW casing pipes were sunk.

* 1.50 m – 30.00 m : By HQ bit, quartzite was drilled and NW casing pipes were set to the depth of 30.00 m.

* 30.00 m – 81.50 m : By NQ bit, quartzite and marlstone were excavated. Since the wall condition was poor in the fracture zone in quartzite, the hole was reaming by NW casing shoe bit and NW casing pipes were sunk down to the depth of 81.50 m.

* 81.50 m – 240.60 m : By NQ bit, marlstone, dolostone, and pyrite ore was drilled to the

depth of 240.60 m, and the work was terminated.

5) IC–14

Hole length	:	140.20 m
Core length	:	126.20 m
Core recovery	:	90.0 %
Date commenced	:	November 12, 1984
Date completed	:	November 17, 1984

* 0 m – 1.50 m : HW casing pipes was set down to 1.50 m.

* 1.50 m – 69.00 m : Marlstone, sandstone, dolostone, and pyrite ore were excavated by HQ bit and NW casing pipes were sunk to the depth of 69.00 m.

* 69.00 m – 140.20 m : By NQ bit, pyrite ore, shale, marlstone, and zinc ore were drilled down to the depth of 140.20 m and the work was completed attaining the object. From 116.40 m to 124.80 m, and from 131.60 m to 133.80 m, zinc ores were confirmed.

6) IC–15

Hole length	:	180.40 m
Core length	:	168.30 m
Core recovery	:	93.3 %
Date commenced	:	November 22, 1984
Date completed	:	December 10, 1984

* 0 m – 2.00 m : HW casing pipes were set down to 2.00 m.

* 2.00 m – 87.50 m : By HQ bit, marlstone, sandstone, dolostone, and fracture zone in pyrite ore were excavated to the depth of 87.50 m. In the fracture zone, where acid water (300 ℓ/min, pH=1) flew out, jamming state hoppened. By reaming the hole with NW shoe bit, NW casing pipes were sunk to the depth of 87.50 m.

* 87.50 m – 123.00 m : Sand-like pyrite ore and limestone were drilled using NQ bit and BW casing pipe were sunk down to the dpeth of 123.00 m.

* 123.00 m – 180.40 m : By BQ bit, limestone, dolostone, sulfide ore, and shale was drilled, and the work was completed at the depth of 180.40 m.

7) IC–16

Hole length	:	161.00 m
Core length	:	139.90 m
Core recovery	:	86.9 %
Date commenced	:	October 20, 1984
Date completed	:	November 4, 1984

* 0 m – 2.00 m : Quartzite was drilled using 116 mm bit and HW casing pipes were set down to 2.00 m.

* 2.00 m – 30.00 m : Quartzite and marlstone were drilled by HQ bit and NW casing pipes were sunk down to 30.00 m.

* 30.00 m – 109.20 m : By NQ bit, marlstone, sandstone, quartzite, and pyrite ore were excavated and BW casing pipes were sunk down to the 109.20 m depth.

* 109.20 m – 161.00 m : Limestone, pyrite ore, shale, and marlstone were excavated using BQ bit down to the depth of 161.00 m, and the hole was terminated since the purpose was completed.

8) IC–17

Hole length	:	160.20 m
Core length	:	147.50 m
Core recovery	:	92.0 %
Date commenced	:	June 26, 1984
Date completed	:	July 4, 1984

* 0 m – 1.70 m : Quartzite was drilled using 116 mm bit and HW casing pipes were set down to 1.70 m.

* 1.70 m – 30.00 m : Quartzite was drilled using HQ bit and NW casing pipes were set down to 30.00 m.

* 30.00 m – 160.20 m : Quartzite, sandstone, marlstone, sulfide ore, and shale were excavated by NQ bit. The hole was terminated at the depth of 160.20 m since the purpose was completed after zinc ore was confirmed between 140.00 m and 141.00 m.

9) IC–18

Hole length	:	200.50 m
Core length	:	162.90 m
Core recovery	:	81.2 %
Date commenced	:	July 10, 1984
Date completed	:	August 11, 1984

* 0 m – 1.50 m : By HQ bits, using bentonite mud water, the hole was excavated in quartzite to the depth of 1.50 m. Reaming the hole with HW casing shoe bits, HW casing-pipes were sunk to the depth of 1.50 m.

* 1.50 m – 164.90 m : By NQ bits, using bentonite mud water, the hole was excavated to the depth of 164.90 m in quartzite, marlstone, fracture zone, sulphide ore zone, zinc mineralized zone, skarn zone, and shale zone.

At the depth between 62.80 m and 86.40 m, the wall condition was extremely poor owing to the wall swelling, due to the weathered fracture zone, and the NQ wire-line lod was destroyed at the depth of 164.90 m. It took 6 days to recover from the trouble.

Zinc mineralization was recognized and confirmed at the depth between 96.90 m and 99.90 m, between 102.80 m and 110.80 m, and between 118.00 m and 122.20 m.

* 164.90 m – 200.50 m : By BQ bits, the hole was excavated in shale and sandstone to the depth of 200.50 m, where the excavation was stopped as the purpose of the hole was thought to have been completed.

10) IC–19

Hole length	:	203.60 m
Core length	:	152.40 m
Core recovery	:	74.9 %
Date commenced	:	November 26, 1984
Date completed	:	February 3, 1985

* 0 m – 103.65 m : By HQ bits, using bentonite mud water, the hole was excavated to the depth of 103.65 m in quartzite, dolostone, and weathered clay fractured zone. Because of the weathered clay fractured zone at the depth between 102.15 m and 103.65 m, jamming happened at the depth of 103.65 m. It took 9 days to recover from the jamming accident. After the recovery, NW casing pipes were sunk to the depth of 103.65 m.

* 103.65 m – 121.50 m : By NQ bits, the hole was excavated in quartzite to the depth of 121.50 m. As the wall was recognized to be stable at this depth, NW casing pipes were sunk to the depth of 121.50 m, after reaming the hole with NW casing diamond shoe bit.

* 121.50 m – 145.00 m : By NQ bits, using bentonite mud water, the hole was excavated in quartzite. In the portion at the depth between 125.50 m and 144.00 m, the hole hit a druse in the quartzite where the wall condition was poor, and BW casing pipes were sunk to the depth of 145.00 m.

* 145.00 m – 203.60 m : By BQ bits, the hole was excataed in quartzite, sulphide ore zone, and shale to the depth of 203.60 m, where the excavation was stopped as the purpose of the hole was thought to have been completed.

I–4 Mobilization and Removal

1) Mobilization

The number of days used for mobilization is given as follows.

IC–17	:	7 days
IC–18	:	3.5 days
IC–11	:	13 days
IC–13	:	6 days
IC–12	:	6 days
IC–16	:	8 days
IC–14	:	5 days
IC–15	:	3.5 days
IC–19	:	8 days

2) Removal

As the climate was unfavorable and the condition of the roads for transportation was poor while removal of the equipment from the drill site of IC–19, it was necessary to repair the roads and to transport the equipment and the materials by 8 workers. They were adjusted and stored at the camp after the transportation of 17 km distance. Total 28 days were used for removal.

1–5 Performance of the drilling

1) Drilling efficiency

As shown in A.I–11, with regard to drill holes totalling 1908.5 meters, the drill length per shift was 2.54 m/shift, and that of real drill works was 4.17 m/shift.

The drilling pace and the number of bit rotation are given as follows.

	Drilling pace	Number of bit rotation
Hard rocks	1.0 ~ 1.5 cm/min	450 ~ 650 r.p.m.
Moderate rocks	1.5 ~ 2.0 cm/min	350 ~ 450 r.p.m.
Soft rocks	2.0 ~ 2.5 cm/min	250 ~ 350 r.p.m.

2) Core recovery

As shown in A. I–11, 1651.35 meters of cores were recovered against 1908.50 meters of the total length of the drill holes.

The average core recovery was 86.5 %.

