REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE BO CU AREA
THE SOCIALIST REPUBLIC OF VIETNAM

CONSOLIDATED REPORT

FEBRUARY 1999

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

The Government of Japan, in response to a request of the Government of the Socialist Republic of Vietnam, decided to conduct a mineral exploration in the Bo Cu area, northern Vietnam, and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The Government of the Socialist Republic of Vietnam appointed the Department of Geology and Minerals of Vietnam (former Geological Survey of Vietnam), the Ministry of Industry to make the survey as a counterpart to the Japanese team. The survey was carried out from 1996 jointly by experts from both governments.

The cooperative mineral exploration for gold resources in the Bo Cu area has continued for three years. It consisted of geological, geochemical and geophysical surveys, and drilling exploration. This consolidated report summarizes the results of the work.

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

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

February 1999

Kimio FUJITA
President
Japan International
Cooperation Agency

Hiroaki HIYAMA
President
Metal Mining Agency of
Japan

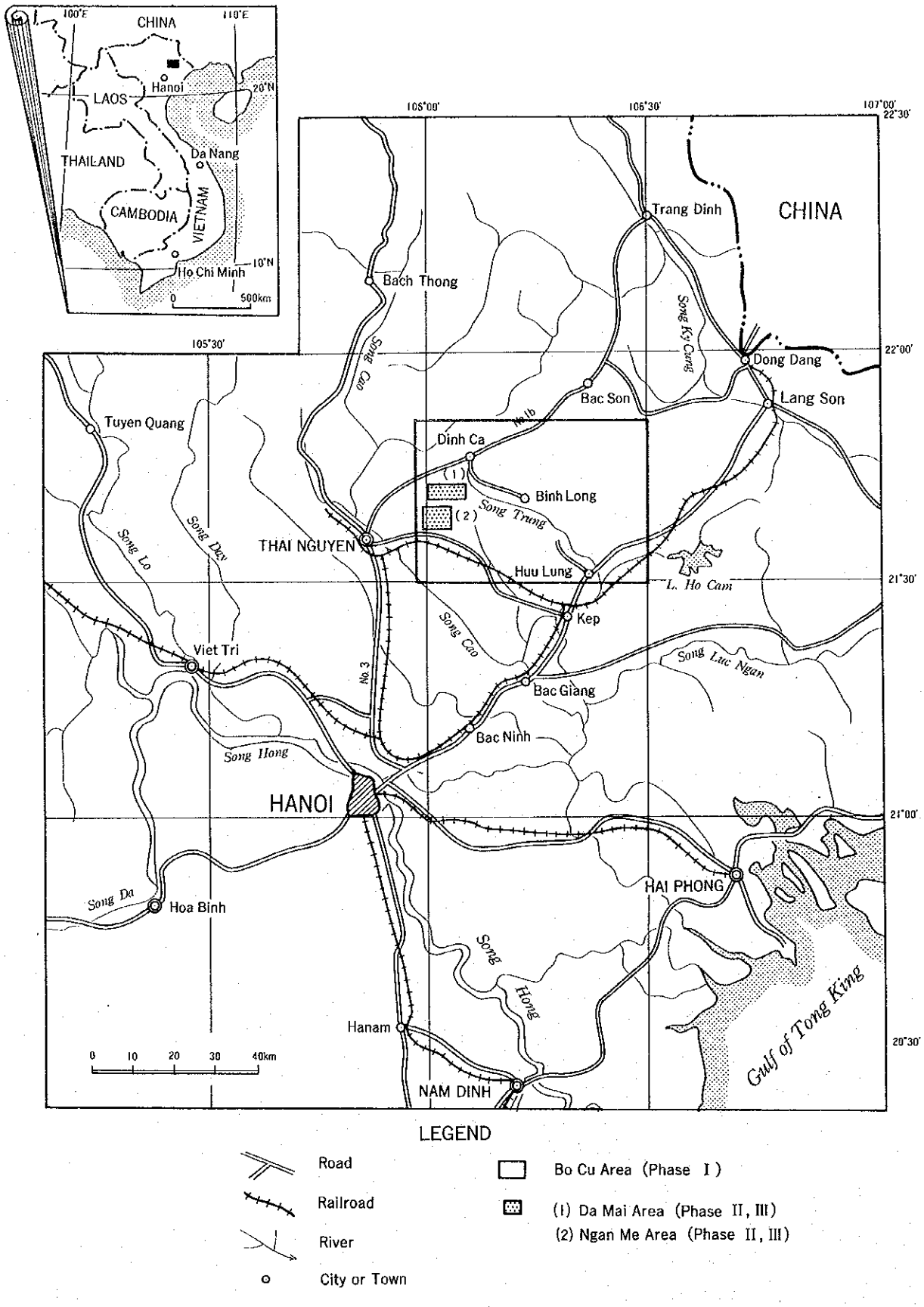

Fig. 1-1 Index Map of the Survey Area

SUMMARY

The Cooperative Mineral Exploration has been carried out for three years in the Bo Cu area. The principal objective of this project is to find a new mineral deposit in the Bo Cu area through the exploration and examination of geology and mineralization.

In 1996, preliminary investigation and the first phase field survey were carried out for the purpose of assessing the potential of mineral resources in the Bo Cu area. The major works completed during the first phase were a review of the existing geological information, regional geological survey, geochemical exploration (stream sediment survey and panning survey), and semi-detailed geological survey and geophysical exploration (CSAMT method). The entire study area was 2,000 km^2, and the semi-detailed survey was made in three areas of approximately 16 km^2 in total -- Da Mai, Gang, and Ngan Me.

In 1997, the second phase survey comprising detailed geological survey, rock-chip geochemical survey, geophysical survey (IP method) and reconnaissance drilling was carried out in two areas -- Da Mai and Ngan Me -- which were selected by the first phase survey for the potential gold prospects. The survey area was 40 km^2 in total. The distribution of gold mineralization in the Da Mai-Khe Dui prospect in the Da Mai Area is approximately 200-300 m wide and more than 1,500 m long on the surface. Gold-bearing quartz veins in the Da Mai-Khe Dui prospect are subdivided into several groups of veins mainly running E-W with dips of steep S or N. Numerous people's mining shafts, adits and prospecting pits are distributed in the prospect. Visible gold was frequently observed in quartz veins in Khe Dui creek. The Ba Khe prospect in the Ngan Me area was another interesting area for gold deposit. Adits and inclined shafts are distributed for about 1,000 m along Ba Khe creek and Na Hon creek. Veins of E-W trend with dips of gentle to steep S occur in this prospect. Although assay results of ore samples were rather disappointing, visible gold occasionally occurs in some part of quartz veins.

Two inclined holes totaling 600 m were drilled in the Da Mai-Khe Dui prospect in the Da Mai area for testing the lower extensions of the significant gold mineralized zones.

In MJVB-1, thirteen groups of quartz veins were caught in total. Although native gold was observed in drill cores and slime of drilling at several depths in the field, no significant assay result was obtained.

In MJVB-2, thirteen groups of quartz veins were intersected, and several significant intersections up to 56.640 g/t Au and 9.0 g/t Ag at 28 cm in width were returned

In 1998, the third phase survey composed of drilling exploration was carried out in two areas -- (1) Da Mai area, and (2) Ngan Me area. The major purpose of the third phase survey was to find bonanzas of gold ores within the mineralized zones defined during the second phase survey -- especially by the IP geophysical survey.

Two inclined holes totaling 600 m (MJVB-3 and MJVB-4) were drilled in the Da Mai-Khe Dui prospect in the Da Mai area, and another two inclined holes totaling 600 m (MJVB-5 and MJVB-6) were drilled in the Ba Khe prospect in the Ngan Me area for testing the lower extensions of the significant gold mineralized zones.

In MJVB-3, a total of eight major groups of quartz veins were caught. Several significant intersections up to 75.600 g/t Au at 35 cm in width were returned. The extensions of some gold-bearing quartz veins which occurred on the surface in the Khe Dui creek were caught in the drill hole. However, most of them showed no gold value.

In MJVB-4, eight major groups of quartz veins were intersected. The development of quartz veins/networks were remarkable in this hole, especially at the depth from around 100 to 150 m. Only one significant result was obtained in this hole: 12.400 g/t Au at 45 cm in width.

In MJVB-5 and MJVB-6, no significant assay result was obtained, although several groups of quartz veins were intersected in the drill holes.

On the basis of the results of the drilling survey in the third phase in which two areas for gold potentials have been tested together with the results of surveys for three years, the following conclusions were obtained. Gold-bearing quartz veins in these areas are lack of continuation and small scale. They dispersedly occur, without any concentration of significant scale. Some of them occasionally show very high grade in Au. Such grades, however, are not stable. The dimension of gold resources was considered to be something from several hundreds to several thousand tons of ores; that is unfortunately far smaller than what is required in our exploration. Therefore, no further work is recommended in the Da Mai, Gang and Ngan Me areas.

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PART I OVERVIEW

PART I OVERVIEW

Chapter 1 Outline of Project

1-1 Background and Objectives

The Vietnam-Japan Cooperative Mineral Exploration has been carried out in one area of the Socialist Republic of Vietnam: "Van Yen and Thanh Hoa (1993-1995)". As a result of these works, a significant amount of information regarding metallic mineral resources was obtained. The exploration also contributed to the technical progress of the Geological Survey of Vietnam, as well as to the acquisition and accumulation of knowledge regarding geology and mineral deposits of the country.

The Ministry of Industry of Vietnam planned to conduct mineral exploration in the Bo Cu area, northern Vietnam, and requested the cooperation of the Japanese Government. In August 1996, the Japanese Government, responding to the request, sent a mission for discussing the Scope of Work and to make a program of the first phase survey. As a result of consultations with the Geological Survey of Vietnam (now the name has changed to the Department of Geology and Minerals of Vietnam), the counterpart of the Japan International Cooperation Agency and the Metal Mining Agency of Japan, an agreement was reached for cooperative mineral exploration in the Bo Cu area on August 8, 1996.

The principal objective of this project was to find a new mineral deposit in the Bo Cu area through the exploration and examination of geology and mineralization. It wa also important to pursue technology transfer to the Vietnamese counterpart organization in the course of the project.

In 1996, preliminary investigation and the first phase field survey were carried out for the purpose of assessing the potential of mineral resources in the Bo Cu area. The major works completed during the first phase were a review of the existing geological information, regional geological survey, geochemical exploration (stream sediment survey and panning survey), and semi-detailed geological survey and geophysical exploration (CSAMT method). The entire study area was 2,000 km^2, and the semi-detailed survey was made in three areas of approximately 16 km^2 in total -- Da Mai, Gang, and Ngan Me.

