REPORT ON GEOLOGICAL SURVEY

OF

NORTHEASTERN BOTSWANA

REPUBLIC OF BOTSWANA

REPORT ON GEOLOGICAL SURVEY OF NORTHEASTERN BOTSWANA

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PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Botswana, decided to conduct collaborative mineral exploration in an area stretching over the Northeast and Central District in the northeastern Botswana and entrusted its execution to Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ). Between July 16 and November 1, 1982, Metal Mining Agency of Japan dispatched a survey team to conduct Phase IV of the project.

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

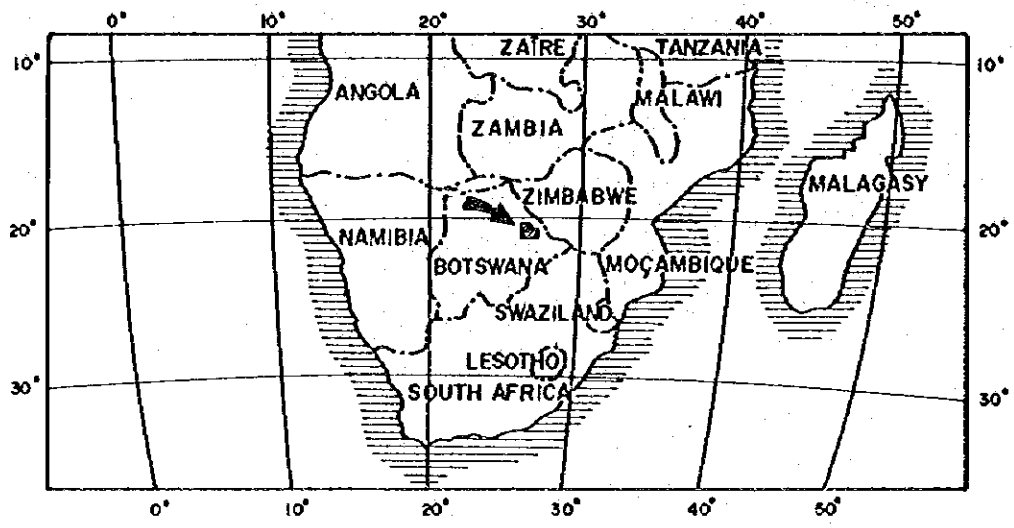
We wish to express our heartfelt gratitude to the Government of the Republic of Botswana and other authorities concerned for the kind cooperation and support extended to the Japanese survey team.

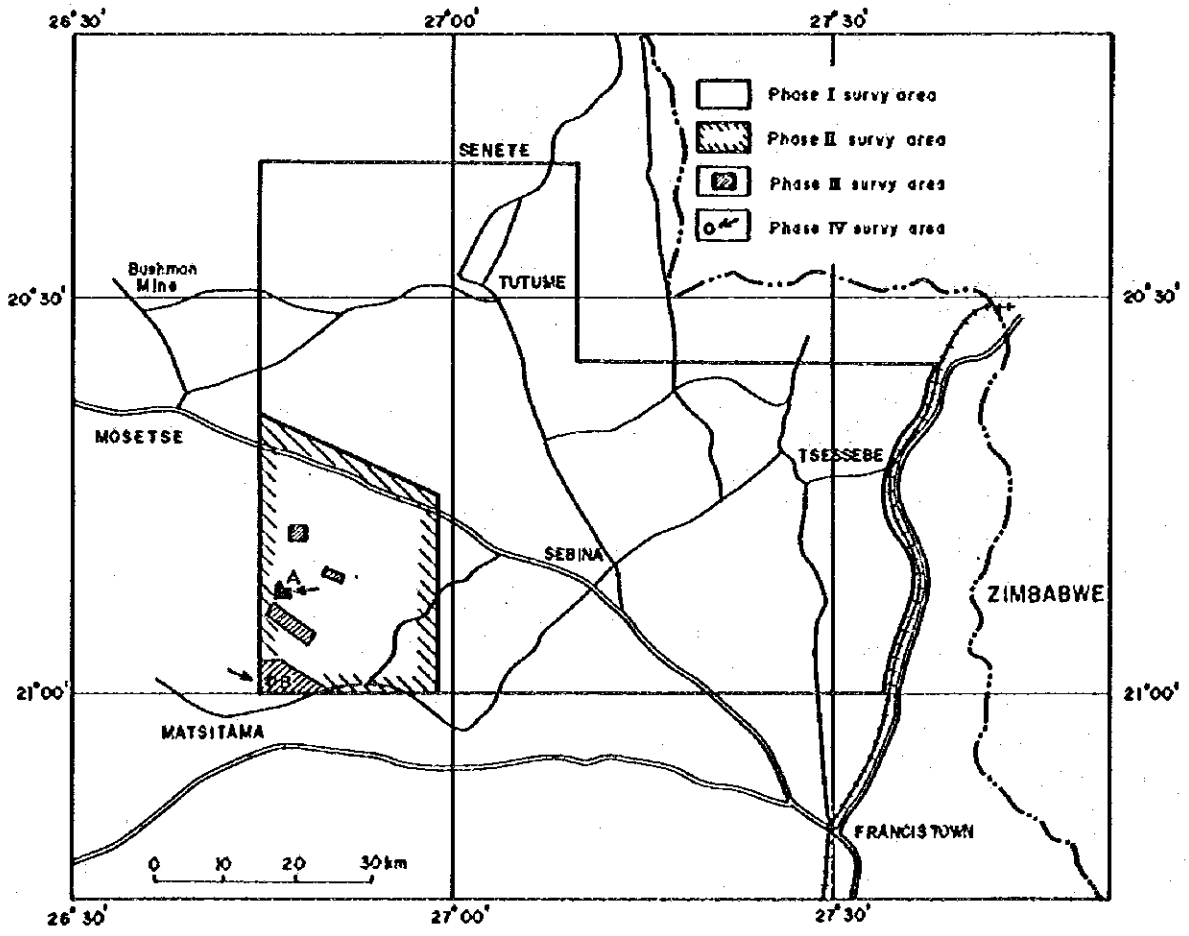
February 1983

Keisuke Arita
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan

Fig. 1 Location map of the survey area





SUMMARY

In the fourth year program, detailed prospecting, mainly depending on drilling, was carried out on areas with copper indications in the northern Matsitama area that had been concentrated by the first to third year surveys.

The survey areas comprise two: an area where drilling in the third year (GSJ–6) confirmed a copper indication, and an area which was considered promising from the result of geochemical survey and the geological conditions. Both are areas offering the hope of occurrence of Matsitama-type deposits.

The former is the area where an anomaly was recognized by a semi-detailed geochemical survey in the second year, covering an 1.3 km x 0.5 km area centering on GSJ–6.

Hence, prior to drilling a detailed geochemical survey was made, resulting in the picking-up of a clear geochemical anomaly about copper extending in the same direction as the strike of country rock.

For this geochemical anomaly eight vertical holes were drilled with intervals of 100 to 200 m, totaling 1,003.3 m in length.

The rock revealed by the drilling is of almost the same quality in all the drill holes: it is formed of homogeneous, dark green, pale green in weathered part, fine to coarse-grained amphibole schist, with biotite quartz schist being interlaid in some parts. In addition very thin layers of limestone were found.

Minearalization was recognized in all the drill holes, and in many cases it extends wide vertically too. It consists of pyrite and chalcopyrite disseminated in the country rock which is amphible schist or accompanied by quartz veinlets. Also hematite in a disseminated or veinlet form was seen almost everywhere.

The mineralization, however, is weak. Even parts where mineral indication is seen in relatively round quantities have copper content of only 0.442% at maximum, and the content remains not more than 0.01% in almost all parts.

Accordingly there has not been found mineral indication enough to support mining operation, but the fact that mineral indication is seen so generally in this geochemical anomaly area indicates that this anomaly area falls on a deposit bearing horizon. However, since all the drill holes presented about the same geology and the same mineral indication and there is no appropriate key bed, the survey team has been unable to find mutual realtions of strata found in the drill holes, and failed to grasp the detailed structure and scale of the mineralization zone.

As the geochemical anomaly shows higher values on the northwest side and tends to expand further in this direction, it is desired that the extent of prospecting be extended to the northwest side.

The latter area is situated about 1 km south of GSJ-12 made in the third year; for each of two geochemical anomalies here, one 100 m-deep hole (GSJ-27 and GSJ-28) was drilled.

As the result, GSJ-27 encountered dolerite, and the geological sequence were unable to be confirmed adequately; nor any mineral indication was found.

IN GSJ-28, mica shist, quartz schist and thin layers of limestone were confirmed; in the limestone layers slight copper indication was recognized.

That these areas have geological conditions similar to those of Matsitama deposits and that mineral indication was found though slightly, suggest the possibility of deposits similar to Matsitama deposits being borne here.

Since geochemical anomaly tends to extend further west, this is an area that makes one hope discovery of deposits if more clear geochemical anomalies are picked up by a detailed geochemical survey and then traced and explored.

CONTENTS

Page

List of Tables

List of Figures

List of Apendices

GENERAL PRESENTATION

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1. Purpose of Surveys

The purpose of these surveys is to obtain basic data for the development of mineral resources in the northeastern region of the Republic of Botswana in cooperation with the Ministry of Mineral Resources and Water Affairs, the Government of the Republic.

As the result of the survey of the third year, copper indications were found in drilling (GSJ–6, 12, 13 and 14), but their characteristics were not well grasped.

Accordingly, the purpose of the surveys in the fourth year has been to make comprehensive appraisal of this survey area by clarifying the scale, quality and other characters of these mineral indications through drilling, geochemical survey and geological survey in the areas intended for such works.

2. Survey Area

The survey area is divided into two: the area around drill hole GSJ–6 and the area on the southwest side of GSJ–12 (hereinafter the former is called Area A and the later Area B).

This survey area is situated in the northeastern region of the Republic of Botswana, and the nearest town is Francistown about 100 km to the east of the area. This town, located about 440 km to the north of the capital city Gaborone, has the communication of a trunk road and the Zimbabwe railway. From Francistown there lies a trunk road leading to Maun about 500 km away west, and this road passes at a 10 km distance from the survey area (Fig. 1).

The area including this survey area belongs in the eastern edge of the Kalahari desert and has a flat lay of the land with little rise and fall, at an altitude from 1,000 to 1,100 m.

In climate it is in a semi-arid zone of the tropics; summer continues from October to April and winter from May to September. Rainfall concentrates in the summer and the annual precipitation amounts to about 440 mm.

3. Contents of Surveys

The surveys were made mainly by drilling. For Area A geochemical survey and geological survey were made before drilling work to make for the decision of drilling positions.

The contents of the field work and laboratory work are shown in the following:

Table 1 Contents of survey

Item	Amount of work	Remarks
Drilling	10 holes, 1,203.40 m	all coring, vertical
Geological and geochemical survey	0.65 km^2	Area A

Table 2 Laboratory test

Item	Amount of work		Remarks
	Geochemical sample	Drilling core	
Microscopic observation of thin section	—	20 pcs	
Microscopic observation of polished section	—	20 pcs	
Chemical analysis (ore)	—	50 pcs	Cu, Pb, Zn, Au, Ag
Chemical analysis (soil)	297 pcs	—	Cu, Zn

4. Organization of Survey Team

Japanese side planning and negotiation

Hiroshi Iwasaki	(Metal Mining Agency of Japan)
Tamotsu Nakajima	(Metal Mining Agency of Japan)

Botswana side planning and negotiation

G. C. Clark	(Geological Survey Department, Botswana)
C. Black	(Geological Survey Department, Botswana)

Japanese Survey Team

Geological survey	Iwao Uchimura
Drilling work	Hisao Ataku
Drilling work	Yoshikazu Sugawara
Drilling work	Katsunori Murakami
Drilling work	Mutsuo Saito
Drilling work	Koichi Ito
Drilling work	Takayuki Akashi

Botswana Survey Team

A. M. Sixpence	(Geological Survey Department, Botswana)

The survey team engaged in th surveys staying in the Republic of Botswana from July 21 to October 29, 1982.

5. Acknowledgement

The survey team is happy to acknowledge its debt to Mr. M. C. Tibone, Permanent Secretary of the Ministry of Mineral Resources and Water Affairs of the Government of the Republic and Mr. C. M. Lekaukau, Deputy Permanent Secretary of the Ministry for their most beneficial advice and help continuing from the preceding years.

The team members wish to take this opportunity to express their gratefulness to

Dr. C. Kim of Jubilee Hopsital of Francistown and his family for their kind care for the health of the team members during the survey period.

DETAILED PRESENTATION

DETAILED PRESENTATION

Chapter I. SURVEY OF COPPER INDICATION AREA

I-1 Preface

The northern Matsitama area, which was selected as the result of the 1st year survey work as a promising area, was concentrated in due order according to the results of geological surveys, geochemical survey, geophysical prospecting, drilling surveys in the 2nd and 3rd year works, to be narrowed down to an area around drill hole GSJ–6 (Area A) and in area on the southwest of GSJ–12 (Area B).

A geological survey, geochemical survey and drilling were made for Area B, and drilling for Area B, for the purpose of finding the conditions of the mineral indications.

As the survey area was restricted to a small extent in this year, no facts that would change the stratigraphic classification were found. Consequently, views on geologic stratigraphy taken in the past were followed.

I-2 Outline of Geology

The northern Matsitama area which includes the survey area corresponds to the northeastern part of the Geologic Map of the Mosetse – Matsitama (Bennett 1970). The geology is formed of mainly a basement complex and additionally new igneous rocks and sediment (Fig. 2).

Bennett (1970) divided the basement complex of this area into the Mosetse River Gneiss Group and the Matsitama Schist and Metasedimentary Group. The following description follows the stratigraphic unit by Bennett (1970) and the report of MMAJ (1981).

I-2-1 Stratigraphy

(1) Mosetse River Gneiss Group

This group is widely distributed in the east of the area. Outcrops are seen only in a scattered manner in the beds and on the banks of major rivers such as the Lepashe river,

Mosope river and their tributaries, the Mukulwane river, Chadibe river and Mmapatse river.

On flatland outcrops are scarcely seen and only a small amount of float are found.

This group consists mainly of gneiss and partly porphyroblastic gneiss is found. In addition, amphibolite – amphibole schist, feldspar and quartz schist, quartzite, and limestone are distributed in a lenticular form or in thin layers.

The principal component minerals of such gneiss are quartz, plagioclase, potassium feldspar, and mica; additionally the gneiss is accompanied by a little amphibole. The porphyroblastic gneiss has the feature of containing crystalloblasts of potassium feldspar 5 to 20 mm in size.

The amphibolite – amphibole schist, which is dark green, is distributed in thin layers. Its principal component minerals are hornblende, plagioclase and quartz; at times a little epidote accompanies it.

The quartzite and quartz schist is light gray to dark gray or light brown to light purplish brown and occasionally light green; they are generally fine-grained.

These rocks consist of quartz grains for the most part, but sometimes contain feldspar and mica; at times banded hematite is recognized. The limestone has white to gray crystals and found as very small bodies.

This group is broadly divided into the upper formation and lower formation from its lithofacies.

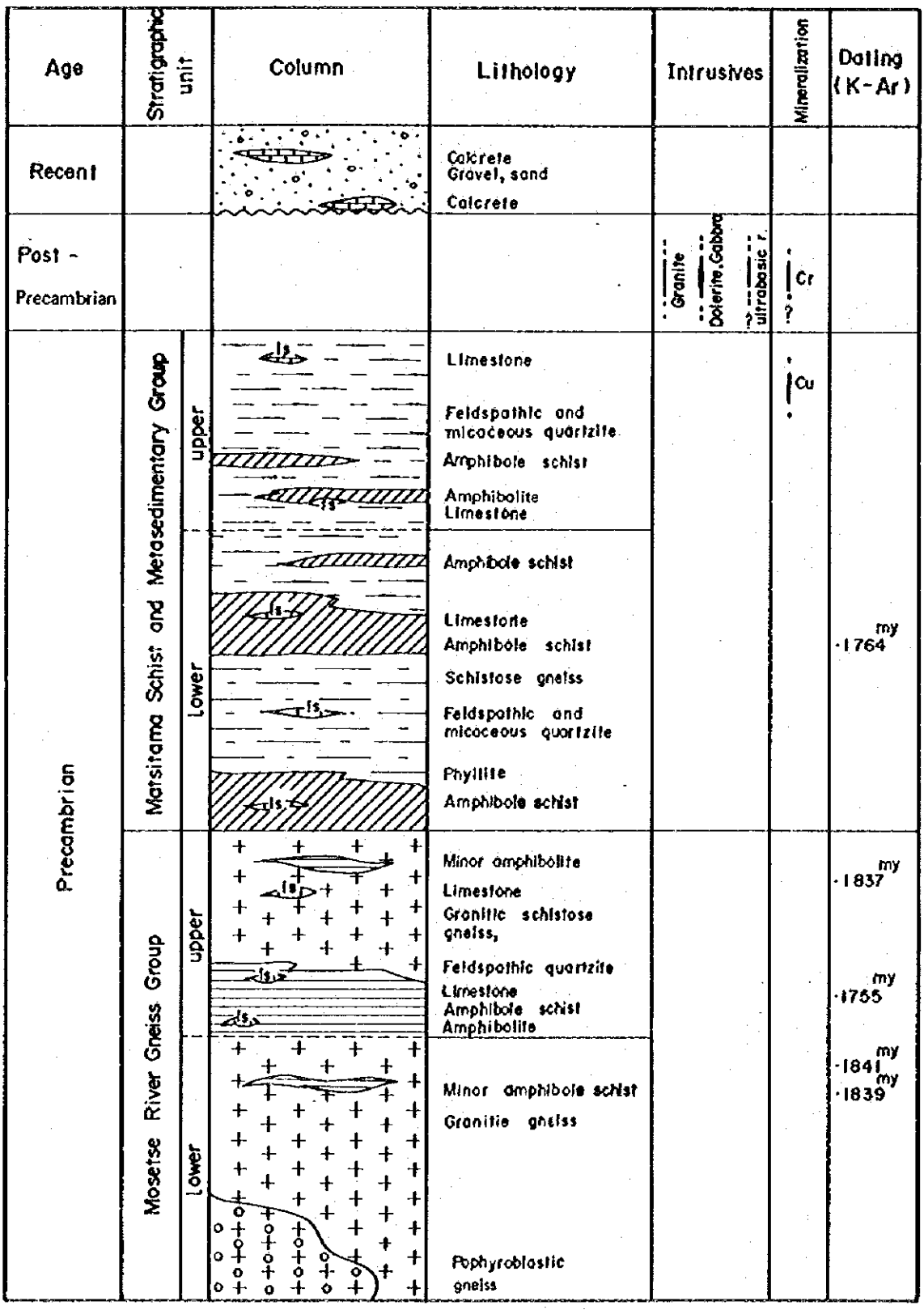
The lower formation are mainly formed of gneiss and porphyroblastic gneiss, and in the formation are interlaid quartz schist, quartzite, amphibolite – amphibole schist.

The upper formation present lithofacies similar to the lower formation, but as compared with the latter, the former have the features that amphibolite – amphibole schist is dominant and that limestone interposes in the formation at places.

(2) Matsitama Schist and Metasedimentary Group

This group is distributed in the southwest and west of the area. Outcrops are limited

Fig. 2 Generalized stratigraphic column



to some parts along the Mosope river, and in the other parts only floats are found sporadically.

It overlies the Mosetse river gneiss group below in conformity and partly is in contact with this group through faults.