Fig. I-1 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-10

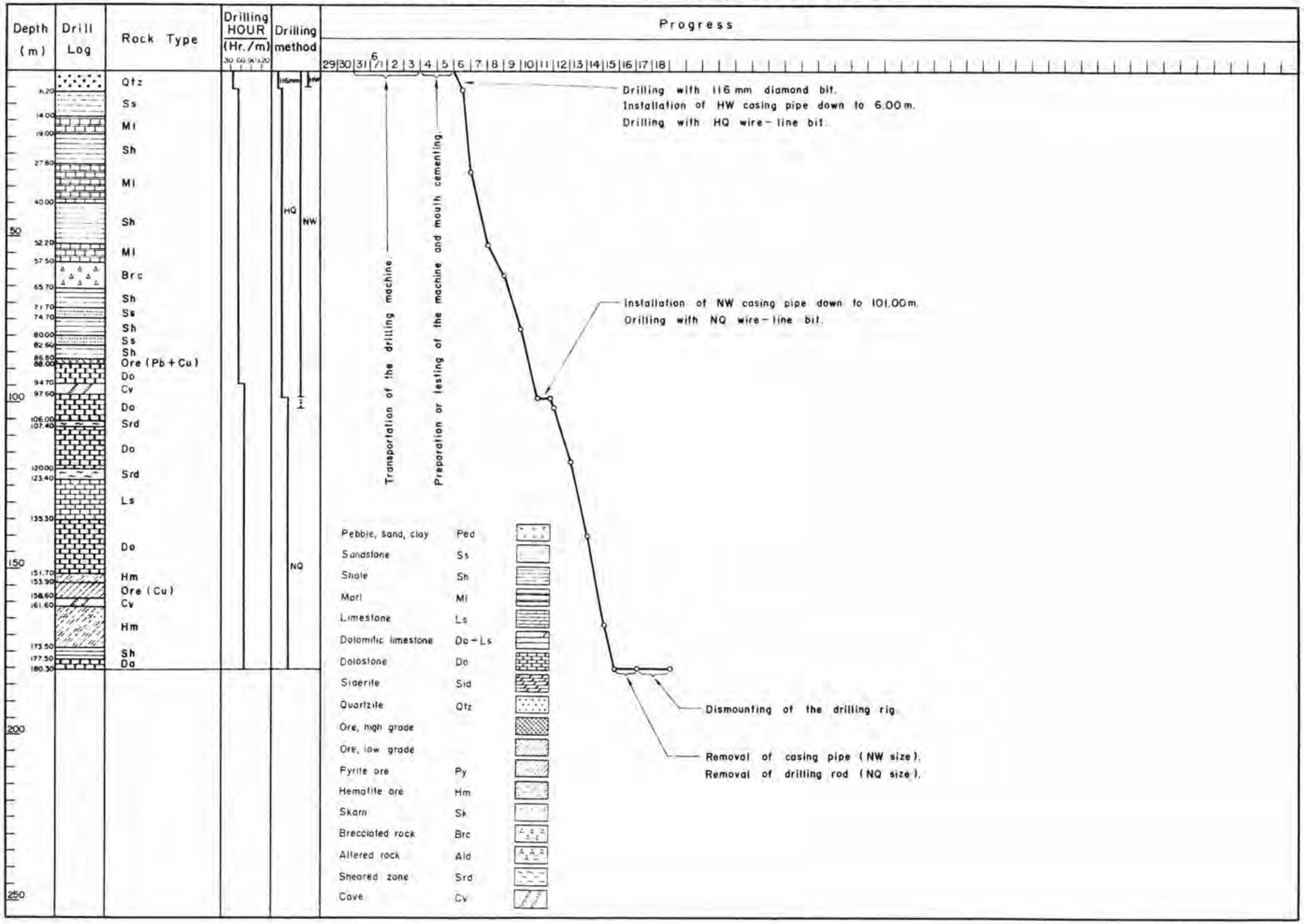


Fig. I – 2 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-II

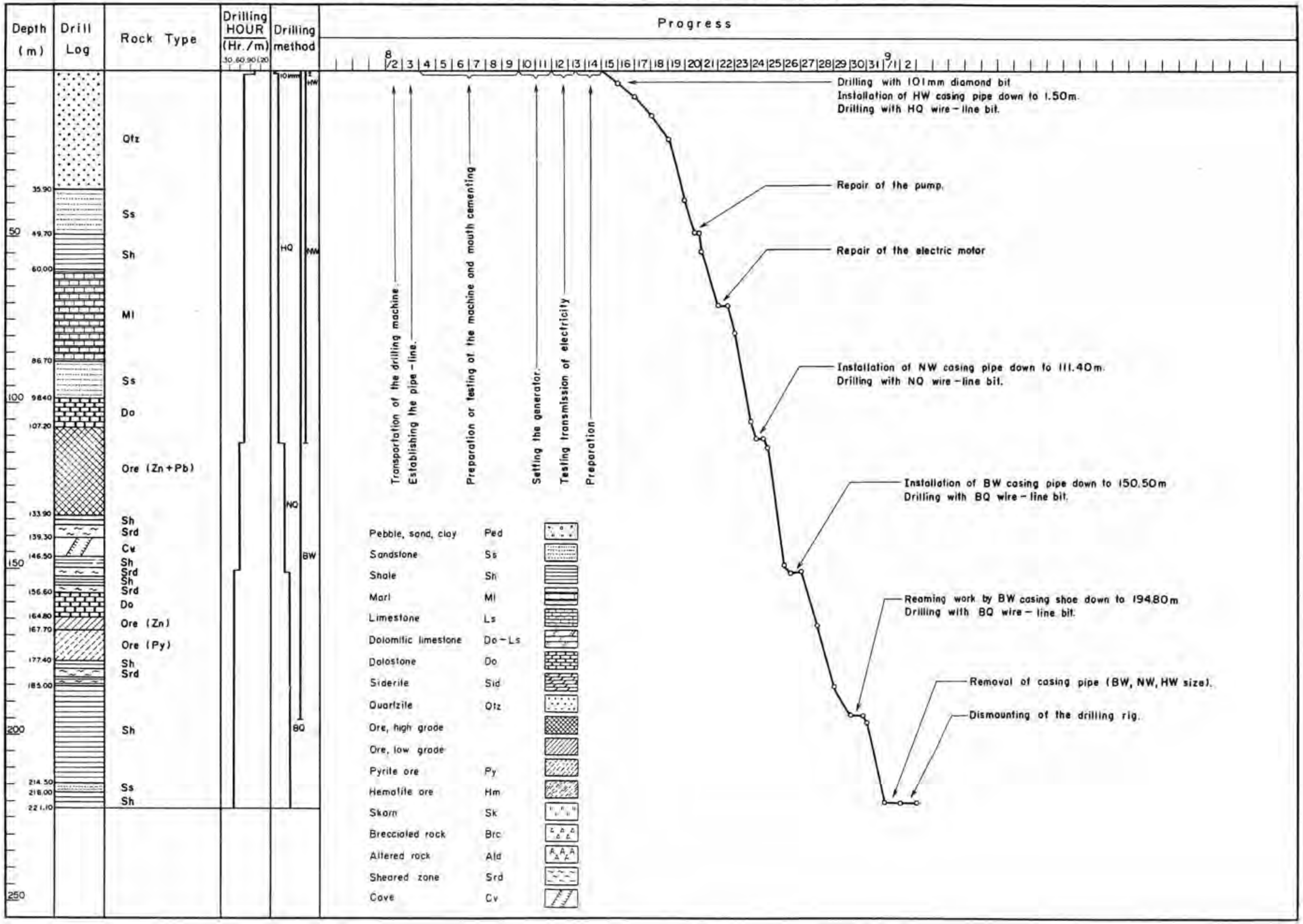


Fig. I - 3 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-12

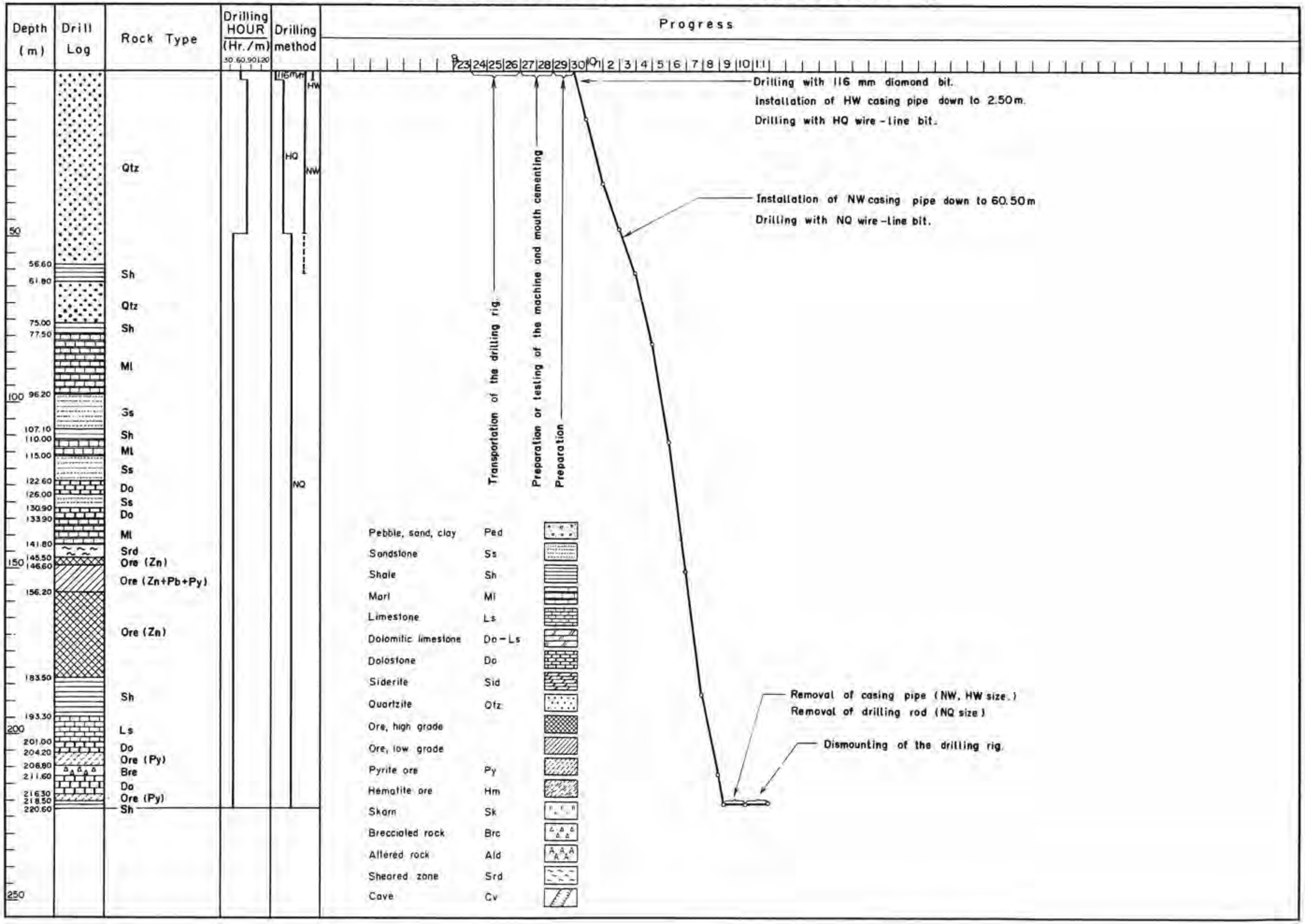


Fig. I－4 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-13

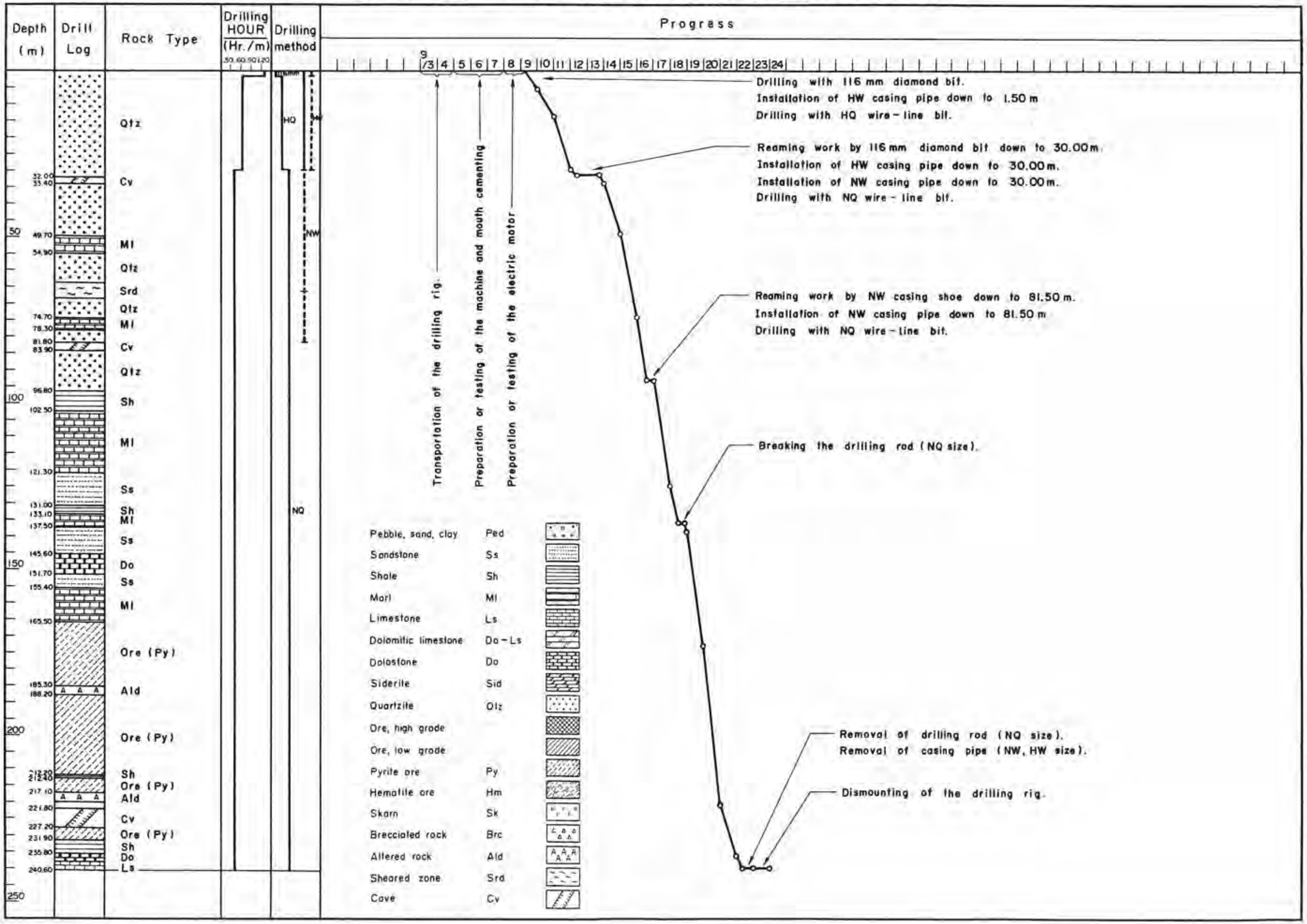


Fig. I－5 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-14

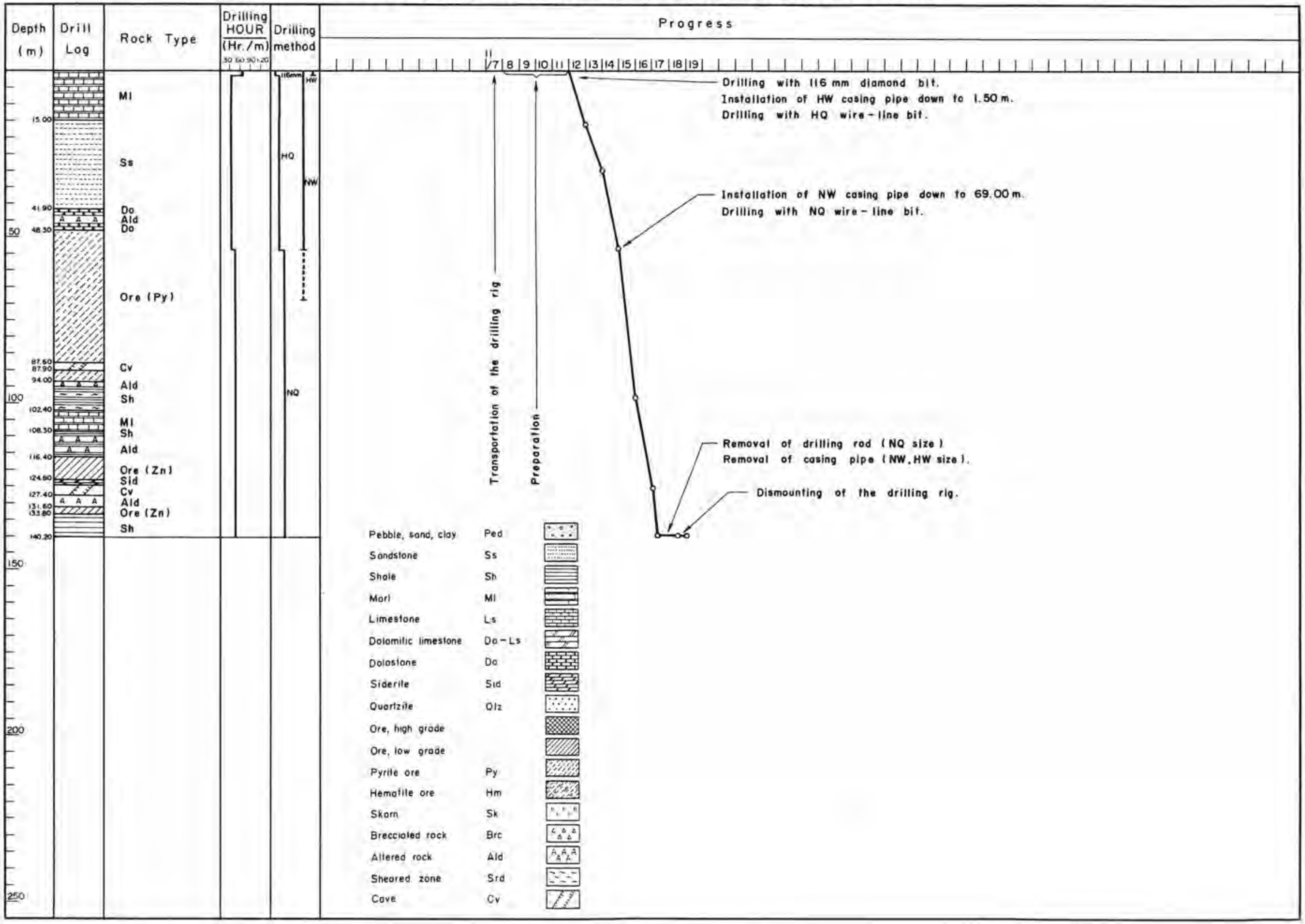


Fig. I - 6 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-15

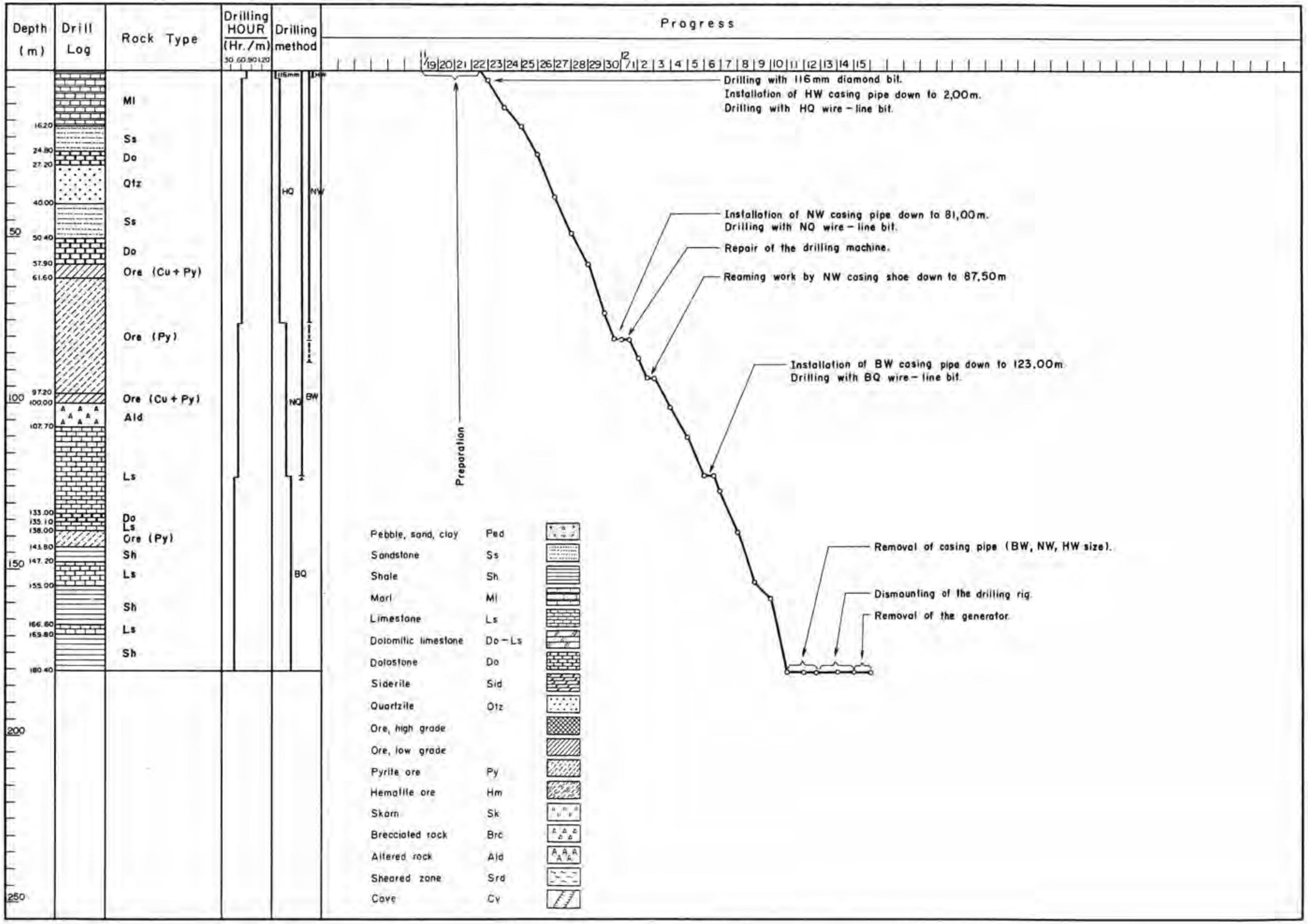


Fig. I－7 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-16

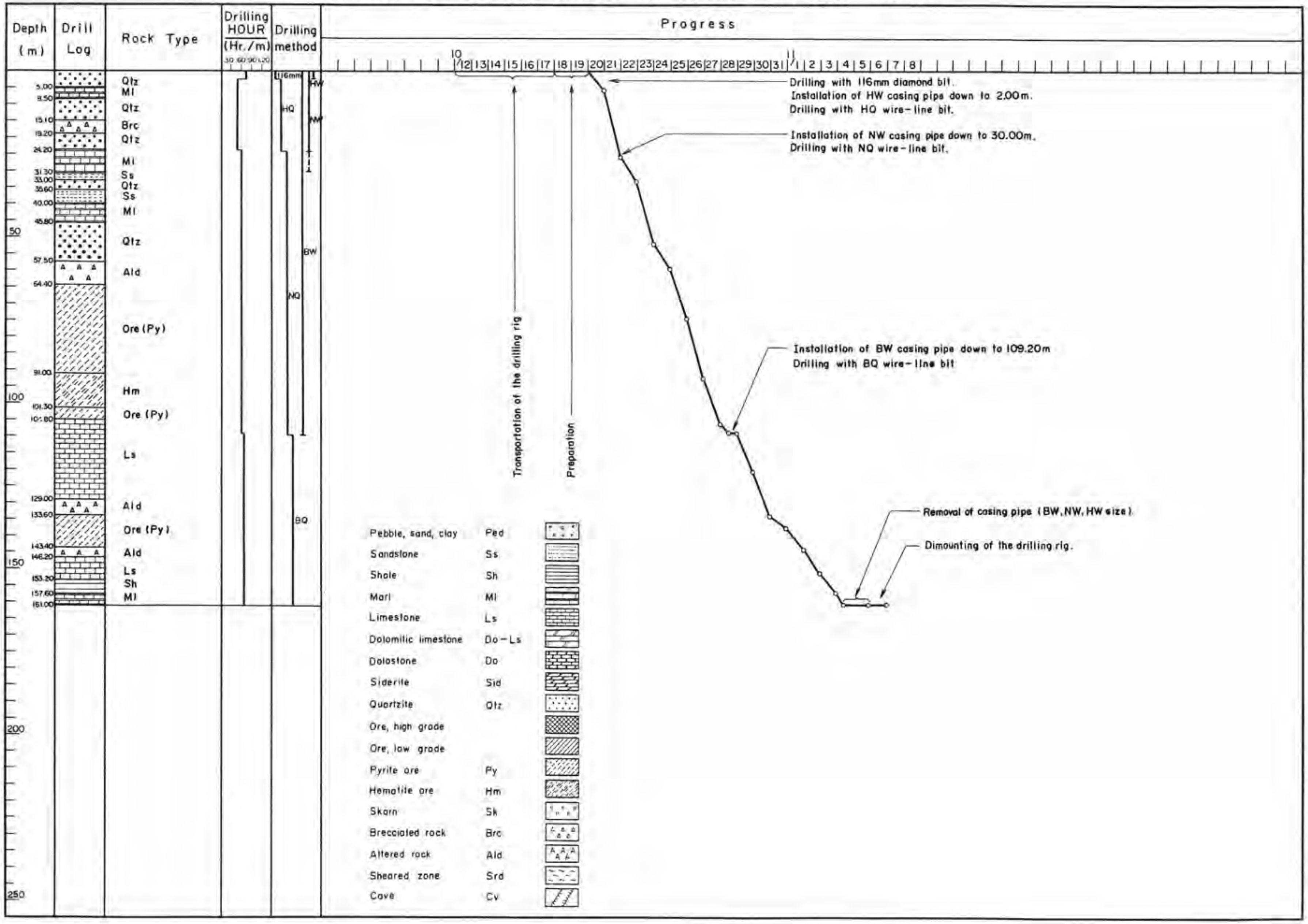


Fig. I − 8 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-17

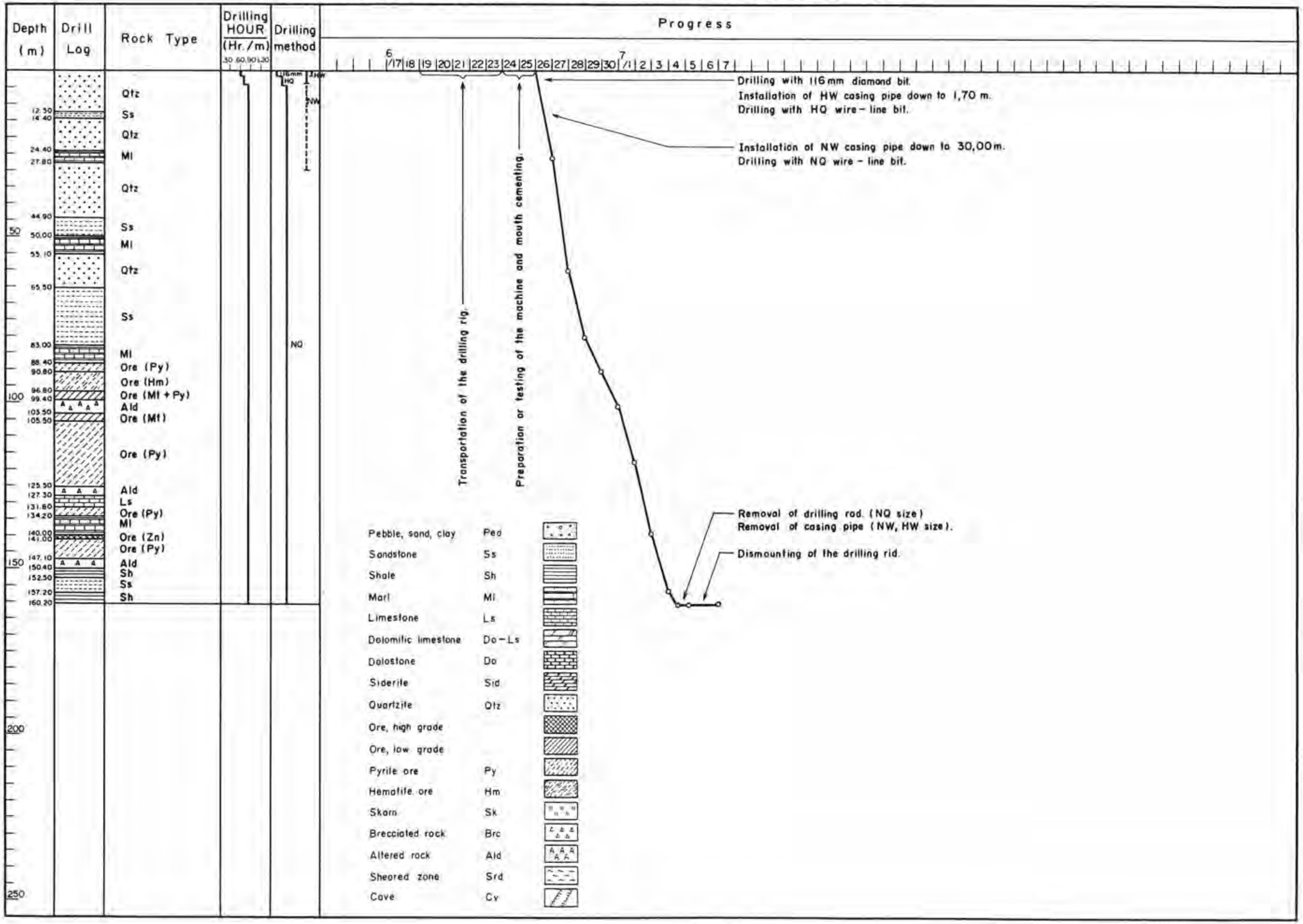


Fig. I-9 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-18

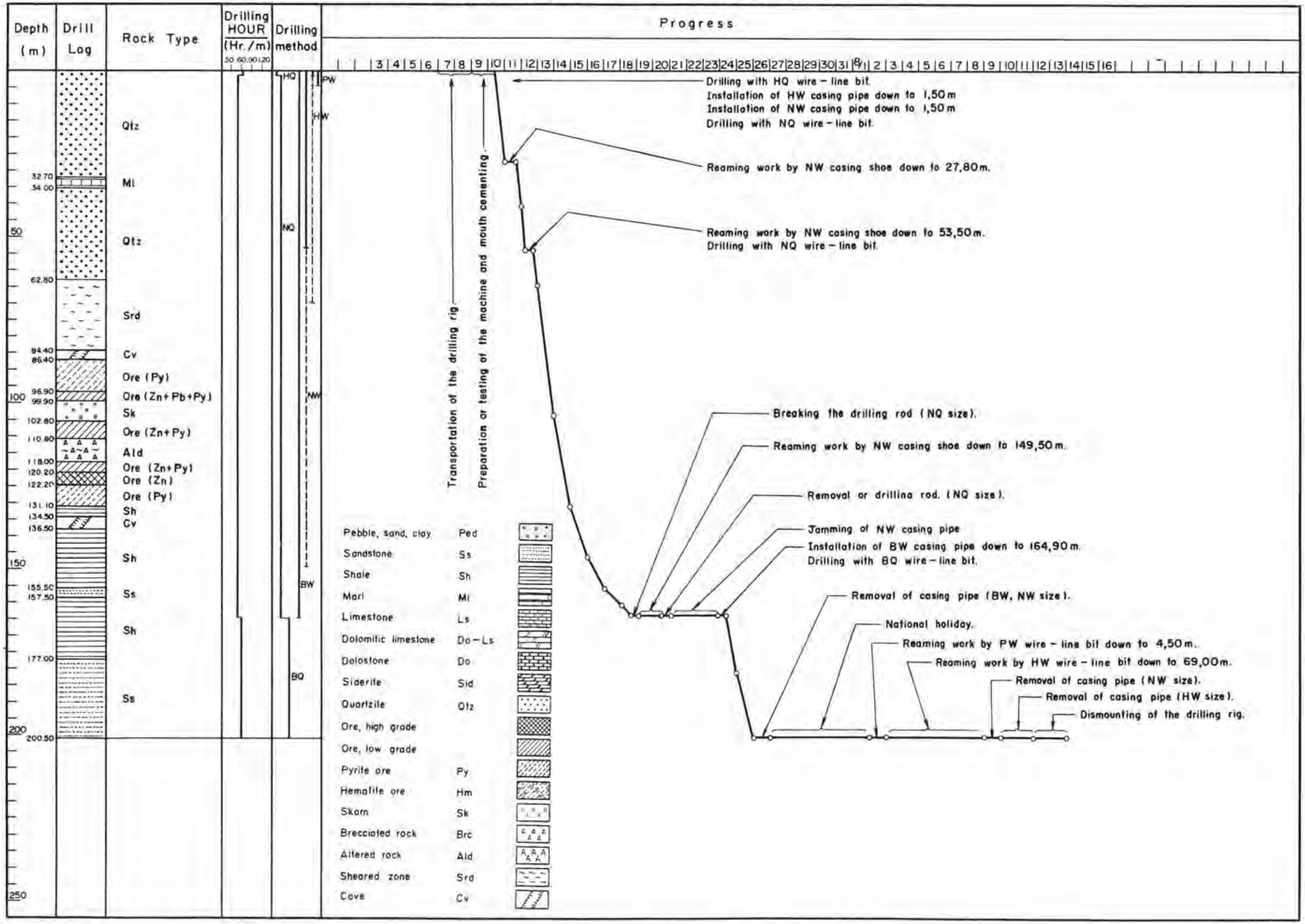
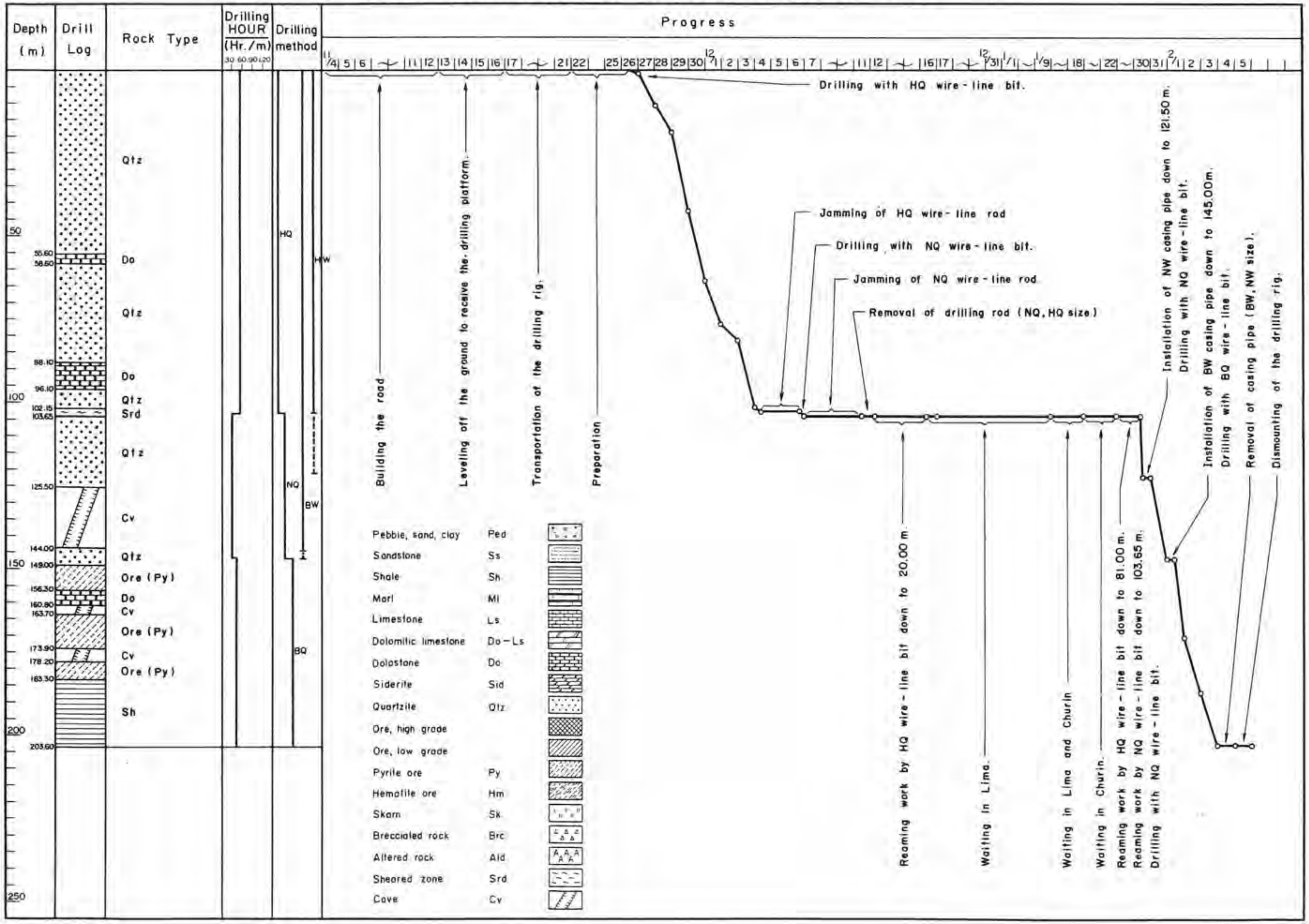


Fig. I - 10 PROGRESSIVE RECORD OF DIAMOND DRILLING. IC-19



CHAPTER 2 GEOLOGY AND MINERALIZATION IN THE DRILL HOLES

2–1 IC–10

(1) Purpose : The purpose of the excavation of this hole was to explore geology and mineralization in the midway area of the two drill holes, DDH–3 and IC–1.

(2) Location : At the point on the surface about 100 meters southwest of the gate of the Adit-N (at the altitude of 4,698 m above sea level). The bearing of the hole was 70°, and the inclination was –45°. The depth of the hole was 180.3 m (Fig. 4 and Fig. 5).

(3) Lithology : Base rock appeared at the depth of 6.2 m. Down to the hole depth of 86.8 m, the rocks were of the Carhuaz Formation which was composed of the alternation of shale, marlstone and sandstone. Santa Formation appeared at the depth of 86.8 m. To the hole depth of 151.7 m, alternation of dolostone and limestone was recognized with some thin insertions of shale. At the hole depth between 151.7 m and 174.5 m, the core was composed of hematite and pyrite with the dissemination of copper minerals.

Below the depth of 174.5 m, shale was recognized and dolostone appeared the bottom of the hole (Fig. I–11 and PL. I–10).

(4) Mineralization and grade : Dissemination of lead and zinc minerals was confirmed in the dolostone and in the siderite, and the dissemination of copper minerals was found in the hematite. However, as they were recognized to be only slightly disseminated, it can be said that no notable mineralization was confirmed in this hole.

2–2 IC–11

(1) Purpose : The purpose of the excavation of this hole was to explore the depth of the pyrite orebody found in the crosscut No.1 tunnel of the Adit-N as well as the northern extention of the enriched portion of the lead-zinc-copper mineralization caught in the drill hole IC–2.

(2) Location : Underground drilling at the point 310 m deep from the gate of the Adit-N. The bearing of the hole was 225°, and the inclination was –40°. The depth of the hole was 221.1 m.

(3) Lithology : Down to the depth of 75.0 m, the rocks were of the Chimu Formation, which was composed mainly of quartzite. To the depth of 98.4 m, transitional zone of the Chimu Formation was recognized, comprising sandstone, shale and marlstone. Down below the depth of 98.4 m, the Santa Formation appeared. To the depth of 107.2 m, dolostone was found and in the portion of the depth between 107.2 m and 133.9 m, high grade lead-zinc orebody was confirmed in the core of the length of 26.7 m. To the depth of 164.8 m, altered rocks and dolostone was

found, and in the portion of the depth between 164.8 m and 177.4 m, pyrite with zinc dissemination was confirmed. Down below the depth of 185.2 m, was found the Carhuaz Formation composed mainly of shale (Fig. I–12 and PL. I–11).

(4) Mineralization and grade : The analysis results of the ore samples collected from the parts of the high grade mineralization are given as follows.

Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
107.2–115.4	8.2	5	39	0.05	4.44	7.97
115.4–124.5	9.1	9	47	0.05	1.38	39.16
124.5–133.9	9.4	5	25	0.04	3.94	19.00
Average	26.7	19	38	0.04	3.16	22.69

(5) Discussion : The above orebody was composed of a large amount of sphalerite including dots and aggregates or in some cases dendric aggregates of disseminated pyrite. Under microscope, small amount of galena, marcasite and pyrrhotite were recognized in addition to the above stated.

As the angle of the drill hole against the structure of the orebody was about 50° (the complement of 40°), the true thickness of this mineralized portion is estimated to be as follows;

$$26.7 \text{ m} \times \sin 50° = 20.45 \text{ m}$$

2–3 IC–12

(1) Purpose : The purpose of this hole was to explore mineralization along the lower extension of the pyrite orebody caught in the No.2 crosscut of the Adit-N, and to investigate the area in the midst of the indications of lead-zinc-copper enriched mineralization found in the drill holes of IC–2 and DDH–5.

(2) Location : Underground drilling at the working face (410 m from the gate) of the Adit-N. The bearing of the hole was 270° and the inclination was –43°. The depth of the hole was 220.6 m.

(3) Lithology : Down to the hole depth of 75.0 m, the rocks were of the Chimu Formation which was composed mainly of quartzite with the inserted layers of shale and marlstone.

To the hole depth of 130.9 m, transitional zone of the Chimu Formation was recognized, comprising the alternation of sandstone, marlstone and dolostone.

The Santa Formation appeared below the depth of 130.9 m. The Formation was composed of brecciated rocks of dolostone, limestone, marlstone and altered rocks. In the portion of the depth between 144.3 m and 183.5 m, was confirmed a high grade lead-zinc orebody in the core of the length of 39.5 m. The portion of the depth between 204.2 m and 208.8 m was composed mainly of pyrrhotite and the portion of the depth between 216.3 m and 128.5 m was composed of pyrite. Phyllitic shale was found at the bottom of the hole (Fig. I–13 and PL. I–12).

(4) Mineralization and grade : Below is given the analysis results of the ore samples collected continuously from every one meter of the core of the length of 39.5 m, where lead-zinc mineralization was confirmed.

Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
144.3–161.5	17.2	17	40	0.01	2.11	8.37
161.5–175.5	14.0	14	153	0.48	3.23	44.80
175.5–183.5	8.0	7	32	0.06	2.64	21.59
Average	39.2	38	78	0.19	2.61	24.08

(5) Microscopic Observation

*IC–12–162 : Composed mainly of a large amount of sphalerite. Pyrite grains are found scattered in sphalerite. Seams of sphalerite, galena and pyrite are recognized to develop cutting the above sphalerite. The ore is composed megascopically of two kinds of sphalerite, dark brown sphalerite and yellow ~ pale brown one. The latter is found to occur in fine seams in the former.

*IC–12–163 : Composed mainly of a large amount of sphalerite. Fine grained galena and euhedral pyrite crystals are found in sphalerite. Lattice-like exsolution structure of pyrrhotite is observed in the sphalerite.

*IC–12–167 : Composed mainly of sphalerite with minor amount of chalcopyrite and pyrite . Fine grains of gersdorffite are recognized. Numerous fine chalcopyrite grains are included in sphalerite, which shows remarkable exsolution structure. Chalcopyrite is observed in fine grains or in dots in sphalerite. It is also associated intimately with pyrite, as is recognized in cracks of pyrite and around pyrite grains. This ore is composed megascopically of two kinds of sphalerite, greenish dark grey sphalerite and pale brown sphalerite. The latter is found to occur in fine seams in the former sphalerite. It is inferred that the former is the one which has exsolution structure of chalcopyrite.

*IC–12–170 : Composed mainly of sphalerite. The sphalerite includes numerous fine chalcopyrite grains and has some zoning structure. Megascopically, it is characteristic that the sphalerite has greenish dark grey color.

*IC–12–174 : Composed mainly of a large amount of sphalerite with minor amount of galena and pyrite. Galena is found to occur in fine grains or in dots in sphalerite. Pyrite is observed to be in aggregates in sphalerite. Megascopically, it is characteristic that the ore has dots or aggregates of galena and pyrite in dark brownish sphalerite.

*IC–12–178 : Composed mainly of a large amount of sphalerite with minor amount of galena and pyrite.

*IC–12–183 : Composed mainly of sphalerite with minor amount of galena, pyrite, chalcopyrite and pyrrhotite. In parts of pyrite, is recognized concentric colloform-like ring structure or corrosion-like structure.

(6) Discussion : According to the X-ray diffraction analysis, the ore is composed mainly of sphalerite while the gangue minerals are mainly quartz associated with chlorite and siderite.
It is megascopically characteristic that the ore is brecciated remarkably. Sphalerite has replaced the brecciated wall rocks. Also, sphalerite of other quality is found to have precipitated in spaces in brecciated ore mass, associated with pyrite and galena.
Unmineralized breccias are included in some cases.

The following three qualities of sphalerite are recognized in the subject ore.

a) greenish dark grey sphalerite : Includes numerous very fine chalcopyrite and has exsolution structure. Composed almost solely of sphalerite and the ore grade reaches up to 40% or even to 50% of Zn.

b) dark brown sphalerite : Fe content is estimated to be highest in this type of sphalerite. The sphalerite is found to include dots and aggregates of pyrite and galena. The ore grade reaches up to 30% or 40% of Zn.

c) yellow ~ pale brown sphalerite : This type of sphalerite is usually pale and transparent in color, and is estimated to contain least Fe content. The sphalerite is recognized to occur in fine seams and disseminatedly in the above-stated two types of sphalerite. Usually, it is associated with euhedral pyrite and galina.

As for the pyrite found in the ore, the following differences are recognized with the occurrences.

a) The brecciated pyrite. Along the cracks sphalerite is found to have been precipitated or to have replaced the pyrite.

b) The pyrite found in dots or in aggregates in massive sphalerite. The pyrite is recognized to have been corroded and replaced by the sphalerite.

c) The pyrite found in dendric aggregates in massive sphalerite.

d) The pyrite found in veinlets, associated with galena, sphalerite, chalcopyrite etc. This type of pyrite is euhedral in usual cases.

From the viewpoints of the above-stated particularities of the ore minerals and ore deposits, it is thought that the followings are the characteristics of the subject ore deposits.

1) Remarkable structural movement would have been there during the period of the mineralization.

2) There must have been at least two or three stages as to mineralization.

3) It is thought to be likely that the ore minerals would have precipitated rapidly in a comparatively short period under the condition of relatively low temperature.

4) Brecciation and fracturing are closely related to the mineralization.

(7) Scale of the ore deposit

The angle of the surface structure of this ore deposit against the direction of the drill hole is about 55° (the complement of 35°) and the true thickness of this ore deposit is estimated as shown below.

$$39.2 \text{ m} \times \sin 55° = 32.11 \text{ m}$$

2–4 IC–13

(1) Purpose : The purpose of this drill hole was to explore the southern extension of the rich mineralization which had been caught by the drill hole DDH–5.

(2) Location : Underground drilling at the working face of the Adit-N. The bearing of the hole was 215° and the inclination was –43°. The depth of the hole was 240.6 m.

(3) Lithology : Down to the hole depth of 96.8 m, the rocks were of the Chimu Formation which was composed mainly of quartzite. To the hole depth of 155.4 m, transitional zone of the Chimu Formation was recognized, comprising the alternation of sandstone, marlstone, shale and dolostone.

The Santa Formation appeared below the depth of 155.4 m. The Formation was composed of limestone, dolostone and marlstone down to the depth of 165.5 m. In the portion of the depth between 165.5 m and 231.9 m, was confirmed massive pyrite orebody in the core of the length of 66.5 m. Below the depth of 231.9 m, alternation was found composed of shale, marlstone and limestone.

(4) Mineralization and grade : The rocks belonging to the Santa Formation were replaced by massive pyrite as a whole. However, no remarkable dissemination of zinc and copper was recognized in the core.

2–5 IC–14

(1) Purpose : The purpose of this drill hole was to explore the northern extension of the rich mineralization which had been caught by the drill hole DDH–6.

(2) Location : The drill hole was in the underground at the point 710 m deep from the gate of the Adit-S. The bearing of the hole was 270° and the inclination was –30°. The depth of the hole was 140.2 m.

(3) Lithology : Down to the hole depth of 43.8 m, the rocks were of the transitional zone of the Chimu Formation, which was composed of the alternation of sandstone and marlstone.
The Santa Formation appeared below the depth of 43.8 m. In the portion of the depth between 48.3 m and 94.0 m was confirmed massive pyrite orebody in the core of the length of 45.7 m. Five layers of zinc orebodies were recognized at the depth between 100.7 m and 133.8 m, the most remarkable of which was found to be the one at the depth between 113.9 m and 123.7 m in the core length of 9.8 m. Below the depth of 133.8 m, was recognized shale of the Carhuaz Formation.

(4) Mineralization and grade : Below is given the analysis results of the ore samples collected from the mineralized portion of the drill cores.

Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
100.7–102.4	1.7	1	30	0.43	0.02	17.50
107.1–113.9	6.8	4	18	0.05	0.04	9.90
113.9–123.7	9.8	9	42	0.27	0.19	21.56
131.6–133.8	2.2	2	28	0.28	0.06	31.00

The average grade of the portion of the core of the length of of 16.6 m at the depth between 107.1 m and 123.7 m was Ag; 23 g/t, Cu; 0.18%, Pb; 0.13% and Zn; 16.78%.

(5) Discussion : According to the X-ray diffraction analysis (IC–14–15), the main alteration minerals were sericite, quartz and chlorite. By the microscopic observation of the polished section of the ore, sphalerite and magnetite are closely associated each other and sphalerite includes very fine grain chalcopyrite.

2–6 IC–15

(1) Purpose : The purpose of this drill hole was to explore the copper mineralization in the area midst of the drill holes of DDH–6 and IC–4.

(2) Location : The drill hole was in the underground at the point 710 m deep from the gate of the Adit-S. The bearing of the hole was 210° and the inclination was −30°. The depth of the hole was 180.4 m.

(3) Lithology : Down to the hole depth of 50.4 m, the rocks were of the transitional zone of the Chimu Formation, which was composed of sandstone, marlstone and dolostone.

The Santa Formation appeared at the depth between 50.4 m and 155.0 m. The unmineralized portion of this formation was composed of limestone with thin insertions of shale. Massive pyrite orebody was confirmed at the depth between 57.9 m and 93.2 m, which was disseminated with chalcopyrite and chalcocite. At the depth between 93.2 m and 100.2 m, hematite orebody was found with the dissemination of copper minerals. The portion at the depth between 138.0 m and 143.8 m was compsed of pyrite and pyrrhotite with the dissemination of lead and zinc. Below the depth of 155.0 m, the Carhuaz Formation was confirmed mainly of shale.

(4) Mineralization and grade : The massive pyrite orebody contains copper minerals such as enargite, chalcopyrite and chalcocite in the form of dissemination in some parts. However, the concentration is found to be scattered.

(5) Discussion : According to the microscopic observation of the polished sections (IC−15−086), a large amount of enargite is recognized in the ore. The enargite is associated with pyrite, chalcopyrite and bornite, and covelline is recognized partly.

2−7 IC−16

(1) Purpose : The purpose of this drill hole was to explore the copper mineralization in the area midst of the drill holes of IC−4 and IC−5.

(2) Location : The drill hole was in the underground at the point 507 m deep from the gate of the Adit-S. The bearing of the hole was 250° and the inclination was −30°. The depth of the hole was 161.0 m.

(3) Lithology : Down to the hole depth of 24.2 m, the rocks were of the Chimu Formation, which was composed mainly of quartzite. Down to the depth of 57.5 m, was found the transitional zone of the Chimu Formation composed of sandstone, marlstone and dolostone. The Santa Formation appeared at the depth of 57.7 m. Pyrite orebody was found at the depth between 64.4 m and 91.0 m, and specularite orebody was confirmed at the depth between 91.0 m and 101.3 m. The portion at the depth between 133.6 m and 143.4 m was composed of pyrite orebody with the dissemination of chalcocite.

The unmineralized portion of this formation was composed of limestone with thin insertions of shale. Below the depth of 153.2 m, was found the Carhuaz Formation composed mainly of shale.

(4) Mineralization : Mineralization of this hole is mainly pyritization and hematitization.

2–8 IC–17

(1) Purpose : The purpose of this drill hole was to explore the northern extension of the copper-zinc skarn type mineralization which had been caught by the drill hole DDH–7 in the Limpe-South (Tinyag) area.

(2) Location : The drill hole was located about 100 m north of the drill hole DDH–7 (4,617 m above sea level) on the surface. The bearing of the hole was 250° and the inclination was –70°. The depth of the hole was 160.2 m.

(3) Lithology : Down to the hole depth of 88.4 m, the rocks were of the Chimu Formation, which was composed mainly of quartzite down to the depth of 44.9 m and of alternation of sandstone, quartzite and marlstone remarkably brecciated.

The Santa Formation appeared below the depth of 88.4 m.

In the portion of the depth between 89.5 m and 99.4 m was confirmed hematite-magnetite-pyrite orebody. Pyrite orebody was found at the depth between 105.5 m and 125.5 m. The unmineralized portion of this formation was composed of limestone and marlstone. Sphalerite concentration was recognized at around the depth of 128 m and 140 m. Below the depth of 149.0 m, was recognized the Carhuaz Formation which was composed of shale and sandstone.

(4) Mineralization and grade : Magnetite and hematite ore is found to have been disseminated with chalcopyrite. Sphalerite was recognized to have been concentrated in the limestone and in the marlstone, though small in scale. Below is given the analysis results of the ore samples collected from the mineralized portion of the drill cores.

Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
94.8– 99.5	4.7	3	11	1.25	0.00	0.09
127.3–127.7	0.4	1	11	9.00	0.00	38.40
140.0–141.0	1.0	1	8	0.42	0.00	22.00

(5) Discussion : According to the microscopic observation of the polished section (IC–17–098), magnetite contains fine bands of pyrite and chalcopyrite, which shows banded structure. It is thought that the hematite would have replaced the magnetite.

2–9 IC–18

(1) Purpose : The purpose of this drill hole was to explore the skarn type mineralization in the Limpe-South (Tinyag) area.

(2) Location : The drill hole was located about 110 m southeast of the drill hole DDH–7 (4,680 m above sea level) on the surface. The bearing of the hole was 250° and the inclination was –50°. The depth of the hole was 200.5 m.

(3) Lithology : Down to the hole depth of 70.4 m, the rocks were quartzite of the Chimu Formation. A fault fracture zone composed of reddish brown gossans was found at the depth between 70.4 m and 86.4 m. The Santa Formation appeared below the depth of 86.4 m down to the depth of 131.1 m. The rocks of the Santa Formation were altered and mineralized as a whole, and tremolite was recognized in some parts. In the portion of the depth between 86.4 m and 99.9 m, was confirmed pyrite orebody, with the dissemination of copper and zinc minerals. Zinc orebody was confirmed at the depth between 102.8 m and 126.8 m in the core of the length of 24 m. Below the depth of 131.1 m, was recognized the Carhuaz Formation which was composed of shale and sandstone.

(4) Mineralization and grade : Below is given the analysis results of the ore samples collected from the mineralized portion of the drill cores.

Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
96.9–101.8	4.9	3	22	2.86	0.03	21.60
101.8–110.8	9.0	9	9	0.90	0.01	28.89
101.8–125.5	14.7	10	7	0.97	0.01	12.24
Average	28.6	22	8	1.32	0.01	19.79

(5) Discussion : In the orebody, some skarn minerals as tremolite was recognized megascopically. However, according to the X-ray diffraction (IC–18–099), main gaingue minerals were talc, chlorite and quartz, and no tremolite was detected. It is thought that the tremolite would be pseudomorph after replaced by talc and other minerals in the process of retrogressive alteration. It is noted that the portion where sphalerite and pyrite are concentrated has been remarkably brecciated, and that sphalerite is found to have filled spaces in the pyrite breccias.

2–10 IC–19

(1) Purpose : The purpose of this drill hole was to explore the skarn type mineralization in Limpe-South (Tinyag) area.

(2) Location : The drill hole was located about 320 m southeast of the drill hole DDH–7 (4,694 m above sea level) on the surface. The bearing of the hole was 250° and the inclination was –50°. The depth of the hole was 203.6 m.

(3) Lithology : Down to the hole depth of 127.6 m, the rocks were quartzite of the Chimu Formation. A fault fracture zone was found in the core length of 21.4 m at the depth between 127.6 m and 149.0 m. In the core length of 38.0 m at the depth between 149.0 m and 187.0 m, there appeared the Santa Formation, which was composed of altered rocks and pyrite. Below the depth of 187.0 m, was recognized the Carhuaz Formation which was composed mainly of altered shale.

(4) Mineralization and grade : Merely weak zinc and copper dissemination was recognized in the core of this drill hole.