In 1997, the second phase survey comprising detailed geological survey, rock-chip geochemical survey, geophysical survey (IP method) and reconnaissance drilling was carried out in two areas -- Da Mai and Ngan Me -- which were selected by the first phase survey for the potential gold prospects. A survey length of 80 km was traversed, and more than 300 rock-chip samples and 70 ore samples were collected. The IP geophysical survey was carried out in the survey areas, and the

chargeability anomalies were analyzed. Two inclined holes totaling 600 m were drilled in the Da Mai-Khe Dui prospect in the Da Mai area for testing the lower extensions of the significant gold mineralized zones.

In 1998, the third phase survey composed of drilling exploration was carried out in two areas -- (1) Da Mai area, and (2) Ngan Me area. The major purpose of the third phase survey was to find bonanzas of gold ores within the mineralized zones defined during the second phase survey -- especially by the IP geophysical survey. It was also required for the further exploration to elucidate the nature and characteristics of gold mineralization in the Bo Cu area. Two inclined holes totaling 600 m were drilled in the Da Mai-Khe Dui prospect in the Da Mai area, and another two inclined holes totaling 600 m were drilled in the Ba Khe prospect in the Ngan Me area for testing the lower extensions of the significant gold mineralized zones.

1-2 Survey Area

The survey area in the first phase was approximately 2,000 km^2 surrounded by the coordinates listed below. It is located approximately 70 km north of Hanoi. It lies over three provinces: Bac Thai, Lang Son and Ha Bac (at that time; now the jurisdiction of those provinces has been changed).

No.	Latitude	Longitude
1	21°50'N	105°58'E
2	21°50'N	106°30'E
3	21°30'N	106°30'E
4	21°30'N	105°58'E

The survey area in the second phase was approximately 40 km^2 comprising two areas -- Da Mai area (25 km^2) and Ngan Me area (15 km^2). It is located approximately 30 km east of Thai Nguyen city, where is situated approximately 70 km direct north of Hanoi.

The survey area in the third phase is composed of two areas -- Da Mai and Ngan Me areas. It is located approximately 30 km east of Thai Nguyen city.

The location map of each phase survey area is shown in Fig. 1-2.

1-3 Exploration Work

The methods and amount of works in each phase are summarized in Table 1-1.

1-4 Duration and Survey Team

(1) Mission for the Project Finding and Scope of Work

The Japanese Preliminary Survey Team of the Japan International Cooperation Agency and the Metal Mining Agency of Japan headed by Mr. Toyo Miyauchi visited Vietnam during the period of August 5 to 10, 1996, and made a field survey in the Bo Cu area. The Scope of Work was agreed and signed on August 8, 1986. The S/W meeting was held by the attendants listed below:

[Members of Japanese Side]

Toyo MIYAUCHI	Leader of the Team, Director, Overseas Activities Department, Metal Mining Agency of Japan

