REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE VAN YEN AND WESTERN THANH HOA AREAS, THE SOCIALIST REPUBLIC OF VIETNAM

PHASE III

MARCH 1996

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of the Socialist Republic of Vietnam, the Japanese Government decided to conduct a Mineral Exploration Project in the Van Yen and Western Thanh Hoa Areas and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

This is the third phase survey. The JICA and MMAJ sent a survey team headed by Mr. Yoneharu Matano to the Socialist Republic of Vietnam from 11 September 1995 to 3 January 1996.

The team exchanged views with the officials concerned of the Government of the Socialist Republic of Vietnam and conducted a field survey in the Van Yen and Western Thanh Hoa areas. After the team returned to Japan, further studies were made.

We hope that this report will serve for the development of this project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Socialist Republic of Vietnam for the close cooperation extended to the team.

March, 1996.

Kimio FUJITA
President,
Japan International Cooperation Agency

Shozaburo KIYOTAKI
President,
Metal Mining Agency of Japan

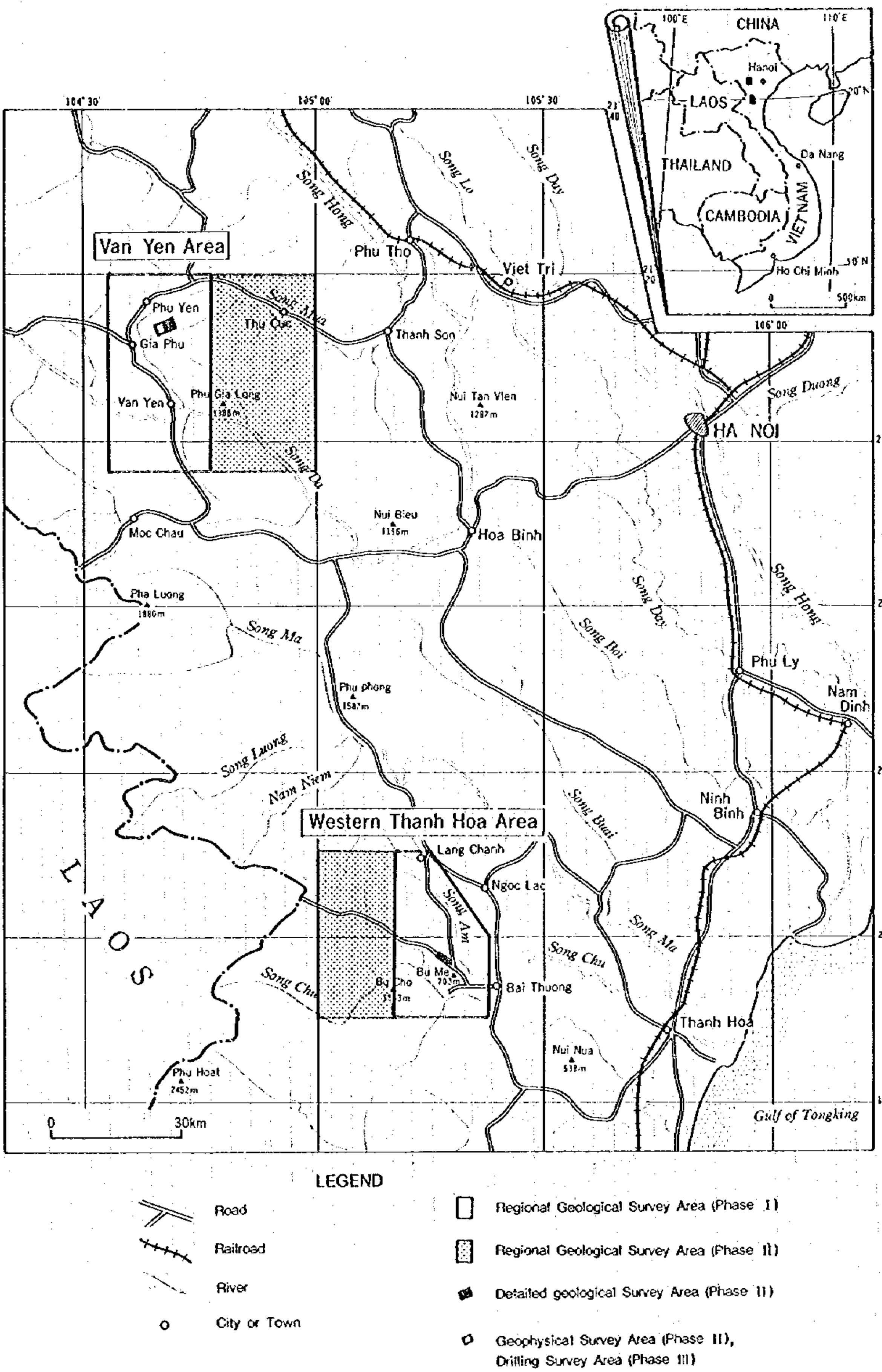

Fig. 1-1 Index Map of the Survey Area

SUMMARY

The work reported in this paper corresponds to the third phase of the three-phase Cooperative Mineral Exploration in the Van Yen and Western Thanh Hoa Areas of the Socialist Republic of Vietnam. The principal objective of the project is to evaluate the mineral potential of the areas through geoscientific investigation and to discover new mineral deposits.

In the first and second phases, regional geological survey and geochemical exploration were conducted in the Van Yen and Western Thanh Hoa areas, and detailed geological survey, geochemical exploration and geophysical survey were consequently continued on the promising zones for ore deposits.

The Suoi Boc zone of the Van Yen area was extracted to be hopeful for lead and zinc mineralization as a result of the above works.

The survey of this phase consists of drilling survey and trench survey in the Suoi Boc zone. Amount of the survey is four inclined drill holes totaling 742.30 m and three trenches with a total length of 600 m.

The followings are the results of the third phase survey and recommendations for the future exploration work.

The geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary sediments. The Middle Triassic is divided into clastic sedimentary rocks and limestone. The clastic sedimentary rocks are composed of mudstone, siltstone and sandstone. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone occurs in the eastern part. The Triassic clastic sedimentary rocks tend to strike N-S to NNE-SSW directions and dip mostly from 20° to 70°E.

The geologic structure of the zone is characterized by the N-S to NNE-SSW direction which is expressed as the strike of sedimentary rocks and faults, and the distribution of igneous rocks and the extension of Quaternary sediments.

As a result of the work in this phase, it has become clear that the geochemical anomalies in the zone indicate the vein-type mineralization. The potential for skarn ore deposits is low because skarn minerals are absent in the Triassic rocks of these anomalous zones.

Consequently, the Suoi Boc mineralized zone is regarded as a vein-type mineralized zone.

The high chageability zones detected last year by IP survey, are interpreted to have been caused by graphite contained in the clastic sedimentary rocks. Therefore, it has been proved that new Pb-Zn ore deposits are not expected to occur in the high chargeability zones.

The vein mineralization in this zone is mostly located in limestone. Many caves occur in the limestone. The sulfide minerals are considered to have been oxidized and dissolved to deeper part by free ground water flowing within caves. It is supposed that the weathering bottom for sulfide minerals may reach to more than 200 m below the surface, although the lower limit of weathering for sulfide minerals was not proved.

The width of brecciated veins containing limonite in the drill holes and trenches does not exceed 2 meters. No big Pb-Zn vein deposit is possibly expected to exist, because the width of vein at the deeper part below the surface is not reasonable to become sharply thicker.

Shear zones composed of limonite and clay, are found in trenches and drill holes. The genesis of these shear zones is interpreted in two ways. One is the weathered products of sulfide bearing brecciated veins. The alternative is that shear zone is composed of limestone fragments and surface soil collapsed in ancient dolines. High content of Pb-Zn will be rare in the deeper part of the veins, as the limestone fragments occupy the major part of the veins even though the genesis is the former one.

As the result of the drilling survey and trench survey done in this phase, no indication for new ore deposits was found. Therefore, no further exploration is needed in this zone.

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PART 1. OVERVIEW

CHAPTER 1. INTRODUCTION

1-1. Background and Objectives of the Survey

In response to the request by the Government of the Socialist Republic of Vietnam to conduct mineral exploration, the Japanese Government dispatched a preparatory survey team to discuss the details of the project. As a result of the consultations between the Geological Survey of Vietnam (GSV) of the Ministry of Heavy Industry and the Metal Mining Agency of Japan, an agreement was reached for the cooperative mineral exploration in the Van Yen and Western Thanh Hoa Areas. The Scope of Work was signed by the representatives of both governments in June 1993. The objective of this project is to assess the mineral potential of the areas through geological survey, geochemical exploration, geophysical survey, and drilling survey during the period of three years from 1993 to 1995.

The first phase survey of this project was carried out in fiscal 1993. The works conducted in the first phase were; compilation of available geological, geochemical and geophysical information, geological and geochemical field survey of the western part of the Van Yen area and the eastern part of the Western Thanh Hoa area.

In fiscal 1994, geological and geochemical survey continued in the remained parts of the Van Yen and Western Thanh Hoa areas, after the compilation of available geological, geochemical and geophysical information was done. Geological survey was executed in the Suoi Boc - Suoi Cu zone and geochemical exploration and geophysical surveys were done in the Suoi Boc zone of the Van Yen area, and geological and geochemical survey was conducted in the Luong Song zone of the Western Thanh Hoa area, since these were concluded to be promising for finding ore deposits by geological survey during the first year.

In fiscal 1995, drilling survey comprising four holes totaling 742.70m in length and trench survey with a length of 600 m continued on the Suoi Boc zone of the Van Yen area.

1-2. Conclusions and Recommendations of the Second Phase Survey

The second phase survey was carried out on the Van Yen and Western Thanh Hoa areas. The conclusions and recommendations of the second phase are described follows.

1-2-1. Van Yen Area

The survey of the second phase comprised regional geological survey, detailed geological survey, and geophysical survey (IP method).

Regional geological survey was carried out on the eastern part of the area. Detailed geological survey in the Suoi Boc - Suoi Cu zone and geochemical and geophysical surveys in the Suoi Boc zone were executed.

The following conclusions were obtained through the above field survey and subsequent analysis.

Regional geological survey

(1) This survey area belongs to the "West Bacbo" tectonic province. The basement of the area comprises the Proterozoic metamorphic rocks represented mainly by gneisses. Unconformably overlying the basement are metamorphic and sedimentary rocks of Cambrian to Permian age, pyroclastic and sedimentary rocks of Triassic (Early and Late) age, and unconsolidated Quaternary sediments. Granitic and gabbroic bodies intruded into the Proterozoic area and abundant small ultramafic bodies are recognized in the central part of the area.

(2) The principal structural trend of the "West Bacbo" is NW-SE system. The Proterozoic to Ordovician rocks in the northeastern and southeastern parts of this area are intensely controlled by the above structure with some faults of the same trend. The rocks of the central part are characterized by the structural trend of WNW-ESE to E-W, and Devonian to Permian strata form two anticlinoriums that have parallel aligoments and plunge westward. Some faults are developed parallel to the above structure. Additionally, Carboniferous to Upper Triassic strata extend in the N-S to NNW-SSE direction in the southwestern part of the area. Thus, the whole area is divided tectonically into three blocks.

(3) The mineralization in this survey area is those of gold, lead-zinc, and platinum-copper-nickel. However, in all cases the mineralization is very weak and no widespread mineralization zone has been found in the area.

3-a) Although the origin of the gold mineralization is supposed to be hydrothermal gold-bearing quartz veins, the essential characteristics of primary deposits remain unknown because the deposits were not discovered through this field survey.

3-b) The lead-zinc mineralization is represented by the Suoi Can mineral showing of hydrothermal vein type. This showing is hosted by the Middle Devonian limestone. The exposed ore body is 30 cm wide and no parallel vein was observed near the body. The content of lead is 8.86 %, but the exposed ore body has very small dimensions.

3-c) Platinum-copper-nickel mineralization occur in and around ultramafic bodies that intruded during the Permian time. The ultramafic bodies are generally small with several meters to 100 m width. The assay results for platinum are not high with the maximum being 40 ppb. The contents of copper and nickel are also approximately 0.1 %. Thus, this type mineralization is very weak in this area.

(4) As a result of stream sediment geochemistry, there is a possibility that the element of Cr is concentrated in some ultramafic bodies. However, the geochemical exploration revealed that no anomalous zone related to significant mineralization was found regarding to the other elements.

(5) Taking all information on geology, mineralization, and geochemistry in this area into consideration, it is not necessary to select areas for further detailed survey within this regional survey area.

Detailed geological survey

(1) The Suoi Boc - Suoi Cu zone is underlain chiefly by the Middle Triassic limestone, mudstone, sandstone, siltstone, and conglomerate. These rocks are classified into two rock facies consisting limestone and the other clastic rocks. The strata of two rock facies extend in the N-S direction with faults parallel to this direction and the strata form complicated folds.

(2) The detailed geological survey in the whole area revealed that no new mineralization zone similar to the known two zones was present. It has been pointed out through first phase survey that the Suoi Boc mineralized zone may be of massive metasomatic lead-zinc type hosted by limestone. However, judging from the results of the detailed survey of this phase, this mineralization has a possibility to be of hydrothermal vein type hosted by sandstone with a strike of N30° W.

(3) As a result of the soil geochemical exploration in the area revolving around the Suoi Boc mineralized zone, four anomalous zones for Pb and Zn were detected. In the center of one strong anomalous zone, Pb and Zn contents are very high (Pb: 29,000 ppm, Zn: 70,000 ppm). The Suoi Boc mineralized zone is located near the center of the anomalous zone, thus the soil geochemical

anomalous zone occurs in good agreement with the mineralized zone. In other three zones, Pb and Zn contents of the central points are also high (Pb and Zn: over 1,000 ppm). Thus, these zones are believed to indicate lead-zinc mineralization. From this fact, it is concluded that the area around the Suoi Boc mineralized zone is promising for finding lead-zinc deposits other than the known one.

Geophysical survey

(1) The low resistivity zones of less than 50 ohm-m are detected in the northeastern edge and central part of the survey area. The low resistivity zones of less than 100 ohm-m are scattered in the areas connected the low resistivity zones less than 50 ohm-m. These low resistivity zones reflect the distribution of mudstone that showed the lowest resistivity in laboratory.

(2) On the Suoi Boc mineralized zone, the chargeability is only several ms higher than the mean value of the whole zone and thus no IP anomaly was detected. This can be understood from the reason that two factors work together. One is the little difference between ore and sandstone in chageability (proved by the laboratory tests). Another is the small size of the mineralization zone.

(3) Two IP anomalies more than 60 ms are detected in the northeastern edge and middle east edge of the survey area. The anomaly in the northeastern edge is the strong one containing the measuring point more than 100 ms. It is inferred that the strong IP anomalies result from mineralization containing pyrite, graphite, or clay under the ground. Moreover, the IP anomaly in the middle east edge is noteworthy because it and a Pb-Zn soil geochemical anomalous zone partly correspond each other.

Recommendations for Third Phase Survey

From the conclusions reached during the first phase and second phase surveys, the following work is recommended for the third phase survey to be carried out in Fiscal 1995.

(1) Drilling exploration for an area around the Suoi Boc Prospect

(2) Detailed geological survey in the northwestern part of the first phase area for an area of 5 km × 8 km ; Stream sediment geochemical anomalies for Pb and Zn are concentrated in this part.

1-2-2. Western Thanh Hoa Area

The survey of the second phase consists of regional geological survey and detailed geological survey.

Regional geological survey was carried out in the area on the west of the first phase area. Detailed geological survey was done in the Luong Son Mineralized zone.

Conclusions

Regional geological survey

(1) This survey area is situated at the northern edge of the "Truongson" tectonic province. The area is underlain by the Cambrian metamorphic basement, the unconformably overlying Ordovician to Triassic metamorphic rocks and marine and continental sedimentary rocks, a large amount of Jurassic pyroclastic rocks (partly interbedded with sedimentary rocks), and unconsolidated Quaternary sediments. Late Triassic gabbros, Late Cretaceous to Paleogene granitic rocks occur widely in the northern to southeastern part of the area.

