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

PHASE II

FEBRUARY 1998

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 Second Phase of the Cooperative Mineral Exploration consists of geological survey, geochemical survey, geophysical survey and drilling exploration for gold resources in the Bo Cu area. The Japanese survey team consisting of two geologists, three geophysicists and a drilling engineer were sent to the survey area during the period of September 15 to December 31, 1997. They worked successfully with the Vietnamese survey team.

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 1998

Kimio FUJITA
President
Japan International
Cooperation Agency

Hiroaki HIYAMA
President
Metal Mining Agency of
Japan

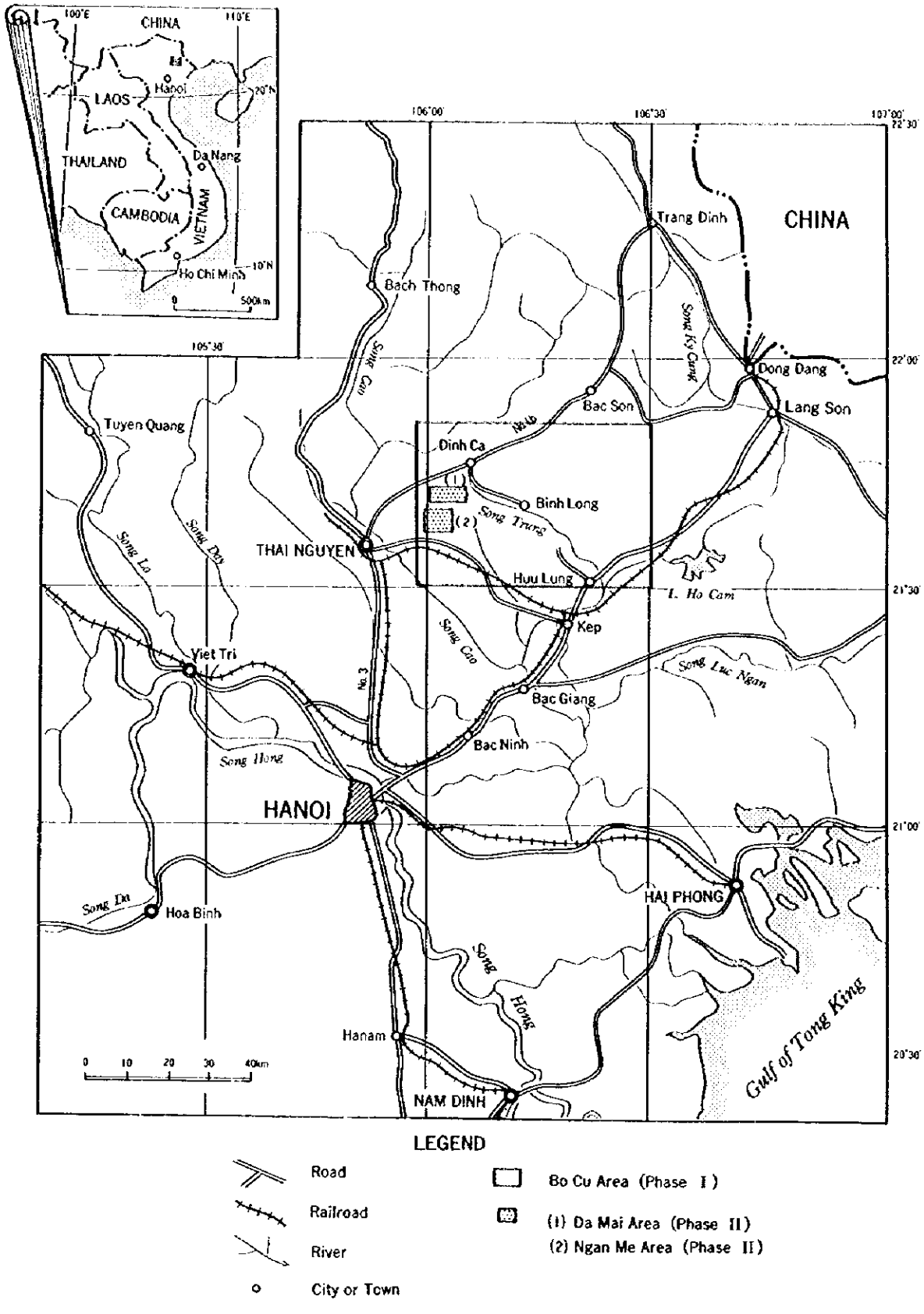


Fig. 1-1 Index Map of the Survey Area

SUMMARY

The survey this year corresponds to the second phase of the Cooperative Mineral Exploration 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. The works this phase were composed of the detailed geological survey, rock-chip geochemical survey, geophysical survey (IP method) and reconnaissance drilling 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 this phase. 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.

The distribution of three stratigraphic units from the Cambrian to the Quaternary systems consisting of five formations was surveyed and the geologic maps of 1:10,000 scale were prepared in the Da Mai and Ngan Me areas by the detailed geological survey this phase. Geostructurally, the survey areas where gold-bearing quartz veins are extensively developed are situated within the Bo Cu anticline whose axis orientates in the direction of WNW-ESE. The veins occur on the crest and northern and southern wings of the Bo Cu anticline, and it is interpreted that the formation of veins is controlled structurally by the regional folding activity started probably from the Triassic period.

Gold-bearing quartz veins occur extensively in both the Da Mai and Ngan Me areas. Although the width of each vein is not magnificent, they sometimes occur together forming a vein zone of several tens to a few hundred meters wide and 500-1,500 m long. The system of quartz veins and nature of gold mineralization were investigated by the detailed geological survey. On the basis of the results of studies on geologic environment, ore and gangue mineralogy, alteration, chemical analysis and fluid inclusion, it is concluded that the type of mineralization is the mesothermal gold vein hosted by sedimentary and metamorphic rocks of the Cambrian Mo Dong and Than Sa Formations. Two vein systems were distinguished by means of the stereo net analysis. One is E-W trend with dips of gentle to steep S, and another is E-W with dips of gentle N. According to the detailed geological survey together with the results of geochemical exploration, two areas for gold-bearing quartz veins have been examined, and potential for each area was evaluated. It is not likely to occur a big scale deposit in this area when seeing from the relative narrow and discontinuous nature of quartz veins as well as the scale and intensity of geochemical anomalies. Within two areas, Da Mai-Khe Dui and Ba Khe are promising prospects for medium to small size high-grade gold resources.

The IP geophysical survey was carried out in order to investigate the relationships between

chargeability/resistivity and alteration and extract these anomalies related to mineralization in the Da Mai and Ngan Me areas. As a result of the geophysical survey, strong chargeability anomaly, weak chargeability anomaly and high resistivity anomaly were extracted and discussed. Strong chargeability anomaly was interpreted to be connected with the distribution of quartz veins containing a considerable amount of sulfide minerals and relatively broad anomaly zones were extracted in the Da Mai and Ngan Me areas. It was expected by the weak chargeability anomaly zone in the Da Mai area that quartz veins containing a small amount of sulfide minerals were distributed. The drilling exploration confirmed it.

The reconnaissance drilling was carried out in the Da Mai area. The target zone was selected based on the results of the detailed geological survey, rock-chip geochemical survey and IP survey. However, the most significant anomalies of both geochemistry and IP geophysics have not been tested this phase due to the restriction of road construction schedule. Two holes totaling 600 m were drilled in the Da Mai-Khe Dui prospect. Many significant intersections of gold-bearing quartz veins were caught in these reconnaissance drill holes.

The drill hole MJVB-1 is located at the upper reaches of Da Mai creek. It targeted to the lower extension of the central part of the Group A veins. In this hole, 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.

The drill hole MJVB-2 is located at the upper reaches of West Da Mai creek. It targeted to the lower extension of the western part of the Group C veins. In this hole, 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

On the basis of the results of the detailed survey this phase in which two areas for gold-bearing quartz veins have been examined and potential for each area was evaluated, several significant gold prospects were delineated. Among these prospects, Da Mai-Khe Dui and Ba Khe are believed to be promising prospects for gold resources.

CONTENTS

CONTENTS

PART I OVERVIEW

PART II DETAILED DISCUSSIONS

PART III CONCLUSIONS AND RECOMMENDATIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

APPENDICES

PLATES

PART I OVERVIEW

PART I OVERVIEW

Chapter 1 Introduction

1-1 Background and Objective

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 survey of this year was the second phase of the Cooperative Mineral Exploration in the Bo Cu area, the Socialist Republic of Vietnam.

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. It is 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 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 survey). 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.

The program this year was composed of the detailed geological survey, rock-chip geochemical survey, IP geophysical survey and drilling exploration in two areas -- (1) Da Mai area, and (2) Ngan Me area. The major purpose of this phase was to define target zones for the further

exploration within the survey area. Exploration efforts were concentrated on the prospective areas which were extracted in the first phase survey. It was also required for the further exploration to elucidate the nature and characteristics of gold mineralization in the Bo Cu area.

1-2 Conclusions and Recommendations of the First Phase Survey

1-2-1 Conclusions of the First Phase Survey

Based on the results of the first phase works comprising regional geological survey, stream sediment geochemical survey, panning survey, semi-detailed geological survey and CSAMT geophysical survey, the following conclusions were obtained.

(1) Regional Geology and Geologic Structure

The distribution of six major stratigraphic units from the Cambrian to the Quaternary systems consisting of 14 formations was surveyed and the geologic map of 1:50,000 scale was prepared in the Bo Cu area by the regional geological survey this phase. Geostructurally, the survey area is characterized by a series of anticlines and synclines called Bac Son anticlinorium whose axes orientate from NE, ENE to WNW. The Bo Cu anticline, whose axis trends WNW-ESE, was defined in the western part of the survey area where gold mineralization was extensively developed. Three major fault systems were distinguished in the survey area: NW, N-S, and NE systems. The main orogenic activity which resulted in the regional folding and tectonic faults in the Bo Cu area was interpreted to be occurred in the Triassic or later period. Small stocks of granite were found at the northern part of the survey area. The nature of this granite was discussed on the basis of the whole rock analysis. It was concluded that this granite belonged to the granitoids of the magnetite series and of the S-type intruded at the marginal zone of the South China plate.