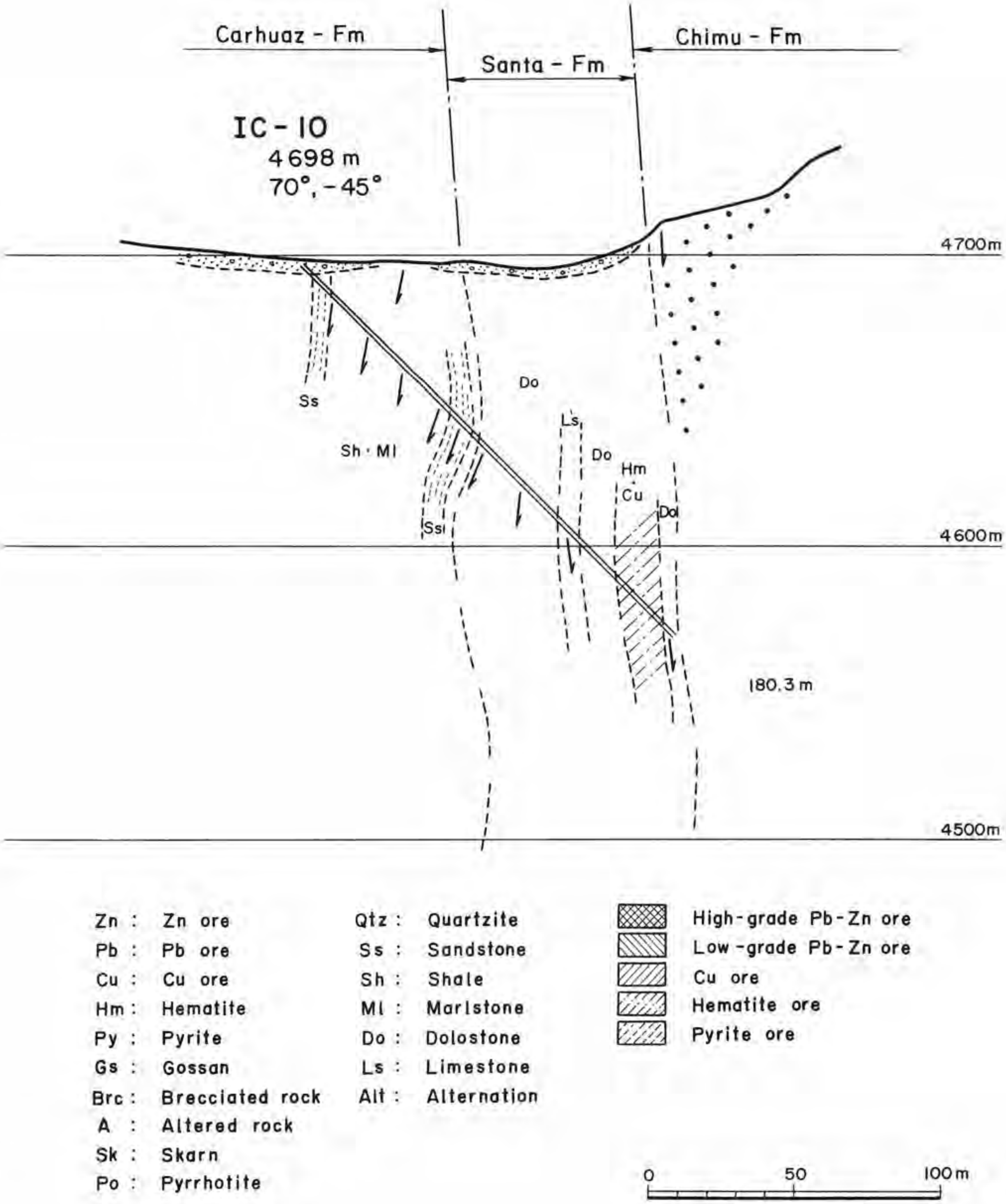
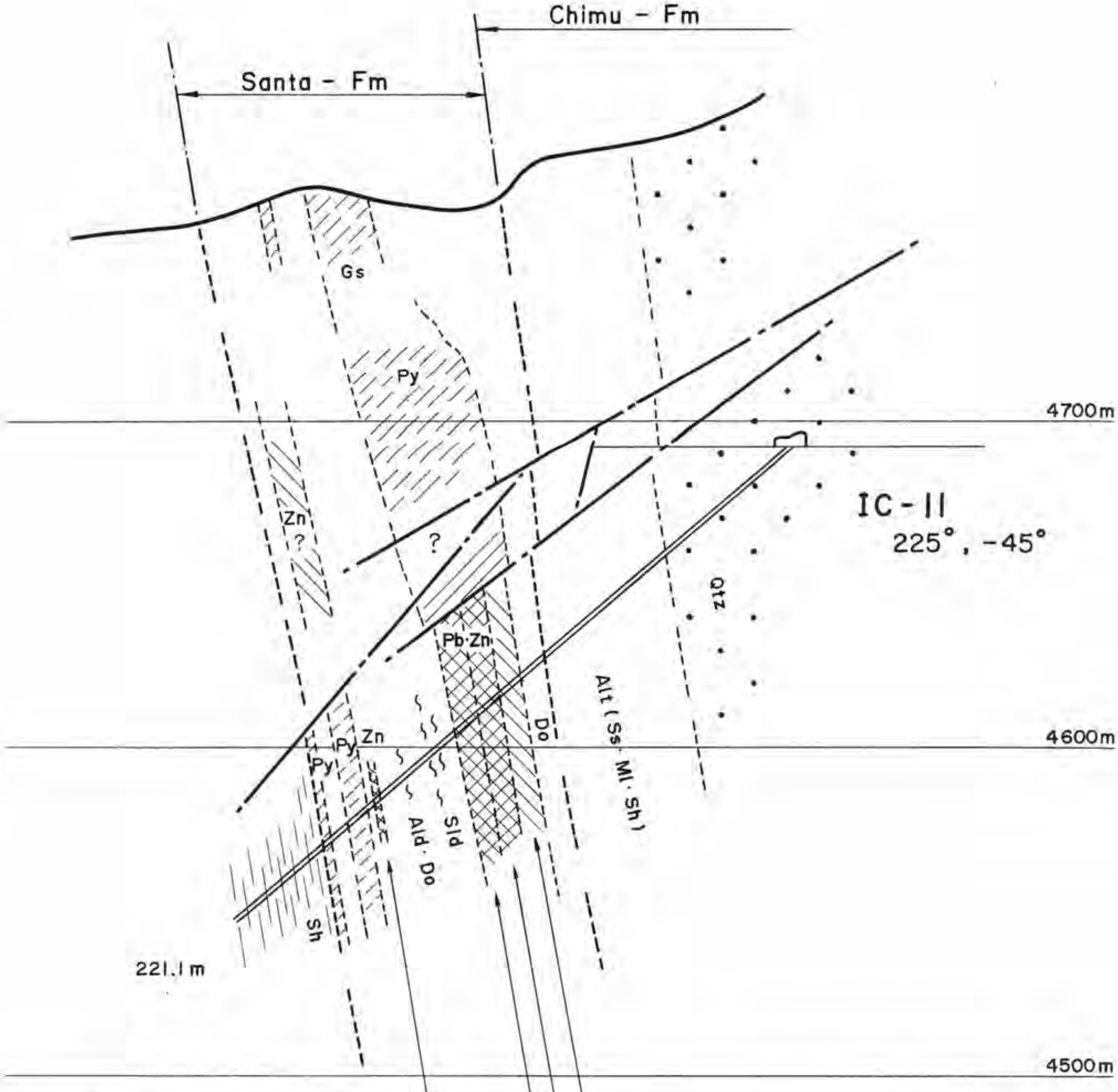


Fig. I-11 Geological Section for IC-10

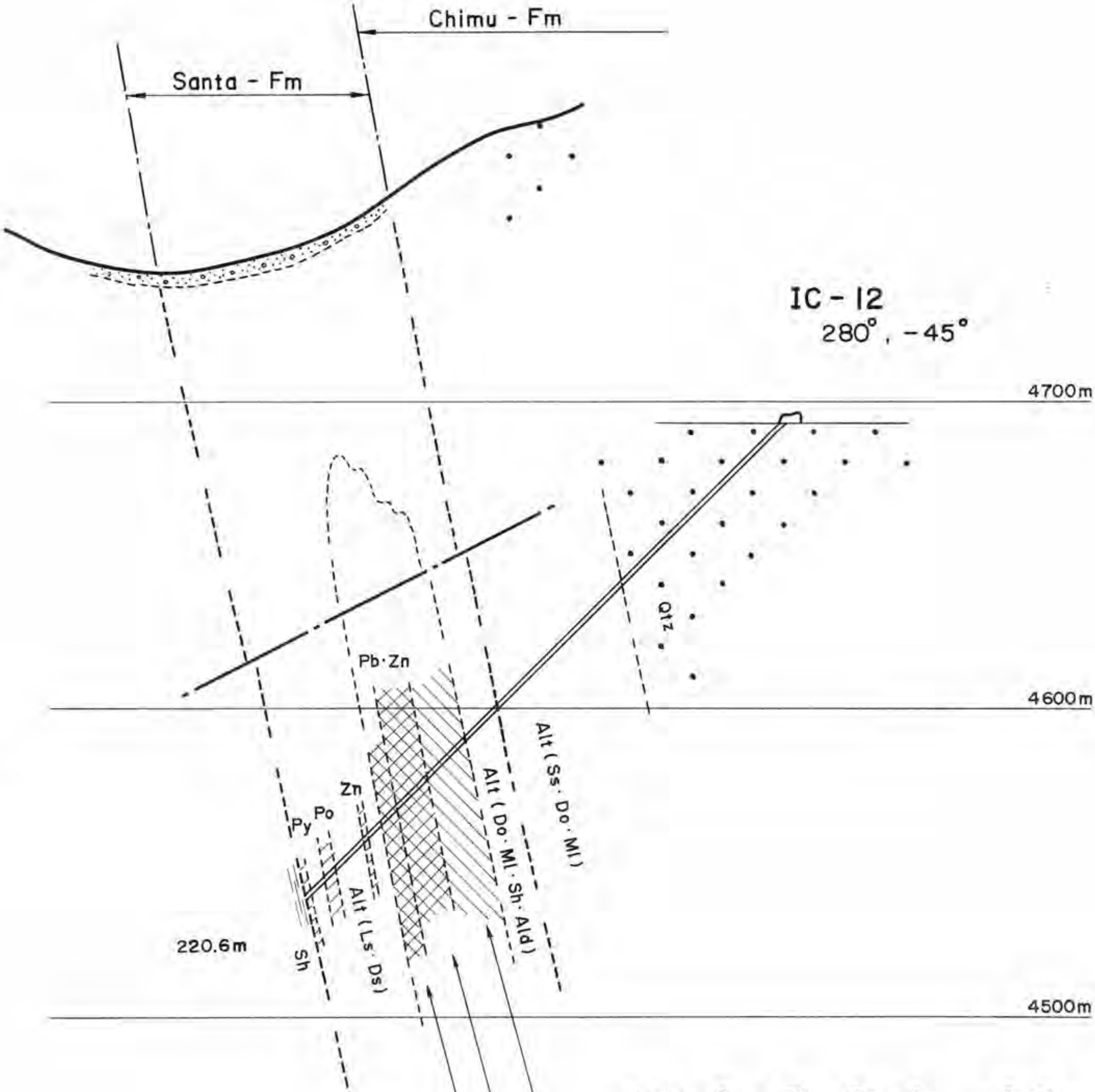


Sandstone
Shale
Quartzite
Fractured zone
Bedding

0 50 100m

	Leng (m)	Cu (%)	Ph (%)	Zn (%)	Ag (g/t)	Depth (m - m)
	8.2	0.05	4.44	7.97	39	107.2 - 115.4
	9.1	0.05	1.38	39.16	47	115.4 - 124.5
	9.4	0.04	3.94	19.00	25	124.5 - 133.9
	1.9	0.00	6.10	29.50	41	164.8 - 166.7
Av.	26.7	0.04	3.20	21.77	37	107.2 - 133.9

Fig. I - 12 Geological Section for IC - 11



	Leng (m)	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Depth (m - m)
	17.2	0.01	2.11	8.38	40	144.3 - 161.5
	14.0	0.48	3.23	44.80	153	161.5 - 175.6
	8.0	0.06	2.64	21.59	32	175.6 - 183.5
Av.	39.2	0.19	2.61	24.08	78	144.3 - 183.5

Fig. I - 13 Geological Section for IC - 12

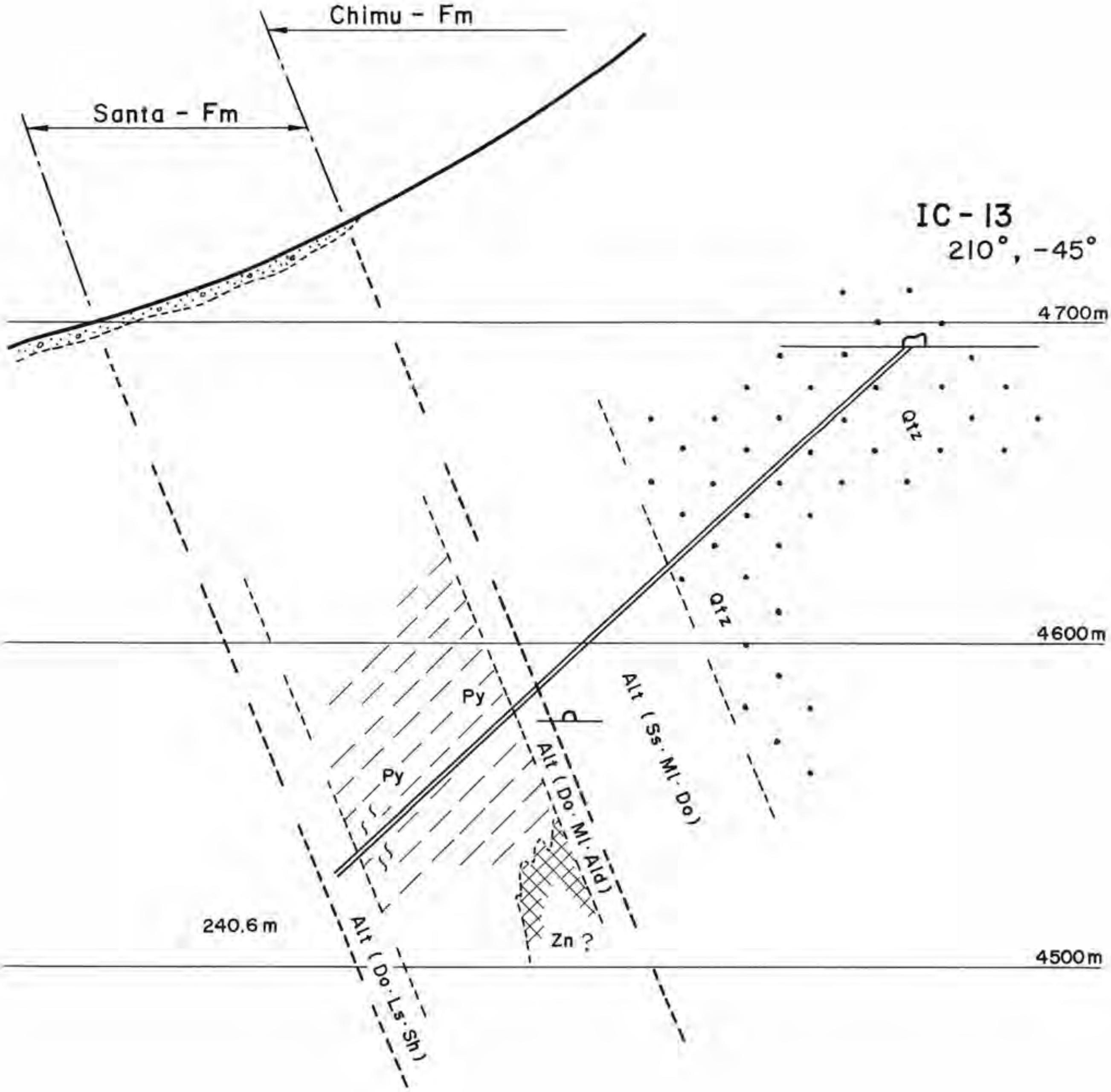


Fig. I - 14 Geological Section for IC - 13

Leng (m)	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Depth (m - m)
1.7	0.43	0.02	17.50	30	100.7 - 102.4
6.8	0.05	0.04	9.90	18	107.1 - 113.9
9.8	0.27	0.19	21.56	42	113.9 - 123.7
2.2	0.28	0.06	31.00	28	131.6 - 133.8
Av. 16.6	0.18	0.13	16.78	32	107.1 - 123.7

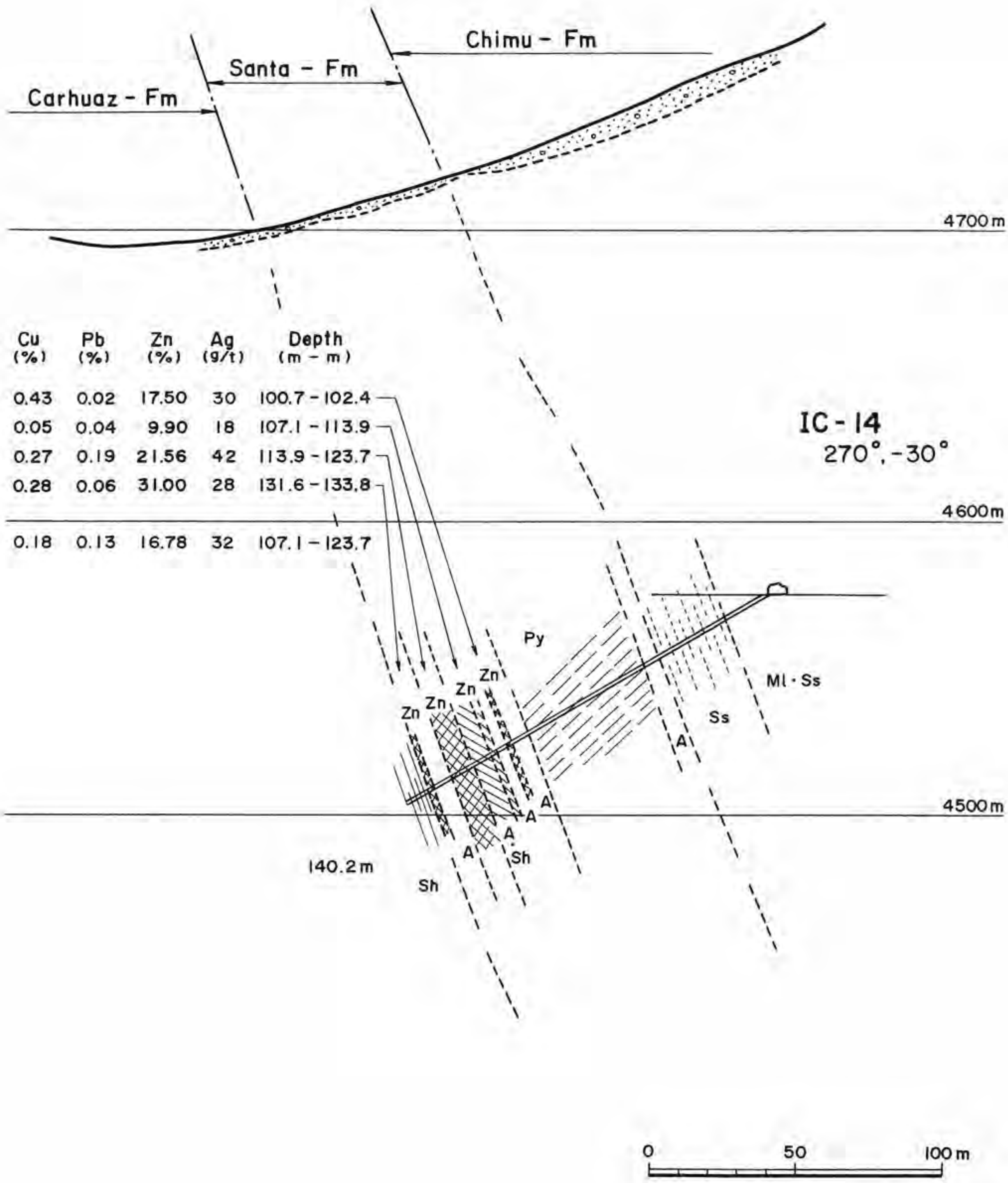


Fig. I - 15 Geological Section for IC - 14

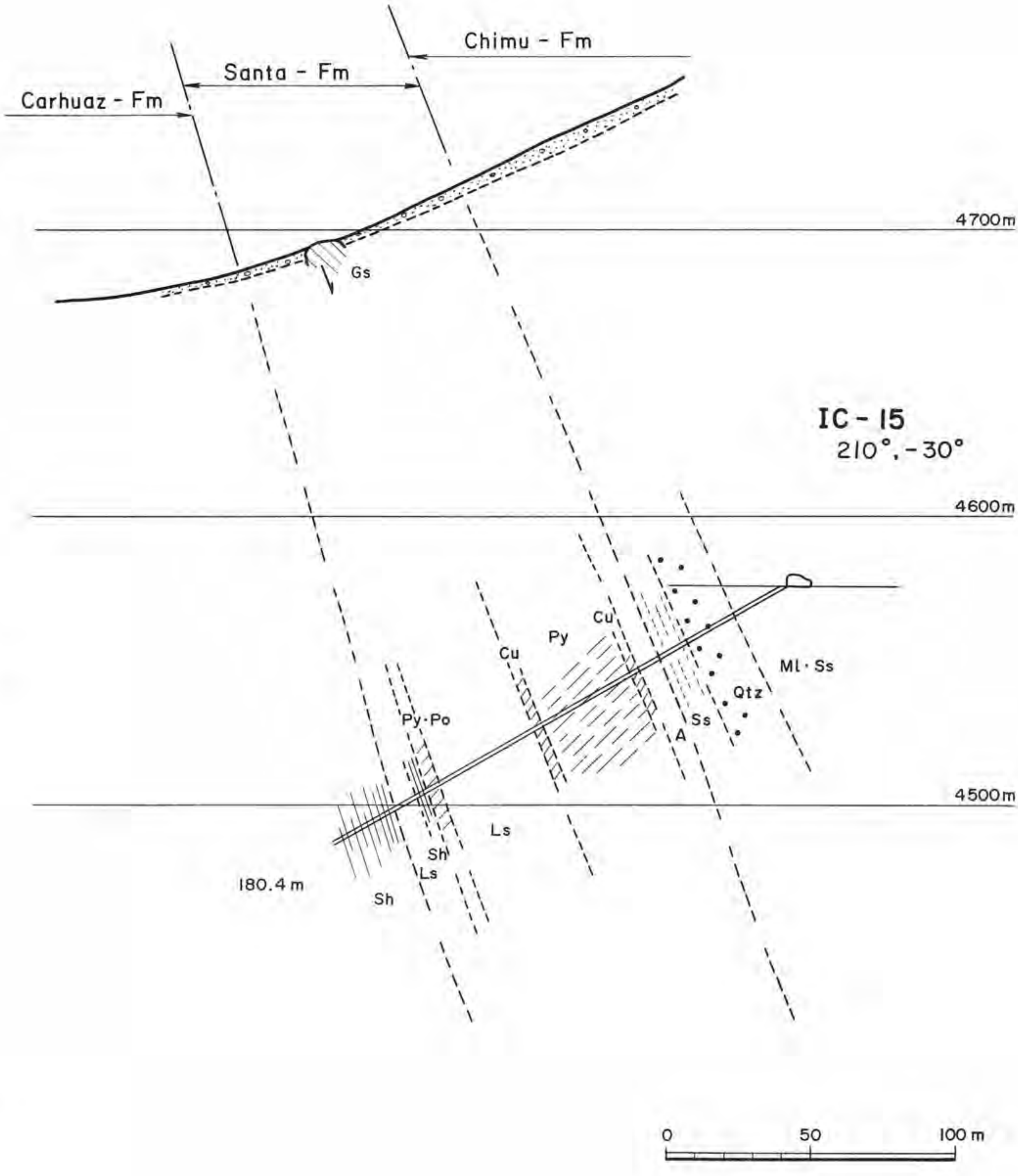


Fig. I - 16 Geological Section for IC - 15

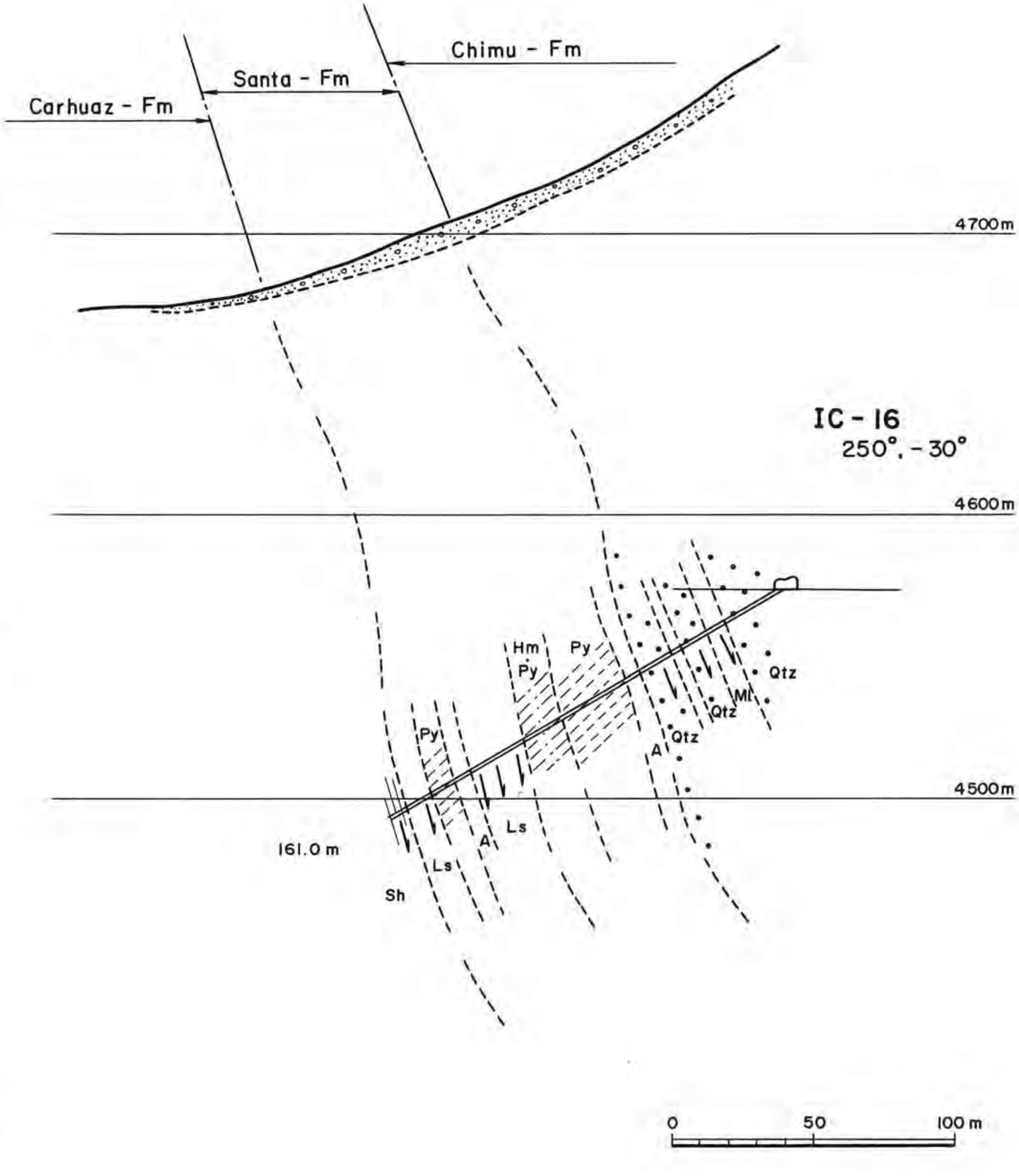


Fig. I - 17 Geological Section for IC - 16

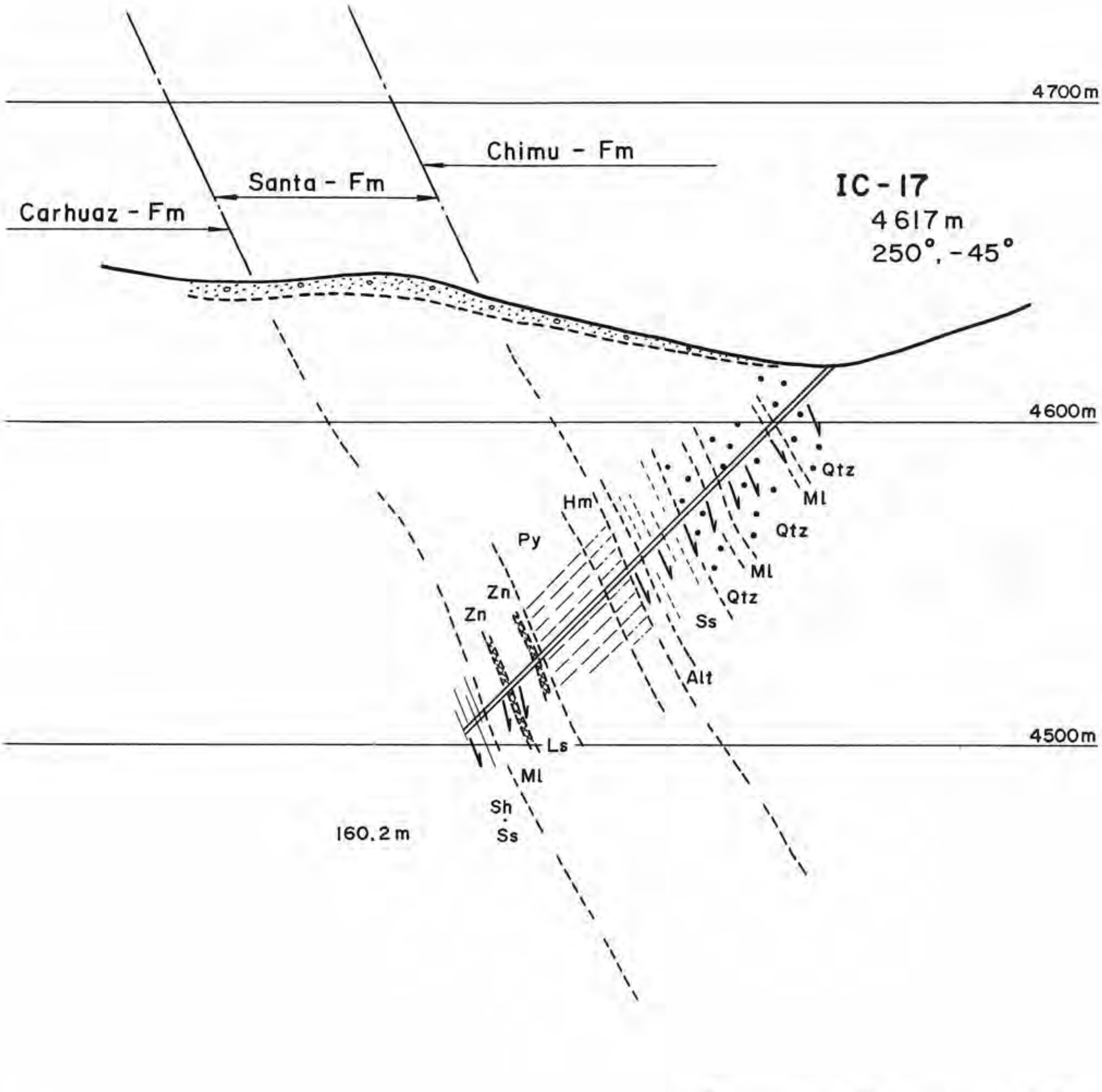
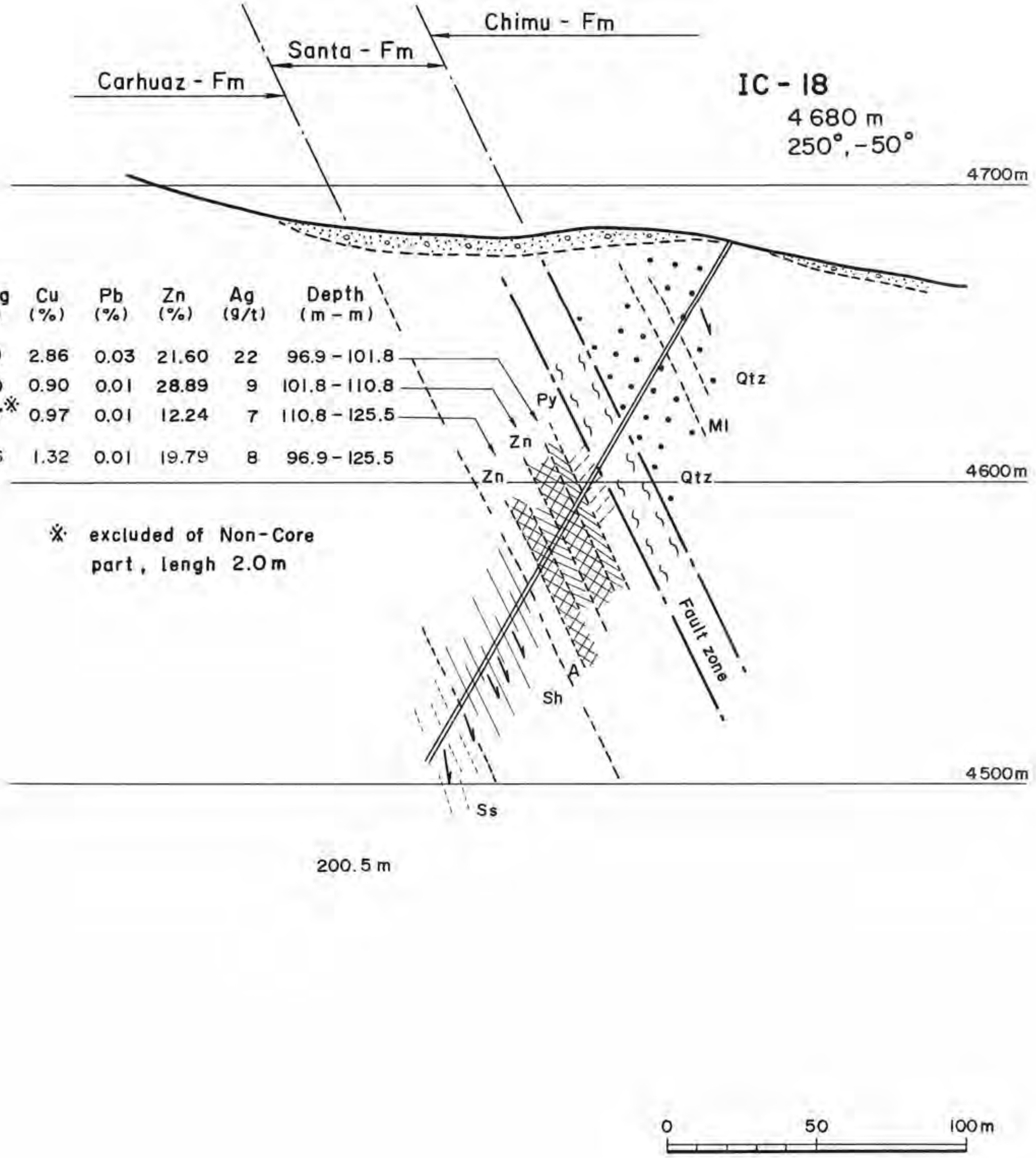