(2) The metamorphic, sedimentary, and pyroclastic rocks that constitute this area generally have NW-SE to WNW-ESE structural trend. The trend is roughly controlled by the major one of the "Truongson" province. It appears that these rocks consist of a series of folds with the same trend of axes as that of the "Truongson". In the northern half of the area, faults are developed in the WNW-ESE direction, and the granitic bodies also extend in this direction. In the southern half of the area, faults of four systems occur in a comples pattern, that are represented by E-W, NW-SE, NE-SW, and N-S.

(3) The mineralization is very weak in the whole area and no remarkable mineralization was found except for only one locality of copper mineral showing. The Western Muong Ly mineral showing comprises four copper-bearing quartz veins within an area of about 20 m width. The veins are hosted by Middle Triassic conglomerate and sandstone with the maximum width being 7 cm. In view of the small dimensions of the showing and low content of copper (0.69 %), the showing is not noteworthy for copper mineralization.

(4) The geochemical exploration with stream sediments revealed that no anomalous zone related to significant mineralization was detected about all eleven elements employed.

(5) Judging from the data on geology, mineralization, and geochemistry, no further exploration is needed in this regional survey area.

Detailed geological survey

(1) The Luong Son Mineralized zone is underlain mainly by the Middle Triassic sandstone, Jurassic (?) dacitic crystal tuff, and Late Triassic intrusive gabbro. The sandstone occurs in a major part of the area and extends generally in the NNW-SSE direction. The strata are inferred to consist of a series of folds with about 2 km wavelength. The gabbroic bodies intruded into sandstone area and extend roughly in the N-S direction.

(2) The gold-bearing hydrothermal quartz veins are concentrated in this mineralized zone. They are hosted by the Middle Triassic sandstone and mudstone as well as Late Triassic gabbroic bodies. During first phase survey, three sites of quartz vein were examined and the chemical analysis of the collected samples revealed that the highest content of gold was 0.24 g/t. Eight outcrops and 15 float zones of quartz vein were newly discovered through the detailed survey of this phase. The highest content of gold obtained is 0.05 g/t, as a result of chemical analysis for samples collected from those localities. The hydrothermal alteration zone with kaolin minerals occurs on the east of a gabbroic body located in the central part of this area. The zone was disclosed to be of about 600 m width and extends roughly in the N-S direction through the present detailed survey.

(3) As a result of the soil geochemical exploration, four strong anomalous zones for Au (Au >50 ppb) were detected in the northwestern part of the area. No remarkable trend of zones is recognized because the zones are sporadically scattered. However, judging from high Au contents of the anomalies, the anomalous zones are believed to imply gold mineralization. Therefore, it can be stated that this area has mineral potential for gold with possibilities of finding gold-bearing quartz veins near the anomalous zones other than the known veins.

Recommendations for Third Phase Survey

The following work is recommended for third phase survey because of the conclusions reached during first phase and second phase survey.

(1) Trenching on the Au soil geochemical anomalous zones for the Luong Son mineralized zone in order to assess the mineral potential, particularly to discover new gold-bearing quartz veins

(2) Detailed geological survey for the Coc Thuong mineralized zone and the surrounding area which is located in the southeastern part of the first phase area ; Quartz veins are concentrated in this zone where the presence of gold was confirmed at some places. Stream sediment geochemical anomalies for Au and Cu are found to occur concentrated over this zone. Thus, this zone is promising for finding gold deposits.

1-3. Outline of the Third Phase Survey

1-3-1. Contents of the Survey

The third phase survey comprises four drill holes totaling 742.70 m in length and trench survey with a length of 600 m on the Suoi Boc zone of the Vau Yen area. Table 1-1 shows the contents of the third phase survey. Laboratory works conducted are laid out in Table 1-2.

Table 1-1 Survey Contents

Contents	Amount of the Works
Drilling survey	4 holes, 742.70 m in total drilled length
Trenching	3 lines, 600 m in total trenched length

Table 1-2 Amount of Laboratory Studies

Drilling Survey

Item	Amount
(1) Thin sections	19 pcs
(2) Polished sections	7 pcs
(3) X-ray diffraction analysis	12 pcs
(4) Chemical analysis a) Rock (Au, Ag, Cu, Pb, Zn) b) Ore (Au, Ag, Cu, Pb, Zn)	 41 pcs 6 pcs
(5) Measurement of Resistivity and polarization	17 pcs

Trench Survey

Item	Amount
(1) Chemical analysis a) Rock (Au, Ag, Cu, Pb, Zn) b) Ore (Au, Ag, Cu, Pb, Zn)	 100 pcs 30 pcs

1-3-2. Survey areas

The survey of this phase was carried out in the Suoi Boc zone, which is located in the northwestern part of the Van Yen Area. The Suoi Boc zone is enclosed by the following coordinates.

1	21°13'46"N	104°38'46"E	3	21°13'05"N	104°40'21"E
2	21°12'41"N	104°39'14"E	4	21°14'01"N	104°39'51"E

1-3-3. Objectives of the Third Phase Survey

(1) Major themes

The principal objective of the survey is to find a new mineral deposit in the Van Yen and Western Thanh Hoa areas through the exploration and examination of geology and mineralization.

Lead-Zinc mineralization hosted in the Middle Triassic sedimentary rocks are observed in the Suoi Boc zone. Pit survey done by GSV revealed that a mineralized zone with galena and sphalerite has 0.1 to 1.0 m wide.

No outcrops of mineralization were found in the course of the field survey of the previous year, but ore lumps dug out from some pits were observed.

Soil geochemistry delineated by the work of the second phase shows that there are four high content zones of Zn in the Suoi Boc zone. The strong IP anomalies that were composed of high chargeability more than 60 ms, were detected in the northeastern part and central part of the survey area.

Based on the results of the previous year, the following works were carried out as the main line of work for the third phase.

Drilling and trenching

To clarify the conditions of subsurface lead and zinc mineralization in the geochemical and geophysical anomalies.

1-3-4. Method of exploration

(1) Drilling

1) The geochemical and geophysical anomalies confirmed by the previous works were drilled.

2) Drilling work was conducted by Drilling Technology Center of GSV.

3) The final diameter of the cores was larger than BQ.

4) Core handling

i) Recovered cores were placed in core boxes with the directions clearly marked and were stored in core shack designated by GSV.

5) Study of cores

i) The cores were studied with care and 1:200 scale columns were prepared.

ii) Microscopic studies of the cores were made as necessary.

(2) Trench survey

1) Trenches were prepared with a width of 1 m to expose the basement.

2) Trenches were studied in detail on geology and the conditions of mineralization, and geologic sketch at scale 1:200 was generally made. Detailed geologic sketch at scale 1:100 was done in the mineralized part.

3) Samples were collected to clarify the geology and the nature of mineralization.

1-4. Members of the Third Phase Survey

(1) Members Participating in the Project

The work of the third phase was carried out during the period of 8 September 1995 to 28 February 1996. Field work was done from 11 September 1995 to 3 January 1996. The members of the survey team are as follows.

Vietnamese Side

Coordinator	Hoang Minh Hue	(Geological Division No. 3, GSV)

Japanese Side

Survey Members of Nikko Exploration & Development Co., Ltd.

Team leader	Yoneharu MATANO
Drilling Engineer	Saichi ISHII

CHAPTER 2. GEOGRAPHY

2-1. Location and Access

The Suoi Boc zone of the Van Yen area is located in Son La Province, about 125 km west of Hanoi. The large village called Phu Yen lies in about 4 km north-northwest of the zone. Its population is about 3,000. Small villages are scattered in the intra-montane basins around this zone.

Three routes to reach Phu Yen from Hanoi are available. The shortest one leads to Phu Yen via Son Tay along the Hong River. The distance along the road is approximately 170 km and it is about seven hours drive by jeep. In this route it is necessary to cross the Da River by ferry at the point to the west of Ba Vi. The road is flat and paved from Hanoi to Ba Vi, while from the Da River westward the road is unpaved and leads to Phu Yen via Thanh Son.

There is only one unpaved road from Phu Yen to the western part of the Suoi Boc zone.

2-2. Topography and Drainage Systems

The Suoi Boc zone is situated in the mountainous belt that ranges in altitude from 200 m to 500 m. The major trend of ridges and drainage system is characterized mainly by the N-S direction, which is the direction of main geological structure of the zone. Because the eastern part of the zone is underlain by limestone, typical karst topography is observed.

The principal stream of the Boc Stream flows westward, and it's width is below 1 m.

2-3. Climate and Vegetation

The whole of Vietnam belongs to the Asian monsoon climatic zone. Climate is similar for the Van Yen and Western Thanh Hoa Areas, since both areas are located in the humid, semi-tropical climatic region. The areas have two seasons, rainy (May to October) and dry (November to April). The precipitation is low during the dry season in these areas. There were three to four rainy days periodically within seven to ten days survey from November to December. Rainy days are frequent until the middle of October, but almost everyday is fine from the beginning of November.

Hot days continue until the end of November with the temperature approaching 30°C. The temperature fluctuates from 20°C in the day time to below 10°C at night from December.

The climatic data have not been obtained for the survey areas concerned. The monthly data in

Hanoi is listed in Table 1-4 for reference. The temperature and precipitation are relatively lower and higher in the mountainous survey areas than the data below.

Table 1-3 Monthly Meteorological Data in Hanoi

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. Temperature (℃)	20.4	204	23.1	27.3	31.7	32.8	32.7	32.0	30.9	28.8	25.6	22.0
Min. Temperature (℃)	13.8	14.7	17.5	20.8	23.9	25.5	25.7	25.4	24.3	21.6	18.2	15.0
Ave. Temperature (℃)	16.6	17.1	19.9	23.5	27.1	28.7	28.8	28.3	27.2	24.6	21.2	17.9
Ave. Humidity (%)	80	84	88	87	83	83	83	85	85	85	81	81
Precipitation (mm)	18	26	48	81	194	236	302	323	262	123	47	20

(Japan External Trade Organization, 1990)

The areas of low altitude are covered by subtropical rain forest in both regional survey areas. Most of the mountainous parts, on the other hand, belong to the tropical high forest zone, and generally are covered by the dense evergreen broadleaf and coniferous trees. Most of the lowlands have been cultivated for paddy rice because of much river water supply, and many places have also been cultivated for upland rice by the slash-and burn agriculture even on the steep mountain sides.

The slight slope of the mountainous parts in the Suoi Boc zone is utilized as yam patches. The steep slope is covered by shrub and weed. The western intra-montane basin of the zone has been cultivated for paddy field.

CHAPTER 3. GENERAL GEOLOGY AND MINERALIZATION

Comprehensive review of geology and mineral resources of Vietnam was carried out by Dang Trung Ngan et al.,(1981), GSV (1990), UNESCAP (1990), and GSV (1991).

These are excellent reference material for understanding the geologic conditions of the country. UNESCAP (1990) is based principally on a book titled "Geology and Mineral Resources of Viet Nam", issued by the General Department of Mines and Geology (GDMG) of Viet Nam in December 1988.

Although stratigraphy of each geologic province has been reported using representative stratigraphic names in GSV (1991), these names are not accepted in this report due to difficulty in specifying their type localities, but the symbols of the geologic units in the above report are adopted as a rule.

3-1. General Geology

The geology of the northern part of Vietnam is divided into four tectonic provinces bounded. They are the "Littoral Bacbo" and "Vietbac" provinces in the northeast and the "West Bacbo" and "Truongson" provinces in the southwest (GSV, 1991) as shown in the Figure 1-2. The Van Yen Area is located in southern end of the "West Bacbo" and the Western Thanh Hoa Area is situated in northern end of the "Truongson" province.

The "West Bacbo" tectonic province is in fault contact with the "Truongson" province. This is the Ma River fault trending in the NW-SE direction along the Ma River. The Paleozoic, Mesozoic, and Cenozoic strata are accumulated successively over the Proterozoic units in both provinces, but there are some geological differences (see Figures 1-3 and 1-4).

In and around the survey areas, the Proterozoic to Cambrian, Cambrian to Lower Ordovician, Lower to Middle Devonian, and Upper Permian to Upper Triassic strata are widely developed, and the Ordovician to Silurian, Upper Silurian to Lower Devonian, Upper Jurassic to Upper Cretaceous units are partly found. The Cenozoic formations with the exception of the Quaternary unit are restricted and sporadic.

The Proterozoic to Cambrian and Cambrian to Lower Ordovician units occur mainly on the right banks of the Da and Ma Rivers, and are composed of metamorphic rocks, namely crystalline schist, quartzite, and marble as well as limestone. The Lower to Middle Devonian are composed of terrestrial red clastic rocks and marine sedimentary rocks consisting mainly of shale and sandstone. They occur on the periphery of the Proterozoic to Cambrian and Cambrian to Lower Ordovician masses. The Upper Permian to Upper Triassic units occur most widely in the survey areas. They are composed mainly of sedimentary rocks, namely carbonate rocks, sandstone, and shale and occur partly with volcanic and pyroclastic rocks, such as andesite, basalt, and rhyolite. Felsic volcanic rocks judged to be the Jurassic to Cretaceous also widely occur in the "Truongson" province in the south.

Intrusive magmatism in the northern part of Vietnam took place in four stages, namely, Proterozoic, Early to Middle Paleozoic, Late Paleozoic to Early Mesozoic, and Late Mesozoic to Early Cenozoic times (Figures 1-3 and 1-4).

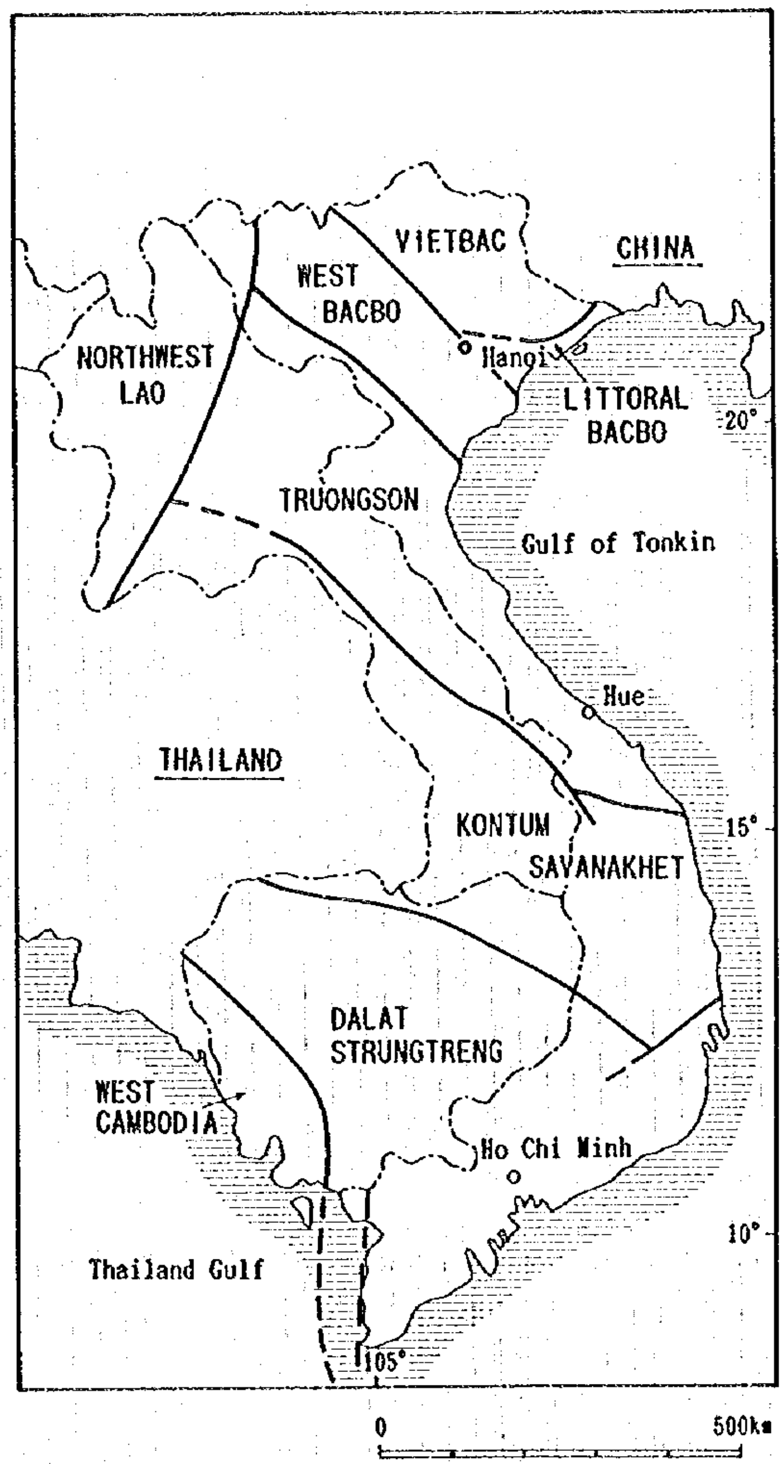


Fig. 1-2 Tectonic Provinces of Vietnam, Laos and Cambodia

In and around the survey areas, the Proterozoic intrusives intruded concordantly into the Proterozoic metamorphic rocks on the right bank of the Hong River. Besides, Early to Middle Paleozoic felsic rocks consisting of diorite and granite and Late Paleozoic to Early Mesozoic felsic rocks of the same nature as the above are located on the right bank of the Ma River ("Truongson" province) occurring as fairly large masses.