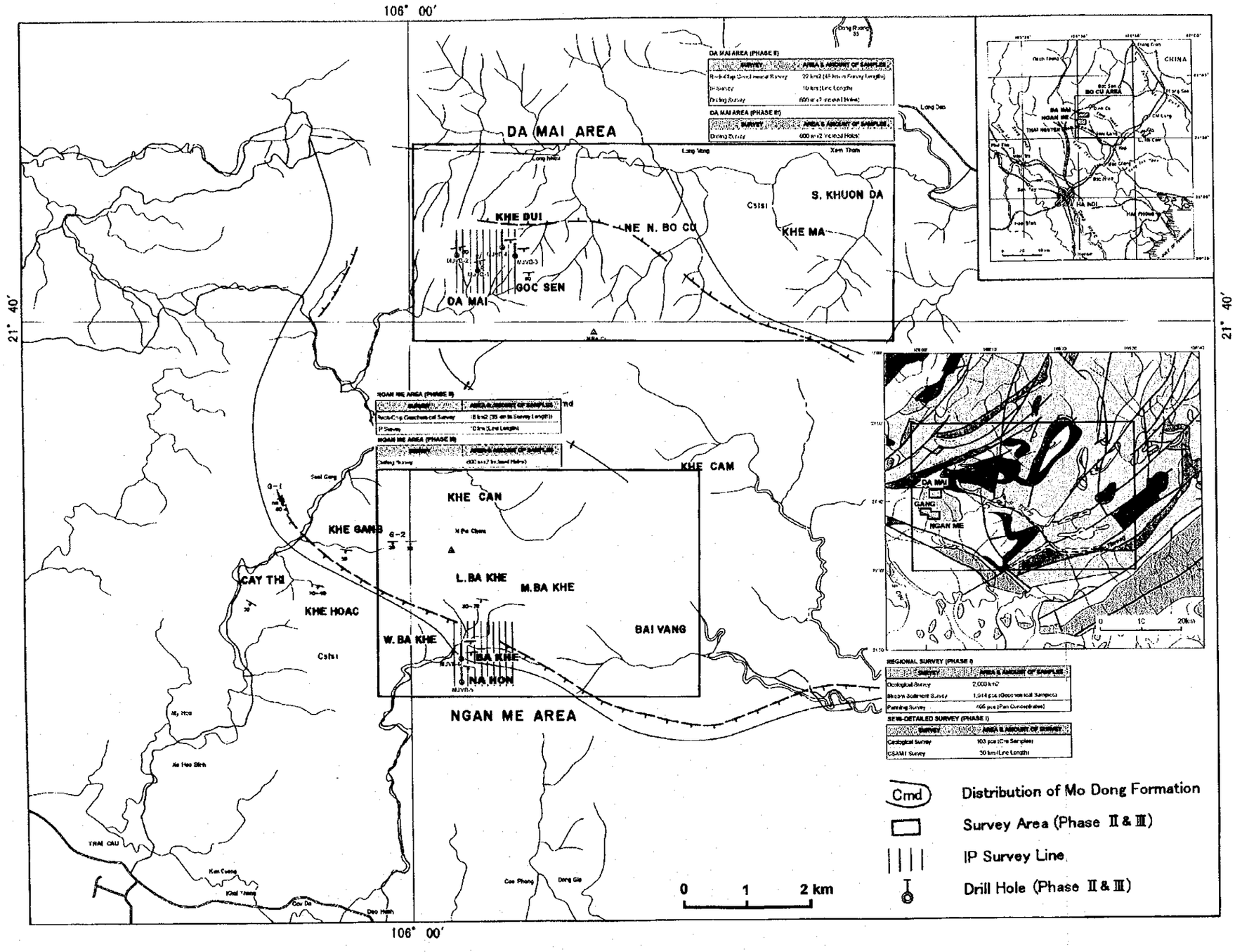

Fig. 1-2 Map Showing the Areas of the First, Second and Third Phase Surveys

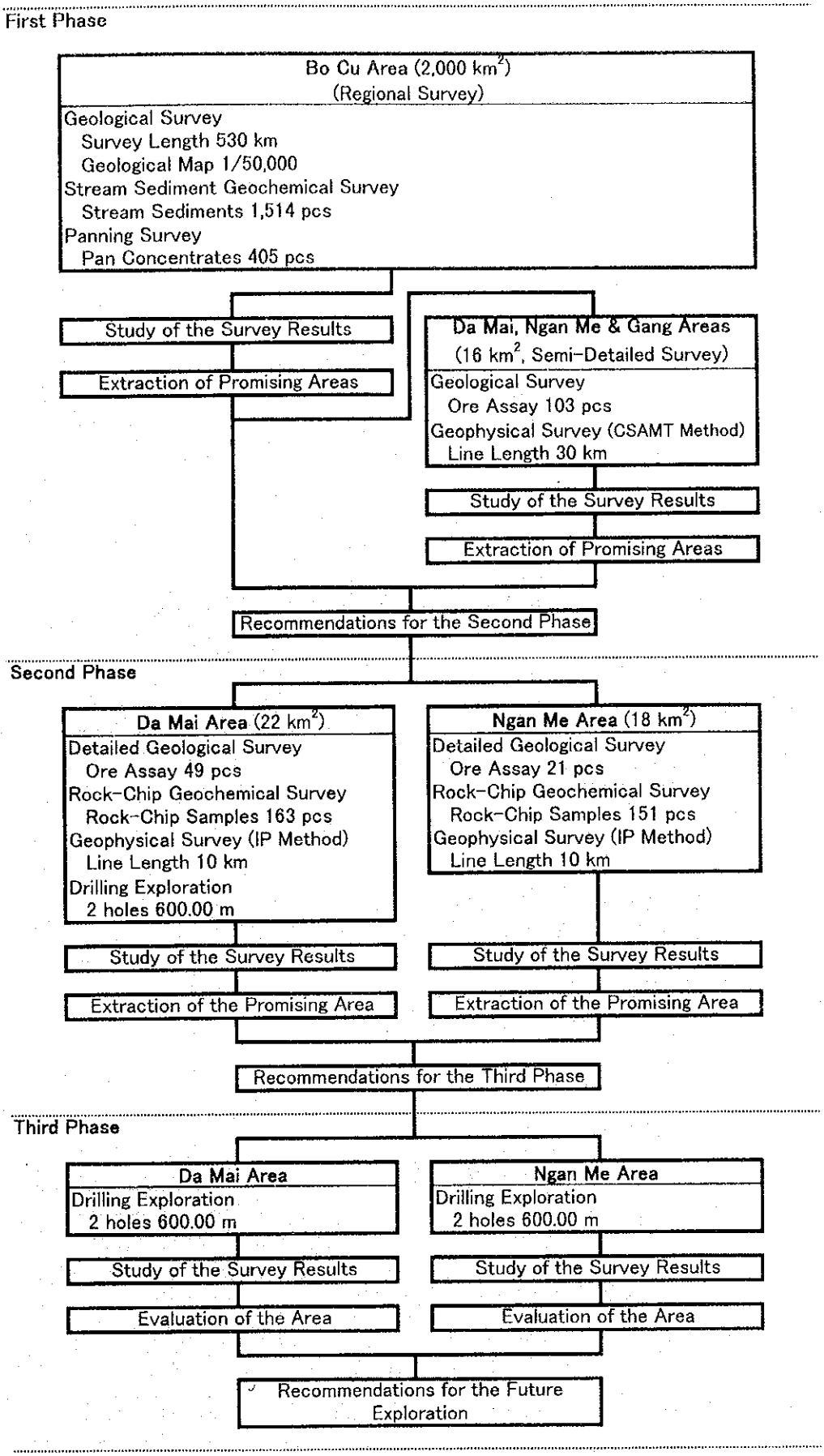

Fig. 1-3 Flowsheet of Survey in the Bo Cu Area

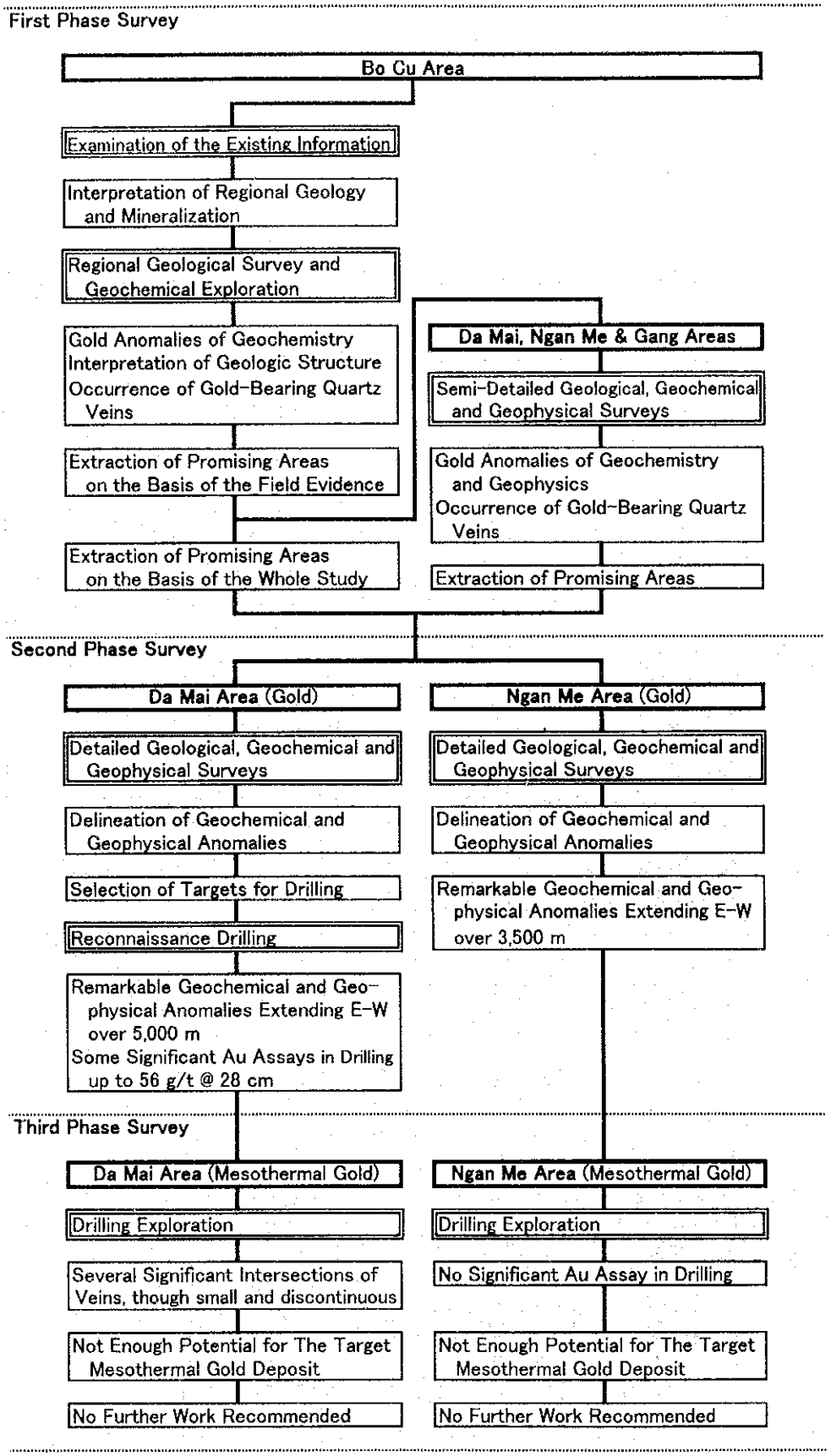

Fig. 1-4 Flow Chart Illustrating the Exploration Steps in the Bo Cu Area

Table 1-1 Summary of Exploration Works in the Bo Cu Area

Phase	Survey	Area	Amount of Work		
First	Regional Survey Geological Survey and Geochemical Exploration (Stream Sediment Survey, Panning Survey)	Regional Area	Area	2,000	km^2
			Survey Length	530	km
			Stream Sediments	1,514	pcs
			Pan Concentrates	405	pcs
	Semi-Detailed Survey Geological Survey	Da Mai, Ngan Me and Gang	Area	16	km^2
	Geophysical Survey (CSAMT Method)	Da Mai, Ngan Me and Gang	Survey Length	30	km
			Survey Points	330	pts
			[Lab Works]		
			Geological Survey and Geochemical Exploration		
			Thin Sections	31	pcs
			Polished Sections of Ore	31	pcs
			X-Ray Diffraction Analysis	40	pcs
			Fluid Inclusion Study (Homogenization Temp)	11	pcs
			Heavy Mineral Identification	405	pcs
			Chemical Analysis		
			Whole Rocks (13 Major Components)	20	pcs
			Stream Sediments (Au,Ag,Cu,Pb,Zn,As,Sb,Hg)	1,514	pcs
			Ore (Au,Ag,Cu,Pb,Zn,As,Hg)	103	pcs
			Geophysical Survey		
			Resistivity & Chargeability	20	pcs
Second	Detailed Survey Geological Survey and Geochemical Exploration (Rock-Chip Survey)	Da Mai and Ngan Me	Area	40	km^2
			Survey Length	86	km
			Rock-Chip Samples	314	pcs
	Geophysical Survey (IP Method)	Da Mai and Ngan Me	Survey Length	20	km
			Survey Points	800	pts
	Drilling Exploration	Da Mai	Drilling (2 Holes)	600	m
			[Lab Works]		
			Geological Survey and Geochemical Exploration		
			Thin Sections	21	pcs
			Polished Sections of Ore	30	pcs
			X-Ray Diffraction Analysis	41	pcs
			Fluid Inclusion Study (Homogenization Temp)	30	pcs
			Fluid Inclusion Study (Salinity)	5	pcs
			Chemical Analysis		
			Rock-Chips (Au,Ag,Cu,Pb,Zn,As,Sb,Hg)	314	pcs
			Ore (Au,Ag,Cu,Pb,Zn,Fe)	70	pcs
			Geophysical Survey		
			Resistivity & Chargeability	20	pcs
			Drilling Exploration		
			Thin Sections	10	pcs
			Polished Sections of Ore	12	pcs
			X-Ray Diffraction Analysis	20	pcs
			Fluid Inclusion Study (Homogenization Temp)	10	pcs
			Fluid Inclusion Study (Salinity)	2	pcs
			Chemical Analysis		
			Ore (Au,Ag,Cu,Pb,Zn,Fe)	53	pcs
Third	Detailed Survey Drilling Exploration	Da Mai and Ngan Me	Drilling (4 Holes)	1,200	m
			[Lab Works]		
			Drilling Exploration		
			Thin Sections	20	pcs
			Polished Sections of Ore	20	pcs
			X-Ray Diffraction Analysis	21	pcs
			Fluid Inclusion Study (Homogenization Temp)	10	pcs
			Fluid Inclusion Study (Salinity)	4	pcs
			Chemical Analysis		
			Ore (Au,Ag,Cu,Pb,Zn,Fe)	101	pcs

Toru NAWATA	Energy and Mining Development Study Division, Mining and Industrial Development Study Department, JICA
Yuichi SASAKI	Technical Cooporation Division, Metal Mining Agency of Japan
Katsutaka NAKAMURA	Representative of Bangkok Office, Metal Mining Agency of Japan

[Members of Vietnamese Side]

Tran Dy	Director General, GSV
Do Huu Hao	Deputy Director General, International Cooperation Department, Ministry of Industry
Nguyen Van De	Senior Geologist, Technology and Product Quality Management Department, Ministry of Industry
Doan Ky Thuy	Director, International Cooperation Division, GSV
Ta Viet Dung	Director, Technical and Planning Division, GSV
Le Van De (Dr)	Deputy Director, International Cooperation Division, GSV
Phan Doan Thanh	Director, GSV-I
Nguyen Van Quy	Senior Geologist, GSV
Dan Ngoc Tran	Senior Hydrogeologist, GSV

(2) First Phase Survey

The geological and geochemical surveys of the first phase were carried out during the period from September 30 to December 21, 1996. Geophysical survey was made within the period from October 14 to December 21. Laboratory works and reporting followed the field works. The organization of the survey team consisted of the following members:

[Metal Mining Agency of Japan]

Eishi ENDO	Coordinator
Susumu NAGAE	Coordinator and Geologist

[Members of Vietnamese Team]

Le Van De (Dr)	(GSV) Coordinator and Geologist
Phan Doan Thanh	(GSV-I) Coordinator and Geologist
Dang Tran Quan	(GSV-I) Team Leader and Geologist
Nguyen Trang Tuyet	(GSV-I) Geologist
Dao Thai Bac	(GSV-I) Geologist
Phan Van San	(GSV-I) Geologist

Vu Duc Tuy	(GSV-I) Geophysicist
Ngo Duc Tan	(GSV-I) Geophysicist
Le Van Du	(GSV-I) Geophysicist

[Members of Japanese Team]

Kohei IIDA	(NED)	Team Leader and Chief Geologist
Hideya KIKUCHI	(NED)	Geologist
Kazuyasu SUGAWARA	(NED)	Geologist
Masahiro SUZUKI	(NED)	Geologist
Takashi YAMAISHI	(NED)	Geophysicist
Shin'ichi SUGIYAMA	(NED)	Geophysicist
Saburo TACHIKAWA	(NED)	Geophysicist

(3) Second Phase Survey

The geological and geochemical surveys of the second phase were carried out during the period from September 15 to October 28, 1997. Geophysical survey was made during the period from September 15 to November 13. Drilling survey was conducted during the period from October 28 to December 31, 1997. Laboratory works and reporting followed the field works. The organization of the survey team consisted of the following members:

[Metal Mining Agency of Japan]