It consits of various kinds of schist, quartzite, amphibolite – amphibole schist, and partly has interposing limestone and phyllite.

The schist is generally leucocratic, and there are feldspar quartz schist, biotite and feldspar quartz schist, muscovite and feldspar quartz schist, and hematite quartz schist.

The quartzite is ordinarily fine-grained and leucocratic, but partly the one which is dark gray, brown, purplish brown or green is seen. The rock forming minerals are mainly quartz, which is accompanied often by feldspar or a small quantity of mafic minerals.

The amphibolite – amphibole schist is distributed in the form of belts. The rock forming minerals are mainly amphibole, feldspar, and quartz, which are often accompanied by epidote and a small quantity of sphene.

The amphibole is principally hornblende, but occasionally actinolite, tremolite, and anthophyllite are seen, and it is often epidotized.

This group is divided into the upper formation and the lower formation according to the combination of lithofacies. The upper formation are distributed in the southwest and have the features of clear lineation in a NW direction, bearing copper ore beds, dominance of felsic rocks, and large quantities of phyllite – micaceous rocks.

In the lower formation, amphibolite – amphibole schist is dominant.

(3) Quaternary System

It is formed of soil, pebbles and calcrete.

I-2-2 Igneous Rocks

Igneous rocks developing in the area are classified into acidic rocks, basic rocks and ultrabasic rocks.

The acidic rocks occur in the form of small dikes of aplite, pegmatite, granite, and syenite.

The basic rocks are mainly dolerite, and additionally small quantities of gabbro and basalt are found. All of these exist in the form of dikes, and most of them have a strike in a NW direction.

The ultrabasic rocks are formed of serpentinite; some of it contains magnetite and a little chromite.

I-2-3 Geological Structure

The formation have been subjected to tectonic movement including folding and faulting. Seen broadly, the formation correspond to the north wing of the Matsitama fold as referred to by Bennett (1970). Repeating folding several times, they present a monoclinal structure as a whole with a strike of NW–SE and a dip to W.

Many of intrusive rock bodies are in a direction ranging from WNW–ESE to E–W. From aerial photographs and LANDSAT image, ones in a direction ranging from NW–SE to E–W as a conspicuous lineament are picked up.

From the above-mentioned, the direction of the fracture pattern controlling this area is considered to be WNW–ESE to E–W.

I-2-4 Mineralization

There are copper and chrome indications in the survey area. In addition, there are sporadically floats of banded hematite quartzite-quartz schist.

The copper indications are situated in the eastern edge of the mineralization zone connecting the Matsitama copper deposits group which was actively prospected by the A.A.C. group from 1972 to 1974 and Bushman mine which is being explored still by the Falconbridge Co. group. The part of the area prospected by the A.A.C. group then (comprising geochemical survey, trenching and drilling) extends into the survey area.

The Matsitama copper deposits group is composed of copper ore occurring in siliceous limestone, calcareous quartzite, mica schist, phyllite and others in the Matsitama Schist

and Metasedimentary Group and accompanied by small quantities of lead and zinc minerals. The group is disposed as a group of a number of ore bodies. Out of them, for the two main ore deposits of Thakadu and Makala, ore reserves amounting to about 8 million tons with Cu content of 2.2% have been confirmed by the A.A.C. group (Baldock 1977). The ore minerals are, in the oxidation zone up to the depth of about 60 m from surface, oxidized ore of mainly malachite, chrysocolla, and minor tenorite etc. In the lower part, they are composed of chalcopyrite, bornite, chalcocite, pyrrhotite, pyrite, and minor lead, zinc and silver minerals.

About 50 km to the northwest of the survey area, there is Bushman mine which is being prospected by Falconbridge Co. This mine comprises a copper ore deposit borne in the country rocks of graphitic quartzite to quartz schist and phyllite in siliceous limestone or dolomite that has been taken into the fracture zone of a major tectonic line running in the north-south direction near Bushman mine, called the Bushman lineament. This deposit has the characteristics that it has been structurally controlled in the N–S direction, that graphite schist is seen in the country rock, and that the mineralization is closely related with graphite concentrating in the fracture zone.

Chromite is borne in ultrabasic rock presumably in a lenticular or pod-like form. The scale of the ore bodies is 0.5 to 1.0 m in width and 5 to 10 m in length.

As the result of the 3rd year survey, Area A and B offer hope of occurrence of Matsitama-type deposits, because of the facts that copper mineralization are observed in drill holes as well as on the surface, that geochemical anomalies are found in these two areas, and that both areas are within the distribution of the Matsitama Schist and Metasedimentary Group.

I-3 Geochemical Survey

I-3-1 Purpose

In the area including the survey aera, amphibolite – amphibole schist belonging in the Matsitama Schist and Metasedimentary Group is distributed. As the result of the 2nd year surveys, geochemical anomalies were picked up here, and also drill holes and minor outcrops of quartzite accompanied by green copper were found about 1 km north of the survey area. From these facts this area was considered promising. Copper indications were confirmed at GSJ–6 that was made aiming at geochemical anomalies in the 3rd year. In this year, for the purpose of confirming the extent of the mineral indications and of determining drilling positions, geochemical survey was made, prior to drilling survey, over an rectangular area of 1.3 km by 0.5 km centering on GSJ–6.

I-3-2 Sampling Method and Number of Samples

The sampling was made on a grid pattern with 50 m intervals between sampling points. For the correct setting of sampling points, a base line in a NW–SE direction running longitudinally through the center of the survey area was settled, and survey lines crossing the base line at right angles were set at 100 m intervals. These survey lines and sampling points were set with the use of a pocket compass and a 100 m measuring rope.

The samples were taken from B horizon at a depth of 30 cm below the surface as a rule; about 50 g of soil under a 80 mesh sieve was made one sample.

The extent of the survey was 1.0 km by 0.5 km in the original plan. As a result of analysis about this scope, however, geochemical anomalies were found to be tending to extend in a NW direction, so taht the extent was expanded 300 m in the same direction. Eventually the extent of survey came up to an area of 1.3 km by 0.5 km, and the number of samples 297.

I-3-3 Method of Analysis

The analysis of the samples was made at the Geological Survey Department of Botswana by the atomic absorption spectroscopy method. The indicative elements were Cu and Zn; Pb was excluded because it had showed only very low values as the results of the survey in the 1st to 3rd years.

I-3-4 Analysis of Data

The analysis data were used in preparation of a content distribution map (Fig. 6, 7) on the site as the material for a study to decide the positions of drilling. In Japan, as in the 2nd and 3rd years, the analysis data were statistically processed and an analytical research by single components was made. The analytical method is described in the following:

(1) Method of Analysis

From the analysis data, a frequency histogram (Fig. 3, 4) and a cumulative frequency distribution diagram (Fig. 5) for each element were prepared. The value of threshold and background of the geochemical anomalies, and anomaly values were obtained from graphical analysis.

Also in numerical calculation the coefficient of correlation between analyzed elements was obtained. In these graphical and numerical processing, the logarithms ($\log_{10}$ int) of ppm values of the analytical values were used. For class differences in the frequency histograms and cumulative frequency distribution diagrams, the difference was made $\log_{10}$ int = 0.1 for copper and $\log_{10}$ int = 0.01 for zinc.

Frequency Histogram and Cumulative Frequency Distribution for Each Element

Element	Frequency histogram	Cumulative frequency distribution
Cu	On the axis of the mean value of 114.425 ppm, imperfect normal logarithmic distribution is presented.	The curve bends at a 140 ppm point, and two content groups are recognized.
Zn	On the axis of the mean value of 41.72 ppm, imperfect normal logarithmic distribution is presented.	The curve bends at a 48 ppm point, and two content groups are recognized.

(2) Coefficient of correlation between elements of Cu and Zn.

The coefficient of correlation from numerical calculation was found to be 0.634, which means relatively fine correlation.

(3) Threshold

The values of threshold were determined making reference to such values as the mean values (M), standard deviations (σ) and the skew points of normal straight lines in the cumulative frequency distribution diagrams shown in the following:

Table 3 Means, standard deviation and skew point

	Mean value (M)	Standard deviation (σ)	M + σ	Skew point
Element	ppm/$\log_{10}$ ppm	ppm/$\log_{10}$ ppm	ppm/$\log_{10}$ ppm	ppm/$\log_{10}$ ppm
Cu	114.425/2.05852	1.482/0.17091	169.60/2.22943	140/2.146128
Zn	41.721/1.62025	1.2490/0.09657	52.1098/1.71692	48/1.68124

The values of threshold: 140 ppm for Cu
48 ppm for Zn

Synthesizing the above-mentioned, classification of the levels of element concentration was made as follows:

Table 4 Class limits of Cu, Zn content distribution (ppm)

Class / Element	Background		Anomaly		
	E	D	C	B	A
Cu	114	140	170	200	
Zn	42	48	52	60	

I-3-5 Interpretation of the Result

Content distribution maps for each element (Fig. 6, 7) was prepared on the basis of the classification of element concentration levels mentioned in the preceding paragraph. Geochemical anomalies deduced from these maps are as follows:

Copper anomalies are distributed in a clear belt zone form extending in the NE–SE direction; anomalies of Class A in particular are seen in the northern half and tend to continue further northwestward.