Ultramafic and mafic rocks are found as Early to Middle Paleozoic and Late Paleozoic to Early Mesozoic intrusive rocks. They consist of dunite and gabbro and turn out generally in the shape of small lenticular bodies.

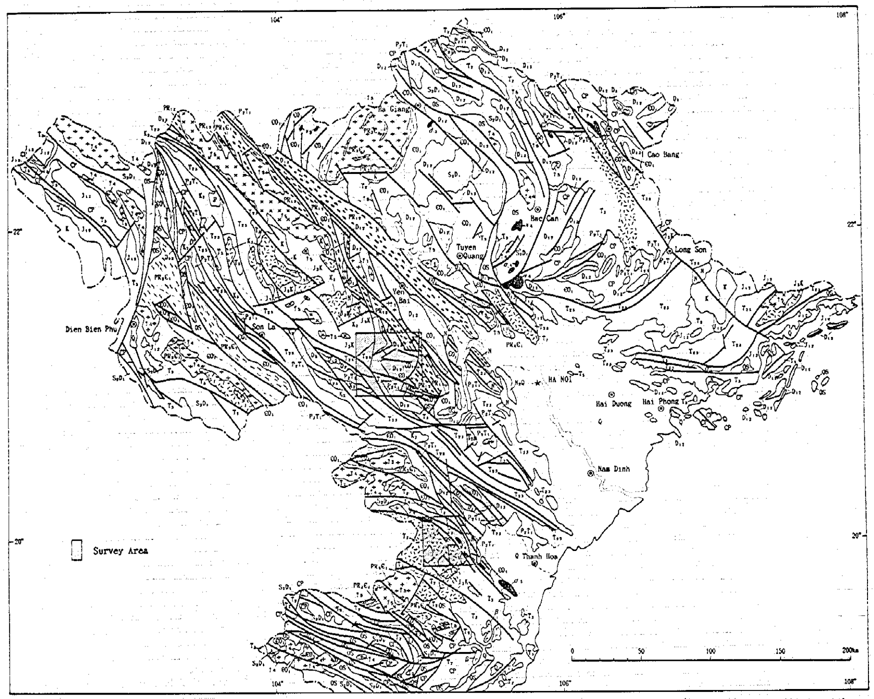
Although Late Mesozoic to Early Cenozoic intrusives are widely developed in the Tu Le region, the central part of the "West Bacbo" province, they are restricted in the southern part of the Western Thanh Hoa Area.

3-2. General Geologic Structure

Geologic structure of the northern part of Vietnam is complicated from repeated tectonic movements extending over long geological age. Every tectonic province, such as "West Bacbo", "Truongson" and others, is aligned in the NW-SE direction. Boundaries of tectonic provinces are the main tectonic lines that extend in the NW-SE direction along the Hong and Ma Rivers. Many NW-SE faults parallel to the main tectonic lines exist in the tectonic provinces and control the occurrence of strata. Furthermore, intrusive rocks occur concordantly with the NW-SE structures.

The "West Bacbo" and "Truongson" provinces are situated at the contact of South China and Indochina plates. It is generally believed that the separation and joining of these two plates had been repeated during Paleozoic to Cenozoic times, but detailed tectonics are not verified yet. These plate movements were accompanied by the formation of rift zones, obduction zones, and subduction zones, as well as with sedimentation, NW-SE striking strata, and the formation of tectonic lines.

Structural control in the NW-SE direction is remarkable also in the survey areas. The wide spread Upper Permian to Upper Triassic units cover an area of 20 to 40 km wide elongated in the NW-SE direction. The Proterozoic to Cambrian and Lower Paleozoic units are also located in a horseshoe-shaped area elongated in the NW-SE direction. These strata used to contact with each other by NW-SE trending faults. Intrusives on the right bank of the Ma River are concordant with the NW-SE structures and small lenticular ultramafic to mafic intrusives also occur scattered along the NW-SE trending tectonic lines.



(Simplified from ESCAP, 1990)

LEGEND

STRATIFIED ROCKS

Q / β	Quaternary : Alluvium with marine deposits in coastal area. β : Basalt
N_2Q	U. Neogene-Quaternary : Gravel, clay, pebble, laterite
N	Neogene : Conglomerate, sandstone, claystone, lignite
P	Paleogene : Trachyte, leucitophyre
K_2	U. Cretaceous : Red continental deposits-conglomerate, sandstone, siltstone
K	Cretaceous : Red continental deposits of conglomerate, sandstone, siltstone, rhyolite
J_3K	U. Jurassic-Cretaceous : Orthophyre, tuff, basalt, rhyolite
J_{1-2}	L-M. Jurassic : Continental deposits of conglomerate, sandstone, siltstone
T_3	U. Triassic : Conglomerate, sandstone, marly shale, coal
T_{23}	M-U. Triassic : Shale, limestone, conglomerate, sandstone, basalt, rhyolite
T_2	M. Triassic : Conglomerate, sandstone, shale, limestone, rhyolite
P_2T_1	U. Permian-L. Triassic : Conglomerate, siltstone, siliceous limestone, shale, coal, basalt
CP	Carboniferous-Permian : Shale, coal, limestone, chert with andesite and basalt
D_3	U. Devonian : Limestone, chert, shale
D_{12}	L-M. Devonian : Conglomerate, sandstone, shale, limestone
S_2D_1	U. Silurian-L. Devonian : Sandstone, shale, limestone, rhyolite, chert
OS	Ordovician-Silurian : Conglomerate, sandstone, shale, chert, rhyolite, orthophyre
$€O_1$	Cambrian-L. Ordovician : Limestone, shale, quartzite, greenstone, chert
$PR_3€_1$	U. Proterozoic-L. Cambrian : Schist, quartzite, dolomite
PR_{1-2}	L-M. Proterozoic : Gneiss, amphibolite, quartzite, marble

INTRUSIVE ROCKS

LATE MESOZOIC-EARLY CENOZOIC

γ_5	Granodiorite, granite, granosyenite, diorite

LATE PALEOZOIC-EARLY MESOZOIC

γ_4	Biotite granite, granophyre, granodiorite, diorite
ν_4	Gabbro
σ_4	Dunite, peridotite

EARLY-MIDDLE PALEOZOIC

γ_3	Biotite granite, plagiogranite, granodiorite, diorite
ν_3	Gabbro-diabase, gabbro
σ_3	Serpentinite, dunite

PROTEROZOIC

γ_2	Granodiorite, granite, migmatite
γ_1	Plagiogranite, granodiorite, granite, migmatite

Fault　Felsic volcanics　River

U: Upper　M: Middle　L: Lower

Fig. 1-3 Generalized Geologic Map in the Northern Part of Vietnam

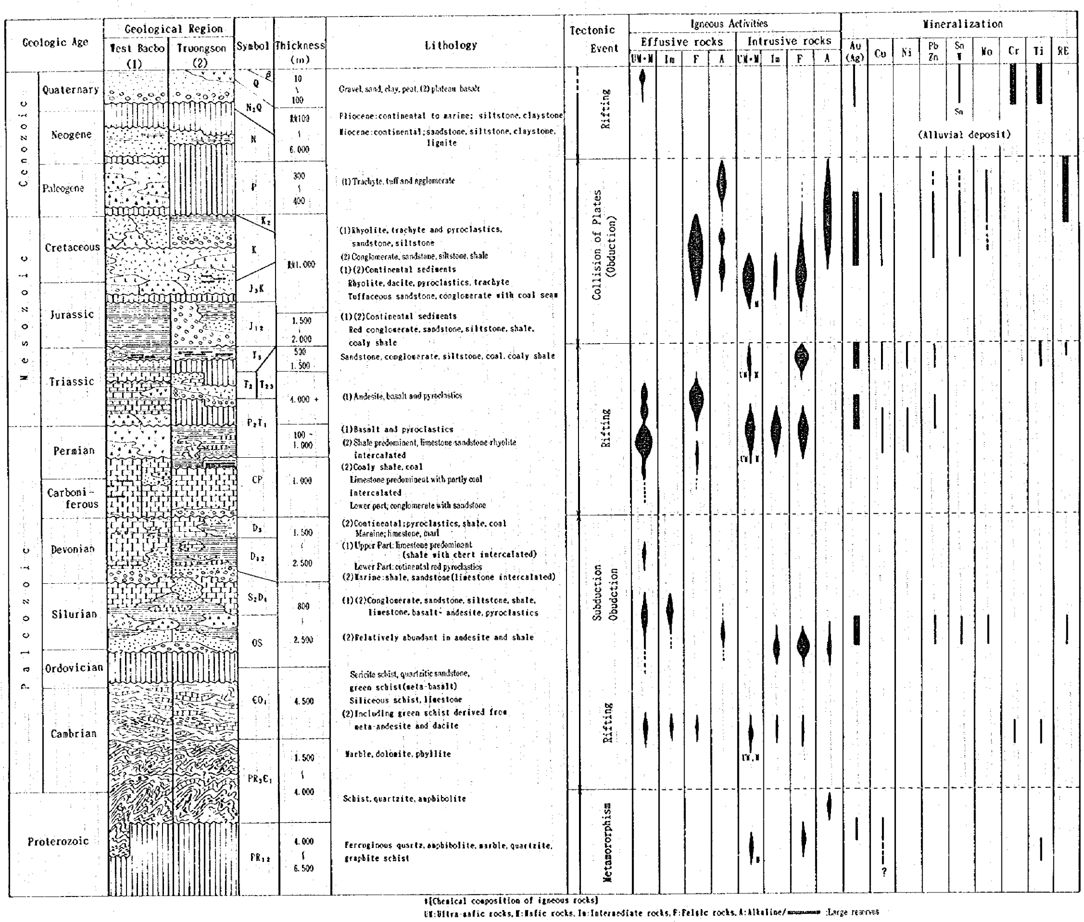


Fig. 1-4 Comprehensive Columnar Sections in the Northern Part of Vietnam

3-3. Mineralization

The long and eventful tectonic movements in Vietnam resulted in a variety in mineralization. Metallogenic epochs can be divided into the following five.

Precambrian epoch
Early to Middle Paleozoic epoch
Indosinian epoch (Late Carboniferous to Late Triassic)
Late Mesozoic to Early Cenozoic epoch (mainly Cretaceous to Paleogene)
Neogene to Quaternary epoch

Many useful mineral deposits and showings are located in the northern part of Vietnam as shown in Figure 1-5. Based on the UNESCAP (1990), several mineral deposits and showings of gold, copper-nickel, tin-tungsten, and placer chromite are revealed in and around the survey areas. Lead-zinc deposits and showings are also observed, but they seem to be small.

Known mineral deposits in and around the survey areas are summarized below.

As gold deposits, the Kim Boi deposit in the central part of the Ha Son Binh Province, and the Lang Neo, the Lang Mo, and Cam Tam deposits in the northern part of the Thanh Hoa Province are known. These are vein deposits emplaced in the Cambrian limestone, Late Permian and Early Triassic mafic volcanics and Triassic sediments. The Suoi Tiat mine is now under operation in the western part of the Van Yen Area as gold bearing copper deposit. Placer gold deposits are found in most of the streams in the mountains. These are rather small and not known in detail.

As a representative nickel-copper deposit, the Ban Phuc deposit is known in Ta Khoa region, Son La Province. This largest nickel-copper sulfide deposit in Vietnam is of vein and dissemination type accompanying ultramafic bodies of Permian to Triassic age. This deposit is located on the right bank of the Da River in the Da River Mobile Belt.

As tin-tungsten deposit, the Quy Hop deposit composed mainly of placer is known in the Nghe An Province. Also cassiterite-sulfide veins are found in crystalline schist in the vicinity. Tin-tungsten pneumatolytic to hydrothermal mineralization zones are developed in the Bu Me Prospect in the Western Thanh Hoa Area. This is now being explored by GSV.

As placer chromium deposit, one in Nui Nua region in the eastern part of Thanh Hoa Province is known. This deposit is situated around an Early to Middle Paleozoic ultramafic body and has been mined for a long time in large scale.

As lead-zinc deposit, the Cho Dien deposit in the Bac Thai Province is well known. In the survey areas, however, lead-zinc deposits are sporadically located, and details on dimensions and location are not known.

CHAPTER 4. DISCUSSIONS ON THE RESULTS OF THE THIRD PHASE SURVEY

4-1. Geology, Geologic Structure and Mineralization

The geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary sediments. The Middle Triassic occurs in the main part of the zone and is divided into two rock facies. One is the clastic sedimentary rocks composed chiefly of black mudstone with siltstone and sandstone subordinately. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone replaces the former in the eastern part. The other is pale gray to black colored limestone.

The beddings are partly developed in mudstone, siltstone and sandstone in the zone. The beds have generally N-S to NNE-SSW strikes and dips from 20° to 70°E.

The Quaternary occurs as a belt in the western lowland extending in the N-S direction.

Dacite porphyry and aplite are intruded into clastic sedimentary rocks near the boundary between the clastic rocks and limestone, and are aligned in NNE-SSW direction.

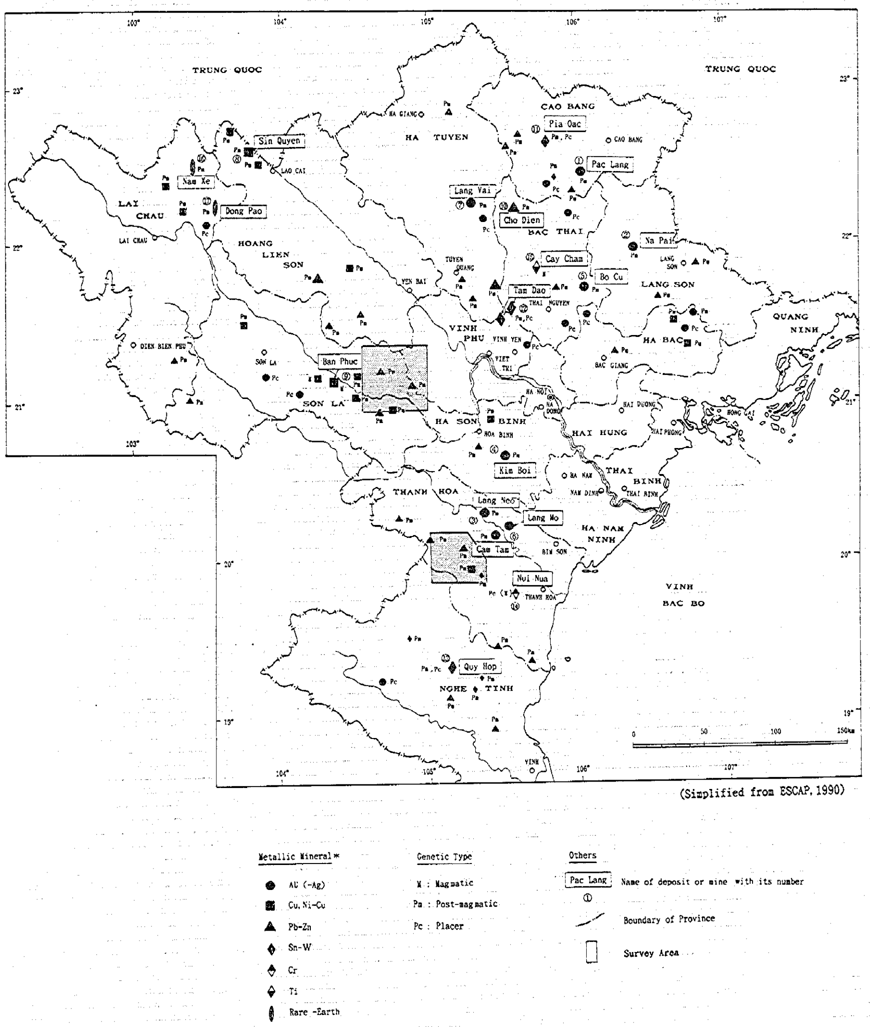
Main fault system in the zone has NNE-SSW direction.