Tadashi ITO	Director, Technical Cooperation Division, Overseas Activities Department
Noboru FUJII	Coordinator and Senior Geologist
Yoshiharu KIDA	Geologist, Bangkok Office

[Members of Vietnamese Team]

Le Van De (Dr)	(DGMV) Coordinator and Geologist
Phan Doan Thanh	(DGMV-NE) Coordinator and Geologist
Nguyen Trong Tuyet	(DGMV-NE) Geologist
Dao Thai Bac	(DGMV-NE) Geologist
Ngo Duc Tan	(DGMV-NE) Geophysicist
Vu Duc Tuy	(DGMV-NE) Geophysicist
Nguyen The Hai	(DGMV-NE) Geophysicist
Le Van Kieu	(INTERGEO) Drilling Engineer

[Members of Japanese Team]

Kohei IIDA	(NED)	Team Leader and Chief Geologist
Masahiro SUZUKI	(NED)	Geologist
Takashi YAMAISHI	(NED)	Geophysicist
Shin'ichi SUGIYAMA	(NED)	Geophysicist
Saburo TACHIKAWA	(NED)	Geophysicist
Hatsuo KUMANO	(NED)	Drilling Engineer

(4) Third Phase Survey

The preparation works for the drilling mainly composed of road construction were carried out during the period from July 1 to the end of September, 1998. Drilling survey was conducted during the period from September 1 to November 26, 1998. Laboratory works and reporting followed the field works. The organization of the survey team consisted of the following members:

[Metal Mining Agency of Japan]

Yoshiharu KIDA	Geologist, Bangkok Office

[Members of Vietnamese Team]

Le Van De (Dr)	(DGMV) Coordinator and Geologist
Phan Doan Thanh	(DGMV-NE) Coordinator and Geologist
Dao Thai Bac	(DGMV-NE) Geologist
Le Van Kieu	(INTERGEO) Drilling Engineer

[Members of Japanese Team]

Kohei IIDA	(NED)	Team Leader and Chief Geologist
Hatsuo KUMANO	(NED)	Drilling Engineer

*Note: GSV; Geological Survey of Vietnam
GSV-I; Division I, GSV
DGMV; Department of Geology and Minerals of Vietnam
(former GSV)
DGMV-NE; North-Eastern Geological Division, DGMV
(former GSV-I)
INTERGEO; INTERGEO Division, DGMV
NED; Nikko Exploration and Development Co., Ltd.

Chapter 2 Geography of the Survey Area

2-1 Location and Access

The Bo Cu area is located in the northern part of Vietnam. It is under the jurisdiction of two provinces: Thai Nguyen and Bac Giang.

The access to the Bo Cu area is obtained via Thai Nguyen, whose population is about 180,000 and which is the nearest town to the survey area within the province. The national road No. 3 connecting Thai Nguyen to Hanoi is roughly sealed (tarred), and it takes about 2 hours by car. From Thai Nguyen to the survey area, there is a couple of roads. They are partly tarred, mostly unsealed. There is locally no bridge for cars where crossed rivers, and they sometimes become muddy when rain continues. In such season, only four-wheel-drive vehicles are possible to go to the survey area. Several tracks are running in the survey area. Most of them are rugged, interrupted by rivers.

2-2 Topography and Drainage System

The survey area is situated in a hilly land. The altitude ranges from 50 to 500m. The geology consists mainly of Paleozoic. The major drainage systems within and surrounding the survey area are Song (river) Rong and Song Trung, both are branches of Song Cau.

2-3 Climate and Vegetation

The area belongs to the subtropical Asian monsoon climate zone. It is composed of four seasons. Spring comes in April, when red flowers of frangboiyan tree start to blossom everywhere in the town and countryside. Summer comes rather earlier, in May when the average temperature goes over 27 degrees C. In addition to the temperature, the humidity also goes up in June and July. Typhoon occasionally visits to this area in July or August. From October to December, it is the best and comfortable autumn season for the people. From the end of December, cold and rainy winter starts, and continues until March at most.

The following is the climatological data in Hanoi and its surrounding area:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave Temp C	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
Precp mm/month	18	26	48	81	194	236	302	323	262	123	47	20

Paddy rice fields cover along the alluvial plains in the survey area.

The subtropical rain forest grows in a lowland in the survey area. Some of the hilly area is developed as a tea plantation.

Chapter 3 Geology of the Survey Area

3-1 Geological Setting of the Northern Part of Vietnam

The survey area is located in the eastern part of the Vietbac district on the geological classification of the northern Vietnam. The Vietbac and Littoral Bacbo districts are separated with the West Bacbo district on the southwestern side by a structural zone of NW-SE direction which passes near Song Hong. This zone forms a part of the boundary between the South China plate on the northeastern side and the Indochina plate on the southwestern side. That is, this area is situated in the southernmost of the South China plate, and structurally corresponds to the southern extension of the Chinese continent. Geology of this area is composed of schist and sedimentary rocks of the Cambrian to Ordovician systems as the basement, and various sedimentary rocks from the lower Devonian to the middle Jurassic systems overlain the basement. Major parts of these geologic units show the structural direction of NE-SW which is comprehensively a characteristic feature in the eastern part of the Vietbac district. They form a complex folding zone. Moreover, they are cut into several blocks by faults of the same direction. The southwestern part of this area (southwestern part of the regional geological survey area and in ranges of the mineralization belt), however, tends to show directions of NW-SE or WNW-ESE. These structural directions extend to the west. The Precambrian rocks along Song Hong exhibit the NW-SE direction distinctly.

No big-scale igneous body is known in this area. Only small stocks are found; the late Triassic biotite granite occurs 50 km northwest from the western boundary of the survey area; the Cretaceous granite also occurs to the southwest of the survey area.

3-2 Geology and Geologic Structure of the Bo Cu Area

Geology of the Bo Cu area is composed of sedimentary and metamorphic rocks of Cambrian, Ordovician, and Devonian to Jurassic systems. The geology is classified into the following six major stratigraphic units: 1) Cambrian sedimentary rocks and schist with some limestone (Mo Dong Formation and Than Sa Formation), 2) Ordovician sedimentary rocks and schist (Na Mo Formation), 3) Devonian sedimentary rocks and schist with some limestone (Bac Bun Formation, Mia Le Formation and Na Quan Formation), 4) Carboniferous to Permian limestone with some clastic rocks (Bac Son Formation and Dong Dang Formation), 5) Triassic sedimentary rocks with interbedded acidic volcanic rocks (Lang Son Formation, Song Hiem Formation, Na Khuat Formation, Mau Son Formation and Van Lang Formation), and 6) Quaternary sediments.

In the central to the eastern part of the Bo Cu area, a series of Carboniferous to Permian limestone crops out widely, and forms the typical Karst topography. The survey area this phase, center of which is Nui (mountain) Bo Cu (540 m), belongs to the southwestern part of the above-mentioned area. It is composed mainly of Cambrian terrigene-sedimentary and metamorphosed rocks of the Mo

Dong and Than Sa Formations. They form the Bo Cu anticlinorium, whose axes trend WNW-ESE direction and plunge to E. Two sides (N and S) of the anticlinorium are cut and controlled by two tectonic faults of the same direction. Series of alluvial gold occurrences surround the anticlinorium, and moreover, almost all known gold-bearing quartz veins in the area are distributed within this anticlinal structure. The rocks except the recent one in the western part of the Bo Cu area generally show strike directions of ENE, E-W and WNW. Those in the central to the southern part dip to the south to south-southwest at angles of 30 to 40 degrees. Therefore, the upper strata crop out to the south. On the other hand, the lower Cambrian system forms an anticlinorium of almost E-W axis in the northern part of the area. The lowest horizon in the Bo Cu area appears on the surface in this part.

3-3 Mineralization

According to the existing geological reports, the occurrences of gold-bearing quartz veins are known in the following areas:

- Da Mai
- Gang
- Cay Thi
- Ngan Me
- Bai Vang

Gold-bearing quartz veins in the Da Mai area are hosted by sandstone, shale and sericite schist of the Mo Dong Formation. The width of veins ranges from a few centimeters to 1 m. The major trend of vein systems is E-W to ENE-WSW. Most of the veins dip steeply to S with some exceptions of the N-dip. Gold is generally accompanied by a small amount of sulfide minerals. Arsenopyrite and pyrite are the two most common sulfide minerals; chalcopyrite and covelline were occasionally found in a bonanza of gold. The vein quartz in the Da Mai area is characterized by grayish color. It is probably caused by the sulfide content. The host rock beside the vein is slightly altered. The major alteration minerals are quartz and sericite. Nine veins were found by the survey of GSV within the area, and they were named No. 1 to No. 9 Veins respectively. According to GSV data, the No. 1 Vein has the average width of 56 cm, and average grade of 12 g/t Au for example. The No. 8 Vein has the average width of 50 cm, and average grade of 31 g/t Au. A grade of 36 g/t Au at 90 cm was reported in some part of the vein (GSV, 1988). The strike length of each vein is said to be several hundred meters intermittently. The extension to the dipping is uncertain.

Gold-bearing quartz veins in the Gang area are hosted by sandstone, shale, sericite schist and black slate of the Mo Dong and Than Sa Formations. The width of veins ranges from about 10 cm to 1 m. The major trend of vein systems is E-W to WNW-ESE. Most of the veins dip gently to S. Veins of N-S and NE systems locally occur. This vein structure is concordant to the general trend of the

bedding of the host sediments in the Gang area. However, some veins crosscut the host bedding at a narrow angle. Gold is generally accompanied by some sulfide minerals. Pyrite and arsenopyrite are the two major sulfide minerals. Other sulfide minerals found under the microscope are: chalcopyrite, covelline, and pyrrhotite. The host rocks beside the vein are slightly altered. Silicification and sericitization are the major wall-rock alteration. Chloritization and kaolinization were locally observed. Two major veins were found by the survey of GSV within the area, and they were named G-1 and G-2 Veins respectively. One is located at a branch creek of S. Hoan (southern side), and another is located at another branch creek (northern side). According to the existing data, the G-1 Vein has the average width of 60 cm, and average grade of 16 g/t Au. The G-2 Vein has the average width of 35 cm, and average grade of 2 g/t Au. The strike length of each ore body was estimated to be several hundred meters intermittently. The extension to the dip side is about 20 m.