Fig. I - 18 Geological Section for IC - 17



Leng (m)	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Depth (m - m)
4.9	2.86	0.03	21.60	22	96.9 - 101.8
9.0	0.90	0.01	28.89	9	101.8 - 110.8
12.7※	0.97	0.01	12.24	7	110.8 - 125.5
Av. 28.6	1.32	0.01	19.79	8	96.9 - 125.5

※ excluded of Non-Core part, lengh 2.0m

Fig. I - 19 Geological Section for IC - 18

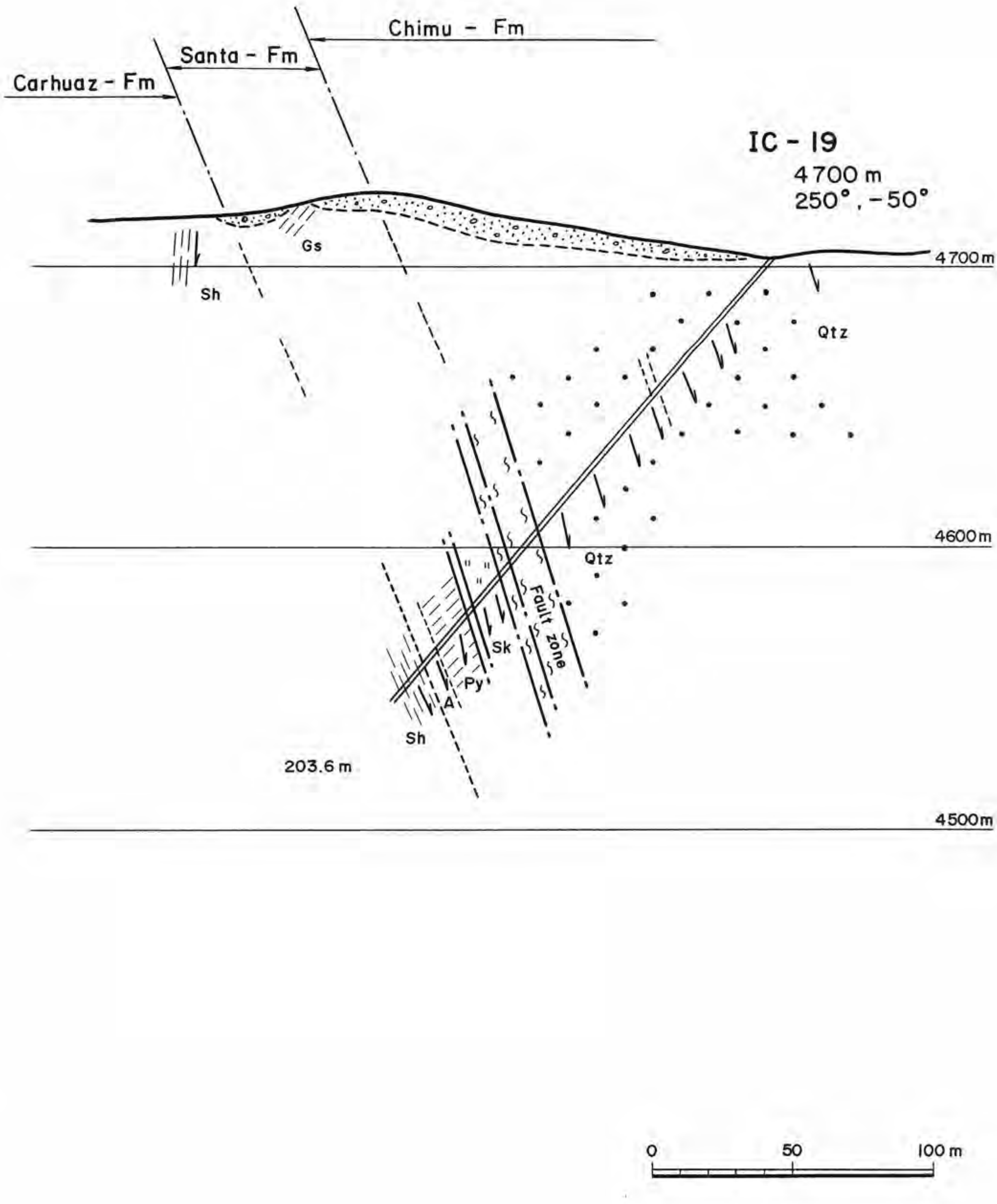


Fig. I - 20 Geological Section for IC - 19

PARTICULARS
PART Ⅱ
TUNNELLING EXPLORATION

PART II TUNNELLING EXPLORATION

CONTENTS

LIST OF FIGURES

CHAPTER 1 TUNNELLING EXPLORATION

I–1 Outline of the Exploration

Following the tunnelling exploration in the last year, 1983, the crosscut-1 and the drilling chambers were excavated as to the Adit-N, while the main tunnel was extended and the crosscut-1 and crosscut-2 in addition to the drilling chamber were excavated as to the Adit-S, in the present year of 1984. The length and the specifications of the tunnels and duration and other working conditions are as follows.

(1) Specifications of the tunnels

Elevation of gate

Adit-N	:	4,689.37 m
Adit-S	:	4,570.14 m
Effective Section	:	2.6 m x 2.5 m
Inclination	:	1/100 ~ 1/200

(2) Length of the tunnels

Name	Planned length	Excavated length	Bearing
Corsscut-2 of Adit-N	175 m	175.0 m	250°
Adit-S	212 m	212.0 m	330°
Adit-S	39 m	39.1 m	320°
Adit-S	30 m	30.0 m	250°
Adit-S	65 m	65.0 m	330°
Crosscut-1 of Adit-S	140 m	141.0 m	250°
Crosscut-2 of Adit-S	85 m	86.2 m	250°
Total	746 m	748.3 m	

(3) Term of exploration

Total days spent for excavation and its related work are 411 days from May 7, 1984 to June 21, 1985, as shown in the Table A. II–1.

Excavation began on June 27, 1984 for the Adit-N and on June 7, 1984 for the Adit-S.

(4) Working system

The road construction and the temporary works were carried out for eight hours per one shift and one shift per day, and the tunnel excavation was carried out for eight hours per shift and three shifts per day.

(5) Number of workers

Personnel worked for tunnel excavation including the road construction and the temporary works are as follows.

Japanese engineers	:	2 min per day
Peruvian engineers	:	6 men per day
Excavation labourers	:	47 men per day
Surface labourers	:	13 men per day

(mechanics, explosives and store-keeper, generator and compressor operater)

Road maintenance	:	5~10 men per day
Chauffeurs of Jeep and pick-up truck	:	3 men per day
Cook	:	4 men per day
Guardmen	:	10 men per day

(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.

Contents and number of the assay and analysis works are shown as follows.

1) Chemical analysis of the mineralized portions (Ag, Cu, Pb, Zn) .... 100 samples
2) Microscopic observation of polished sections .... 10 pieces
3) X-ray diffraction analysis .... 5 samples

1–2 Road Maintenance

In this year, the existing road from Oyon to Iscaycruz through Pampahuay was utilized with some repair and maintenance works. The road was collapsed at the three points owing to the heavy rain in March, 1984. The two points were within 9.5 km between Oyon and Pampahuay and the rest was about 6.5 km far from Pampahuay. These collapses were recovered with manual labour and a bulldozer (D7–17A). Road surface and road sides were also badly damaged between Pampahuay and the camp (14 km) and between the branching point and Limpe South (9 km). They were repaired with manual labour and a bulldozer, too. The road from Pampahuay to the camp and to Limpe South was maintained by repairing on necessity with manual labour by securing labourers all the while.

1–3 Temporary Construction

The existing lodging house and temporary houses at the gates of Adit-N and Adit-S were utilized after repaired. For the treatment of the waste coming from the excavation of the tunnels of Adit-N and Adit-S, waste piers were prepared near the gates of each adit. For the ventilation, 4 fans were set in the tunnels of Adit-N and 6 fans were set in the tunnels of Adit-S. (The fans set were Hitachi propeller fan 170 m^3/min., 80 mm AQ, 3.7 kW) Barbed wire which had been prepared around the underground magazine and the storage was repaired when broken.

Major machinery, equipment and buildings for use are listed in Table A.II–5.

1–4 Excavation

Engineers and members and working hours of excavation are as follows.

(1) Engineers

Adit-N : Seiichi Fruyado
Rene Chicori Orozco
Alejandro Victorio
Melecio Tolentino

Adit-S : Kunihiko Tsukanaka
Luis Manrique
Enrique Bustamante
Ignacio Bustamante

(2) Personnel

Excavation personnel for each adit is one Japanese engineer, three Peruvian engineers and 30 labourers, totalling 34 men. Excavation was carried out by one engineer and ten labourers per shift on three shifts per day.

(3) Working hours

The first shift : 7:00 – 15:00
The second shift : 15:00 – 23:00
The third shift : 23:00 – 7:00

1–5 Adit-N Excavation

The figures shown are the distance from the gate.

(1) Crosscut-2 of Adit-N

* 0 m – 63.3 m : The rocks are quartzite with many fissilities almost perpendicular to the bearing of the tunnel. Alternation of shale and argillaceous shale is found to the 42 m point and dolostone is found to the 63.3 m point. Rocks are soft and weak in many parts and after 19.8 m point excavation timbering was applied. Total 30 timbers were required.

* 63.3 m – 100.5 m : To the 98 m point, rocks are the alternation of dolostone and shale. No timbering was necessary. In a section between 98 m and 100.5 m, rocks are argillaceous shale and total 2 timbers were required.

* 100.5 m – 127.1 m : Pyrite zone. There are many fractures and total 11 timbers were required between 109.8 m and 122.8 m.

* 127.1 m – 144.3 m : Rocks are pyrite and soft and weak dolostone. Total 17 timbers were required.

* 144.3 m – 165.3 m : Rocks are the alternation of limestone and shale, and excavation was carried out without timbering.

* 165.3 m – 175 m : Though the alternation of limestone and shale continues to 168.3 m point, many fractures appeared and excavation timbering was required. In the section between 168.3 m and 170.8 m, there appeared a fracture zone with hematite. After 170.8 m point, rocks are of argillaceous shale and water springs out. Spilling method using logs (10 cm ~ 15 cm in diameter) on the ceiling of the tunnel was employed, which made the efficiency lower. Total 14 timbers were required.

(2) Drilling Chambers

Two drilling chambers were excavated at the points of 310 m and 510.8 m in the Adit-N. The drilling chamber at 510.8 m point has walls with many fractures and the ceiling was supported with timbers and 15 kg/m rails.

(3) Maintenance of the existing tunnels

In the section from the gate to the 25.2 point (excavated in 1982), total 7 timbers were required, and along the crosscut-1, total 3 timbers were required between 38 m and 40.5 m.

The total timbers in the tunnels of Adit-N are 84, and true progress remained to be as much as 1.5333 m per one day (including (the drilling chambers). It is noted that 4 ventilation fans (3.7 kW, 170 m^3/min) were set and used for quick deflation of smoke and gas after blasting.

1–6 Excavation of Adit-S

(1) Adit-S (A)

The base 0 m point for the measurement of distance was taken at the starting point of the tunnel excavation in 1984 (which is as far as 600 m from the gate).

* 0 m – 86.1 m : Rocks are mainly soft and weak marlstone with many fractures and joints almost paralles to the direction of the tunnel. At around the 77 m point, quartzite appeared on the left side wall facing the depth of the tunnel. In this section, 52 three-pieces tunnels sets, 7 two-pieces tunnel sets and 3 support-timberings were employed.

* 86.1 m – 159.6 m : Rocks are quartzite and excavation was comparatively in good order.

* 159.6 m – 251.1 m : After 159.6 m point, soft and weak marlstone appeared on the left wall. At around 170 m point, whole of the walls were composed of this marlstone and timbering was required for the excavation. There are many joints and fractures along the center of the ceiling of the tunnel in the far side of the 175 m point, and even spring-water (5 ℓ/min) was encountered, and spilling method was employed. In the far side of the 215 m point, was recognized the increase of the rock pressure, and the excavation was fairly difficult. Total 104 timbers were required in this section.

(2) Adit-S (B)

At the 235 m point, the bearing of the tunnel was changed to 250°. After excavating 30 meters, the bearing was turned to the original direction of 330° and the tunnel was excavated as far as 65 meters. The base 0 m point has been taken to be 235 m point of the tunnel in the above paragraph.

* 0 m – 5.0 m : Rocks are marlstone with many joints and fractures and the timbering was necessary for the excavation. Total 4 timbers were required.

* 5.0 m – 35.6 m : Rocks are the alternation of dolostone, sandstone and marlstone. There was a spring-water out of the ceiling (about 20 ℓ/min, pH=3), but the excavation was carried out fairly in good order.

* 35.6 – 39.4 m : Although the rocks are hard dolostone, there are many fractures parallel to the direction of the tunnel. Therefore, total 4 timbers were required.

* 39.4 m – 50.0 m : Rocks are dolostone and excavation was in good order without any timbering.

* 50.0 m – 67.3 m : As there are fractures parallel to the direction of the tunnel, total 12 excavate-timberings were employed.

* 67.3 m – 95.0 m : Excavation of the tunnel was carried out in the rocks of the alternation of dolostone and limestone to the 95 m point, where a druse (width is 1.2 m; but it was not possible to measure anything about height, depth and length, because of the collape of walls and the spring water.) was found and great amount of water sprang out from there (2,500 ℓ/min, pH=2). Although it was tried to excavate the tunnel further more, the work was ceased there after all, because it was thought to be dangerous.

(3) Crosscut-1 of Adit-S

* 0 m – 50.0 m : Rocks are sandstone, dolostone and marlstone. Fractures are almost perpendicular to the direction of the tunnel. Therefore, the excavation was fairly in good order,

and only 2 timbers were required. At the 49 m point, acidic water sprang out (600 ℓ/min, pH=1 ~ 2) and the excavation work had to be stopped at the 50 m point for a whip (from September 27th to October 7th).

* 50.0 m – 100.0 m : After the 50 m point, pyrite zone appeared with many druses. In the portion from 53 m to 55 m, the tunnel encountered another spring water (1,200 ℓ/min, pH=1), and the excavation work had to be stopped. It was after the amount of flowing water decreased to 1,200 ℓ/min (pH=1 ~ 2) and the place from where the water sprang out moved from the ceiling to the floor of the tunnel that the excavation work was commenced again. The point from where the water sprang out moved with the progress of the tunnel excavation, and the amount of flowing water varied between 900 ℓ/min and 1,600 ℓ/min (pH=1 ~ 2). The spring water was acidic and had great influence to corrode rails and pipes rapidly. They had to be repaired and replaced. In the section between 80 m and 100 m, the rocks are hematite and white altered rocks, and total 9 timbers were required.

* 100.0 m – 141.0 m : Pyrite zone appeared as far as to the 130.0 m point. In the limestone zone found to the 141.0 m point, the excavation was in good order without timbering.

(4) Crosscut-2 of Adit-S

The 89.2 m point of the Adit-S (B) was taken to be the 0 m base point of the measurement of distance.

* 0 m – 18.1 m : The rocks are limestone to the 6.0 m point. Pyrite followed to the 7.5 m point, and the excavation work was in good order. The far side of the 7.5 m point is composed of the orebody (Zn, Pb) and the tunnel encountered remarkable spring-water at the 14.6 m point (1,200 ℓ/min, pH=3). Water pressure of the spring water was so high for the drilling and for the charging that the excavation work had to be stopped for a while. After three days, the amount of the flowing-water decreased to 900 ℓ/min, but as the water pressure was still too high, the working face was widened in order to reduce the water pressure by letting the spring water scatteringly poured out. The water sprang out until the excavation proceeded to the 15.0 m point. The excavation of the tunnel was kept carried out as far as to the 18.1 m point in the orebody.

* 18.1 m - 48.9 m : The rocks are argillaceous dolostone in the far side of the 18.1 m point to the 48.9 m point. There was a spring water out of the floor of the tunnel at the 26.6 m point (1,100 ℓ/min, pH=3) and the spilling method was employed for the excavation (the diameter of the logs is 10 cm x 15 cm). With the progress of the excavation, the amount of the spring water decreased down to 30 ℓ/min and the excavate timbering was employed. Total 33 timbers were required.

* 48.9 m – 60.8 m : The rocks are dolostone to the 51.8 m point and in the far side of it, limestone appeared. The excavation was in good order without timbering.

* 60.8 m – 65.0 m : At around the 60 m point, orebody (Pb-Zn-Py) appeared and it continued to around the 65 m point. As many fractures and joints were found in this section, excavate timbering was applied.

* 65.0 m – 78.2 m : Pyrite continues to the 76.3 m point. In the far side of this 76.3 m point, the rocks are limestone and the excavation was in good order without timbering.

(5) Crosscut-3 of Adit-S

* 0 m – 8.0 m : The rocks are mainly dolostone and the excavation was in good order without timbering.

(6) Drilling Chamber

Two drilling chambers were prepared at around the 500 m point and at around the 700 m point. The drilling chamber at the 700 m point was supported with timbers and 15 kg/m rails as many joints and fractures were found there.

(7) Maintenance of the existing tunnels

Total 5 timbers were required in the section between 478.3 m and 496.3 m from the gate of the existing tunnel.

The true progress of the excavation works of the Adit-S was as much as 1.959 m per one day (including the drilling chamber). Total 239 three-pieces tunnel sets, 7 two-pieces tunnel sets and 3 support-timberings were applied. It is noted that 6 ventilation fans (3.7 kW, 170 m^3/min.) were set and used for quick deflation of smoke and gas after blasting. Frequent replacement of pipes and rails was necessary as they were easily corroded by the acidic spring water.

CHAPTER 2 GEOLOGY AND MINERALIZATION IN TUNNELS

2–1 Crosscut-2 of Adit-N

The excavated length of the crosscut-2 of Adit-N was 175 meters and the direction is WSW starting from the 460 m point of the Adit-N.

By the observation of the geology in the tunnel, the Chimu Formation composed mainly of whitish, massive, compact and hard quartzite is recognized from the starting point to the 49 m point. In the far side to the 92 m point, the transitional zone of the Chimu Formation was found, which is composed of grey dolostone, mudstone and marlstone. The strike was N15~25°W, and the dip is as steep as 75°~80° to the east. At about 20 m point, 38 m point and 85 m point, are recognized some faults parallel to the bedding planes developed in the soft rocks such as muddy layers and dolostone which are in contact with hard rocks. A fault of NE series was found at about 57 m point.

The Santa Formation appeared in the section between 92 m and 170 m points. Pyrite bodies are confirmed in the sections between 98 m and 126 m points and between 136 m and 140 m points. There are several different variation of occurrences as massive pyrite, argillaceous and weak pyrite, siliceous pyrite and drusy pyrite. Copper minerals like chalcopyrite and chalcocite are locally concentrated and copper grade of some of them are as high as more than 5% (NN-112) according to the analysis of the samples collected along the walls by 1 meter channel sampling. In the section between 126 m and 136 m points, dolostone and altered argillaceous rocks are found disseminated with sphalerite. The ore grade of the 8 samples collected along the both walls in the section between 120 m and 127 m points is given as follows.

	Lenth (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
North wall	7	4	34	1.11	0.44	5.18
South wall	7	4	29	0.62	0.17	0.79
Average	7	8	32	0.89	0.31	2.98

In the far side of the 140 m point, the rocks are limestone with the thin insertions of shale layers. Some faults parallel to the bedding planes are recognized at the points of 126 m and 163 m. At the 120 m point, a fault filled with hematite is found and beyond this fault, is recognized the Carhuaz Formation which is composed of remarkably brecciated shale.

2–2 Adit-S (A)

The excavation of the Adit-S was commenced at the 600 m point from the gate of the tunnel in this year. The direction of the tunnel is N 30°W. The length of the excavation was 251 meters and the total cummulative length is 851 meters.

As to the geology along the main tunnel the Adit-S, the alternation of marlstone, mudstone, dolostone and sandstone is recognized from the 600 m point to the 680 m point. Quartzite is found in the far side to the 770 m point, and after that marlstone and mudstone are found to the 851 m point. The stratigraphical trend is N20°~30°W, which is almost parallel to the bearing of the Adit. The dip is 75°~85°E.

The quartzite is leucocratic, siliceous, compact and hard. The marlstone and the mudstone are pale grey, massive, soft and weak. At around the 820 m point, siliceous boulder is recognized.

The dolostone is dark grey and has granular appearance. It is soft and weak. It is estimated that this type of the dolostone would be composed mainly of ankerite of the composition of Fe $>$ Mg. The rocks other than quartzite are soft and weak, and timbering was required for all the excavation. Especially, along the contact between the soft rocks and the quartzite, the condition of the rocks for excavation was very poor as the faults parallel to the bedding planes are well developed there.

2–3 Adit-S (B)

Excavating about 30 meters in WSW direction from the 235 m point of the Adit-S (A) and another 64 meters in NNW direction, totalling 94 meters of the length of the excavation, the tunnel reached the proposed position of the crosscut-2.

As to the geology, the transitional zone of the Chimu Formation is recognized to the 32 m point, which is composed of the alternation of sandstone, marlstone, mudstone, and dolostone. Beyond the fault of the trend of N20°W located at the 32 m point (at the bending of the tunnel), the Santa Formation is recognized. The Santa Formation is composed of pale grey, compact dolostone which has been altered from limestone. It is estimated that this type of the dolostone would be composed mainly of kutnahorite of the composition of Mn $>$ Mg.

The tunnel encountered a remarkable fault of the trend of WNW-ESE with the dip of 45° ~ 55°. There is a large scale of druse beyond this fault. Some sphalerite is disseminated in the rocks around the fault.

2–4 Crosscut-1 of Adit-S

The crosscut-1 of Adit-S was excavated in the WSW direction from the 700 m point of the

Adit-S, and the length of the excavation is 141 meters.

As to the geology, the transitional zone of the Chimu Formation is recognized to the 46 m point, which is composed of the alternation of sandstone, marlstone, mudstone, and dolostone. Beyond the fault parallel to the bedding planes, the Santa Formation is recognized. The Santa Formation is composed of, to the 100 m point, massive pyrite body, to the 120 m point, dolostone and limestone, to the 130 m point, pyrite, and in the far side of this point, unmineralized limestone with thin insertions of shale. Dissemination of sphalerite is recognized in the pyrite orebody at around the 129 m point. The strike of the Santa Formation is about N20°W and the dip is 70°~75° to the east.

2–5 Crosscut-2 of Adit-S

The crosscut-2 of Adit-S was excavated westward from the 88 mm point of the Adit-S (B), and the total length of the excavation is 79 meters.

Dissemination of galena and sphalerite is recognized, from the 3 m point, in the dolostone and in the siderite. High grade massive zinc orebody consisting mainly of sphalerite is found in the section between 6 m and 15 m points. From the 15 m point to the 21 m point, pyritic lead-zinc ore is recognized. Between the 21 m point and 42 m point, argillaceous and dolomitic fracture zone is found.

There is a brecciated zinc orebody with abundant pyrite in the section between 60 m and 67 m points. In the far side of this orebody, pyrite zone is recognized to the 76 m point, where dolostone appears. The crosscut toward the east is of the length of 8 meters from the 85 m point of the Adit-S (B).

The result of the analysis of the samples collected continuously from every 1 meter of the mineralized portion along the both walls as the channel sampling is given as follows.

	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
D7 North wall	3–21	18	18	161	0.16	4.25	29.80
South wall	5–19	13	13	210	0.16	3.28	30.54
Average		15	31	182	0.16	3.84	30.11

	Depth (m)	Length (m)	No. of Samples	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
U6 North wall	60–67	7	7	15	0.06	2.84	8.64
South wall	61–66	5	5	33	0.10	2.47	13.97
Average		6	12	26	0.08	2.63	11.75

The above D7 orebody was caught in the drill hole DDH-5 at the approximately same locality. According to the data of the DDH-5, the horizontal width of this orebody is 11.9 meters and the ore grade is Ag 163 g/t, Cu 0.14%, Pb 2.92% and Zn 27.15%. The result of the confirmation of this orebody in the tunnel is better than the data obtained in the drill hole in the viewpoints either of scale or of grade.