From the above facts it is concluded that the geologic structure of the zone is characterized by N-S to NNE-SSW system.

Quartz vein and silicified zone revealed in clastic sedimentary rocks by trench survey have strikes of N-S direction. Also brecciated veins in limestone are oriented from NNW-SSE, N-S to NNE-SSW direction.

The mineralization confirmed in this zone is some lumps of Pb-Zn ore dug out from a pit prepared by GSV. This lumps of ore consist mainly of cerussite and sphalerite with a small amount of pyrite, galena, and anglesite. According to GSV, mineralized zone in the pit has 0.1 to 1.0 m in width. It is presumed that this mineralized zone is hosted by clastic sedimentary rocks, as there is an extremely large amount of clastic rocks in the waste dump of the pit.

The extent of quartz bearing silicified zone leads to the above mentioned pit in a distance of



*Smaller size -symbols may show occurrences of the minerals concerned.
They have not been described in the text of ESCAP REPORT, 1990.

Fig. 1-5 Distribution Map of the Major Ore Deposits in the Northern Part of Vietnam

about 15 m. The width of this silicified zone is nearly equal to that of the mineralized zone. Also this mineralized zone is hosted by clastic rocks. Consequently it is supposed that the silicified zone is continuous to the mineralized zone and this Pb-Zn mineralization is vein-type one hosted by clastic rocks.

4-2. Geochemical Anomalies and Mineralization

As a result of the soil geochemical exploration in the Suoi Boc zone, four anomalous zones for Pb and Zn were detected. Three of those anomalies are aligned in a line nearly oriented to NNE-SSW direction. The Suoi Boc mineralized zone is located within the one anomalous zone of those three. The another one geochemical anomaly neighbors on a high chageability anomaly obtained by geophysical survey.

Four soil samples collected around the Suoi Boc mineralized zone contain more than 0.1 % Zn. Two of those samples contain 1.1% and 7.4% Zn. The geochemically anomalous samples collected in the north of the mineralized zone contain slightly higher than 0.1% Zn. The content of Zn in the former anomalous zone is rather high in comparison with the latter.

The sample point of 7.4% Zn in content is located near the above mentioned pit. It is supposed that this soil sample containing fragments of ore dug out from pits or old tunnel was collected.

It is considered that the content of Zn in this soil sample indicates not to have formed through weathering but to have resulted from the artificial addition of Zinc concentrated materials

There are two types of mineralization in the trenches dug on the geochemical anomalous zone around the Suoi Boc mineralized zone. One is limonite bearing silicified zones hosted by clastic sedimentary rocks. The another type is limonite network and veinlets hosted by limestone. This limonite bearing silicified zone and the Pb-Zn mineralized zone constitute one continuous vein-type mineralization as described above. The geochemical anomalies around the Suoi Boc mineralized zone is supposed to have been caused by network, veinlets mineralization and Pb-Zn bearing vein.

It is consequently considered that geochemical anomaly around the Suoi Boc mineralized zone has detected vein-type mineralization in clastic rocks and limestone.

Soil samples in the geochemical anomalous zone have from 0.12 to 0.20% Zn,which is detected in the north of the Suoi Boc mineralized zone. Two trenches, namely MJT-2 and MJT-3, were prepared in this anomalous zone. The geology of these trenches consists of limestone. No skarn minerals are found in the trenches. There are brecciated vein, network and veinlets, that contain limonite. The extent of dense distribution of brecciated vein, network and veinlets corresponds with that of geochemical anomalies.

It is concluded that the geochemical anomalies in the north of the Suoi Boc zone have detected a mineralized zone constituted by brecciated vein, network and veinlets in limestone.

4-3. Geophysical Anomalies and Mineralization

The strong IP anomalies were detected in two localities of the northeastern part and one locality of central part of the zone. These anomalies are aligned in NNE-SSW direction and lie in clastic rocks beside the boundary between clastic rocks and limestone.

Two anomalies were examined by drilling, namely MJVS-1 and MJVS-4.

The geology of drilling holes consists of black mudstone and shear zone. The shear zone is constituted by fragments of fine-grained sandstone, black mudstone, limestone and calcareous mudstone with a matrix of pelitic materials.

There are rarely pyrite dissemination or veinlets of quartz and pyrite in the fragments. Pyrite dissemination is observed in a very small part of matrix. It is not considered that sulfide minerals in drilled cores had caused IP anomalies, because total volume of sulfide minerals is extremely small.

The results of geophysical properties measurements are follows.

Limestone breccia with pyrite dissemination has high chargeability. One fine-grained sandstone sample shows the same chargeability as the pyrite disseminated limestone breccia. Fragments without sulfide minerals such as fine-grained sandstone, calcareous mudstone and limestone collected from MJVS-1 and MJVS-4 have higher chargeability than limestone from MJVS-2 and MJVS-3.

Microscopical observations on polished sections of core samples revealed the existence of graphite. It is widely accepted that graphite causes strong IP anomaly.

From the above facts, it is concluded that high chargeability anomalies have been caused by graphite, and they don't show the occurrence of sulfide mineralization.

Three high chargeability anomalies detected last year are aligned in NNE-SSW direction. Clastic sedimentary rocks in the zone strike N-S to NNE-SSW direction. Three anomalies are situated on the fracture zone found with MJVS-1 and MJVS-4. It is presumed that these chargeability anomalies have been caused by partial distribution of rocks rich in graphite in the fracture zone

4-4. Potential for Resources

As a result of the second phase survey, it was concluded that geochemical anomalies and high chargeability anomalies in the Suoi Boc zone have been promising for Pb-Zn ore deposits.

Trench survey and drilling survey were conducted in two geochemical anomalies. The results of these works are follows.

Geochemical anomalies were caused by the existence of vein-type mineralization. Skarn ore deposits are not expected to occur in these anomalies, because no skarn minerals are found in clastic rocks and limestone below the surface.

Vein-type mineralization occurs mainly in limestone. There are limestone caves in the limestone formation of the Suoi Boc zone. Sulfide minerals were weathered to deeper part by free ground water through these caves. The weathering may reach to deeper than 200 m below the surface, but the limit of weathering to sulfide minerals is unknown. Pb-Zn content of veins in the shallow part of the zone will be low due to the weathering to the depth of 200 m below the surface.

The width of brecciated veins containing of limonite in the trenches is 0.2 m in maximum. The width of the similar veins in the drill holes reaches up to 1.5 m. No big Pb-Zn vein deposit is possibly expected to occur, because the width of vein in the deeper part than 200 m below the surface is not reasonable to become sharply thicker.

Shear zones composed of limonite and clay, are found in trenches and drill holes. The width of these zones is 7.5 m in the trench. Many shear zones are found in the drilling holes. The genesis of these shear zones is interpreted in two ways. One is the weathered products of sulfide bearing brecciated veins. The alternative is that shear zone is composed of limestone fragments and surface soil collapsed into ancient dolines. High content of Pb-Zn is rare in the deeper part of the veins, as the limestone fragments occupy the main part of the veins even though the genesis is the former one.

Two high chargeability zones of three ones detected by previous geophysical work were examined by two drill holes. It became clear that high chargeability anomalies were caused by the existence of graphite in the clastic sedimentary rocks. No lead and zinc ore deposit is expected to occur in the high chargeability zones.

As the result of the drilling survey and trench survey done this phase, no indication for discovering new ore deposits was found. Therefore, no further exploration is needed in this zone.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATION

5-1. Conclusions

The survey of this phase consists of drilling survey and trench survey in the Suoi Boc zone. Amount of the survey is four inclined drill holes totaling 742.30 m and three trenches with a total length of 600 m.

The followings are the results of the third phase survey and recommendations for the future exploration work.

(1) The geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary sediments. The Middle Triassic is divided into clastic sedimentary rocks and limestone. The clastic sedimentary rocks are composed of mudstone, siltstone and sandstone. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone mainly occurs in the eastern part. The Triassic clastic sedimentary rocks tend to strike N-S to NNE-SSW direction and to dip mostly from 20° to 70°E.

(2) The geological structure of the zone is characterized by the N-S to NNE-SSW direction that is expressed as the strikes of sedimentary rocks and faults, the distribution of igneous rocks and the extension of Quaternary sediments.

(3) As a result of the work in this phase, it has become clear that the geochemical anomalies in the zone indicate the vein-type mineralization. The potential for skarn ore deposits is low because skarn minerals are absent in the Triassic rocks of these anomalous zones.

(4) The Suoi Boc mineralized zone is consequently regarded as a vein-type mineralized zone.

(5) The high chageability zones detected last year by IP survey, are interpreted to have been caused by graphite contained in the clastic sedimentary rocks. Therefore it has been proved that new Pb-Zn ore deposits are not expected to occur in the high chargeability zones.

(6) The vein mineralization in this zone is mostly located in limestone. Many limestone caves occur in the limestone. The sulfide minerals are considered to have been oxidized and dissolved to deeper part by free ground water flowing within caves. It is supposed that the weathering bottom for sulfide minerals may reach to deeper than 200 m below the surface, although

the lower limit of weathering for sulfide minerals was not proved.

(7) The width of brecciated veins containing limonite in the drill holes and trenches, does not exceed 2 meter. No big Pb-Zn vein deposit is possibly expected to occur, because the width of vein at the deeper part below the surface is not reasonable to become sharply thicker.

(8) Shear zones composed of limonite and clay, are found in trenches and drill holes. The genesis of these shear zones is interpreted in two ways. One is the weathered products of sulfide bearing brecciated veins. The alternative is that shear zone is composed of limestone fragments and surface soil collapsed into ancient dolines. High content of Pb-Zn will be rare in the deeper part of the veins, as the limestone fragments occupy the major part of the veins even though the genesis is the former one.

5-2. Recommendation for Future Exploration

As the result of the drilling survey and trench survey done in this phase, no indication for new ore deposits was found. Therefore, no further exploration is needed in this zone.

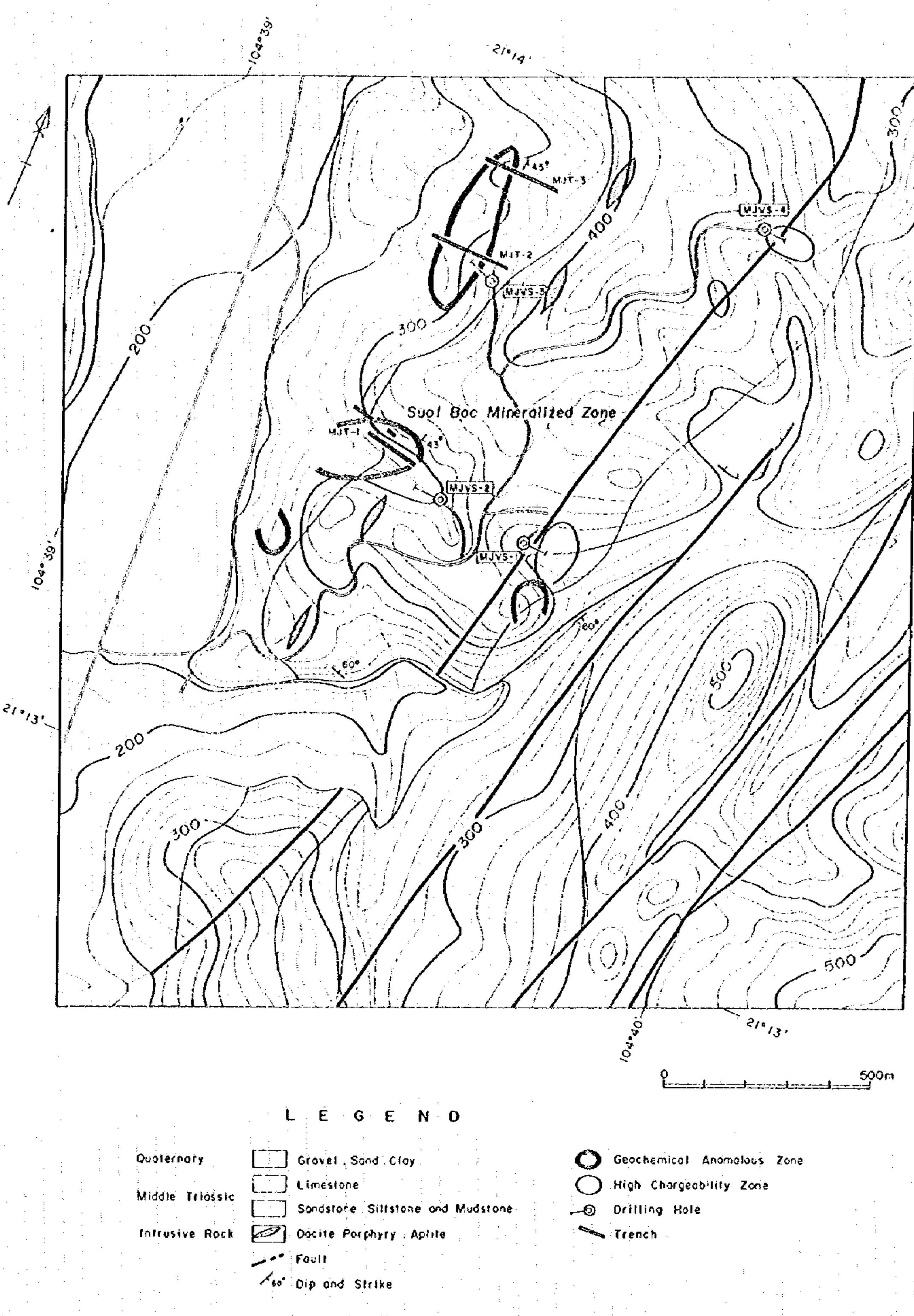


Fig. 1-6 Integrated Interpretation Map of the Survey Result in the Suoi Boc Zone

PART 2. DETAILED DISCUSSION

PART 2. DETAILED DISCUSSION

CHAPTER 1. OUTLINE OF THE SUOI BOC ZONE

1-1. Outline of the Zone

The Suoi Boc zone is located in the northwestern part of the Van Yen area, and covers an area of 4.5 km^2. This zone is situated in a mountain ridge area that lies between Mua River, a tributary of Hong River, and Toc River, a tributary of Da River.

A gravel road of 4 km is available to the western part of the zone from Phu Yen located at 125 km west of Hanoi.

The Suoi Boc zone consists of slightly steep mountains from 200 m to 500 m in altitude. The major trend of ridges is characterized mainly by the N-S direction, which is the direction of main geological structure of the zone. Because the eastern part of the zone is underlain by limestone, typical karst topography is observed. Karst springs are located at the western part of the zone.

There are a lot of houses along the road that pass the intra-mountainous basin of the western part of the zone. The western lowland of the zone is utilized as rice field and market gardens. The slope in the mountainous area is cultivated as yam fields.

The Suoi Boc mineralized zone was known through the regional geological survey of the first phase. Detailed geological survey, soil geochemical exploration and geophysical survey (IP method) were conducted in second phase. This zone was consequently extracted as a promising area for Pb-Zn ore deposits.

Drilling survey comprising four holes totaling 742.70 m to evaluate geochemical anomalous zones of Zn and high chargeability zones, was carried out in this zone this phase. Trench survey of 600 m in total length was executed to examine geochemical anomalous zone at the same time.

1-2. Geology and Mineralization

Geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary unconsolidated sediments. The Middle Triassic is distributed largely in the zone and is divided into two rock facies. One is the clastic sedimentary rocks composed chiefly of black mudstone with siltstone and sandstone subordinately. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone occurs largely in the eastern part. The other is pale gray to black colored limestone. The limestone forms rather steep cliffs in many localities of the zone.