The Cay Thi deposit makes up of gold-bearing quartz veins hosted in black shale of the Cambrian Than Sa Formation. Pyrite is associated with the vein. The quartz vein occurs along the bedding plane of the host sediments which dip gently. The width of vein is narrow, commonly 3 to 5 cm, and occasionally 10 to 30 cm. In this area, gold ore is mined by local people some 300 m along S. Hoan. Gold-bearing quartz veins near the river are mined, and ores are processed in a small scale. In this area, alluvial gold is mined by local people everywhere along S. Hoan. Sand and gravel at the riverbed are mined down to 3 to 4 m deep, and ores are processed by a series of crashers and traditional blanket sluicing.

Gold-bearing quartz veins in the Ngan Me area are hosted mainly by sandstone, shale and phyllite of the Mo Dong Formation. The geology of the southwestern corner of the Ngan Me area consists of sandstone, phyllite and schist of the Than Sa Formation (lower member). The width of veins changes place to place from a few centimeters up to 2 m. Veins often show a lens-like shape. The main trend of vein systems is E-W to ENE-WSW. Two groups of veins - one is steeply dipping to S, and another is gently dipping to S - were distinguished. A small amount of pyrite was seen in some veins. A trace of arsenopyrite, pyrrhotite, chalcopyrite, covelline, sphalerite, galena was observed in some part of the veins.

Gold showings are also known along the upper reaches of Bai Vang which is located about 2 km due east of the Ngan Me area. The deposit is thought to be the extension of that in the Ngan Me area.

Chapter 4 Conclusions and Recommendations

4-1 Conclusions

On the basis of the results of the surveys for three years, the following conclusions are obtained.

4-1-1 Da Mai Area

(1) As a result of exploration for three years, significant gold mineralization which is represented by the distribution of extensive outcrops of quartz veins/networks and was outlined by the distribution of distinctive geochemical and geophysical anomalies has been surveyed in the Da Mai area. The type and conditions of gold mineralization in this area were discussed on the basis of petrology, mineralogy, hydrothermal alteration and fluid inclusion studies. It was interpreted that the gold mineralization was formed under mesothermal conditions. The gold-bearing quartz veins are hosted by sandstone and schist of the Cambrian Mo Dong Formation. The prospects are located near the crest of the Bo Cu anticline. This geological setting is probably a crucial factor for the formation of gold-bearing quartz veins.

(2) In the second and third phases, four holes totaling 1,200 m were drilled in the Da Mai-Khe Dui prospect in the Da Mai area. Several intersections of gold-bearing quartz veins were caught in these drill holes.

In MJVB-1, thirteen major groups of quartz veins were caught in total. Although native gold was observed in drill cores and slime of drilling at several depths in the field, no significant assay result was obtained.

In MJVB-2, thirteen major groups of quartz veins were intersected, and several significant intersections up to 56.640 g/t Au at 28 cm in width (51.24 – 51.52 m) were returned.

In MJVB-3, eight major groups of quartz veins were caught in total, and a few significant intersections up to 75.600 g/t Au at 35 cm in width (79.85 – 80.20 m) were obtained.

In MJVB-4, eight major groups of quartz veins were intersected. Although native gold was observed in drill cores and slime of drilling at some depths in the field, only one significant assay result (12.400 g/t Au at 45 cm in width, 60.15 – 60.60 m) was obtained.

Although ore bodies of something like a dimension of several hundred meters by several hundred meters in the length and in the depth with width of 1 to 2 meters, and several tens g/t Au in ore grade have been targeted in this area, the results of drilling was disappointing. The ore potentials were presumed to be less than what were expected.

4-1-2 Ngan Me Area

(1) As a result of exploration for three years, gold mineralization has been surveyed in the Ngan Me area. The type and conditions of gold mineralization in this area were discussed on the basis of petrology, mineralogy, hydrothermal alteration and fluid inclusion studies. It was interpreted that the gold mineralization was formed under mesothermal conditions similar in the Da Mai area. The gold-bearing quartz veins are hosted by sandstone and schist of the Cambrian Mo Dong and Tan Sa Formations. The prospects are located on the southwestern wing of the Bo Cu anticline. This geological setting is probably an essential factor for the formation of gold-bearing quartz veins.

(2) In the Ba Khe prospect in the Ngan Me area, two holes totaling 600 m were drilled in the third phase. The results were disappointing. No significant intersection of gold-bearing quartz veins was found in these drill holes, although the development of quartz veins was significant.

4-1-3 Gang Area

(1) As a result of exploration carried out in the first phase, gold mineralization which is represented by the distribution of extensive outcrops of quartz veins/networks and was outlined by the distribution of distinctive geochemical anomalies was surveyed in the Gang area. The type and conditions of gold mineralization in this area were discussed on the basis of petrology, mineralogy, hydrothermal alteration and fluid inclusion studies. It was interpreted that the gold mineralization was formed under mesothermal conditions similar in the Da Mai and Ngan Me areas. The gold-bearing quartz veins are hosted by sandstone and schist of the Cambrian Mo Dong and Tan Sa Formations. The prospects are located near the crest to the southwestern wing of the Bo Cu anticline. This geological setting is probably an important factor for the formation of gold-bearing quartz veins.

(2) Although no drilling exploration has been tried, the gold potential in the Gang area was estimated to be not large from the evidence of the surface showing of mineralization. It counted to be next to those of the Da Mai and Ngan Me areas.

4-2 Recommendations for the Future Exploration

Da Mai Area

Exploration for gold ores of a certain size and of high grade has been carried out for three years in the Da Mai area. Despite the occurrences of high-grade gold ores in some part of the quartz veins, the dimension seems to be small for our exploration target. Therefore, no further work is recommended in the Da Mai area.

Ngan Me Area

The results of exploration in the Ngan Me area were similar to those in the Da Mai area. Therefore, no further work is recommended in the Ngan Me area.

Gang Area

Judging from the surface showing of gold mineralization in the Gang area, the potential for gold looks to be smaller than those in the Da Mai and Ngan Me areas. Therefore, no further work is recommended in the Gang area.

PART II DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

Chapter 1 Regional Survey

1-1 Introduction

The Bo Cu area (regional survey area) is located about 70 km north of Hanoi. It is situated in an inland area. The area lies along the upper to middle reaches of Song Rong and Song Trung, both are branches of Song Cau. The altitude of the area is not high; most of the area is situated between 50 and 500 m above sea level.

The area lies geologically among the distribution of Paleozoic to Mesozoic clastic rocks and limestone. Tertiary rocks do not occur in the Bo Cu area. Quaternary sediments occur along some drainage systems in the southern part of the survey area. These strata show complex foldings and cut by faults forming an anticlinorium with NE-SW to ENE-WSW axes.

Based on the review of the existing geological information, together with the discussion held among Japanese and Vietnamese survey members at the beginning of the field survey, a preliminary geologic framework and stratigraphy were proposed, and regional geological survey was carried out in the first phase over the regional survey area. The survey covered over a rectangular area of 2,000 km^2. The field works for the regional survey area were composed of geological survey, stream sediment geochemical survey and panning survey. The major themes followed in the geological survey are: (1) to investigate the mineral potential -- mainly of basemetals and gold --, and (2) to prepare geologic map of 1:50,000 of the Bo Cu area.

1-2 Geological Survey

1-2-1 Survey Method

The first phase geological works in the Bo Cu area consisted of geological mapping and an investigating survey for the mineral potential.

Prior to the fieldwork, a series of topographic maps of 1:10,000 scale was prepared from the compilation of existing topographic maps (1:50,000 and 1:25,000) and satellite images. Several sets of GPS instruments were employed for locating major surveying points in the field.

During the fieldwork, geology, gold mineralization and alteration were surveyed, and samples for petrography, ore mineralogy and other laboratory studies were collected together with samples for assaying at every major outcrop and mineral showing. Features of mineralization and alteration such as silicification, kaolinization and sulfide impregnation were carefully checked in the survey.

Several significant mineralized localities were found during the field survey. The route maps of 1:10,000 scale were produced by these surveys. The important outcrops, mineral showings and old workings were studied in much detail (sketches of 1:50 to 1:200), and samples were taken for laboratory analysis.

A total length of more than 530 km was explored during the regional survey in the Bo Cu area, and the geological information was compiled into a geologic map of 1:50,000 scale. The geology, geologic profile and stratigraphy of the Bo Cu area are shown in Figs. 1-5 and 1-6.

The numbers of samples collected in the survey are: 40 altered rock and clay samples for X-ray diffraction analysis, 31 rock samples for thin sections, 20 igneous rock samples for whole rock analysis, 11 quartz vein samples for fluid inclusion study and 103 ore samples for assaying (Au, Ag, Cu, Pb, Zn, As and Hg) and polished sections. The results of laboratory works and assaying are briefly summarized in Tables 2-1-1 to 2-1-4.

1-2-2 Stratigraphy

The geology of the Bo Cu area is composed of the following six major stratigraphic units:

- Cambrian sedimentary rocks and schist with some limestone (Mo Dong Formation and Than Sa Formation)
- Ordovician sedimentary rocks and schist (Na Mo Formation)
- Devonian sedimentary rocks and schist with some limestone (Bac Bun Formation, Mia Le Formation and Na Quan Formation)
- Carboniferous to Permian limestone with some clastic rocks (Bac Son Formation and Dong Dang Formation)
- Triassic sedimentary rocks with interbedded acidic volcanic rocks (Lang Son Formation, Song Hiem Formation, Na Khuat Formation, Mau Son Formation and Van Lang Formation)
- Quaternary sediments

The general trends of these formations are ENE-WSW, E-W and WNW-ESE with local disorders. They form a series of foldings with the axes of NE-SW, ENE-WSW or WNW-ESE direction. These sedimentary-metamorphic formations are cut by numerous fault systems whose major trends are NW-SE, N-S and NE-SW. Small intrusive bodies of granite occur locally in these formations. Based upon the photogeological analysis on the JERS-1 OPS and SAR images, the geologic structure of the Bo Cu area is characterized by the development of lineaments trending NE-SW to ENE-WSW direction.