Fig.3 Histogram of Cu

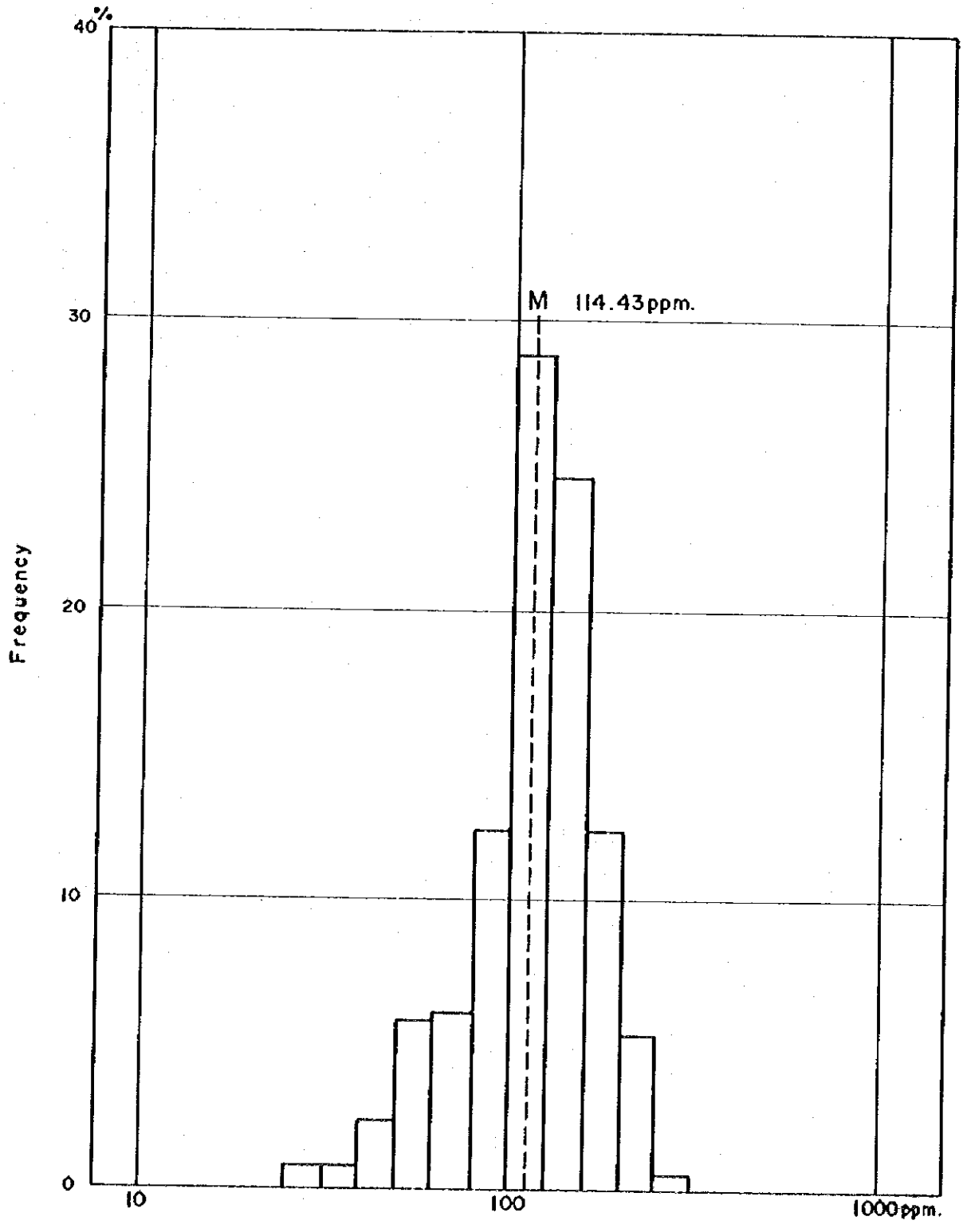


Fig.4 Histogram of Zn

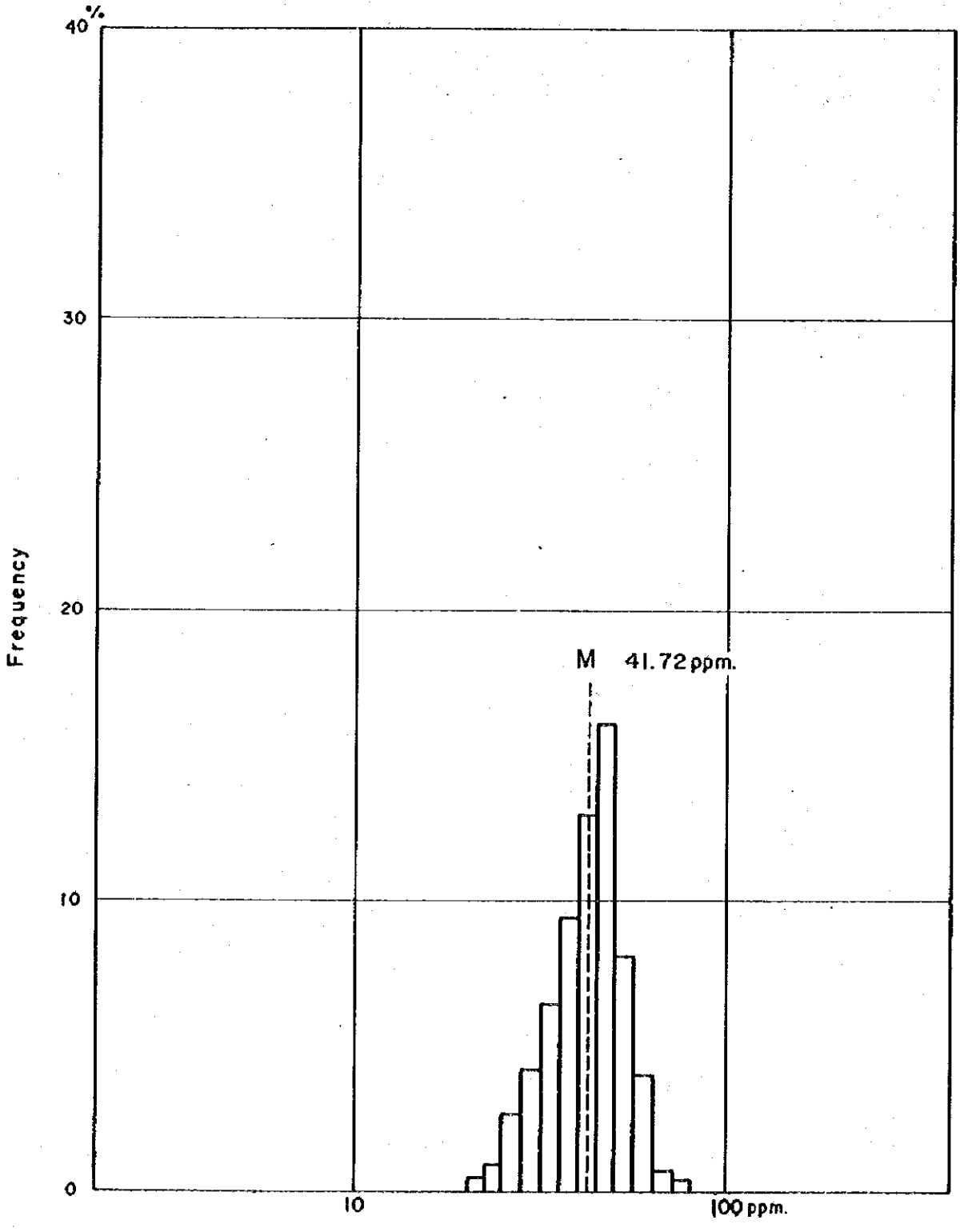


Fig.5 Cumulative frequency distribution for Cu, Zn

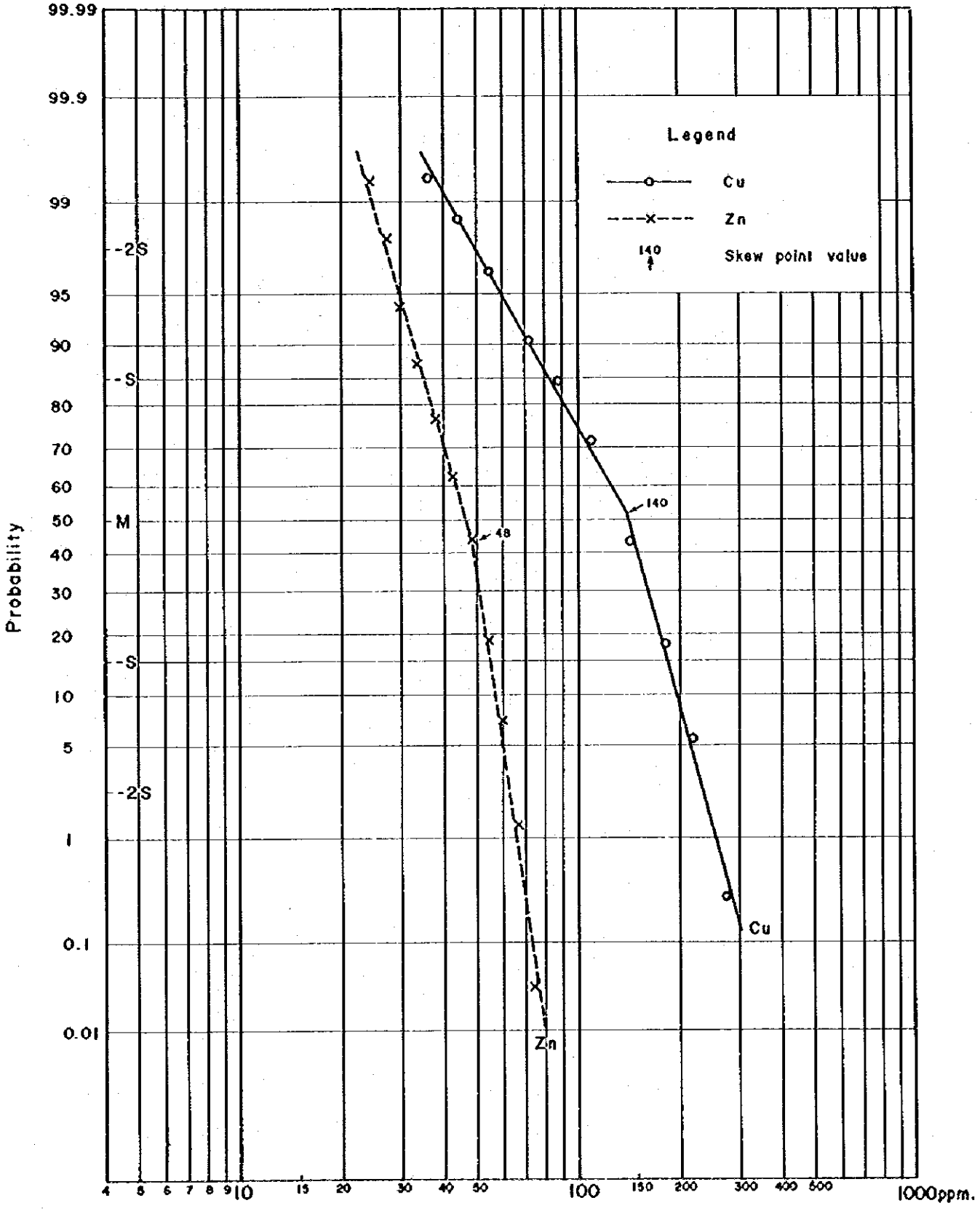
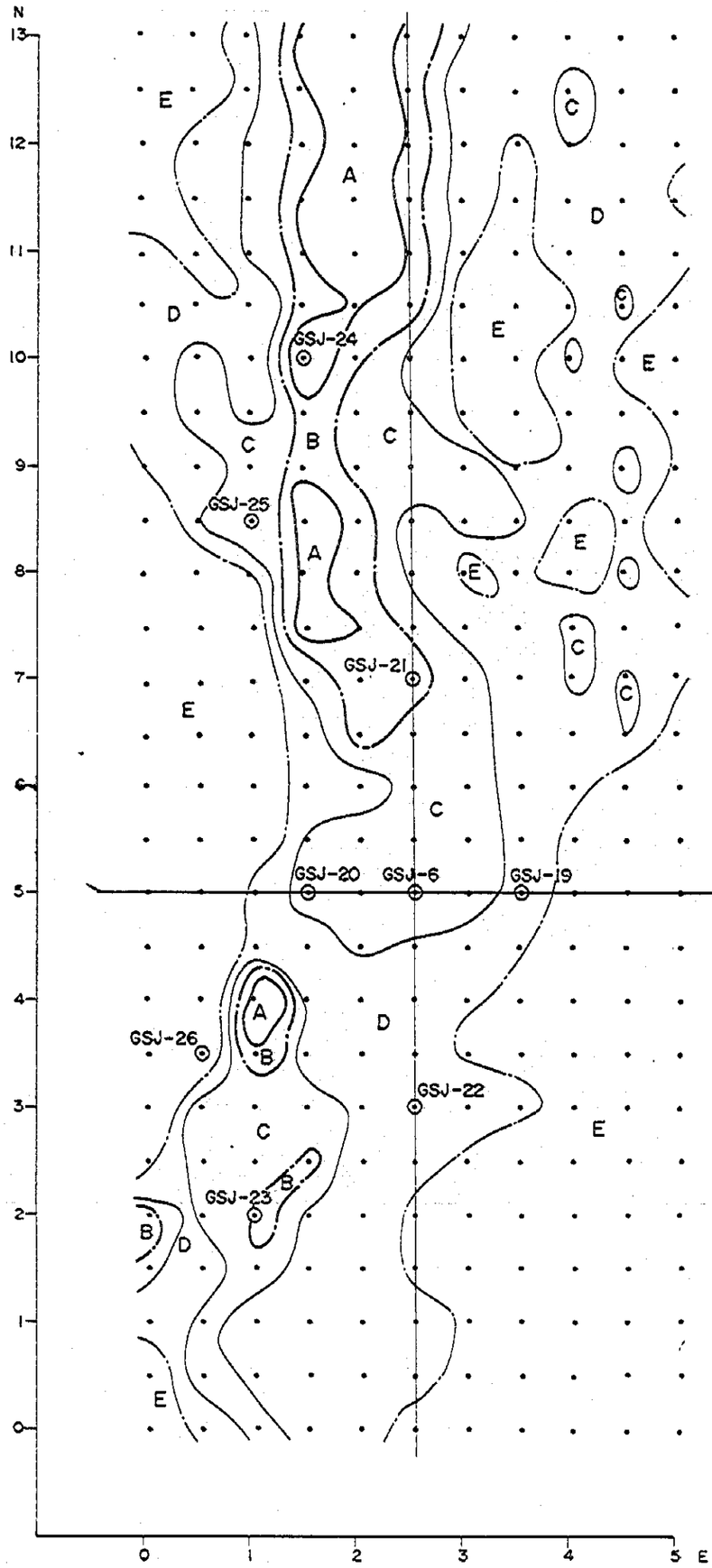
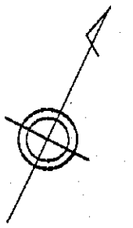


Fig. 6 Cu content distribution map





Legend

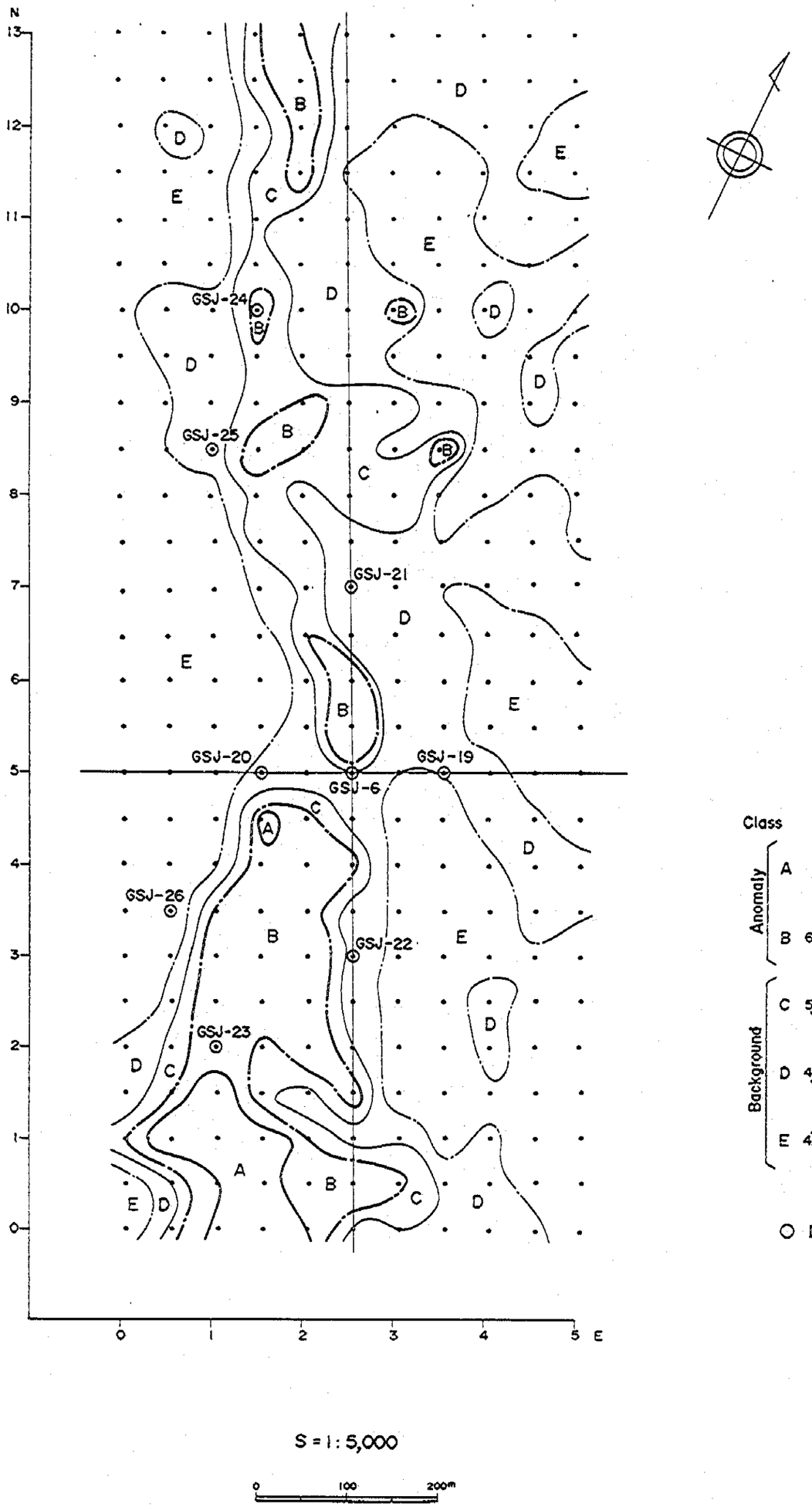
Class		Symbol	Range (ppm)
Anomaly	A	A 200	200 ≦ Cu
	B	200 B 170	170 ≦ Cu < 200
Background	C	170 C 140	140 ≦ Cu < 170
	D	140 D 114	114 ≦ Cu < 140
	E	114 E	Cu < 114

○ Drilling site

S = 1 : 5,000

0 100 200m

Fig. 7 Zn content distribution map



Legend

Class		Symbol	Range (ppm)
Anomaly	A	60	60 ≦ Zn
	B	60 52	52 ≦ Zn < 60
Background	C	52 48	48 ≦ Zn < 52
	D	48 42	42 ≦ Zn < 48
	E	42	Zn < 42

○ Drilling site

S = 1 : 5,000

0 100 200m

Zinc anomalies, though not very clear compared with copper anomalies, present almost the same trend generally as the latter, and anomalies overlapping with copper anomalies are seen in a belt form in the NW–SE direction. Among them anomalies of Class A are found in the southern extremity and tend to extend further southward.

I-4 Drilling

I-4-1 Purpose of Drilling

Drilling was made to find the conditions of mineral occurrence in the area surrounding GSJ–6 where copper mineralization were recognized (Area A) as the result of the 3rd year work and on the west side of GSJ–11 and 12 where geochemical anomalies were recognized (Area B) as the result of the same work.

(1) Area A

Amphibole schist and partly quartz schist which belong to the Matsitama Schist and Metasedimentary Group are distributed in a 0.65 km^2 area centering on GSJ–6.

There are scarcely any outcrops; scattered floats are formed of chips of amphibole schist and quartzite, and partly calcrete is seen.

Among outcrops existing only in a small quantity, an outcrop of amphibole schist lying in the northwest corner of the survey area has the size of 3 m by 0.8 m with an N45°W strike and a 45°W dip, and very small quantities of green copper are disseminated.

The result of geochemical survey made prior to the drilling showed clear copper anomalies in zonal distribution, and anomalies of Class A stretched on the northern west side. But an area including the above-mentioned outcrop with mineral indications does not show anomalies.

The drilling of GSJ–6 in the 3rd year work was aimed at a strong geochemical anomaly, and copper indications, low in grade but over an extensive scope, were found.

In the 1982 project, in the first place four holes (100 m length x 2 and 150 m length x 2) were drilled around the GSJ–6 to find the scale, grade and characteristics of the mineralisation. The result of these drillings and the result of the aforementioned geochemical survey

were combinedly studied, and then further four holes (100 m length x 2 and 150 m length x 2) were drilled.

(2) Area B

For two anomalies picked up as a result of the 3rd year geochemical survey, in the fourth year a 100 m long drill hole was made for each. In this area, the Matsitama Schist and Metasedimentary Group is distributed. At several places on the surface, floats containing copper were found; the highest values of geochemical anomalies in the area were recognized; and Area B is near the Matsitama ore deposit. These facts made this area promising of bearing a deposit.

I-4-2 Result of Drilling

(1) Area A

In this area the geological structure is in a NW–SE direction, the same bearings being taken by geochemical anomaly. As a result of drilling one hole (GSJ–6) in the third year and eight holes (GSJ–19 to 26) in the fourth year, totaling nine, mineral indication was recognized in all the holes. As for the mineral grade, it was generally low, with parts with copper content of 0.1% or over being seen only in a scattered manner, and the contents of lead and zinc were 0.01% or less in almost all parts. However, the fact that areas presenting geochemical anomaly present mineral indication in a measure indicates that this area nearly coincides with a deposit bearing horizon (Fig. 8, 9).

As for mutual relation between the drill holes, however, almost all the holes showed the same rock and state of mineral indication, making correlation between lithofacies and mineral indications impossible, and the survey team was unable to learn detailed geological structure and the characteristics of deposits.

In the following are described the findings from each drill hole.

GSJ–19 (150.50 m in depth)

This hole is located 100 m northeast of GSJ–6. Geology in this hole mainly consists of dark-green amphibole schist, with light-gray biotite quartz schist being interlaid in the part between 73.80 and 77.50 m depths and in the part between 129.00 and 132.10 m depths. The part between 7.30 and 8.30 m depths is weathered and light-brown, and also weathering is found in thin layers at the depths of 13,50 m, 20 m, and 23 m. The amphibole schist is medium-grained until a 28 m depth, medium to fine-grained down to about a 49 m depth, coarse-grained to about a 60 m depth, and further down it is fine-grained with coarse-grained parts being interposed at places. It is the same rock, almost homogeneous to the bottom of the hole.

The schistosity of the amphibole schist is comparatively clear, but it turns massive in coarse-grained parts and its schistosity is unclear. The biotite quartz schist shows very clear schistosity, and minute fold are recognized in parts. All of this schistosity gently dips at angles of 20° to 40°.

In the amphibole schist a large number of quartz veinlets are found here and there, and in additon epidotization is recognized in speckles or vienlets.

As for mineralization, mineralization of pyrite, chalcopyrite and hematite is found in a scattered manner from a 28 m depth to the hole bottom in the amphibole schist.

The pyrite and chalcopyrite are seen in a disseminated form or accompanying fine quartz veins in the country rock. Besides, green copper is found along a quartz vein at a 30.10 m depth and along a crack at a 35 m depth.

Hematite is also found here and there in a large amount in a veinlet form, often accompanied by a sulphide. At a 74.80 m depth minute dissemination of magnetite is seen.

In the parts between 35 and 39 m depths between 80 and 85 m depths and between 135 and 139 m depths, mineralization of sulphides was seen in comparatively round quantities, but as the result of analysis all of these parts presented a low grade, less than 0.1% of copper content, except for 0.157% between the depths of 80 m and 82 m. The contents of lead and zinc turned out less than 0.01%.

GSJ–20 (150.50 m in depth)

Hole 20 is located 100 m southeast of GSJ–6. Geology in this hole consists of dark-green, homogeneous amphibole schist. In the parts between 34.60 and 34.70 m depths and between 73.90 and 74.10 m depths it has interlaid crystalline limestone, and this turns into calcareous rock in the part between 110.00 and 111.80 m depths. As for the amphibole schist, parts of medium to fine-grained one are dominant as a whole, with coarse-grained parts found at places. The schistosity is clear partly, but as a whole most parts are of unclear schistosity. The dip of schistosity is between 20° and 30° generally.

Quartz veinlets are seen in large numbers like GSJ–19, and epidotization is recognized in speckles.

Mineralization is found over almost the whole length from a 35 m depth to the hole bottom, but the parts presenting comparatively round quantities of sulphides are

those between 40.00 and 43.50 m depths, 50.50 and 62.00 m depths, 73.40 and 73.30 m depths, and 110.00 and 111.80 m depths. As a result of analysis, copper content of 0.145% was found in the part between 40.00 and 43.50 m depths. Here is dissemination of azurite in a very little quantity, in addition to chalcopyrite and pyrite, and there included are copper containing fine quartz veins in some part. The content of copper was 0.136% between the depths of 50.50 m and 53.00 m and less than 0.1% between 53.00 m and 62.00 m.

Both are disseminated chalcopyrite and pyrite in very small particles. The content of copper was found to be 0.442% between the depths of 73.40 m and 74.30 m. This mineral indication is chalcopyrite and pyrite disseminated on the hanging wall and foot wall of a thin layer of limestone. In the part between 110.00 and 111.80 m depths copper content was 0.092%. In this part massive hematite is dominant and additionally there is pyrite disseminated with it; there is only a slight amount of chalcopyrite. Lead and zinc are scarcely contained.

GSJ–21 (100.40 m in depth)

Hole 21 is located 200 m northwest of GSJ–6. Geology in this hole is formed of dark-green, massive amphibole schist, which is medium to coarse-grained until a depth of about 25 m, fine-grained to a depth of about 70 m, and medium to coarse-grained down to the hole bottom; its sohistosity is not very clear. Between the depths of 90.50 m and 95.00 m it has interlaid, light-brown amphibole and quartz schist with clear schistosity. Like the aforementioned drill holes, a large number of fine quartz veins are seen in the amphibole schist, and also epidotized parts are recognized here and there.

Minealization is found in many places though weak, in the amphibole schist below a 30 m depth; it consists of minute particles of chalcopyrite and pyrite in a disseminated form and pyrite and chalcopyrite accompanying fine quartz veins.

In the part between 40.00 and 71.00 m depths where mineralization was seen continuously, as a result of analysis, the content of copper was 0.122% between the depths of 67.00 m and 68.00 m, and 0.309% between 68.00 m and 68.90 m.

GSJ–22 (100.20 m in depth)

Hole 22 is located 200 m southwest of GSJ–6. Geology in this hole is: weathered light-green to greenish brown amphibole schist up to a depth of about 25 m and below this depth dark-green amphibole schist with unclear schistosity, which is medium to coarse-grained until a depth of about 50 m and fine-grained below there; it has interlaid, light-gray to light-brown biotite quartz schist between 53.00 and 57.50 m depths, 72.30 and 74.50 m depths, and 96.50 and 99.40 m depths. The part between 95.10 and 96.50 m depths is hematite-containing amphibole schist of purplish red color, with schistosity presenting minute fold.

There are a large number of fine quartz veins, with sulphides accompanying them seen at places. Also minute particles of chalcopyrite and pyrite are scattered in a disseminated form, but mineralization is generally weak.

GSJ–23 (150.50 m in depth)

Hole 23 is located about 200 m south of GSJ–22. This was drilled aiming at a geochemical anomaly of Class B. Rock in this hole is remarkably weathered up to a depth of 20 m and is light-brown. Below this depth geology is formed of dark-green amphibole schist, which is medium to coarse-grained until a 63 m depth and medium to fine-grained until the hole bottom. Clear schistosity is presented in the weathered part of the top, but it is mostly unclear as a whole. There are large numbers of fine quartz veins, which are often accompanied by sulphides.

Mineralization is found over the whole length, though weak. As the result of analysis, in all the parts between 47.40 and 49.00 m depths, 61.00 and 62.00 m depths, 80.00 and 95.00 m depths, 110.00 and 112.00 m depth, and 143.30 and 144.50 m depths, where mineralization is recognized in comparatively round quantities, the content of copper was found to be less than 0.1%.

GSJ–24 (150.50 m in depth)

Hole 24 is located about 300 m north of GSJ–21. This was drilled aiming at a geochemical anomaly of Class A. Rock in this hole, though partly weathered and light-green in the top part until a depth of about 30 m, consists of coarse to fine-grained, dark-green amphibole schist as a whole, having biotite quartz schist

interlaid between 65.40 and 67.10 m depths and between 70.00 and 71.00 m depths. Clear schistosity is seen until a depth of about 35 m, but there are more parts with unclear schistosity below this depth. The parts of quartz schist have extremely clear schistosity. Its inclination ranges from 30° to 50°.

As for mineralization, there is mineralization of pyrite, chalcopyrite and hematite in the amphibole schist. As a result of analysis in the parts between 74.00 and 75.00 m depths and between 91.00 and 92.50 m depths where mineralization is recognized in comparatively round quantities, the content of copper was found to be 0.081% and 0.102% respectively.