The bedding is partly developed in mudstone, siltstone and sandstone in the zone. The beds

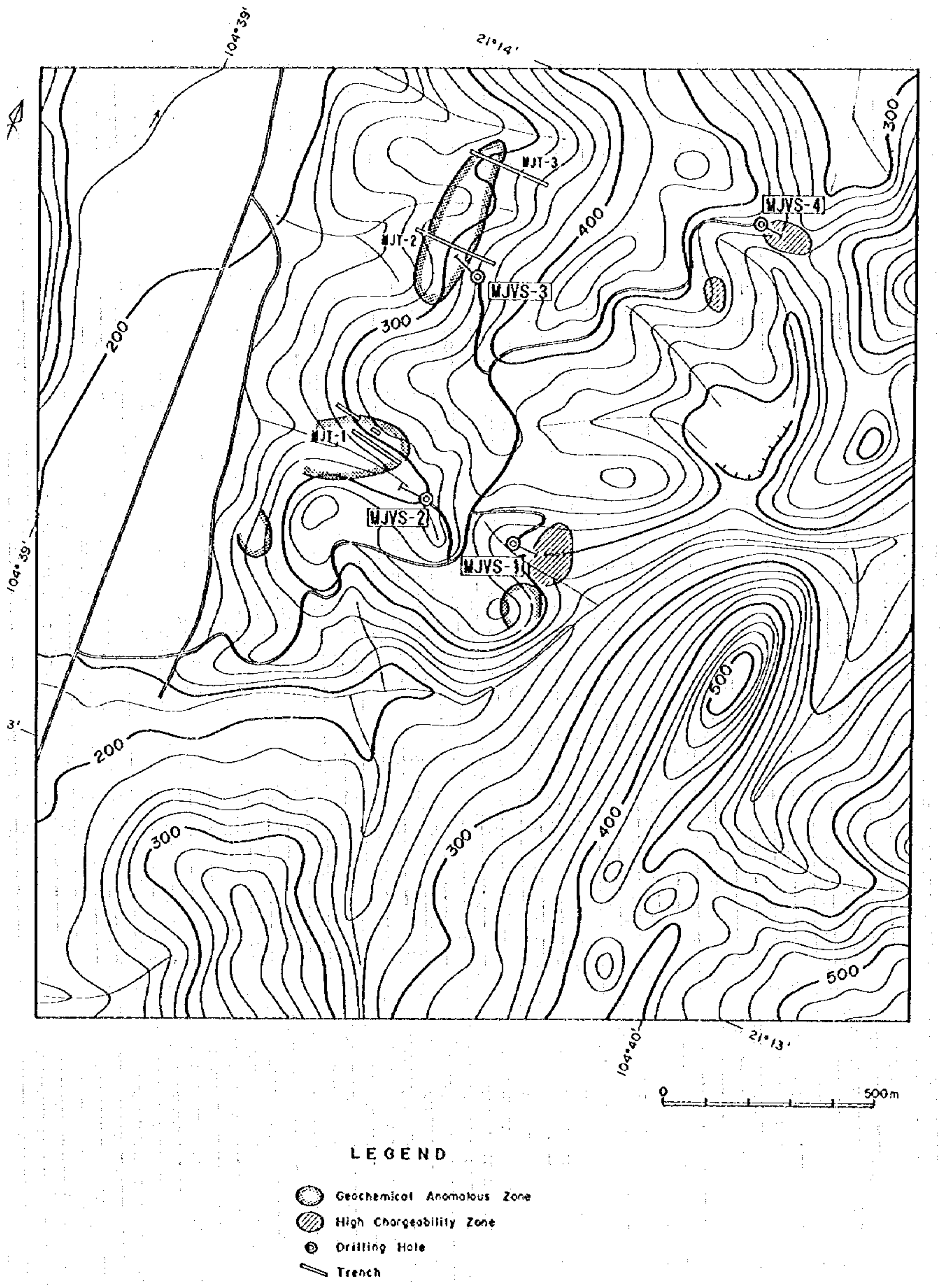


Fig. 2-1 Location Map of Trenches and Drill Holes

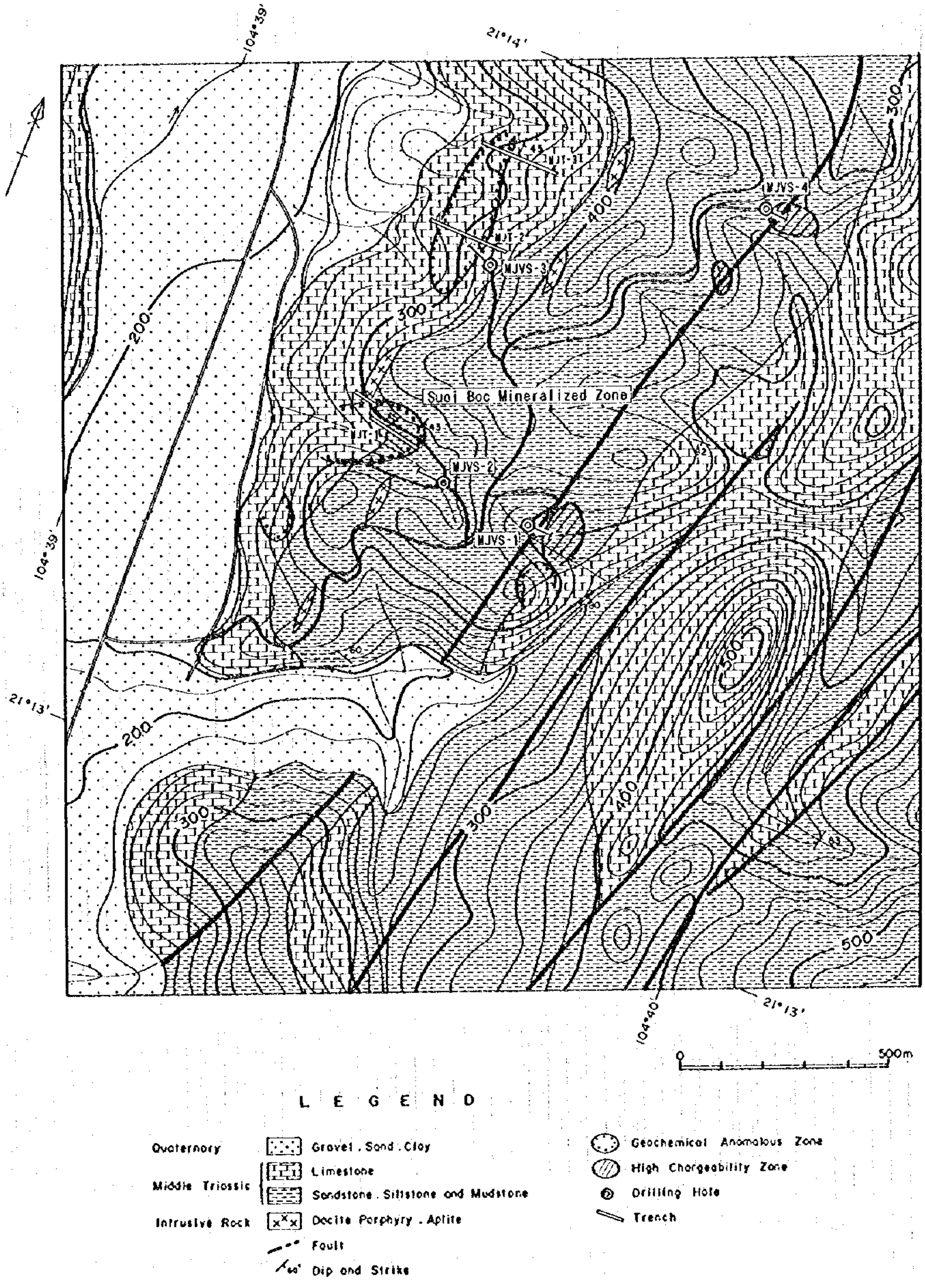


Fig. 2-2 Geologic Map of the Suoi Boc Zone

have generally N-S to NNE-SSW strikes and dips from 20° to 70°E.

The Quaternary occurs as a belt in the western lowland extending in the N-S directions.

Dacite porphyry and aplite occur in clastic sedimentary rocks near the boundary between the clastic rocks and limestone as small intrusive rocks, and are aligned in NNE-SSW direction.

There are no outcrops of mineralization but lumps of ore dug out from a pit in the Suoi Boc mineralized zone. Although the tunnel exploration (crosscut gallery) was carried out by Chinese engineers in this zone during 1982 to 1983, the tunnel could not be confirmed at present. In addition to the above, the Mapping Division of GSV had dug five pits around the tunnel, but they have collapsed and the details are not clear. According to GSV, the pits were 8 to 10 m deep and mineralized zone of galena and sphalerite was found with 0.1 to 1.0 m width at one pit. One ore sample collected in the waste dump of the pit consists mainly of cerussite and sphalerite with a small amount of pyrite, galena, and anglesite.

Four Zn geochemical anomalous zones were extracted by the second phase survey. One of them covers the Suoi Boc mineralized zone.

High chargeability was detected by the second phase survey in two zones at the northeastern part and one zone at the central part of the Suoi Boc zone. The high chargeability zone at the central part neighbors one geochemical anomalous zone.

The distribution map of geochemical anomalies was superimposed on the map of geophysical anomalies. It is interpreted on this superimposed map that these geochemical and geophysical anomalies are almost aligned on 2 lines. Western line is situated in limestone or at the side of the boundary between limestone and clastic sedimentary rocks, and consists of three zones of geochemical anomaly. Eastern line is constituted by three zones of high chargeability and a geochemical anomalous zone.

General trend of strike of sedimentary rocks, the distribution of intrusive rocks and strike of major faults is N-S to NNE-SSW direction.

It is supposed that the distribution of geochemical anomalous zones and high chargeability zones have been controlled by the geologic structure of the Suoi Boc zone.

Skarn type ore deposits containing Pb and Zn were expected to occur in the Suoi Boc zone, according to the following facts.

The distributional direction of geochemical anomalous zones and high chageability zones coincides with the principal direction of strike of Middle Triassic. Above anomalies occur near the boundary of clastic sedimentary rocks and limestone. Felsic intrusive rocks are distributed in the Suoi Boc zone.

On the other hand, apparent resistivities are not low, and chargeabilities are low in the western geochemical anomalous zones. It was supposed on this fact that geochemical anomalous zones may indicate small scale ore deposits not to generate IP anomalies.

It was also supposed that the eastern high chargeability anomalies may have been caused by graphite bearing rocks, because these anomalies are located in black mudstone dominant area.

The points to be proved by the survey of this phase are type of mineralization in this zone, meanings of geochemical anomalies and high chargeability anomalies.

CHAPTER 2. TRENCH SURVEY

2-1. Outline of the Trench Survey

Pb-Zn geochemical anomalies were detected in four zones last year. These anomalous zones are situated around the Suoi Boc mineralized zone, at the south and north of the mineralized zone and at the central part of the Suoi Boc zone.

Geochemical anomalies concentrate around the Suoi Boc mineralized zone. Two soil samples in this geochemical anomalous zone contain more than 1% Zn.

Geochemical anomalous zone that is located at the north of the Suoi Boc mineralized zone, is constituted by four anomalous samples. This anomalous zone extends in N-S to NNE-SSW direction that is the general direction of strikes in the sedimentary rocks.

Trench survey was carried out at above two geochemical anomalous zones to elucidate geology and the characteristics of mineralization.

Three trenches were dug. The length of each trench was 200 m with directions of N80°E or N90°E. The trenches had 1 m wide and were stripped to basement. Three trenches were named MJT-1, MJT-2 and MJT-3 northward.

MJT-1 had encountered the waste dump area of old pits prepared by GSV. As a part of this trench collapsed, this part was shifted to 30 m north. The location of the western part of MJT-1 was changed, because this part is positioned on a limestone cliff.

The location of trenches is shown in Figure 2-1. Sketch of trenches and interpretation results are shown appendix 21 and Figure 2-3 respectively.

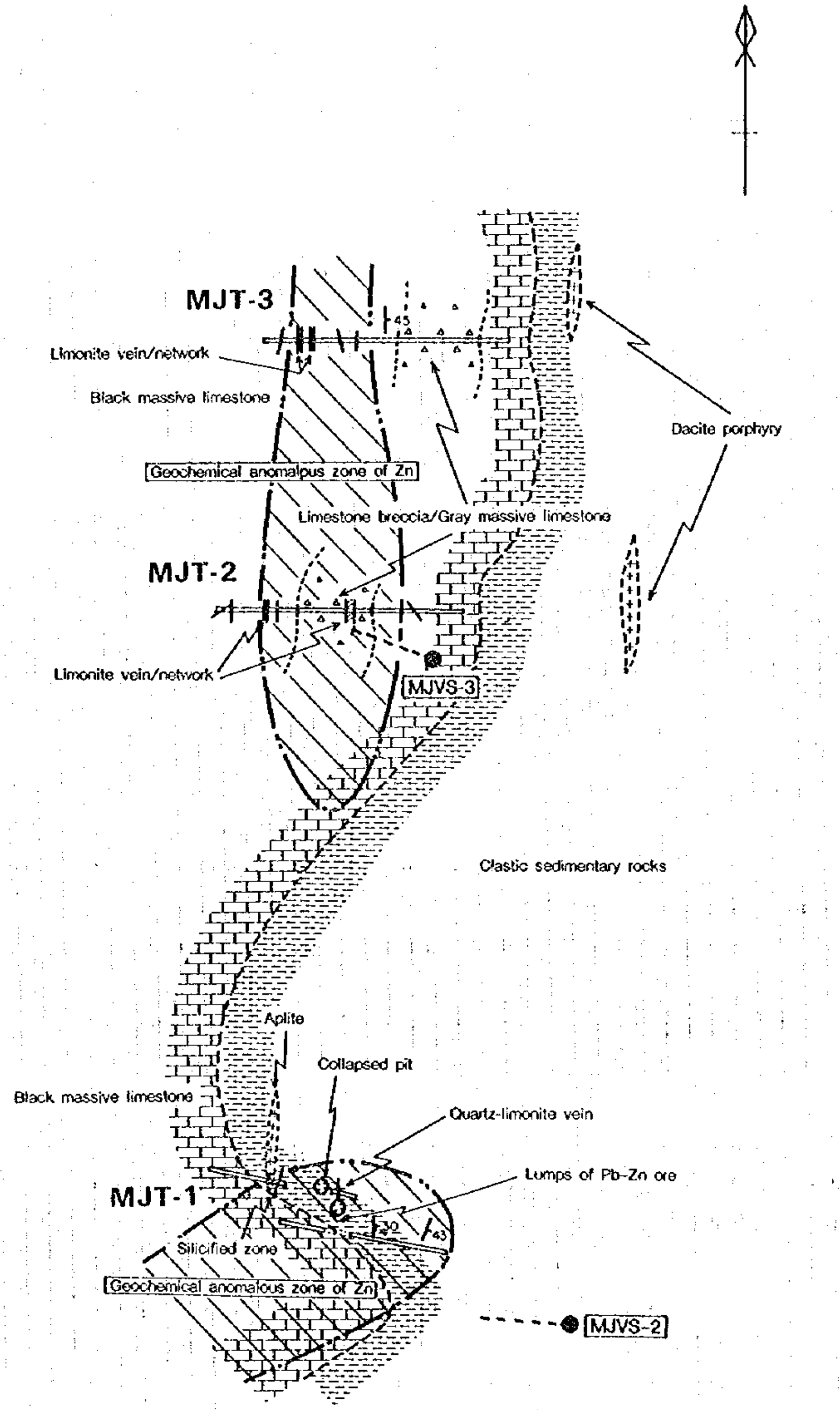


Fig. 2-3 Interpretation Map of the Trench Survey

Trenches were mapped in a scale of 1/200. One hundred rock samples and thirty ore samples were analyzed chemically with elements of Au, Ag, Cu, Pb and Zn.

2-2. Geology

Geology of three trenches consists of limestone, fine- to coarse-grained sandstone and siltstone of Middle Triassic, and Cretaceous aplite.

Limestone is macroscopically divided into four rock facies : black massive limestone, gray massive limestone, limestone breccia and banded limestone.

Black limestone consists of aphanitic carbonates and a small amount of quartz and organic matter. Network of calcite is frequently observed in this limestone.

Gray massive limestone is constituted by fine-grained carbonates.

Limestone breccia contains fragments of black limestone and their size is less than 10 cm. Limestone breccia contains also quartz fragments. The matrix of this breccia is composed of calcite, dolomite, quartz and mica. The size of calcite crystal in the matrix is greater than that in breccia and is similar to that in gray limestone.