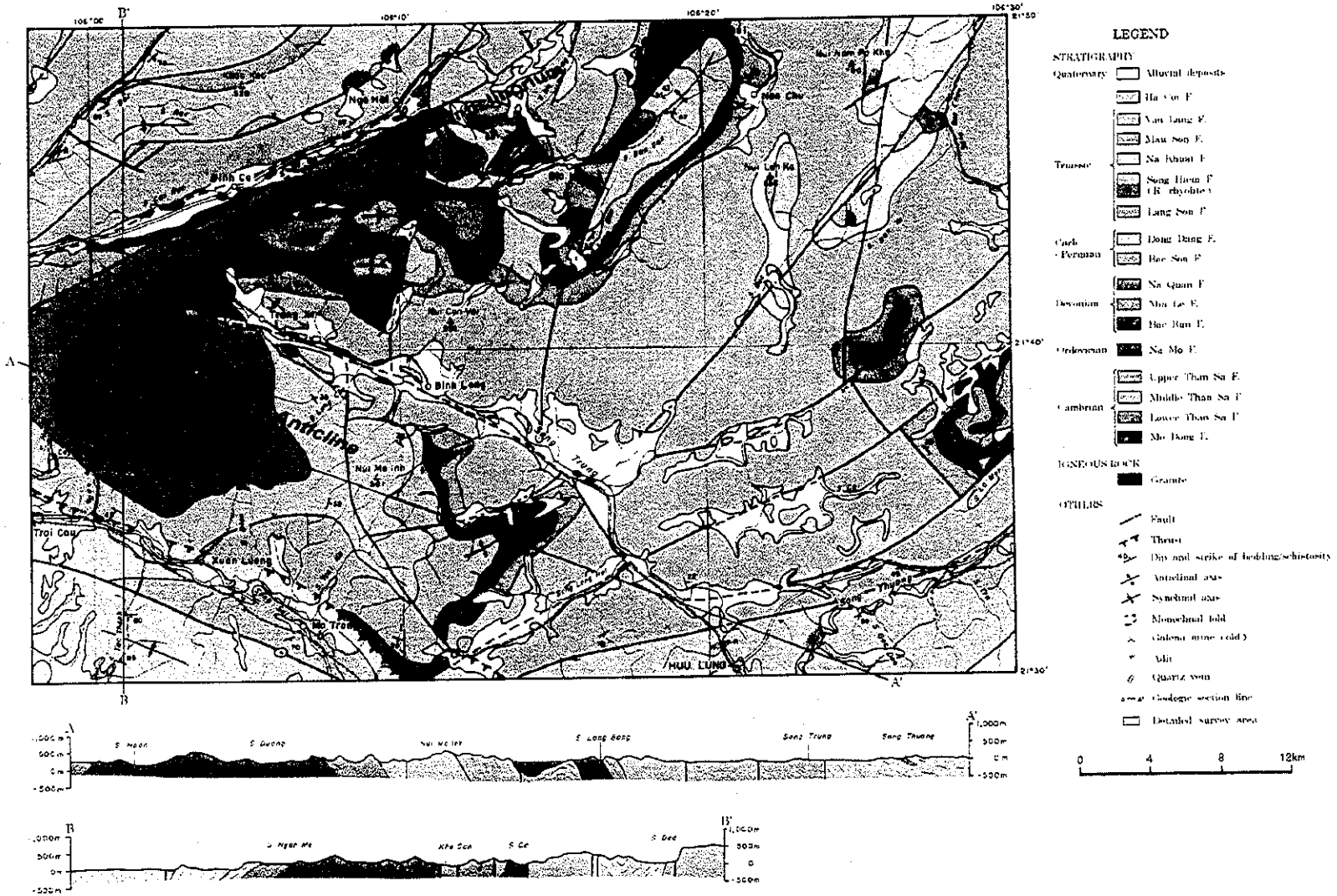

Fig. 1-5 Geology and Geologic Profile of the Bo Cu Area

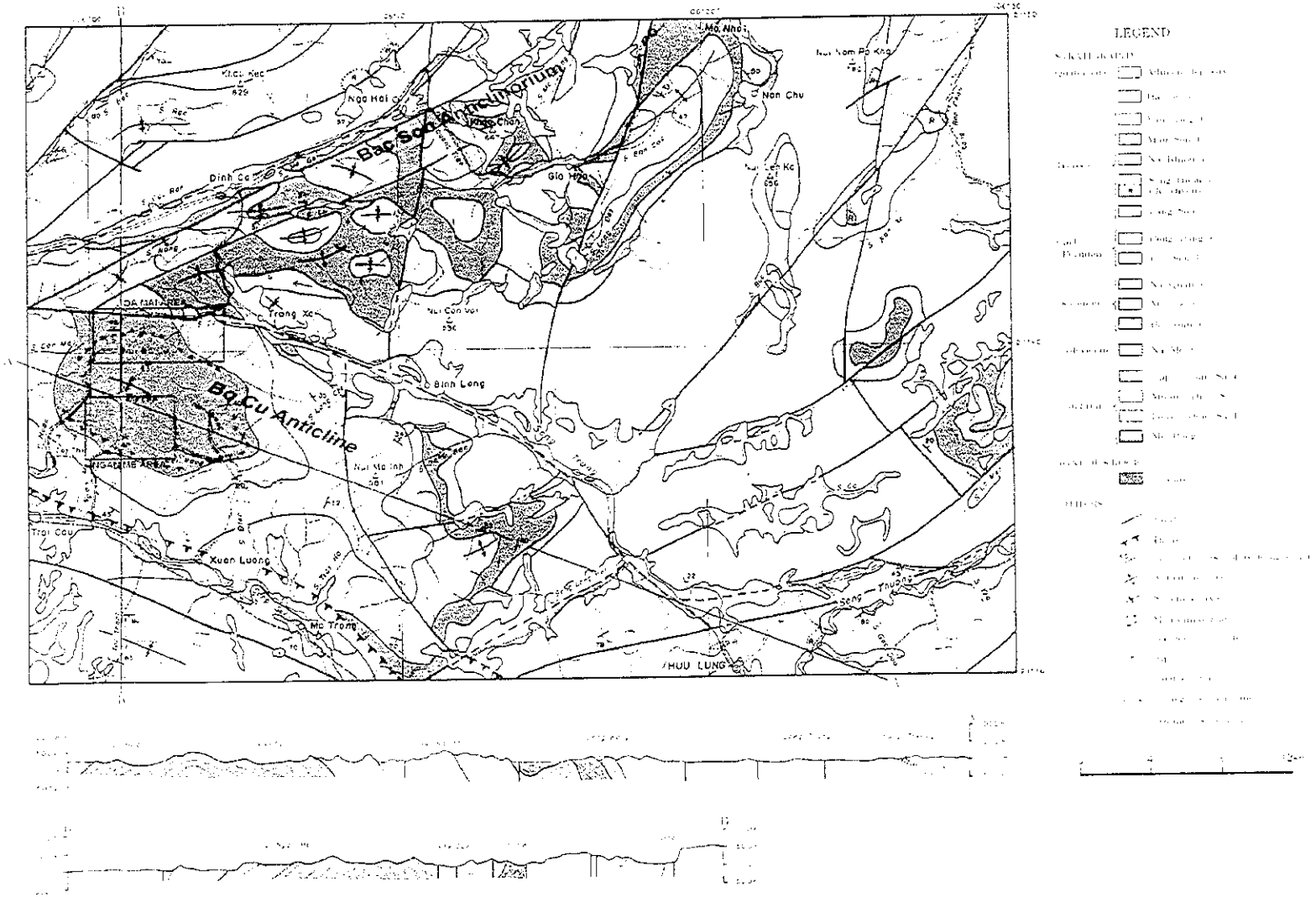

Fig. 1-5 Geology and Geologic Profile of the Bo Cu Area

Group	System	Series	Formation		Mark	Column	Thick-ness (m)	Lithology
CENO-ZOIC	Quater-nary				Q			boulder, gravel, sand, silt, clay
MESO-ZOIC	Triassic	Upper	Van Lang		$T_{3n\text{-}rvl2}$		300	sandstone, claystone, conglomerate
			Mau Son		T_{3cms1}		500	sandstone, claystone, conglomerate
		Lower - Middle	Na Khuat		T_{2nk}		700-1,150	claystone, sandstone, siltstone, limestone
			Song Hiem		$T_{1\text{-}2sh}$		1,300-1,500	rhyolite, tuff, tuffaceous sandstone, sandstone, siltstone, schist, conglomerate
			Lang Son		T_{1ls}		300-450	phyllitic sandstone, sandstone, siltstone, limestone, chalky clay
PALEO-ZOIC	Carb-Permian		Dong Dang		P_{2dd}		200	massive limestone, siliceous limestone, marly limestone, claystone
			Bac Son		$C\text{-}P_{bs}$		700-900	massive limestone, dolomitic limestone, oolitic limestone, crystalline limestone, siliceous limestone, marly limestone
	Devoni-an	Midd-le	Na Quan		D_{2nq}		200-300	crystalline limestone, siliceous limestone
		Lower	Mia Le		D_{1ml}		300-500	marly limestone, chalky claystone, psammitic schist
			Bac Bun		D_{1bb}		300	sandstone, quartzitic sandstone, psammitic schist, violet-red schist/ claystone, limestone, conglomerate
	Ordo-vician		Na Mo		O_{nm}		250	quartzitic sandstone, psammitic schist, slate, phyllite
	Cambrian		Than Sa	Upper	C_{3ts3}		>150	sandstone, quartzitic sandstone, violet schist, conglomerate
				Middle	C_{3ts2}		200-500	sandstone, quartzitic sandstone, schist, marly limestone, chalky clay
				Lower	C_{3ts1}		500-600	dark-gray/violet schist, psammitic schist, sandstone, conglomerate
			Mo Dong		C_{md}		>300	sandstone, quartzitic sandstone, psammitic schist, sericite schist

Fig. 1-6 Stratigraphic Column of the Bo Cu Area

Table 2-1-1 Summary of Microscopic Observation of Thin Sections (1)