GSJ–25 (100.30 m in depth)

Hole 25 is located about 200 m west of GSJ–21. This hole was drilled on the west side of a geochemical anomaly of Class A. Neighboring strata have a strike of N45°W and a dip of 40°W, and this anomaly of Class A also extends in the same direction, distributed in a belt shape. This drill hole was aimed at the side of the dip of a bedded deposit presumed from these facts.

In the part until a depth of about 20 m, the rock is weathered and greenish brown, and below this part the rock is dark-green amphibole schist with many parts of coarse grains. Except for the weathered part of the top, schistosity is not very clear.

Minealization is recognized at many places though weak. Parts where mineralization is seen in comparatively round quantities are those between 55.50 and 59.00 m depths, 66.50 and 69.50 m depths, and 92.00 and 99.30 m depths. As a result of analysis, copper content was found to be 0.385% between the depths of 55.50 m and 56.30 m, and 0.142% between 96.00 m and 98.00 m; in the other parts the content was less than 0.1%.

GSJ–26 (100.40 m in depth)

Hole 26 is located about 200 m west of GSJ–22. This was aimed at the side of the dip of a mineralization zone on the west side of a geochemical anomaly, like the case of GSJ–25.

Fig.8 Geological map of Area A

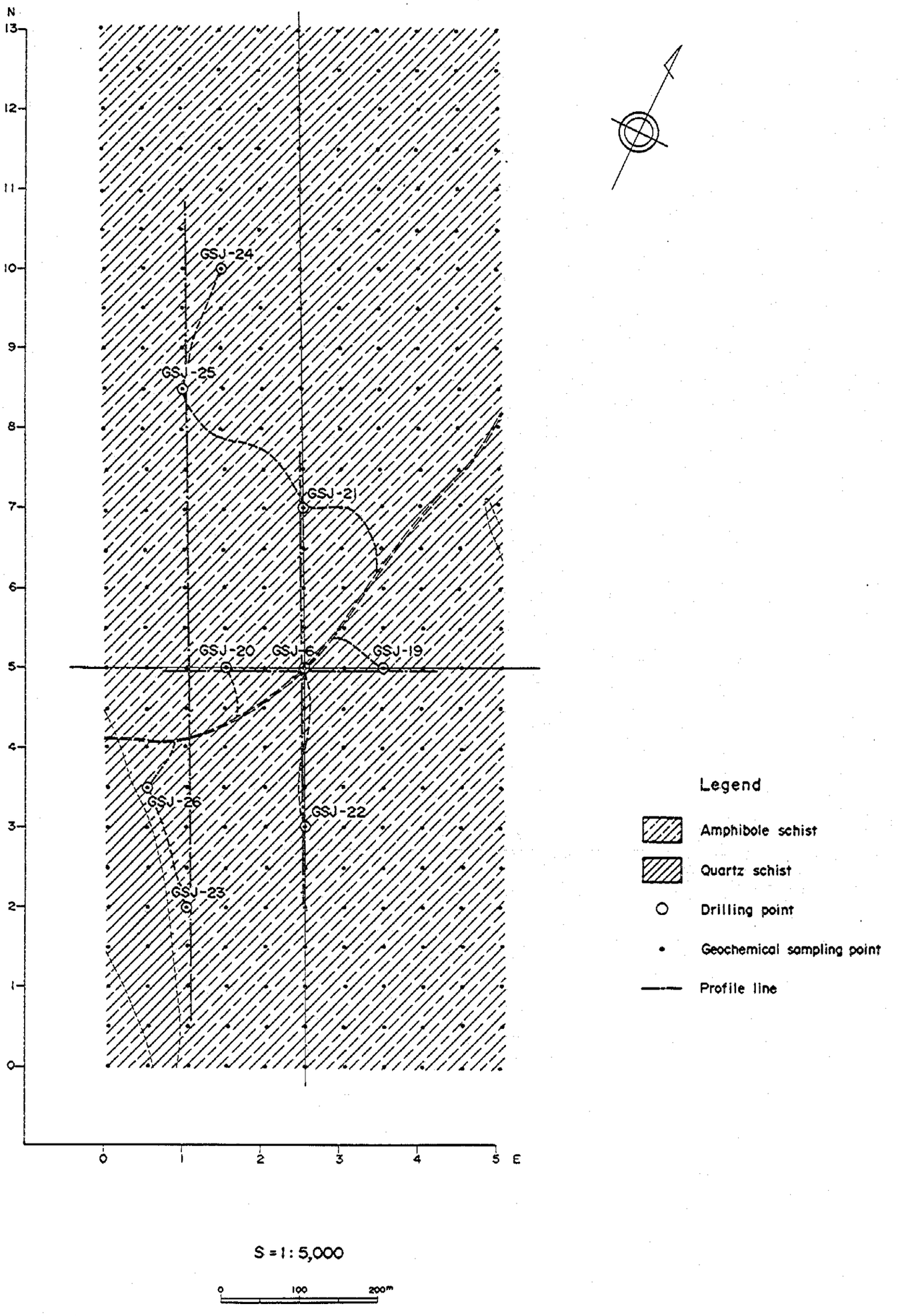
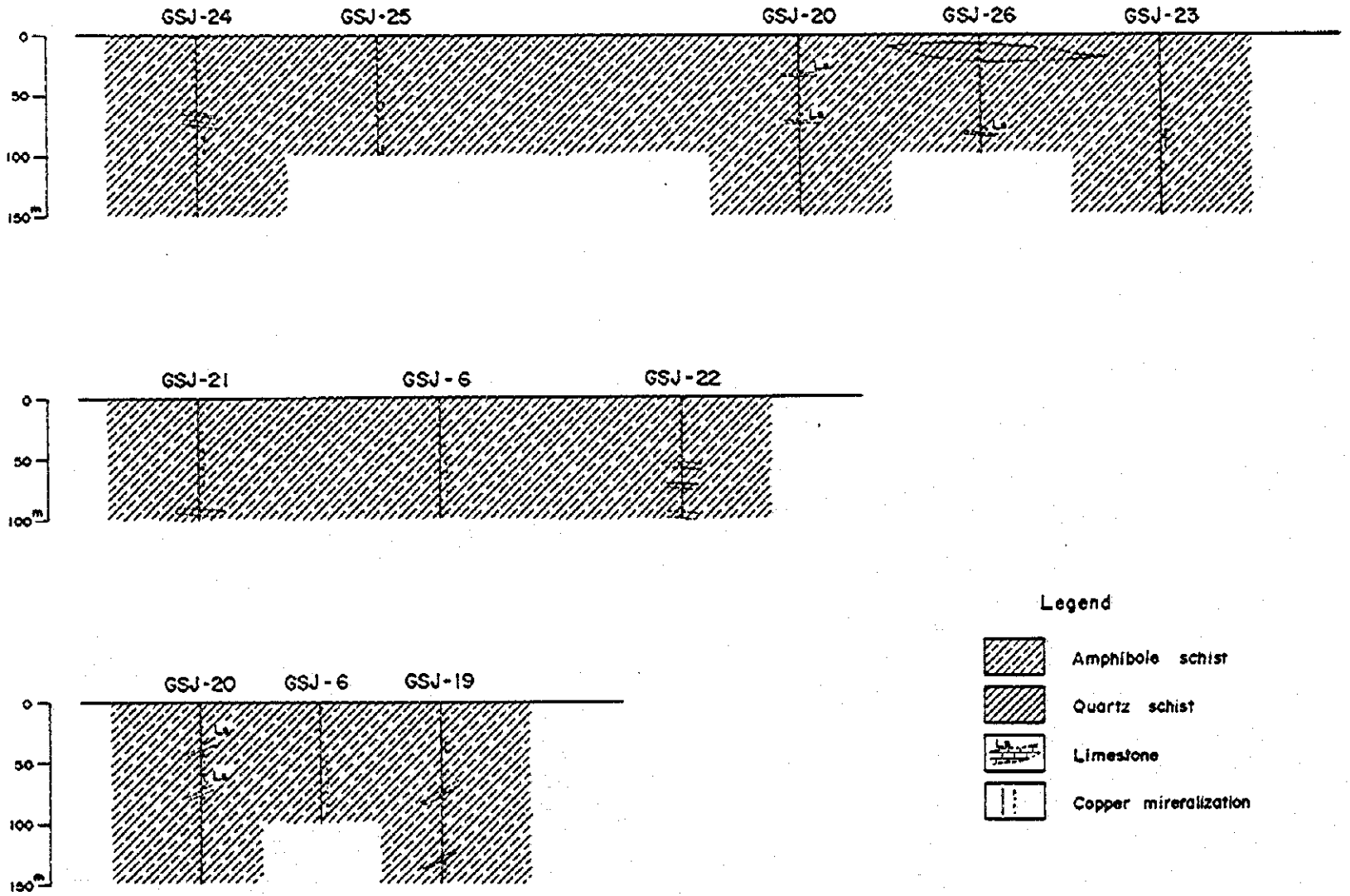


Fig.9 Geological profile of drilling (Area A)



The top of this hole up to a depth of 7.50 m is markedly weathered amphibole schist. The part between 75.0 and 23.50 m depths is quartz schist with weak schistosity, but the part below it consists of medium to fine-grained, dark-green amphibole schist with comparatively clear schistosity.

Mineralization is weak generally, but between the depths of 85.80 m and 86.00 m chalcopyrite, about 2 cm x 2 cm, was found in calcareous rock.

(2) Area B

Satisfactory results were not obtained in the drilling of GSJ–27 because of appearance of dolerite. But in the drilling of GSJ–28 limestone was found, and this was found to be accompanied by copper mineralization. From these facts and other geological conditions, this area was found to have similarity to the Matsitama deposit group (Fig. 10, 11).

The result for each drill hole is described in the following:

GSJ–27 (100.05 m in depth)

Hole 27 is situated on a line connecting GSJ–11 and GSJ–12 drilled in the third year and is 900 m apart from GSJ–12. This drilling was made ofr a geochemical anomaly of Class A. Geology in this hole is formed of gray to dark-gray mica schist to mica quartz schist with clear schistosity. The schistosity has an inclination of about 40°.

Dolerite appeared in the parts between 21.50 and 31.90 m depths, 34.50 and 39.50 m depths, 43.90 and 54.00 m depths, and 59.00 and 76.40 m depths. This made it impossible to adequately grasp the conditions of geology and deposits. No mineralization was recognized.

GSJ–28 (100.05 m in depth)

Hole 28 is located 1.3 km south of GSJ–27. Geology in this hole consists of gray quartz schist and mica schist, having white crystalline limestone interlaid between the depths of 87.90 m and 88.00 m and between the depths of 95.50 m and 95.70 m. It has clear schistosity showing an inclination ranging from 20° to 40°. As for mineralization, only slight dissemination of chalcopyrite is seen in the lower thin limestone layer.

Fig.10 Geological map of Area B

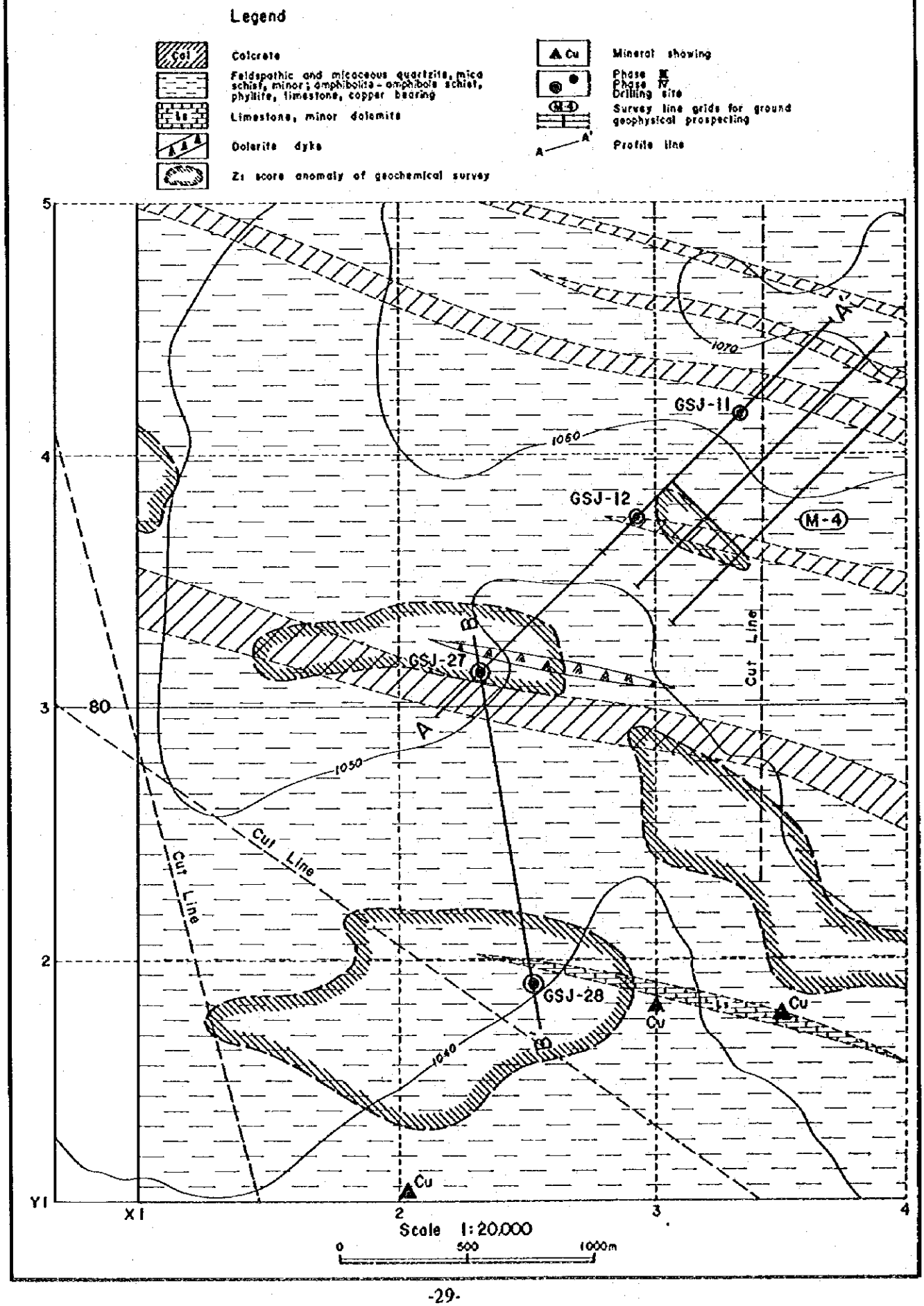
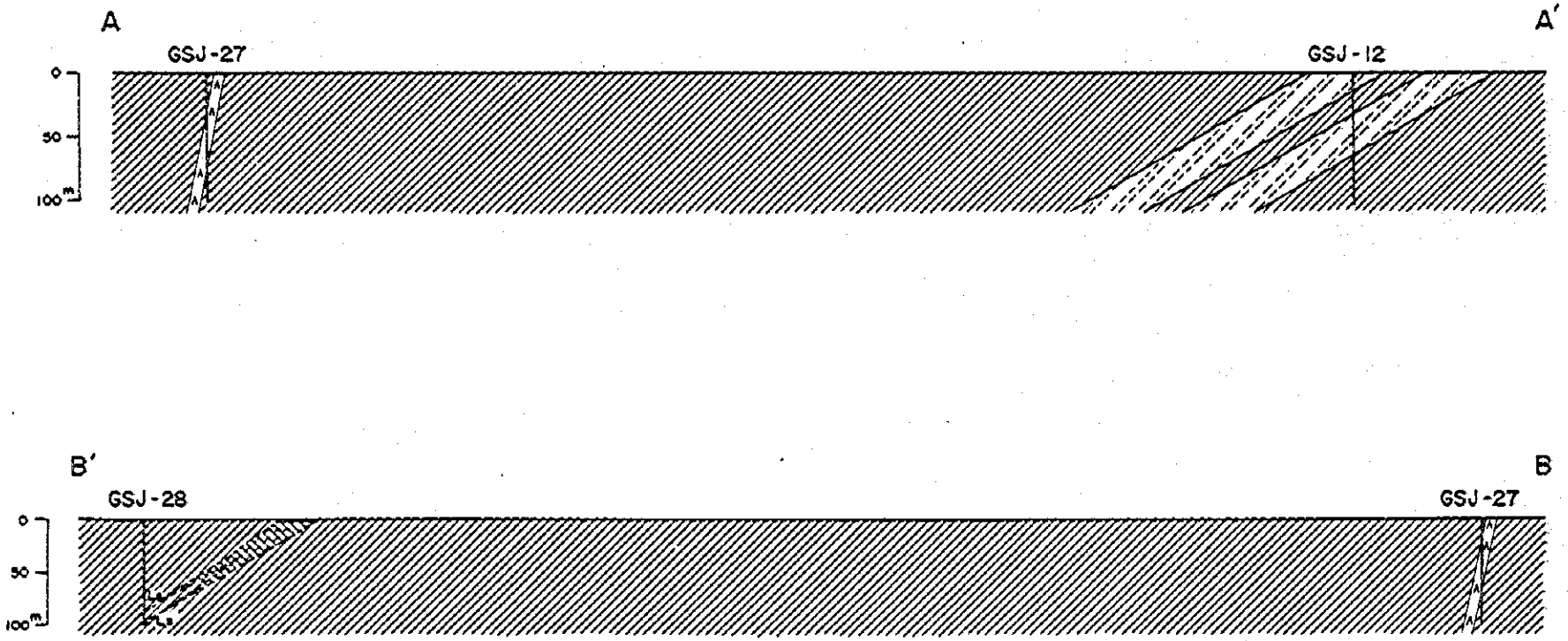


Fig.11 Geological profile of drilling (Area B)



Chapter II. DRILLING SURVEY

II-1 Outline of Drilling Survey

II-1-1 Purpose of Drilling

Drilling survey was carried out in the northern Matsitama area as a part of the fourth year survey program in the northeastern region of the Republic of Botswana.

The purpose of this survey was to reveal more detailed conditions of mineral indications in the promising areas that had been concentrated as the results of surveys in the second and third years.

II-1-2 Brief Description of Operation

Six drilling engineers left Japan on August 6, 1982, and entered Botswana via Johannesburg and Lusaka. On August 12 they engaged in inspection of drilling machines, other equipment and materials, procurement of materials, and shipment of them for bringing into the site. On August 14 they started for the survey area, and arrived there on 16 by way of Francistown.

In the survey area a point about 300 m south of the site of GSJ-6 which was drilled in the third year was made the campsite. After setting up the camp, they made confirmation of the sites planned for drilling, clearance of transport routes, and preliminary inspection of the water supply sources; drilling operation was started on August 23.

The drilling was for all coring by the ordinary method. At the start 75 mm metal crown bits were used, and after reaching rock they were replaced by 66 mm diamond bits, which were again changed for 56 mm diamond bits at a depth of about 40 m. Parallel drilling operation with two drilling machines was carried on. The used machines are as follows:

Type of drilling machine:	TDC-1G (Tone)
Number:	2 units*
Capacity:	150 m

* Note: they are called No.1 Machine and No.2 Machine hereinafter.

As for the form of operation, the personnel were formed into drilling squads, each comprising one head and three workers for one machine, working on three 8-hour shifts.

In addition, two 5 t trucks were arranged to carry water, one driver and one assistant operated a truck to keep supply of water to the drilling work, working on three 8-hour shifts.