Banded limestone has white and gray bands alternately with 10 cm wide. These bands strike N-S and dip 40° to 70°E. This limestone is composed of fine-grained calcite. Many calcite veinlets occur in this limestone.

Clastic sedimentary rocks in the trench are fine- to coarse-grained sandstone and siltstone. These clastic rocks occur only in MJT-1 and are strongly weathered and loose.

Aplite occurs in MJT-1 and intrudes into fine-grained sandstone and siltstone with 3m wide, and strikes N-S direction.

Geologic structure of the range from the Suoi Boc mineralized zone to the north of this zone studied by three trenches, is summed up as follows.

Almost all limestone is massive. The geologic structure in limestone is no clear. Limestone has partly banded structure. These bands strike N-S and dip generally 45° to 60°E.

Clastic sedimentary rocks are partly bedded with general strike of N-S to NNE-SSW and main dip of 27° to 50°E.

Clastic rocks around aplite strike NNE-SSW and dip 5° to 25°W. Small-scaled faults occur around aplite dike.

It is concluded that sedimentary rocks around three trenches show monoclinal structure with general strike of N-S to NNE-SSW, and dip easterly. It is supposed that a small anticlinal or dome structure occurs around the area where clastic sedimentary rocks dip gently to west from intruded part to limestone in MJT-1.

The geology of each trench is follows.

MJT-1 : Clastic sedimentary rocks of sandstone and siltstone intruded partly by aplite, and black massive limestone westward

MJT-2 : black massive limestone, limestone breccia and black massive limestone westward

MJT-3 : black massive limestone, gray massive limestone, limestone breccia, banded limestone and black massive limestone westward

2-3. Mineralization and Alteration

There is some difference of mineralization in clastic rocks and limestone.

Brecciated vein, network and veinlets occur in limestone.

The width of brecciated vein in limestone is 20 cm in maximum and varies frequently. The vein contains a large amount of limestone fragments with matrix of mainly goethite and a small amount of hematite, quartz and mica. There is a fracture zone with 7.5 m wide in limestone breccia of MJT-2. This zone is filled up by limestone fragments, goethite, hematite, quartz and mica.

Network and veinlets are composed of hematite. Veinlets are distributed in whole limestone. Parallel veinlets are found in MJT-3.

Quartz vein, vein-form silicified zone, network and dissemination occur in clastic sedimentary rocks.

Three vein-form silicified zones are found in MJT-1. They are silicified fine-grained sandstone. The boundary between silicified part and unsilicified part is sharp and is nearly vertical.

One silicified zone is accompanied by quartz vein with a width of 10 cm and contains limonite and hematite. There is an old pit at 15 m south of this silicified zone, and this direction coincides with the strike of this silicified zone. Silicified rocks containing of sphalerite, galena and limonite are found in the waste dump of this pit.

Network occurs in fine-grained sandstone and is constituted with hematite veinlets with a width from 2 to 3 mm. The total width of network zone is less than 1 m.

Hematite disseminated bodies in irregular shape with discontinuous veinlets are found in fine-grained sandstone and aplite.

Massive limonite floats are found in soil profile. One float has a quartz-pyrite veinlet with a width of 1 mm.

Assay results of mineralized zones in three trenches are shown in Appendix 1. All mineralized zones in trenches have been weathered, and accordingly content of lead and zinc is extremely low.

Channel sampling for rocks in trenches was carried out for the purpose of clarifying a relationship between geochemical anomaly and rock facies. The results of chemical analysis for rock samples are in Appendix 2.

The statistic of Zn content is shown below as an example.

Rock type	Number of samples	Geometric mean	Range
Clastic sedimentary rocks	24	69 ppm	33 - 460 ppm
Limestone	74	230 ppm	40 - 1,282 ppm
Aplite	2	33 ppm	30 - 36 ppm

Comparing clastic rocks with limestone, limestone has high Zn content. It is interpreted that a distinct difference of average content in Zn is caused by veinlet density in limestone and clastic rocks.

2-4. Discussions on the Results of Trench Survey

Straight expression of Pb-Zn mineralization is ore lumps containing Pb-Zn, dug out from old pits. These ore lumps include cerussite, sphalerite, pyrite, galena, anglesite, limonite and quartz.

The silicified zone accompanying with quartz vein is 1.2m wide, has a strike of N-S and a dip of 80°E. Ore lumps containing Pb-Zn have been dug out from the pit that is located at 15 m south of the silicified zone. The mineralized zone in the pit has almost the same width as the silicified zone in MJT-1. It is consequently considered that the silicified zone in MJT-1 is continuous from the mineralized zone in the pit.

Main fault system in the Suoi Boc zone has NNE-SSW direction.

From the above facts, it is concluded that the geologic structure of the zone is characterized by N-S to NNE-SSW direction.

Quartz vein and silicified zone revealed in clastic sedimentary rocks by trench survey have strikes of N-S direction. Also brecciated veins in limestone are oriented from NNW-SSE, N-S to NNE-SSW direction.

The mineralization occurred in this zone is some lumps of Pb-Zn ore dug out from the pit prepared by GSV. This lumps of ore consist mainly of cerussite and sphalerite with a small amount of pyrite, galena, and anglesite. According to GSV, mineralized zone in the pit has 0.1 to 1.0 m in width. It is presumed that this mineralized zone is hosted by clastic sedimentary rocks, as there is an extremely large amount of clastic rocks in the waste dump of the pit.

The extension of quartz bearing silicified zone reaches to the above mentioned pit in a distance of about 15 m. The width of this silicified zone is nearly equivalent to that of the mineralized zone. Also this mineralized zone is hosted by clastic rocks. Consequently it is supposed that the silicified zone is continuous to the mineralized zone and this Pb-Zn mineralization is vein-type one hosted by clastic rocks.

Four soil samples collected around the Suoi Boc mineralized zone contain more than 0.1 % Zn. Two of those samples contain 1.1% and 7.4% Zn. The geochemically anomalous samples collected in the north of the mineralized zone contain slightly higher than 0.1% Zn. The content of Zn in the former anomalous zone is rather high in comparison with the latter.

The sample point of 7.4% Zn in content is located near to the above mentioned pit. It is supposed that this soil sample containing fragments of ore dug out from pits or old tunnel was collected.

It is considered that the content of Zn in this soil sample indicates not to have formed through weathering but to have resulted from the artificial addition of zinc contained materials.

Soil samples in the geochemical anomalous zone have 0.12 to 0.20% Zn, where was detected in the north of the Suoi Boc mineralized zone. Two trenches, namely MJT-2 and MJT-3, were prepared in this anomalous zone. The geology of these trenches is limestone. No skarn minerals are found in the trenches. Brecciated vein, network and veinlets that contain limonite, are found. The extent of concentration of brecciated vein, network and veinlets conforms to that of geochemical anomalies.

It is concluded that the geochemical anomalies in the north of the Suoi Boc zone detected a mineralization constituted by brecciated vein, network and veinlets in limestone.

CHAPTER 3. DRILLING SURVEY

3-1. Survey Method

Geological anomalous zones and high chargeability zones of the Suoi Boc zone were extracted as promising area for ore deposits through regional geological survey in the first phase and detailed geological survey, geochemical exploration and geophysical survey in the second phase.

Drilling survey comprising four holes totaling 742.70 m in length was executed in the geochemical anomalous zones and high chargeability zones for the purpose of elucidating the subsurface mineralization.

Details of each hole are summarized in Table 2-1.

The drilling locations, schematic geologic column of the zone and geologic cross sections are shown in Figures 2-1, 2-2 and 2-3, respectively.

Four drilling machines were prepared for drilling work. Four holes, namely, MJVS-1, MJVS-2, MJVS-3 and MJVS-4 were drilled.

A series of core logs of 1:200 scale was prepared, and the whole drilled cores were photographed in color. Nineteen thin sections for petrology and seven polished sections for ore microscopy were prepared. Twelve rock samples were examined for X-ray powder analysis. Six ore assay samples and forty-one rock geochemistry samples were obtained.

Table 2-1 Coordinates of Drill Holes and Hole Length

Hole No.	Latitude - Longitude		Altitude	Azimuth	Inclination	Drilled Length
MJVS-1	21°13'26"N	104°39'37"E	310 m	S85°E	-70°	166.40 m
MJVS-2	21°13'28"N	104°39'27"E	330 m	N85°W	-70°	210.00 m
MJVS-3	21°13'44"N	104°39'25"E	365 m	N70°W	-70°	206.30 m
MJVS-4	21°13'55"N	104°39'45"E	370 m	S85°E	-70°	160.00 m

3-2. Geology and Mineralization

3-2-1. Geology

Geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary unconsolidated sediments. The Middle Triassic is distributed in the main part of the zone and is divided into two rock facies. One is the clastic sedimentary rocks composed chiefly of black mudstone with siltstone and sandstone subordinately. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone occurs largely in the eastern part. The other is pale gray to black colored limestone. The limestone forms rather steep cliffs in many localities in the zone.

The mudstone, siltstone and sandstone are partly bedded. The beds have generally N-S to NNE-SSW strikes and dips from 20° to 70°E.

The Quaternary occurs as a belt in the western lowland extending in the N-S directions.

Dacite porphyry and aplite occur in clastic sedimentary rocks near the boundary between the clastic rocks and limestone as small intrusive rocs, and are aligned in NNE-SSW direction.

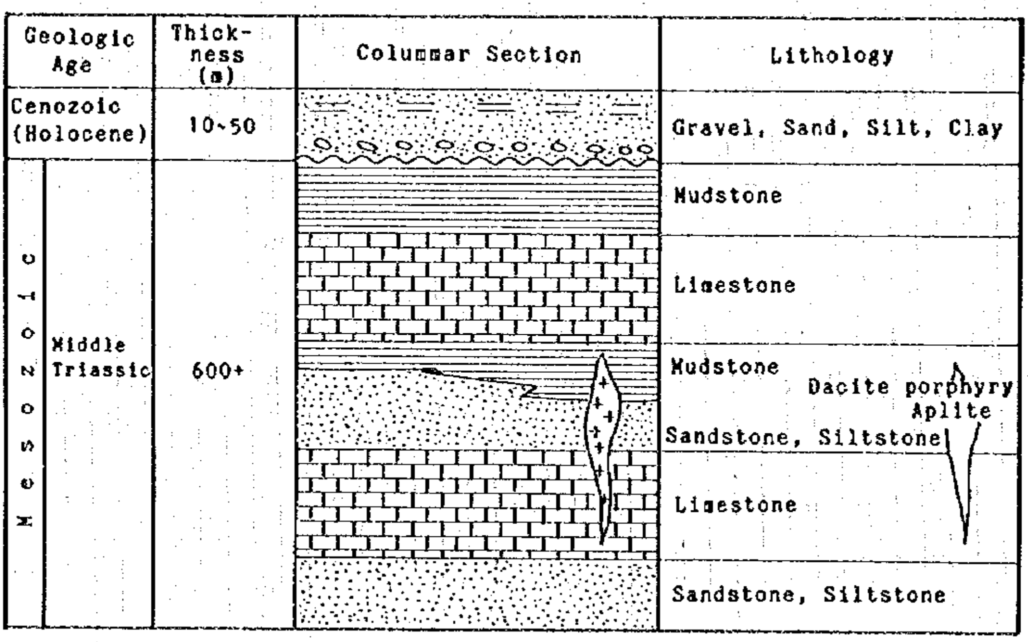


Fig. 2-4 Schematic Columnar Section of the Suoi Boc Zone

3-2-2. Mineralization

There are no outcrops but lumps of ore dug out from a pit in the Suoi Boc mineralized zone. Although the tunnel exploration (crosscut gallery) was carried out by Chinese engineers in this zone during 1982 to 1983, the tunnel could not be confirmed at present. In addition to the above, the Mapping Division of GSV had prepared five pits around the tunnel, but they have collapsed and the details are not clear. According to GSV, the pits were 8 to 10 m deep and a mineralized zone with galena and sphalerite was found with 0.1 to 1.0 m width at one pit. One ore sample collected in the waste dump of pits consists mainly of cerussite and sphalerite with a small amount of pyrite, galena, and anglesite.

Four Zn geochemical anomalous zones were extracted by the second phase survey. One of them covers the Suoi Boc mineralized zone.

High chargeabilities more than 60 millisecond were detected by the second phase survey in two zones at the northeastern part and one zone at the central part of the Suoi Boc zone. The high chargeability zone at the central part neighbors one geochemical anomalous zone.

Drilling survey was carried out to elucidate the mineralization below the geochemical anomalous zone around the Suoi Boc mineralized zone and at the north of the Suoi Boc mineralized zone, and the mineralization below two high chargeability zones.

Ore deposits to be expected to occur in this zone are skarn-type or vein-type deposits containing Pb-Zn.

3-3. Drilling Method, Equipment and Progress

3-3-1. Drilling Method and Equipment

(1) Method

For surface part, drilling was done by conventional drilling method using double core tube attached two metal bits, namely, 112 mm and 91 mm in outer diameter respectively, and 108 mm casing pipes were inserted. The hole of MJVS-3 was exceptionally enlarged with 132 mm metal bits after drilling with above two-type bits, and Casing pipes of 127 mm in outer diameter inserted.

Drilling continued by conventional drilling method using double core tube attached two metal bits, namely, 91 mm and 76 mm in outer diameter respectively, and 89 mm casing pipes were inserted.

Drilling was consecutively done by conventional drilling method using double core tube attached two metal bit, namely, 76 mm and 59 mm in outer diameter respectively.

There were fracture zones in the holes. Dense bentonite water was prepared to prevent the collapse of wall.

NQ wireline diamond bits have been prepared, but the shape of diamond bits is not suitable for drilling of fracture zones, and wireline drilling method was consequently not employed.

(2) Equipment

Drilling machines were two L-38 of Longyear and two Russian SBK-4. Specifications of drilling machines and equipment are shown in Appendix 7. Diamond bits and expendable items used during drilling work are listed in Appendix 6 and 8 respectively.

(3) Working System

Drilling operation was carried out by three shifts per day (seven to nine hours per shift), while the appurtenant works, such as road construction, rig construction, mobilization and demobilization, were done by one shift per day. A shift crew consists of one drilling engineer and two workers normally. Two workers per shift were engaged in water supply to drilling site. One supervisor of each drill hole directed his staff. One superintendent and his assistant managed whole drilling works.

A base camp for drilling operation was set near a karst spring of the Suoi Boc zone. The commutation between the base camp and drilling site was by car.

(4) Transportation

Drilling operation was carried out by the Center of Drilling and Geomechanics (CDG), GSV. Machines, drilling tools and mud materials were trucked from CDG, Hanoi to Suoi Boc when necessary.

(5) Drilling Water

Water for drilling was taken from a karst spring and was pumped up with two pumps and pipes of 40 mm in diameter. One pipe line totaling 1,600 m in length was prepared for MJVS-1 and MJVS-2. Other pipeline to MJVS-3 and MJVS-4 carried water along a distance of 2,000 m. Pumping of water was done three shifts per day, following drilling operation.

Capacity of water supply with one pump is 120 liter per minute.

(6) Withdrawal

After completion of drilling program, the machines and equipment were sent back to CDG, Hanoi. Drilling cores were stored in Division No. 3 in Phu Tho, 60 km ENE of Suoi Boc.

3-3-2. Progress of Drilling

The progress of each drill hole is described below. Summary of working time, records of drilling operation, records of drilling performance and charts of drilling progress are shown in Appendix 9 to 17 and Appendix 22 to 25 respectively.

(1) MJVS-1

Drilling machine L-38 of Longyear was employed in this hole.

From the surface to 31.5 m in depth, drilling was done by conventional method with double core tube attached two metal bits, namely 112 mm and 91 mm in diameter using bentonite mud water. Casing pipes of 108 mm in outer diameter were inserted to 32 m in depth.

Single core tube attached metal bit of 91 mm in diameter was used to drill from 31.5 m to 55 m in depth with conventional drilling method using bentonite mud water. Casing pipes of 108 mm in diameter extended to 39.5 m.

Single core tube was replaced by double core tube because high core recovery was not achieved with single core tube, and two metal bits, namely 91 mm and 76 mm in outer diameter, were attached to double core tube to drill from 55.0 m to 82.5 m in depth. Casing pipes were lengthened to 61.0 m. When drill hole reached near 75 m, drilling water was lost completely.