(2) Galena Mineralization

Regarding metallic mineral deposits in the Bo Cu area, two significant mineralizations, gold-bearing quartz veins and galena veins, were recognized. The galena veins occur mostly in the Carboniferous-Permian limestone. Several galena showings were found in the course of the regional geological survey and geochemical exploration. Some of them contain a significant amount of lead and silver. The similarity of geology and mineralization was discussed with the galena deposit in the Cho Dien area which was a famous Pb-Zn district in the northern Vietnam. The potential of galena resources was estimated to be small from the survey results. As for the other mineral resources, a sedimentary phosphorite seam and a couple of magnetite lenses, both were considered to be small for that type of deposit, were known within the survey area.

(3) Gold Mineralization

Gold-bearing quartz veins occur extensively in the western part of the Bo Cu area. Although the width of each vein is not magnificent, they sometimes occur together forming a vein zone of 100 - 300 m wide and 500 - 1,000 m long. The system of quartz veins and the nature of gold mineralization were investigated by the detailed geological survey. Based on the results of studies such as geologic environment, ore and gangue mineralogy, alteration, chemical analysis and fluid inclusion, it was interpreted that the type of mineralization was mesothermal gold vein hosted by sedimentary and metamorphic rocks of the Cambrian Mo Dong and Than Sa Formations. Two vein systems were distinguished by means of the stereo net analysis. One was N80°E with steeply dipping S, and another was E-W with gently dipping S. The veins occur on the wing of the Bo Cu anticline, and it was interpreted that the formation of veins was controlled structurally by the regional folding activity started probably from the Triassic period. According to the detailed geological survey together with the results of geochemical exploration, three areas for gold-bearing quartz veins have been examined, and potential for each area was preliminary evaluated. It is not likely to occur a big scale deposit in this area when seeing from the relative narrow and low grade quartz veins as well as the scale and intensity of geochemical anomalies. Among three areas and their extensions, Da Mai-Khe Dui and Ba Khe are promising prospects for gold resources.

(4) Geophysical Survey

The resistivity of the survey areas is high as a whole. The resistivity structure matches with the geologic structure. Especially, the Da Mai area has higher resistivity than the other areas and the high resistivity areas suggesting the distribution of granite were detected broadly below about 300m from the surface. With reference to the mineralized zone, the high resistivity zones resulting from the group of quartz veins more than 100m in width were extracted. The known prospects related to these zones and their features were as follows:

Da Mai area

- •Nos.7 and 8 on lines D-3 to D-5 (Da Mai, extension to deep zone, steep dip)
- •Southern part of lines D-7 to D-9 (Goc Sen, extension to deep zone, steep dip)

Gang Area

- •Southern part of lines G-5 to G-7 (Khe Gang, shallow zone, gentle dip)
- •Middle part of lines G-3 to G-4 (Khe Gang, shallow zone, gentle dip)
- •Northern part of lines G-4 to G-7 (no known prospects in the vicinity, shallow zone, gentle dip)

Ngan Me area

- •Southern part of line N-5 (Ba Khe, extension to deep zone and east, steep dip)
- •Middle part of line N-2 (Ba Khe, shallow zone)

The results of laboratory tests gave an obvious contrast between the quartz vein containing pyrite and the other rocks in the survey areas. IP method is available for the high resistivity zones extracted by this survey in order to delineate prospective parts, because these zones seem to contain few amount of graphite.

(5) Da Mai-Khe Dui Prospect (Da Mai Area)

The distribution of gold mineralization in the Da Mai-Khe Dui prospect is approximately 200-300 m wide and more than 1 km long. Gold-bearing quartz veins in the Da Mai-Khe Dui prospect are characterized by the vein trend of steeply dipping S. A significant amount of sulfide minerals is contained in the vein. Assay results by the GSV survey were significant this prospect. The mining activity by local people there is already at the waning stage. High grade ores near the surface were nearly mined out. However it still has significant gold resources in the deeper part and the extensions. The gold mineralization was expected to extend to the east through the Northeast of N. Bo Cu until Khe Ma gold anomalous zones for approximately 5 km. Remarkable Au anomalies of stream sediments and some gold anomalies of pan concentrates were found in the Northeast of N. Bo Cu and Khe Ma this phase.

(6) Ba Khe Prospect (Ngan Me Area)

The Ba Khe prospect in the Ngan Me area was understood to be another target for the further exploration. Adits and inclined shafts are distributed for about 900 m along the creek. Two systems of veins, E-W with steeply dipping S and E-W with gently dipping S, occur together in this prospect. The width of veins changes variously; some part shows a lens-like shape. Branching and joining of veins were frequently observed. Although assay results of ore samples were rather disappointing this time, the visible gold occasionally occurs in some part of quartz veins. The activities of local miners are limited above the ground water level. The gold mineralization is likely to extend both westwards to the West Ba Khe creek and eastwards to the Bai Vang gold anomalous zone for approximately 3.5 km. In Bai Vang, a couple of significant Au anomalies in stream sediments and tens of gold anomalies of pan concentrates were detected this phase.

(7) Other Prospects

The Cay Thi and its surrounding zone in the Gang area also have some potential for gold resources. Two zones of veins both are gently dipping S occur in this prospect. These two zones run parallel each other at 40 m apart vertically. Several significant assay results were obtained this phase. The other interesting gold prospects in the Gang area were Khe Gang and Khe Hoac. Gold-bearing quartz veins in these prospects showed similar trend and nature as in the Cay Thi prospect.

1-2-2 Recommendations for the Second Phase Survey

Da Mai-Khe Dui Prospect (Da Mai Area)

It was recommended that the detailed survey comprising IP survey and geological survey (including trenching and geochemical rock-chip survey) should be made in this prospect and its eastern extension for the purpose of defining the drill target. After the detailed survey, a reconnaissance drilling for testing the IP anomalies should be made.

Ba Khe Prospect (Ngan Me Area)

A detailed survey comprising IP survey and geological survey (including trenching and geochemical rock-chip survey) was recommended in the Ba Khe prospect and its extensions in the next phase. The purpose of this survey would be to define the drill target for the further exploration.

1-3 Outline of the Second Phase Survey

1-3-1 Survey Area

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

1-3-2 Exploration Theme

The work this phase corresponded to the second phase survey in the Bo Cu area, and was composed of the detailed geological survey, rock-chip geochemical survey, IP geophysical survey and drilling exploration in the Da Mai and Ngan Me areas.

The major themes of geological survey and rock-chip geochemical survey were to survey mineral showings in the prospects, to catch geochemical anomalies, and to define target mineralization for the further exploration by means of the detailed investigation on geology and mineralization in two areas. The potential of mesothermal gold deposits was searched in the areas.

The major exploration themes of geophysical survey were to analyze the relationship between mineralization and geophysical properties and to catch geophysical anomalies in the survey

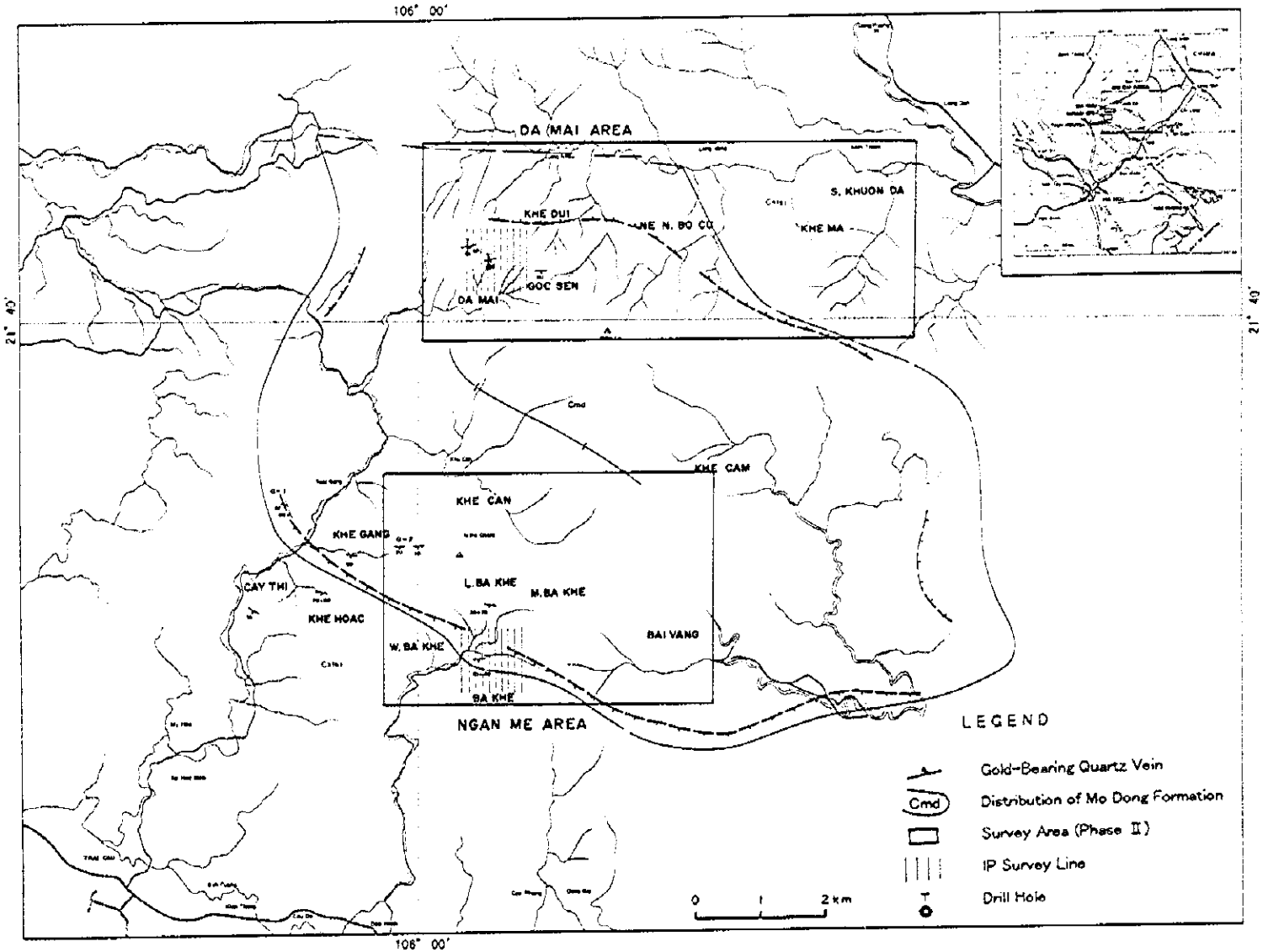


Fig. 1-2 Map Showing the Area of the Second Phase Survey

areas. The IP geophysical survey was tested for extracting the IP anomalies (both apparent resistivity and chargeability) which were expected to be related to the mesothermal gold mineralization in the survey areas.