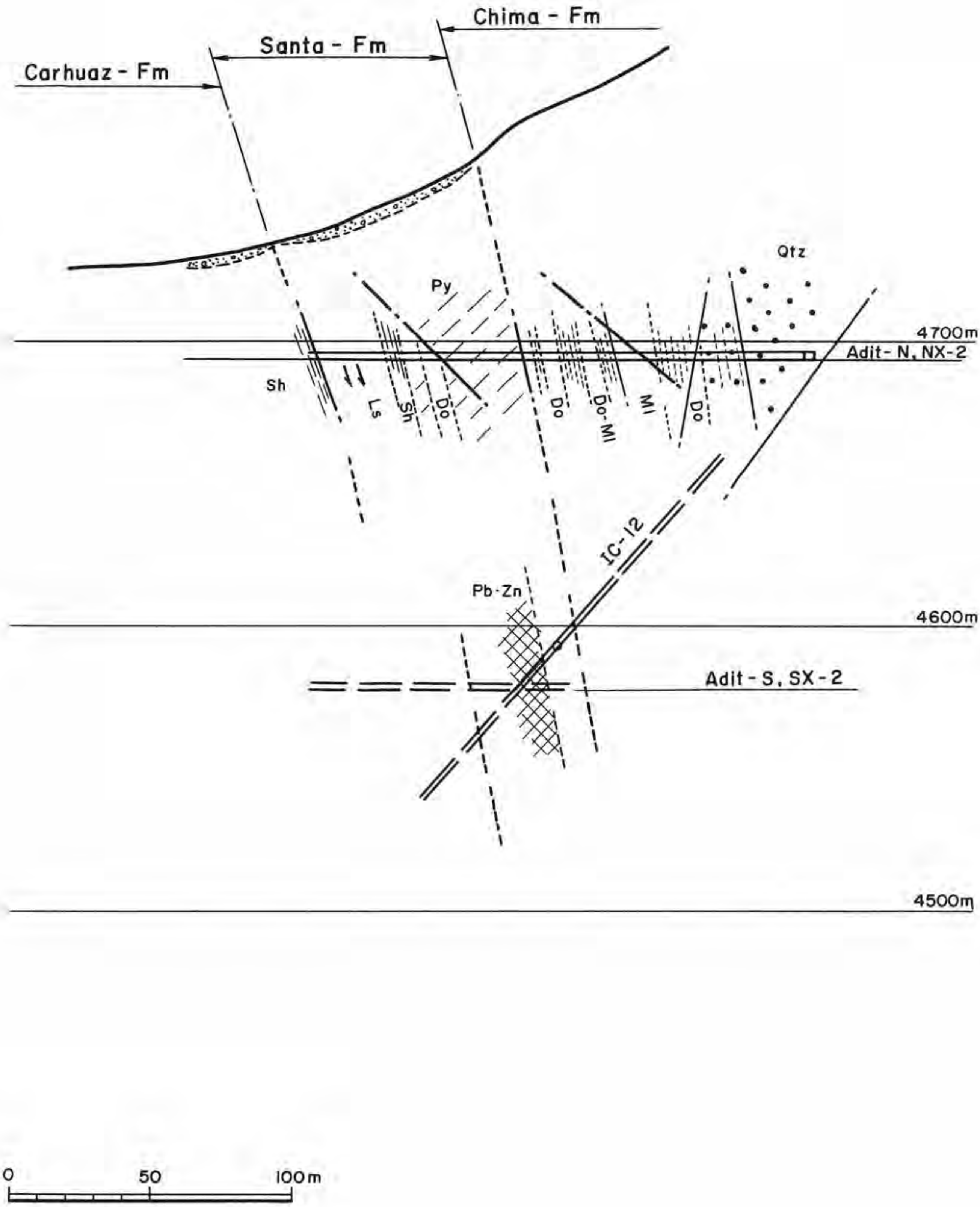


Fig. II - 1 Geological Section for Crosscut, NX-2

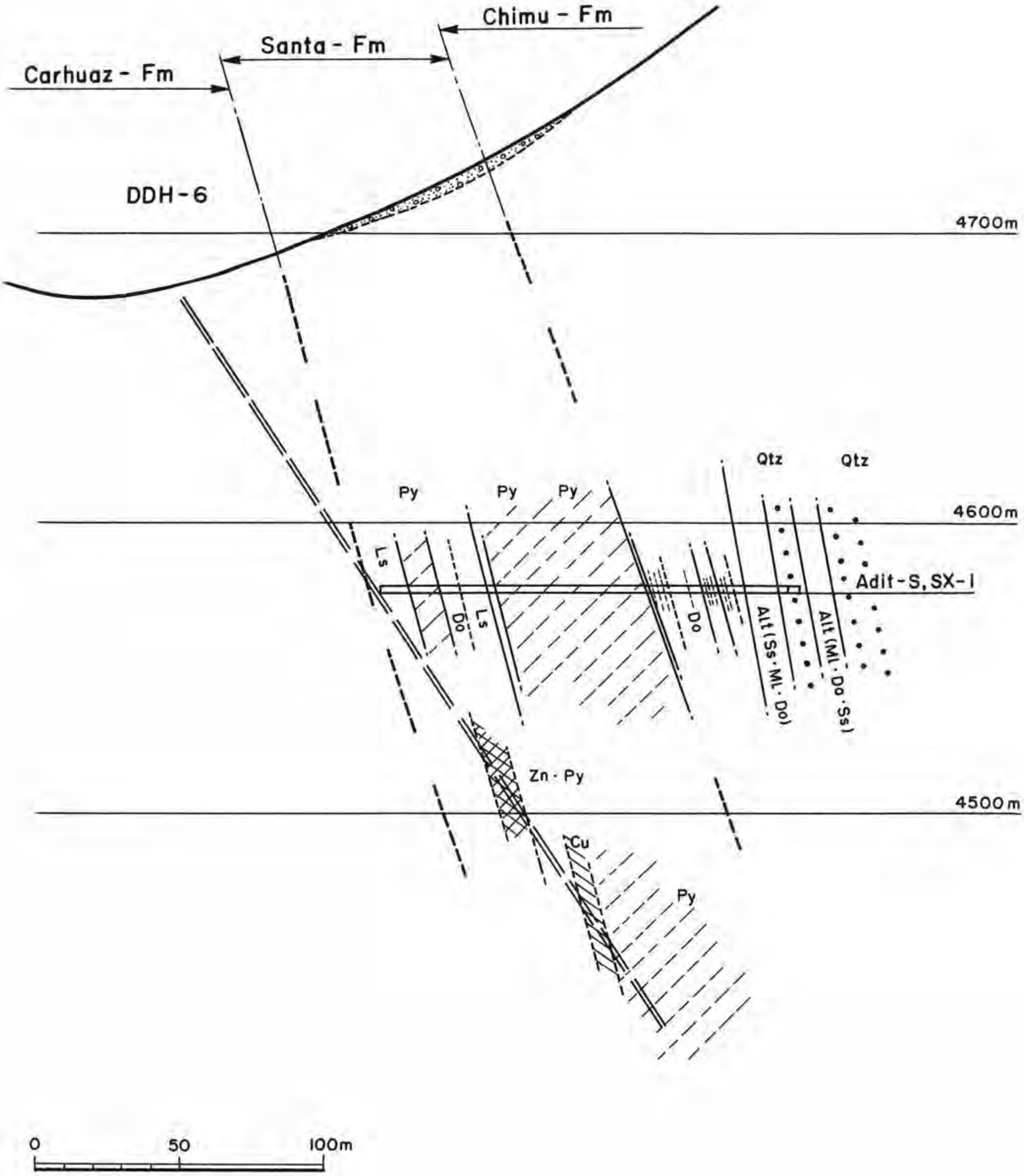
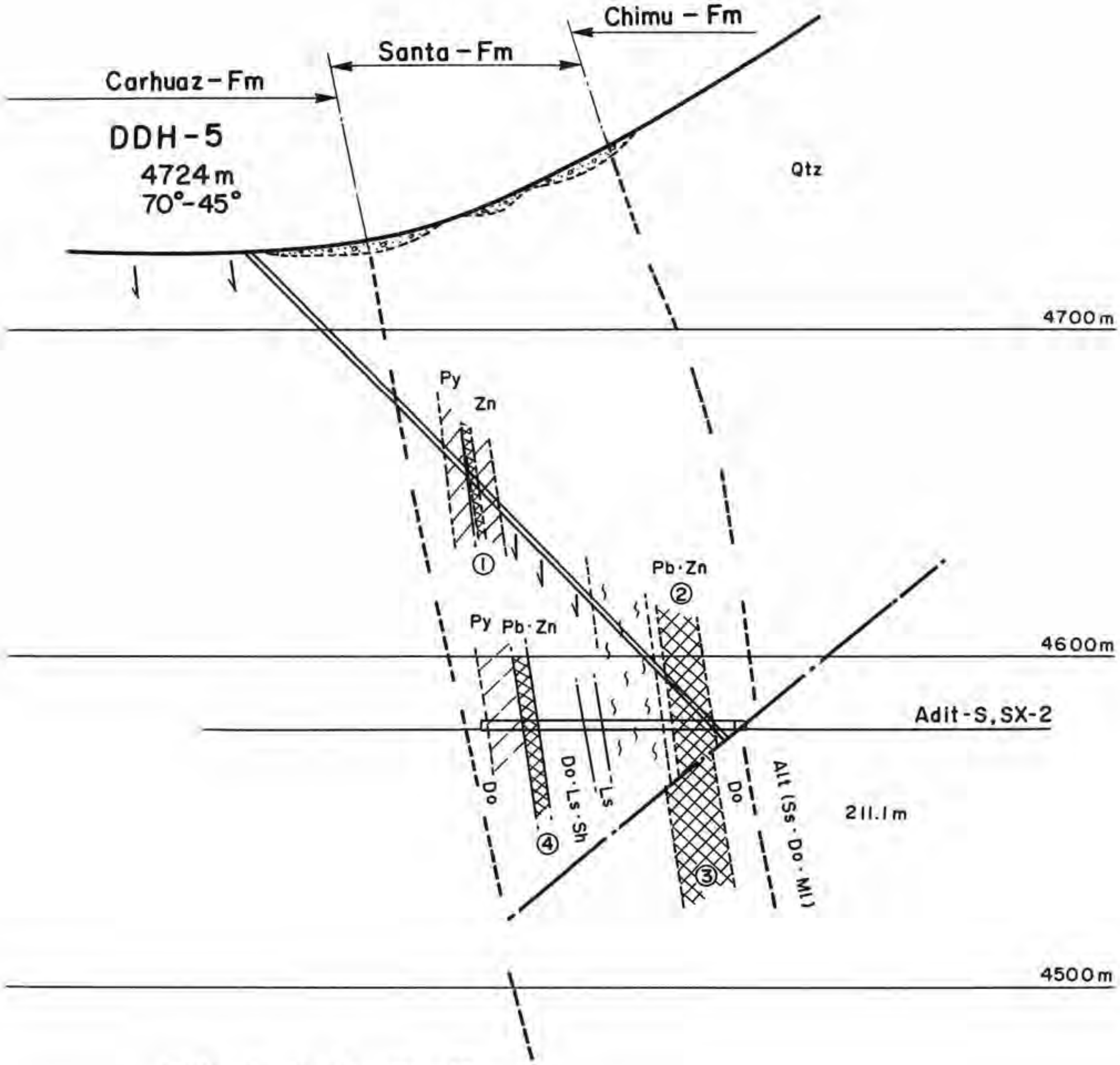


Fig. II-2 Geological Section for Crosscut, SX-1



	Depth (m-m)	Length (m)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	
DDH-5	95.6-101.7	6.1	35	1.10	2.89	15.22	①
〃	181.10-204.0	23.0	163	0.14	2.97	27.15	②
SX-2	3.0-21.0	15.0	182	0.16	3.80	30.10	③
〃	58.0-65.0	6.0	26	0.08	2.63	11.75	④

Fig. II-3 Geological Section for DDH-5 and SX-2

APPENDICES
PART I
DATA OF DRILLING

LIST OF APPENDICES

A. I - I List of the 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
"	TCM-5A	1	Capacity NQ 510m, BQ 660m Inner Diameter of Spindle 93mm Weight (except engine) 2,300kg
Pump	NAS-3C	1	Piston ϕ75mm Capacity 130, 72, 39, 22 ℓ/min Pressure 26 ∿ 40 kg/cm^2
"	NAS-3B	1	Piston ϕ75mm Capacity 130, 72, 39, 22 ℓ/min Pressure 26 ∿ 40 kg/cm^2
	MS-303	1	Piston ϕ25mm Capacity 25 ∿ 41 ℓ/min Pressure 35 kg/cm^2
Engine for Drilling machine	F5L-912	1	Diesel Engine 1,800 rpm/65PS
Engine for pump	ZT-90L	1	Diesel Engine 1,800 rpm/20PS
	NS-130C	1	Diesel Engine 1,800 rpm/9.5PS
	NS-65C	1	Diesel Engine 1,800 rpm/5.5PS
Electric Motor for Drilling Machine	NV180M4	1	Electric Motor 1,750 rpm/30HP
Electric Motor for Drilling Pump	NV132N4	1	Electric Motor 1,745 rpm/12HP
Electric Motor for Mud Mixer	NV100LA4	1	Electric Motor 1,730 rpm/3.6HP
Generator	SAR #76	1	115kW, 1,800 rpm/220V, 60Hz
Generator	TS-3.5S	2	8.5kW, 1,800 rpm/220V, 60Hz
Generator	YSG-3.5	2	3.5kVA, 220V, 60Hz
Engine for Generator	NS-65C	2	Diesel Engine 1,800 rpm/5.5PS
Mud Mixer	MCE-200A	1	Volume 200ℓ, 800 ∿ 1000 rpm/min
Submersible Pump	KTV-22L	1	2.2kW, 3P, 220V, 60Hz, 0.6 m^3/min
Transformer	60KVA	4	50kVA, 3P, 3,300V/210V

Item	Model	Quantity	Capacity, Type, and Specification
Rod Holder	RH-85	1	Hand Type
Drill Rods	HQ-WL	40	3.00 m/PC
"	"	2	1.50 m/PC
"	NQ-WL	100	3.00 m/PC
"	"	2	1.50 m/PC
"	BQ-WL	100	3.00 m/PC
"	"	2	1.50 m/PC
Casing Pipes	112mm	5	3.00 m/PC
"	"	4	1.00 m/PC
"	"	2	0.50 m/PC
"	HW	20	3.00 m/PC
"	"	5	1.00 m/PC
"	"	4	0.50 m/PC
"	NW	70	3.00 m/PC
"	"	5	1.00 m/PC
"	"	2	0.50 m/PC
"	BW	90	3.00 m/PC
"	"	10	1.00 m/PC
"	"	2	0.50 m/PC

A. I-2 Articles of Consumption and Drilling Parts

(1)

Item	Specification	Unit	Quantity									
			IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19
Light oil		ℓ	2,760	7,365	6,110	7,796	3,618	13,904	9,010	3,216	9,084	6,676
Gasoline		ℓ	200	180	145	161	86	216	240	128	320	517
Mobil oil #30		ℓ	100	85	40	60	10	60	85	40	55	75
" #90		ℓ	30	20	10	20	3	25	30	10	40	30
Hydraulic oil #10		ℓ	-	30	22	30	5	25	35	-	50	45
Grease		kg	-	-	-	-	-	-	-	-	-	-
Cutting Oil		ℓ	-	120	75	100	35	90	90	-	-	120
Bentonite	50 kg/Bag	Bag	105	146	130	144	92	157	125	80	231	265
Libonite		kg	110	118	109	135	71	134	76	94	196	178
Tel-cellose		kg	24	26	26	26	15	28	18	27	45	37
Tel-stop		kg	130	-	-	-	-	-	-	167	140	-
Speeder-P		ℓ	65	-	-	-	-	-	-	50	55	-
Cement	40 kg/Bag	Bag	10	12	21	18	10	9	8	8	12	22
Diamond shoe	PC	Pc	-	-	-	-	-	-	-	-	1	-
" "	HW	"	1	1	1	2	1	1	1	1	5	-
" "	NW	"	1	1	2	2	2	1	2	3	6	1
" "	BW	"	-	2	-	-	-	1	1	-	2	1
Diamond bit	PQ	Pc	-	-	-	-	-	-	-	-	-	-
" "	116mm	"	1	-	2	3	1	1	1	1	-	-
" "	101mm	"	-	1	-	-	-	-	-	-	-	-
" "	HQ	"	5	8	5	5	6	6	3	1	2	19
" "	NQ	"	3	3	6	9	4	3	4	5	9	4
" "	BQ	"	-	4	-	-	-	3	4	-	3	4
Diamond shell	PQ	Pc	-	-	-	-	-	-	-	-	-	-
" "	116mm	"	1	-	1	1	1	1	1	1	-	-
" "	101mm	"	-	1	-	-	-	-	-	-	-	-
" "	HQ	"	2	2	1	1	1	3	1	1	1	4
" "	NQ	"	2	1	3	2	2	2	1	2	3	2
" "	BQ	"	-	2	-	-	-	2	2	-	1	2
Single Core tube	114mm x 0.5m	set	-	-	-	-	-	-	1	-	-	-
" "	99mm x 0.5m	"	-	1	-	-	-	-	-	-	-	-

(2)

Item	Specification	Unit	Quantity									
			IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19
Wire line core barrel	HQ x 1.5m	set	-	-	-	-	-	-	1	-	-	1
" "	NQ x 1.5m	"	-	-	-	-	1	-	-	-	-	1
" "	BQ x 1.5m	"	-	-	-	-	-	1	-	-	-	-
Inner tube assembly	HQ x 1.5m	set	-	-	-	-	-	-	-	-	-	1
" "	NQ x 1.5m	"	-	-	-	-	-	-	-	-	-	1
" "	BQ x 1.5m	"	-	-	-	-	-	-	-	-	-	1
Outer tube	HQ x 1.5m	Pc	-	-	-	-	-	-	1	-	-	-
" "	NQ x 1.5m	"	-	-	-	-	1	-	-	-	-	-
" "	BQ x 1.5m	"	-	-	-	-	-	-	1	-	-	-
Inner tube	HQ x 1.5m	Pc	-	-	-	-	-	-	1	-	-	-
" "	NQ x 1.5m	"	-	-	-	-	1	-	-	-	-	-
" "	BQ x 1.5m	"	-	-	-	-	-	-	1	-	-	-
Guide Pipe	HQ	Pc	-	-	1	-	-	-	-	-	-	2
" "	NQ	"	-	-	1	-	-	-	-	-	-	2
" "	BQ	"	-	-	-	-	-	-	1	-	-	-
Guide coupling	HQ	Pc	-	-	1	-	-	-	-	-	-	2
" "	NQ	"	-	-	1	-	-	-	-	-	-	2
" "	BQ	"	-	-	-	-	-	-	1	-	-	-
Core lifter case	HQ	Pc	-	-	-	-	-	-	2	-	2	4
" "	NQ	"	-	-	2	-	2	-	-	-	-	2
" "	BQ	"	-	1	-	-	-	2	2	-	2	2
Core lifter	HQ	Pc	-	-	-	-	-	-	4	-	-	8
" "	NQ	"	-	-	2	-	4	-	-	-	-	4
" "	BQ	"	-	2	-	-	-	4	4	-	4	4
Water swivel Packing		Pc	-	-	3	-	-	6	-	-	6	-
Water swivel spindle		"	-	-	1	-	-	1	-	-	1	-
Suction hose	50mm x 3.0m	"	-	-	-	1	-	-	-	-	-	1
Piston rod		"	-	-	-	-	-	-	4	-	4	4
Valve steel ball	38.1mm	"	-	-	8	-	-	-	-	-	8	8
V-Packing		"	-	-	8	-	-	-	-	-	8	8
V-belt	TGM-3C	set	-	-	1	-	-	1	-	-	1	-
" "	NAS-3Cx2T-90L	"	-	-	1	-	-	1	-	-	1	-
" "	NAS-3B	"	-	-	1	-	-	1	-	-	1	-
" "	MCE-200A	"	-	-	1	-	-	1	-	-	1	-
" "	YSG-3.5xNS-65C	"	-	-	1	-	-	1	-	-	1	-

(3)

Item	Specification	Unit	Quantity									
			IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19
Core box	HQ	Pc	26	31	14	9	15	21	6	1	-	23
" "	NQ	"	12	5	36	38	16	8	14	34	29	8
" "	BQ	"	-	8	-	-	-	10	9	-	5	8
Wire	#10	kg	8	10	10	9	15	12	7	10	8	5
"	#12	"	4	3	2	3	5	2	3	4	2	2
Nail		"	2	4	4	3	5	3	4	2	3	4
Wire rope	6mm x 450m	Roll	-	1	-	-	1	-	-	-	-	-
" "	12mm x 30m	"	-	-	-	-	-	1	-	-	1	1
Manila rope	18mm x 30m	"	-	-	-	1	-	-	-	-	2	1
Vinyl rope	8mm x 100m	"	1	-	-	-	-	-	-	-	1	1
Rag		kg	10	5	5	5	15	5	10	5	10	15

A. I-3 Preparation and Removal Records

Item		Hole No.	IC-10		IC-11		IC-12		IC-13		IC-14		IC-15		IC-16		IC-17		IC-18		IC-19	
Preparation and removal	In		31th May. '84		2th Aug. '84		24th Sep. '84		3th Sep. '84		7th Nov. '84		19th Nov. '84		12th Oct. '84		19th Jun. '84		7th Jul. '84		4th Nov. '84	
			5th Jun. '84		14th Aug. '84		29th Sep. '84		8th Sep. '84		11th Nov. '84		22th Nov. '84		19th Oct. '84		25th Jun. '84		9th Jul. '84		26th Nov. '85	
	Out		16th Jun. '84		1st Sep. '84		9th Oct. '84		23th Sep. '84		17th Nov. '84		11th Dec. '84		5th Nov. '84		5th Jul. '84		12th Aug. '84		4th Feb. '85	
			18th Jun. '84		2th Sep. '84		11th Oct. '84		23th Sep. '84		18th Nov. '84		15th Dec. '84		6th Nov. '84		6th Jul. '84		13th Aug. '84		5th Feb. '85	
			Days	Man-shifts	Days	Man-shifts	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		1	16	-	-	-	-	-	-	-	-	-	-	-	-	1	16	1	16	9	72
	Haulage		2	32	8.5	136	3	48	2	32	3.5	56	-	-	6	96	2	32	1.5	24	5	40
	Installation		2	32	3	48	3	48	2	32	1.5	24	3.5	56	2	32	2	32	1	16	4.5	48
	Water pipe		0.5	8	1	16	-	-	1	16	-	-	-	-	-	-	2	32	-	-	-	-
	Test run, etc.		0.5	8	0.5	8	-	-	1	16	-	-	-	-	-	-	-	-	-	-	4	32
	Total		6	96	13	208	6	96	6	96	5	80	3.5	56	8	128	7	112	3.5	56	22.5	192
Removal	Dismantling		1	16	1	16	1.5	24	1	16	1	16	1	16	1	16	1.5	24	2	32	0.5	10
	Pipe removal		1	16	1	16	1	16	-	-	0.5	8	2	32	1.5	24	1	16	-	-	1.5	32
	Haulage		1	16	-	-	-	-	-	-	-	-	2	32	-	-	-	-	-	-	-	-
	Road rein-statement		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Others		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total		3	48	2	32	2.5	40	1	16	1.5	24	5	80	2.5	40	2.5	40	2	32	2	42
Grand Total			9	144	15	240	8.5	136	7	112	6.5	104	8.5	136	10.5	168	9.5	152	5.5	88	24.5	234

A. I-4 Operation Results of Drill Hole, IC-10

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	31th May. '84 ∿ 5th Jun. '84	6	6	-	96
Drilling	6th Jun. '84 ∿ 15th Jun. '84	10	10	-	160
Removing	16th Jun. '84 ∿ 18th Jun. '84	3	3	-	48
Total	31th May. '84 ∿ 18th Jun. '84	19	19	-	304

Drilling Length

Planned Length	180.00 m	Over-burden	6.20 m
Increase or Decrease in Length	m	Core Length	146.45 m
Length Drilled	180.30 m	Core Recovery	81.2 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	92.8 %	92.8 %
100 ∿ 180.30m	67.0 %	81.2 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

Drilling		114°30'	43.4 %	31.8 %
Hoisting & Lowering Rod		30°00'	11.4 %	8.3 %
Hoisting & Lowering I.T.		56°00'	21.2 %	15.6 %
Miscellaneous		63°30'	24.0 %	17.6 %
Repairing		-	- %	- %
Others		-	- %	- %
Total		264°00'	100 %	73.3 %
Removing	Preparation	24°00'	-	6.7 %
Removing	Moving	72°00'	-	20.0 %
G. Total		360°00'	-	100 %

Efficiency of Drilling

180.30 m/Working Period	9.5 m/day
180.30 m/Working Days	9.5 m/day
180.30 m/Drilling Period	18.0 m/day
180.30 m/Net Drilling Days	18.0 m/day
Total workers/ 180.30 m	1.68 Man/m
Total Drilling Workers/ 180.30 m	0.88 Man/m

Hoisting & Lowering Rod 15 Times	Hoisting & Lowering I.T. 135 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 6.00 m	3.3 %	100 %
NW 101.00 m	56.0 %	100 %
m	%	%

Remarks

G : Grand

I.T.: Inner Tube

A. I -5 Operation Results of Drill Hole, IC-1 1

Working Period		Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
	Preparation	2th Aug. '84 ∿ 14th Aug. '84	13	13	-	208
	Drilling	15th Aug. '84 ∿ 31th Aug. '84	17	17	-	272
	Removing	1st Sep. '84 ∿ 2th Sep. '84	2	2	-	32
	Total	2th Aug. '84 ∿ 2th Sep. '84	32	32	-	512

Drilling Length				
	Planned Length	220.00 m	Over-burden	- m
	Increase or Decrease in Length	m	Core Length	178.80 m
	Length Drilled	221.10 m	Core Recovery	80.9 %

Working Time				
	Drilling	145°00'	33.6 %	25.3 %
	Hoisting & Lowering Rod	56°30'	13.0 %	9.9 %
	Hoisting & Lowering I.T.	92°30'	21.4 %	16.2 %
	Miscellaneous	120°00'	27.8 %	21.0 %
	Repairing	12°00'	2.8 %	2.1 %
	Others	6°00'	1.4 %	1.0 %
	Total	432°00'	100 %	75.5 %
	Removing: Preparation	80°00'	-	14.0 %
	Removing: Moving	60°00'	-	10.5 %
	G. Total	572°00'	-	100 %

Casing Pipe Inserted	Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
	HW 1.50 m	0.7 %	100 %
	NW 111.40 m	50.4 %	100 %
	BW 194.80 m	88.1 %	100 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	98.1 %	98.1 %
100 ∿ 200 m	62.8 %	81.8 %
200 ∿ 221.10 m	73.8 %	80.9 %
m	%	%
m	%	%
m	%	%

Efficiency of Drilling

221.10 m/Working Period	6.91 m/day
221.10 m/Working Days	6.91 m/day
221.10 m/Drilling Period	13.01 m/day
221.10 m/Net Drilling Days	13.01 m/day
Total workers/ 221.10 m	2.32 Man/m
Total Drilling Workers/ 221.10 m	1.23 Man/m

Hoisting & Lowering Rod 37 Times	Hoisting & Lowering I.T. 225 Times

Remarks

G : Grand

I.T.: Inner Tube

A. I-6 Operation Results of Drill Hole, IC-12

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	24th Sep. '84 ∿ 29th Sep. '84	6	6	–	96
Drilling	30th Sep. '84 ∿ 9th Oct. '84	9.5	9.5	–	152
Removing	9th Oct. '84 ∿ 11th Oct. '84	2.5	2.5	–	40
Total	24th Sep. '84 ∿ 11th Oct. '84	18	18	–	288

Drilling Length

Planned Length	200.00 m	Over-burden	– m
Increase or Decrease in Length	m	Core Length	215.80 m
Length Drilled	220.60 m	Core Recovery	97.8 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	99.0 %	99.0 %
100 ∿ 200 m	96.3 %	97.7 %
200 ∿ 220.60 m	100 %	97.8 %
m	%	%
m	%	%
m	%	%

Working Time

Drilling		115°00'	46.7 %	34.4 %
Hoisting & Lowering Rod		29°30'	12.0 %	8.8 %
Hoisting & Lowering I.T.		62°30'	25.4 %	18.7 %
Miscellaneous		39°00'	– %	11.7 %
Repairing		–	– %	– %
Others		–	– %	– %
Total		246°00'	100 %	73.6 %
Removing	Preparation	51°00'	–	15.3 %
	Moving	37°00'	–	11.1 %
G. Total		334°00'	–	100 %

Efficiency of Drilling

220.60 m/Working Period	12.25 m/day
220.60 m/Working Days	12.25 m/day
220.60 m/Drilling Period	23.22 m/day
220.60 m/Net Drilling Days	23.22 m/day
Total workers/ 220.60 m	1.31 Man/m
Total Drilling Workers/ 220.60 m	0.69 Man/m

Hoisting & Lowering Rod 34 Times	Hoisting & Lowering I.T. 232 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 2.50 m	1.1 %	100 %
NW 60.50 m	27.4 %	100 %
m	%	%

Remarks

G : Grand

I.T.: Inner Tube

A. I-7 Operation Results of Drill Hole, IC-13

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	3th Sep. '84 ∿ 8th Sep. '84	6	6	-	96
Drilling	9th Sep. '84 ∿ 22th Sep. '84	14	14	-	224
Removing	23th Sep. '84 ∿ 23th Sep. '84	1	1	-	16
Total	3th Sep. '84 ∿ 23th Sep. '84	21	21	-	336

Drilling Length

Planned Length	220.00 m	Over-burden	- m
Increase or Decrease in Length	m	Core Length	213.10 m
Length Drilled	240.60 m	Core Recovery	88.6 %

Working Time

Drilling		118°00'	35.8 %	29.1 %
Hoisting & Lowering Rod		46°30'	14.1 %	11.5 %
Hoisting & Lowering I.T.		91°30'	27.7 %	22.5 %
Miscellaneous		68°00'	20.6 %	16.7 %
Repairing		6°00'	1.8 %	1.5 %
Others		-	- %	- %
Total		330°00'	100 %	81.3 %
Removing	Preparation	41°00'	-	10.1 %
Removing	Moving	35°00'	-	8.6 %
G. Total		406°00'	-	100 %

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 30.00 m	12.5 %	50 %
NW 81.50 m	33.9 %	100 %
m	%	%

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	78.3 %	78.3 %
100 ∿ 200 m	99.3 %	90.1 %
200 ∿ 240.60 m	90.1 %	88.6 %
m	%	%
m	%	%
m	%	%

Efficiency of Drilling

240.60 m/Working Period	11.45 m/day
240.60 m/Working Days	11.45 m/day
240.60 m/Drilling Period	17.18 m/day
240.60 m/Net Drilling Days	17.18 m/day
Total workers/ 240.60 m	1.39 Man/m
Total Drilling Workers/ 240.60 m	0.93 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
39 Times	219 Times

Remarks

G : Grand

I.T.: Inner Tube

A. I-8 Operation Results of Drill Hole, IC-14

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	7th Nov. '84 ∿ 11th Nov. '84	5	5	-	80
Drilling	12th Nov. '84 ∿ 17th Nov. '84	5.5	5.5	-	88
Removing	17th Nov. '84 ∿ 18th Nov. '84	1.5	1.5	-	24
Total	7th Nov. '84 ∿ 18th Nov. '84	12	12	-	192

Drilling Length

Planned Length	140.00 m	Over-burden	m
Increase or Decrease in Length	m	Core Length	126.20 m
Length Drilled	140.20 m	Core Recovery	90.0 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	89.8 %	89.8 %
100 ∿ 140.20 m	90.5 %	90.0 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

Drilling		61°00'	42.4 %	31.4 %
Hoisting & Lowering Rod		21°00'	14.6 %	10.8 %
Hoisting & Lowering I.T.		28°30'	19.8 %	14.7 %
Miscellaneous		33°30'	23.2 %	17.3 %
Repairing		-	- %	- %
Others		-	- %	- %
Total		144°00'	100 %	74.2 %
Removing	Preparation	40°00'	-	20.6 %
Removing	Moving	10°00'	-	5.2 %
G. Total		194°00'	-	100 %

Efficiency of Drilling

140.20 m/Working Period	11.68 m/day
140.20 m/Working Days	11.68 m/day
140.20 m/Drilling Period	25.50 m/day
140.20 m/Net Drilling Days	25.50 m/day
Total workers/ 140.20 m	1.37 Man/m
Total Drilling Workers/ 140.20 m	0.63 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
28 Times	166 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 1.50 m	1.1 %	100 %
NW 69.00 m	49.2 %	100 %
m	%	%

Remarks

G : Grand

I.T.: Inner Tube

A. I -9 Operation Results of Drill Hole, IC-15

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	19th Nov. '84 ∿ 22th Nov. '84	3.5	3.5	–	56
Drilling	22th Nov. '84 ∿ 10th Dec. '84	18.5	18.5	–	296
Removing	11th Dec. '84 ∿ 15th Dec. '84	5	5	–	80
Total	19th Nov. '84 ∿ 15th Dec. '84	27	27	–	432

Drilling Length

Planned Length	160.00 m	Over-burden	– m
Increase or Decrease in Length	m	Core Length	168.30 m
Length Drilled	180.40 m	Core Recovery	93.3 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	91.3 %	91.3 %
100 ∿ 180.40 m	95.8 %	95.8 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

Drilling		118°00'	23.7 %	19.9 %
Hoisting & Lowering Rod		49°30'	9.9 %	8.3 %
Hoisting & Lowering I.T.		132°30'	26.6 %	22.3 %
Miscellaneous		192°00'	38.6 %	32.3 %
Repairing		6°00'	1.2 %	1.0 %
Others		–	– %	%
Total		498°00'	100 %	83.8 %
Removing	Preparation	30°00'	–	5.1 %
	Moving	66°00'	–	11.1 %
G. Total		594°00'	–	100 %

Efficiency of Drilling

180.40 m/Working Period	6.68 m/day
180.40 m/Working Days	6.68 m/day
180.40 m/Drilling Period	9.75 m/day
180.40 m/Net Drilling Days	9.75 m/day
Total workers/ 180.40 m	2.39 Man/m
Total Drilling Workers/ 180.40m	1.64 Man/m

Hoisting & Lowering Rod 39 Times	Hoisting & Lowering I.T. 296 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 2.00 m	1.1 %	100 %
NW 87.50 m	48.5 %	89.7 %
BW 123.00 m	68.2 %	100 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-10 Operation Results of Drill Hole, IC-16

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	12th Oct. '84 ∿ 19th Oct. '84	8	8	-	128
Drilling	20th Oct. '84 ∿ 4th Nov. '84	15.5	15.5	-	248
Removing	5th Nov. '84 ∿ 6th Nov. '84	2.5	2.5	-	40
Total	12th Oct. '84 ∿ 6th Nov. '84	26	26	-	416

Drilling Length

Planned Length	160.00 m	Over-burden	- m
Increase or Decrease in Length	m	Core Length	139.90 m
Length Drilled	161.00 m	Core Recovery	86.9 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	87.8 %	87.8 %
100 ∿ 161 m	85.7 %	86.9 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

Drilling		110°00'	27.0 %	21.7 %
Hoisting & Lowering Rod		33°30'	8.2 %	6.6 %
Hoisting & Lowering I.T.		125°30'	30.7 %	24.7 %
Miscellaneous		139°00'	34.1 %	27.3 %
Repairing		-	- %	- %
Others		-	- %	- %
Total		408°00'	100 %	80.3 %
Removing	Preparation	20°00'	-	3.9 %
Removing	Moving	80°00'	-	15.8 %
G. Total		508°00'	-	100 %

Efficiency of Drilling

161.00 m/Working Period	6.19 m/day
161.00 m/Working Days	6.19 m/day
161.00 m/Drilling Period	10.39 m/day
161.00 m/Net Drilling Days	10.39 m/day
Total workers/ 161.00 m	2.58 Man/m
Total Drilling Workers/ 161.00 m	1.54 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
28 Times	198 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 2.00 m	1.2 %	100 %
NW 30.00 m	18.6 %	100 %
BW 109.20 m	67.8 %	100 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-11 Operation Results of Drill Hole, IC-17

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	19th Jun. '84 ∿ 25th Jun. '84	7	7	-	112
Drilling	26th Jun. '84 ∿ 4th Jul. '84	9.5	9.5	-	136
Removing	5th Jul. '84 ∿ 6th Jul. '84	2.5	2.5	-	40
Total	19th Jun. '84 ∿ 6th Jul. '84	19	19	-	288

Drilling Length

Planned Length	160.00 m	Over-burden	- m
Increase or Decrease in Length	m	Core Length	147.50 m
Length Drilled	160.20 m	Core Recovery	92.0 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	97.3 %	97.3 %
100 ∿ 160.20 m	82.9 %	92.0 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

	Drilling	117°00'	51.8 %	37.0 %
	Hoisting & Lowering Rod	22°30'	10.0 %	7.1 %
	Hoisting & Lowering I.T.	43°00'	19.0 %	13.6 %
	Miscellaneous	43°30'	19.2 %	13.8 %
	Repairing	-	- %	- %
	Others	-	- %	- %
	Total	226°00'	100 %	71.5 %
Removing	Preparation	20°00'	-	6.3 %
Removing	Moving	70°00'	-	22.2 %
	G. Total	316°00'	-	100 %

Efficiency of Drilling

160.20 m/Working Period	8.4 m/day
160.20 m/Working Days	8.4 m/day
160.20 m/Drilling Period	16.8 m/day
160.20 m/Net Drilling Days	16.8 m/day
Total workers/ 160.20 m	1.79 Man/m
Total Drilling Workers/ 160.20 m	0.84 Man/m

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
HW 1.50 m	0.9 %	100 %
NW 30.00 m	18.7 %	100 %
m	%	%

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
12 Times	129 Times

Remarks

G : Grand

I.T.: Inner Tube

A. I-12 Operation Results of Drill Hole, IC-18

Working Period

	Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
Preparation	7th Jul. '84 ∿ 9th Jul. '84	3.5	3.5	–	56
Drilling	10th Jul. '84 ∿ 11th Aug. '84	32.5	26.5	6	424
Removing	12th Aug. '84 ∿ 13th Aug. '84	2	2	–	32
Total	7th Jul. '84 ∿ 13th Aug. '84	38	32	6	512