Also a jeep or small-size truck was placed at each drilling site for the personnel to come and for bringing in materials.

The drilling basically relied on clear water drilling, and depending on the conditions of the hole, bentonite water and cement were used to maintain and protect the wall of the hole.

The drilling operation came to an end on October 4 with No.1 Machine and on October 14 with No.2 Machine. The achieved quantity of work was a total of 10 holes (all vertical) for a total drilling length of 1,203.40 m.

After the finish of withdrawal work, machines, camping materials, drill cores and other things were brought into the office of Geological Survey at Lobaste and stored in designated places.

The drilling team stayed in Botswana 73 days from August 11 to October 22. Although the progress was hampered by such trouble as delayed arrival of materials from Japan, waiting for water because of a breakdown of a pump at the water supply sources, and a torrential downpour at the time of withdrawal, the drilling operation went on smoothly as a whole, and the original plan was realized.

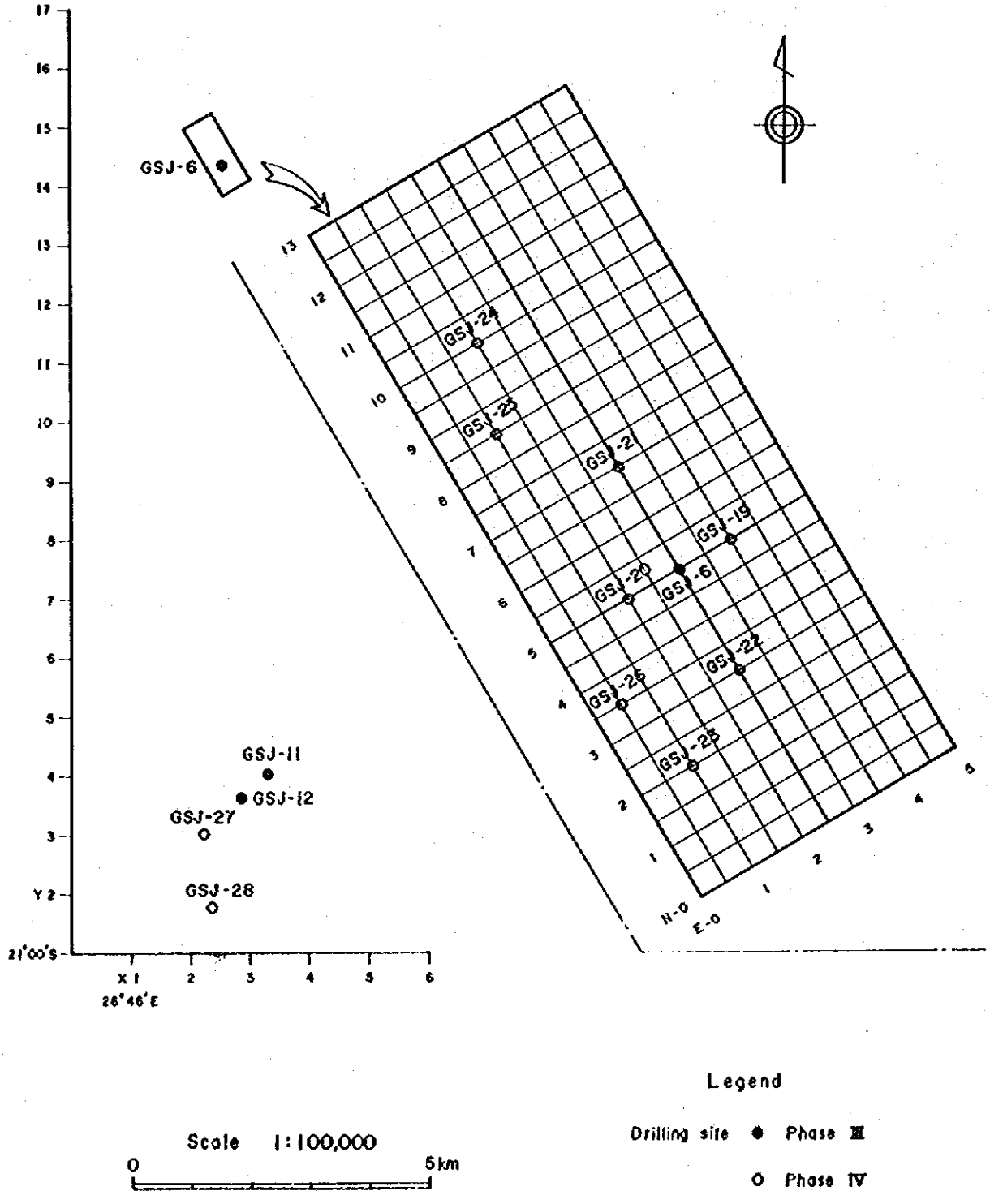
II-1-3 Examination of Cores and Analytical Study

All the cores from the drill holes were observed by a team geologist for the quality of rock, alteration, mineralization and other matters, and geologic columnar sections on a scale of 1/2,000 were prepared.

II-2 Drilling Positions

The drilling points were divided into two areas: the vicinity of GSJ–6 (Area A) and the southwest side of GSJ–12 (Area B). The former is within a distance of several hundred meters from the campsite, but the latter is situated about 13 km to the south of the

Fig.12 Location map of drilling



campsite and about half an hour was required by car to reach the sites (Fig. 12).

The drilling positions were on a flat land with little undulations at an altitude of 1,000 to 1,100 m. The neighboring area is a Savanna covered with thin woods of Mopani and Acacia.

II-3 Preparatory Activities

II-3-1 Preparation of Roads

Reconnaissance of the sites planned for drilling work was made since August 17, and a plan for the routing of roads to transport machines and materials and a plan to bring in materials were made.

For the drilling points in Area B, an existing road was expanded and improved, and 2 km cleared roads to reach the drilling points were prepared. In Area A also, roads branching out from the main road to the drilling points were prepared.

II-3-2 Carrying in Machines, Equipment and Materials

The machines, equipment and materials were brought in on three 5t trucks and one 7t truck from the office of Geological Survey at Lobaste to the campsite. However, gasoline, diesel oil, food and other things were purchased at Francistown at necessity and brought in on a small-size truck.

II-3-3 Preparation for Drilling

Since all the drilling points were on flatland, ground was leveled to some extent and drilling seats, 10 m x 15 m in size, were prepared.

II-3-4 Drilling Water

The operating period fell in the local dry season, so there was no surface water near the drilling sites, nor there was any well. The drilling water was taken from a well in the village of Matsitama about 30 km south of the campsite and a well in the village of Mosetse about 50 km west of the campsite. The water, put in drums, was transported on two 5t trucks. About four hours being needed for drawing water and a both way trip, to meet the need of drilling operation,

a 24 hour system was adopted to transport water.

II-4 Drilling Operation

A 75 mm metal crown was used to drill the top layers including weathered rock, the depth ranging from 0 to 3.00 m, and the hole was protected with a 73 mm casing pipe.

Below that, drilling was made with 66 mm diamond bits, and keeping watch on the conditions of the hole a 63 mm casing pipe was inserted to maintain the hole. Thereafter, the bits were replaced by 56 mm diamond bits and drilling was continued to the planned depth (100 m or 150 m each).

Drilling of all the holes principally depended on clear water drilling, but generally there were many water escaping parts at a depth from 10 to 50 m, and on each such an occasion efforts were made to prevent lost circulation and to prevent the hole from breaking by means of cementation and forcing in drilling mud.

Since the sources of drilling water were distant, a long time was taken to transport it, and also a pump to draw water and a water-carrying truck broken down occasionally, which caused the drilling operation to be suspended for lack of water.

As the areas near the drilling points were formed of homogeneous amphibole schist, drilling operation made progess at about the same rate with all the holes, all attaining the planned depths.

The circumstances of the progress of drilling at each site are described as follows:

GSJ–19 (Drilling length: 150.50 m)

0 to 5.00 m: At first a 75 mm metal crown was used in drilling; after reaching hard rock at a 5.00 m depth, a 73 mm casing pipe was inserted and set up to a 5.00 m depth.

5.00 to 38.50 m: Drilling was made with 66 mm diamond bits, and at a 34 m depth a casing pipe was put in; after that the drill hit a lost circulation layer, and the hole was enlarged with 66 mm diamond bits until a 38.50 m depth to insert a 63 mm casing pipe there.

38.50 to 150.50 m: Drilling was made with 56 mm diamond bits. The rock was stable allowing smooth progress, and the hole was brought to a completion.

GSJ–20 (Drilling length: 150.50 m)

0 to 4.50 m: Drilling was made with a 75 mm metal crown, and a 73 mm casing pipe was inserted up to a 4.50 m depth.

4.50 to 43.50 m: Drilling was made with 66 mm diamond bits. The drill encountered lost circulation layers frequently, and every time cementation was made to prevent lost circulation.

43.50 to 150.50 m: Drilling was carried on with 56 mm diamond bits. Stable rock allowed smooth progress and completion of the operation.

GSJ–21 (Drilling length: 100.40 m)

0 to 3.00 m: A 75 mm metal crown was used to drill; a 73 mm casing pipe was inserted and set up to a 3.00 m depth.

3.00 to 35.00 m: Drilling was made with 66 mm diamond bits. Since water escaped entirely at a 25.20 m depth, cement was injected. Thereafter also the amount of returning water was little, so drilling mud and gel cement were used. But the amount of returning water did not recover, and a 63 mm casing pipe was inserted and set at a 35.00 m depth.

35.00 to 100.40 m: Drilling was made with 56 mm diamond bits. The progress was made smoothly and came to the finish.

GSJ–22 (Drilling length: 100.20 m)

0 to 4.00 m: Drilling was made with a 75 mm metal crown; a 73 mm casing pipe was inserted and set up to a 4.00 m depth.

4.00 to 33.50 m: Drilling was made with 66 mm diamond bits. Since weathering was remarkable and soft rock and hard rock alternated many times until a depth of about 25 m, causing frequent lost circulation and breaking of the hole, every time

of such occurrence cement was injected and drilling mud was used. A 63 mm casing pipe was inserted and set at a 33.50 m depth.

33.50 to 100.20 m: Drilling was made with 56 mm deamond bits, and the drilling smoothly came to a finish.

GSJ–23 (Drilling length: 150.50 m)

0 to 12.00 m: Drilling was made with a 75 mm metal crown, a 73 mm casing pipe was inserted at a 9 m depth, but after this depth frequent alternation of soft rock and hard rock caused serious breaking of the hole. So that the casing pipe was drawn out; after the hole was enlarged with a 75 mm metal crown up to a 12 m depth, a 73 mm casing pipe was inserted and set again until the 12 m depth.

12 to 21.50 m: Drilling was made with 66 mm diamond bits; the core barrel was often clogged with core pieces, and a 63 mm casing pipe was inserted and set at a depth of 21.50 m.

21.50 to 150.50 m: Drilling was made with 56 mm diamond bits. Water escaped at the depths of 31.80 m and 33.40 m, but it was stopped by forcing in drilling mud. After the trouble the rock was stable, and the operation smoothly came to a finish.

GSJ–24 (Drilling length: 150.50 m)

0 to 3.50 m: Drilling was made with a 75 mm metal crown; a 73 mm casing pipe was inserted and set up to a 3.50 m depth.

3.50 to 41.00 m: Drilling was made with 66 mm diamond bits; the work made smooth progress, and a 63 mm casing pipe was inserted until a 41 m depth.

41.00 to 150.50 m: Drilling was made with 56 mm diamond bits. The rock was stable, and the operation was smoothly brought to a finish.

GSJ–25 (Drilling length: 100.30 m)

0 to 3.50 m: Drilling was made with a 75 mm metal crown; a 73 mm casing pipe

was inserted and set until a 3.50 m depth.

3.50 to 35.00 m: Drilling was made with 66 m diamond bits. Water escaped frequently, but drilling was carried on while stopping water by cement injection. A 63 mm casing pipe was inserted and set at a 35.00 m depth.

35.00 to 100.30 m: Drilling was made with 56 mm diamond bits. The rock was homogeneous and stable, and the work was smoothly brought to a finish.

GSJ–26 (Drilling length: 100.40 m)

0 to 6.00 m: Drilling was made with a 75 mm metal crown, but the hole broke seriously, and a 73 mm casing pipe was inserted and set until a 6.00 m depth.

6.00 to 13.50 m: Drilling was made with 66 mm diamond bits, the drilling length did not extend satisfactorily. A 63 mm casing pipe was inserted and set until a 13.50 m depth.

13.50 to 100.40 m: Drilling was made with 56 mm diamond bits. Until a depth of about 50 m water escaped frequently, but efforts were made to stop it by forcing in drilling mud. After this trouble the operation proceeded in a comparatively satisfactory manner, and it was brought to a finish.

GSJ–27 (Drilling length: 100.05 m)

0 to 3.50 m: Drilling was made with a 75 mm metal crown; a 73 mm casing pipe was inserted and set until a 3.50 m depth.

3.50 to 42.00 m: Drilling was made with 66 mm diamond bits. Since water escaped entirely at a 38.90 m depth, cementation was made. When, after waiting eight hours for hardening of cement, cement was being cut downward, the rod met with jamming. Recovery work from this trouble was continued about eight hours, but it ended in failure, and three rods had to to be abandoned in the hole. Consequently, drilling was resumed by shifting the position by 30 cm to the south side. A 63 mm casing pipe was inserted and set at a 42.00 m depth.

42.00 to 100.05 m: Drilling was made with 56 mm diamond bits. In this section

water escaped at several places, but drilling was carried out and brought to a finish by preventing lost circulation with forced in drilling mud.

GSJ–28 (Drilling length: 100.05 m)

0 to 3.00 m: Drilling was made with a 75 mm metal crown; a 73 mm casing pipe was inserted and set until a 3.00 m depth.

3.00 to 42.00 m: Drilling was made with 66 m diamond bits. Although water escaped to a degree, the operation proceeded smoothly. A 63 mm casing pipe was inserted and set until a 42.00 m depth.

42.00 to 100.05 m: Drilling was made with 56 mm diamond bits. In this section the rock was stable, allowing comparatively smooth progress of drilling.

II-5 Machine Transferring Operation

A 5t truck and a small-size truck were used to transfer a drilling machine, equipment and materials between drilling sites. Since, except for GSJ–27 and 28, the moving distance was as short as several hundred meters and a cleared road was had been prepared prior to the transfer, the transferring operation was able to be carried out rather smoothly.

II-6 Withdrawal Operation

Drilling work by the two drilling machines was finished on October 4 and October 14 respectively. Immediately after the finish, casing pipes were drawn out, the drilling machines and the towers were dismantled, and brought over to the campsite. At the campsite, machines were inspected, put in order, and packed up. The machines and other things, including drill cores and camping materials, were loaded onto 5t trucks and 7t large-size trucks, five trucks in all. However, a heavy rain on October 16 and 17 caused the rise of rivers and muddiness of roads, making the team wait for two days. Although the operation of taking out the machines and other things met with difficulties for the following several days, all the machines, equipment and materials were brought to the office of Geological Survey at Lobaste and stored in designated places.

II-7 Records of Drilling Work

The result of analytical study of the drilling work and its records are set forth in Table 5-10 and Fig. 13.

Table 5 Summarized operational data of each hole

Drill hole No.	Drilling Period	Drilling Length	Core		No. of Drilling Shift			Drilling Speed		Remarks
			Length	Recovery	Drilling	Others	Total	*m/shift	**m/shift	
		m	m	%						
GSJ-19	Sep. 16, '82 ~ Sep. 24, '82	150.50	150.50	100	19	1	20	7.92	7.53	
GSJ-20	Sep. 9, '82 ~ Sep. 19, '82	150.50	150.50	100	19	3	22	7.92	6.84	
GSJ-21	Sep. 3, '82 ~ Sep. 9, '82	100.40	100.40	100	13	1	14	7.72	7.17	
GSJ-22	Sep. 6, '82 ~ Sep. 16, '82	100.20	100.20	100	15	4	19	6.68	5.27	
GSJ-23	Oct. 4, '82 ~ Oct. 14, '82	150.50	150.50	100	22	3	25	6.84	6.02	
GSJ-24	Sep. 27, '82 ~ Oct. 5, '82	150.50	150.50	100	18	2	20	8.36	7.53	
GSJ-25	Sep. 19, '82 ~ Sep. 25, '82	100.30	100.30	100	14	2	16	7.16	6.27	
GSJ-26	Sep. 24, '82 ~ Oct. 4, '82	100.40	100.40	100	20	4	24	5.02	4.18	
GSJ-27	Aug. 25, '82 ~ Sep. 6, '82	100.05	100.05	100	17	9	26	5.89	3.85	
GSJ-28	Aug. 26, '82 ~ Sep. 3, '82	100.05	100.05	100	12	1	13	8.34	7.70	
Total		1,203.40	1,203.40	100	169	30	199	7.12	6.05	

* Drilled per one shift covering net drilling operations.