The main theme of drilling exploration this phase was to test the lower parts of the mineralized zones which were delineated by geological, geochemical and geophysical surveys.

1-3-3 Exploration Work

The field work this phase was composed of the detailed geological survey, rock-chip geochemical survey, IP geophysical survey, and reconnaissance drilling. It consists of approximately 40 km^2 in total area. The drilling was carried out in the Da Mai area this phase.

A series of 1:5,000 scale route maps were be produced through surveying with fifty-meter tape and a Brunton-type compass. The results of the geological survey were compiled on 1:10,000 scale maps.

Geological survey and rock-chip (mainly quartz vein outcrops) sampling were made along major drainage systems at a sampling interval of approximately 3 pieces per 800 m length.

A survey length of more than 80 km was traversed, and more than 300 rock-chip samples were collected altogether in this phase.

IP geophysical survey was carried out in the Da Mai and Ngan Me areas using time-domain induced polarization method. Total line length and the number of lines were 20 km and 20 lines respectively.

The configuration of electrode was dipole-dipole array. The spacing of potential electrode was 50 m horizontally, and the electrode separation index was n=1, 2, 3, 4, 5. Resistivity and chargeability of selected rock and ore samples were measured in the laboratory in Japan. The same method as the field measurement was used.

Sections and plan maps of apparent resistivity and chargeability were made just after the completion of field survey. The interpretation of these results was compared with the results of geological and geochemical surveys. Integrated analysis was made through results of field work and laboratory test with full use of available data. The two-dimensional model inversion technique was applied for the typical anomalous pseudo-section of resistivity and chargeability.

A couple of the lower extensions of the surface showings of mesothermal gold mineralization was tested by diamond drilling. The target zones were selected on the basis of the results of geological, geochemical, and IP geophysical surveys. The program consisted of two inclined holes of diamond drilling totaling 600 m. The minimum size of core was NQ. Drill logs were prepared at a scale of 1:200. A total of more than 50 assay samples was obtained from drill cores.

The amount of samples for chemical analysis and laboratory work is listed in the following table:

Chemical Analysis & Lab Work	Amount of Samples
Geological Survey & Geochemical Exploration	
Thin Sections	21 pcs
Polished Sections of Ore	30 pcs
X-Ray Diffraction Analysis	41 pcs
Fluid Inclusion Study (Homogenization Temperature)	30 pcs
Fluid Inclusion Study (Salinity)	5 pcs
Chemical Analysis	
a) Rock-Chips (Au,Ag,Cu,Pb,Zn,As,Sb,Hg)	314 pcs
b) Ores (Au,Ag,Cu,Pb,Zn,Fe)	70 pcs
Geophysical Survey (IP)	
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 Temperature)	10 pcs
Fluid Inclusion Study (Salinity)	2 pcs
Chemical Analysis	
a) Ores (Au,Ag,Cu,Pb,Zn,Fe)	53 pcs

1-3-4 Survey Team

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	Coordinater 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	(INTERDEO) 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

*Note: DGMV; Department of Geology and Minerals of Vietnam
DGMV-NE; North-Eastern Geological Division, DGMV
INTERGEO; INTERDEO 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 Bo Cu Area

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-

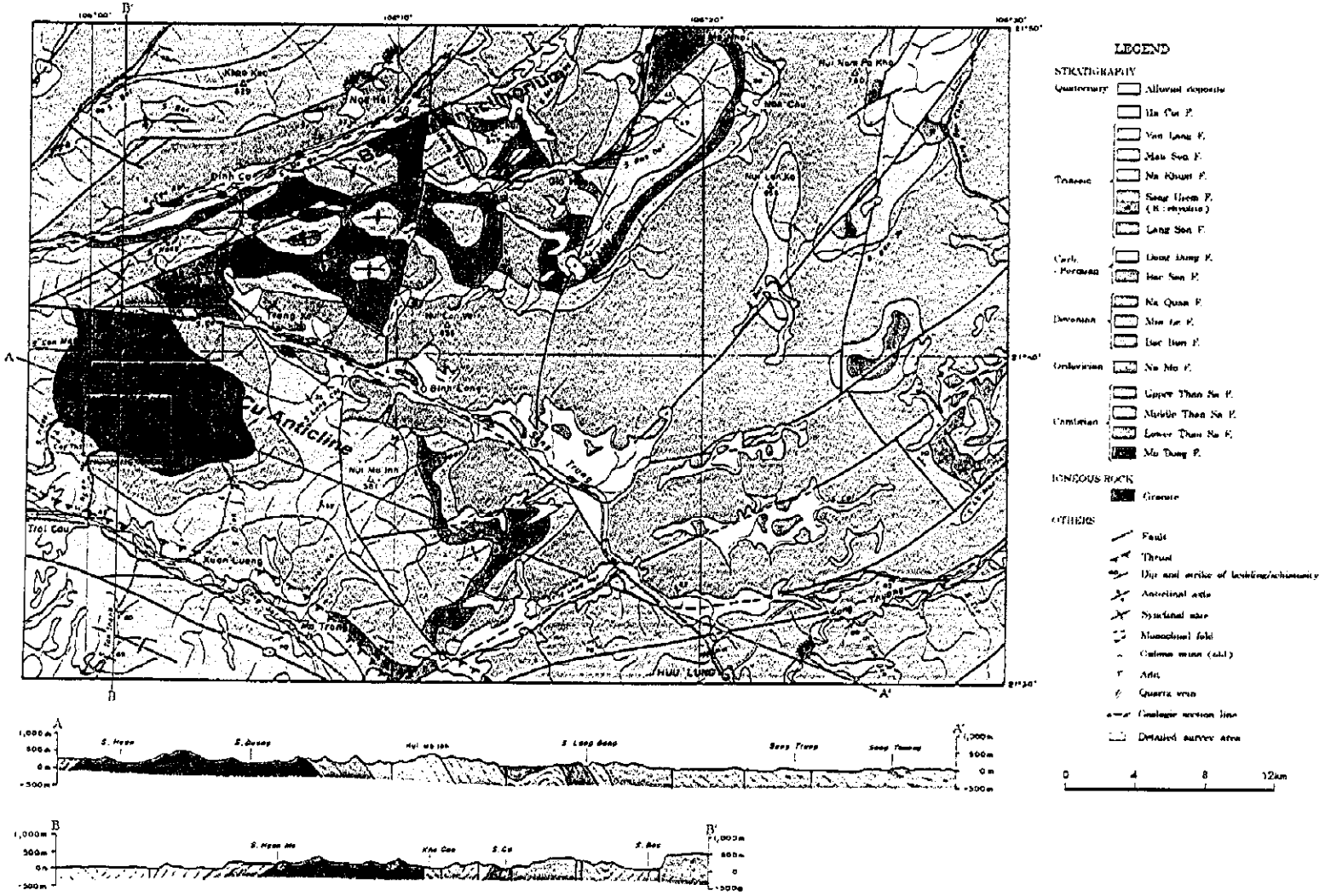


Fig. 1-3 Geology and Geologic Profile of the Bo Cu Area

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
			Than Sa Middle	C_{3ts2}		200-500	sandstone, quartzitic sandstone, schist, marly limestone, chalky clay
			Than Sa 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. 1-4 Stratigraphic Column of the Bo Cu Area

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. 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 Vein 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. 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 Vein respectively. One is located at one 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. 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 Discussion on the Results of the Second Phase Survey

4-1 Geology, Geologic Structure and Mineralization

The geology of the Bo Cu area consists of sedimentary and metamorphic rocks of Cambrian, Ordovician, and Devonian to Jurassic systems. Acidic volcanics occur in the lower-middle Triassic system. The major part of these geologic units exhibits the NE, ENE and WNW directions which represent the characteristics of the regional geologic structure, and forms a complex folding structure. The Bo Cu area is cut into many blocks by tectonic faults. Intrusive of a large-scale igneous complex was not found in this area; only small stocks of granite occur within and in the vicinity of the Bo Cu area. The Bo Cu area is structurally characterized by a series of anticlines and synclines named Bac Son anticlinorium comprising Bo Cu anticline, Bac Son anticline and Trang Xa-Nhat The syncline. The major directions of these folding axes are NE to ENE in the northwestern to the eastern part. Whereas in the southwestern part of the area, there is a distinctive anticlinal structure whose axis trends WNW. Most of gold-bearing quartz veins occur at the crest and on the wing of this anticline. The main orogenic activity in the Bo Cu area was interpreted to be occurred in the Triassic or later period. The formation of the Bo Cu anticline, the formation of regional tectonic faults and acid volcanic activity in the Triassic Song Hiem Formation unanimously indicate the importance of this period.

The occurrence of gold-bearing quartz veins is characterized structurally by the spatial closeness to the Bo Cu anticline. Two promising areas for mesothermal gold deposits were extracted through the survey in the first phase within the Bo Cu area, and the detailed survey was carried out in this phase.

Concerning the geological settings and vein structure, each area shows its characteristic feature.

The Da Mai area is located on the northern wing of the Bo Cu anticline. The veins were divided into two groups in their trends: (1) E-W system with dips of steep S, and (2) E-W system with dips of gentle N. Although the basic trends are like these, there are small varieties in the prospects. In the Da Mai-Khe Dui prospect, the most remarkable trend is E-W with 53°S, and next is E-W with 40°N. It changes slightly to the east in the NE of N. Bo Cu prospect, where there are trends of E-W with 73°S and E-W with 20°N. In the Khe Ma-S. Khuon Da prospect which is situated in the most eastern part of the Da Mai area, veins of the E-W trend with dips of steep S become obscure; veins of N-dip are distinct (ENE-WSW with 52°N).

The Ngan Me area is situated from the central to the southern wing of the Bo Cu anticline. The vein systems mainly show E-W trend with dips of gentle and steep S. They also change slightly from prospect to prospect. In the Ba Khe and Middle Ba Khe-Left Ba Khe prospects, veins of E-W trend with moderately S-dips are common. In the Bai Vang prospect which lies to the east of the Ba Khe prospect, veins of E-W trend with steep S-dips become common. In the Khe Can and Khe Cam

prospects, both are situated near the crest of the Bo Cu anticline, E-W to ENE-WSW trends with dips of gentle S are dominant.