Drilling Length

Planned Length	200.00 m	Over-burden	– m
Increase or Decrease in Length	m	Core Length	162.90 m
Length Drilled	200.50 m	Core Recovery	81.2 %

Core Recovery for each 100 m section

Depth of Hole	Section	Total
0 ∿ 100 m	79.0 %	79.0 %
100 ∿ 200.50 m	83.6 %	81.2 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time

Drilling		106°00'	21.4 %	18.9 %
Hoisting & Lowering Rod		38°00'	7.7 %	6.8 %
Hoisting & Lowering I.T.		62°00'	12.5 %	11.1 %
Miscellaneous		70°00'	14.0 %	12.5 %
Repairing		220°00'	44.4 %	39.3 %
Others		–	– %	– %
Total		496.00'	100 %	88.6 %
Removing	Preparation	22°00'	–	3.9 %
	Moving	42°00'	–	7.5 %
G. Total		560°00'	–	100 %

Efficiency of Drilling

200.50 m/Working Period	5.27 m/day
200.50 m/Working Days	6.26 m/day
200.50 m/Drilling Period	6.16 m/day
200.50 m/Net Drilling Days	7.56 m/day
Total workers/ 200.50 m	2.55 Man/m
Total Drilling Workers/ 200.50 m	2.11 Man/m

Hoisting & Lowering Rod	Hoisting & Lowering I.T.
42 Times	296 Times

Casing Pipe Inserted

Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
PW 4.50 m	2.2 %	100 %
HW 69.00 m	34.4 %	100 %
NW 149.50 m	74.5 %	68 %
BW 164.90	82.2 %	100 %

Remarks

G : Grand

I.T.: Inner Tube

A. I-13 Operation Results of Drill Hole, IC-19

Working Period		Period	Number of Days	Actual Working Days	Day Off	Total Number of Workers
	Preparation	4th Nov. '84 ∿ 26th Nov. '84	22.5	22.5	–	192
	Drilling	26th Nov. '84 ∿ 3th Feb. '85	69.5	32.5	37	852
	Removing	4th Feb. '85 ∿ 5th Feb. '85	2	2	–	42
	Total	4th Nov. '84 ∿ 5th Feb. '85	94	57	37	1,086

Drilling Length				
Planned Length	200.00 m	Over-burden	– m
Increase or Decrease in Length	m	Core Length	152.40 m
Length Drilled	203.60 m	Core Recovery	74.9 %

Core Recovery for each 100 m section		
Depth of Hole	Section	Total
0 ∿ 100 m	94.8 %	94.8 %
100 ∿ 203.60 m	54.8 %	74.9 %
m	%	%
m	%	%
m	%	%
m	%	%

Working Time				
Drilling		195°30'	30.4 %	25.4 %
Hoisting & Lowering Rod		52°30'	8.2 %	6.8 %
Hoisting & Lowering I.T.		106°30'	16.6 %	13.9 %
Miscellaneous		108°30'	16.8 %	14.1 %
Repairing		180°00'	28.0 %	23.4 %
Others		–	%	– %
Total		643°00'	100 %	83.6 %
Removing	Preparation	80°00'	–	10.4 %
Removing	Moving	46°00'	–	6.0 %
G. Total		769°00'	–	100 %

Efficiency of Drilling	
203.60 m/Working Period	2.17 m/day
203.60 m/Working Days	3.57 m/day
203.60 m/Drilling Period	2.93 m/day
203.60 m/Net Drilling Days	6.26 m/day
Total workers/ 203.60 m	5.33 Man/m
Total Drilling Workers/ 203.60 m	4.18 Man/m
Hoisting & Lowering Rod 48 Times	Hoisting & Lowering I.T. 287 Times

Casing Pipe Inserted		
Pipe Size & Meterage	Inserted Length / Drilling Length %	Recovery of Casing Pipe
NW 121.50 m	59.7 %	88.9 %
BW 145.00 m	71.2 %	82.8 %
m	%	%

Remarks

G : Grand

I.T.: Inner Tube

A. I - 14 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-10	TGM-3C	6th Jun. '84 15th Jun. '84	180.30^{m}	146.45^{m}	81.2$^{\%}$	35	17	52	5.15	3.47	
IC-11	TGM-5A	15th Aug. '84 ~31th Aug. '84	221.10	178.80	80.9	34	14	48	6.50	4.61	
IC-12	TGM-5A	30th Sep. '84 ~ 9th Oct. '84	220.60	215.80	97.8	36	47	83	6.13	2.66	
IC-13	TGM-5A	9th Sep. '84 -22th Sep. '84	240.60	213.10	88.6	57	29	86	4.22	2.80	
IC-14	TGM-5A	12th Nov. '84 ~17th Nov. '84	140.20	126.20	90.0	43	20	63	3.26	2.23	
IC-15	TGM-5A	22th Nov. '84 ~10th Dec. '84	180.40	168.30	93.3	36	15	51	5.01	3.54	
IC-16	TGM-5A	20th Oct. '84 ~4th Nov. '84	161.00	139.90	86.9	57	18	75	2.82	2.15	
IC-17	TGM-3C	26th Jun. '84 ~4th Jul. '84	160.20	147.50	92.0	21	9	30	7.63	5.34	
IC-18	TGM-3C	10th Jul. '84 ~11th Aug. '84	200.50	162.90	81.2	71	24	95	2.82	2.11	
IC-19	TGM-5A	25th Nov. '84 ~3th Feb. '85	203.60	152.40	74.9	68	100	168	2.99	1.21	
Total			1,908.50	1,651.35	86.5	458	293	751	4.17	2.54	

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

A. I-15 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-10	114°30'	30°00'	56°00'	24°00'	–	39°30'	–	–	96°00'	360°00'
IC-11	145°00'	56°30'	92°30'	24°00'	18°00'	78°00'	12°00'	6°00'	140°00'	572°00'
IC-12	115°00'	29°30'	62°30'	1°00'	–	38°00'	–	–	88°00'	334°00'
IC-13	118°00'	46°30'	91°30'	12°00'	30°00'	26°00'	6°00'	–	76°00'	406°00'
IC-14	61°00'	21°00'	28°30'	11°00'	–	22°30'	–	–	50°00'	194°00'
IC-15	118°00'	49°30'	132°30'	12°00'	–	180°00'	6°00'	–	96°00'	594°00'
IC-16	110°00'	33°30'	125°30'	12°00'	–	127°00'	–	–	100°00'	508°00'
IC-17	117°00'	22°30'	43°00'	8°00'	–	35°30'	–	–	90°00'	316°00'
IC-18	106°00'	38°00'	62°00'	9°00'	58°00'	3°00'	220°00'	–	64°00'	560°00'
IC-19	195°30'	52°30'	106°30'	24°00'	–	84°30'	180°00'	–	126°00'	769°00'
Total	1,200°00'	379°30'	800°30'	137°00'	106°00'	634°00'	424°00'	6°00'	926°00'	4,613°00'
				877°00'						

A. I-16 Drilling Meterage of Diamond Bits

(1)

Item	Size	Type	Bit No.	Drilling meterage by drill hole. Unite meter										Total
				IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19	
Bit	PC	PC	J10057	m	m	m	m	m	m	m	m	(4.50)m	m	- m
			Total	-	-	-	-	-	-	-	-	(4.50)	-	-
	116mm	116mm	C-2940	6.00										6.00
			C-2941			1.20								1.20
			C-2942			1.30								1.30
			C-2943				0.60							0.60
			C-2944				0.40							0.40
			C-2945				0.50							0.50
			C-2946					1.50						1.50
			C-2947						2.00					2.00
			C-2948							2.00				2.00
			C-2949								1.70			1.70
			Total	6.00	-	2.50	1.50	1.50	2.00	2.00	1.70	-	-	17.20
	101mm	101mm	P-1020		0.50									0.50
			Total	-	0.50	-	-	-	-	-	-	-	-	0.50
	HX	HQ-WL	S-300	19.40										19.40
			S-301	18.10										18.10
			S-302	19.80										19.80
			S-303	20.10										20.10
			S-304	15.60										15.60
			S-305		14.70									14.70
			S-306		16.40									16.40
			S-307		11.20									11.20
			S-308		10.80									10.80
			S-309		12.10									12.10
			S-310		13.30									13.30
			S-311		15.10									15.10
			S-312		17.30									17.30
			S-313			7.40								7.40
			S-314			8.50								8.50
			S-315			10.20								10.20
			S-316			8.40								8.40
			S-317			11.70								11.70
			S-318				5.60							5.60
			S-319				5.90							5.90
			S-320				4.80							4.80
			S-321				6.20							6.20
			S-322				6.00							6.00
			S-323					7.60						7.60
			S-324					6.90						6.90
			S-325					8.10						8.10
			S-326					10.20						10.20
			S-327					9.30						9.30
			S-328					10.40						10.40
			S-329						10.20					10.20
			S-330						11.30					11.30
			S-331						14.60					14.60
			S-332						15.10					15.10
			S-333						12.30					12.30
			S-334						10.40					10.40
			S-335							7.40				7.40
			S-336							7.00				7.00
			S-337							7.70				7.70
			S-338								2.10			2.10
			S-339									0.70		0.70
			S-340									0.80		0.80
			S-341										9.40	9.40
			S-342										9.30	9.30
			S-343										10.10	10.10
			S-344										10.60	10.60
			S-345										12.20	12.20

Item	Size	Type	Bit No.	Drilling meterage by drill hole. Unite meter										Total
				IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19	
			S-346										11.10	11.10
			S-347										12.30	12.30
			S-348										11.10	11.10
			S-349										12.00	12.00
			S-350										12.50	12.50
	HX	HQ-WL	S-351										11.20	11.20
			S-352										9.40	9.40
			S-353										8.70	8.70
			S-354										10.10	10.10
			S-355										9.60	9.60
			S-356										10.80	10.80
			S-357										11.90	11.90
			S-358										12.10	12.10
			S-359										12.25	12.25
			Total	93.00	110.90	46.20	28.50	52.50	73.90	22.10	2.10	1.50	206.65	637.35
			N-500	25.60										25.60
			N-501	27.80										27.80
			N-502	27.90										27.90
			N-503		13.20									13.20
			N-504		12.60									12.60
			N-505		13.30									13.30
			N-506			30.30								30.30
			N-507			28.10								28.10
			N-508			27.20								27.20
			N-509			28.30								28.30
			N-510			26.40								26.40
			N-511			31.60								31.60
			N-512				24.50							24.50
			N-513				24.10							24.10
			N-514				24.60							24.60
Bit			N-515				22.30							22.30
			N-516				22.40							22.40
			N-517				23.00							23.00
			N-518				23.70							23.70
			N-519				22.40							22.40
			N-520				23.60							23.60
			N-521					20.60						20.60
	NX	NQ-WL	N-522					20.10						20.10
			N-523					22.60						22.60
			N-524					22.90						22.90
			N-525						15.20					15.20
			N-526						16.10					16.10
			N-527						14.80					14.80
			N-528							21.30				21.30
			N-529							22.60				22.60
			N-530							21.80				21.80
			N-531							19.40				19.40
			N-532								30.40			30.40
			N-533								30.60			30.60
			N-534								32.10			32.10
			N-535								31.80			31.80
			N-536								31.50			31.50
			N-537									19.40		19.40
			N-538									18.60		18.60
			N-539									17.20		17.20
			N-540									18.10		18.10
			N-541									17.80		17.80
			N-542									18.20		18.20
			N-543									16.60		16.60
			N-544									17.40		17.40
			N-545									20.10		20.10

Item	Size	Type	Bit No.	Drilling meterage by drill hole. Unite meter										Total
				IC-10	IC-11	IC-12	IC-13	IC-14	IC-15	IC-16	IC-17	IC-18	IC-19	
Bit	NX	NQ-WL	N-546										11.30	11.30
			N-547										11.40	11.40
			N-548										11.10	11.10
			N-549										10.35	10.35
			Total	81.30	39.10	171.90	210.60	86.20	46.10	85.10	156.40	163.40	44.15	1,084.25
	BX	BQ-WL	Y-600		17.80									17.80
			Y-601		16.90									16.90
			Y-602		17.60									17.60
			Y-603		18.30									18.30
			Y-604						20.10					20.10
			Y-605						19.70					19.70
			Y-606						18.60					18.60
			Y-607							13.40				13.40
			Y-608							12.80				12.80
			Y-609							13.00				13.00
			Y-610							12.60				12.60
			Y-611									12.10		12.10
			Y-612									11.60		11.60
			Y-613									11.90		11.90
			Y-614										14.60	14.60
			Y-615										15.10	15.10
			Y-616										14.10	14.10
			Y-617										12.65	12.65
			Total	-	70.60	-	-	-	58.40	51.80	-	35.60	56.45	272.85

A. I-17 Specifications of Diamond Bits

Size	Type	Carats per bit	Matrix	Stones per carat	Water way	Number	Remark
PC	PC	45	Z	1/30	6	J10057	Reset
		42	X	1/30	6	C-2940	Reset
		42	X	1/30	6	C-2941	"
		42	Z	1/30	6	C-2942	"
		42	Z	1/30	6	C-2943	"
		42	Z	1/30	6	C-2944	"
116mm	116mm	42	Z	1/30	6	C-2945	"
		42	Z	1/30	6	C-2946	"
		42	Z	1/30	6	C-2947	"
		42	ZZ	1/30	6	C-2948	"
		42	ZZ	1/30	6	C-2949	"
101mm	101mm	40	Z	1/30	6	P-1020	Reset
		40	X	1/30	6	S-300	Reset
		40	X	1/30	6	S-301	"
		40	X	1/30	6	S-302	"
		40	X	1/30	6	S-303	"
		40	Z	1/30	6	S-304	"
		40	Z	1/30	6	S-305	"
		40	Z	1/30	6	S-306	"
		40	Z	1/30	6	S-307	"
		40	Z	1/30	6	S-308	"
		40	Z	1/30	6	S-309	"
		41	C	1/30	6	S-310	"
		41	C	1/30	6	S-311	"
		41	C	1/30	6	S-312	"
		35	H-9	35 mesh	6	S-313	"
		35	H-9	35 mesh	6	S-314	"
		35	H-9	35 mesh	6	S-315	"
		35	H-9	35 mesh	6	S-316	"
		35	H-9	35 mesh	6	S-317	"
		35	H-9	35 mesh	6	S-318	"
HX	HQ-WL	35	H-9	35 mesh	6	S-319	"
		50	J-7	40 mesh	6	S-320	"
		50	J-7	40 mesh	6	S-321	"
		50	J-7	40 mesh	6	S-322	"
		45	A-65	40 mesh	6	S-323	"
		45	A-65	40 mesh	6	S-324	"
		45	A-65	40 mesh	6	S-325	"
		45	A-65	40 mesh	6	S-326	"
		45	A-65	40 mesh	6	S-327	"
		45	A-65	40 mesh	6	S-328	"
		45	A-65	40 mesh	6	S-329	"
		45	A-65	40 mesh	6	S-330	"
		45	A-65	40 mesh	6	S-331	"
		45	A-65	40 mesh	6	S-332	"
		45	A-75	40 mesh	6	S-333	"
		45	A-75	40 mesh	6	S-334	"
		45	A-75	40 mesh	6	S-335	"
		45	A-75	40 mesh	6	S-336	"
		45	A-75	40 mesh	6	S-337	"
		45	A-75	40 mesh	6	S-338	"
		45	A-75	40 mesh	6	S-339	"
		45	A-75	40 mesh	6	S-340	"
		45	A-75	40 mesh	6	S-341	"
		45	A-75	40 mesh	6	S-342	"
		45	A-75	40 mesh	6	S-343	"
		45	A-75	40 mesh	6	S-344	"
		45	A-75	40 mesh	6	S-345	"
		45	A-75	40 mesh	6	S-346	"
		45	A-75	40 mesh	6	S-347	"
		45	A-75	40 mesh	6	S-348	"
		45	A-75	40 mesh	6	S-349	"
HX	HQ-WL	45	A-85	40 mesh	6	S-350	"
		45	A-85	40 mesh	6	S-351	"
		45	A-85	40 mesh	6	S-352	"
		45	A-85	40 mesh	6	S-353	"
		45	A-85	40 mesh	6	S-354	"
		45	A-85	40 mesh	6	S-355	"
		45	A-85	40 mesh	6	S-356	"
		45	A-85	40 mesh	6	S-357	"
		45	A-85	40 mesh	6	S-358	"
		45	A-85	40 mesh	6	S-359	"

Size	Type	Carats per bit	Matrix	Stones per carat	Water way	Number	Remark
		30	Y	1/30	4	N-500	Reset
		30	Y	1/30	4	N-501	"
		30	Y	1/30	4	N-502	"
		30	Y	1/30	4	N-503	"
		30	Y	1/30	4	N-504	"
		30	Y	1/30	4	N-505	"
		30	Y	1/30	4	N-506	"
		30	Y	1/30	4	N-507	"
		30	Y	1/30	4	N-508	"
		30	Y	1/30	4	N-509	"
		30	Z	1/30	4	N-510	"
		30	Z	1/30	4	N-511	"
		30	Z	1/30	4	N-512	"
		30	Z	1/30	4	N-513	"
		30	Z	1/30	4	N-514	"
NX	NQ-WL	30	Z	1/30	4	N-515	"
		30	Z	1/30	4	N-516	"
		30	Z	1/30	4	N-517	"
		30	Z	1/30	4	N-518	"
		30	Z	1/30	4	N-519	"
		24	J-7	35 mesh	4	N-520	"
		24	J-7	35 mesh	4	N-521	"
		24	J-7	35 mesh	4	N-522	"
		24	J-7	35 mesh	4	N-523	"
		35	H-9	40 mesh	4	N-524	"
		35	H-9	40 mesh	4	N-525	"
		35	H-9	40 mesh	4	N-526	"
		35	H-9	40 mesh	4	N-527	"
		35	A-65	40 mesh	4	N-528	"
		35	A-65	40 mesh	4	N-529	"
		35	A-65	40 mesh	4	N-530	"
		35	A-65	40 mesh	4	N-531	"
		35	A-65	40 mesh	4	N-532	"
		35	A-65	40 mesh	4	N-533	"
		35	A-65	40 mesh	4	N-534	"
		35	A-65	40 mesh	4	N-535	"
		35	A-65	40 mesh	4	N-536	"
		35	A-65	40 mesh	4	N-537	"
		35	A-75	40 mesh	4	N-538	"
		35	A-75	40 mesh	4	N-539	"
NX	NQ-WL	35	A-75	40 mesh	4	N-540	"
		35	A-75	40 mesh	4	N-541	"
		35	A-75	40 mesh	4	N-542	"
		35	A-75	40 mesh	4	N-543	"
		35	A-75	40 mesh	4	N-544	"
		35	A-75	40 mesh	4	N-545	"
		35	A-75	40 mesh	4	N-546	"
		35	A-75	40 mesh	4	N-547	"
		35	A-75	40 mesh	4	N-548	"
		35	A-75	40 mesh	4	N-549	"
		20	Z	1/30	4	Y-600	Reset
		20	Z	1/30	4	Y-601	"
		20	Z	1/30	4	Y-602	"
		20	Z	1/30	4	Y-603	"
		20	Z	1/30	4	Y-604	"
		20	Z	1/30	4	Y-605	"
		20	Z	1/30	4	Y-606	"
		20	Z	1/30	4	Y-607	"
BX	BQ-WL	20	Z	1/30	4	Y-608	"
		20	Z	1/30	4	Y-609	"
		16	H-9	35 mesh	4	Y-610	"
		16	H-9	35 mesh	4	Y-611	"
		16	H-9	35 mesh	4	Y-612	"
		23	A-75	40 mesh	4	Y-613	"
		23	A-75	40 mesh	4	Y-614	"
		23	A-75	40 mesh	4	Y-615	"
		23	A-75	40 mesh	4	Y-616	"
		23	A-75	40 mesh	4	Y-617	"

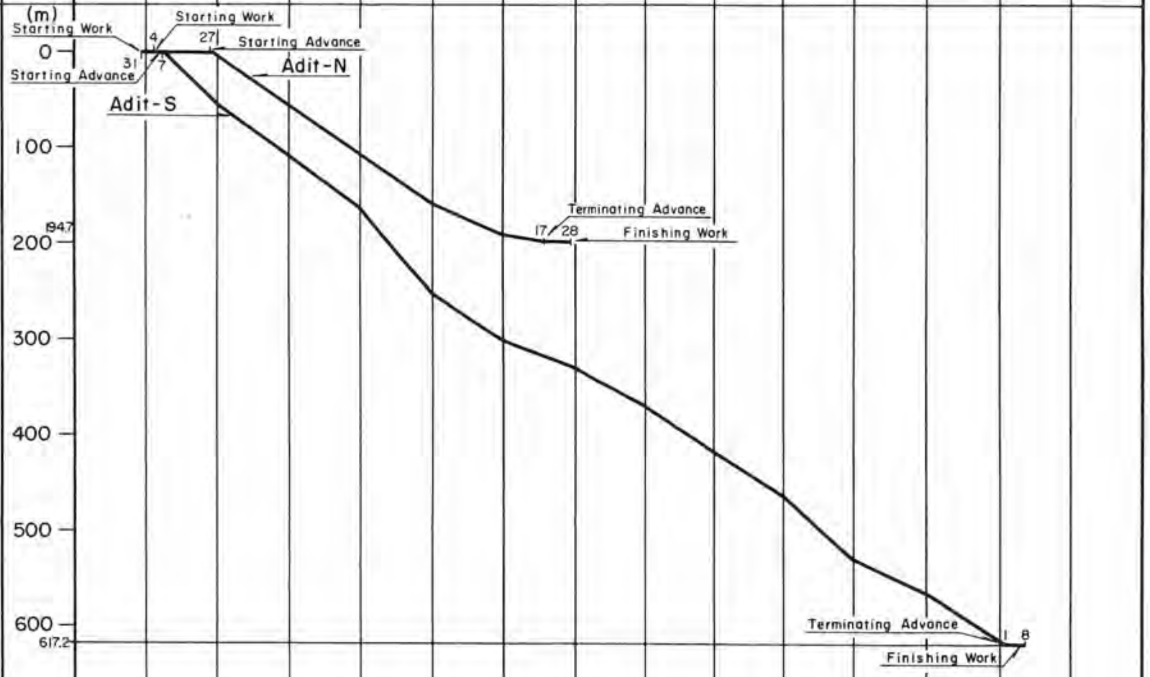
APPENDICES
PART Ⅱ
DATA OF TUNNELLING

LIST OF APPENDICES

A. Ⅱ-1 Actual Progress of Investingation

Item	1984 May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	1985 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
1 Mobilization (Tokyo ∿ Lima ∿ Site)	7 9 25 30														
2 Road Construction															
Restoration	10 30	3 13													
Construction	31	2													
Repair			22										18		
3 Equipment Moving in Provisional Works (with housing)	31	9													
4 Advance															
Adit-N 175.00 m		4					28								
Adit-S 573.30 m	31													8	
5 Equipment Moving out														9 15	
6 Demobilization (Site ∿ Lima ∿ Tokyo)							14 19							16 21	
7 Preparation of Report														22	31

A. II-2 Record of Progress

Item			1984 May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	1985 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
Mobilization	Tokyo ~ Lima ~ Site		7–9, 25–30														
Road Construction	Restoration		10–30	3–13													
	Construction		31–	–2													
	Repair				22–										–18		
Equipment Moving in Provisional Works			31–	–9													
Advance	Adit-N 175.0m 19.7m (Boring Chamber) Total 194.7m Adit-S 573.3m 43.9m (Boring Chamber) Total 617.2m																
Equipment Moving out																9–15	
Demobilization	Site ~ Lima ~ Tokyo								14–19							16–21	
Preparation of Report																22–	–31

A. II-3 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	Boring Chamber	No.of Days	Total	Work-ing Days	Suspend-ed Days	Construc-tion Re-pair of Road	No.of Days	Moving in Provision	No.of Days	Total No.of Days
	Accessory Works (Date) 31,May 84 9,Jun.84	(Date)	day	(Date)	day	(Date)	day	day	day	day	(Date) 10,May 84 18,May 85	day 168	(Date) 31,May 84 9,Jun.84	day 10	day 178
Adit-N		25,Jun.84 26,Jun.84	2	10,Jul.84 28,Nov.84	131	27,Jun.84 14,Jul.84 31,Jul.84 25,Aug.84	12 13	158	151	7			4,Jun.84 23,Jun.84	20	20
Adit-S		6, Jun. 84 6, Jun. 84	1	17,Jun.84 8,Jun.85	339	7,Jun.84 23,Jun.84 27,Sept.84 27,Oct.84	14 14	368	357	11			31,May 84 5,Jun.84	6	6
	Moving out 9,Jun.85 15,Jun.85													7	7
Total No. of Days			3		470		53	526	508	18		168		43	211

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

A. Ⅱ-4 Summary of Performance

Adit Name	Moving in Moving out	No. of Working Shift: No. of Shift of Advance	No. of Working Shift: Total No. of Shift	No. of Man-shift: Engineer	No. of Man-shift: Worker	No. of Hours for Each Work: 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.	28	28	28	376	280	-	-	280	-	-	-	280
	" Constr.	3	3	3	51	30	-	-	30	-	-	-	30
	" Repair	137	137	89	631	1,096	-	-	1,096	-	-	-	1,096
	Provision	10	10	13	54	-	-	-	-	-	80	-	80
Adit-N		383	426	593	3,704	2,129	937	248	3,314	32	8	54	3,408
Adit-S		958	1,035	1,421	11,662.5	5,589	2,259	760	8,608	-	-	8	8,616
	Equipment Moving out	7	7	21	112	-	-	-	-	-	56	-	56
Total		1,526	1,646	2,168	16,590.5	9,124	3,196	1,008	13,328	32	144	62	13,566

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

A. II-5 List of the Equipment-used and Provisional Construction for Tunnelling

Name of Equipment	Type and Specification	No., Q'ty	Remarks
Compressor	ATLAS COPCO XA 350 Vod	2	1 for N, 1 for S.
Loader	ATLAS COPCO LM 36	1	for N.
	ATLAS COPCO LM 56	1	for S.
	JOY HL 20	1	for S.
Drifter	ATLAS COPCO BBC-16W	6	3 for N, 3 for S.
Tub	Side Dump Type, Manual Handling 1.0 m^3	10	4 for N, 6 for S.
Bit Grinder	ATLAS COPCO LSD-61	1	
Generator	YAMMER YSG-35N	1	
	CATERPILLAR SR-4 90 KVA	1	1 for S.
	CATERPILLAR SR-4 55 KVA	1	1 for N.
Ventilator	HITACHI ϕ500 m/m 3.7 KW 170 m^3/min	10	4 for N, 6 for S.
Bulldozer	CATERPILLAR D7-17A	1	
Vehicle	TOYOTA LAND CRUISER FJ-55	1	
	TOYOTA LAND CRUISER FJ-45	1	
	TOYOTA LAND CRUISER FJ-40	1	
House	Storied House, Galvanized Iron 13 m^2	2	Generator. 1 for N, 1 for S.
	Storied House, Galvanized Iron 50 m^2	1	Camp House.
	Storied House, Galvanized Iron 94 m^2	1	Camp House.
	Storied House, Galvanized Iron 80 m^2	1	Kitchen, Dining Room.
	Storied House, Galvanized Iron 190 m^2	1	Camp House. Office.
	Storied House, Galvanized Iron 18 m^2	1	Warehouse.
	Storied House, Galvanized Iron 18 m^2	2	Compressor Chamber 1 for N, 1 for S.
	Storied House, Galvanized Iron 18 m^2	2	Fuel Storage 1 for N, 1 for S.
Powder Magazine	Subterranean Type Powder Magazine	1	
	Subterranean Type Blasting Supplies	1	

A. II-6 Summary of Drift Heading, Adit-N

Date of Starting Work	4, June, 1984
Date of Starting Advance	27, June, 1984
Date of Terminating Advance	17, November, 1984
Date of Finishing Work	28, November, 1984

		Until 17, Nov. 1984			Until 28, Nov. 1984			Remarks
		No. of Days	Per cent (%)		No. of Days	Per cent (%)		
Working Days	Advance	(days) 127	80.9	76.0	(days) 127	76.5	71.3	
	Housing	2	1.3	1.2	2	1.2	1.1	
	Others	28	17.8	16.8	37	22.3	20.8	
Sub-Total		157	100.0	94.0	166	100.0	93.2	
Suspended Days		10	-	6.0	12	-	6.8	
Total		167	-	100.0	178	-	100.0	

		Perforation	Preparation of Advance, Housing	Accessory Other Works	Remarks
Staff	Interior	(men) 525	(men) 6	(men) 62	1 man=8 hrs/shift
	Surface	-	-	-	
Worker	Interior	2,761	12	150	
	Surface	767.5	3	10.5	
Sub-Total	Interior	3,286	18	212	
	Surface	767.5	3	10.5	
Total		4,053.5	21	222.5	G. Total 4,297 men

	Until 17, Nov. 1984		Until 28, Nov. 1984		Remarks
	175.0m	*194.7m	175.0m	*194.7m	
Advance m per 1 working day	(m) 1.115	(m) 1.240	(m) 1.054	(m) 1.173	
Advance m per 1 actual working day	1.378	1.533	1.378	1.533	
Advance m per 1 necessary worker	1.048	1.166	0.983	1.094	
Advance m per 1 necessary worker	0.041	0.046	0.041	0.045	
No. of Support	84 sets				
Timbering Length (%)	83.1 m (47.5%)				

* Included with Boring chamber.

A. II-7 Summary of Drift Heading, Adit-S

Date of Starting Work	31, May, 1984
Date of Starting Advance	7, June, 1984
Date of Terminating Advance	1, June, 1985
Date of Finishing Work	8, June, 1985

		Until 1, June, 1985			Until 8, June, 1985			Remarks
		No. of Days	Per cent (%)		No. of Days	Per cent (%)		
Working Days	Advance	(days) 315	91.8	85.8	(days) 315	90.0	84.2	
	Housing	1	0.3	0.3	1	0.3	0.3	
	Others	27	7.9	7.4	34	9.7	9.1	
Sub-Total		343	100.0	93.5	350	100.0	93.6	
Suspended Days		24	-	6.5	24	-	6.4	
Total		367	-	100.0	374	-	100.0	

		Perforation	Preparation of Advance, Housing	Accessory Other Works	Remarks
Staff	Interior	(men) 1,380	(men) 3	(men) 38	1 man=8 hrs/shift
	Surface	-	-	-	*Included guardmen
Worker	Interior	8,031	20	230	
	Surface	2,084	3	*1,294.5	
Sub-Total	Interior	9,411	23	268	
	Surface	2,084	3	1,294.5	
Total		11,495	26	1,562.5	G. Total 13,083.5 men

	Until 1, June, 1985		Until 8, June, 1985		Remarks
	573.3m	*617.2m	573.3m	*617.2m	
Advance m per 1 working day	(m) 1.671	(m) 1.799	(m) 1.638	(m) 1.763	
Advance m per 1 actual working day	1.820	1.959	1.820	1.959	
Advance m per 1 necessary day	1.562	1.682	1.533	1.650	
Advance m per 1 necessary worker	0.045	0.047	0.044	0.047	
No. of Support	239 sets				
Timbering Length (%)	255.3m (44.5%)				

* Included with Boring chamber

A. II-8 Summary of Material Consumption

Name	Specification	Q'ty	Remarks
Petroleum		233,968 ℓ	
Gasoline		18,470 ℓ	
Drifter Oil		1,050 ℓ	
Engine Oil		2,681 ℓ	
Compressor Oil		5,977 ℓ	
Grease		447 kg	
Dynamite	DINASOL 7/8" x 7"	13,889.26 kg	
Detonator	FAMESA No. 8	29,684 nos	
Fuse	FAMESA	211,709 ft	
Insert Bit	COROMANT 22 m/m Hex. Gauge 38 m/m, L 1.8m	682 nos	
Carbide		4,342 kg	
Timbering Wood		136.769 m^3	
Board		58.662 m^3	
Sleeper		1,349 nos	
Supports		323 sets	

Note: Includes road construction etc.