After casing pipes of 89 mm in diameter were inserted to 82.5 m, drilling was carried on to 165.0 m with single core tube attached 76 mm metal bits or double core tube attached 76 mm and 59 mm metal bit by conventional drilling method using bentonite mud water.

Wireline method with diamond bits was tried to use for this hole but was not employed, because the shape of diamond bits for wireline method is not proper for fractured rocks in MJVS-1

When drill hole reached to 165.0 m, collapse of the wall happened in the part below 99 m in depth. Cementing for this part was attempted. After drilling was advanced 1.4 m deeper, the collapse of the wall again occurred, because drilling encountered aquifer. Cleaning of the hole was repeatedly attempted three days, but the continuation of this hole was given up.

(2) MJVS-2

Drilling machine L-38 of Longyear was employed in this hole. A mission gear of drilling machine L-38 was broken at 111.5 m in depth and L-38 was replaced by SBK-4.

From the surface to 72 m in depth, drilling was done by conventional method with double core tube attached two metal bits, namely 112 mm and 91 mm in diameter using bentonite mud water. Casing pipes of 108 mm in outer diameter were inserted to 73.7 m in depth.

From 72 m to 111 m in depth, drilling was continued by conventional method with double core tube attached two metal bits, namely 91 mm and 76 mm in diameter using bentonite mud water. Cementing was done because water was lost in the part deeper than 89 m.

After the cement was set and was cut using above double core tube, drilling was resumed.

The double core tube was jammed when the hole was lowered 0.5 m deeper. A accident of dropping drilling rods in the hole was encountered, when jamming has been restored. A mission gear of drilling machine was broken, when rods have been recovered.

Drilling machine SBK-4 was carried into drilling site from Hanoi. After SBK-4 was set up, rods in the hole were recovered.

From 111.5 m, drilling was continued by conventional method with double core tube attached two metal bits using bentonite mud water. When drilling has been done around 207 m in depth, wall collapse happened at two parts near 98 m and 137 m in depth. Drilling has been achieved to 210.0 m by maintaining the hole to be clean. The continuation of drilling was given up, because the wall of hole collapsed again at 137 m in depth and hole was misdrilled by these collapsed fragments.

(3) MJVS-3

Drilling machine Russian SBK-4 was employed in this hole.

From the surface to 4 m in depth, drilling was done by conventional method with single core tube attached metal bits of 112 mm in diameter without water. From 4 m to 16 m, drilling was continued by conventional method with above double core tube using bentonite mud water. Drilling was consecutively done by conventional method with single core tube attached 89 mm metal bit or double core tube to 173.4 m in depth. Casing pipes of 127 mm and 89 mm were inserted to 44 m and 161 m respectively.

From 173.4 m to 183.4 m, the hole was lengthened by conventional method using single core tube attached metal bit, and to 206.3 m using single core tube attached diamond bit.

Jamming happened when drilling was advancing from 206.3 m to 210.0 m. To recover drilling rods and core tube was attempted. Hoisting wire was cut and core tube and drilling rods were dropped in the hole. Core tube and rods were abandoned, because core tube could not be drawn into casing pipes with fishing tools.

(4) MJVS-4

Drilling machine Russian SBK-4 was used for this hole.

From the surface to 4 m in depth, drilling was done by conventional method with single core tube attached metal bit of 112 mm in diameter without water. From 4 m to 60 m, drilling was continued by conventional method with double core tube attached two metal bits, namely 112 mm and 91 mm in diameter using bentonite mud water. Drilling was consecutively done to 160.0 m in depth by conventional method with double core tube attached two metal bits, namely 91 mm and 76 mm.

3-4. Geology and Mineralization of the Drill Holes

The results of ore and rock assay of cores, thin section microscopy, polished section microscopy, and X-ray diffraction are shown in Appendix 3, 4, 18, 19 and 20 respectively. The core logs are laid out in Appendix 26 to 29.

3-4-1. Geology

The rocks drilled are Middle Triassic clastic sedimentary rocks and limestone. In the holes fracture zones are frequently found.

Clastic sedimentary rocks consist of coarse-grained to fine-grained sandstone, siltstone and mudstone. Sandstone is composed of mineral fragments, such as quartz, feldspar and mica, and rock fragments, namely shale, quartzite and limestone, and matrix of mainly clay minerals, namely illite and chlorite, and quartz with a small amount of aphanitic carbonate. Siltstone is composed of the same fragments as sandstone. Mudstone is black colored, and contains a small amount of organic matters. Calcareous mudstone is rarely found.

Limestones include black massive limestone, gray massive limestone and limestone breccia. Many caves are observed in limestones. These caves are interpreted as limestone caves. Black and gray massive limestones were accompanied by many calcite veinlets.

Geology of MJVS-1 and MJVS-4 consists mainly of fracture zone. Breccia of mudstone, fine-grained sandstone, siltstone, calcareous mudstone and calcite is included in the fracture zone

Breccia of mudstone is dominant in the western part of fracture zone, but amount of other rocks increases eastward in the fracture zone. Fine-grained sandstone contains a small amount of graphite.

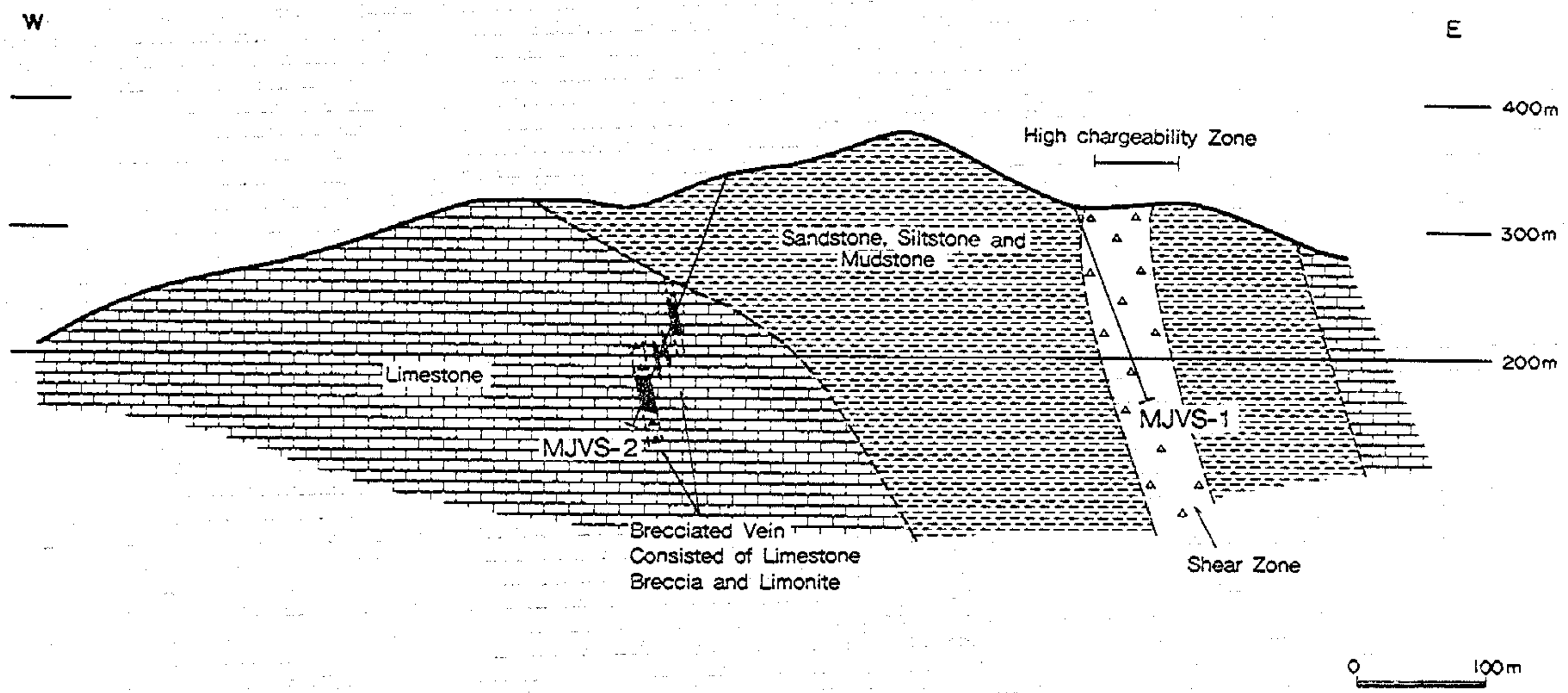


Fig. 2-12 Geologic Cross Sections of the Suoi Boc Zone (1)

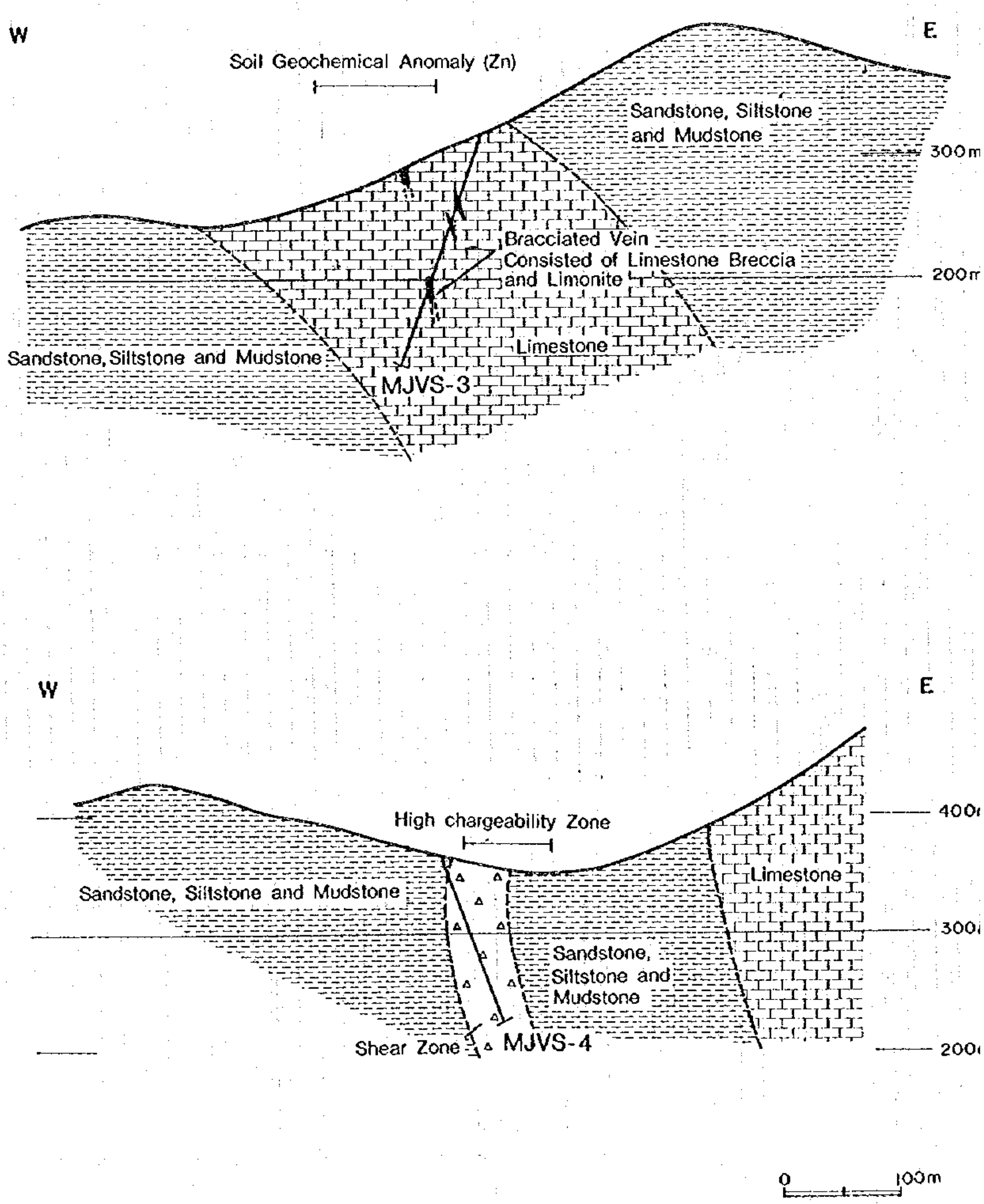


Fig. 2-5 Geologic Cross Sections (2)

Limestone caves are developed to the deeper part of limestone bodies. Water flows on the Boc River of the eastern part of the zone. The Boc River is more than 220 m above sea level. It is supposed that ground water level was rather low in the past, because the bottom of MJVS-2 is 140 m above sea level. The thickness of Quaternary sediments is possibly big at the western part of the zone.

The comparison between the geology of the drill holes and the surface geology reveals the followings.

The geology of the drilling survey area consists of limestone, sandstone and siltstone, and mudstone ascendingly. The geologic structure of this area is monoclinic with strikes of N-S to NNE-SSW and dips of 20° to 70°E.

3-4-2. Drill Hole Description

MJVS-1

This hole was aimed to elucidate the mineralization at the geochemical anomalous zone and high chargeability zone. The hole was drilled with a depth of 166.4 m, azimuth of S85°E and inclination of -70°.

0 - 8.0 : Pale brown mudstone, weathered
8.0 - 13.2 : Black mudstone, soft, partly brown to reddish brown
13.2 - 16.5 : Reddish brown mudstone
16.5 - 22.0 : Black mudstone, soft
22.0 - 36.0 : Black mudstone, soft, partly sheared
36.0 - 57.3 : Sheared black mudstone, partly brown
57.3 - 57.8 : Sheared brown fine sandstone
57.8 - 60.2 : Sheared pale gray siltstone
60.2 - 60.5 : Sheared brown fine sandstone
60.5 - 76.0 : Sheared-argillized black mudstone, matrix is gray clay
76.0 - 89.0 : Shear zone with fragments of silicified fine sandstone (Py dissemi.) and black mudstone
89.0 - 93.0 : Black argillized zone
93.0 - 103.4 : Shear zone with fragments of black sandstone, pale gray sandstone and black mudstone
(89.0 - 103.4 : Pyrite rarely disseminated in matrix of shear zone)
103.4 - 110.0 : Dark gray massive limestone, sheared ?
110.0 - 112.0 : Sheared-argillized zone
112.0 - 116.5 : Shear zone with fragments of silicified fine sandstone
116.5 - 124.0 : Shear zone with fragments of sandstone and black mudstone
124.0 - 129.0 : Shear zone with fragments of black mudstone
129.0 - 140.0 : Sheared-argillized zone with fragments of dark gray fine sandstone and black mudstone
140.0 - 143.0 : Sheared-powdered limestone

143.0 - 146.0 : Sheared-argillized zone with fragments of dark gray fine sandstone
146.0 - 156.0 : Sheared-argillized zone with fragments of limestone, Py-disseminated limestone and black mudstone
156.0 - 158.0 : Sheared black limestone
158.0 - 162.5 : Shear zone with fragments of black mudstone and black fine sandstone, Both contain weakly disseminated pyrite.
162.5 - 166.4 : Shear zone with fragments of black mudstone and quartz sandstone, filled with dark gray clay

Geophysical properties measurement of cores shows that high chargeability was caused by graphite in sandstone fragments of fracture zone. The origin of geochemical anomaly is unknown.

MJVS-2

This hole is targeted to elucidate the condition of mineralization of Zn geochemical anomalies around the Suoi Boc mineralized zone, particularly around the boundary between limestone and clastic rocks. The hole was drilled with a depth of 210.0 m, azimuth of N85°W and inclination of -70°.

