REPORT
ON
HE MINERAL EXPLORATION

MINERAL DEPOSITS AND TECTONICS OF TWO CONTRASTING GEOLOGIC ENVIRONMENTS IN REPUBLIC OF THE PHILIPPINES

PHASE IV (Part I)

N V・VI AREA, WEST NEGROS AREA AND SAMAR I~III AREA

MARCH 1988

N INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PHASE Ⅳ (Part Ⅰ)

PALAWAN Ⅴ・Ⅵ AREA, WEST NEGROS AREA AND SAMAR Ⅰ～Ⅲ AREA

MARCH 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

Preface

The Government of Japan, in response to the request by the Government of the Republic of the Philippines, decided to survey the potential of mineral resources in the eastern Luzon, Visayas and Palawan and entrusted the survey work to the Japan International Cooperation Agency (JICA). The Agency, considering the importance of technical nature of the survey work, in turn sought the cooperation of the Metal Mining Agency of Japan (MMAJ) to accomplish the work.

In its forth fiscal year (1987), the JICA and the MMAJ sent to the Republic of the Philippines survey teams in order to survey Samar I ~ III Area from July to August, 1987. The survey works were carried out on geological, geochemical survey and spot investigation for mineral showings according to schedule with great cooperation of the Philippine autholities concerned, especially the Mines and Geo-Sciences Bureau (MGB), Department of Environment and Natural Resources.

This Report presents the studies on the Samar I ~ III Area, and the Palawan V (Basuanga) Area, Palawan VI (Quezon-Rio Tuba) Area and West Negros Area surveyed at the third fiscal year (1986).

In conclusion, we wish to take this opportunity to express our heartful gratitude to the officials of the Government of the Philippines and the Ministries of Foreign Affairs and International Trade and Industry of Japan, the officials of the Embassy of Japan in the Philippines and member of concerned companies.

March, 1988

Kensuke Yanagiya

President
Japan International Cooperation Agency

Junichiro Sato

President
Metal Mining Agency of Japan

Summary

This report summarizes the results of the field surveys and statistical treatment of the microchemical analyses data on Palawan V (Busuanga) Area(survey area: 1,260 km^2), Palawan VI (Quezon-Rio Tuba) Area (survey area: 3,370 km^2) and West Negros Area (survey area: 2,400 km^2) which is on its third year fieldwork and the results of the field surveys from the Samar I~III Areas (survey area: 2,148 km^2) which is on its fourth year period in observance of the Implementation Agreement that was concluded on the 26th of September, 1984.

Synthetic considerations of the results had led to the clarification of the following items:

1) Geology

The Palawan V (Busuanga) Area consists of Busuanga, Culion and Coron Islands. The Triassic Liminangcong Formation is distributed at the Busuanga and Culion Islands. The Jurassic Coron Formation is distributed at the Busuanga and Culion Islands. The Permian Minilog Formation, made up mainly of limestone distribute in Coron Island.

The Palawan VI (Quezon-Rio Tuba) Area consists of areas located southwest of mainland Palawan and the Balabac Island. The former consists of basic pyroclastics and ultramafic rocks which form the core of the mountain range in these areas with post-Miocene sediments deposited on its periphery.

The eastern portion of the Balabac Island is made up of basic pyroclastic rocks while the western part is underlain by Neogene sedimentary rocks.

Basement rocks of the West Negros Area consist of Mesozoic basic pyroclastic rocks exposed as plateaus and diorites. Palaeogene and Neogene sedimentary rocks are distributed around these basement rocks.

2) Deposits

The known metallic ore deposits in the survey area are as follows:

1. Palawan V (Busuanga) Area — bedded manganese type deposit (Busuanga)
2. Palawan VI (Quezon-Rio Tuba) Area — nickel-laterite type deposits in basic rocks (Rio Tuba etc.), massive sulfide type deposits (Balabac etc.), Cyprus type massive sulfide deposits (Barong Barong, Males etc.) and quartz vein type deposit.

3. West Negros Area — porphyry copper type deposits (Sipalay etc.), quartz vein type deposit.

4. Samar I~III Area — Kuroko type deposits (Bagacay etc.), vein type manganese deposits (San Jose etc.)

3) Geological survey

Ten elements were analyzed on selected samples collected from the survey areas. Statistical univariate analysis was performed on all the resusits of the chemical analyses of samples from the Palawan V (Busuanga), Palawan VI (Quezon-Rio Tuba) and West Negros areas.

4) Synthetic considerations of the results had clarified the following items:

(1) Polymetallic anomalous zones of Cu, Zn, Ni, Co and Cr are present southeast of Pulute Range in the northeastern part of Palawan VI (Quezon-Rio Tuba) Area

(2) Polymetallic anomalous zones of Cu, Pb, Zn, Co, Ni, As, Hg and Mo are present 15-22 km east of Sipalay in West Negros Area

(3) Polymetallic anomalous zones of Zn, Ni, Co, As and Hg are present upstream of Bayawan River in the southern part of West Negros Area

(4) Polymetallic anomalous zones of Cu, Pb, Zn, As, Sb and Hg are present in the limestone formation of Coron Island in the Palawan V (Busuanga) Area

(5) Polymetallic anomalous zones of Cu, Pb, Zn and As are present in limestone, 10 km northeast of Rio Tuba in the Palawan VI (Quezon-Rio Tuba) Area

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1. INTRODUCTION

1. Introduction

1-1 Background and Objective of the Survey

1-1-1 Background and Particulars

Pursuant to the Implementing Arrangement (IA) entered into between the Government of the Philippines through the Mines and Geo-Sciences Bureau (MGB) and the Government of Japan through the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ) signed on September 26, 1984, the third phase fieldworks of the project were carried out in Northern Sierra Madre, Cebu, Panay, Romblon, Busuanga, Southern Palawan and West Negros Areas, and the fourth phase was carried out in Samar Area. This report particulary embodies the geological and geochemical survey conducted in Busuanga, Palawan and Negros Areas from February 9, to March 13, 1987, and in Samar Area from July 20, to September 2, 1987. (Ref. Fig. 1)

1-1-2 Objective of the Survey

The objective of the present survey consist of the preparation of mineral inventory maps and of mineral potential areas, by means of statistical analysis of the results of chemical assays, combined with other laboratory examinations on the various samples collected during the geochemical and geological surveys of the Palawan V Area (Busuanga) 1,260 km^2, Palawan VI Area (Quezon-Rio Tuba) 3,370 km^2, West Negros Area 2,400 km^2 and Samar I~III Area 2,148 km^2.

Existing geological data from these areas were considered in the preparation of this report.

1-2 Contents of the Survey

1-2-1 Fieldwork

During the fieldwork, stream sediment samples were collected at the rate of one sample per 1-2 km^2 along the drainage systems in the survey areas, and micro-chemical analysis of these samples were executed for Cu, Pb, Zn, Ag, As, Hg, Sn, W, Mn, Mo on the Palawan V (Busuanga) Area, as well as for Cu, Pb, Zn, Ag, As, Hg, Ni, Cr, Co, Mn on the Palawan VI (Quezon-Rio Tuba) Area, for Cu, Pb, Zn, Ag, As, Hg, Ni, Co, Mn, Mo on the West Negros area, and for Cu, Pb, Zn, Ag, As, Hg, Ni, Co, Mn, Cr on the Samar I~III Area.

At the same time, pH and electric conductivity of the stream water at sampling points were measured. Heavy mineral samples were collected by panning at junction or mouth of the main drainage systems.

The heavy mineral samples were analyzed for Au, Ag and Ga. In conjunction with the foregoing geochemical survey, mapping and investigation of geological structures and