A. II-9 Details of Material Consumption

Name	Specification	Q'ty		Remarks
		Adit-N	Adit-S	
Petroleum		63,550 ℓ	167,018 ℓ	
Gasoline		5,730 ℓ	12,440 ℓ	
Drifter Oil		281 ℓ	769 ℓ	
Engine Oil		801 ℓ	1,880 ℓ	
Compressor Oil		1,710 ℓ	4,267 ℓ	
Grease		124 kg	323 kg	
Dynamite	7/8" x 7"	3,144.02 kg	10,703.84 kg	
Detonator	FAMESA No. 8	6,728 nos	22,806 nos	
Fuse	FAMESA	48,215 ft	163,002 ft	
Insert Bit	COROMANT 22 m/m Hex. Gauge 38 m/m, L 1.8 m	153 nos	529 nos	
Carbide		1,177 kg	3,157 kg	
Timbering Wood	ϕ0.10m x 3.0m ϕ0.20m x 3.0m	33.206 m^3	102.800 m^3	
Board	0.2m x 0.05m x 1.8m	14.148 m^3	44.154 m^3	
Sleeper	0.10m x 0.15m x 1.2m	329 nos	1,020 nos	
Supports		84 sets	239 sets	

A. II-10 Surveying Results, Adit-N

(1) Main Tunnel (1)

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
N1	-	-	310,357.32	8,809,084.56	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	163°59'46"	6.526	310,461.50	8,809,029.04	4,690.84
N8 -N9	150°25'56"	23.839	310,473.26	8,809,008.30	4,691.00
N9 -N10	150°29'21"	21.000	310,483.60	8,808,990.03	4,691.28
N10-N11	150°26'51"	26.255	310,496.56	8,808,967.19	4,691.58
N11-N12	150°24'01"	37.265	310,514.96	8,808,934.79	4,691.72
N12-N13	150°18'26"	23.576	310,526.64	8,808,914.31	4,691.72
N13-N14	150°14'46"	31.690	310,542.37	8,808,886.79	4,692.08
N14-N15	150°14'46"	24.488	310,554.52	8,808,865.54	4,692.23
N15-N16	150°19'36"	29.836	310,569.29	8,808,839.61	4,692.39
N16-N17	150°16'21"	22.620	310,580.50	8,808,819.97	4,692.49
N17-N18	150°16'21"	25.642	310,593.22	8,808,797.70	4,692.61
N18-N19	150°11'56"	30.309	310,608.28	8,808,771.40	4,692.80
N19-N20	150°02'46"	38.273	310,628.37	8,808,736.55	4,693.09
N20-N21	149°58'36"	28,736	310,641.76	8,808,713.37	4,693.26
N21-F		25.400			

(2) Crosscut - 1

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
N15			310,554.52	8,808,865.54	4,692.23
N15-CN4	238°31'56"	23.816	310,534.21	8,808,853.10	4,692.31
CN4-CN5	238°33'06"	24.249	310,513.51	8,808,840.45	4,692.56
CN5-CN6	238°27'41"	35.339	310,483.40	8,808,821.97	4,693.02
CN6-CN7	238°14'31"	31.479	310,456.63	8,808,805.40	4,693.41
CN7-CN8	238°12'51"	31.427	310,429.92	8,808,788.85	4,693.90
CN8-F		6.300			

(3) Crosscut - 2

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
N20			310,628.37	8,808,736.55	4,693.09
N20-NN1	240°14'06"	41.352	310,592.47	8,808,716.02	4,693.45
NN1-NN2	241°06'36"	36.717	310,560.33	8,808,698.28	4,693.78
NN2-NN3	241°04'46"	34.134	310,530.45	8,808,681.77	4,694.00
NN3-NN4	241°06'26"	22.200	310,511.01	8,808,671.05	4,694.66
NN4-F		42.000			

A. Ⅱ-11 Surveying Result, Adit-S

(1) Main Tunnel (1)

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
S1			310,967.55	8,807,861.50	4,570.14
S1 -S2	0°30'14"	20.501	310,967.730	8,807,882.00	4,570.20
S2 -S3	2°03'59"	31.665	310,968.87	8,807,913.64	4,570.44
S3 -S4	2°01'24"	24.790	310,969.75	8,807,938.42	4,570.76
S4 -S5	1°46'14"	19.767	310,970.36	8,807,958.18	4,570.91
S5 -S6	0°10'24"	33.714	310,970.46	8,807,991.89	4,571.21
S6 -S7	358°24'09"	8.223	310,970.23	8,808,000.11	4,571.33
S7 -S8	328°57'32"	26.228	310,956.71	8,808,022.58	4,571.57
S8 -S9	328°36'22"	21.505	310,945.50	8,808,040.94	4,571.85
S9 -S10	331°22'42"	29.499	310,931.37	8,808,066.83	4,572.24
S10-S11	332°19'52"	29.813	310,917.53	8,808,093.24	4,572.40
S11-S12	331°31'02"	23.435	310,906.35	8,808,113.84	4,572.50
S12-S13	331°27'12"	26.428	310,893.72	8,808,137.05	4,572.71
S13-S14	331°18'52"	35.267	310,876.80	8,808,167.99	4,573.23
S14-S15	331°20'12"	35.945	310,859.56	8,808,199.53	4,573.56
S15-S16	330°50'12"	38.066	310,841.01	8,808,232.77	4,573.59
S16-S17	330°41'47"	30.635	310,826.01	8,808,259.49	4,573.72
S17-S18	330°26'37"	38.355	310,807.09	8,808,292.85	4,574.21
S18-S19	331°04'42"	35.358	310,789.99	8,808,323.80	4,574.28
S19-S20	331°34'42"	31.299	310,775.09	8,808,351.32	4,574.44
S20-S21	331°21'07"	45.191	310,753.43	8,808,390.98	4,574.53
S21-S22	331°25'57"	34.741	310,736.82	8,808,421.49	4,574.81
S22-S23	331°25'27"	37.725	310,718.77	8,808,454.62	4,575.34
S23-S24	331°15'27"	25.051	310,706.72	8,808,476.59	4,575.62
S24-SX-0	331°17'37"	16.304	310,698.91	8,808,490.86	4,575.73
SX-0-S25	331°19'07"	22.188	310,688.26	8,808,510.32	4,575.84
S25-S26	331°19'37"	39.371	310,669.37	8,808,544.87	4,576.78
S26-S27	331°19'37"	28.50	310,655.70	8,808,569.87	4,577.19
S27-S28	332°39'37"	26.15	310,643.69	8,808,593.10	4,577.63
S28-S29A	319°09'37"	21.85	310,629.40	8,808,609.63	4,577.81
S29A-S30	251°26'	21.60	310,608.92	8,808,602.75	4,578.08
S30-S31	264°31'	7.90	310,601.06	8,808,602.00	4,578.22
S31-S32	298°31'	4.50	310,597.11	8,808,604.15	4,578.31
S32-S33	331°26'	23.21	310,586.01	8,808,624.53	4,578.46
S33-S34	331°26'	26.95	310,573.12	8,808,648.20	4,578.85
S34-S34A	331°26'	3.25	310,571.57	8,808,651.05	4,578.89
S34A-F		6.70			
S28-S29A			310,629.40	8,808,609.63	4,577.81
F		15.0			

(2) Crosscut - 1

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
S-24-SX-0			310,698.91	8,808,490.86	4,575.73
SX-0-SX-1	251°11'07"	37.269	310,663.63	8,808,478.38	4,576.49
SX-1-SX-2	251°10'10"	36.950	310,628.66	8,808,466.91	4,577.83
SX-2-SX-3	251°10'10"	39.450	310,591.32	8,808,454.18	4,578.54
SX-3-F		29.331			

(3) Crosscut - 2

Survey Point	Direction	Horizontal Distance (m)	Coordinate (m)		Elevation (m)
			Longitude	Latitude	
S34-S34A			310,571.57	8,808,651.05	4,578.89
S34A-S2S	281°26'	10.75	310,561.03	8,808,653.18	4,579.14
S2S-S3S	251°26'	22.10	310,540.08	8,808,646.14	4,579.62
S3S-S4S	251°26'	29.92	310,511.72	8,808,636.61	4,579.67
S4S-F		18.10			
S33-S34			310,573.12	8,808,648.20	4,578.85
F		9.70			

APPENDICES
PART Ⅲ
GEOLOGICAL DATA

LIST OF APPENDICES

A. Ⅲ-I Assay Results (1) Drilling Core (1)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
401	IC-10-087	86.8- 88.0	1.2	Cu	0.01	0.01	0.32	12	
402	IC-10-093	92.5- 93.8	1.3	Py	0.01	0.07	0.21	30	
403	IC-10-147	145.1-149.3	4.2	Sid	0.15	0.22	1.00	10	
404	IC-10-150	149.3-151.7	2.4	Do	0.02	0.05	0.60	4	
405	IC-10-153	151.7-153.5	1.8	Hm	0.96	0.02	0.16	5	
406	IC-10-156	153.9-158.6	4.7	Cu	0.08	0.07	0.11	6	
407	IC-10-162	161.6-163.3	1.7	Hm	1.09	0.05	0.16	8	
408	IC-10-164	163.3-165.4	2.1	Cu	0.14	0.02	0.20	10	
409	IC-10-170	168.6-170.6	2.0	Hm	0.02	0.03	0.18	4	
410	IC-10-172	170.6-172.6	2.0	Hm	0.02	0.07	0.36	3	
411	IC-10-174	172.6-174.6	2.0	Hm	1.57	0.02	0.07	8	
412	IC-10-176	174.6-177.5	2.9	Sh	0.03	0.02	0.35	5	
413	IC-10-178	177.5-180.3	2.8	Do	0.01	1.42	0.70	38	
414	IC-11-107	105.5-107.2	1.7	Do	0.01	0.06	0.88	45	
415	IC-11-108	107.2-108.4	1.2	Ore	0.01	3.60	6.80	20	
416	IC-11-109	108.4-109.6	1.2	Ore	0.03	4.00	6.40	31	
417	IC-11-110	109.6-111.5	1.9	Ore	0.15	7.60	11.20	62	
418	IC-11-112	111.5-113.4	1.9	Ore	0.01	3.20	7.30	35	
419	IC-11-114	113.4-115.4	2.0	Ore	0.01	3.40	7.20	38	
420	IC-11-116	115.4-116.4	1.0	Ore	0.04	4.10	37.7	35	*
421	IC-11-117	116.4-117.4	1.0	Ore	0.03	3.60	32.2	44	*
422	IC-11-118	117.4-118.4	1.0	Ore	0.09	0.64	46.5	74	*
423	IC-11-119	118.4-119.4	1.0	Ore	0.00	0.98	29.8	34	
424	IC-11-120	119.4-120.4	1.0	Ore	0.02	0.45	21.0	27	
425	IC-11-121	120.4-121.4	1.0	Ore	0.05	0.43	34.9	38	*
426	IC-11-122	121.4-122.4	1.0	Ore	0.06	1.28	47.1	61	*
427	IC-11-123	122.4-123.4	1.0	Ore	0.06	0.42	51.8	59	*
428	IC-11-124	123.4-124.5	1.1	Ore	0.06	0.63	50.4	51	*
429	IC-11-125	124.5-125.6	1.1	Ore	0.03	2.46	15.0	25	
430	IC-11-126	125.6-126.8	1.2	Ore	0.04	4.00	12.6	26	
431	IC-11-129	128.3-130.2	1.9	Ore	0.03	3.90	10.0	23	
432	IC-11-131	130.2-132.0	1.8	Ore	0.04	3.60	24.0	25	
433	IC-11-133	132.0-133.9	1.9	Ore	0.06	4.80	29.6	27	
434	IC-11-135	133.9-138.8	4.9	Ald	0.10	0.20	5.90	19	
435	IC-11-140	138.8-146.5	7.7	Sid	0.05	0.98	6.30	5	
436	IC-11-158	156.6-160.7	4.1	Do	0.00	0.08	0.77	4	
437	IC-11-162	160.7-164.8	4.1	Do	0.05	0.75	4.15	4	
438	IC-11-166	164.8-166.7	1.9	Ore	0.03	6.10	29.50	41	
439	IC-11-167	166.7-167.7	1.0	Ore	0.01	0.24	0.80	9	
440	IC-11-172	169.2-173.3	4.1	Py	0.01	0.09	2.35	6	
441	IC-11-176	173.3-177.4	4.1	Py	0.00	0.10	2.00	7	
442	IC-12-145	144.3-145.5	1.2	Ore	0.02	0.35	15.0	15	
443	IC-12-146	145.5-146.5	1.0	Ore	0.05	0.15	3.6	2	
444	IC-12-147	146.5-147.5	1.0	Ore	0.01	3.45	18.0	82	
445	IC-12-148	147.5-148.5	1.0	Ore	0.02	7.90	20.6	55	
446	IC-12-149	148.5-149.5	1.0	Ore	0.03	1.65	8.2	86	
447	IC-12-150	149.5-150.5	1.0	Ore	0.02	1.08	12.2	20	*
448	IC-12-151	150.5-151.5	1.0	Ore	0.01	1.26	8.0	22	
449	IC-12-152	151.5-152.5	1.0	Ore	0.01	1.62	3.9	27	
450	IC-12-153	152.5-153.5	1.0	Ore	0.01	2.55	9.0	44	

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
451	IC-12-154	153.5-154.5	1.0	Ore	0.01	1.90	4.5	38	
452	IC-12-155	154.5-155.5	1.0	Ore	0.01	1.26	4.8	30	
453	IC-12-156	155.5-156.5	1.0	Ore	0.00	0.77	5.4	41	
454	IC-12-157	156.5-157.5	1.0	Ore	0.00	1.20	3.9	22	
455	IC-12-158	157.5-158.5	1.0	Ore	0.01	1.88	1.0	23	
456	IC-12-159	158.5-159.5	1.0	Ore	0.00	1.50	4.6	19	
457	IC-12-160	159.5-160.5	1.0	Ore	0.01	2.12	6.3	22	
458	IC-12-161	160.5-161.5	1.0	Ore	0.01	5.50	12.0	133	
459	IC-12-162	161.5-162.5	1.0	Ore	0.01	12.40	37.3	709	*
460	IC-12-163	162.5-163.5	1.0	Ore	0.04	4.70	40.6	182	*
461	IC-12-164	163.5-164.5	1.0	Ore	0.09	2.40	39.6	156	*
462	IC-12-165	164.5-165.5	1.0	Ore	0.62	0.12	46.1	73	*
463	IC-12-166	165.5-166.5	1.0	Ore	1.78	0.03	54.1	104	*
464	IC-12-167	166.5-167.5	1.0	Ore	1.98	0.07	49.0	131	*
465	IC-12-168	167.5-168.5	1.0	Ore	0.69	0.08	40.4	158	*
466	IC-12-169	168.5-169.5	1.0	Ore	1.04	0.06	56.3	172	*
467	IC-12-170	169.5-170.5	1.0	Ore	0.08	0.07	52.0	136	*
468	IC-12-171	170.5-171.5	1.0	Ore	0.15	0.17	49.0	79	*
469	IC-12-172	171.5-172.5	1.0	Ore	0.03	13.50	31.8	64	*
470	IC-12-173	172.5-173.5	1.0	Ore	0.02	3.00	43.5	67	*
471	IC-12-174	173.5-174.5	1.0	Ore	0.06	1.75	41.8	83	*
472	IC-12-175	174.5-175.5	1.0	Ore	0.18	6.80	45.7	22	*
473	IC-12-176	175.5-176.5	1.0	Ore	0.15	1.43	28.8	66	
474	IC-12-177	176.5-177.5	1.0	Ore	0.04	2.98	20.4	45	
475	IC-12-178	177.5-178.5	1.0	Ore	0.03	4.00	16.8	41	
476	IC-12-179	178.5-179.5	1.0	Ore	0.03	2.60	34.9	36	*
477	IC-12-180	179.5-180.5	1.0	Ore	0.06	4.25	28.6	52	*
478	IC-12-182	180.5-182.3	1.8	Do	0.04	0.28	6.0	4	
479	IC-12-183	182.3-183.5	1.2	Ore	0.07	4.45	27.0	7	
480	IC-12-184	183.5-184.5	1.0	Sh	0.00	0.01	0.6	7	
481	IC-12-185	184.5-185.5	1.0	Sh	0.02	0.12	9.0	20	
482	IC-12-190	189.0-190.6	1.6	Ald	0.08	0.05	10.5	20	
483	IC-12-206	204.2-206.5	2.3	Po	0.01	0.24	1.18	30	
484	IC-12-208	206.5-208.8	2.3	Po	0.04	0.06	1.00	30	
485	IC-12-217	216.3-218.5	2.2	Py	0.01	0.06	0.18	40	
486	IC-13-166	165.5-170.5	5.0	Py	0.06	0.02	0.19	30	
487	IC-13-171	170.5-175.5	5.0	Py	0.24	0.03	0.26	50	
488	IC-13-229	227.2-229.0	1.8	Py	0.04	0.00	0.05	10	
489	IC-13-231	230.6-231.9	1.3	Hm	0.25	0.00	0.47	30	
490	IC-14-037	86.6- 38.4	1.8	Ss	0.05	0.02	4.60	2	*
491	IC-14-047	45.0- 50.0	5.0	Ald	0.35	0.02	0.03	30	
492	IC-14-052	50.0- 55.0	5.0	Py	0.01	0.03	0.48	50	
493	IC-14-057	55.0- 60.0	5.0	Py	0.05	0.02	0.17	44	
494	IC-14-062	60.0- 65.0	5.0	Py	0.08	0.02	0.09	30	
495	IC-14-067	65.0- 70.0	5.0	Py	0.09	0.01	0.04	28	
496	IC-14-072	70.0- 75.0	5.0	Py	0.02	0.01	0.05	41	
497	IC-14-077	75.0- 80.0	5.0	Py	0.63	0.06	0.08	63	
498	IC-14-082	80.0- 85.0	5.0	Py	0.48	0.02	0.04	40	
499	IC-14-087	85.0- 90.0	5.0	Py	0.14	0.04	0.32	70	
500	IC-14-092	90.0- 95.0	5.0	Py	0.50	0.01	0.08	40	

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
501	IC-14-097	95.0- 98.2	3.2	Ald	0.35	0.01	0.44	30	
502	IC-14-099	98.2-100.7	2.5	Sh	0.66	0.01	0.80	20	
503	IC-14-101	100.7-102.4	1.7	Ore	0.43	0.02	17.5	30	
504	IC-14-108	107.1-108.3	1.2	Ore	0.02	0.01	8.9	5	*
505	IC-14-109	108.3-110.1	1.8	Sh	0.04	0.04	5.3	12	
506	IC-14-111	110.1-111.9	1.8	Sh	0.12	0.07	16.6	25	
507	IC-14-113	111.9-113.9	2.0	Ald	0.01	0.03	8.6	25	
508	IC-14-115	113.9-115.1	1.2	Ore	0.18	0.07	20.8	40	
509	IC-14-116	115.1-116.4	1.3	Sh	0.14	0.00	10.9	20	
510	IC-14-117	116.4-117.4	1.0	Ore	0.23	0.08	24.7	50	*
511	IC-14-118	117.4-118.4	1.0	Ore	0.19	0.01	24.0	30	*
512	IC-14-119	118.4-119.4	1.0	Ore	0.23	0.07	29.0	30	*
513	IC-14-120	119.4-120.4	1.0	Ore	0.15	0.32	23.0	60	
514	IC-14-121	120.4-121.5	1.1	Ore	0.23	0.87	23.0	50	
515	IC-14-122	121.5-122.6	1.1	Ore	0.35	0.28	24.3	60	*
516	IC-14-123	122.6-123.7	1.1	Ore	0.73	0.07	17.7	40	
517	IC-14-124	123.7-124.8	1.1	Py	3.02	0.05	0.36	80	
518	IC-14-131	130.0-131.6	1.6	Ald	0.06	0.03	2.38	10	
519	IC-14-132	131.6-132.7	1.1	Ore	0.36	0.06	32.8	30	*
520	IC-14-133	132.7-133.8	1.1	Ore	0.19	0.05	29.2	25	
521	IC-15-058	57.9- 59.9	2.0	Cu	0.06	0.01	0.08	6	
522	IC-15-060	59.9- 61.9	2.0	Cu	0.15	0.00	0.15	15	
523	IC-15-062	61.9- 63.9	2.0	Py	0.13	0.01	0.04	15	
524	IC-15-092	90.0- 93.2	3.2	Py	0.13	0.00	0.14	15	
525	IC-15-094	93.2- 97.2	4.0	Hm	0.07	0.01	0.80	15	
526	IC-15-098	97.2- 98.8	1.6	Cu	1.89	0.01	0.81	20	
527	IC-15-100	98.8-100.2	1.4	Cu	0.15	0.01	0.14	50	
528	IC-15-139	138.0-140.9	2.9	Py	0.03	0.21	2.71	18	
529	IC-15-141	140.9-143.8	2.9	Py	0.04	0.24	2.48	20	
530	IC-15-143	143.8-145.0	1.2	Do	0.12	0.02	8.31	20	
531	IC-16-050	50.0- 55.0	5.0	Ald	0.03	0.00	0.04	5	
532	IC-16-055	55.0- 60.0	5.0	Ald	0.64	0.00	0.26	4	
533	IC-16-060	60.0- 65.0	5.0	Ald	0.03	0.01	0.08	4	
534	IC-16-065	65.0- 70.0	5.0	Py	0.05	0.01	0.17	4	
535	IC-16-070	70.0- 75.0	5.0	Py	0.10	0.00	0.00	10	
536	IC-16-075	75.0- 80.0	5.0	Py	0.05	0.00	0.04	5	
537	IC-16-080	80.0- 85.0	5.0	Py	0.06	0.00	0.53	5	
538	IC-16-085	85.0- 91.0	6.0	Py	0.03	0.00	0.16	5	
539	IC-16-092	91.0- 93.0	2.0	Spc	0.11	0.01	0.07	4	
540	IC-16-094	93.0- 95.0	2.0	Spc	0.23	0.01	0.06	4	
541	IC-16-096	95.0- 97.0	2.0	Spc	0.32	0.01	0.15	4	
542	IC-16-098	97.0- 99.0	2.0	Spc	0.67	0.04	0.23	6	
543	IC-16-100	99.0-101.3	2.3	Spc	0.13	0.00	0.04	4	
544	IC-16-102	101.3-104.8	3.5	Py	0.06	0.03	0.13	5	
545	IC-16-130	129.0-130.5	1.5	Ald	0.06	0.01	3.50	5	
546	IC-16-131	130.5-131.8	1.3	Ald	0.05	0.01	9.00	7	
547	IC-16-132	131.8-132.8	1.0	Ald	0.58	0.02	2.75	2	
548	IC-16-133	132.8-133.6	0.8	Ald	0.01	0.04	0.03	7	
549	IC-16-135	133.6-138.5	4.9	Py	0.80	0.13	0.25	30	
550	IC-16-140	138.5-143.4	4.9	Py	0.65	0.19	0.59	20	

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
551	IC-17-089	88.4- 90.8	2.4	Py	0.34	0.00	0.53	6	
552	IC-17-091	90.8- 92.8	2.0	Hm	1.18	0.01	0.04	10	
553	IC-17-093	92.8- 94.8	2.0	Hm	0.17	0.01	0.04	6	
554	IC-17-095	94.8- 96.8	2.0	Hm	1.02	0.00	0.02	6	
555	IC-17-097	96.8- 98.2	1.4	Mt	1.18	0.00	0.18	15	
556	IC-17-099	98.2- 99.5	1.3	Mt	1.67	0.01	0.10	15	
557	IC-17-104	103.5-104.8	1.3	Mt	0.50	0.01	0.08	8	
558	IC-17-106	105.5-110.5	5.0	Py	0.02	0.01	0.03	5	
559	IC-17-111	110.5-115.5	5.0	Py	0.03	0.03	0.20	4	
560	IC-17-116	115.5-120.5	5.0	Py	0.21	0.01	0.11	6	
561	IC-17-121	120.5-125.5	5.0	Py	0.04	0.01	0.06	5	
562	IC-17-127	127.3-127.7	0.4	Ore	9.00	0.00	38.40	11	*
563	IC-17-132	131.8-133.0	1.2	Py	0.09	0.00	0.80	6	
564	IC-17-133	133.0-134.2	1.2	Py	0.30	0.01	0.56	6	
565	IC-17-140	140.0-141.0	1.0	Ore	0.42	0.00	22.00	8	
566	IC-18-070	70.0- 75.0	5.0	Gos	0.02	0.01	0.06	10	
567	IC-18-075	75.0- 80.0	5.0	Gos	0.08	0.01	0.31	6	
568	IC-18-080	80.0- 85.0	5.0	Gos	0.09	0.01	0.10	8	
569	IC-18-085	85.0- 90.0	5.0	Py	0.06	0.01	0.18	6	
570	IC-18-090	90.0- 95.4	5.4	Py	0.30	0.01	0.12	4	
571	IC-18-096	95.4- 96.9	1.5	Py	0.22	0.00	0.12	4	
572	IC-18-097	96.9- 98.5	1.6	Cu	7.46	0.05	26.66	13	
573	IC-18-099	98.5- 99.9	1.4	Cu	0.95	0.02	27.49	8	
574	IC-18-101	99.9-101.8	1.9	Sk	0.40	0.01	13.00	5	
575	IC-18-102	101.8-102.8	1.0	Py	0.39	0.01	25.50	5	
576	IC-18-103	102.8-103.8	1.0	Ore	3.06	0.02	34.60	14	*
577	IC-18-104	103.8-104.8	1.0	Ore	1.09	0.01	31.60	8	*
578	IC-18-105	104.8-105.8	1.0	Ore	0.46	0.00	29.80	6	*
579	IC-18-106	105.8-106.8	1.0	Ore	0.51	0.01	22.49	10	
580	IC-18-107	106.8-107.8	1.0	Ore	0.32	0.01	20.83	10	
581	IC-18-108	107.8-108.8	1.0	Ore	0.77	0.01	39.00	10	*
582	IC-18-109	108.8-109.8	1.0	Ore	0.78	0.00	32.00	10	*
583	IC-18-110	109.8-110.8	1.0	Ore	0.75	0.00	24.16	10	
584	IC-18-112	110.8-112.4	1.6	Sk	0.24	0.03	5.25	4	
585	IC-18-113	112.4-114.0	1.6	Sk	0.15	0.00	8.00	4	
586	IC-18-115	114.0-115.3	1.3	Sk	0.48	0.01	16.62	7	
587	IC-18-116	115.3-116.4	1.1	Mt	1.71	0.01	1.09	14	
588	IC-18-117	116.4-118.0	1.6	Sk	0.26	0.04	6.00	6	
589	IC-18-119	118.0-119.1	1.1	Ore	0.51	0.01	28.33	13	
590	IC-18-120	119.1-120.2	1.1	Ore	0.36	0.01	11.66	8	
591	IC-18-121	120.2-121.2	1.0	Ore	4.20	0.01	25.83	10	
592	IC-18-122	121.2-122.2	1.0	Ore	1.18	0.00	14.50	4	
593	IC-18-125	124.2-125.5	1.3	Cu	2.44	0.00	17.50	8	
594	IC-18-126	125.5-126.8	1.3	Cu	0.58	0.01	0.22	6	
595	IC-18-131	130.4-131.1	0.7	Py	0.10	0.01	0.05	6	
596	IC-18-132	131.1-132.0	0.9	Sh	1.13	0.01	5.20	10	
597	IC-18-133	132.5-134.5	2.0	Sh	0.08	0.01	0.26	2	
598	IC-18-139	137.7-140.0	2.3	Sh	0.10	0.01	0.07	3	
599	IC-18-141	140.0-142.4	2.4	Sh	0.05	0.01	0.05	5	
600	IC-18-143	142.4-143.3	0.9	Ald	0.07	0.01	0.16	3	

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
601	IC-19-145	144.0-149.0	5	Gos	0.05	0.3	0.8	38	**
602	IC-19-150	149.0-154.0	5	Ald	0.25	0.1	1.2	10	**
603	IC-19-155	154.0-159.0	5	Ald	1.57	0.1	1.4	10	**
604	IC-19-160	159.0-164.3	5.3	Ald	0.41	0.1	2.2	10	**
605	IC-19-165	164.3-168.7	4.4	Py	0.17	0.1	2.7	10	**
606	IC-19-170	168.7-173.9	5.2	Py	0.12	0.1	0.3	7	**
607	IC-19-175	178.2-179.7	1.5	Py	0.02	0.1	0.2	10	**
608	IC-19-180	179.7-184.0	4.3	Ald	0.06	0.1	0.3	7	**
609	IC-19-185	184.0-187.0	3.0	Ald	0.04	0.0	0.1	10	**
610	IC-19-190	187.0-193.9	6.9	Sh	0.03	0.1	0.2	69	**

Ore: Pb·Zn ore
Cu: Cu ore
Py: Pyrite
Po: Pyrrhotite
Mt: Magnetite
Spc: Specularite
Hm: Hematite
Ald: Altered rock
Sid: Siderite
Do: Dolomite
Sh: Shale
Alt: Alternation
Sk: Skarn
Gos: Gossan

Non-mark: All elements were assayed by INGEMMET Lab.
* : Assayed by INGEMMET Lab., but only Zn was assayed by Plenge
** : All elements were assayed by Plenge

A. Ⅲ-1 Assay Results (2) Tunnelling Sample (1)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
701	CN-5-34	80 - 81	1	Py	1.40	0.03	0.07	50	N-CX1
702	CN-5-35	81 - 82	1	Py	0.53	0.01	0.14	13	
703	CN-6-01	82 - 83	1	Py	0.08	0.03	0.12	11	
704	CN-6-03	84 - 85	1	Py	3.06	0.03	0.11	26	
705	CN-6-25	106 -107	1	Py	0.32	0.01	0.25	11	
706	CN-6-27	108 -109	1	Py	0.99	0.01	0.05	6	
707	NN-098	98 - 99	1	Py	0.03	0.01	0.08	8	N-CX2
708	NN-100	100 -101	1	Py	0.03	0.01	0.06	6	
709	NN-102	102 -103	1	Py	0.10	0.02	0.04	6	
710	NN-104	104 -105	1	Py	0.13	0.05	0.16	11	
711	NN-108	108 -109	1	Py	0.24	0.05	0.10	16	
712	NN-112	112 -113	1	Py	5.63	0.34	0.15	40	
713	NN-116	116 -117	1	Py	0.19	0.06	0.13	19	
714	NN-120	120 -121	1	Py	0.56	0.37	1.50	11	
715	NN-122	122 -123	1	Py	1.38	1.05	1.79	70	
716	NN-124	124 -125	1	Py	0.67	0.58	9.38	42	
717	NN-126	126 -127	1	Py	0.67	0.10	9.25	11	
718	NN-128	128 -129	1	Ald	1.72	0.04	0.30	12	
719	NN-130	130 -131	1	Ald	0.33	0.33	1.64	13	
720	NN-132	132 -133	1	Ald	0.03	0.01	0.03	30	
721	NN-134	134 -135	1	Alt	0.06	0.02	0.03	20	
722	NN-136	136 -137	1	Alt	0.86	0.02	0.10	20	
723	NN-138	138 -139	1	Py	0.05	0.01	0.04	7	
724	NN-140	140 -141	1	Py	0.87	0.01	2.93	6	
725	NN-123S	123 -124	1	Py	0.07	0.01	0.15	63	
726	NN-125S	125 -126	1	Py	1.38	0.56	1.93	40	
727	NN-127S	127 -128	1	Ald	0.09	0.06	0.19	4	
728	NN-129S	129 -130	1	Ald	0.93	0.05	0.87	10	
729	NN-131S	131 -132	1	Ald	0.10	0.01	0.13	8	
730	NN-169S	169 -170	1	Hm	0.65	0.04	0.27	20	
731	SX-052	52.0- 53.0	1	Py	0.16	tr	tr	97	S-CX1**
732	SX-055	54.5- 55.5	1	Py	0.12	nd	tr	19	**
733	SX-057	57.0- 58.0	1	Ald	0.27	nd	0.1	14	**
734	SX-062	62.0- 63.0	1	Py	0.17	tr	0.2	15	**
735	SX-065	64.5- 65.5	1	Py	0.33	tr	tr	13	**
736	SX-067	67.0- 68.0	1	Py	0.08	tr	0.1	24	**
737	SX-070	69.5- 70.5	1	Py	0.09	0.1	0.1	46	**
738	SX-072	72.0- 73.0	1	Py	0.06	tr	0.2	24	**
739	SX-075	74.5- 75.5	1	Py	0.27	tr	tr	7	**
740	SX-077	77.0- 78.0	1	Py	0.14	tr	tr	6	**
741	SX-080	79.5- 80.5	1	Py	0.06	nd	tr	4	**
742	SX-082	82.0- 83.0	1	Py	0.36	tr	tr	6	**
743	SX-085	84.5- 85.5	1	Ald	0.65	nd	tr	13	**
744	SX-087	87.0- 88.0	1	Py	0.01	tr	tr	7	**
745	SX-090	90.0- 91.0	1	Ald	0.01	nd	tr	17	**
746	SX-095	94.5- 95.5	1	Hm	0.03	tr	0.1	66	**
747	SX-099	98.5- 99.5	1	Ald	0.05	tr	0.1	3	**
748	SX-124	124.0-125.0	1	Py	7.00	0.1	0.1	76	**
749	SX-129	129.0-130.0	1	Py	0.04	tr	0.3	21	**
750	SX-131	131.0-132.0	1	Ald	0.04	tr	1.0	4	**