** Drilled per one shift covering works conducted.

Table 6 Summarized operational data of drill holes

No. of drilling (A)	10 Holes	Total length (B)	1,203.40 m	Core recovery	100%
No. of working day (C)	92 day/hole	No. of working shift (D)	199	Working hour (E)	1,616
C/A	9.2	D/A	19.9 shifts/hole	E/A	161.6 hours/hole
B/C	13.08 m/day	B/D	6.05 m/shift	B/E	0.74 m/hour
No. of drilling day (F)	70	No. of drilling shift (G)	169	Drilling hour (H)	648
F/A	7 day/hole	G/A	16.9 shift/hole	H/A	64.8 hour/hole
B/F	17.19 m/day	B/G	7.12 m/shift	B/H	1.86 m/hour

Table 7-1 Operational results of drill hole, GSJ-19

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 16, '82 ~ Sep. 16, '82			1	0.5		12
	Drilling	Sep. 17, '82 ~ Sep. 23, '82			7	7		84
	Removing	Sep. 24, '82 ~ Sep. 24, '82			1	0.5		12
	Total	Sep. 16, '82 ~ Sep. 24, '82			9	8		108
Drilling Length	Planned Length	150.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.50 m	Core Length	150.50 m	Depth m	Section %		Total %
	Length Drilled	150.0 m	Core Recovery	100 %	0 ~ 100	100		
					100 ~ 150.50	100		100
Working Time	Drilling	82°30′	56.51%	54.28%	Drilling Efficiency			
	Accompanying Works	63°30′	43.49%	41.78%	150.50/9	Total Length / Drilling Period		16.72 m/Day
	Repairing		%	%	150.50/8	Total Length / Working Days		18.81 m/Day
	Total	146°00′	100 %	%	150.50/7	Total Length / Net Drilling Days		21.50 m/Day
	Removing Preparation	2°00′		1.31%	84/150.50	Net Drilling Workers / Total Length		0.56 men/m
	Removing Moving	4°00′		2.63%	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	152°00′		100%	Drilled Length	5.00 m	33.50 m	112.00 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	5.00 m	33.50 m	112.00 m
	73 mm : 5.00 m	3.32 %		100%	Remarks			
	63 mm : 38.50 m	25.58 %		100%				

Table 7-2 Operational results of drill hole, GSJ-20

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparations	Sep. 9, '82 ~ Sep. 9, '82			1	0.5		9
	Drilling	Sep. 10, '82 ~ Sep. 18, '82			9	9		81
	Removing	Sep. 19, '82 ~ Sep. 19, '82			1	1		9
	Total	Sep. 9, '82 ~ Sep. 19, '82			11	10.5		99
Drilling Length	Planned Length	150.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.50 m	Core Length	150.50 m	Depth m	Section %		Total %
	Length Drilled	150.0 m	Core Recovery	100 %	0 ~ 100	100		
					100 ~ 150.50	100		100
Working Time	Drilling	74°30′	50.34 %	42.33 %	Drilling Efficiency			
	Accompanying Works	73°30′	49.66 %	41.76 %	150.50/11	Total Length / Drilling Period		13.68 m/Day
	Repairing		%	%	150.50/10.50	Total Length / Working Days		14.33 m/Day
	Total	148°00′	100 %	%	150.50/9	Total Length / Net Drilling Days		16.72 m/Day
	Removing Preparation	2°00′		1.14 %	81/150.50	Net Drilling Workers / Total Length		0.54 m/Day
	Removing Moving	8°00′		4.54 %	Drilled Length by Bit Size			
	Others	18°00′		10.23 %	Bit Size	75 mm	66 mm	56 mm
	Grand Total	176°00′		100 %	Drilled Length	4.00 m	39.50 m	107.00 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	4.00 m	39.50 m	107.00 m
	73 mm : 4.00 m	2.66 %		100 %	Remarks			
	63 mm : 43.50 m	28.90 %		93 %				

Table 7-3 Operational results of drill hole, GSJ-21

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 3, '82 ~ Sep. 3, '82			1	1		9
	Drilling	Sep. 4, '82 ~ Sep. 8, '82			5	5		57
	Removing	Sep. 9, '82 ~ Sep. 9, '82			1	1		12
	Total	Sep. 3, '82 ~ Sep. 9, '82			7	7		78
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.40 m	Core Length	100.40 m	Depth m	Section %		Total %
	Length Drilled	100.40 m	Core Recovery	100 %	0 ~ 100.40	100		100
Working Time	Drilling	41°00′	38.0 %	34.2 %	Drilling Efficiency			
	Accompanying Works	59°00′	54.6 %	49.1 %	100.40/7	Total Length / Drilling Period		14.34 m/Day
	Repairing	8°00′	7.4 %	6.7 %	100.40/7	Total Length / Working Days		14.34 m/Day
	Total	108°00′	100 %	9.0 %	100.40/5	Total Length / Net Drilling Days		20.08 m/Day
	Removing: Preparation	4°00′		3.3 %	57/100.40	Net Drilling Workers / Total Length		0.57 men/m
	Removing: Moving	8°00′		6.7 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	120°00′		100 %	Drilled Length	3.00 m	32.00 m	65.40 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	3.00 m	32.00 m	65.40 m
	73 mm : 3.00 m	2.99 %		100 %	Remarks			
	63 mm : 35.00 m	34.86 %		100 %				

Table 7-4 Operational results of drill hole, GSJ-22

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 6, '82 ~ Sep. 6, '82			1	0.5		12
	Drilling	Sep. 7, '82 ~ Sep. 15, '82			9	9		108
	Removing	Sep. 16, '82 ~ Sep. 16, '82			1	1		12
	Total	Sep. 6, '82 ~ Sep. 16, '82			11	10.5		132
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.20 m	Core	100.20 m	Depth m	Section %		Total %
	Length Drilled	100.20 m	Core Recovery	100 %	0 ~ 100.20	100		100
Working Time	Drilling	52°00′	41.27 %	32.50 %	Drilling Efficiency			
	Accompanying Works	74°00′	58.73 %	46.25 %	100.20/11	Total Length / Drilling Period		9.11 m/Day
	Repairing		%	%	100.20/10.5	Total Length / Working Days		9.54 m/Day
	Total	126°00′	100 %	%	100.20/9	Total Length / Net Drilling Days		11.13 m/Day
	Removing Preparation	2°00′		1.25 %	108/100.20	Net Drilling Workers / Total Length		1.08 men/m
	Removing Moving	8°00′		5.00 %	Drilled Length by Bit Size			
	Others	24°00′		15.00 %	Bit Size	75 mm	66 mm	56 mm
	Grand Total	160°00′		100 %	Drilled Length	4.00 m	29.50 m	66.70 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	4.00 m	29.50 m	66.70 m
	73 mm : 4.00 m	3.92 %		100 %	Remarks Matsitama water pump trouble.			
	63 mm : 33.50 m	33.43 %		90 %				

Table 7-5 Operational results of drill hole, GSJ-23

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Oct. 4, '82 ~ Oct. 4, '82			1	1		12
	Drilling	Oct. 5, '82 ~ Oct. 14, '82			10	10		120
	Removing	Oct. 14, '82 ~ Oct. 14, '82			1	1		12
	Total	Oct. 4, '82 ~ Oct. 14, '82			12	12		144
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.50 m	Core Length	150.50 m	Depth m	Section %		Total %
	Length Drilled	150.50 m	Core Recovery	100 %	0 ~ 100	100		
					100 ~ 150.50	100		100
Working Time	Drilling	88°00′	47.83 %	45.84 %	Drilling Efficiency			
	Accompanying Works	96°00′	52.17 %	50 %	150.50/12	Total Length / Drilling Period		12.54 m/Day
	Repairing		%	%	150.50/12	Total Length / Working Days		12.54 m/Day
	Total	184°00′	100 %	95.84 %	150.50/10	Total Length / Net Drilling Days		15.05 m/Day
	Removing Preparation	4°00′		2.08 %	120/150.50	Net Drilling Workers / Total Length		0.80 men/m
	Removing Moving	4°00′		2.08 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	192°00′		100 %	Drilled Length	12.00 m	9.50 m	129.00 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	12.00 m	9.50 m	129.00 m
	74 mm : 12.00 m	7.97 %		75 %	Remarks			
	63 mm : 21.50 m	14.29 %		100 %				

Table 7-6 Operational results of drill hole, GSJ-24

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 27, '82 ~ Sep. 27, '82			1	1		12
	Drilling	Sep. 28, '82 ~ Oct. 5, '82			8	8		96
	Removing	Oct. 5, '82 ~ Oct. 5, '82			1	1		12
	Total	Sep. 27, '82 ~ Oct. 5, '82			10	10		120
Drilling Length	Planned Length	150.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.50 m	Core Length	150.50 m	Depth m	Section %		Total %
	Length Drilled	150.50 m	Core Recovery	100 %	0 ~ 100	100		
					100 ~ 150.50	100		100
Working Time	Drilling	74°00′	46.25 %	42.04 %	Drilling Efficiency			
	Accompanying Works	86°00′	53.75 %	48.86 %	150.50/10	Total Length / Drilling Period		15.05 m/Day
	Repairing		%	%	150.50/10	Total Length / Working Days		15.05 m/Day
	Total	160°00′	100 %	%	150.50/8	Total Length / Net Drilling Days		18.81 m/Day
	Removing Preparation	8°00′		4.55 %	96/150.50	Net Drilling Workers / Total Length		0.64 men/m
	Removing Moving	8°00′		4.55 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	176°00′		100 %	Drilled Length	3.50 m	37.50 m	109.50 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	3.50 m	37.50 m	109.50 m
	73 mm : 3.50 m	2.33 %		100%	Remarks			
	63 mm : 41.00 m	27.24 %		73%				

Table 7-7 Operational results of drill hole, GSJ-25

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 19, '82 ~ Sep. 19, '82			1	0.5		12
	Drilling	Sep. 20, '82 ~ Sep. 24, '82			5	5		60
	Removing	Sep. 25, '82 ~ Sep. 25, '82			1	1		12
	Total	Sep. 29, '82 ~ Sep. 25, '82			7	6.5		84
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.30 m	Core Length	100.30 m	Depth m	Section %		Total %
	Length Drilled	100.30 m	Core Recovery	100 %	0 ~ 100.30	100		100
Working Time	Drilling	50°30′	46.33 %	39.45 %	Drilling Efficiency			
	Accompanying Works	58°30′	53.67 %	45.70 %	100.30/7	Total Length / Drilling Period		14.33 m/Day
	Repairing		%	%	100.30/6.5	Total Length / Working Days		15.43 m/Day
	Total	109°00′	100 %	85.15 %	100.30/5	Total Length / Net Drilling Days		20.06 m/Day
	Removing Preparation	3°00′		2.35 %	60/100.30	Net Drilling Workers / Total Length		0.60 men/m
	Removing Moving	16°00′		12.50 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	128°00′		100 %	Drilled Length	3.50 m	31.50 m	65.30 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	3.50 m	31.50 m	65.30 m
	73 mm : 3.50 m	3.49%		100 %	Remarks			
	63 mm : 35.00 m	34.90%		100 %				

Table 7-8 Operational results of drill hole, GSJ-26

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Sep. 24, '82 ~ Sep. 24, '82			1	1		12
	Drilling	Sep. 24, '82 ~ Oct. 3, '82			10	10		120
	Removing	Oct. 4, '82 ~ Oct. 4, '82			1	1		12
	Total	Sep. 24, '82 ~ Oct. 4, '82			11	11		144
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.40 m	Core Length	100.40 m	Depth m	Section %		Total %
	Length Drilled	100.40 m	Core Recovery	100 %	0 ~ 100.40	100		100
Working Time	Drilling	75°00′	40.76 %	37.50 %	Drilling Efficiency			
	Accompanying Works	109°00′	59.24 %	54.50 %	100.40/11	Total Length / Drilling Period		9.13 m/Day
	Repairing		%	%	100.40/11	Total Length / Working Days		9.13 m/Day
	Total	184°00′	100 %	92 %	100.40/10	Total Length / Net Drilling Days		10.04 m/Day
	Removing: Preparation	8°00′		4.00 %	120/100.40	Net Drilling Workers / Total Length		1.20 men/m
	Removing: Moving	8°00′		4.00 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	200°00′		100 %	Drilled Length	6.00 m	7.50 m	86.90 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	6.00 m	7.50 m	86.90 m
	73 mm : 6.00 m	5.98 %		100 %	Remarks			
	63 mm : 13.50 m	13.45 %		100 %				

Table 7-9 Operational results of drill hole, GSJ-27

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Aug. 25, '82 ~ Aug. 25, '82			1	0.5		4
	Drilling	Aug. 25, '82 ~ Sep. 5, '82			12	11.5		108
	Removing	Sep. 6, '82 ~ Sep. 6, '82			1	1		12
	Total	Aug. 25, '82 ~ Sep. 6, '82			14	13.0		124
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.05 m	Core Length	100.05 m	Depth m	Section %		Total %
	Length Drilled	100.05 m	Core Recovery	100 %	0 ~ 100.05	100		100
Working Time	Drilling	66°30′	35.47 %	33.25 %	Drilling Efficiency			
	Accompanying Works	61°30′	32.80 %	30.75 %	100.05/14	Total Length / Drilling Period		7.15 m/Day
	Repairing	59°30′	31.73 %	29.75 %	100.05/13	Total Length / Working Days		7.70 m/Day
	Total	187°30′	100 %	%	100.05/11.5	Total Length / Net Drilling Days		8.70 m/Day
	Removing Preparation	4°30′		2.25 %	108/100.05	Net Drilling Workers / Total Length		1.08 men/m
	Removing Moving	8°00′		4.00 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	200°00′		100 %	Drilled Length	3.00 m	39.00 m	58.05 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	3.00 m	39.00 m	58.05 m
	73 mm : 3.00 m	2.99 %		100 %	Remarks: Due to jamming at 36.80m, drilled new hole.			
	63 mm : 42.00 m	41.98 %		100 %				

Table 7-10 Operational results of drill hole, GSJ-28

		Period			Number of Days	Actual Working Days	Day off	Total Number of Workers
Working Period	Preparation	Aug. 26, '82 ~ Aug. 26, '82			1	1		6
	Drilling	Aug. 26, '82 ~ Sep. 2, '82			8	8		60
	Removing	Sep. 3, '82 ~ Sep. 3, '82			1	1		4.5
	Total	Aug. 26, '82 ~ Sep. 3, '82			10	10		70.5
Drilling Length	Planned Length	100.00 m			Core Recovery for each 100 m section			
	Increase in Length	0.05 m	Core Length	100.05 m	Depth m	Section %		Total %
	Length Drilled	100.05 m	Core Recovery	100 %	0 ~ 100.05	100		100
Working Time	Drilling	44°00′	46.8 %	39.3 %	Drilling Efficiency			
	Accompanying Works	50°00′	53.2 %	44.7 %	100.05/10	Total Length / Drilling Period		10.0 m/Day
	Repairing		%	%	100.05/10	Total Length / Working Days		10.5 m/Day
	Total	94°00′	100 %	84.0 %	100.05/8	Total Length / Net Drilling Days		12.5 m/Day
	Removing Preparation	10°00′		8.9 %	60/100.05	Net Drilling Workers / Total Length		0.6 men/m
	Removing Moving	8°00′		7.1 %	Drilled Length by Bit Size			
	Others				Bit Size	75 mm	66 mm	56 mm
	Grand Total	112°00′		100 %	Drilled Length	3.00 m	39.00 m	58.05 m
Inserted Casing Pipe	Pipe Size & Inserted Length	Inserted Length / Drilling Length		Recovery of Casing Pipe	Core Length	3.00 m	39.00 m	58.05 m
	73 mm : 3.00 m	3.00 %		100 %	Remarks			
	63 mm : 42.00 m	41.98 %		100 %				