Fig.-1 Location Map of the Survey Area

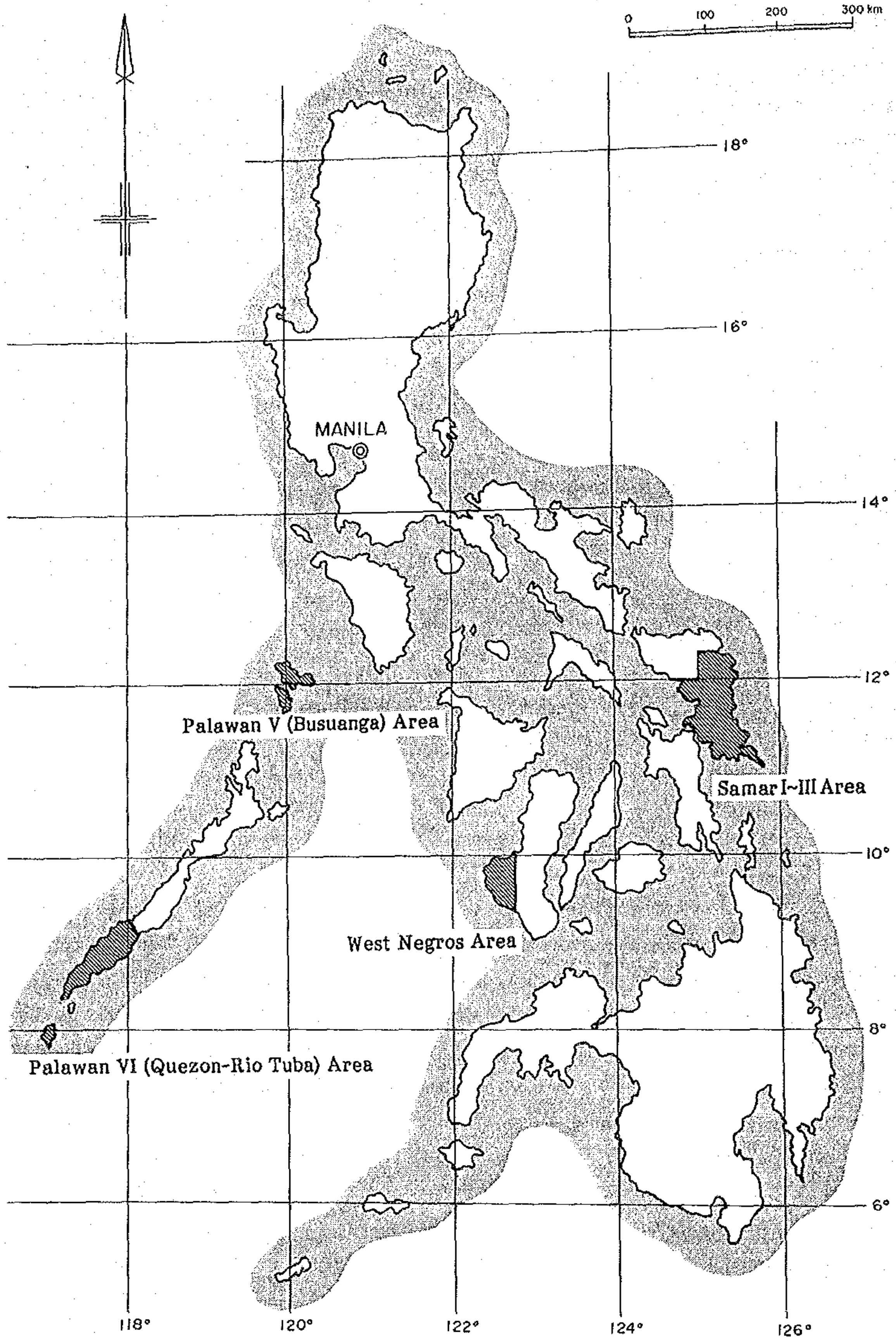


Fig.-2 Location Map of Palawan V (Busuanga) Area

Fig.-3 Location Map of Palawan VI (Quezon-Rio Tuba) Area

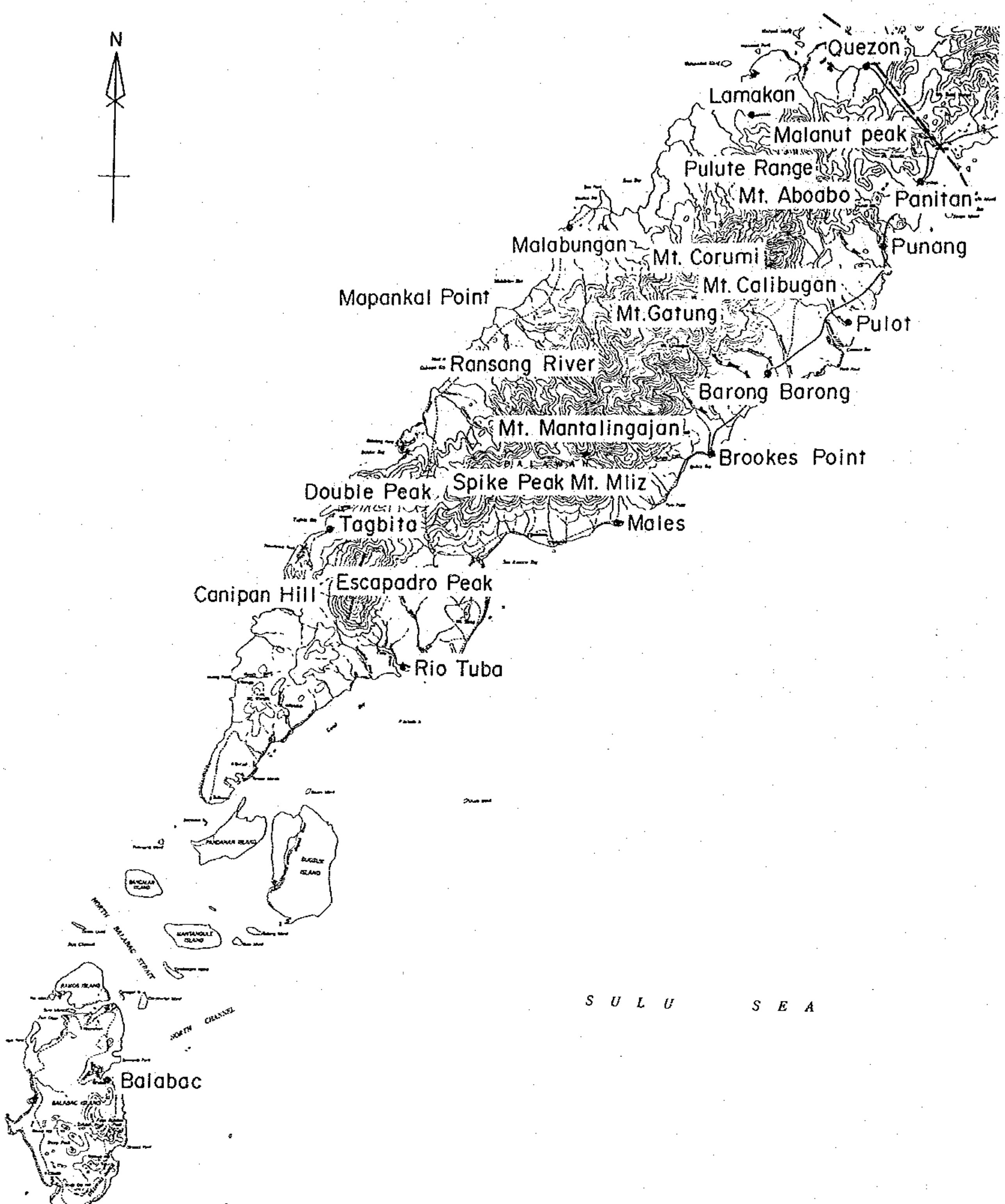


Fig.-4 Location Map of West Negros Area

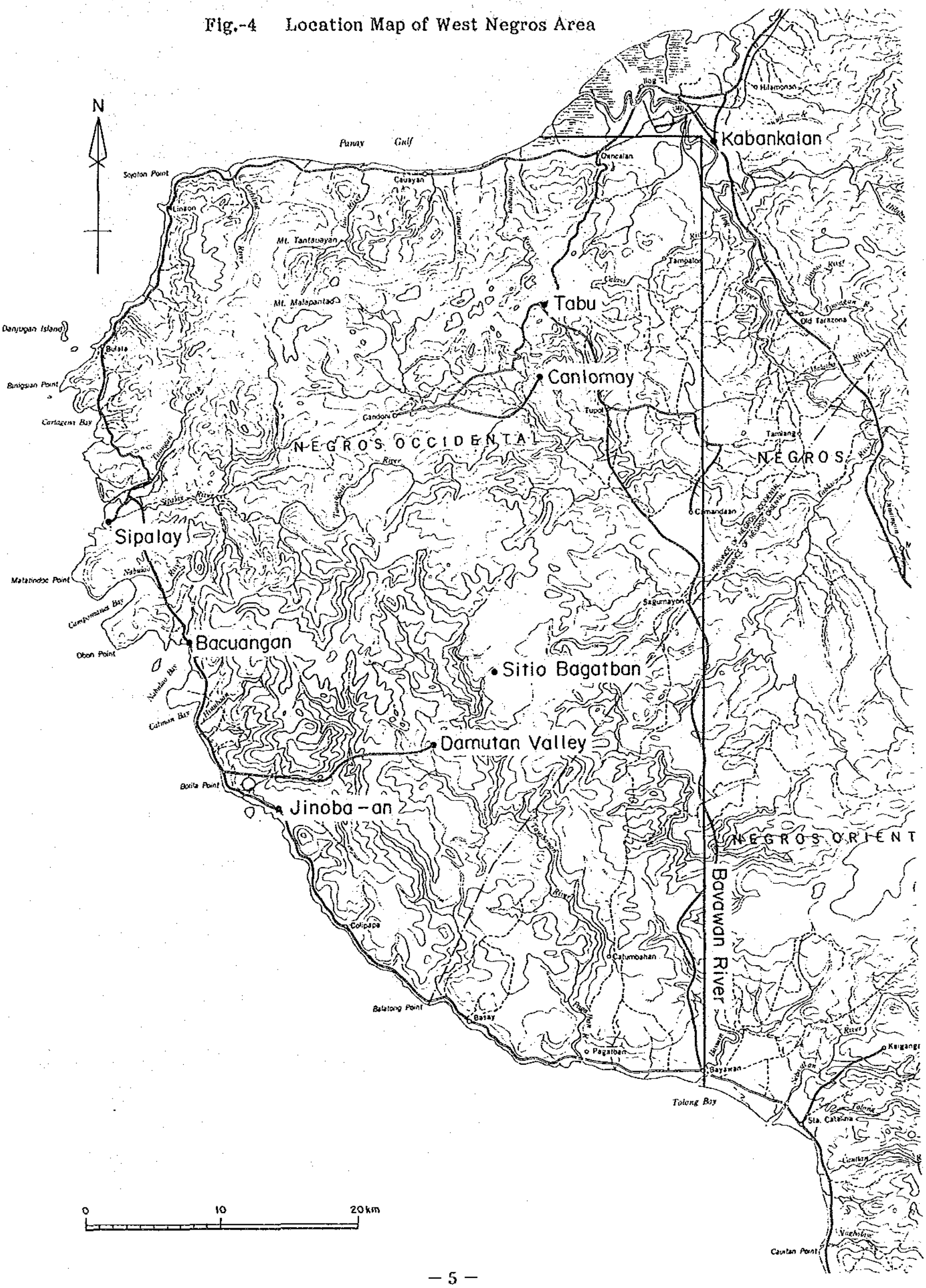
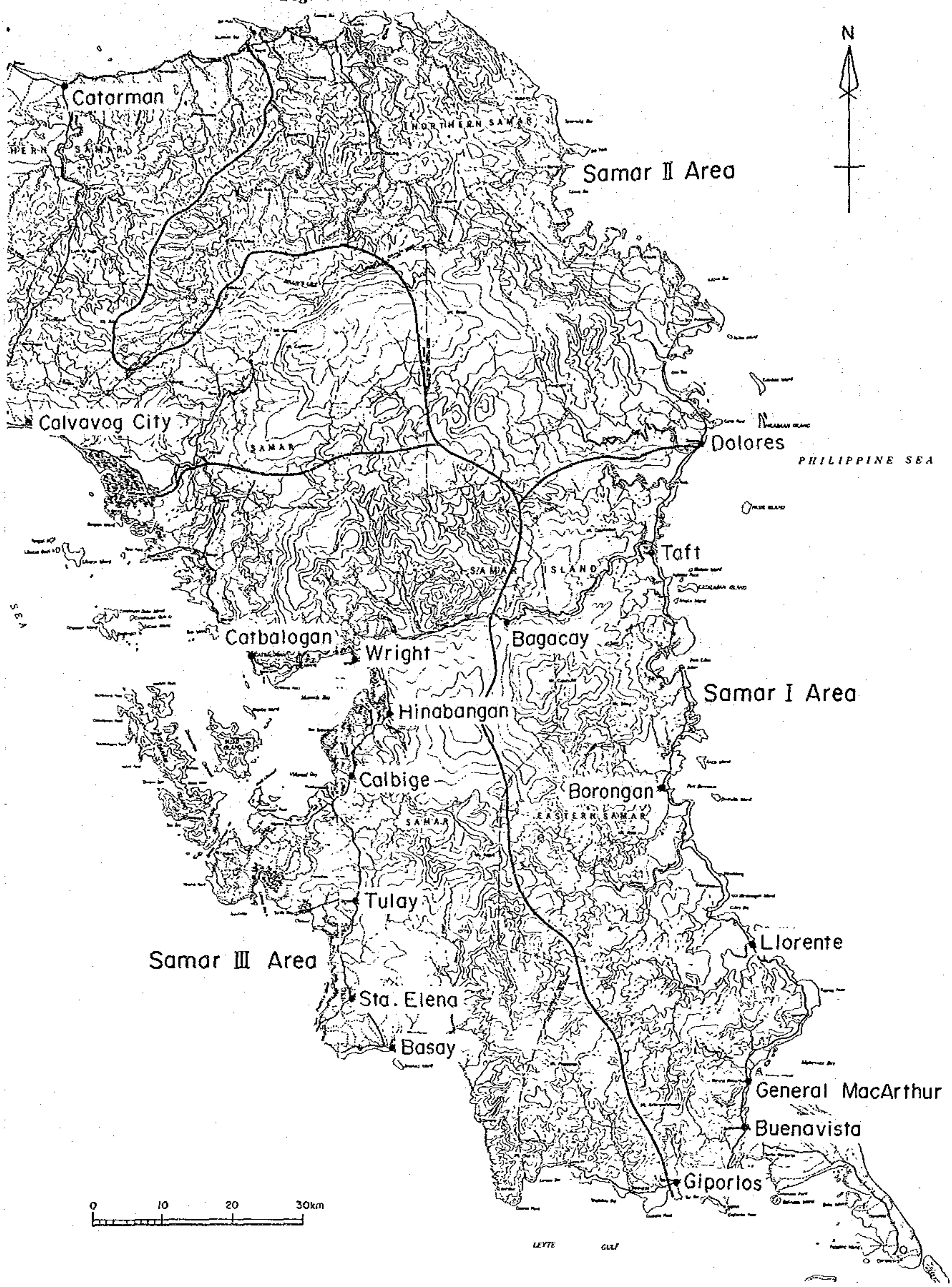


Fig.-5 Location Map of Samar I~III Area



known mineral showings in these areas were carried out.