(2)

No.	Sample No.	Depth (m)	Length (m)	Rock Type	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Note
751	SX-134	133.5-134.5	1	Do	0.01	tr	0.5	4	**
752	S34-06	5.4- 6.4	1	Do	0.09	15.6	19.2	143	S-CX2**
753	S34-07	6.4- 7.4	1	Do	0.04	2.3	5.6	26	**
754	S34-08	7.4- 8.4	1	Ore	0.03	5.8	9.1	53	**
755	S34-09	8.4- 9.4	1	Ore	0.08	2.7	41.2	118	**
756	S34-10	9.4- 10.4	1	Ore	0.08	2.2	36.7	121	**
757	S34-11	10.4- 11.4	1	Ore	0.07	4.3	30.2	233	**
758	S2S-01	0.2- 1.2	1	Ore	0.11	0.5	36.3	139	**
759	S2S-02	1.2- 2.2	1	Ore	0.35	0.4	44.3	168	**
760	S2S-03	2.2- 3.2	1	Ore	0.42	0.3	46.9	177	**
761	S2S-04	3.2- 4.2	1	Ore	0.50	0.4	45.5	179	**
762	S2S-05	4.2- 5.2	1	Ore	0.50	0.7	50.8	198	**
763	S2S-06	5.2- 6.2	1	Ore	0.19	1.9	38.8	163	**
764	S2S-07	6.2- 7.2	1	Ore	0.05	6.7	20.0	146	**
765	S2S-08	7.2- 8.2	1	Ore	0.09	7.1	25.1	293	**
766	S2S-09	8.2- 9.2	1	Ore	0.05	9.9	26.9	400	**
767	S2S-10	9.2- 10.2	1	Ore	0.03	7.0	19.9	157	**
768	S2S-11	10.2- 11.2	1	Ore	0.04	5.8	19.4	138	**
769	S2S-12	11.2- 12.2	1	Ore	0.11	2.9	20.5	52	**
770	S2S-13	12.2- 13.2	1	Py	0.11	2.2	4.5	76	**
771	S34-05S	4.4- 5.4	1	Do	0.05	0.7	4.0	34	**
772	S34-06S	5.4- 6.4	1	Do	0.02	0.5	1.8	15	**
773	S34-07S	6.4- 7.4	1	Do	0.04	2.0	4.5	92	**
774	S34-08S	7.4- 8.4	1	Ore	0.04	2.4	27.5	118	**
775	S34-09S	8.4- 9.4	1	Ore	0.06	2.6	6.7	42	**
776	S34-10S	9.4- 10.4	1	Ore	0.16	0.2	34.1	94	**
777	S2S-01S	0.2- 1.2	1	Ore	0.23	0.7	32.2	110	**
778	S2S-02S	1.2- 2.2	1	Ore	0.46	0.2	48.6	161	**
779	S2S-03S	2.2- 3.2	1	Ore	0.57	0.3	51.6	187	**
780	S2S-04S	3.2- 4.2	1	Ore	0.17	0.4	46.3	181	**
781	S2S-05S	4.2- 5.2	L	Ore	0.10	4.1	31.0	174	**
782	S2S-06S	5.2- 6.2	1	Ore	0.04	2.5	8.9	95	**
783	S2S-07S	6.2- 7.2	1	Ore	0.05	9.4	28.4	619	**
784	S2S-08S	7.2- 8.2	1	Ore	0.08	8.3	33.9	651	**
785	S2S-09S	8.2- 9.2	1	Ore	0.06	7.4	30.5	216	**
786	S2S-10S	9.2- 10.2	1	Ore	0.05	4.1	17.3	76	**
787	S2S-11S	10.2- 11.2	1	Py	0.06	1.4	6.3	70	**
788	S2S-12S	11.2- 12.2	1	Py	0.14	2.1	6.6	24	**
789	S3S-29	29.0- 30.0	1	Ore	0.05	0.9	6.2	80	**
790	S3S-30	30.0- 31.0	1	Ore	0.15	6.4	34.8	57	**
791	S3S-31	31.0- 32.0	1	Ore	0.18	0.5	18.1	23	**
792	S3S-32	32.0- 33.0	1	Ore	0.04	5.1	6.0	23	**
793	S3S-33	33.0- 34.0	1	Ore	0.13	3.8	6.0	26	**
794	S3S-34	34.0- 35.0	1	Ore	0.10	0.4	17.4	13	**
795	S3S-35	35.0- 36.0	1	Ore	0.06	0.2	9.3	9	**
796	S3S-30S	29.6- 30.6	1	Ore	0.03	2.3	5.6	11	**
797	S3S-31S	30.6- 31.6	1	Ore	0.04	0.7	3.3	10	**
798	S3S-32S	31.6- 32.6	1	Ore	0.06	0.7	21.9	12	**
799	S3S-33S	32.6- 33.6	1	Ore	0.03	6.0	7.0	22	**
800	S3S-34S	33.6- 34.6	1	Ore	0.14	4.5	5.4	22	**

A. Ⅲ-1 Assay Results (3) Check Assay

No.	Sample No.	INGEMMET Cu (%)	INGEMMET Pb (%)	INGEMMET Zn (%)	INGEMMET Ag (g/t)	Huanzala Mine Cu (%)	Huanzala Mine Pb (%)	Huanzala Mine Zn (%)	Huanzala Mine Ag (g/t)	Huanzala Mine Fe (%)	Plenge Zn (%)	Plenge S (%)	Remarks
416	IC-11-109	0.03	4.00	6.4	31	0.04	4.8	5.4	32	17.8	5.2	16.6	
421	IC-11-117	0.03	3.60	32.2	44	0.04	3.6	31.8	44	17.4	32.2	31.8	
426	IC-11-122	0.06	1.28	44.4	61	0.07	1.4	47.2	56	12.5	47.1	32.1	
431	IC-11-129	0.03	3.90	10.0	23	0.06	3.5	8.0	24	30.9	7.2	31.8	
441	IC-11-176	0.00	0.10	2.0	7	0.02	0.1	2.2	8	40.4	1.8	41.2	
446	IC-12-149	0.03	1.65	8.2	86	0.04	1.5	7.4	24	32.2	6.7	34.1	
451	IC-12-154	0.01	1.90	4.5	38	0.02	1.5	3.4	32	44.7	2.9	30.1	
456	IC-12-159	0.00	1.50	4.6	19	0.02	1.2	3.4	16	27.5	3.2	18.9	
461	IC-12-164	0.09	2.40	42.0	156	0.09	2.1	40.7	140	5.5	39.6	23.7	
463	IC-12-166	1.78	0.03	66.0	104	1.70	0.1	55.1	100	5.5	54.1	31.0	
466	IC-12-169	1.04	0.06	70.0	172	0.96	0.1	56.2	156	5.4	56.3	31.2	
468	IC-12-171	0.15	0.17	52.0	79	0.15	0.2	49.4	76	6.7	49.0	29.9	
471	IC-12-174	0.06	1.75	39.0	83	0.08	1.9	42.2	76	12.9	41.8	32.8	
476	IC-12-179	0.03	2.60	36.0	36	0.04	2.5	35.6	32	12.7	34.9	27.1	
481	IC-12-185	0.02	0.12	9.0	20	0.05	0.3	7.8	12	17.4	6.6	4.6	
491	IC-14-047	0.35	0.02	0.0	30	0.08	0.1	0.4	9	23.2	0.2	25.5	
501	IC-14-097	0.35	0.01	0.4	30	0.36	0.1	1.1	24	16.2	0.5	5.1	
506	IC-14-111	0.12	0.07	16.6	25	0.13	0.1	15.3	20	11.8	14.4	8.5	
511	IC-14-118	0.19	0.01	30.3	30	0.22	0.1	25.5	40	26.4	24.0	38.0	
516	IC-14-123	0.73	0.07	17.7	40	0.72	0.1	14.5	44	33.6	13.4	42.0	
571	IC-18-096	0.22	0.00	0.1	4	0.23	0.0	0.2	4	32.8	0.3	36.4	
576	IC-18-103	3.06	0.02	42.5	14	3.10	0.0	35.5	12	11.6	34.6	29.1	
581	IC-18-108	0.77	0.01	45.0	10	0.79	0.0	39.1	8	9.0	39.0	26.0	
586	IC-18-115	0.48	0.01	16.6	7	0.48	0.0	15.3	8	25.0	13.4	8.7	
591	IC-18-121	4.20	0.01	25.8	10	4.30	0.0	21.9	8	18.5	21.3	29.1	

A. Ⅲ-2 Summary of Microscopic Observation

Sample No.	Type (Minerals)	Sphalerite	Sphalerite *	Galena	Chalcopyrite	Bornite	Enargite	Tennantite	Chalcocite	Covellite	Gersdorffite		Pyrite	Marcasite	Pyrrhotite	Magnetite	Hematite	Limonite	Remarks
IC-11-111	Pb-Zn-Py ore	◎	∘	○									○	○	∘				Mar replaces Py
IC-11-120	Zn-Py ore	◎	∘	○	•								◎		•				
IC-12-156	Zn-Py-Po ore	○		∘									○		◎				Po is massive
IC-12-162	Pb-Zn ore	◎	∘	○									○		•				
IC-12-163	Pb-Zn ore	◎	∘	∘									∘		∘				Po is dots in Sp
IC-12-167	Zn ore	◎	◎		○						•		○						Gf is with Py
IC-12-170	Zn ore	◎	○	•	∘								∘						
IC-12-174	Pb-Zn ore	◎		○	•								○						
IC-12-178	Pb-Zn-Py ore	◎		○									○		∘				Po is fgd in Sp
IC-12-183	Pb-Zn-Py ore	◎	∘	○	∘								○		∘				Po is in Gl
IC-14-115	Zn ore	○	○	∘	∘											◎			Mt is auhedral, aggr. and diss.
IC-14-118	Zn ore	○	○	∘	∘								○			∘	•		
IC-14-133	Zn-Py ore	○	○		∘								○						
IC-15-086	Eng-Py ore				∘	∘	◎		∘	∘			○						Eng is between gangue m.
IC-15-100	Cp-Py ore				◎								○				∘	∘	Hm is tabular and needle
IC-17-098	Mt ore				∘								∘	∘		◎			Banding str.
IC-17-128	Zn diss ore	○	○		∘								∘						
IC-18-125	Zn-Py ore	○	∘		∘				∘				◎						
CN-6-12	Cp-Py ore				◎								◎		•				
NN-105	Cc ore	∘		∘	∘			∘		∘			◎						Ten is with Cp, in Sp

◎ abundant ○ common ∘ fairly • rare * Sphalerite with Chalcopyrite dots

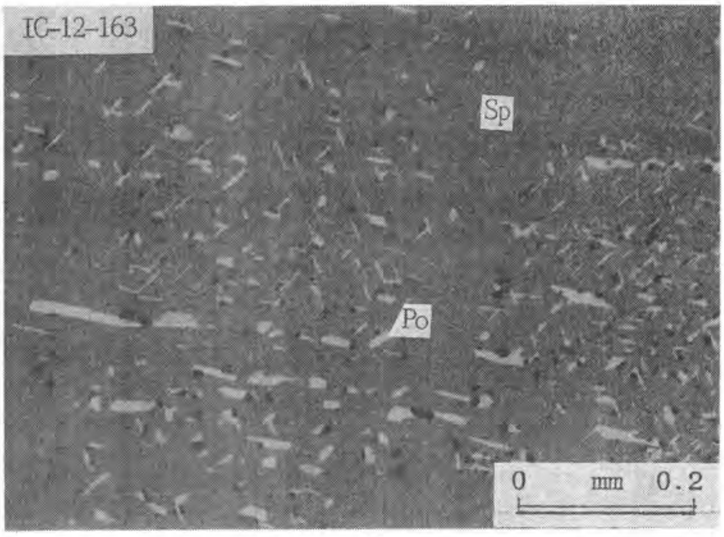
A. Ⅲ-3 Microscopic Observation of Polished Sections

(1)

Sample No.	Rock Type	Observation Note
IC-11-111	Pb-Zn-Py ore	Ore minerals are composed of great amount of sphalerite, moderate amount of pyrite, marcasite and galena with minor amount of pyrrhotite. Sphalerite is in massive form, containing small dots of pyrrhotite. Galena is porphyritically distributed around sphalerite in many cases. Pyrite is euhedral ∿ anhedral and is in aggregates. Marcasite is seen to have replaced pyrite in parts. Pyrrhotite is found in dots and is contained in sphalerite and pyrite.
IC-11-120	Zn-Py ore	Ore minerals are composed of great amount of pyrite, large amount of sphalerite, small amount of galena and slight amount of chalcopyrite and pyrrhotite. Pyrite is euhedral ∿ anhedral and is found in aggregates. Sphalerite is recognized to occur in spaces between pyrite grains, containing slight amount of dots of chalcopyrite and pyrrhotite. Galena is found in sphalerite, along boundaries between sphalerite and pyrite, and in spaces between pyrite grains.
IC-12-156	Zn-Py-Po ore	Ore minerals are composed of great amount of pyrrhotite, moderate amount of sphalerite and pyrite with small amount of galena. Pyrrhotite constitutes matrix. In some cases pyrite is euhedral and is contained in pyrrhotite while in other cases it is found to have filled cracks of pyrrhotite. Sphalerite and galena are found to be in the space between pyrrhotite grains.
IC-12-162	Pb-Zn ore	Ore minerals are composed of great amount of sphalerite, moderate amount of galena and pyrite with slight amount of pyrrhotite. Sphalerite is found in massive form, containing slight amount of dots of pyrrhotite. Pyrite is euhedral ∿ anhedral and is found scattered in sphalerite and in gangue minerals although seams of pyrite and found in parts.
IC-12-163	Pb-Zn ore	Ore minerals are composed of great amount of sphalerite and small amount of galena, pyrite and pyrrhotite. Sphalerite is recognized in massive form. Galena is fine grained and is found contained in sphalerite grains. Pyrite is euhedral, fine grained and is observed to be contained in sphalerite. Pyrrhotite has lattice-like exolution structure (see photograph).
IC-12-167	Zn ore	Ore minerals are composed of great amount of sphalerite, moderate amount of chalcopyrite and pyrite with slight amount of gersdorffite. Sphalerite is recognized in massive form containing chalcopyrite dots. Chalcopyrite has exolution structure in dots in sphalerite in some cases, while in other cases it is found in cracks of pyrite, along margins of pyrite or in spaces between sphalerite grains. Pyrite is anhedral and is contained in sphalerite. Gersdorffite is several ten um in diameter, and is associated with pyrite contained in sphalerite (see photograph).
IC-12-170	Zn ore	Ore minerals are composed of great amount of sphalerite, small amount of chalcopyrite and pyrite with slight amount of galena. Sphalerite is recognized in massive form containing chalcopyrite dots. Sphalerite has zonal structure according to dots of chalcopyrite. Chalcopyrite is fine grained and is contained in sphalerite in addition to the one found in dots. Pyrite and galena are also fine grained and are contained in sphalerite.
IC-12-174	Pb-Zn ore	Ore minerals are composed of great amount of sphalerite, moderate amount of galena and pyrite with slight amount of chalcopyrite. Sphalerite is in massive form. Pyrite is euhedral to anhedral and is recognized to be in aggregates in sphalerite. Galena is found to be fine grained or porphyritically in sphalerite (see photograph).
IC-12-178	Pb-Zn-Py ore	Ore minerals are composed of great amount of sphalerite, moderate amount of galena and pyrite with slight amount of pyrrhotite. Sphalerite is found in massive form and in network. Pyrite has bird-eye structure in some parts.

Sample No.	Rock Type	Observation Note
IC-12-183	Pb-Zn-Py ore	Ore minerals are composed of great amount of sphalerite, moderate amount of galena and pyrite with small amount of chalcopyrite and pyrrhotite. Sphalerite is found in massive form. Most of galena and chalcopyrite are recognized to be along boundaries between sphalerite and pyrite. Pyrite has bird-eye structure in parts and has been altered in some way. The order of the crystallization is estimated as below (see photograph). Pyrite Sphalerite Galena Chalcopyrite Pyrrhotite 
IC-14-115	Zn-Mt ore	Ore minerals are composed of large amount of sphalerite and magnetite with less amount of galena and chalcopyrite. Sphalerite contains dots of chalcopyrite and is distributed porphyritically. Magnetite is euhedral and is found in aggregates or in dissemination. The crystallization of magentite is estimated to have been prior to that of sphalerite. Galena is fine grained and is contained in sphalerite.
IC-14-118	Zn ore	Ore minerals are composed of large amount of sphalerite, moderate amount of pyrite, small amount of galena and chalcopyrite with slight amount of hematite. Sphalerite is observed to occur porphyritically, containing chalcopyrite dots. Pyrite is euhedral ∿ anhedral and is contained in sphalerite. Magnetite is recognized to be in gangue minerals or in sphalerite. Hematite is columnar and is found to be in sphalerite or along margins of magnetite. Hematite is estimated to have replaced magnetite.
IC-14-133	Zn-Py ore	Ore minerals are composed of large amount of sphalerite, moderate amount of pyrite and small amount of chalcopyrite. Sphalerite is recognized to be distributed porphyritically, containing chalcopyrite dots. Pyrite is euhedral ∿ anhedral and is found to be contained in sphalerite.
IC-15-086	Eng-Py ore	Ore minerals are composed of large amount of enargite, moderate amount of pyrite and small amount of chalcopyrite, chalcocite, bornite and covellite. Enargite is found to have filled spaces between grains. It contains pyrite and is also observed to have replaced pyrite partly. Chalcopyrite, bornite and chalcocite are recognized to be around enargite or in cracks of enargite. Covellite is found to be along margins of chalcopyrite. Covellite is thought to be one of the secondary minerals.
IC-15-100	Cp-Py ore	Ore minerals are composed of large amount of chalcopyrite, moderate amount of pyrite and small amount of hematite and limonite. Chalcopyrite is distributed porphyritically, containing pyrite.
IC-17-098	Mt ore	Ore minerals are composed of great amount of magnetite and small amount of pyrite, chalcopyrite and hematite. Magnetite is found to be in banded structure and anhedral pyrite is recognized along the cracks parallel to the banding. Chalcopyrite is found to be distributed around pyrite and in cracks of magnetite. Hematite is thought to have replaced magnetite. The order of the crystallyzation is estimated as below. Magnetite Pyrite Chalcopyrite Hematite 
IC-17-128	Zn diss ore	Ore minerals are composed of large amount of sphalerite and small amount of chalcopyrite and pyrite. Sphalerite is disseminated in banded form and it contains dots of chalcopyrite. Pyrite is recognized to be distributed around sphalerite and therefore the crystallization of pyrite is thought to have been later than that of sphalerite.
IC-18-125	Zn-Py ore	Ore minerals are composed of large amount of pyrite, moderate amount of sphalerite and small amount of chalcopyrite and chalcocite. Pyrite is euhedral to anhedral and is found in aggregates. Sphalerite is recognized to have occupied spaces between pyrite grains and contains dots of chalcopyrite partly. Chalcocite is found along margins of sphalerite as well as in cracks of sphalerite. Chalcocite is thought to be one of the secondary minerals. In some parts of pyrite and sphalerite, brecciation is recognized.

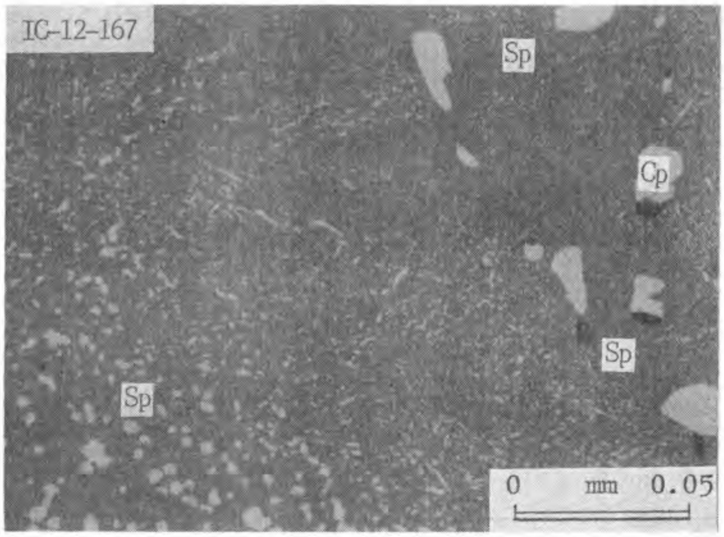
Sample No.	Rock Type	Observation Note
CN-6-12	Cp-Py ore	Ore minerals are composed of large amount of pyrite, moderate amount of chalcopyrite, and slight amount of pyrrhotite. Pyrite is euhedral ∿ anhedral and is found in aggregates. Spaces between pyrite grains have been filled with chalcopyrite. Pyrrhotite is fine grained though only several grains of pyrrhotite are recognized in pyrite.
NN-105	Cc ore	Ore minerals are composed of large amount of pyrite and small amount of covellite, chalcopyrite, sphalerite and galena. Pyrite is anhedral and is found in dissemination or in aggregates. Partly it is brecciated. Galena is fine grained and is contained in pyrite. Sphalerite is found in and around pyrite. Copper minerals as tennantite, chalcopyrite and covellite are recognized to be distributed around pyrite. Covellite is thought to be one of the secondary minerals. It is noted that, according to the results of qualitative analysis carried out with E.P.M.A., the tennantite found here does contain very little of silver (see photograph).



Sample No. IC-12-163

Type of Ore: Pb-Zn Ore

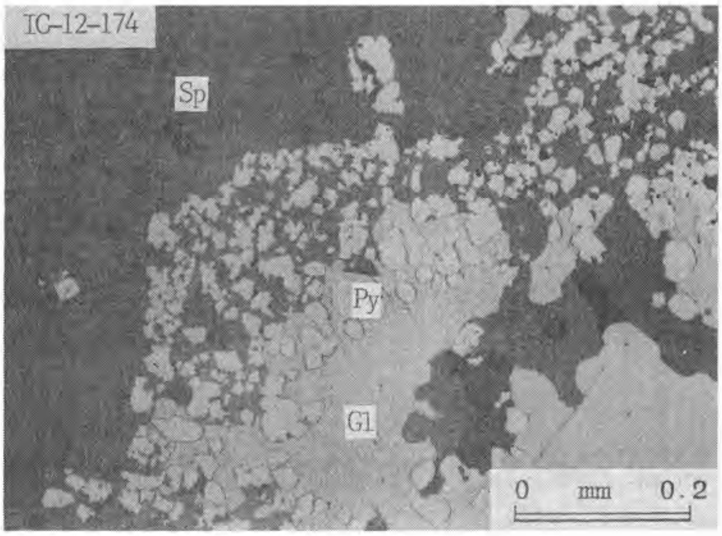
Sp: Sphalerite
Po: Pyrrhotite



Sample No. IC-12-167

Type of Ore: Zn Ore

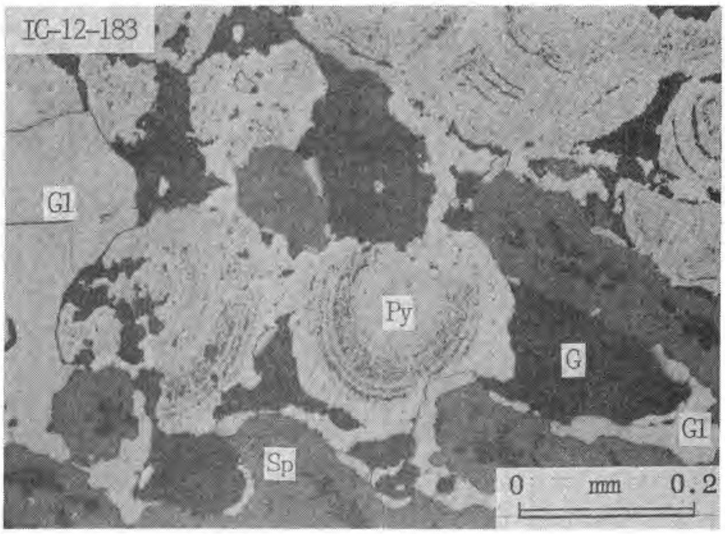
Sp: Sphalerite
Cp: Chalcopyrite



Sample No. IC-12-174

Type of Ore: Pb-Zn Ore

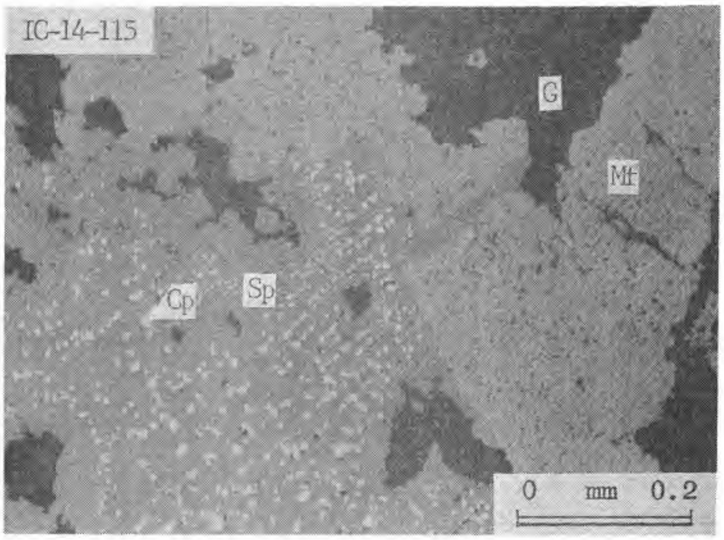
Sp: Sphalerite
Gl: Galena
Py: Pyrite



Sample No. IC-12-183

Type of Ore: Py-Zn-Py Ore

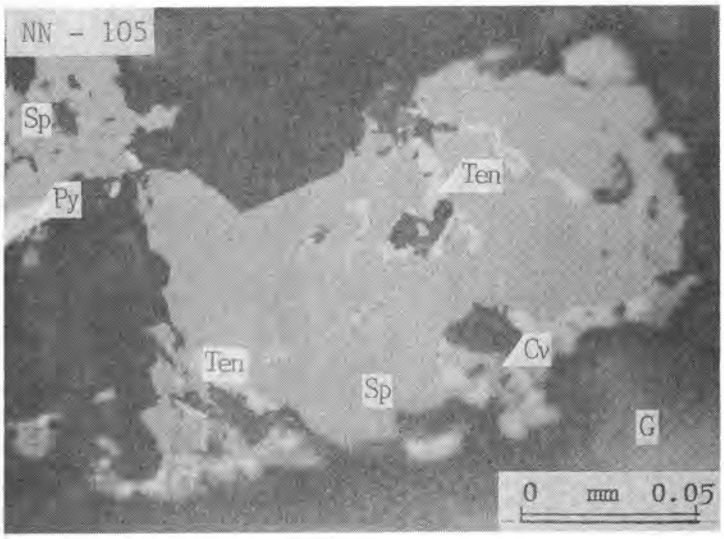
Gl: Galena
Sp: Sphalerite
Py: Pyrite
G: Gangue m.



Sample No. IC-14-115

Type of Ore: Zn-Mt Ore

Sp: Sphalerite
Cp: Chalcopyrite
Mt: Magnetite
G : Gangue m.



Sample No. NN-105

Type of Ore: Cu Ore

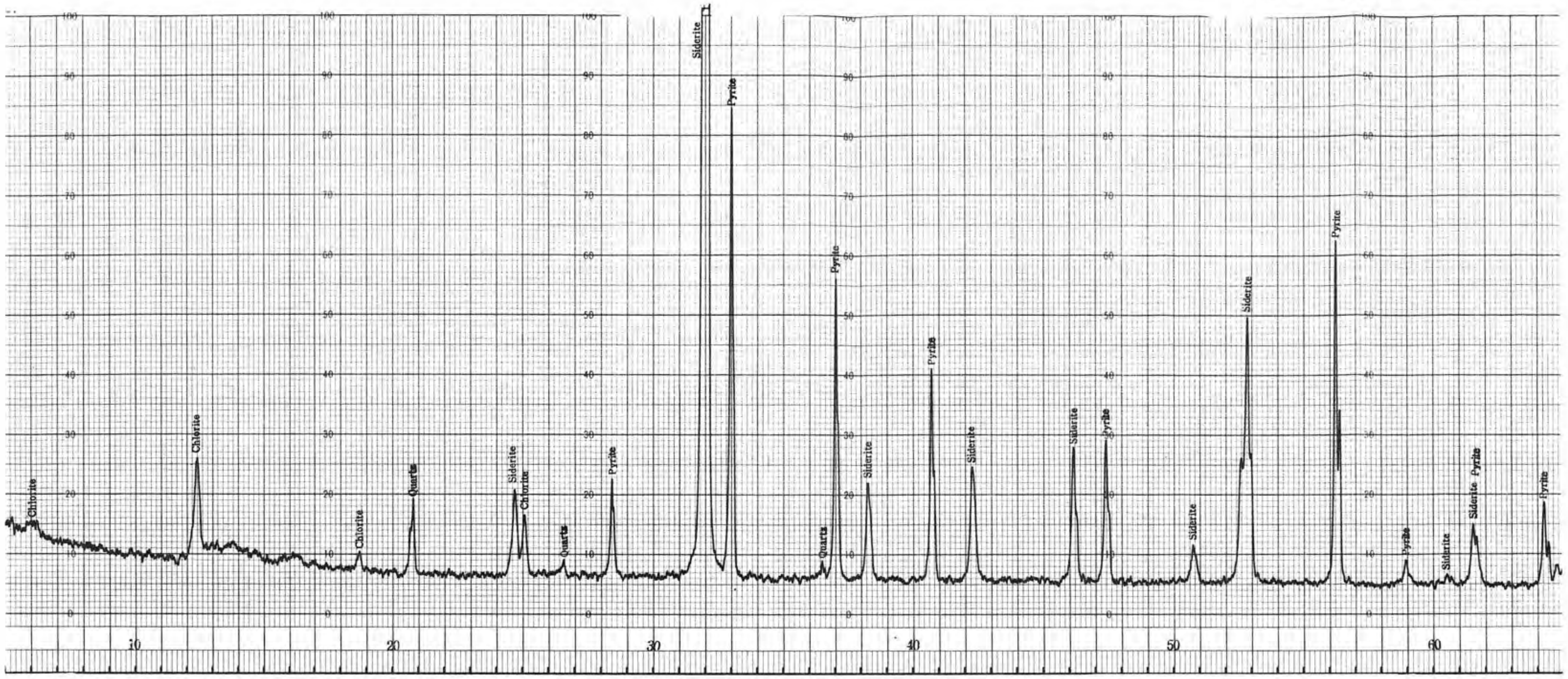
Sp: Sphalerite
Cv: Covellite
Py: Pyrite
Ten: Tennantite
G: Gangue m.

A. Ⅲ-5 Summary of X-Ray Diffraction Analysis

Sample No.	Type \ Mineral	Quartz	Calcite	Siderite		Sericite	Chlorite	Talc	Rutile		Chalcopyrite	Galena	Sphalerite	Pyrite	Magnetite		Amorphous
IC-12-102	Do	◎				∘			∘					∘			
IC-12-146	Ald	◎		•									◎				◎
IC-12-163	Zn-ore	∘					•					∘	◎				
IC-12-167	Zn-ore	∘									○		◎	∘			
IC-12-218	Siderite-Py	•		◎			∘							◎			
IC-14-095	Ald	◎					◎							∘			
IC-14-115	Zn-ore	○	•			○	∘	•					◎		◎		
IC-18-099	Skarn		•				∘	◎					◎				
NN-125	Zn diss Ald	◎	∘					∘					◎				
SX-070	Py-clay	◎				○								◎			

◎ abundant ○ common ∘ fairly • rare

A. Ⅲ-6 X-Ray Diffraction Chart



Sample No. IC-12-218

Target	Cu
G. Monochro	
Voltage	40 kv
Current	150 mA
Full Scale Range	4000 cps
Time Constant	0.5 sec
Scanning Speed	4 °/min
Chart Speed	4 cm/min
Divergency	1 °
Receiving Slit	0.15 mm
Detector	S.C
Date	3. 1984
Diffractometer	Rotaflex RU-200

MINDECO

Sample No. IC-18-099

Target	Cu
G. Monochro	
Voltage	40 kv
Current	150 mA
Full Scale Range	4000 cps
Time Constant	0.5 sec
Scanning Speed	4 °/min
Chart Speed	4 cm/min
Divergency	1 °
Receiving Slit	0.15 mm
Detector	S.C
Date	3. 1984
Diffractometer	Rotaflex RU-200

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