Fig. 13-1 PROGRESS RECORD OF DRILLING GSJ–19

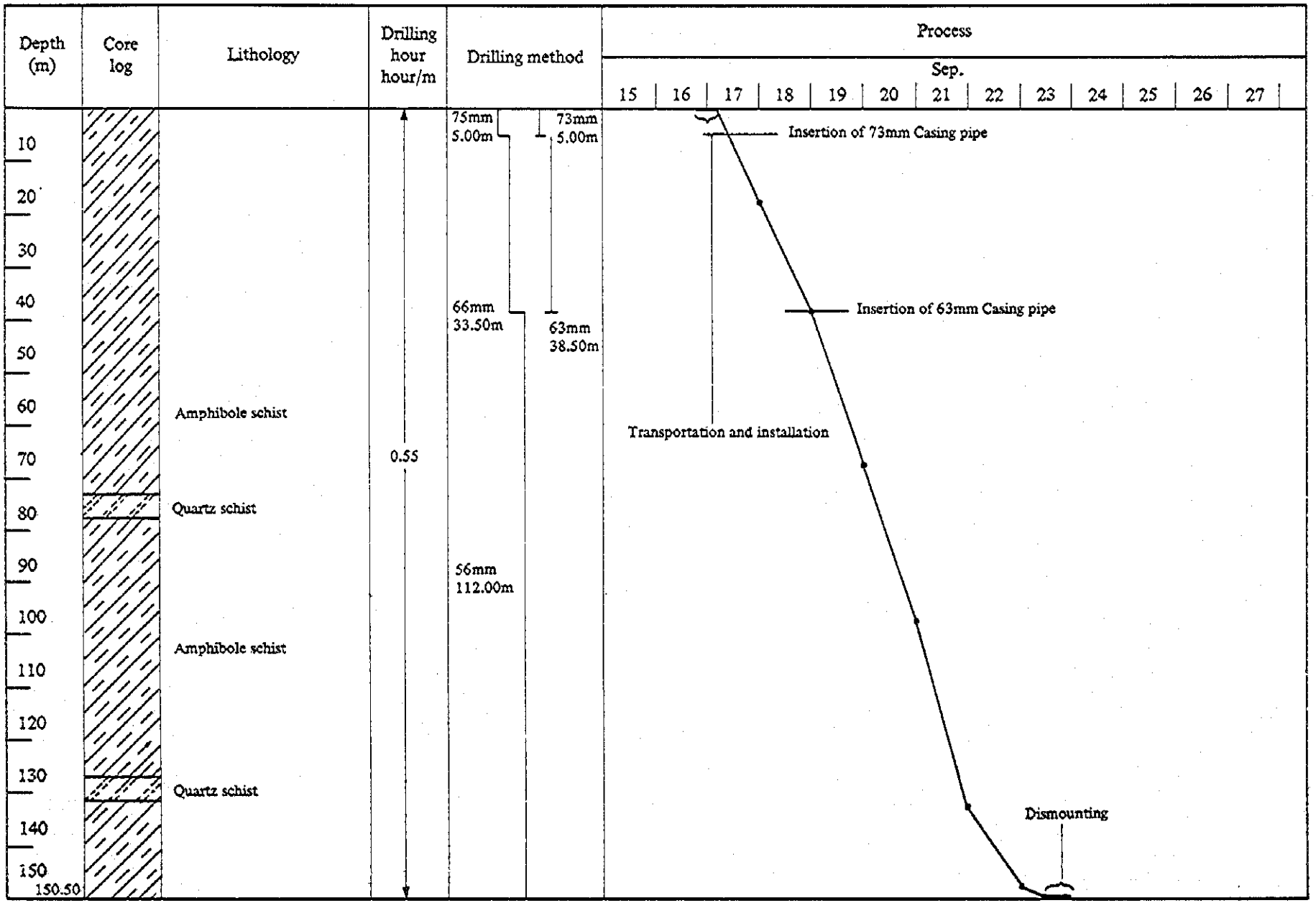


Fig. 13-2 PROGRESS RECORD OF DRILLING GSJ–20

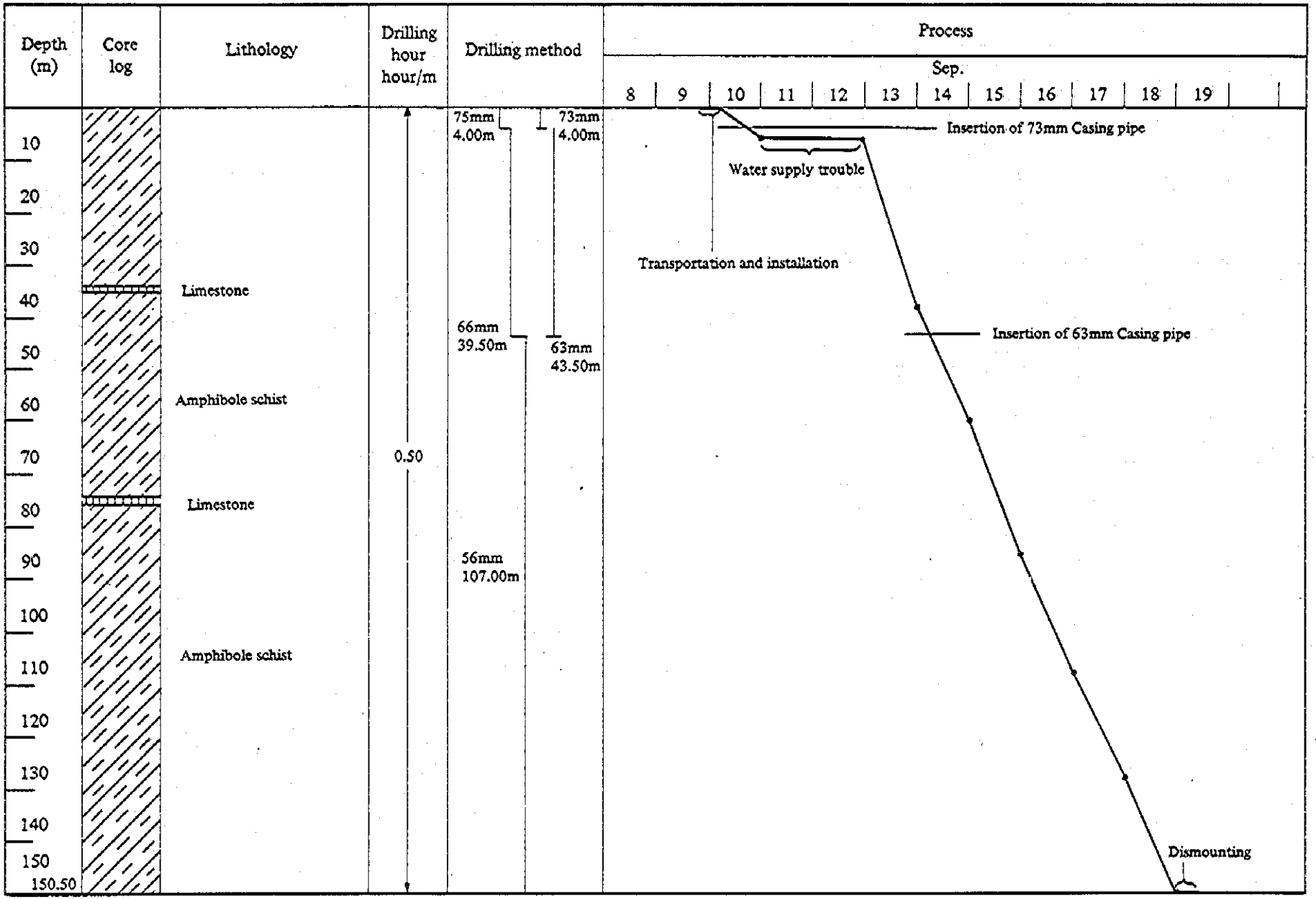


Fig. 13-3 PROGRESS RECORD OF DRILLING GSJ–21

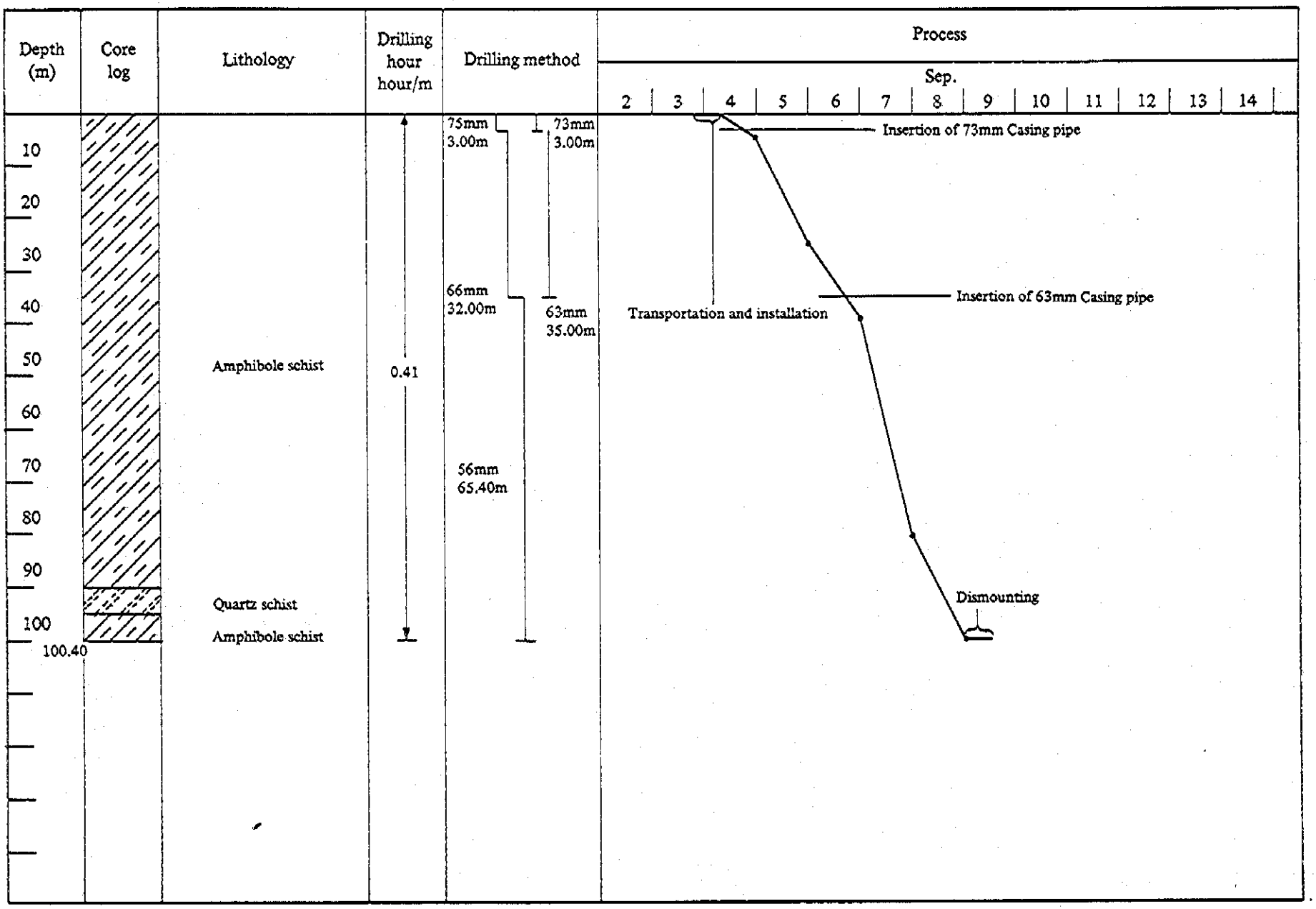


Fig. 13-4 PROGRESS RECORD OF DRILLING GSJ–22

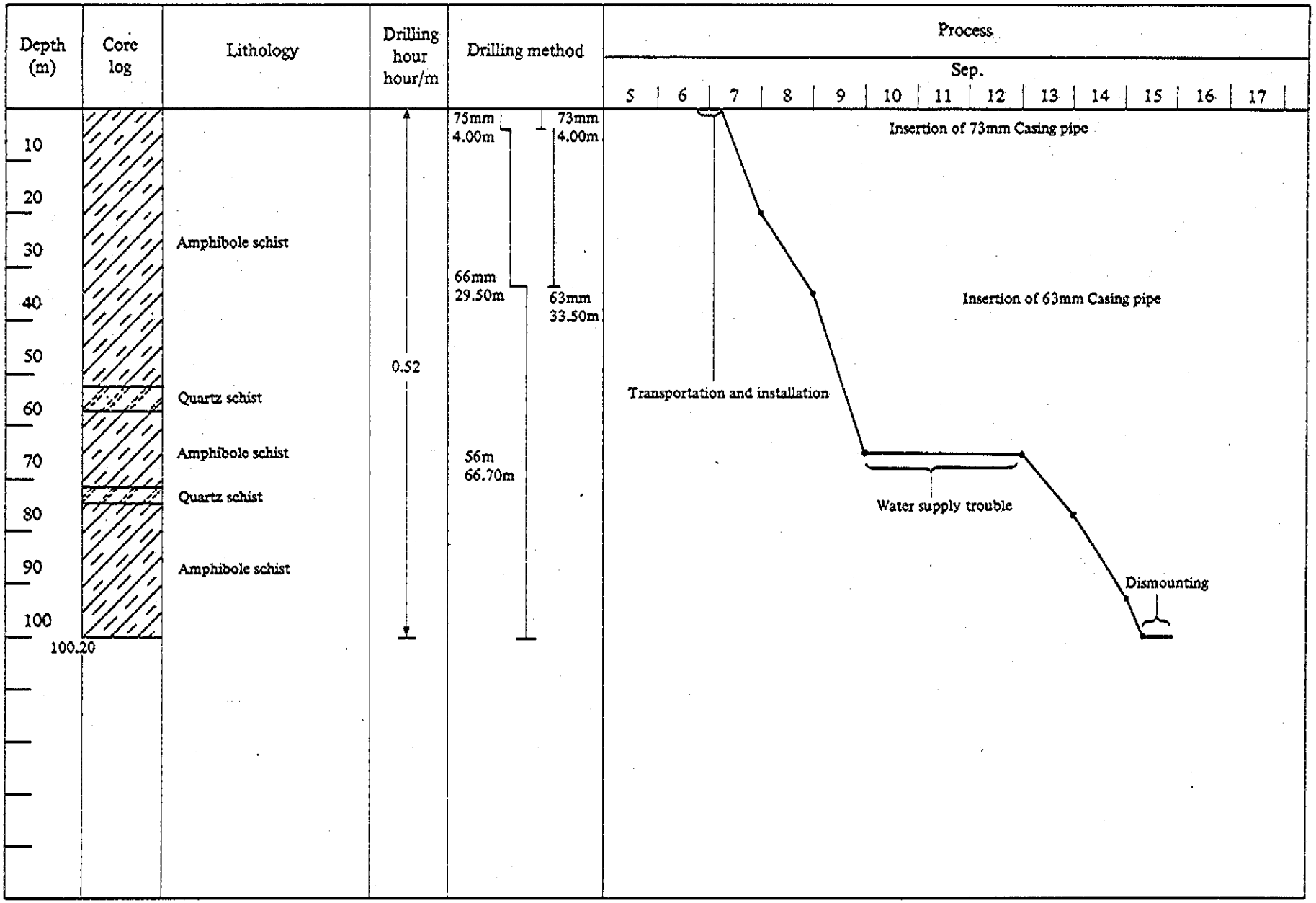


Fig. 13-5 · PROGRESS RECORD OF DRILLING GSJ–23

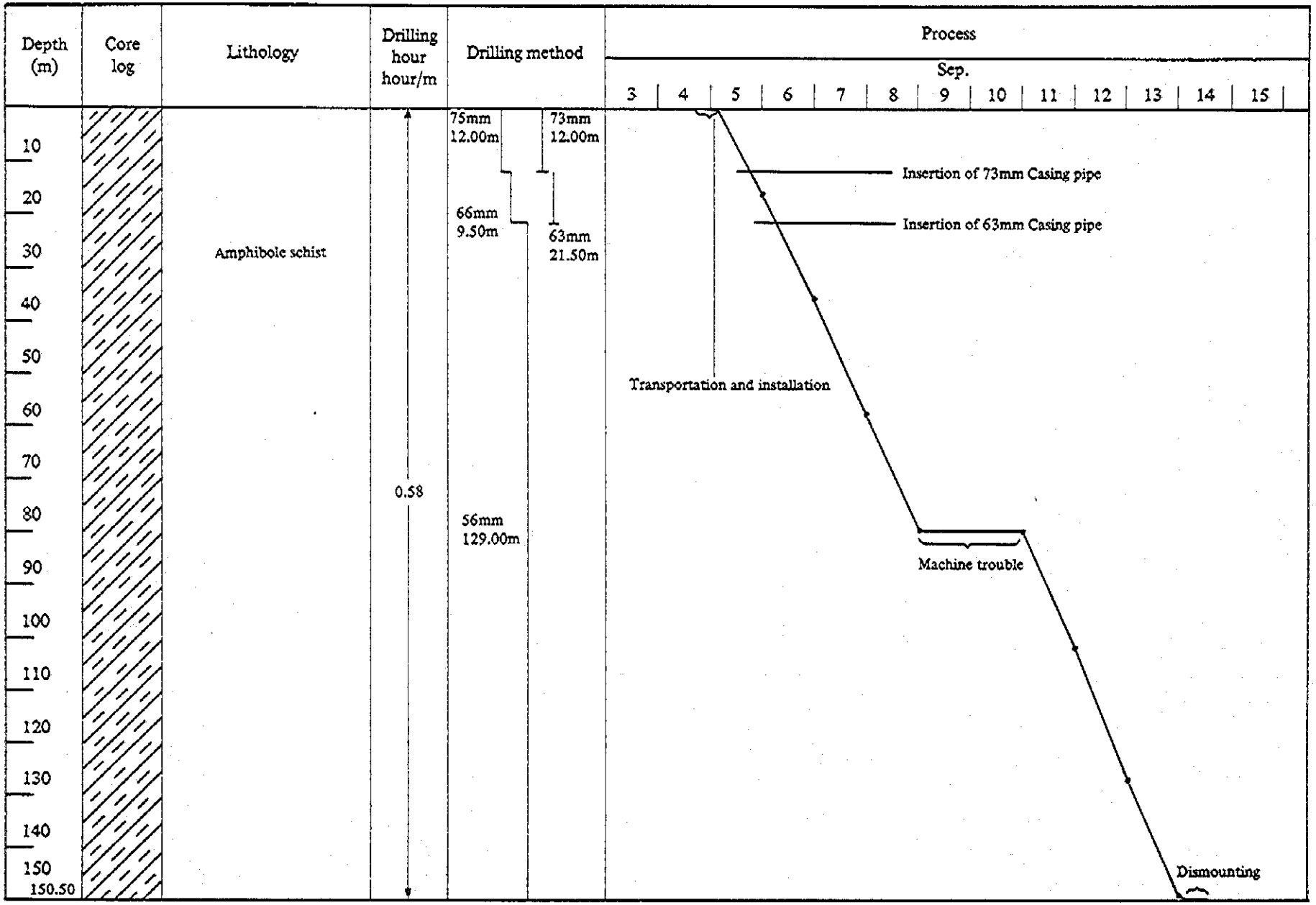


Fig. 13-6 PROGRESS RECORD OF DRILLING GSJ–24

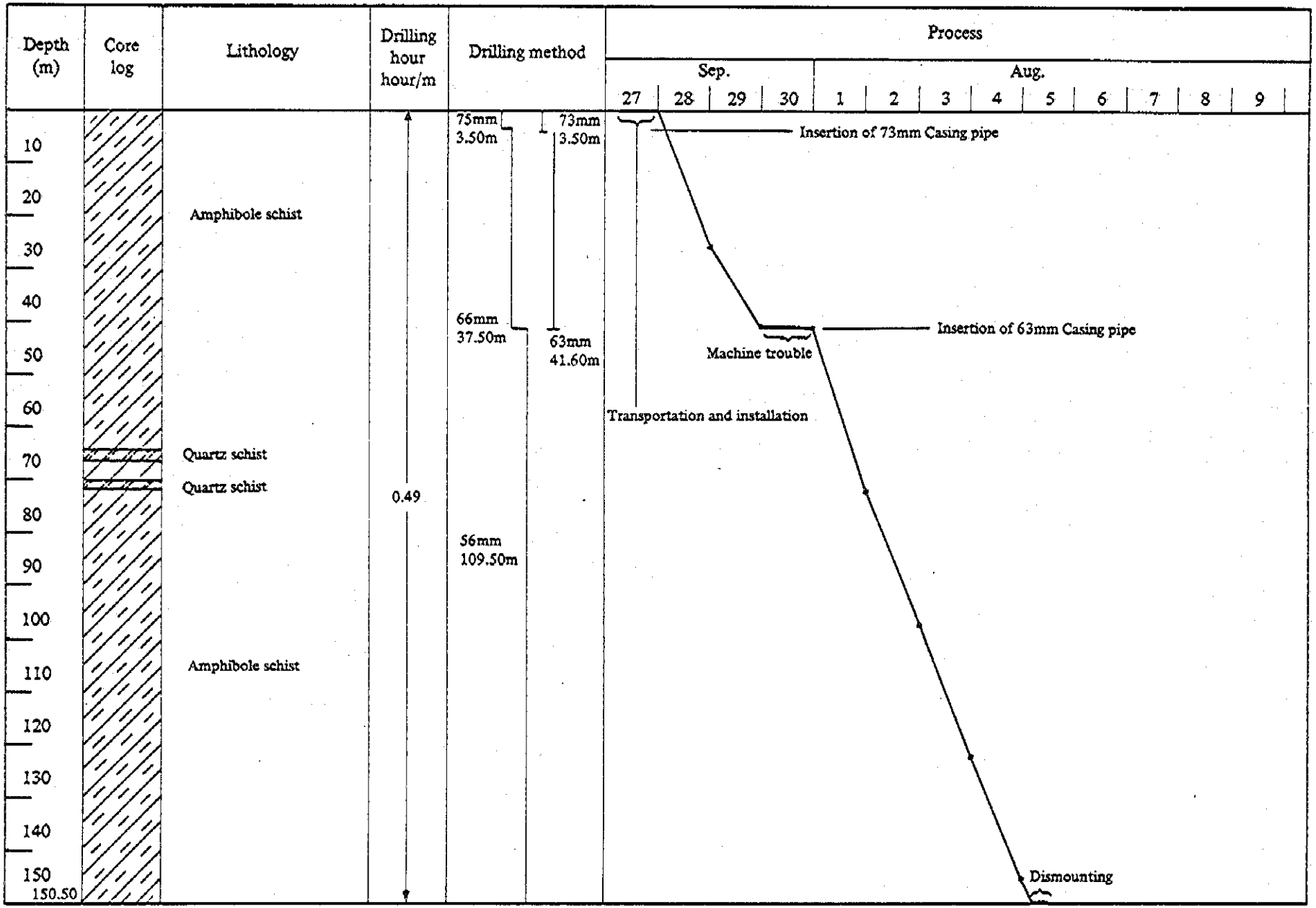


Fig. 13-7 PROGRESS RECORD OF DRILLING GSJ–25

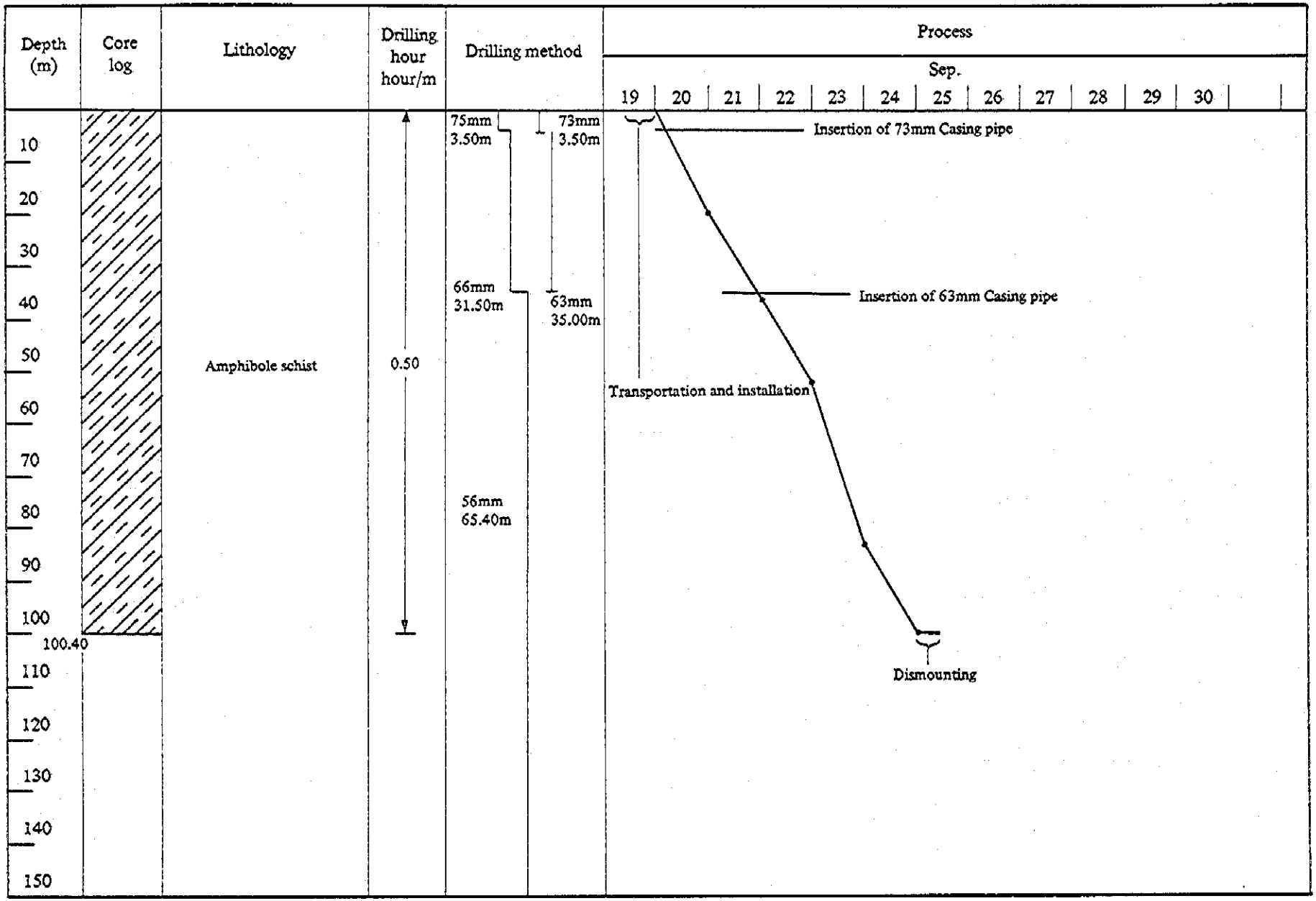


Fig. 13-8 PROGRESS RECORD OF DRILLING GSJ–26

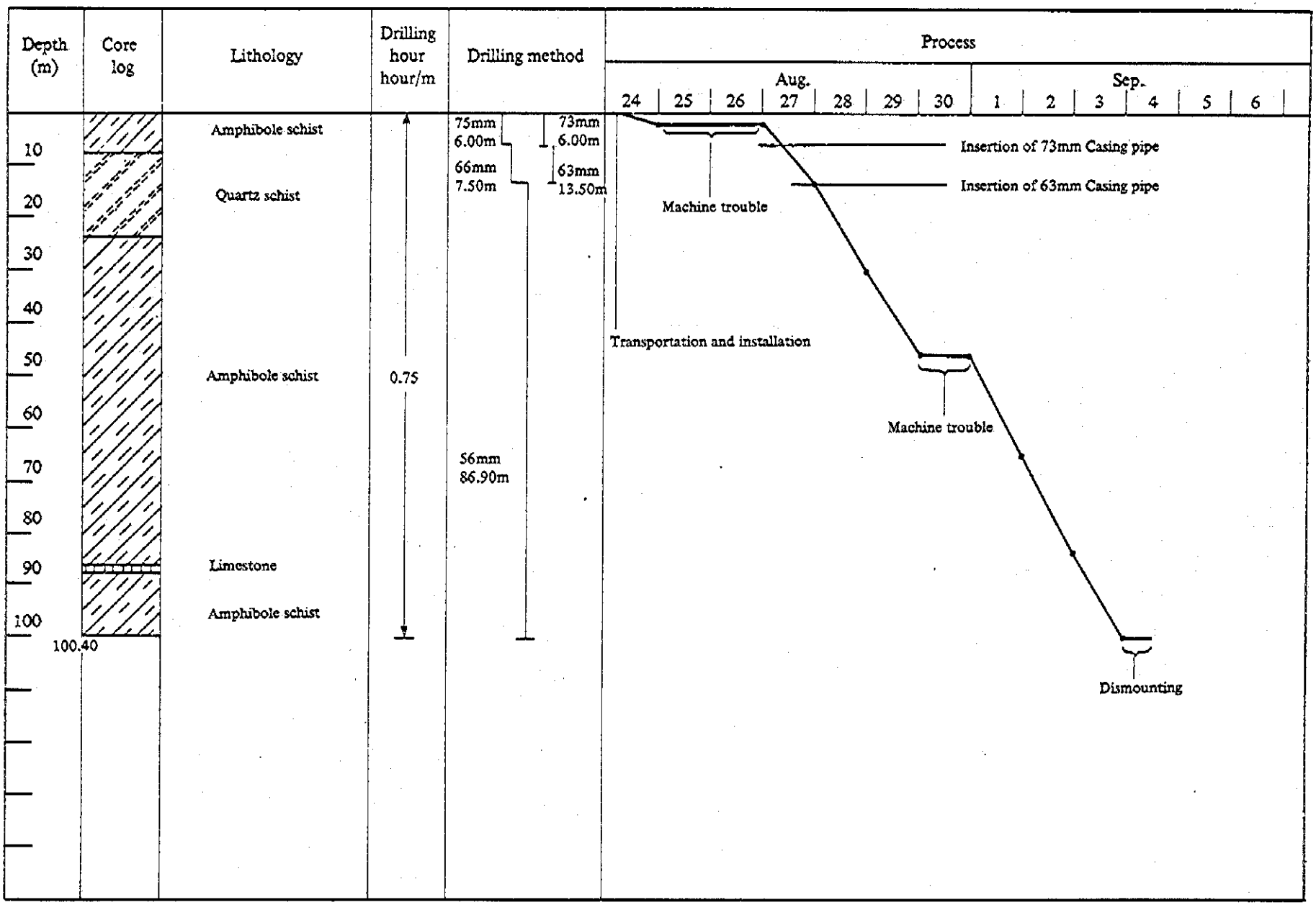


Fig. 13-9 PROGRESS RECORD OF DRILLING GSJ-27

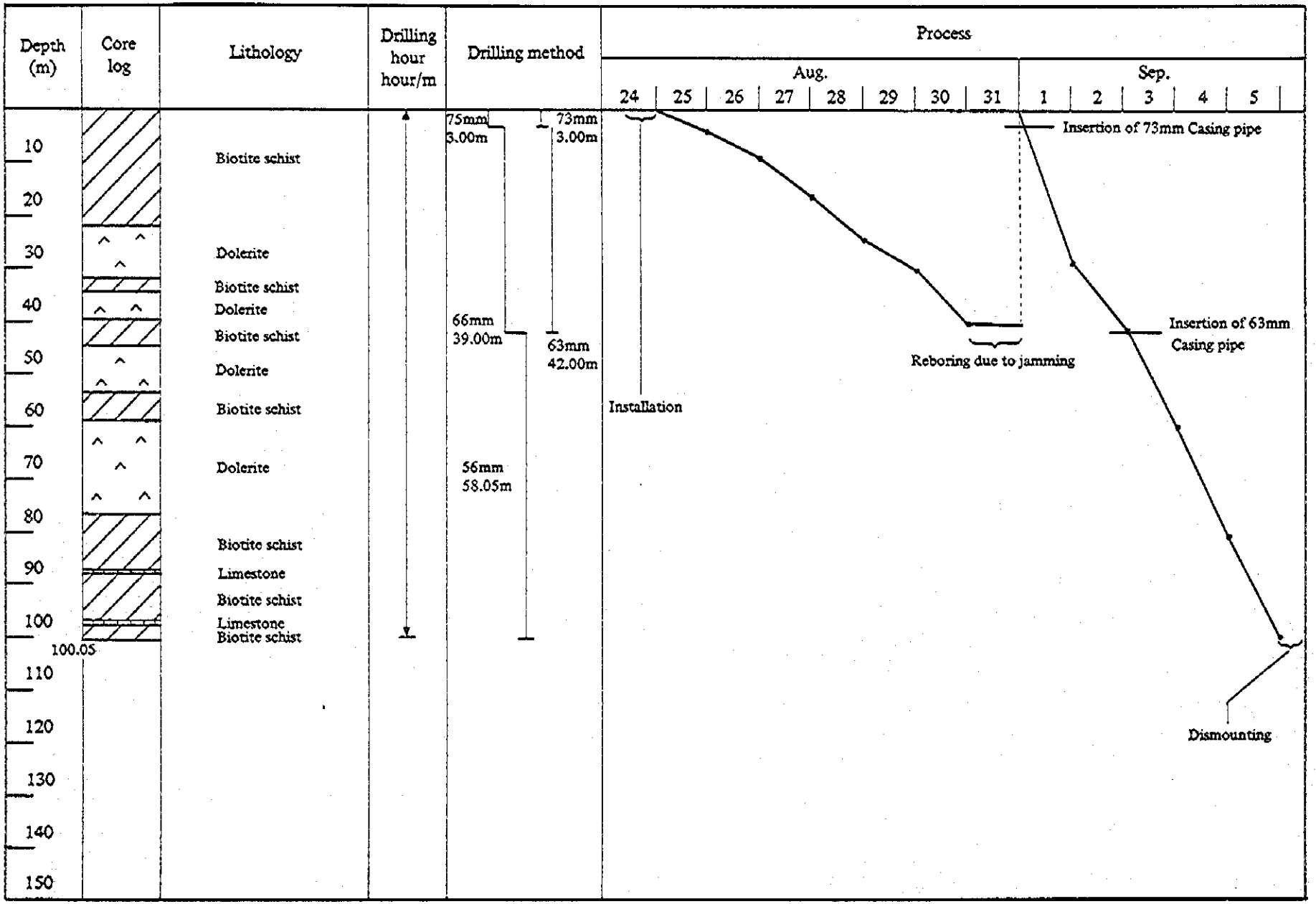


Fig. 13-10 PROGRESS RECORD OF DRILLING GSJ-28

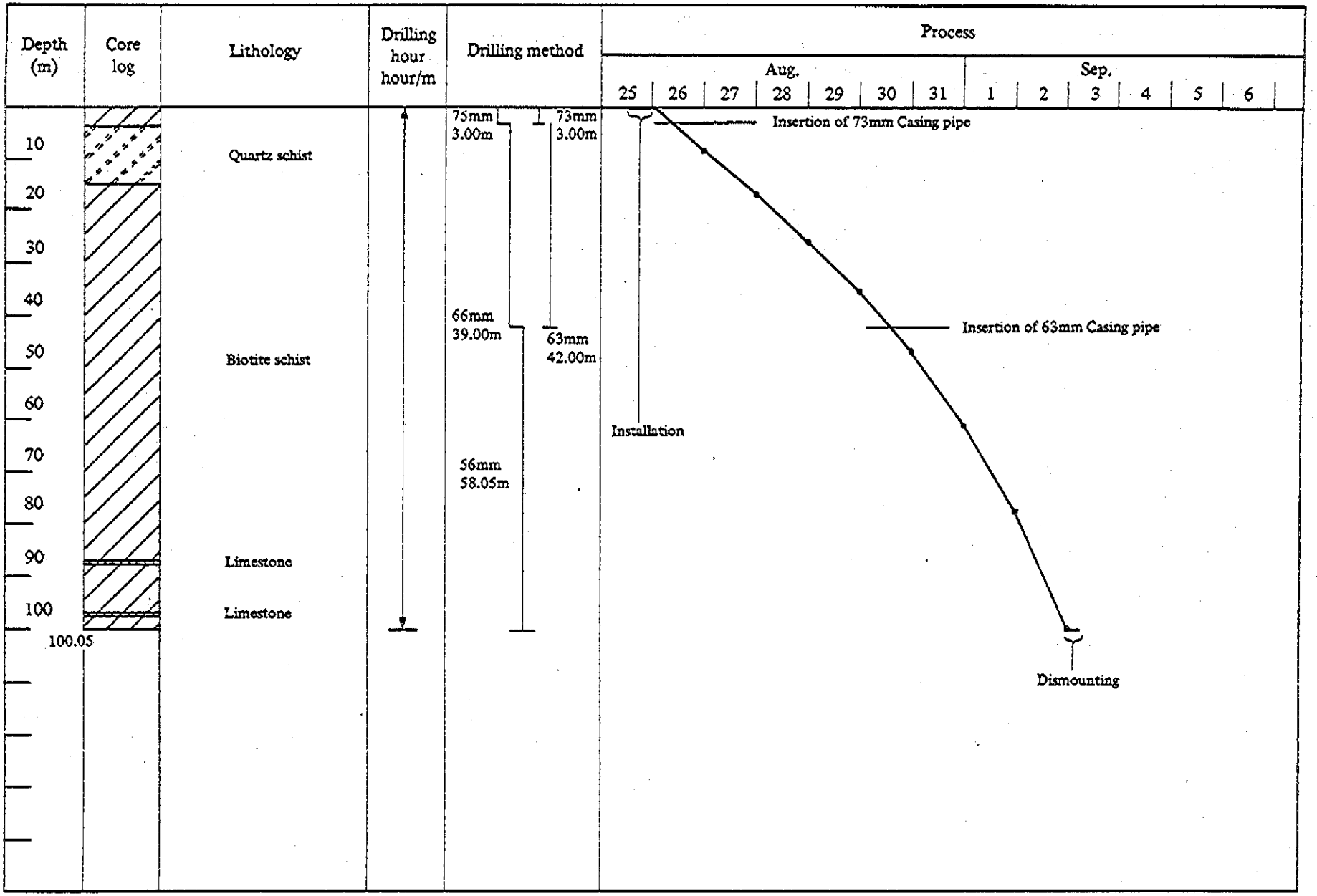


Table 8 Drilling equipment

Item	Model	Quantity	Specification	
Drilling Machine	TD-1G (Tone Boring, Co.)	2 sets	Capacity: Dimensions: Height; Length; Width; Weight:	AW Rod 150 m 1,190 mm 1,250 mm 800 mm 390 kg
	Swivel Head		Spindle speed:	135,270,560 r.p.m.
	Hoist		Hoisting capacity,	Max. 850 kg
	Oil Pump		Capacity: Max. pressure:	0 ~ 26 ℓ/min. 70 kg/cm^2
	NS-110C (YANMER)	2	Diesel engine Revolution: Related power:	 2,200 r.p.m. 11 PS
Drilling Pump	NAS-2 (Tone)	2	Cylinder bore dia.: Delivery volume: Max. pressure: Stroke:	63 mm 62 ℓ/min. 70 kg/cm^2 160 r.p.m.
	NS-75C (YANMER)	2	Diesel engine Revolution: Related power:	 2,200 r.p.m. 7.5 PS
Derick	Tripod (KYOEI)	2	Steel pipe Max. load capacity:	 3,000 kg
Drill Rod		85 4	AW – 3 m AW – 1.5 m	
Casing Pipe		11 5 47 5 7	73 mm – 3 m 73 mm – 1.5 m 63 mm – 3 m 63 mm – 1.5 m 63 mm – 0.5 m	
Double Core Tube	DN-AW	3	DN 65 – 1.5 m	
Double Core Tube	DN-AW	5	DN 55 – 2 m	
Single Core Tube		2	J74 – 0.3 m	
Single Core Tube		1	J74 – 1.5 m	

Table 9 Consumed bits

Hole No. \ Bit Type		75 mm		66 mm		56 mm		Remarks
		Metal		Bit	Reamer	Bit	Reamer	
GSJ-19	Legnth Quantity	5.00 1		33.50 2	33.50 1	112.00 9	112.00 2	
GSJ-20	Length Quantity	4.00 1		39.50 3	39.50 1	107.00 10	107.00 2	
GSJ-21	Length Quantity	3.00 1		32.00 2	32.00 1	65.40 6	65.40 2	
GSJ-22	Length Quantity	4.00 1		29.50 2	29.50 1	66.70 7	66.70 2	
GSJ-23	Length Quantity	12.00 1		9.50 2	9.50 1	129.00 10	129.00 3	
GSJ-24	Length Quantity	3.50		37.50 2	37.50 1	109.50 9	109.50 3	
GSJ-25	Length Quantity	3.50		31.50 2	31.50 1	65.30 6	65.30 2	
GSJ-26	Length Quantity	6.00 1		7.50 1	7.50 1	86.90 9	86.90 2	
GSJ-27	Length Quantity	3.00 1		39.00 3	39.00 1	58.05 6	58.05 2	
GSJ-28	Length Quantity	3.00 1		39.00 2	39.00 1	58.05 6	58.05 2	
Total	Length Quantity	47.00 10		298.50 21	298.50 10	857.90 78	857.90 22	
Length / Bit		4.7		14.21	29.85	10.99	33.99	
Bit / Hole		1		2.1	1	7.8	2.2	

Table 10 Consumables used

Hole No.	Diesel oil	Gasoline	Mobile oil	Grease	Cement	Bentonite
	ℓ	ℓ	ℓ	kg	bag	bag
GSJ - 19	316	58	10	1.5	5	3
GSJ - 20	307	56	8	1.5	4	3
GSJ - 21	206	38	5	1	2	3
GSJ - 22	215	40	7	1	4	3
GSJ - 23	325	60	15	2.0	5	4
GSJ - 24	298	55	10	1.5	5	2
GSJ - 25	191	35	2	1	3	3
GSJ - 26	220	41	15	2	3	3
GSJ - 27	240	44	7	2	6	4
GSJ - 28	198	36	5	1	3	2
Total	2,516	463	84	14.5	40	30

Chapter III. COMPREHENSIVE ANALYSIS

Surveys, mainly depending on drilling, were carried out on the two areas selected as the result of the survey programs in the first to third years.

In Area A a detailed geochemical survey picked up a clear anomaly, which presented distribution concordant with the strata. In this anomaly area, the more the positions move to the north, the stronger becomes anomaly, and the anomaly area tends to extend further northward.