Sample No.	Locality	Rock Name	Formation	Texture	Phenocryst/Crystal Fragment									Groundmas/Matrix						Alteration & Remarks
					Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
	Regional Area																			
A006T	S. Mo Ga	Arkose Sandstone	D1bb	Clas	●	·	△						·							
A084T	Ban Chau	Rhyolite	T1-2sh	Porp	△		○						·	△		△				Pl → Ch·Ep
A178T	S. Tra	Rhyolite	T1-2sh	Porp	·		△						·	△		○				Pl → Ch
A211T	S. Trung	Rhyolite	T1-2sh	Porp	△	·	○	·					·	△		○				Pl → Se, Bi → Ch
A212T	S. Trung	Tuff	T1-2sh	Pycl	△	·	·						·	●		△			·	Pl → Ch·Se
A252T	Ba Khe	Sandstone	Cmd	Clas	●		·						·							Subfeldspathic Arenite
B004T	Nui Bo Con	Sandstone	Cmd	Clas	●		△													Feldspathic Arenite
B011T	S. Khuyei	Sandstone	C3ts	Clas	●		·													Subfeldspathic Arenite
C008T	Cue Duong	Rhyolite	T1-2sh	Porp	△	·	○	·						△		○				Pl·Bi → Ch
C009T	Cue Duong	Rhyolite	T1-2sh	Porp	·	·	○							△		○				Pl → Ch·Se·Ep
C011T	Cue Duong	Rhyolite	T1-2sh	Porp	△	·	○	·						△		○				Pl·Bi → Ch
C019T	Luong Naung	Rhyolite	T1-2sh	Porp	△	·	△					·	·	△		○				Pl → Ch·Ep
C020T	Luong Naung	Rhyolite	T1-2sh	Porp	△	△	△	·				·	·	△		○				Pl·Kf → Ch·Ka, Bi → Ch
C021T	Huu Le	Rhyolite	T1-2sh	Porp	△	·	△					·	·	△		●				Pl → Se·Ep, Kf → Se
C023T	Mo Nhai	Granite	T-Cg	Hypd-gr	○	●	△	·												Weakly cataclastic
C025T	Mo Nhai	Granite	T-Cg	Hypd-gr	●	●	△	·					·							Weakly cataclastic
C026T	Mo Nhai	Quartz-rich Granite	T-Cg	Hypd-gr	●		△													Qz recrystalized
C028T	Mo Nhai	Barite	--	--																Barite crystal with Se·Qz
C056T	S. Dien	Shale	C3ts	Clas																Composed of Qz,clay,Se,Ch
D056T	S. Dao	Psammitic Schist	D1ml	Clas·Comp	●		·													Qz-vein intersected
D125T	Ho Tam Hoa	Granite	T-Cg	Hypd-gr	●	○	○	·												Pl → Se, Weakly cataclastic
D126T	Deo Keo Gan	Granite	T-Cg	Hypd-gr	●	○	○	·												Pl → Se, Weakly cataclastic
D127T	Deo Keo Gan	Granite	T-Cg	Hypd-gr	●	○	●	·												Pl → Se, Weakly cataclastic
D181T	Nga Hai	Rhyolite	T1-2sh	Porp	△	·	○	·					·	○		●				Pl → Se
D183T	Ban It	Rhyolite	T1-2sh	Porp	●	·	●	·						△		○				Pl → Se
D185T	Ban It	Sericite Schist	C-Pbs	Clas·Comp																Composed of Se,Ch,Ca,clay
D360T	S. Hoan	Altered Sandstone	Cmd	Clas	●															Altered into Se
D395T	Cay Tri	Claystone	C3ts	Clas	○															Mainly composed of clay,Se
D401T	Ngan Me	Psammitic Schist	Cmd	Clas·Comp	●		·	·												
D454T	Da Mai	Sericite Schist	Cmd	Clas·Comp																Mainly composed of Se,clay
D461T	Da Mai	Psammitic Schist	Cmd	Clas·Comp	●		●													

Abundance of Minerals: ●;Abundant, ○;Common, △;Rare, ·;Trace

Formation Names : Cmd;Mo Dong, C3ts1;Than Sa Lower, Onm;Na Mo, D1bb;Bac Bun, D1ml;Mia Le, D2nq;Na Quan, C-Pbs;Bac Son, P2dd;Dong Dang, T1ls;Lang Son, T1-2sh;Song Hiem, T2nk;Na Khuat, T-Cg;Granite Intrusive

Textures : Pycl;Pyroclastic, Clas;Clastic, Porp;Porphyritic, Lepb;Lepidoblastic, Glom-gr;Glomerophyric granular, Hypd-gr;Hypidiomorphic granular, Ophi;Ophitic, Int-gr;Inter-granular, Hol-pp;Holocrystalline-porphyritic, Comp;Compressed, Gran;Granular

Minerals : Qz;Quartz, Kf;Potash Feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates, Ms;Muscovite

Table 2-1-1 Summary of Microscopic Observation of Thin Sections (2)

Sample No.	Locality	Rock Name	Formation	Texture	Phenocryst/Crystal Fragment									Groundmas/Matrix						Alteration & Remarks
					Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
	Da Mai Area																			
A003T	Da Luon	Schist	Cmd	Lepb	△								·							Mainly composed of clay,Se,Ch
A022T	Khe Thuon	Schist	Cmd	Lepb	·								·							Mainly composed of clay,Se,Ch
A041T	Lang Vang	Qz Vein	--	--	●								·							Some Se
A062T	Dong Cao	Dolomite	Cmd	Gran	△								·							Mainly composed of dolomite,Ca
A075T	Khuon Da	Limestone	C3ts1	Gran	·								·							Mainly composed of Ca
A078T	Khuon Da	Schist	C3ts1	Lepb	○								△							Mainly composed of Qz,clay,Se,Ch
A094T	Khe Cuc Tac	Schist	Cmd	Clas	△		·						·							Mainly composed of clay,Se,Ch
A105T	Khe Cuc Tac	Shale	Cmd	Clas	△								△							Mainly composed of clay,Se,Ch
B007T	Khe Dui	Schist	Cmd	Clas	△								·							Mainly composed of clay,Se,Ch
B016T	Khe Dui	Qz Vein (White)	--	--	●								·							Some Se,Ms,Ca
B018T	Khe Dui	Qz Vein (White)	--	--	●								·							Some Se,Ch,Ms
B029T	Khe Ma	Sandstone	Cmd	Clas	○		·						·							Mainly composed of Qz,Ca,Ms,Se,Ch
B070T	S. Hoan	Sandstone	C3ts1	Clas	●		△						·							Mainly composed of Qz,Se,Ch
B077T	S. Hoan	Schist	Cmd	Lepb	△								·							Mainly composed of clay,Se,Ch
	Ngan Me Area																			
A119T	S. Ho Mai	Schist	Cmd	Lepb	△		·						·							Mainly composed of Se,Ch
A149T	S. Na Hon	Schist	C3ts1	Lepb	·								·							Mainly composed of Se,Ch
A208T	Khe Can	Quartzitic Sandstone	Cmd	Clas	●		·						·							Mainly composed of Qz,clay,Se,Ch
B098T	Ba Khe	Qz Vein (White/L-gray)	--	--	●								·							Some Se,Ch,Ca,clay
B104T	Ba Khe	Qz Vein (White/L-gray)	--	--	●								·							Some Se,Ms
B123T	Ba Khe	Quartzitic Sandstone	Cmd	Clas	●		·	·					·							Mainly composed of Qz,clay,Se,Ch
B172T	Khe Cam	Schist	Cmd	Clas	●		△						·							Mainly composed of Qz,Se,Ch

Abundance of Minerals: ● ;Abundant, ○ ;Common, △ ;Rare, · ;Trace

Formation Names : Cmd;Mo Dong, C3ts1;Than Sa Lower, Onm;Na Mo, D1bb;Bac Bun, D1ml;Mia Le, D2nq;Na Quan, C-Pbs;Bac Son, P2dd;Dong Dang, T1ls;Lang Son, T1-2sh;Song Hiem, T2nk;Na Khuat, T-Cg;Granite Intrusive

Textures : Pycl;Pyroclastic, Clas;Clastic, Porp;Porphyritic, Lepb;Lepidoblastic, Glom-gr;Glomerophyric granular, Hypd-gr;Hypidiomorphic granular, Ophi;Ophitic, Int-gr;Inter-granular, Hol-pp;Holocrystalline-porphyritic, Comp;Compressed, Gran;Granular

Minerals : Qz;Quartz, Kf;Potash Feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates, Ms;Muscovite

Table 2-1-1 Summary of Microscopic Observation of Thin Sections (3)

Sample No.	Depth	Rock Name	Formation	Texture	Phenocryst/Crystal Fragment									Groundmas/Matrix						Alteration & Remarks
					Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
	MJVB-1																			
105T	97.48 m	Qz Vein (White)	--	--	●		·						·							Some Ca, Ch, Se
108T	104.05 m	Black Schist	Cmd	Lepb	○		△						·							Mainly composed of clay,Se,Ch
118T	136.75 m	Qz Vein (White)	--	--	●		·						·							Some Ca, Ch, Se
120T	150.05 m	Quartzitic Sandstone	Cmd	Clas	●		·						·							Mainly composed of Ms,Se,Ch,Ca
122T	155.45 m	Qz Vein (L-gray)	--	--	●		·						·							Some Ca
123T	250.05 m	Black Schist	Cmd	Lepb	○		△						·							Mainly composed of clay,Se,Ch
	MJVB-2																			
202T	77.15 m	Qz Vein (L-gray)	--	--	●		·						·							Some Se,clay,Ch,Ca
209T	137.63 m	Qz Vein (White/L-gray)	--	--	●		·						·							Some Se,clay,Ch
214T	149.58 m	Qz Vein (L-gray)	--	--	●		·						·							Some Se,clay,Ch,Ca
218T	159.30 m	Qz Vein (White/L-gray)	--	--	●		·						·							Some Se,Ch,Ca,clay
	MJVB-3																			
304T	75.48 m	Alt SS/Schist	Cmd	Clas	○		△						·							Mainly composed of Ch,Se,clay
306T	80.03 m	Qz-Cal Vein (White/L-gray)	--	--	○		·						·							Some Se,clay,Ch,Ca
309T	105.08 m	Alt SS/Schist	Cmd	Clas	●		·						·							Mainly composed of Se,clay,Ch
317T	200.08 m	Alt SS/Schist	Cmd	Lepb	○		△						·							Mainly composed of clay,Se,Ch
324T	275.18 m	Gray SS	Cmd	Clas	○		△						·							Mainly composed of Se,clay,Ch
	MJVB-4																			
406T	100.08 m	Black Schis	Cmd	Clas	△		·						·							Mainly composed of Se,caly,Ch
410T	116.81 m	Qz-Cal Vein (White)	--	--	○		·						·							Some Se,clay,Ch,Ca
420T	148.59 m	Qz-Cal Vein (White)	--	--	○		·						·							Some Ca,Se
427T	200.18 m	Black Schist	Cmd	Clas	△		·						·							Mainly composed of Ch,clay,Se
	MJVB-5																			
505T	75.05 m	Black Schist	C3ts1	Clas	△		·						·							Mainly composed of Se,clay,Ch
509T	110.59 m	Qz Vein (L-gray)	--	--	●		·						·							Some Se,Ch
511T	142.35 m	Qz Vein (White/L-gray)	--	--	○		·						·							Some Se, Ch, Ca
515T	150.18 m	Gray Psammite	C3ts1	Clas	●		·						·							Mainly composed Se,Ch
522T	275.20 m	Gray Psammite/Schist	C3ts1	Clas	△		·						·							Mainly composed of clay,Se,Ch
	MJVB-6																			
617T	54.80 m	Qz Vein (L-gray)	--	--	●		·						·							Some Se
621T	96.48 m	Qz Vein (L-gray)	--	--	●		·						·							Some Ch
622T	108.28 m	Qz Vein (L-gray)	--	--	△		·		△				·							Some clay,Se
623T	150.15 m	Gray Psammite	Cmd	Clas	△		·						·							Mainly composed of Se,Ch
626T	187.33 m	Qz Vein (White)	--	--	●		·						·							Some Se,Ch,Ca
630T	280.01 m	Qz Vein (L-gray)	--	--	○		·						·							Some Se,Ch