Gold-bearing quartz veins were thought to be formed in fissures of tensional nature. Shear structure is not developed along the veins. Quartz veins in the Bo Cu area are not large but rather small. They sometimes show a lens-like shape. Swelling in width with rapid shrinking and branching were frequently observed. Another characteristic feature of veins in this area is their mode of occurrence. They form groups. Swarm of veins occurs in a narrow zone generally extending in the E-W direction.

Gold occurs mainly as free native gold in quartz vein in this area. This is the main reason why the gold grade exhibits a very erratic nature. Gold grade tends to be higher in a part where is relatively rich in sulfide minerals. Two most common sulfide minerals thought to be related to the gold mineralization are: pyrite and arsenopyrite.

Silicification, chloritization, sericitization and carbonitization were frequently observed in and around quartz veins. Quartz veins of a certain size always accompany strong silicification, chloritization and sericitization. Two kinds of quartz veins were distinguished: white quartz veins and gray to light gray quartz veins. In veins which were composed mainly of white quartz, intensive chloritization and sericitization were recognized. In veins composed of gray quartz together with a small amount of white quartz, sericitization was slightly weaker than in white quartz veins, and chloritization was significantly weaker than in white quartz veins. Carbonate minerals such as calcite and ankerite were found mainly in gray quartz; therefore, gray quartz veins sometimes contain a significant amount of carbonate minerals.

The mineralization in two survey areas has its characteristic feature.

In the Da Mai area, some veins are relatively rich in sulfide minerals. Veins which contain a significant amount of sulfide minerals are those in Khe Dui and in Khe Khuon Phung in the Da Mai-Khe Dui prospect. Sulfide minerals identified in the Da Mai-Khe Dui area are: pyrite, arsenopyrite, pyrrholite, chalcopyrite, covelline, chalcocite, tetrahedrite, enargite, sphalerite, galena, scorodite, and limonite. Native gold of up to 0.3 mm in diameter was found in some samples from Khe Dui. Native gold frequently occurs as free gold in quartz veins. It also occurs in a form accompanied by sulfide minerals such as arsenopyrite and scorodite. Ag/Au ratio in samples is generally low in this area. The average Ag/Au ratio calculated from the analytical results of both ore and rock-chip samples is about 1. Alteration around quartz veins is not so strong in the Da Mai area. Host rocks of several centimeters to a few meters from veins were altered. Alteration observed in this area is: silicification, chloritization, sericitization, and carbonitization. Results of fluid inclusion studies revealed that the formation temperature of quartz varied in a broad range: from low to medium temperature up to significantly high temperature (over 370 °C). The salinity of fluid inclusions indicated that the ore fluid was relatively thick in NaCl content (up to 8 %). Polyphase inclusions were identified frequently in quartz. Halite was observed as solid crystals in such inclusions.

In the Ngan Me area, most of the veins are relatively poor in sulfide minerals. Veins which contain a significant amount of sulfide minerals are those in Ba Khe and in Na Hon in the Ba Khe prospect. Sulfide minerals observed in the Da Mai-Khe Dui area are: pyrite, arsenopyrite, pyrrhotite, chalcopyrite, covelline, sphalerite, galena, and limonite. Ag is slightly high in samples this area. The average Ag/Au ratio calculated from analytical results of both ore and rock-chip samples is around 4. Alteration around quartz veins is not so strong in the Ngan Me area. Host rocks of several centimeters to a few meters from veins were altered. Alteration observed in this area is: silicification, chloritization, sericitization, and carbonitization. Results of fluid inclusion studies were not so different from in the Da Mai area. They showed that the formation temperature of quartz varied in a broad range (164 to 350 °C), only slightly narrower than in the Da Mai area. The salinity of fluid inclusions showed moderately thick in NaCl content (about 5 %). Polyphase inclusions were identified in quartz.

The gold-bearing quartz veins in the detailed survey area are understood to belong to the mesothermal gold deposit. This matter has been confirmed according to the following evidences:

(1) Geologic environment that the veins are hosted mainly by sedimentary and metamorphic rocks of the Cambrian system.

(2) Gangue minerals of veins (consisting of quartz and some calcite).

(3) Ore mineral assemblage (particularly, arsenopyrite, pyrite, chalcopyrite and galena are intimately accompanied).

(4) The occurrence of pyrrhotite and bornite (found in the first phase survey) which probably indicates comparatively high temperature-type deposit.

(5) Alteration features (mainly composed of silicification, sericitization and chloritization).

(6) Significantly low Ag/Au ratio (=1 to 4 averaging of ore and rock-chip samples).

(7) High homogenization temperature and comparatively high salinity of fluid inclusions.

Gold-bearing quartz veins occur near the crest and on the wing of the Bo Cu anticline. The formation of these veins was probably controlled by the folding activity. According to the results of the stereo net analysis, two vein systems -- E-W with S-dip, and E-W with N-dip -- were distinguished. The details of conditions such as the stress-strain field and tectonic environments are not clear. Further studies are required. Results of mineralogical and fluid inclusion studies indicate that the ore forming fluid may be generated (not all but at least) partly from magmatic water probably originated from magmatic intrusions. There is a possibility about the existence of a granite body in the deep near the crest of the Bo Cu anticline.

Two areas show their own features in the vein trend, mineral assemblage and fluid inclusion property. Da Mai area: occurring two groups of vein trends in the same area -- E-W trends with dips of steep S and with dips of gentle N, relatively rich in sulfide minerals, fluid inclusions of broad variation with comparatively high homogenization temperature and fine size; Ngan Me area: veins of

E-W trend with dips of gentle to steep S, relatively poor in sulfide minerals, higher Ag/Au ratio than in the Da Mai area, slightly narrower and lower homogenization temperature of fluid inclusions.

These varieties are understood to be originated from the difference of the conditions of their formation. The spatial relation with the heat source -- probably somehow related to the granitic intrusion -- is considered to be one of the main factor concerned.

The place of the mineralization in this area was presumed within a marginal part of the South China plate according to the results of the regional geological survey in the first phase. It was suggested that the gold mineralization in this area belonged to the category of the continental-type gold deposit.

4-2 Geochemistry

Rock-chip geochemical survey was carried out for the purpose of defining hidden mineralized zones which would otherwise be undetected by geological survey, as well as for clarifying the extensions of mineral occurrences encountered through the geological traverse. Samples of quartz veins and altered rocks were collected from every outcrop and some pits/trenches in the survey area. The results of ore assays were examined together with the geochemical results. Several significant anomalous zones were outlined through the rock-chip geochemical survey. The major anomalous zones thus defined are: Da Mai-Khe Dui, Northeast of N. Bo Cu and Khe Ma-Khuon Da prospects in the Da Mai area, Ba Khe, Middle Ba Khe-Left Ba Khe, Bai Vang and Khe Can prospects in the Ngan Me area. Among these localities, intensive Au anomalies were found at (1) Da Mai-Khe Dui-West Da Mai zone in the Da Mai area, and (2) Ba Khe-West Ba Khe-Na Hon zone in the Ngan Me area. These two zones are also characterized by the co-occurrence of anomalies of various basemetal elements, especially Pb and As.

The correspondence of basemetal elements to Au is very well both in the Da Mai and Ngan Me areas. Generally, they occur in a concentrated form at some small areas. As shown above, the best association with Au was observed in As. Next was in Pb. The other elements also showed some significant correspondence to Au.

Each zone has a specific feature in the intensity and assemblage of anomalous elements. In the Da Mai-Khe Dui-West Da Mai zone, Au anomalies occur very intensively. It was recognized particularly in the level of Au. Within this zone, West Da Mai is characterized by the occurrence of Cu anomalies. Whereas, Khe Dui is characterized by the occurrence of Pb anomalies. Da Mai is rather monotonous; only weak As anomalies were detected together with Au anomalies. In the Ba Khe-Na Hon-West Ba Khe zone, As anomalies, very intense ones, occur almost all over the zone. Weak Hg anomalies and strong Fe association were found in this zone. These characteristic features can be explained by the mineral assemblage of gold-bearing quartz veins. Anomalies of Au and some base metals (especially Pb and As) corresponded markedly to the intensive mineralized zones such as Da Mai-Khe Dui-West Da Mai and Ba Khe-Na Hon-West Ba Khe.

4-3 Geophysics

In these areas, the geophysical survey results gave the followings to the IP anomalies extracted in a zone where quartz veins are distributed.

- •Strong chargeability anomaly
- •Weak chargeability anomaly
- •High resistivity anomaly

Strong chargeability anomaly is highly related to a distribution of quartz veins and connected with a distribution of quartz veins containing a considerable amount of sulfide minerals. Weak chargeability anomaly is expected that quarts veins containing a small amount of sulfide minerals are distributed, in case where the chargeability of the host rocks is low. High resistivity anomaly may be expected that a large group of quartz veins is distributed. The locations and features of the above anomaly zones extracted in the Da Mai and Ngan Me area, and the relation to the known prospects are as follows.

1) Da Mai area

Strong Chargeability Anomaly

- •Northern part of lines D-IP-8 to D-IP-10

This anomaly zone has a WNW-ESE direction and is composed of two parallel anomalies. It tends to further continue to the east of the survey area and extend to the deeper zone. It seems to reflects the prospect around Khe Dui stream. It suggests that the prospect around the Khe Dui stream contains a large amount of sulfide minerals and continue to the east.

Weak Chargeability Anomaly

- •Central part of the survey area

This anomaly zone has a WNW-ESE. However, it tends not to extend to the deeper zone. It seems to be attributed to the prospect around the Da Mai stream. In this year, the drilling exploration was carried out in the western part of this anomaly zone and caught the groups of quartz veins containing a small amount of sulfide minerals. This result is matched with the geophysical survey results.

2) Ngan Me area

Strong Chargeability Anomaly

•Southern part of lines N-IP-2 to N-IP-9

This anomaly zone is the broadest in the Ngan Me area. It includes high chargeability more than 40 mV/V in lines N-IP-1 to N-IP-2 and lines N-IP-8 to N-IP-9. It has a E-W direction, and tends to incline to the south and disappear in the deep zone below SL 50m. It seems to be attributed to groups of quartz veins containing a large amount of sulfide minerals in the Ba Khe prospect around the Na Hon stream. It shifts slightly toward the south of the known quartz veins

•Central part of lines N-IP-1 to N-IP-2.