For this anomaly area a total of nine vertical holes were drilled in the third and fourth years, and mineral indication was recognized in all of them. That, though this indication is weak, the geochemical anomaly is accompanied by mineralization, indicates coincidence of the indication with a deposit bearing horizon. However, geology in this area is formed of homogeneous amphibole schist for the most part, lacking in the variety of the quality of rock and lithofacies, and also the geology and mineral indication that have been confirmed by the drill holes presented almost the same conditions, showing no particular key bed. Therefore, mutual relations between the drill holes were unable to be found, nor were understood the structure and scale of the mineralization zone.

In Area B one of the two drill holes aimed at a geochemical anomaly encountered dikes of dolerite, and most of the strata were missed and no mineral indication was found. In another hole two thin layers of limestone in mica schist were confirmed, and in one of these chalcopyrite dissemination, though slight, was found.

In this area a promising area was unable to be concentrated because here geochemical anomaly is a little weaker than in Area A, the anomaly was unable to be adequately narrowed down as it had been picked up by a semi-detailed geochemical survey, and because only two drill holes were drilled.

Chapter IV. CONCLUSION AND OUTLOOK FOR FUTURE

In the fourth year, on the basis of the result of the surveys in the first to third years, surveys were conducted, primarily depending on drilling, on the vicinity of GSJ-6 that had been selected as a highly promising area for occurrence of copper deposits (Area A) and on an anomaly area that had been picked up by geochemical survey (Area B).

As for Area A, mineral indications confirmed by drilling was weak in all the drill holes, and no indication that could justify mining operation was unable to be found. However, the fact that the geochemical anomaly area presents distribution concordant with the strata indicates that this coincides with a deposit bearing horizon. Also this anomaly area shows higher anomaly values on the northwest side, and also tends to extend further northwestward.

This area falls in a part of anomaly areas that were picked up in the second year survey program. So that for the future it is desired that the scope of exploration be extended so that this anomaly area is covered, and that for anomaly areas that are picked up by a detailed geochemical survey, mineral indications be confirmed through drilling holes about 100 m in depth.

In Area B, since the number of drilled holes was too few and on top of that one drill hole encountered dolerite, the geology and the conditions of mineral indication were not able to be adequately known, and no clear promising area was concentrated. However, it suggests the possibility of this area bearing a Matsitama-type deposit that this area is equipped with geological conditions similar to those of Matsitama deposits and also copper indication was found, though slightly, in the findings from drilling.

Since the geochemical anomaly of this area tends to extend further westward, for the future it is desired that the extent of exploration be expanded westward and anomalies be picked up by a detailed geochemical survey, confirming mineral indications through shallow drilling.

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APENDICES