0 - 2.0 : Soil
2.0 - 5.0 : Pale brown fine sandstone, weathered
5.0 - 15.0 : Pale brown to pale gray micaceous fine sandstone
15.0 - 16.2 : Gray siltstone, soft
16.2 - 18.8 : Pale brown fine sandstone, soft
(17.8 - 18.8 : Limonite disseminated)
18.8 - 19.5 : Gray siltstone, soft
19.5 - 20.6 : Gray fine sandstone, weathered
20.6 - 22.6 : Brown coarse sandstone, loose
22.6 - 24.7 : Pale brown to pale gray fine sandstone, weathered
24.7 - 26.0 : Gray siltstone, soft, Hematite network in part
26.0 - 28.0 : Gray fine sandstone
28.0 - 28.9 : Brown coarse sandstone
28.9 - 30.5 : Gray siltstone, soft
30.5 - 33.0 : Gray fine sandstone, soft
33.0 - 35.0 : Gray coarse sandstone, soft
35.0 - 36.0 : Gray fine sandstone, soft
36.0 - 40.4 : Brown fine sandstone to siltstone
(39.0 - 39.2 : Weakly silicified, limonite veinlets)
40.4 - 49.6 : Gray fine sandstone
(41.0 - 41.4 : Weakly silicified, limonite veinlets)
(43.5 : Limonite vein, width 2 cm)
(49.9 : Limonite vein, width 1 cm)
49.6 - 50.8 : Pale brown medium sandstone
50.8 - 52.8 : Brown fine sandstone
52.8 - 54.0 : Shear zone, Limonite veinlets
54.0 - 56.8 : Shear zone with fragments of weakly silicified mudstone, Limonite network in part
56.8 - 57.8 : Shear zone with fragments of fine sandstone and mudstone

57.8 - 58.2 : Pale brown coarse sandstone
58.2 - 63.6 : Gray fine sandstone, partly weathered
63.6 - 65.0 : Brown siltstone, strongly weathered
65.0 - 72.0 : Shear zone with fragments of fine sandstone, siltstone and coarse sandstone
72.0 - 83.3 : Sheared gray siltstone, Limonite veinlets in part
83.3 - 84.5 : Sheared fine sandstone, brown
84.5 - 84.9 : Silicified siltstone, sheared
84.9 - 86.1 : Sheared siltstone
86.1 - 89.0 : Sheared fine sandstone, gray to brown
89.0 - 91.8 : Pale brown to brown fine sandstone, sheared ?
91.8 - 93.2 : Sheared siltstone, matrix hematite
93.2 - 95.3 : Gray fine sandstone
(91.8 - 95.3 : Hematite network)
95.3 - 98.5 : Sheared limestone, matrix clay and hematite
98.5 - 102.0 : Sheared limestone, matrix calcite
102.0 - 112.0 : Black massive limestone
(105.4 - 112.0 : Calcite-hematite veinlets)
112.0 - 116.4 : Sheared limestone with reddish brown to gray clay
116.4 - 118.0 : Black massive limestone
118.0 - 126.5 : Sheared limestone with gray clay, partly limonite or hematite stained
126.5 - 128.0 : Black massive limestone with calcite and calcite-hematite veinlets
128.0 - 134.0 : Sheared limestone filled with gray clay
134.0 - 150.0 : Black massive limestone
(138.8 - 150.0 : Hematite veinlets)
150.0 - 172.0 : Limestone breccia, Limonite veinlets
172.0 - 189.0 : Sheared limestone filled with reddish brown clay
189.0 - 210.0 : Pale gray massive limestone, partly limestone breccia, Limonite veinlets

Limonite veinlets, network and dissemination are observed in clastic rocks partly. Hematite veinlets are in limestone. Shear zone with limonite bearing clay occurs in limestone.

MJVS-3

The purpose of this drilling is to clarify the mineralization below the Zn geochemical anomalous zone at the north of the Suoi Boc mineralized zone. The hole was drilled with a depth of 206.3 m, azimuth of N85° W and inclination of -70°.

0 - 12.5 : Soil and gravel
12.5 - 14.3 : Black massive limestone, Hematite veinlets
14.3 - 20.7 : Limestone breccia
(17.3 - 17.7 : Hematite-goethite vein)
20.7 - 63.5 : Black massive limestone
(23.3 : Hematite sheared vein)
(26.0 - 26.5 : Hematite network)
(34.5 - 35.0 : Hematite-goethite veinlets)
63.5 - 65.0 : Sheared limestone filled with limonite
(61.0 - 100.0 : Limonite veinlets)
65.0 - 67.6 : Black massive limestone
67.6 - 70.1 : Sheared limestone filled with reddish brown clay
(70.0 - 70.1 : Goethite-hematite vein contained sheared limestone)

70.1 - 83.4 : Black massive limestone
83.4 - 85.3 : Sheared limestone
85.3 - 87.5 : Black massive limestone
87.5 - 88.2 : Sheared limestone filled with limonite
88.2 - 91.0 : Black massive limestone
91.0 - 92.5 : Sheared limestone
92.5 - 121.6 : Limestone breccia
(100.0 - 150.0 : Limonite veinlets)
121.6 - 126.7 : Limestone breccia
126.7 - 133.0 : Limestone breccia
133.0 - 136.2 : Sheared limestone filled with gray clay or goethite-hematite
136.2 - 142.5 : Black massive limestone
142.5 - 153.7 : Sheared black limestone filled with pale gray clay
153.7 - 155.2 : Sheared black limestone filled with brown clay
155.2 - 206.3 : Black massive limestone
(185.8 - 190.2 : Calcite-limonite veinlets)

Limonite bearing brecciated vein and veinlets occur in limestone.

MJVS-4

This hole is aimed to elucidate the condition of mineralization in the high chargeability zone at the northeastern part of the zone. The hole was drilled with a depth of 160.0 m, azimuth of S85°E and inclination of -70°.

0 - 4.5 : Weathered brown mudstone
4.5 - 10.0 : Black mudstone
10.0 - 11.2 : Sheared-argillized zone
11.2 - 16.5 : Black mudstone
16.5 - 20.1 : Argillized zone with fragments of black mudstone
20.1 - 64.6 : Sheared-argillized zone with fragments of black mudstone, partly phyllitic
64.6 - 68.0 : Black mudstone, partly phyllitic, Quartz-pyrite veinlets
68.0 - 77.0 : Breccia of black mudstone and fine sandstone
(71.0 : Quartz-pyrite veinlets, width 1 cm)
(73.5 - 75.5 : Pyrite dissemination)
77.0 - 79.0 : Shear zone with fragments of calcareous mudstone
79.0 - 90.7 : Shear-clay zone with fine sandstone fragments
90.7 - 97.2 : Sheared-argillized zone with fragments of black mudstone
97.2 - 100.0 : Sheared black mudstone, Pyrite dissemination in mudstone
100.0 - 102.0 : Dark gray clay
102.0 - 106.0 : Sheared-argillized zone with fragments of fine sandstone and black mudstone, Pyrite dissemination in black mudstone
106.0 - 114.0 : Dark gray clay
114.0 - 118.8 : Sheared black mudstone
118.8 - 126.5 : Sheared-argillized zone with fragments of black mudstone and fine sandstone, partly black mudstone fragments rich
126.5 - 160.0 : Sheared-argillized zone with fragments of black mudstone and fine sandstone

Geophysical properties measurement revealed that high chargeability around these hole was caused by graphite contained in fine-grained sandstone.

3-4-3. Mineralization

Ore minerals observed in drill cores are pyrite, chalcopyrite, hematite and goethite. Gangue minerals are carbonate and quartz.

The mineralization in the cores consists of brecciated vein, veinlets, network and dissemination.

The mineralization in clastic rocks is veinlets, network and dissemination. Limonite veinlets and network are intermittently found from the surface to 95.3 m in depth of MJVS-2. Pyrite dissemination is found in the clay of fracture zone, and in the fragments of black mudstone and fine-grained sandstone of MJVS-1 and MJVS-2. The disseminated sulfide includes chalcopyrite. A quartz-pyrite veinlet is found in the black mudstone of MJVS-4.

The mineralization of limestone is brecciated vein, veinlets and network. The number of brecciated veins is four in MJVS-2 (drilled length is from 1.7 m to 17.0 m), and six in MJVS-3 (drilled length is 0.4 to 6.3 m). All of brecciated veins contain a lot of fragments of limestone and limonite or limonite bearing clay fills fragments. Veinlets and network are 1 to 2 mm wide and are accompanied by some goethite.

The assay results of ore samples that contain a large quantity of limonite are shown in Appendix 3. The analytical results of veins and mineralized zone are shown in Appendix 4.

3-4-4. Physical Properties of the Cores

Seventeen core samples were collected from MJVS-1, MJVS-2, MJVS-3 and MJVS-4 for the measurement of physical properties such as resistivity and chargeability to elucidate the origin generating high chargeability. The method of measurement is the same as the laboratory measurement of the second phase.

Average resistivities are follows. Average resistivity of limestone is relatively higher then that of mudstone. This trend is the same as the results of superficial rock samples of last phase.

Rock	Resistivity (ohm-m)
Limestone	11285
Sandstone	4580
Mudstone	272

There is a distinct difference of chargeability of cores between MJVS-1 and MJVS-4, and MJVS-2 and MJVS-3. Chargeability of cores in MJVS-2 and MJVS-3 is several milliseconds, and is same value as rock samples collected on surface last year. Half of cores from MJVS-1 have the chargeability of more than 100 milliseconds (highest is 372.6 ms). Half of cores from MJVS-4 have more than 50 milliseconds (highest value is 79.6 ms).

The results of laboratory chargeability measurement support the distribution of chargeabilities obtained last year. Polished section microscopy shows that high chargeabilities of cores in MJVS-1 are caused by disseminated pyrite and graphite. High chargeabilities in MJVS-4 are possibly caised by graphite. Sandstone and siltstone chips include less than 3% (superficial content) of graphite, collected from MJVS-1 and MJVS-4.

3-5. Discussions on the Results of the Drilling Survey

Pb-Zn vein or skarn deposits have been expected to occur according to the results of the survey done until last year.

Geochemical anomalous zones and high chargeability zones targeted by drilling survey, are distributed in the western part and eastern part of the zone separately. Both anomalous zones are discussed below individually.

Drilling was done in the two geochemical anomalous zones. One is around the Suoi Boc mineralized zone. The other is the anomalous zone extended northerly from the north of the Suoi Boc mineralized zone. MJVS-2 and MJVS-3 have had a task to clarify the condition of mineralization below the geochemical anomalous zones. Concurrently the trench of MJT-1 was dug around MJVS-2 and that of MJT-2 was around MJVS-3.

The geology of MJVS-2 consists of clastic rocks and limestone. Limestone constitutes the cores of MJVS-3. These results reveal that sedimentary rocks have strikes of N-S to NNE-SSW and dips of almost 30°E to 100 m in depth.

The mineralization observed in MJVS-2 and MJVS-3 is brecciated vein, network and veinlets. No skarn minerals are found in limestone and clastic rocks. Weak silicification is hosted by clastic rocks of MJVS-2. Consequently no skarn ore deposits possibly occur in the zone.

Veins, network and veinlets are accompanied by oxidized iron minerals such as limonite. No Pb-Zn minerals are found in the drilling cores. The results of ore assay support this fact.

Clastic sedimentary rocks occur from the surface to about 100 m in depth in MJVS-2. Deep weathering is recognized in these clastic rocks. It is supposed that ground water has freely flowed down through limestone caves around MJVS-2 and MJVS-3. It is considered that no primary sulfides have been left to the depth surveyed by the drill holes because oxidation and dissolution of sulfides reached to deeper part of the zone.

The Suoi Boc mineralized zone has galena, sphalerite etc. The reason that sulfide minerals remain in this mineralized zone, is interpreted that the weathering to this zone was obstructed due to the permeability lowered by strong silicification.

No big Pb-Zn ore deposits at the shallow part below the geochemical anomalous zone are accordingly expected to occur.

The results of drilling survey done at the high chargeability zones are discussed below.

Two high chargeability zones were assessed by two drill holes.

The geology of the holes consists of black mudstone and fracture zone in MJVS-1 and MJVS-4. The fracture zone is constituted with fragments of fine-grained sandstone, black mudstone, limestone and calcareous mudstone, and a matrix of pelitic materials.

Pyrite dissemination and veinlets of quartz-pyrite are found in the fragments of the fracture zones. Weak pyrite dissemination is recognized in part of pelitic materials.

The results of geophysical properties measurement show that a fragment of limestone with pyrite dissemination has extremely high chargeability. A fragment of fine-grained sandstone has high chargeability as the former pyrite-disseminated limestone. Fragments of fine-grained sandstone, calcareous mudstone and limestone without pyrite dissemination that have collected from MJVS-1 and MJVS-4, have higher chargeability than limestone from MJVS-2 and MJVS-3.

Polished section microscopy for clastic rocks of MJVS-1 and MJVS-4 shows that all of the polished sections contain of graphite. Graphite generally has strong IP effect (high chargeability).

It is consequently proved that high chargeability anomalies detected by IP survey last year were caused by graphite and don't indicate the existence of sulfide minerals.

One high chargeability zone other than above two zones was detected. These three high chargeability zones were aligned on NNE-SSW direction. The clastic sedimentary rocks of this zone strike N-S to NNE-SSW. The three high chargeability zones are distributed on the fracture zone encountered by MJVS-1 and MJVS-4. It is accordingly supposed that high chargeability was caused by partial distribution of rocks rich in graphite

One geochemical anomalous zone neighbors on the high chargeability zone around MJVS-1. It is supposed that geochemical anomaly is caused by a small-scaled Pb-Zn mineralization, as the geophysical anomalies have been caused by graphite.

One geochemical anomaly is extracted other than above three geochemical anomalous zones. The former is constituted with one anomalous point. No big Pb-Zn ore deposits are expected to occur around this anomaly because the extent of this anomaly is small comparing with the anomalous zones around the Suoi Boc mineralized zone and the north of the Suoi Boc mineralized zone.

Dacite porphyry and aplite dike are found in the Suoi Boc zone. The age of intrusion is supposed Cretaceous. Vein deposit to be expected to occur in the zone is possibly considered to have been formed with these acidic intrusions.

PART 3. CONCLUSIONS AND RECOMMENDATION

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CHAPTER 1. CONCLUSIONS

The survey of this phase consists of drilling survey and trench survey in the Suoi Boc zone. Amount of the survey is four inclined drill holes totaling 742.30 m and three trenches with a total length of 600 m.

The followings are the results of the third phase survey and recommendations for the future exploration work.

(1) The geology of the Suoi Boc zone consists of Middle Triassic sedimentary rocks, Cretaceous dacite porphyry and aplite, and Quaternary sediments. The Middle Triassic is divided into clastic sedimentary rocks and limestone. The clastic sedimentary rocks are composed of mudstone, siltstone and sandstone. Siltstone and sandstone predominate in the western part of the zone, whereas mudstone mainly occurs in the eastern part. The Triassic clastic sedimentary rocks tend to strike N-S to NNE-SSW direction and to dip mostly from 20° to 70° E.

(2) The geological structure of the zone is characterized by the N-S to NNE-SSW direction that is expressed as the strikes of sedimentary rocks and faults, the distribution of igneous rocks and the extension of Quaternary sediments.

(3) As a result of the work in this phase, it has become clear that the geochemical anomalies in the zone indicate the vein-type mineralization. The potential for skarn ore deposits is low because skarn minerals are absent in the Triassic rocks of these anomalous zones.

(4) The Suoi Boc mineralized zone is consequently regarded as a vein-type mineralized zone.

(5) The high chageability zones detected last year by IP survey, are interpreted to have been caused by graphite contained in the clastic sedimentary rocks. Therefore it has been proved that new Pb-Zn ore deposits are not expected to occur in the high chargeability zones.

(6) The vein mineralization in this zone is mostly located in limestone. Many limestone caves occur in the limestone. The sulfide minerals are considered to have been oxidized and dissolved to deeper part by free ground water flowing within caves. It is supposed that the

weathering bottom for sulfide minerals may reach to deeper than 200 m below the surface, although the lower limit of weathering for sulfide minerals was not proved.

(7) The width of brecciated veins containing limonite in the drill holes and trenches, does not exceed 2 meter. No big Pb-Zn vein deposit is possibly expected to occur, because the width of vein at the deeper part below the surface is not reasonable to become sharply thicker.

(8) Shear zones composed of limonite and clay, are found in trenches and drill holes. The genesis of these shear zones is interpreted in two ways. One is the weathered products of sulfide bearing brecciated veins. The alternative is that shear zone is composed of limestone fragments and surface soil collapsed into ancient dolines. High content of Pb-Zn will be rare in the deeper part of the veins, as the limestone fragments occupy the major part of the veins even though the genesis is the former one.

CHAPTER 2. RECOMMENDATION FOR FUTURE EXPLORATION

As the result of the drilling survey and trench survey done in this phase, no indication for new ore deposits was found. Therefore, no further exploration is needed in the Suoi Boc zone.

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