This anomaly zone is the second broadest in this area and includes high chargeability more than 40 mV/V. It tends not to extend in the deep zone below SL 0m. It seems to be attributed to groups of quartz veins containing a large amount of sulfide minerals in the Ba Khe prospect around the Ba Khe stream. The known quartz veins are distributed around this anomaly zone.

•Northeastern part of the survey area

Small scale anomaly zones are scattered. It seems to be attributed to groups of quartz veins containing a large amount of sulfide minerals in the Middle Ba Khe - Left Ba Khe prospect.

High Resistivity Anomaly

Broad high resistivity anomaly zones are distributed in the ridge parts located a little to the south of the survey area. They are distributed up to 50 m from the surface in depth. Their distributions could not conform to those of the known quartz veins.

4-4 Potential of Mineral Resources

Potentials of gold ore deposits were investigated in the first phase survey, and the following ideas were obtained: The type of mineralization is mesothermal gold-bearing quartz veins hosted by the Cambrian Mo Dong and Than Sa Formations; The veins occur on the wing of the Bo Cu anticline; The formation of veins is controlled structurally by the regional folding activity; The development of quartz veins is relatively intense; Geochemical anomalies occur densely; Remarkable chargeability anomalies of the IP geophysics occur; The size and magnitude of gold mineralization are estimated to be medium or small from the features of mineral showings and geochemical/geophysical anomalies.

In the second phase, the detailed survey comprising geological survey, rock-chip geochemical survey, IP geophysical survey and reconnaissance drilling were carried out in two areas selected by the first phase survey.

In the Da Mai-Khe Dui prospect, two holes totaling 600 m were drilled. Many significant intersections of gold-bearing quartz veins were caught in these reconnaissance 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 were returned as follows: 56.640 g/t Au and 9.0 g/t Ag (51.24 – 51.52 m), 1.880 g/t Au and 2.0 g/t Ag (137.38 – 137.87 m), 1.020 g/t Au (181.00 – 181.11 m), 10.815 g/t Au (181.22 – 181.32 m), and 1.400 g/t Au (256.67 – 256.79 m).

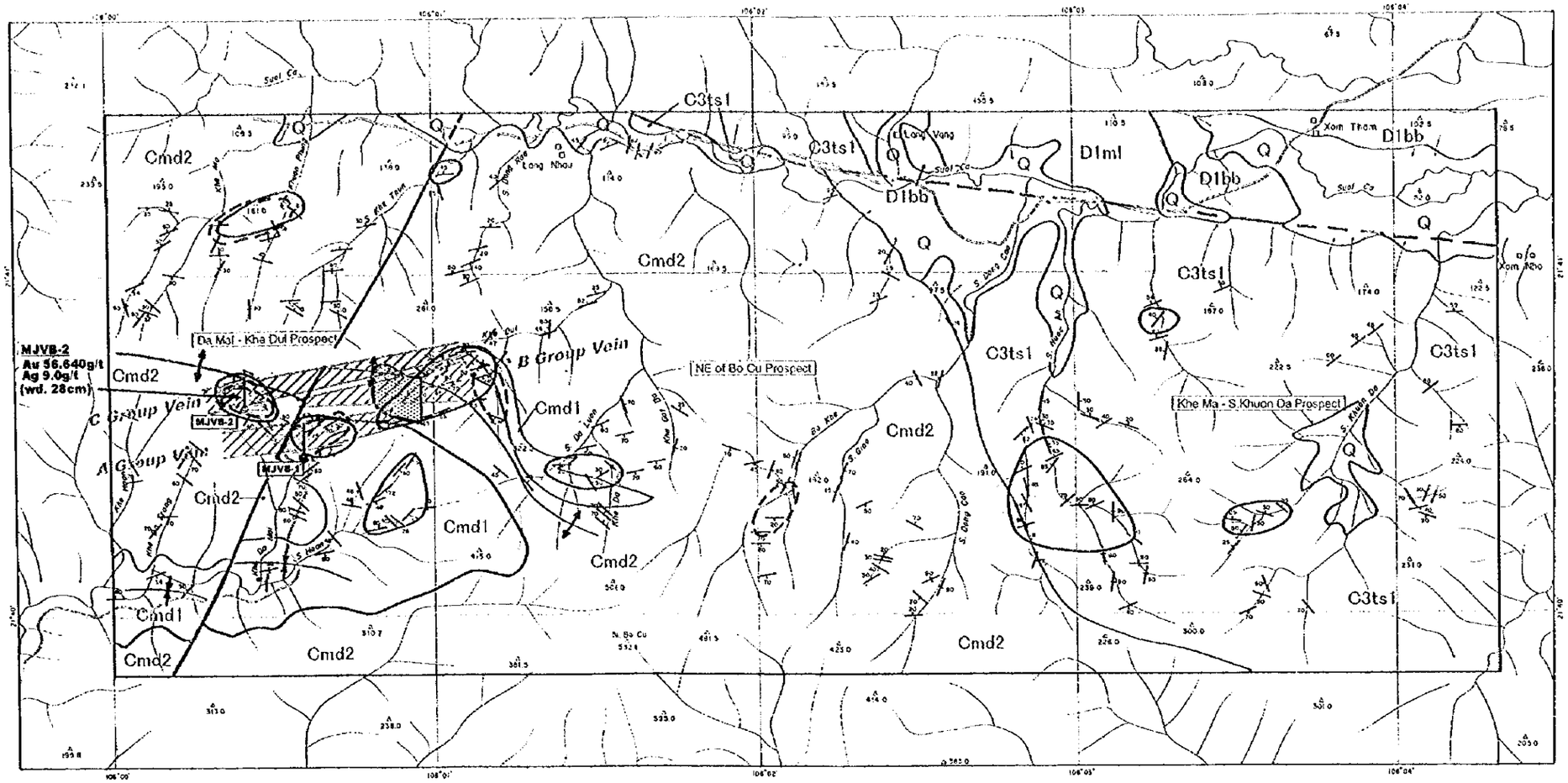
Gold-bearing quartz veins were formed in fissures of tensional nature. Swarm of veins occurs in zones generally running E-W on the wing of the Bo Cu anticline. Each vein is not long. It extends at most several hundred meters. Most of the veins continue several tens meters, then become thin, and disappear.

Gold occurs mainly as free native gold in quartz veins in this area. This is the main reason why the gold grade shows an very erratic nature. High grades of Au were returned from some part, while other part showed no significant value of Au even where visible gold was observed. Gold grade tends to be higher in a part where is relatively rich in sulfide minerals.

Thus, the gold deposit in the Bo Cu area is estimated to be not large scale but medium or rather small one. It is likely that some quartz veins may contain very rich gold. The target ore body is thought to be 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. Ore grade is expected to be several tens g/t Au.

On the basis of the results of the detailed geological survey and IP survey in this phase, two promising zones were extracted: (1) Da Mai-Khe Dui prospect in the Da Mai area, and (2) Ba Khe prospect in the Ngan Me area. Quartz veins with frequent occurrence of visible gold are intensively developed on the surface in these prospects. Geochemical anomalies were concentrated and remarkable chargeability anomalies were delineated in these zones. Bonanzas of gold ore are

expected. Targets for drilling can be chosen from some deeper zones extended from the significant veins on the surface within the geochemical and/or chargeability anomalies defined at (1) Group B and Group C veins at Khe Dui creek in the Da Mai-Khe Dui prospect, and (2) Ba Khe and Na Hon Groups of veins in the Ba Kho prospect. The integrated interpretations of the survey results for two detailed survey areas are shown in Figs. 1-5 and 1-6.

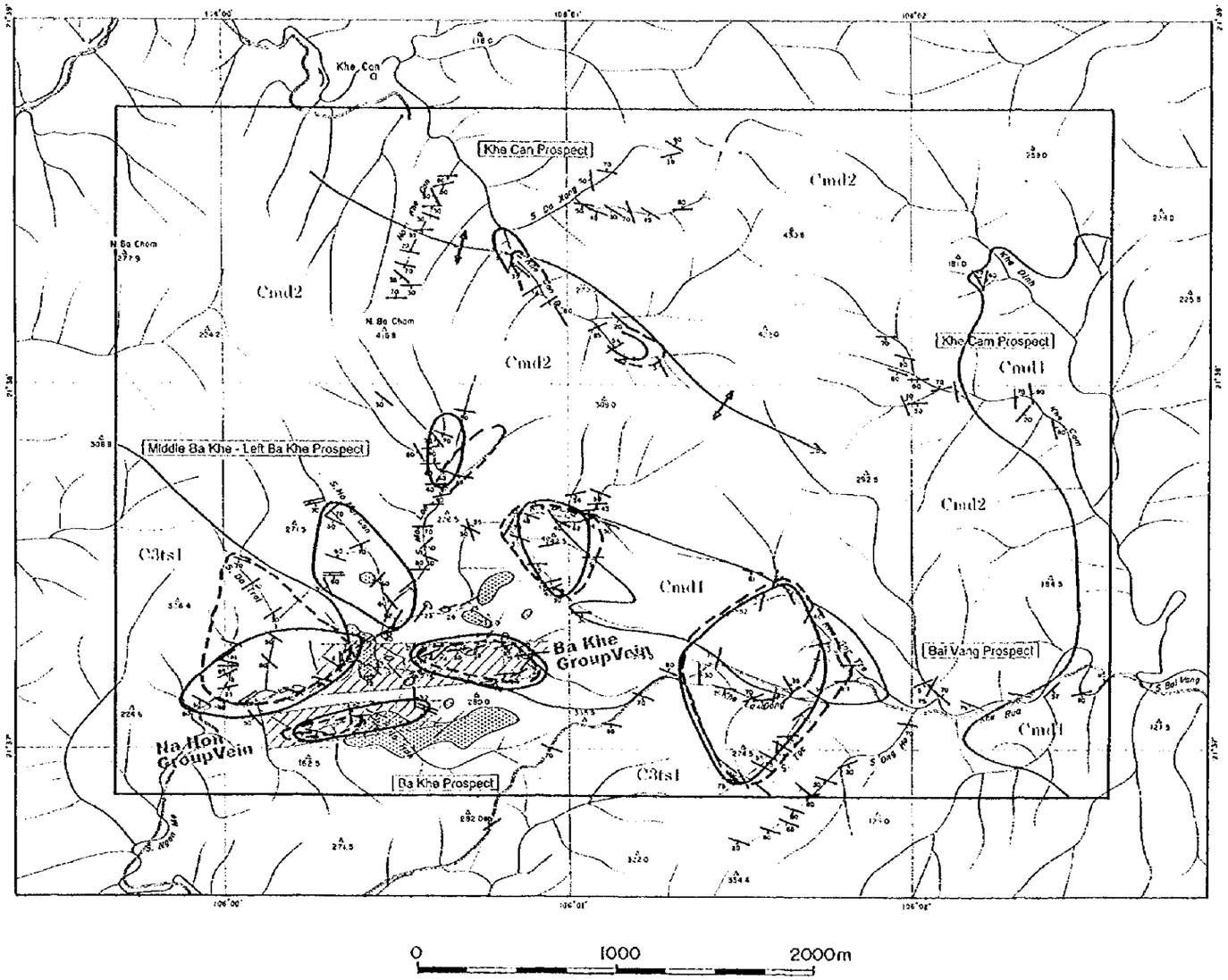


LEGEND

Quaternary	Q	Alluvial Deposits
Devonian	D1ml	Mia Le Formation
	D1bb	Bac Bun Formation
Cambrian	C3ts1	Lower Than Sa Formation
	Cmd2	Mo Dong Formation 2. Mainly composed of sandstone
	Cmd1	1. Alternation of schist & sandstone