Abundance of Minerals: ● ;Abundant, ○ ;Common, △ ;Rare, · ;Trace

Formation Names : Cmd;Mo Dong, C3ts1;Than Sa Lower, Onm;Na Mo, D1bb;Bac Bun, D1ml;Mia Le, D2nq;Na Quan, C-Pbs;Bac Son, P2dd;Dong Dang, T1ls;Lang Son, T1-2sh;Song Hiem, T2nk;Na Khuat, T-Cg;Granite Intrusive

Textures : Pycl;Pyroclastic, Clas;Clastic, Porp;Porphyritic, Lepb;Lepidoblastic, Glom-gr;Glomerophyric granular, Hypd-gr;Hypidiomorphic granular, Ophi;Ophitic, Int-gr;Inter-granular, Hol-pp;Holocrystalline-porphyritic, Comp;Compressed, Gran;Granular

Minerals : Qz;Quartz, Kf;Potash Feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates, Ms;Muscovite

Table 2-1-2 Summary of X-Ray Diffraction Analysis (1)

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals							Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneos Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Dl	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
	Regional Area																																	
B002X	Phyllite near Qz vein	Cmd	Da Mai			△																	◎	・									
B003X	Silicified sandstone	Cmd	Da Mai			○																	○	△									
B013X	Silicified sandstone	Cmd	Da Mai	・		△																	△				△	○					
B018X	Black slate	C-Pbs	Tan Lap																				◎										
B019X	Slate, Gn disseminated	C-Pbs	Tan Lap																△										△	◎			
B027X	Graphite schist	Cmd	S. Tram			△													△	△			○										
B028X	Schist	Cmd	S. Tram			△																	◎			△							
D371X	HW (sheared Sch) of Qz lens	C3ts	Khe Hoac			△																	◎	・									
D372X	Qz lens in sheared zone		Khe Hoac			・																	◎										
D373X	FW (sheared Sch) of Qz lens	C3ts	Khe Hoac			△																	◎	△									
D378X	Qz vein		Khe Hoac			△																	○	△									
D379X	Shear zone with Qz lens		Khe Gang			△																	○	△									
D382X	Qz vein		Khe Gang		△	△																	△	△									
D383X	Qz vein		Khe Gang			△																	◎										
D384X	FW of Qz vein	Cmd	Khe Gang			△		△															△	△									
D385X	Qz lens		Khe Gang			△																	△	△									
D386X	Qz vein		Khe Gang		△	△																	○	△									
D388X	HW (sheared Sch) of Qz vein	Cmd	Khe Gang		・	△																	△	△									
D389X	Qz vein		Khe Gang			△																	◎	・									
D390X	FW (sheared Sch) of Qz vein	Cmd	Khe Gang			△																	◎	・									
D393X	Qz vein + sheared Sch		Cay Thi			△		△															◎	△									
D394X	Qz vein + sheared Sch		Cay Thi			△		△															△	△									
D399X	Qz		Cay Thi																△											・	・		
D405X	Sheared SS with Qz lens		Ngan Me		△	△																	◎	△									
D407X	Qz vein		Ngan Me		△	△																	◎	△									
D412X	Qz vein		Ngan Me		△	△																	◎										
D414X	Qz vein		Ngan Me			△		△															◎	・									
D416X	HW (shaeared Sch) of Qz vein	Cmd	Ngan Me		△	△																	△	△									
D417X	Qz vein		Ngan Me		△	△																	○	△									
D418X	FW (Sch) of Qz vein	Cmd	Ngan Me		△	△																	△	△									
D423X	Qz vein		Ngan Me			△																	◎										
D426X	Qz vein		Ngan Me																				◎			△							
D446X	HW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																	◎	△									
D447X	FW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																	△	△				△					
D451X	HW (sheared Sch) of Qz vein	Cmd	Khe Dui			△																	○	△				・					
D453X	Qz		Da Mai		△	△																	◎										
D457X	HW (SS) of Qz vein	Cmd	Da Mai			△																	◎	△									
D458X	FW (SS) of Qz vein	Cmd	Da Mai			△																	△	・									
D459X	FW (sheared claystone) of Qz	Cmd	Da Mai			△																	○	△									

Abundance of Minerals : ◎;Abundant, ○;Common, △;Few, ・;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Pr;Pyrophyllite, Mx;Mixed-Layer Mineral, Ha;Halloysite, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, An;Analcime, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Dl;Dolomite, Si;Siderite, Cr;α -Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagio -clase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Sp;Sphalerite, Gn;Galena, Ep;Epidote, Rd;Rhodochrosite, Ho;Hornblende, At;Anatase
HW;Hanging Wall, FW;Footwall, Sch;Schist, SS;Sandstone (Formation Name is explained in Fig. 1-6)

Table 2-1-2 Summary of X-Ray Diffraction Analysis (2)

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneos Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
	Da Mai Area																																	
A002X	Qz vein	--	Da Luon		△	○																		◎	○									
A005X	Qz vein	--	Da Luon		△	△																		◎	·									
A009X	Qz vein	--	Da Luon			○																		◎	△									
A011X	Qz vein	--	Da Luon		·	·																		◎	·									
A016X	Qz vein	--	Gac Ba		·	△																		◎	△									
A017X	Qz vein	--	Gac Ba			△		·																◎	·		·?							
A034X	Qz vein	--	Lang Vang		○	△																		◎	·									
A035X	HW (altered Sch) of Qz vein	Cmd	Lang Vang		○	○																		○	△		·							
A057X	Sch in altered zone	Cmd	Dong Cao		○	○																		◎	○									
A067X	Sch	C3ts1	Khuon Da		·	○																		○	△		·							
A091X	Qz vein	--	Cuc Tac			△		·																◎	·		·?							
A094X	Altered zone near Qz vein	Cmd	Cuc Tac		△	○																		○	△									
B010X	Qz vein	--	Khe Dui		·	△														·				◎	△									
B011X	Qz vein	--	Khe Dui			·																		◎	△									
B012X	Qz vein	--	Khe Dui			△		·																◎	△									
B013X	Qz vein	--	Khe Dui			·																		◎	·									
B014X	Qz vein	--	Khe Dui		·	○																		◎	△		·							
B015X	Qz vein	--	Khe Dui	·?	·	○																		◎	△	·								
B016X	Qz vein	--	Khe Dui		△	○																		○	△	△								
B017X	Altered zone near Qz vein	Cmd	Khe Dui		○	○																		○	△									
B018X	HW (altered Sch) of Qz vein	Cmd	Khe Dui		△	·																		◎	·									
B056X	Qz vein	--	Dong Cao		△	·																		◎	·		·							
B084X	Sch near Qz vein	Cmd	S. Hoan			△		·?																◎	·									

Abundance of Minerals : ◎;Abundant, ○;Common, △;Few, · ;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Pr;Pyrophyllite, Mx;Mixed-Layer Mineral, Ha;Halloysite, Cp;Clinoptiolite, Md;Mordenite, Lm;Laumontite, An;Analcime, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;α -Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagio -clase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Sp;Sphalerite, Gn;Galena, Ep;Epidote, Rd;Rhodochrosite, Ho;Hornblende, At;Anatase HW;Hanging Wall, FW;Footwall, Sch;Schist, SS;Sandstone

Table 2-1-2 Summary of X-Ray Diffraction Analysis (3)

Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites				S-Salts			Carbonates			Silicates			Fldsp		Miscellaneous Minerals								
				Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	An	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Sp	Gn	Ep	Rd	Ho	At
	Ngan Me Area																																	
A123X	Qz vein	--	Ho Mai		·	△																		◎	·									
A143X	Sch near Qz vein	C3ts1	Na Hon			·																		◎	·									
A144X	HW (sandstone) of Qz vein	C3ts1	Na Hon			·																		◎		·								
A148X	HW (sandstone) of Qz vein	C3ts1	Na Hon		·	·		·											·?					◎	·	·		·						
A151X	Qz vein	--	Na Hon			△		·?																◎	·		·							
A156X	Qz vein	--	S. Ngan Me			·																		◎	·	·?								
A158X	Sandstone	C3ts1	S. Ngan Me			○		·																○	△			·						
A165X	Altered zone with Qz veinlets	Cmd	Khe Chuoi			·																		◎		·								
A166X	Qz vein	--	Khe Chuoi			·																		◎	·	·		·						
A167X	Qz vein	--	Khe Chuoi			·																		◎	·									
B096X	Altered sandstone with Qz vein	Cmd	Ba Khe		△														·					◎	△		·							
B098X	Qz vein	--	Ba Khe		·	·																		◎	·									
B104X	Qz vein	--	Ba Khe	·?		·																		◎	·		·							
B110X	Qz vein and HW sandstone	Cmd	Ba Khe			·																		◎		·								
B117X	Qz vein	--	Ba Khe			·																		◎	·									
B123X	Qz vein	--	Ba Khe			·																		◎	·									
B126X	Qz vein	--	Ba Khe			·																		◎	·									
B127X	Qz vein	--	Ba Khe		·	○																		◎	·		△				?			

Abundance of Minerals : ◎;Abundant, ○;Common, △;Few, · ;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Pr;Pyrophyllite, Mx;Mixed-Layer Mineral, Ha;Halloysite, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, An;Analcime, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;α -Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagio -clase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Sp;Sphalerite, Gn;Galena, Ep;Epidote, Rd;Rhodochrosite, Ho;Hornblende, At;Anatase
HW;Hanging Wall, FW;Footwall, Sch;Schist, SS;Sandstone