The details of the collected samples are as follows:

1) Palawan V (Busuanga) Area (Ref. Fig.-2)

Survey area	1,260	km^2	
Stream sediment samples	699		
Duplicate samples	18		
Heavy mineral samples	57		
Spot survey points	3		
Samples for petrographical analysis	10	(Identification	5)
Samples for polished ore section	5	(ditto	5)
Samples for ore assay	5	(Assaying	5)
Samples for whole rock analysis	5	(Analysis	5)
Samples for X-ray diffraction analysis	5	(Diffraction	5)
Samples for microfossil analysis	5	(Identification	5)
Samples for heavy mineral separation	5	(Separation	5)

2) Palawan VI (Quezon-Rio Tuba) Area (Ref. Fig.-3)

Survey area	3,370	km^2	
Stream sediment samples	2,064		
Duplicate samples	42		
Heavy mineral samples	136		
Spot survey points	9		
Samples for petrographical analysis	23	(Identification	10)
Samples for polished ore section	15	(ditto	10)
Samples for whole rock analysis	11	(Assaying	10)
Samples for ore assay	19	(ditto	10)
Samples for X-ray diffraction analysis	12	(Diffraction	10)
Samples for K-Ar dating	7	(K-Ar dating	2)
Samples for microfossil analysis	12	(Identification	10)
Samples for heavy mineral separation	10	(Separation	10)

3) West Negros Area (Ref. Fig.-4)

Survey area	2,400	km^2
Stream sediment samples	1,090	
Duplicate samples	20	
Heavy mineral samples	100	
Spot survey points	9	

Samples for petrographical analysis	20	(Identification	10)
Samples for polished ore section	15	(ditto	10)
Samples for whole rock analysis	10	(Assaying	10)
Samples for ore assay	10	(ditto	10)
Samples for X-ray diffraction analysis	10	(Diffraction	10)
Samples for K-Ar dating	5	(K-Ar dating	3)
Samples for microfossil analysis	10	(Identification	5)
Samples for heavy mineral separation	10	(Separation	10)

4) Samar I Area (Ref. Fig.-5)

Survey area	395	km^2	
Stream sediment samples	237		
Duplicate samples	8		
Heavy mineral samples	26		
Spot survey points	2		
Samples for petrographical analysis	10	(Identification	5)
Samples for polished ore section	7	(ditto	5)
Samples for whole rock analysis	4	(Assaying	4)
Samples for ore assay	8	(ditto	5)
Samples for X-ray diffraction analysis	8	(Diffraction	5)
Samples for K-Ar dating	2	(K-Ar dating	1)
Samples for microfossil analysis	6	(Identification	5)
Samples for heavy mineral separation	5	(Separation	5)

Samar II Area (Ref. Fig.-5)

Survey area	843	km^2	
Stream sediment samples	418		
Duplicate samples	15		
Heavy mineral samples	34		
Spot survey points	-		
Samples for petrographical analysis	5	(Identification	5)
Samples for polished ore section	-		
Samples for whole rock analysis	-		
Samples for ore assay	-		
Samples for X-ray diffraction analysis	-		
Samples for K-Ar dating	-		
Samples for micro fossil analysis	5	(Identification	5)
Samples for heavy mineral separation	5	(Separation	5)

Samar III Area (Ref. Fig.-5)

Survey area	910 km^2	
Stream sediment samples	654	
Duplicate samples	19	
Heavy mineral samples	60	
Spot survey points	3	
Samples for petrographical analysis	20	(Identification 10)
Samples for polished ore section	4	(ditto 4)
Samples for whole rock analysis	5	(Assaying 5)
Samples for ore assay	3	(ditto 3)
Samples for X-ray diffraction analysis	10	(Diffraction 10)
Samples for K-Ar dating	5	(K-Ar dating 1)
Samples for microfossil analysis	5	(Identification 5)
Samples for heavy mineral separation	5	(Separation 5)

Samar I~III Areas Total

Survey area	2,148 km^2	
Stream sediment samples	1,309	
Duplicate samples	42	
Heavy mineral samples	120	
Spot survey points	5	
Samples for petrographical analysis	35	(Identification 20)
Samples for polished ore section	11	(ditto 9)
Samples for whole rock analysis	9	(Assaying 9)
Samples for ore assay	11	(ditto 8)
Samples for X-ray diffraction analysis	18	(Diffraction 15)
Samples for K-Ar dating	7	(K-Ar dating 2)
Samples for microfossil analysis	16	(Identification 15)
Samples for heavy mineral separation	15	(Separation 15)

After accomplishment of the field surveys, analyses of stream sediments and heavy mineral samples with the corresponding statistical treatment of the results, petrographic and microscopic analyses of thin and polished sections, X-ray diffraction analyses, whole rock analyses, ore assaying, paleontological and radiometric (K-Ar) datings were performed with the purpose of coming out with mineral inventory maps and at the same time, pointing out potential areas of mineralization for future works.

1-3 Composition of Member and Itinerary of the Survey

1-3-1 Composition of the Survey Mission

The members of the Japanese and Filipino teams who participated in planning the survey program, in negotiations and in field works were as follows:

A. Planning of the Survey Program and Negotiations.

Japanese Panel:	
Kyoichi Koyama	MMAJ
Hideo Hirano	id
Seiichi Ishida,	id
Yoshitaka Hosoi	id
Natsumi Kamiya	id
Philippine Panel:	
Benjamin Leong	DENR
Guillermo R. Balce	MGB
Romeo M. Luis	id
Edwin G. Domingo	id
Romeo L. Almeda	id
Noel V. Ferrer	id

B. Members of the Survey Team

Japanese Party		
Project Manager:		Yoshikazu Okubo, Akira Yatsuji, OMRD
Palawan V (Busuanga) Area		
Leader:	Akio Shida	Nittetsu Mining Consultant Co., Ltd.
	Kooji Uchiyama	id
	Tatsuaki Nakatsuka	id
Palawan VI (Quezon-Rio Tuba) Area		
Leader:	Kazuyoshi Masubuchi	Dowa Engineering Co., Ltd.
	Shigehisa Fujiwara	id
	Yukuo Kinryu	id
	Makoto Takeda	id
	Hiroshi Miyamoto	id
	Junichi Ishikawa	id
West Negros Area		
Leader:	Hireo Kuroda	Bishimetal Mining Co., Ltd.

	Hiroo Nakane	id
	Mitsutaka Banba	id

Samar I Area

Leader:	Masaji Marutani	Mitsui Mineral Development Engineering Co., Ltd.
	Ryohei Otsubo	id
	Kazuhiro Adachi	id
	Kazuhiko Yamanaka	id

Samar II Area

Leader	Hideya Kikuchi	Nikko Exploration & Development Co., Ltd.
	Yoshihiro Kikuchi	id
	Kazuyasu Sugawara	id
	Kenji Sato	id

Samar III

Leader:	Masakazu Kawai	Sumiko Consultants Co., Ltd.
	Takashi Kuriyama	id
	Takumi Onuma	id
	Atsuo Isogami	id

Philippine Party

Project Manager:	Romeo L. Almeda	MGB
Assistant Manager:	Noel V. Ferrer	id
Chemical Manager:	Edwin G. Domingo	id

Palawan V (Busuanga) Area

Leader:	Orlando Pineda	MGB
Sub leader:	Benjamin Cadawan	id
Sub leader:	Fidel Zepeda	id

Palawan VI (Quezon-Rio Tuba) Area

Leader:	Arnulfo Cabantog	MGB
Leader:	Leonardo Morales	id
Subleader:	Mario Aurelio	id
Subleader:	Rogel Santos	id
Subleader:	Generoso Revilla	id
Subleader:	Edgardo Malaca	id

West Negros Area

Leader:	Pedro Rovillos, Jr.	MGB

Subleader:	Edwin Rillon	id
Subleader:	Emmanuel Santos	id

Samar I Area

Leader:	Antonio Apostol Jr.	MGB
Leader:	Leonardo Morales	id
Subleader:	Nelson Quiwa	id
Subleader:	Rogal Santos	id

Samar II Area

Leader:	Orlando Pineda	MGB
Leader:	Pedro Rovillos Jr.	id
Subleader:	Generoso Revilla	id
Subleader:	Urbano Palaganes	id

Samar III Area

Leader:	Arnulfo Cabantog	MGB
Leader:	Benjamin Cadawan	id
Subleader:	Mario Aurelio	id
Subleader:	Fidel Zepeda	id

In addition to this, about 30 other MGB geologists joined the field works.

C. Composition of the field party

One field party was composed of one Japanese geologist and 3 MGB geologists, and such three parties were assigned to each survey area. Furthermore, one geologic aide was assigned to each area to be in charge of drying and sieving of samples and making the necessary coordinations.

D. Treatment disposal of chemical analysis

It this survey, microchemical analysis of 5,284 stream sediment samples including duplicates (10 elements analyzed for each samples) and 413 heavy mineral samples (3 elements analyzed) were conducted. This work was accomplished by atomic absorption spectrometry (AAS) method up to February, 1988 at PETROLAB.

1-3-2 Itinerary of the Survey

The field work was conducted from February 9 to March 13, 1987 on Palawan V (Busuanga) Area, Palawan VI (Quezon-Rio Tuba) Area and West Negros Area, and from July 2 to August 29, 1987 on Samar I~III Area. (as described already in the third phase report) The corresponding laboratory works were performed from March, 1987 to February, 1988. As in the preceding year, for the purpose of increasing the analyzing capacity, one Japanese chemical analyst was assigned to check the above operation and to supply necessary materials. The details of the itinerary are shown below.

Table-1 Itinerary List of Actual Survey

	'87 Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	'88 Jan.	Feb.	Mar.
Meeting and Preparation			20 —	— 24	25 —	— 2						
Field work				24 —	— 25							
Chemical Analysis		1 —	—	—	—	—	—	—	—	—	— 20	
Synthetic Analysis				6 —	—	—	—	—	—	—	— 26	
Report Making								1 —	—	—	—	— 10

2. GENERAL DISCRIPTION OF PHYSIOGRAPHY, GEOLOGY AND MINERAL DEPOSITS

2. General Description of Physiography, Geology and Mineral Deposits

2-1 Physiography and Geology

The survey areas are located around part of the Sulu Sea and belong to the Palawan and Western Physiographic Province.

A) Palawan V (Busuanga) Area consists of Busuanga, Culion and Coron. It is located between Mainland Palawan and Mindro.
In Busuanga, the ridges and mountains follow trend at the north-western part and NW-SE trend at the southern end.
Rock facies exhibit parallel arrangement to these directions. The chert formation (LF-1) is distributed at the highland part, while the sandstone and shale formation (LF-2) is located at the lowland part.
In Culion Is., the rock facies consists only of chert formation (LF-1). It shows wavy folding but the linear direction are not so clear as in Busuanga Is., Coron Is. consists almost wholly of Permian limestone, except for small exposures of chert along the fault which passes at the northwest coast of the island where karst topography have been observed.

B) Palawan VI (Quezon-Rio Tuba) Area consists of the southwestern part of Mainland Palawan and Balabac Is. The central mountain range of the northern part of the area consist of basic clastic rocks (K) and ultramafic rocks (Uc) having an elevation of 1,000-2,000 m height and exhibiting steep slopes in the NW and SE side of the range. The southwestern part of Rio Tuba and the coastal area are flat consisting mainly of Miocene sedimentary rocks.