- Fault
- Anticlinal Axis
- Synclinal Axis
- Drill Hole
- Gold-bearing Quartz Vein
- Group of Vein
- Major Geochemical Anomaly (Au)
- Major Geochemical Anomaly (Basemetal)
- Strong IP Anomaly (Chargeability > 30mV/V)
- Weak IP Anomaly (Chargeability > 15mV/V)

Fig. 1-5 Integrated Interpretation of the Survey Results in the Da Mai Area



LEGEND

Cambrian
- C3ts1 — Lower Than Sa Formation
- Cmd2 — Mo Dong Formation
  2. Mainly composed of sandstone
- Cmd1 — 1. Alternation ofschist & sandstone

Fault

Anticlinal Axis

Gold-bearing Quartz Vein

Group of Vein

Major Geochemical Anomaly (Au)

Major Geochemical Anomaly (Basemetal)

Strong IP Anomaly (> 30mv/v)

Fig. 1-6 Integrated Interpretation of the Survey Results in the Ngan Me Area

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

On the basis of the results of the second phase works comprising detailed geological survey, rock-chip geochemical survey, IP geophysical survey and reconnaissance drilling survey, the following conclusions are obtained.

(1) Geology and Geologic Structure

The distribution of three stratigraphic units from the Cambrian to the Quaternary systems consisting of five formations was surveyed and the geologic maps of 1:10,000 scale were prepared in the Da Mai and Ngan Me areas by the detailed geological survey this phase. Geostructurally, the survey areas where gold-bearing quartz veins are extensively developed are situated within the Bo Cu anticline whose axis orientates in the direction of WNW-ESE. The veins occur on the crest and northern and southern wings of the Bo Cu anticline, and it is interpreted that the formation of veins is controlled structurally by the regional folding activity started probably from the Triassic period.

(2) Gold Mineralization

Gold-bearing quartz veins occur extensively in both the Da Mai and Ngan Me areas. Although the width of each vein is not magnificent, they sometimes occur together forming a vein zone of several tens to a few hundred meters wide and 500-1,500 m long. The system of quartz veins and nature of gold mineralization were investigated by the detailed geological survey. On the basis of the results of studies on geologic environment, ore and gangue mineralogy, alteration, chemical analysis and fluid inclusion, it is concluded that the type of mineralization is the mesothermal gold vein hosted by sedimentary and metamorphic rocks of the Cambrian Mo Dong and Than Sa Formations. Two vein systems were distinguished by means of the stereo net analysis. One is E-W trend with dips of gentle to steep S, and another is E-W with dips of gentle N. According to the detailed geological survey together with the results of geochemical exploration, two areas for gold-bearing quartz veins have been examined, and potential for each area was evaluated. It is not likely to occur a big scale deposit in this area when seeing from the relative narrow and discontinuous nature of quartz veins as well as the scale and intensity of geochemical anomalies. Within two areas, Da Mai-Khe Dui and Ba Khe are promising prospects for medium to small size high-grade gold resources.

(3) IP Geophysical Survey

In the survey areas, strong chargeability anomaly, weak chargeability anomaly and high resistivity anomaly were taken as the IP anomalies related to quartz veins. Strong chargeability anomaly is connected with a distribution of quartz veins containing a considerable amount of sulfide

minerals. Weak chargeability anomaly is expected that quartz veins containing a small amount of sulfide minerals are distributed.

In the Da Mai area, a strong chargeability anomaly zone was extracted in the northern part of lines D-IP-8 to D-IP-10 and a weak chargeability anomaly zone was done in the central part of the survey area. The strong anomaly zone (WNW-ESE direction) seems to reflects the prospect around the Khe Dui stream, and tends to continue to the east of the survey area and extend to the deeper zone. The weak anomaly zone (WNW-ESE direction) seems to be attributed to the prospect around the Da Mai stream. It extends over all the lines, but tends not to extend to the deeper zone. The drilling exploration against the weak anomaly zone revealed the distribution of quartz veins containing a small amount of sulfide minerals. It confirmed the validity of the geophysical survey results.

In the Ngan Me area, strong chargeability anomaly zones including high chargeability more than 40 mV/V were extracted in the southern part of lines N-IP-2 to N-IP-9 and the central part of lines N-IP-1 to N-IP-2. The anomaly zone in the southern part of lines N-IP-2 to N-IP-9 (E-W direction and S-dip) is the broadest in the Ngan Me area and seems to be attributed to the Ba Khe prospect around the Na Hon stream. The anomaly zone in the central part of lines N-IP-1 to N-IP-2 seems to be attributed to the Ba Khe prospect around the Ba Khe stream. Neither tend to extend in the deeper zone.

(4) Drilling Exploration

In the drilling exploration this phase, road construction for the transportation of drilling machine and equipment has been taken for a certain time. Therefore, there was a restriction in the selection of drilling sites. The drilling target zones in which the most significant anomalies of both geochemistry and IP geophysics were defined have not been tested this phase. Two holes totaling 600 m were drilled in the Da Mai-Khe Dui prospect of the Da Mai area. Many significant intersections of gold-bearing quartz veins were caught in these reconnaissance drill holes, although some of the targeted extensions of veins on the surface have been appeared to be insignificant in the depth.

The drill hole MJVB-1 is located at the upper reaches of Da Mai creek. It targeted to the lower extension of the central part of the Group A veins of the Da Mai-Khe Dui prospect. In this hole, 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.

The drill hole MJVB-2 is located at the upper reaches of West Da Mai creek. It targeted to the lower extension of the western part of the Group C veins of the Da Mai-Khe Dui prospect. In this hole, thirteen major 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

(5) Da Mai Area

The distribution of gold mineralization in the Da Mai-Khe Dui prospect is approximately 200-300 m wide and more than 1,500 m long. 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. Assay results such as 55.704 g/t Au at 8 cm in width and 13.385 g/t Au and 4.0 g/t Ag at 45 cm in width were obtained through the detailed survey this phase. A couple of distinctive IP anomalies -- strong one in Khe Dui creek and weak one in West Da Mai-Da Mai creek -- were delineated by the geophysical survey. The latter was tested by drilling this phase. However, the former anomaly remains untested. The occurrence of high-grade gold ores of a dimension of several hundred meters by several hundred meters in the length and in the depth with width of 1 to 2 meters is expected in Khe Dui creek.

(6) Ngan Me Area

The Ba Khe prospect in the Ngan Me area is another promising target for the further exploration. 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. Au and basemetal anomalies of rock-chips occur intensively. Several strong IP anomalies were delineated in the geophysical survey this phase. One is located at the western part of the Ba Khe gold zone. Another one, which is a significant chargeability anomaly, occurs from the lower reaches to the upper reaches of Na Hon creek. High-grade gold ores like in the Da Mai-Khe Dui prospect are expected to exist in these anomaly zones.

5-2 Recommendations for the Third Phase Survey

Da Mai-Khe Dui Prospect

The reconnaissance drilling is recommended in the Da Mai-Khe Dui prospect. The drilling shall aim at the lower extension of the most significant mineralized zones within the geochemical and geophysical anomalies. The targets should be selected from zones of the Group B and Group C veins developed at Khe Dui creek.

Ba Khe Prospect

The reconnaissance drilling is recommended in the Ba Khe prospect. The drilling shall aim at the lower extension of the most significant mineralized zones within the geochemical and geophysical anomalies. The targets should be selected from zones of the Ba Khe Group and Na Hon Group veins.

PART II DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

Chapter 1 Detailed Geological Survey

1-1 Outline of the Area

The Bo Cu 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. The Tertiary rock does 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 to ENE axes.

Based on the results of the first phase survey, which covered over a rectangular area of 2,000 km^2 and composed of regional geological survey, stream sediment geochemical survey, panning survey, semi-detailed geological survey and geophysical survey (CSAMT method), two areas – Da Mai and Ngan Me areas – were selected for the potential gold prospects in the second phase detailed survey. These two areas are amounted to approximately 40 km^2 in total, and situated in the western part of the Bo Cu area. Along with the detailed geological survey in two areas, detailed rock-chip geochemical survey was carried out in the second phase. The major themes followed in the detailed geological survey together with the detailed rock-chip geochemical survey are: (1) to survey mineral showings in the prospects, to catch geochemical anomalies, and to define target mineralization for the further exploration by means of the detailed investigation on geology and mineralization in two areas, and (2) to prepare geologic maps of 1:10,000 scale.

1-2 Survey Method

The second phase geological works in the Bo Cu area consisted of the target definition of the drilling survey for gold deposits and geological mapping.

Prior to the field work, a series of topographic maps of 1:5,000 scale was prepared from the compilation of existing topographic maps (1:25,000). Several sets of GPS instruments were employed for locating major surveying points in the field.

During the field works, 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 and sulfide impregnation were carefully checked in the survey. The major properties examined and recorded in the field note are as follows:

I. Vein property
   (1) Vein width, dip & strike
   (2) Nature of quartz vein (color, grain size, texture, appearance)
   (3) Contained ore minerals
   (4) Associated gangue minerals
   (5) Host rock
II. Wall-rock property
   (1) Alteration (kind, grade, color, hardness)
   (2) Sulfide dissemination (kind of sulfide minerals, degree of dissemination)
   (3) Wall-rock (name, formation, structure)

Several significant mineralized localities were found during the field survey. The route maps of 1:5,000 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 85 km was explored during the survey in the survey areas, and the geological information was compiled into a geologic map of 1:10,000 scale. The geology and geologic profile of the survey areas are shown in Figs. 2-1 and 2-2.

The numbers of samples collected in the survey are: 41 altered rock and quartz vein samples for X-ray diffraction analysis, 21 rock and quartz vein samples for thin sections, 30 ore samples for polished sections, 70 ore samples for assaying (Au, Ag, Cu, Pb, Zn and Fe), and 30 quartz vein samples for fluid inclusion study.

1-3 Geology and Geologic Structure

1-3-1 Introduction

The geology of the Bo Cu area is composed of 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) and Quaternary sediments.

The general trend of these formations is ENE, E-W and WNW with local disorders. They form a series of foldings with the axes of NE, ENE or WNW direction. These sedimentary-metamorphic formations are cut by numerous fault systems whose major trends are NW, N-S and NE. Small intrusive bodies of granite occur locally in these formations.

The survey areas this phase, where are located at the western part of the Bo Cu area, are composed stratigraphically the following units:

Mo Dong Formation
Than Sa Formation (Lower Member)
Bac Bun Formation
Mia Le Formation
Quaternary sediments

The geology and geologic profile of the Da Mai and Ngan Me areas are shown in Figs. 2-1 and 2-2 respectively. The stratigraphic column of the Da Mai and Ngan Me areas are illustrated in Fig. 2-3.

1-3-2 Stratigraphy

Mo Dong Formation (C_{md})

The Mo Dong Formation is composed of gray to dark gray sandstone, quartzitic sandstone, psammite and sericite schist of the Cambrian System. An alternating bed of sandstone and schist (C_{md1}) occurs at the upper part of the thick sandstone strata (C_{md2}) of the Mo Dong Formation in the Da Mai and Ngan Me areas. Thin lens of limestone occurs locally at the upper part of this formation. This is the oldest rock of the Bo Cu area exposed on the surface. The Mo Dong Formation crops out widely in the survey area and forms the major host rocks of mesothermal gold deposits. The representative localities of this formation are: Da Mai, Ngan Me and Khe Gang.

Than Sa Formation (C_{ts})

The Than Sa Formation overlies on the Mo Dong Formation. It corresponds to the Cambrian System. This formation is subdivided into three members: Than Sa duoi (lower), Than Sa giua (middle), and Than Sa tren (upper). The lower member is outcropped within the survey area. It is composed of gray to dark gray sandstone, psammite, and multi-color (mainly violet) schist. Lens of

marly limestone is intercalated in the sandstone. It forms the host rocks of mesothermal gold deposits together with the Mo Dong Formation. The major localities are: Cay Thi and Ngan Me (southwestern part).

Bac Bun Formation (D_{1bb})

The lower Devonian Series are called the Bac Bun Formation. It is mainly composed of a series of sandstone, which shows gray to light gray and various features: coarse sandstone, quartzitic sandstone or psammitic sandstone, with intercalations of violet red color schist to reddish brown claystone (sometimes weakly schistose) and limestone. A conglomerate unit occurs at the bottom of this formation. It occurs at the northeastern part of the Da Mai area

Mia Le Formation (D_{1ml})

A thick pile of limestone occurs from the lower Devonian up to the Permian Series; some are continuous to the lower Triassic. The lower Devonian limestone is named the Mia Le Formation. It is composed mainly of marly limestone, partly of chalky claystone, and rarely of psammite. It occurs at the northeastern part of the Da Mai area.

Quaternary Sediments (Q)

The Quaternary Series is composed of gravels, sands, silts and clays along the alluvial plains in the survey areas.

1-3-3 Intrusive Rocks

Small stocks of granite occur near Binh Gia in the northern part of the Bo Cu area. There is no other outcrop within the Bo Cu area. Outside the survey area, the late Triassic biotite granite occurs 50 km northwest from the western boundary of the Bo Cu area; the Cretaceous granite also occurs to the southwest of the Bo Cu area. Near the Da Mai, Khe Gang and Ngan Me areas, there were thought to be cryptobatholiths of granitic rocks, which were considered to be something related to the mesothermal gold mineralization in those areas. Some report showed the existence of a small granite body south of Da Mai in the map (General Department of Geology & Mineral Resources, 1988). No such evidence, however, has been indicated in the field survey.

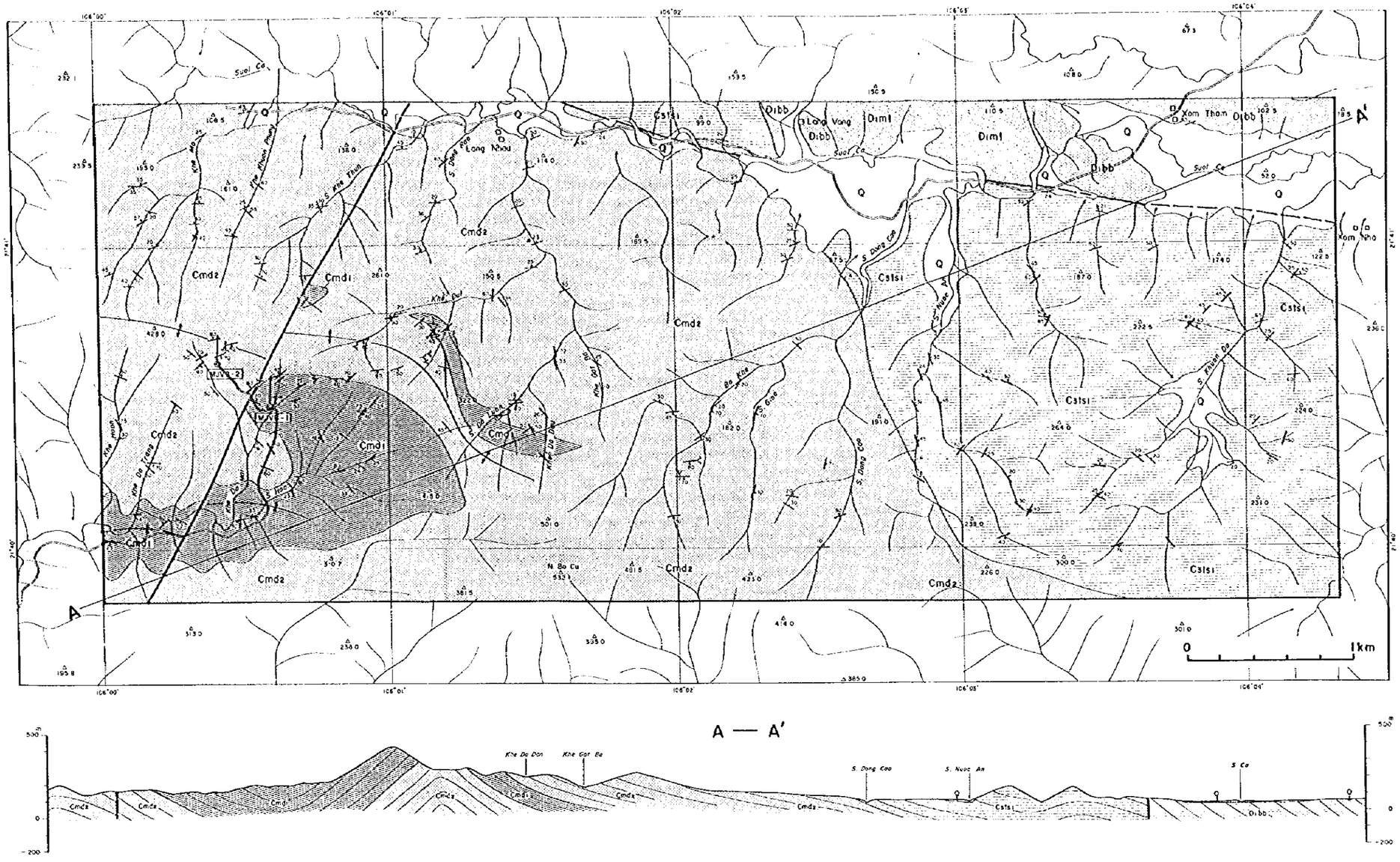
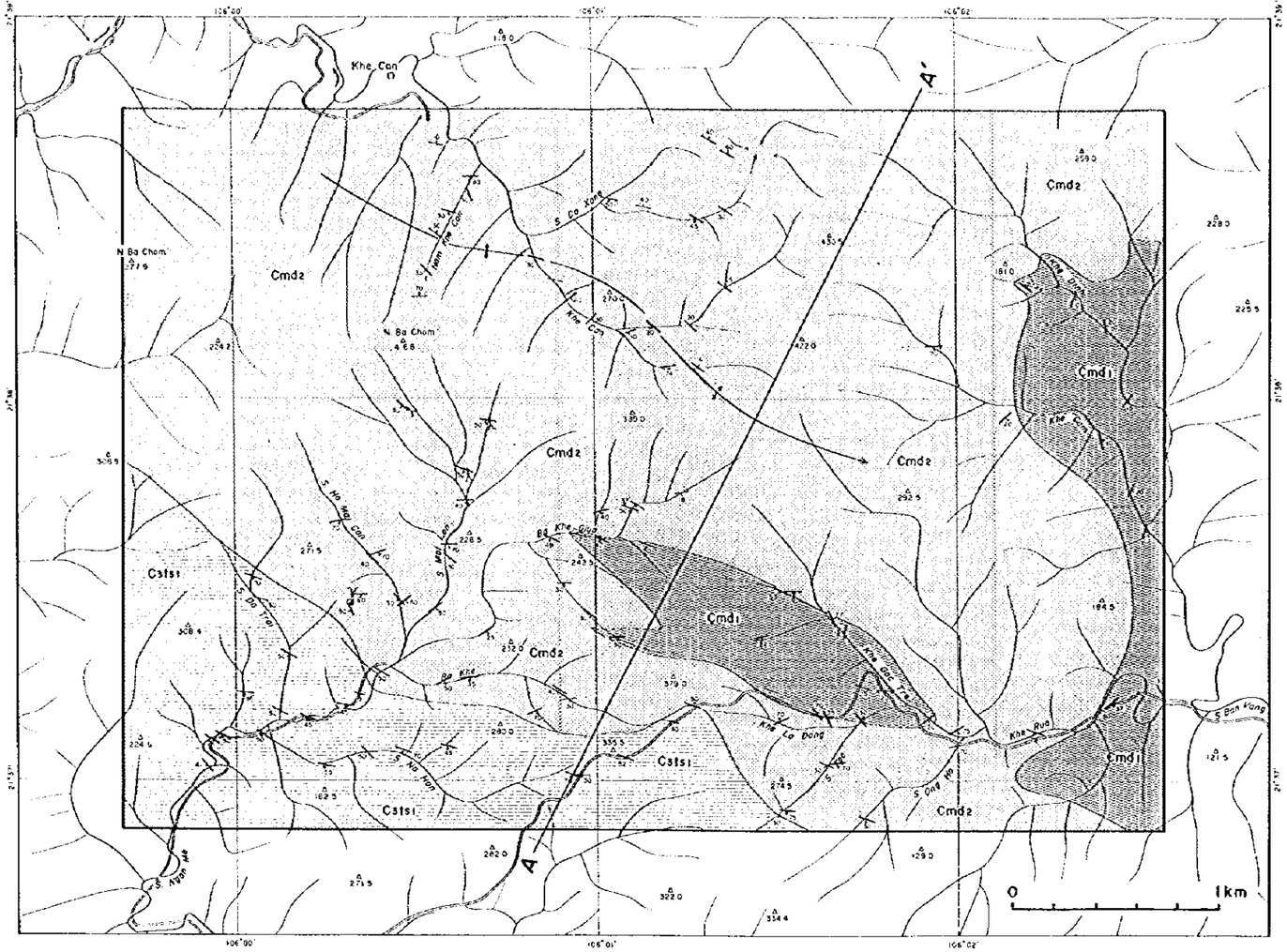
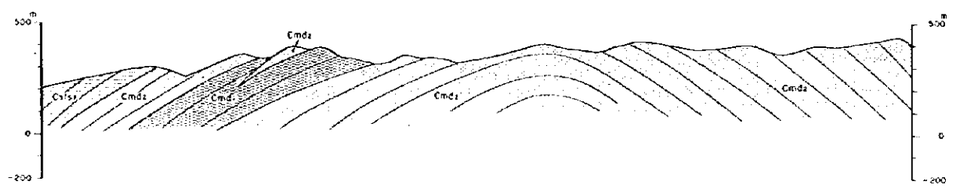