C) West Negros Area is located at the western portion of the Central Physiographic Province. Hills, 400-500 meters in elevation are ubiquitous in the area. Main drainage systems, 40-50 km in length, show strong bending and flow toward the Sulu Sea.
The basement formation consist of Mesozoic basic pyroclastics and diorite intruded into Mesozoic, Paleogene and Neogene formations.
In Palawan V (Busuanga) Area, the Liminangcong Formation noted to be surrounding the Minilog Formation, is distributed in the Busuanga and Culion Is. The limestone of the Coron Formation occurring at the southern portion of the Busuanga Is. is thought to be Jurassic but its direction relationship with the Liminangcong Formation is unknown.
In Palawan VI (Quezon-Rio Tuba) Area, the ultramafic rocks intruded the northern part of the central mountain range in a NE-SW or N-S direction. The NE-SW direction seems to be the dominant trend of the geologic structures in the northeastern part of the area as shown by the NE-SW trending synclines elongated

over 70 km in the NW side of the central mountain range which ultimately control Miocene sediment structures.

The fault system which cut the abovementioned structure is exposed at the Pulute range in the northern and southeastern part of Balabac Is.

The crystalline schist which is thought to be the Pre-Cretaceous basement is observed accompanied by ultramafic rocks in small outcrops 4 km west of Pyramid Hill in the northeastern part of the area.

In West Negros Area, the geological structure is characterized by diorite intrusions and unconformity between formations. The intrusive rocks which have been divided into three bodies elongate in a NNW-SSE direction. Intrusive rocks which have NE-SW direction are observed near Sipalay in the north and Jinoba-an in the central part. This may indicate the presence of a block structure in the basement formation controlled by the above two structural directions.

D) Samar I~III Area belong to the central part of the Eastern Physiographic Province and the Samar-Davao sub-province. Mt. Capotoan (896 m above sea level) is the highest place in this island. Samar island consists of mountain and hill zones cut by complicated drainage patterns. The basement rocks of Samar I~III Area consists of Late Cretaceous - Paleogene metavolcanics, metasediments and ultramafic rocks. Paleogene diorite intruded these rock units. Neogene to Quarternary pyroclastics and limestone overlie the abovementioned lithologies.

2-2 Geological Structures (Ref. PL-1-1~4)

In Palawan V (Busuanga) Area, the Liminangcong Formation which is composed of middle-lower Triassic sandstone shale and chert are distributed at Culion Is. and the Busuanga Is. along the periphery of the Minilog Formation which is the oldest rock unit exposed as part of a horst in Coron Is. and exhibiting NW-SE trending folds.

Its northern part is controlled by fold axis of NE-SW trend. Limestone member of the Jurassic Coron Formation is distributed at its southern part but its relationship with the Liminangcong Formation had not yet been established.

In Palawan VI (Quezon-Rio Tuba) Area, ultramafic rocks are distributed at the mountain range trending NE-SW and N-S. These seems to be the dominant structural controls in the area.

As an example, NE-trending synclinal structure is exposed intermittently east of Double Peak, 10 km south of Lomakan in the NW side of the mountain range. The NW-SE trending faults that cut the NE or N-S structure are recognized at Pulute Range and at the southeastern part of Balabac Is.

Pre-Cretaceous crystalline schists which are considered to be the basement rocks of this district are exposed with ultramafic rocks 4 km west of Pyramid Hill.

In West Negros Area, its geological structures are characterized by the intrusion of dioritic rocks and the unconformity between formations.

The NNW-SSE trending intrusive rocks have been identified to be of three bodies. On the other hand, NE-SW trending intrusives have been noted near Sipalay Mine and Jinoba-an. It seems that two fault systems are considered to be in the area.

The Miocene D1 Formation are distributed around the Bf formation which is made up of basement and dioritic rocks. Sedimentation occurred after the uplift of the basement rocks in large-scale block movement.

In Samar I~III Area, the mountain range have a N-S trending anticlinal structure. Faults ran parallel along the direction of this anticlinal axis. Conjugate faults have also been encountered in this Area.

2-3 Ore Deposits

There are considerable difference in mineralization between Palawan V and VI and West Negros Area.

In Palawan V (Busuanga) Area, bedded manganese oxide is the only type of mineralization, while, in Palawan VI (Quezon-Rio Tuba) Area, nickeliferous laterite in weathering zone of ultramafic rocks, massive sulfide in Miocene sediments, vein type deposits in basalt lava and silica sand in the west coast are known.

In West Negros Area, many porphyry copper type showings related with diorite are observed.

In Samar I Area, Kuroko type deposit (Bagacay) is known in Miocene tuff.

3. RESULTS OF GEOLOGICAL SURVEY AND INVESTIGATION OF ORE DEPOSITS

3. Results of Geological Survey and Investigation of Ore Deposits

3-1 Geology and Ore Deposits of Palawan V (Busuanga) Area (Ref. PL-1-1)

3-1-1 General Summary

The survey area is located about 320 km SSW of Manila, midway between Mindoro Is. and Main Palawan Is. and consist of Busuanga Is., Culion Is. and Coron Is. It belongs to Coron & Salvacion District, Region-VI A, Palawan Province. District office is situated at Coron and Salvacion in Busuanga Is.

Access between Busuanga Is. and Manila is through air flight service which is available three times a week. Flight time is one hour. Ferry boat service is available between Port Coron and Manila twice a week and travel time takes 40 hours. Unpaved car road are well developed in the innerland of the Busuanga Is. However, coastal roads are not well developed except for the southwestern portion. Coast to coast trips can be made utilizing hired boats. Field surveys in Culion and Coron Is. were carried out mostly utilizing hired boats.

The geographic situation is as follows.

Area:	1,260 km^2
Elevation:	0 - 640 m
Highest Peak:	Mt. Tundalara (640 m)
Average Temperature:	About 27°C
Average Annual Precipitation:	2,000 mm

The climate belongs to the typical monsoon zone of the Western Pacific Ocean, where dry season (Jan. - Jul.) and rainy season (Aug. - Dec.) are observed.

The mountain range is basically deforested due to logging. Lowland areas are used partially for farming. Second growth trees, shrubs and bamboos cover the undeveloped lands. The small alluvial plains developed along rivers are planted with rice, coconut and banana. Mangrove can be seen at the lowland near the mouths of rivers.

3-1-2 Stratigraphy

The succession of the rocks which underlie the area is shown in Fig. 6. The geology of Palawan V (Busuanga) Area consists of basement rocks (MF) composed of massive recrystallized limestone belonging to the Minilog Formation (correlated Permian by BMG), Mesozoic group composed of alternating chert, sandstone and siltstone belonging to the Liminangcong Formation (correlated lower-middle Triassic by BMG) and limestone belonging to the Coron Formation (correlated Jurassic by BMG). Quarternary unconsolidated sediments cover all of the above rock units. Description for each geological unit are as follows:

Fig.-6 Schematic Columnar Section of Palawan V Area

Geological Age			Marcilla Map 3056 II	The Result of This Time		
Era	Period	Epoch	BMG 1984	Palawan V Area	Code	Rock Facies
Ceno-zoic	Quater-nary	Recent	Qal	Qal	Qal	Recent Sediment, Coral
	Tertiary					
Meso-zoic	Jurassic	Lower	Coron Formation	Coron Formation	CF	Limestone
	Triassic	Middle	Liminangcong Formation	Upper Liminang-cong Formation	LF2	Mainly Chert
		Lower		Lower Liminang-cong Formation	LF1	Chert, Sandstone, Siltstone
Paleo-zoic	Per-mian	Upper	Minilog Formation	Minilog Formation	MF	Limestone bearing chert breccia

Ref. Marcilla's Geological Map, 1/50,000 (BMG, 1984)

- Minilog Formation: MF

This formation is composed of massive recrystallized milky white to dark gray limestone, which include nodule of reddish chert and basalt (-1 m to 10 m) and cut partially by calcite veins (width: 10-30 cm).

This formation is distributed in almost the whole area of Coron Is. but its structure is unclear due to its massive and recrystalline nature. The relationship with the overlying Liminangcong Formation is only defined by a fault contact at the northwest coast of Coron Is.

(Results of microscopic observation)

The sample (NF-92B) of altered basalt in Minilog limestone has been changed to hydrous aluminum aggregation. The original rock is estimated as a basalt by the result of plagioclase relict phenocryst observation.

(Results of whole rock analysis)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL
NF-92B	0.19	3.27	49.96	18.96	0.06	0.20	0.21	0.10	4.42	0.47	0.38	0.02	10.76	88.81

NF-92B: Altered basalt

(Result of microfossil identification)

Two samples (NF-92A. NF-100A) collected from the east coast of Coron Is., did not yield any microfossil.

(Results of X-ray diffraction analysis)

The calcite vein sample (NF-100B) which was collected at the southern part of the east coast of Coron Is. is composed of abundant calcite, medium amount of gypsum and small amount of kutnahorite. Basanite like peak are observed but not confirmed.

- Lower Liminangcong Formation: LF-1

This formation is composed of alternating sandstone, siltstone and chert, distributed mainly along the west and middle-north side of Busuanga Is.
Sandstone and siltstone have gray or reddish brown color mainly, and partially white to greenish gray color. Banded structure is observed in places, wavy folding which has 1 m to several 10 m wave length are developed in places but the scales are not uniform. The relationship to the upper chert formation (LF-2) seems to be conformable.

(Results of microscopic observation)

The sample collected from the upstream part of Mamakin River (NF-033) is a siliceous microfossil bearing sandstone in which potash feldspar has changed to chlorite.

(Results of microfossil identification)

One sample was collected in the northwestern part of Busuanga Is. but did not yield any microfossils.

- Upper Liminangcong Formation: LF-2

This formation is mainly composed of chert and is distributed in the middle-south and east side of Busuanga Is. and in almost the whole area of Culion Is.

Chert has grayish white, gray reddish brown and greenish gray color.

Banded structure which show 5-20 cm thickness in single layer develop in places. Micro-folding structures are also found.

Manganese deposits which are controlled by these chert structures are located in the middle east part of Busuanga Is. and in the west part of Culion Is.

The relationship between this formation and the limestone rich formation distributed around Tangat Is. (southern part of Busuanga Is.) and along the Coron Passage is unclear, as their direct contact has not been observed. The limestone rich formation is correlated to the Coron Formation (Jurassic) by its rock facies.

(Results of microscopic observation)

The sample collected near Lanka Mine at the east side of Busuanga Is. (NA039) is a radiolarian chert composed of micro-crystals of quartz. Chalcedonic quartz veinlet cut it.

The sample collected from the mountain range of northern Culion Is. (NK022) is a radiolarian chert composed of micro-crystals of quartz, crushed partially and included many fragments of shale.

The sample collected from the west coast of Culion Is. (SE002) is a sandstone composed of fragments of chert, siltstone and shale. Potash feldspar and plagioclase altered partially to calcite and sericite.

(Results of microfossil identification)

Two samples collected from the southeastern part of Culion Is. and southeastern part of Busuanga Is. did not yield any microfossil.

(Results of whole rock analyses)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL
NA039	0.05	88.40	5.36	2.86	0.09	0.09	0.39	0.30	0.27	0.17	0.29	0.03	2.64	100.90
NE-2	1.88	75.79	10.84	3.61	0.77	0.55	2.07	1.70	0.38	0.18	0.34	0.04	3.74	100.00
NF033	0.66	79.70	9.81	1.78	0.43	0.42	2.39	1.90	0.31	0.14	1.01	0.04	1.91	99.84
NK022	0.39	89.67	4.00	2.93	0.33	0.07	0.09	0.40	0.52	0.13	0.09	0.01	1.90	100.15

NA039, NK022: Chert NE-2, NF033: Sandstone

3-1-3 Intrusive Rocks

During this survey, intrusive rocks have not been recognized in this area.