Fig. 2-1 Geology and Geologic Profile of the Da Mai Area



A — A'



LEGEND

STRATIGRAPHY

	Csfs1	Lower Than So Formation
Cambrian	Cmd	Mo Dong Formation 1 : alternation of schist and sandstone 2 : mainly composed of sandstone

OTHERS

- Fault
- 50 — Dip and strike of bedding / schistosity
- 80 — Dip and strike of quartz vein
- Anticlinal axis
- Adit / Inclined shaft
- Shaft / Pit
- A — A' Geologic section line

Fig. 2-2 Geology and Geologic Profile of the Ngan Me Area

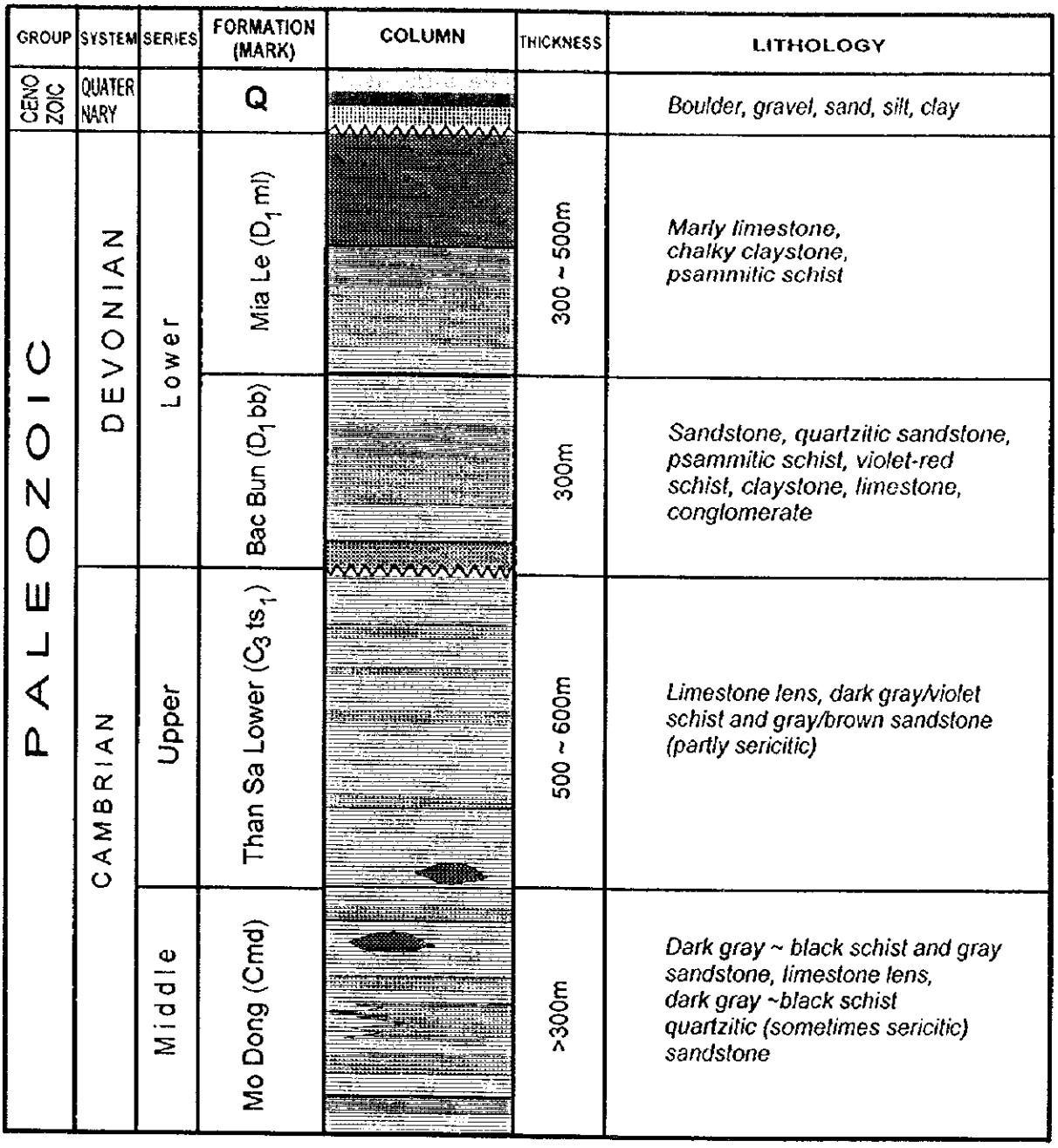


Fig. 2-3 Stratigraphic Column of the Da Mai and Ngan Me Areas

1-3-4 Geologic Structure

(1) Regional Scheme

The Bo Cu area is structurally characterized by a series of anticlines and synclines called Bac Son anticlinorium. It is elongated from Bo Cu mountain following east to northeast to Bac Son, Dong Mo until Lang Son. It is well proportioned; the southern side is cut by a fault running along the national road No. 1a and Quynh Dong-Bo Ha fault. The northern side is componented by Mesozoic formations. The axis of the anticlinorium orientates to ENE to NE. It passes through Bo Cu, Mo Nhai and Bac Son. It is composed of terrigenous, terrigene-carbonate, carbonate, and terrigene-volcanic sediments of the middle Cambrian to the middle Triassic in ages. The Bac Son anticlinorium consists mainly of Bo Cu anticline, Bac Son anticline and Trang Xa-Nhat The syncline. The time of these folding activities is considered to be Mesozoic.

Three major faults systems are distinguished in the Bo Cu area: NW system, N-S system and NE system. Faults of NW system are normal, compound ones, generated earlier than those of NE system. The most prominent NW fault occurs in the southern part of the Bo Cu area, running from Thai Nguyen through Trai Cau and Quynh Dong down to Yen Thien. Both NW and SE sides are cut through Mesozoic strata, and partly covered by Quaternary sediments. This fault system is interpreted to be formed nearly at the same time as the Bo Cu anticlinal activity. Faults of N-S system occur in two areas: May Khoan-Khao Lien-Deo Giao, and Coc Vuong-Dong Khuong. These sublongitudinal faults are cut in many places by faults of NE system. Faults of NE system occur pervasively over the Bo Cu area. They are subdivided into two groups: northwestern group and southeastern group. These faults cut both those of NW system and N-S system. Along these faults, intense deformation and shearing are observed.

(2) Da Mai Area

Da Mai area is situated on the northern wing of the Bo Cu anticline. The general strike of strata is WNW-ESE with gentle to moderate N-dip.

The geology is composed of Mo Dong, Than Sa, Bac Bun and Mia Le Formations. The Mo Dong Formation crops out widely in the Da Mai area. It consists mainly of sandstone (C_{md2}). Alternating beds of sandstone and schist (C_{md1}) occur at the upper part of the formation in the Da Mai area. A local anticline with an axis of WNW-ESE was observed along the ridge of Da Mai creek. The Than Sa Formation -- the Lower Member -- occurs in the eastern part of the area. The Bac Bun and Mia Le Formations occur at the northeastern corner of the area. Gold-bearing quartz veins are hosted by the Mo Dong and Than Sa Formations.

A series of tectonic faults run from east to west along S. Ca at the northern part of the Da Mai area. The southern side of the fault was uplifted in this area. A local fault of NNE-SSW system was observed in the western part of this area.

(3) Ngan Me Area

The Ngan Me area is situated from the central to the southern part of the Bo Cu anticline. The geology shows WNW-ESE to E-W trend in general. The strata dip to the south at the central to the southern part of the area. Whereas in the northern part, they show flat or gentle N-dip.

The geology of the Ngan Me area is composed of Mo Dong and Than Sa Formations. Most of the area is covered by sandstone of the Mo Dong Formation. The Than Sa Formation – Lower Member – occurs at the southwestern part of the area, where it strikes E-W to WNW-ESE and dips steeply to the south. Gold-bearing quartz veins are hosted both by the Mo Dong and Than Sa Formations. No specific fault was observed in the Ngan Me area.