3-1-4 Geological Structures

The sedimentary rocks which are distributed in this area are classified as the Minilog Formation, Liminangcong Formation and Coron Formation (from older to younger).

The relationships among these formations are almost unclear except for one fault contact observed between Minilog and Liminangcong Formations northwest of Coron Is. As for the Minilog Formation, the structural feature is not clear due to its massive and recrystallized nature.

The structure of upper and lower Liminangcong Formation (LF-1, LF-2) which compose the main part of this area show wavy folding that have several hundred meters to several km in wave length.

Trends of folding axes varies from NW-SE at the eastern and middle parts of the Busuanga Is. and NE-SW at the western part.

In Culion Is., it is NNW-SSE in the north, N-S at the middle part and NE-SW in the south. These arrangement of folding axis directions seems to form a loop around the horst shaped Minilog Formation of Coron Is.
Manganese deposits in the Liminangcong Formation seems to have been concentrated as a result of these structural controls. Post formational brecciation and deformations have also been recognized.

3-1-5 Results of Mineral Showing Survey (Ref. Appendix 11)

Mineral showings in this area are only that of manganese. The following 3 showings were investigated (Ref. Fig. 7). The abstracts of these survey are shown in Table 2.

No.	Name of showing	Kind of Ore	Evaluation
1	Lanka	Bedded Mn-Oxide	Necessity of a follow-up survey is low
2	Dapdapan	id	id
3	Kabol Kabol	id	id

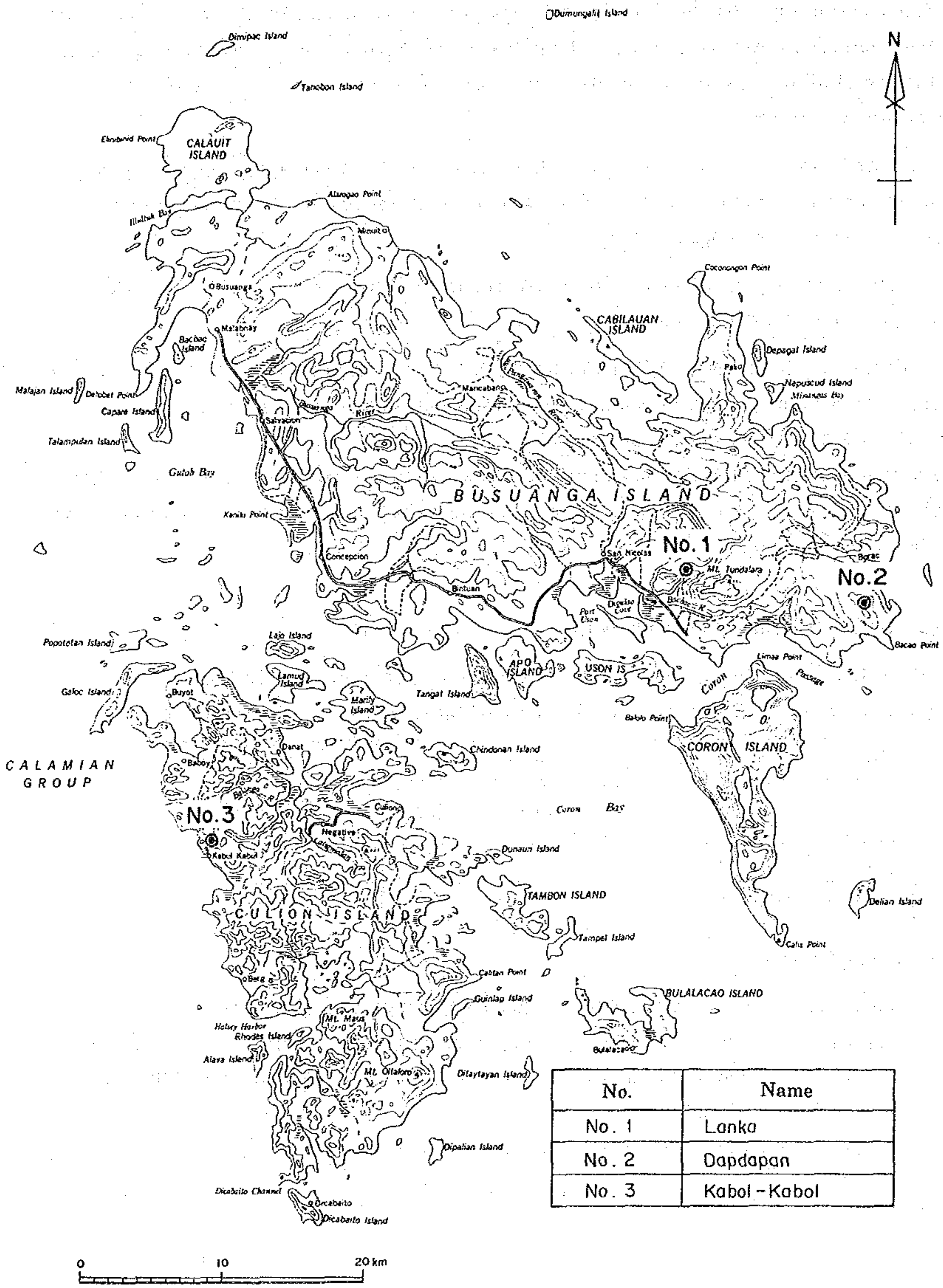
1) Lanka Showing

Location: 6 km ESE of San Nicolas, southern part of Busuanga Is.

Details: Lenticular shaped manganese oxide ore. Thickness: 1-2m, length: about 10 m (drifting about 10 m by adit), strike: N60° E, dip: vertical.

Country rock: Banded chert of Liminangcong Formation

Fig.-7 Location Map of Mineral Showing in Palawan V (Busuanga) Area



No.	Name
No. 1	Lanka
No. 2	Dapdapan
No. 3	Kabol-Kabol

Table-2 Abstract of Mineral Showing Survey in Palawan V (Busuanga) Area

No.	Name of Showing	Kind of Deposit	Mineral	Country Rock	Evaluation	Summary	Assay Results					
1	Lanka	Bedded Mn-oxide	Mn	Chert	D	Some lenticular shaped Mn-oxide deposits in banded chert. Ore minerals: Cryptonelane, Pyrolusite Gangue mineral: Quartz High grade part (W: 1 - 2 m) was prospected.	(Ore assay)	Fe_2O_3	MuO	P_2O_5	SiO_2	S (%)
							NA-037	2.65	13.23	0.27	78.07	0.019
							NA-038	0.51	5.77	0.14	92.54	0.007
							NA-040	0.64	42.96	0.44	33.03	0.002
2	Dapdapan	Banded Mn-oxide	Mn	Chert	D	Banded Mn-oxide deposition in banded chert Ore minerals: Pyrolusite, psilomelane Gangue mineral: Quartz	(Ore assay)	Fe_2O_3	MuO	P_2O_5	SiO_2	S (%)
							T-1	1.35	22.06	0.28	63.60	0.002
3	Kabol-Kabol	Calcite vein bearing Mn-oxide	Mn	Calcareous chert	D	Some calcite veins in calcareous chert. Ore mineral: Cryptomelane	(Ore assay)	Fe_2O_3	MuO	P_2O_5	SiO_2	S (%)
							NK-046	12.65	19.90	0.85	53.03	0.009

Evaluation D : Necessity of follow up survey is low

Others: In the northern side, another similar scaled ore body is assumed. Between both ore bodies, a low grade ore body (20 m thickness) is observed.

(Assay results)

Sample No.	Fe_2O_3	MnO	P_2O_5	SiO_2	S (%)	
NA-037	2.65	13.23	0.27	78.07	0.019	
NA-038	0.51	5.77	0.14	92.54	0.007	Quartz > Hematite > Pyrolusite
NA-040	0.64	42.96	0.44	33.03	0.002	Quartz > Cryptomelane > Ramsdellite > Hematite

(Polished section observation)

Sample NA037 consists of medium amount compact aggregation of micro-crystals and small amount of iron hydroxide.

Sample NA038 consists of small amount of pyrolusite veinlet with rare amount of cryptomelane and hematite.

A sample NA040 consists of abundant compact micro-crystals aggregation of cryptomelane which accompanies pyrolusite (shows partially colloform texture) networks.

In these samples, quartz is predominant as a gangue mineral.

2) Dapdapan Showing

Location: 2 km south of Borac, eastern part of Busuanga Is.

Details: Banded manganese ore, pyrolusite, psilomelane are recognized. Thickness: 4 m, Strike: N 40 E, Dip: vertical, Exploration adit has 35 m length.

Country Rock: Reddish brown chert.

(Assay results)

Sample No.	Fe_2O_3	MnO	P_2O_5	SiO_2	S (%)	
T-1	1.35	22>06	0.28	63.60	0.002	Quartz > Cryptomelane > hematite

(Polished section observation)

Sample T-1 consists of medium amount of compact massive aggregation of cryptomelane, in which small amount of iron hydroxide (mainly goethite) veinlet penetrated. Quartz is predominant as a gangue mineral.

3) Kabol Kabol Showing

Location: 1 km northwest of Kabol Kabol, west coast of Culion Is.

Details: Manganese dioxide ore accompanies calcite vein.
Country rock is calcareous chert of Liminangcong Formation, the showing faces the west side slope. Calcite veins have N59 W strike, 80 SW dip. Several other manganese mineral bearing calcite veins are observed.

(Assay results)

Sample No.	Fe_2O_3	MnO	P_2O_5	SiO_2	S (%)	
NK046	12.65	19.90	0.85	53.03	0.009	Quartz > Cryptomelane

(Polished section observation)

Sample NK046 consists of medium amount of cryptomelane, which shows mainly fine-grained, compact massive appearance, and medium amount of iron hydroxide (geothite or lepidochrocite). Rare amount of psilomelane and pyrolusite exhibiting colloform texture accompany the abovementioned minerals.

3-2 Geology and Ore Deposits of Palawan VI (Quezon-Rio Tuba) Area (Ref. PL-1-2)

3-2-1 General Summary

The survey area is located about 700 km SW of Manila.
Palawan IV (Nara) Area which was surveyed in 1986 is located north of this area.

Air flight service is available from Manila to Puerto Princesa (capital city of Palawan). Travel time is about one hour. Unpaved car roads connect Puerto Princesa to Aboabo (northern part of the survey area). Travel time takes 4 hours by bus. South of Aboabo, rough roads have been developed up to Rio Tuba. However, farther from this area, roads have not yet been developed. Balabac Is. which is in the southernmost part of the survey area can be reached from Rio Tuba by boat which takes about 6 hours. Chartered airplane from Rio Tuba to Candwanga Is. then to Balabac Is. by boat can also be utilized.

The geographic situation is as follows:

Area:	3,370 km^2
Elevation:	0 - 2,085 m
Highest Peak:	Mt. Mantalingajan (2,085 m)
Average Annual Temperature:	27.5°C
Average Annual Precipitation:	1,570 mm

The climate belongs to the monsoon zone of the Western Pacific Ocean, where dry season (Dec. - May) and rainy season (Jun. - Nov.) are observed. Central range of south western Palawan has 1,000 - 2,000 m elevation and shows steep topography but the coastal area and southwestern part of Rio Tuba has flat plain where farming and cattle raising were noted.

3-2-2 Stratigraphy

Succession of formation is shown in Fig. 8 (This figure corresponds to the report of southwestern Palawan in 1986).

The basement formation of this area is Pre-Cretaceous schist (BC) (correlated by BMG as Triassic), basic lava formation (K) accompanied by basic tuff and chert correlated as Cretaceous which are distributed along the central Palawan mountain range and around Mt. Balabac. Alternation of sandstone and shale (N-1) correlated to the middle to lower Miocene sediments and accompanied by partially basic pyroclastics and limestone are distributed around the Cretaceous basic lava.

Alternation of sandstone, mudstone and siltstone (N-2) correlated to the upper Miocene are exposed in a broad area along west coast of Palawan Is.
Quaternary Alluvial unconsolidated sediments (Qt) are distributed at the alluvial plains from Brookes Point to Rio Tuba in the south coast, along main drainages and in the northern part of Balabac Is.
Intrusive rocks are ultramafic rocks (Uc), gabbro (Gb) and granodiorite (Gd) intruded in to the schist (Bc) and basic lava (K) and distributed in the central Palawan mountain range and eastern part of Balabac Is.

Description for each geological unit is as follows:

- Schist Group (Bc)

  The schist group is the oldest formation in the survey area.

  Locality: Small scale outcrops are recognized at 4 km west of Pyramid Hill and around Mt. Gantung in the northeastern part of the area.

  Rock Facies: Consists mainly of green schist accompanied by pelitic and partially siliceous schist. Green schist is composed of basic material which has green to dark green color. Schistosity development is weak. Pelitic schist has black color. Schistosity develops well. Folding structure is observed in places. Siliceous schist has reddish brown color and massive appearance with weak development of schistosity. The relationship between these schists is not clear.

  Original Age: Schist group is correlated as Triassic by BMG.

Fig.-8 Schematic Columnar Section of Palawan VI Area

Geological Age			BMG (1981)	The Result of This Time		
Era	Period	Epoch	Stratigraphy in the Central to Southern Palawan	Palawan VI Area	Code	Rock Facies
Cenozoic	Quaternary	Recent	Elevated Coral	Recent sediment	Qt	Coal, Sand, Gravel
		Pleistocene				
	Tertiary	Pliocene	Iwalling Formation Alfonso XIII Formation	N2 Formation	N2	Sandstone, Mudstone, Siltstone
		Miocene	Isgod Formation Ransang Formation	N1 Limestone N1 Formation N1 Pyroclastics	NILS NI NIBt	Limestone, Sandstone, Shale Basaltic pyroclastics
		Oligocene	Pandian Formation			
		Palaeocene	Panas Formation			
Mesozoic	Cretaceous ~ Jurassic		Irahuan Metavolcanics	K-Formation, Gb, Uc	K	Basaltic lava, Tuff
	Triassic		Schist	Metamorphic rocks, Gb, Gd	BC	Schist
Paleozoic	Permian ~ Carboniferous		Altered Arkose			

Uc : Ultramafic rocks
Gd : Granodiorite
Gb : Gabbro

Ref. Geology & Mineral Resources of the Philippines, Vol. 1, 1982, BMG

(Results of whole rock analysis)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL (%)
SPR01	8.31	48.53	12.28	13.94	6.38	6.28	2.19	0.80	2.12	0.43	0.27	0.01	4.29	97.52

SPR01: Green schist

(Results of microscopic observation)

The sample (SPR01) collected 6 km NW of Brookes Point is an actinolite bearing green schist. Medium amount of albite, small amount of epidote and rare amount of quartz, sphene and iron oxide are recognized. Veinlet of iron hydroxide is found along the crack.

- Basic Lava Formation (K)

This formation unconformably overlies the schist group.

Locality: This formation shows broad distribution in the northeastern part of the survey area, especially around Mt. Aboabo, along Mantalingajan mountain range, west side of Brookes Point, upstream part of Iwahig River and around Balabac Peak of Balabac Is.

Rock Facies: Composed mainly of basic lava, accompanied by basic tuff and chert. Basic lava shows dark green to dark gray color. Brecciation and pillow structure are visible. Each block of pillow has flat ellipse shape (several cm to several 10 cm). At the marginal part, hematite is often recognized and zeolite fills cavities.

Basic tuff shows dark green to green color and used to occupy the upper horizon of basic lava although development is weak. Cyprus type massive sulfide deposit occurs in the same horizon in places. This horizon is important for exploration of such deposit.

Chert shows red to reddish brown color and is hard. Formation is limitedly distributed and recognized partially in the upper portion of the formation.

Original Age: Assumed as Cretaceous by BMG.

(Results of whole rock analyses)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL (%)
SOR39	5.83	47.18	15.55	9.81	5.04	8.15	4.54	1.10	1.77	0.50	0.16	0.01	4.30	98.11
SPR-5	4.55	52.70	13.84	9.83	3.53	7.30	6.17	1.30	1.89	0.59	0.24	0.01	2.70	100.10

SOR39, SPR-5: Basalt

(Results of microscopic observation)

The sample collected in K Formation at 10 km NNW of Males (SOR39) is a basalt which consists of weakly turbid plagioclase and clinopyroxene with intergranular texture. Chlorite partially altered clinopyroxene and occurred as cavity filling or veinlet (width: 2 - 0.03 mm).

(Results of X-ray diffraction)

The andesite sample collected in K Formation at 10 km west of Barong Barong (SOR05) contained abundant quartz and small amount of calcite and kaolinite.

- N-1 Formation

This formation unconformably overlies the K Formation.

Locality: This formation shows NE-SW elongation and is widely distributed from Quezon (NE part of the area) to Wangle River (west part of the area) and is exposed partially around Caramay River and Balabac Is.

Rock Facies: Mainly composed of alternating sandstone and shale (N-1), interbedded basic pyroclastics (N-1Bt) and limestone (N-1Ls). Alternation of sandstone and shale (N-1) shows several cm to several 10 cm alternation unit. Bedding plane is developed partially but generally massive and unclear bedding. Shale has black color. Sandstone has generally gray color and is coarse to medium-grained with fine-grained conglomerate.

Basic pyroclastics (N-1Bt) are generally dark gray tuff breccia accompanied by tuff. Basically of basaltic material but andesite portion was also recognized. Small scale distribution was seen at the NE side of Gap Hill in the central part of the area.

Limestone (N-1Ls) interfingering in the upper part of N-1 Formation, shows pale gray to pale brown color, generally fine grained and somewhat pelitic, and is exposed north of Gap Hill (central area), near Malanut Peak (north east part), east to northeast side of Rio Tuba and middle west side of Balabac Is.

Molluscs fossils were noted in places.

Original Age: Correlated as middle-lower Miocene by BMG. In this survey, fossils were detected as upper Cretaceous, but this formation was correlated as middle Miocene by synthetic judgment.

(Results of microscopic observation)

The sample of N-1Bt collected 9 km NW of Brookes Point (SPR-5) is basalt which included chilled margin facies and a scoria which consists of fresh plagioclase, clinopyroxene and orthopyroxene in the ground mass and shows intersertal texture. Chlorite and calcite occurred as cavity fillings.

(Microfossil identification)

The sample of N-1Ls collected at the west slope of Malanut Peak (SS-43R) contains radiolarian fossils but preservation are so bad that their genus cannot be decided (Foot Note).

Nannoplankton fossils were detected from this sample. The original age of it was determined as lower Eocene as a result of nannoplankton identification. The sample of N-1 mudstone collected 20 km ENE of Rio Tuba (SC-21) is correlated as upper Cretaceous by nannoplankton dating.

Another nannoplankton datings showed that the N-1 shale sample SU008R (middle of the survey area, upstream of Ransang River) is correlatable to the middle Miocene, the N-1 sandstone sample SLR-15 (NE of the survey area 5 km WNW of Punang) is correlatable from middle Eocene to middle Miocene and the N-1 sandstone sample SLR-14 (NE of the survey area: downstream of Caramay River) is correlatable to Eocene. (Foot Note II.)

- N-2 Formation

This formation unconformably overlies the N-1 Formation.

Locality: This formation is distributed around Quezon (northeast part of the area), east and south side of Malabungan and Tagbita (west coast).

Rock Facies: Sandstone, mudstone and siltstone are the main members of this formation with conglomerate partially interbedded. Sandstone shows pale gray to brown color, is generally fine to medium-grained, and stratified but massive parts are also observed.

The siliceous part of sandstone is mined as raw material for silica sand near Tagbita. On the contrary, it has a calcareous nature near Quezon. Mudstone shows generally pale gray to brown color and is turffaceous, but sometimes has a calcareous nature and is interbedded with sandstone in several to several 10 cm unit.

(Foot Note) Age determinations on Radiolaria & Foraminifera were conducted by Dr. M. Okamura: Department of Geology, Kochi University, Japan

(Foot Note II) Age deatermination on nannoplankton were done by Dr. N. Okada: Geo-Sciences Faculty, Yamagata University, Japan

The appearance of this formation is very similar to the N-1 Formation, but differ from the N-1 Formation due to the existence of N-1Ls limestone layer in the uppermost part of N-1 Formation.

Original Age: Correlated as upper Miocene by BMG (1982).

(Microfossil identification)

Microfossil were not yielded by sample from this formation.

- Alluvium (Qt)

Alluvium sediments are composed of unconsolidated gravel, sand, silt and mud, distributed along the main drainage and alluvial plain from Brookes Point to the southwestern part of Rio Tuba.

- Intrusive Rocks

Ultramafic rocks (Uc), granodiorite (Gd) and gabbro (Gb) are observed as intrusive rocks in this area.

(1) Ultramafic rocks (Uc) composed of harzburgite, dunite and pyroxenite, show generally dark green color but strongly serpentinized part change to pale green and soft. The distribution is observed from Mt. Cormi (north part of the area) to Mt. Mantalingajan (middle part), Bulanjao Range (southern part) and northern part of Balabac Is.

Dunite has suffered strong serpentinization, showed greasy luster and served as country rock of the lateritic nickel deposit in some places.

Harzburgite include short columnar phenocrysts (2 - 10 mm) of pyroxene. Pyroxenite is composed of 0.5 - 1 mm pyroxene crystals and occur as dykes.

(Whole rock analysis of Uc)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL (%)
SXR03	3.30	52.12	2.71	5.77	16.17	17.90	0.32	0.10	0.12	0.16	0.14	0.01	0.69	96.21

(Microscopic observation of Uc)

The sample collected 10 km west of Mt. Landargun (middle part of the area) is a pyroxenite composed of clinopyroxene, orthopyroxene and olivine. Clinopyroxene and orthopyroxene sometimes include each other crystals. Olivine has small scale undefinite habit (0.4 - 0.2 mm).

(2) The granodiorite (Gd) has a limited distribution at the upstream of Pulot River (northern part of the area). Gd is pale gray in color and comparatively fine grained. Small amount of hornblende occurs.

(Whole rock analyses of Gd)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL (%)
SLR-12	2.17	69.67	14.49	3.83	1.32	3.31	4.46	1.70	0.14	0.19	0.07	0.01	1.30	100.60
SW33R	0.96	67.13	10.91	8.41	0.29	1.11	4.80	5.50	0.51	0.20	0.21	0.01	1.15	100.25

SLR-12: Granodiorite SW33R: Altered dacitic rock

(Microscopic observation of Gd)

The sample (SLR-12) collected 6 km NE of Mt. Corumi (northern part of the area) is a hornblende biotite granodiorite and is a holocrystalline, comparatively fine grained equigranular rock. Some part of the hornblende and biotite minerals were altered to chlorite and epidote.

The sample (SW033R) collected 9 km NW of Mt. Mantalingajan (middle part of the area) at the western margin of Uc is a strongly altered dacitic rock in which almost all parts were altered to chlorite, epidote and actinolite. Small amount of plagioclase remained unaltered. Quartz occurs as a cavity filling mineral.

(Results of K-Ar Dating)

The result of K-Ar dating of the sample SLR-12 shows 35.5±1.8 Ma. (correlated to upper Oligocene). The age is not coincide with the age comparison of BMG.

The same analysis of the sample SW-33R shows 14.9±0.7 Ma. (correlated to middle Miocene).

(3) Gabbro (Gb: partially dolerite) observed as stock or dyke occurrences in the Uc or K Formation at the central mountain range. Stock shaped gabbro sometimes show stratified structure. Generally, it has a medium to fine grained equigranular texture and shows diabasic texture at the marginal part.

(Results of whole rock analyses)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL
SLR-2	3.45	49.55	14.89	6.04	9.24	14.97	1.22	0.60	0.24	0.23	0.15	0.01	0.47	97.61
SOR-22	4.59	48.23	20.38	7.29	3.96	11.42	3.35	1.10	1.06	0.30	0.13	0.02	2.58	99.82
SPR-28	4.28	48.78	19.05	7.47	4.02	8.87	4.17	2.50	1.30	0.47	0.13	0.03	4.60	101.40
SV-010R	1.62	42.29	25.94	2.29	7.20	14.49	1.23	0.70	0.05	0.26	0.03	0.01	3.20	97.69

SLR-2, SOR-22, SXR-03: Pyroxenite SPR-28: Harzburgite

(Results of microscopic observation)

The sample SLR-2 collected 7 km west of the Pyramid Hill (northern part of the area) is a stock shaped gabbro in the Uc which consists of plagioclase, clinopyroxene and hornblende and has a holocrystalline equigranular texture (ophitic texture in places). Some part of the clinoppyroxene are altered to hornblende and the marginal parts of the hornblende crystals are altered to talc or chlorite.

The sample (SOR-22) collected 12 km north of Brookes Point (middle part of the area) at the marginal part of Uc is a holocrystalline equigranular gabbro which consists of biotite, clinopyroxene and plagioclase. Plagioclase had undergone considerable alteration. Serpentine and prehnite-calcite veins cut this rock.

The sample (SPR-28) collected 8 km NNE of Batarasa (south coast of the middle part of the area) is a dolerite which contains phenocrysts of plagioclase and mafic minerals. These phenocrysts have changed almost completely to aggregations of sericite, chlorite and calcite.

The sample (SV010R) collected the 16 km SE of Malabungan (north coast of the middle part of the area) in the northern margin of Uc is a holocrystalline equigranular leucocratic olivine gabbro. Sericite patches in plagioclase phenocrysts and serpentine along the cracks of olivine are observed as alteration products.

3-2-3 Geological Structures

The geological structures of southwestern Palawan dominantly trend NE-SE which is parallel to the direction of the ultramafic rock intrusions in the central mountain range. The faults crossing this direction are observed at the northeastern part of the area and the Balabac Is.

Faults: The NW-SE trending fault that passes the Pulute Range northeast of the area cuts the Uc, K and N-1 formations. The NE side block had been uplifted by this fault. Other structures noted include the NW-SE fault near Mt. Gantung which had cut the Uc and K formations and faults parallel to the direction of the intrusion assumed at the southeastern part of Matalingajan mountain range.

Foldings: Numerous foldings are recognized in the Schist Group and N-1 Formation. Microfoldings are also observed in the lower portion of the N-1 Formation.

As syncline structure is noted at the midstream of Lamican River in the northwestern part which plunges gently to the NE. Wavy folding with a NE-SW axis and 2 km wavelength is observed near Gap Hill in the midwestern part.

Bedding planes of the N-1 Formation at the western side of Escapardo Peak in the southern part define a semi-dome structure (in the north, strike NE, dip NW; in the middle, strike NE, dip W and in the south, strike NW, dip SW). Small scale NE trending folds are observed in the N-1 Formation of the Balabac Is.

3-2-4 Results of Mineral Showing Survey (Ref. Appendix 11)

9 mineral showings were surveyed in this area.

Classification of these 9 showings are as follows:

a) Nickel-laterite type deposit.

1) Pulute Range 2) Rio Tuba

b) Massive sulfide type deposit.

3) Balabac

c) Massive sulfide type (Cyprus type) deposit

4) Barong Barong A 5) Barong Barong B

6) Barong Barong C 7) Males

d) Sulfide bearing quartz vein type deposit

8) Pulot

e) Silica sand type deposit

9) Tagbita

Details of these showings are in Fig. 9 and in the Appendix at the latter part of this volume (route maps, sketches and data sheets). The abstracts of these survey are shown in Table 3.

Descriptions of these showing are as follows:

1) Pulute Range

This showing is a nickel laterite type located 20 km SSW of Quezon. Olympic Mines & Development Co. had tried excavating laterite zone which has a range of 2 km x 1 km and over 3.5 m thickness (certified as a result of test pit inspection). Veinlets of garnierite are observed in dunite boulders which remain in the test pit.

(Results of ore assay)

Sample No.	Fe_2O_3	Al_2O_3	MgO	Ni	Cr_2O_3 (%)	
SLR-10B	19.61	3.11	0.66	1.24	2.91	Nickel-laterite ore
SLR-10C	6.07	0.98	26.75	3.45	0.23	Garnierite impreguated zone

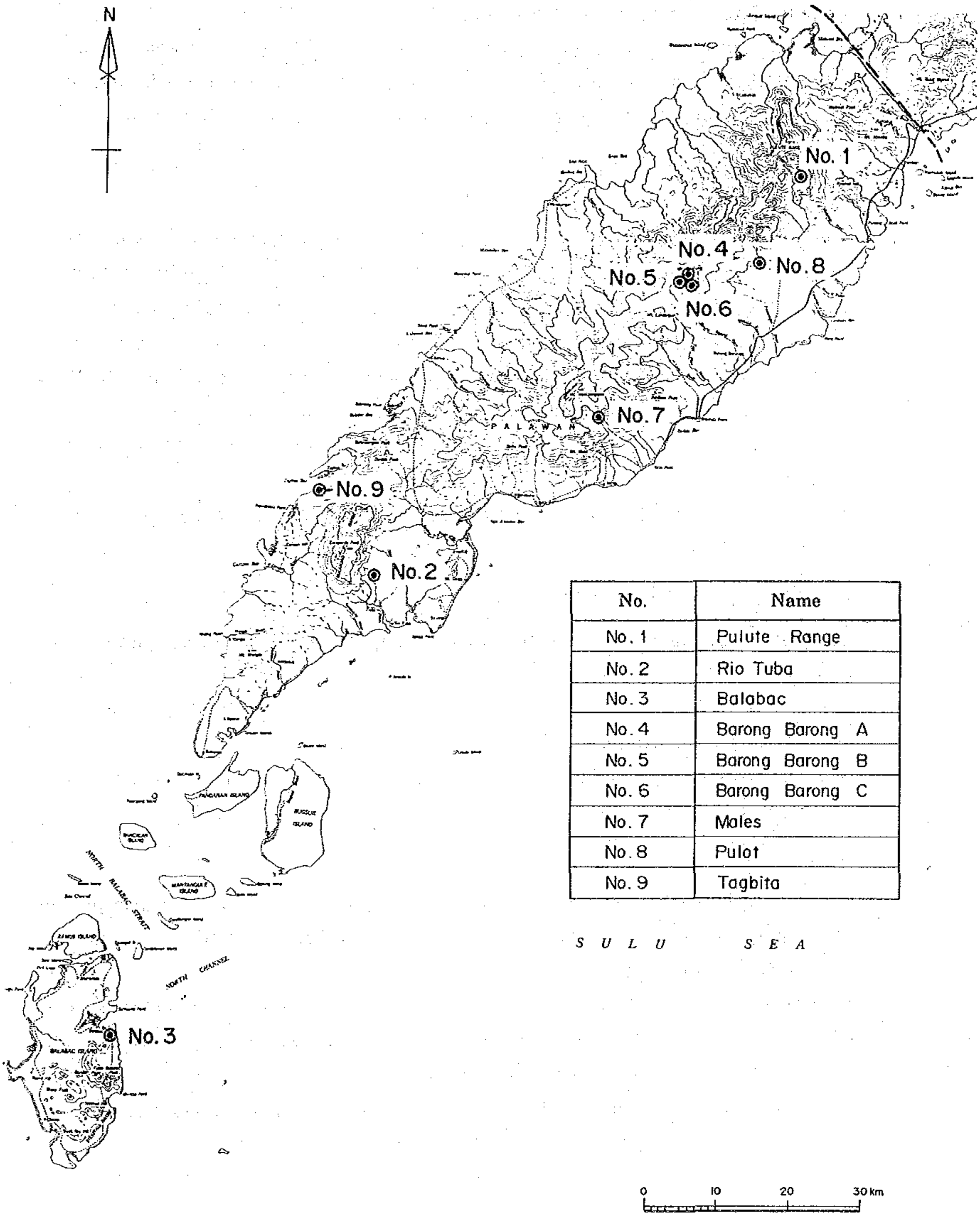
(Results of X-ray diffraction)

SLR10A & B : Wide range of goethite peaks are observed in the X-ray chart of both samples; another material estimated to be amorphous.

(Microscopic observation of polished section)

The sample SLR10C collected from the dunite boulder in a test pit is a

Fig.-9 Location Map of Mineral Showing in Palawan VI (Quezon-Rio tuba) area



No.	Name
No. 1	Pulute Range
No. 2	Rio Tuba
No. 3	Balabac
No. 4	Barong Barong A
No. 5	Barong Barong B
No. 6	Barong Barong C
No. 7	Males
No. 8	Pulot
No. 9	Tagbita

serpentinized and lateritized peridotite with small amount of chromite and magnetite as ore minerals. Garnierite has not been identified for its silicate nature.

Chromite shows xenomorphic habit in olivine crystals and sometimes takes granular form (grain size. 1 - 0.2 mm).

Magnetite has indefinite form (grain size: 0.08 - 0.01 mm) and also occurs as veinlet fillings. (width: 0.02 - 0.005 mm) Origin of these magnetite is that of an alteration product during serpentinization. Magnetic colloid attached to magnetite.

2) Rio Tuba

This deposit located in southwestern Main Palawan Is. 260 km SW from Puerto Princesa is one of the famous nickel laterite mine in the Philippines. Rio Tuba Nickel Co. has operated since 1977 and has produced 500,000 tons nickel-laterite ore (cut off grade 2% nickel, including about 30% moisture in concentrates).

At the surface, about 5 m thick lateritic soil exists and beneath it a 2 - 3 m thick low grade ore layer (nickel content: 1.5 - 1.9%) is known.

High grade ore zone which have 3 - 5 m thickness and over 2% nickel content underlie the low grade layer.

The ore zone show green to yellowish green color, loose and clayey appearance in general, but hard blocks have been noted in places.

(Results of X-ray diffraction)

Sample Pit-4A (sample of lateritic soil): Detected small amount of goethite and rare amount of quartz and talc.

Sample Pit-4B (sample of saponitic material in ore zone): Detected rare amount of saponite and serpentinite.

Sample Pit-4C (sample of serpentine zone below ore zone): Detected only abundant serpentinite.

3) Balabac

The deposit is located near Balabac village of the Balabac Is. (southernmost part of the area). From Rio Tuba, it takes 6 hours by boat or 2 hours by air via Candwanga Is. air strip.

Mineralization is of the massive sulfide type in the N-1 Formation which consists of sandstone, shale, limestone and basalt lava. Cyprus type massive sulfide or vein type appearance had been noted sometimes.

Abundant pyrite, chalcopyrite and bornite occur as ore minerals. Gangue minerals are quartz and clay minerals.

Table-3 Abstract of Mineral Showing Survey in Palawan VI (Quezon-Rio Tuba) Area

No.	Name of Showing	Kind of Deposit	Mineral	Country Rock	Evaluation	Summary	Results of Indoor Test
1	Pulute Range	Nichel-laterite	Ni	Ultramafic rock	C	Olympic Mines & Development Co. had trial exploration. Laterite zone has the range of 2 km × 1 km and over 3.5 m thickness. Veinlets of garnierite are observed in dunite.	(Ore assay) Fe_2O_3 Al_2O_3 MgO Ni CuO_3(%) SLR-10BB 19.61 3.11 0.66 1.24 2.91 SLR-10C 6.07 0.98 26.75 3.45 0.23 Small amount of chromite, rare amount of magnetite are recognized
2	Rio Tuba	Nicke-laterite	Ni	Ultramafic rock	A	Rio tuba Nickel Co. has operated since 1977. Production: 500,000 t Ni-laterite ore (cut off grade 2% Ni, about 30% moisture in concentrates) per year. Low grade layer (2 - 3 m thickness, 1.5 - 1.9% Ni) at 5 m under surface — high grade layer (2 - 5 m, over 2% Ni) under low grade layer. Ore zone is loose and clayey in general.	(X-ray diffraction) Detected geothite, quartz, talc, saponite and serpentinite.
3	Balabac	Massive sulfide	Cu	N-1 Formation	B	Ore minerals: Pyrite, Chalcopyrite, Bornite Gangue minerals: quartz, clay minerals	(Ore assay) Cu Pb Zn (%) Ag Au (g/t) BC-2 3.07 0.01 0.06 11.80 0.69
4	Barong Barong A	Cyprus type massive sulfide	Cu	Basalt lava	B	Network of Pyrite, sphalerite and quartz veinlets in country rock	(Ore assay) Cu Pb Zn (%) Ag Au (g/t) SMR-19A 3.22 0.01 5.40 16.50 0.10
6	Barong Barong C	Cyprus type massive sulfide	Cu	Basalt lava	B	Ore compose of pyrite, chalcopyrite and quartz	(Ore assay) Cu Pb Zn (%) Ag Au (g/t) SMR-1A 1.58 0.01 0.05 10.50 0.20 SMR-1B 6.52 0.02 0.01 52.00 0.21
7	Males	Cyprus type massive sulfide		Basalt lava	B	Ore compose of poyrite, chalcopyrite and quartz.	(Ore assay) Cu Pb Zn (%) Ag Au (g/t) SOR-37B 0.52 0.02 0.19 13.3 0.10
8	Pulot	Quartz vein	Cu	Basalt lava	C	Some quartz veins bearing chalcopyrite (W. 5 - 15 cm)	(Ore assay) Cu Pb Zn (%) Ag Au (g/t) SJ-139 1.42 0.01 0.01 6.5 0.07
9	Tagbita	Residual	Silica-sand	Sandstone	B	Tagbita Silica Industries Co. has operated since 1983. Production: 150,000 t Silica-Sand, 250,000 t Ceramic raw material per year.	Mineral composition of sandstone in this area: quartz 40 - 50%, K-feldspar 15 - 20%, kaoline 30 - 40%, Fe-oxide 1 - 2%, heavy mineral rare amount.

Evaluation A : Necessity of follow up survey is highest
B : Necessity of follow up survey is high
C : Possibility of follow up survey is reliable

(Results of ore assay)

Sample No.	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)	
BC-2	3.07	0.01	0.06	11.80	0.69	Massive sulfide

(Microscopic observation of polished section)

The sample BC-1 collected from the northeastern part of the excavated ore body is a massive sulfide ore which consists of abundant pyrite, medium amount of chalcopyrite (brownish: Foot Note 1) and rare amount of sphalerite including foliated (0.03 - 0.05 mm) covellite as secondary mineral and quartz as gangue mineral.

Pyrite has both idiomorphic and colloform habits and shows clastic structure in places; some brownish chalcopyrite show zonal arrangement with colloform pyrite. Sphalerite has indefinite form (grain size: 0.03 - 0.01 mm).

The sample BC-2 collected from the central part of the ore body consists of abundant pyrite, medium amount of brownish chalcopyrite, rare amount of sphalerite, galena and miargyrite. Covellite as alteration mineral and quartz as gangue mineral also occur. Colloform pyrite has not been seen.

4) Barong Barong A

This showing is located upstream of Barong Barong River 20 km north of Brookes Point. Mining owner is Lebach Mining Corp.

The mineralization is the cyprus type massive sulfide. Network of pyrite, sphalerite and quartz veinlets develop in the footwall basaltic lava. Country rock (basalt lava) is changed to green-grayish green color as the result of chloritization and silicification.

(Results of ore assay)

Sample No.	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)	
SMR-9	0.20	-0.01	0.23	7.0	-0.07	Pyrite, Sphalerite

(Foot Note 1) The possibility of the brownish chalcopyrite of containing Se had been checked by EPMA at the Technology Division of the Tokyo University which yielded a negative result. Detection limit of this EPMA for Se is <0.5%.

(Microscopic observation of polished section)

The sample SMR-19A collected from the central part of the lens shaped ore body consists of abundant marcasite, pyrite, chalcopyrite and sphalerite (0.2 - 0.03 mm size) and extra rare amount of galena (0.02 - 0.01 mm size) and miargyrite (0.03 - 0.01 mm size).

Chalcopyrite shows brownish reflection color similar to that of the Balabac Is. Pyrite shows idiomorphic granular babit (0.2 - 0.03 mm size) and framboidal (0.03 - 0.01 mm size) texture. Marcasite occurs as aggregation of columnar crystals although in other cases, it also occurs as altered fine crystals in the intergrains of chalcopyrite and sphalerite.

6) Barong Barong C

This showing is also of the Cyprus type massive sulfide, located along the Barong Barong River 600 m southeast of Barong Barong A showing. Ore is massive and composed of pyrite, chalcopyrite, quartz and hematite. Footwall of the ore body is altered basalt lava which has changed to pale green-grayish green color. Chlorite, calcite and quartz have been noted. Boulders of ferrigeneous quartz and hard mudstone which could be the hanging wall are observed.

(Results of ore assay)

Sample No.	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)	
SMR-1A	1.58	0.01	0.05	10.50	0.20	Hematite
SMR-1B	6.52	0.02	0.01	52.00	0.21	Pyrite, Chalcopyrite

(Microscopic observation of polished section)

The sample SMR-1A collected from the alternation of reddish brown ferrigenous chert and mudstone hanging wall of the ore body, consists of medium amount of pyrite (grain size: 0.5 - 0.01 mm) which shows idiomorphic or indefinite habit and is partially crushed, small amount chalcopyrite (grain size: 0.3 - 0.1 mm veinlet width: 0.1 - 0.03 mm) which shows indefinite form and small amount of hematite (grain size: 0.15 - 0.01 mm) which occurs as aggregations of columnar or needle shaped crystals at the intergrain parts of pyrite. These ore minerals are disseminated as veinlets. The sample SMR-1B collected from the central part of the ore body consists of abundant compact aggregation of idiomorphic or granular pyrite, small amount of brownish chalcopyrite and very rare amount of hematite and sphalerite which fill the intergrain space of pyrite. Aggregation of foliated covellite crystals occur as secondary mineral.

7) Males

This showing is of the Cyprus type massive sulfide deposit similar to the Barong Barong ABC showings located upstream of Tamlang River 15 km west of Brookes Point.

Basalt lava in the footwall of the ore formation is altered. Presence of chlorite and calcite have been noted.

At about 1 km NW of this showing, an ore boulder which consists of magnetite, pyrite and chalcopyrite was sampled. However, the provenance of this boulder is unknown. The boulder seems to have been derived from a contact metamorphic deposit as magnetite is contained.

(Results of ore assays)

Sample No.	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)	
SOR-37B	0.52	0.02	0.19	13.30	0.01	Pyrite, Chalcopyrite
SOR-38A	0.03	-0.01	0.04	2.30	-0.07	Magnetite, Pyrite and Chalcopyrite

(Microscopic observation of polished section)

The sample SOR-37B collected from the altered basalt midstream of Tamlang River consists of abundant granular pyrite (grain size: 2 - 0.03 mm), rare amount of chalcopyrite which fills the intergrain spaces of pyrite and rare amount of sphalerite (0.03 - 0.01 mm) which include some pyrite or fill its intergrain spaces. Chalcopyrite is brownish similar to that of the Balabac Is. and Barong Barong showings.

8) Pulot

This showing is a vein type deposit. Several veins observed along the upstream portion of Malalong River 25 km NNE of Brookes Point, have 5 - 15 cm vein width, N50°E to N60°E strike and 40° to 60° SE dip (these attitudes correspond to that of the fissure systems in adjacent areas).

Country rock is basalt lava, in which chlorite, sericite and quartz occur as a result of strong alteration. Such alteration zone is developed for about a 100 m range along the stream.

(Results of ore assay)

Sample No.	Cu (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)	
SJ-139	1.42	-0.01	0.01	6.50	-0.07	Chalcopyrite in quartz vein

(Microscopic observation of polished section)

The sample SJ-139 collected from a quartz vein in dark green basalt at upstream of Malalong River consists of medium amount of chalcopyrite, rare amount of pyrite, very rare amount of colloidal pyrite, sphalerite star in chalcopyrite, and covellite around the margin of chalcopyrite. Gangue mineral is quartz.

9) Tagbita

This showing is characterized by silica sand outcrops located near Tagbita Bay at the west coast of southwestern Palawan Main Is. Development of this outcrops was started in 1983 by Tagbita Silica Industries Co. 150,000 tons of silica sand and 250,000 tons of ceramic raw material per year were produced in recent years. Mineral composition of the sandstone in this area is as follows:

Quartz	K-feldspar	Kaoline	Fe-oxide	Heavy mineral
40 - 50%	15 - 20%	30 - 40%	1 - 2%	Rare amount

Result of the chemical analysis of sandstone from mine data is as follows:

SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	Ignition loss
86.48%	9.00%	0.10%	0.25%	0.65%	0.86%	0.40%	3.25%

(Results of X-ray diffraction analysis)

Abundant quartz and rare amount of K-feldspar and kaolin were detected in the silica sand sample.

3-3 Geology and Ore Deposits of West Negros Area (Ref. PL-1-3)

3-3-1 General Summary

The survey area is located at the southwestern part of Negros in the Philippines. Its northern limit is 10° north latitude and its eastern limit is 122° 48' east longitude. The area covers about 2,400 km^2.

Regular air service is available between Manila and Bacolod (470 km) 4 times a day. From Bacolod to the northern limit of the survey area (about 100 km), travel takes around 2 hours by car and is facilitated by the available paved roads.

Main traffic in the survey area depend on the coastal roads. Accessibility of the inland areas is difficult except for two routes between Kabankalan-Candoni and Sipalay-Sipalay Mine. As a consequence, most of the fieldwork were conducted on foot.

The geographic situation is as follows

Area	2,400 km^2
Elevation	0 - 619 m

Highest Peak	Mt. Malapandan (619 m)
Average temperature	27°C
Average annual precipitation	2,368 mm

The climate belongs to the monsoon zone of the Western Pacific Ocean, having a dry season (Nov. - Feb.) and a wet season (May - Oct.). The dry season is further subdivided into a cool season (Nov. - Feb.) and a hot season (Mar. - Apr.).

This area belongs to the western side of the Central Physiographic Province, and is characterized by highland (400 - 500 m height) topography. Main drainage systems are Sipalay River in the northwestern part, Ilog River in the northern part and Tyabana, Pagatban and Bayawan River in the southern part. These rivers have 40 - 50 km length with the alluvial plains located at the river mouth part. Farming are carried on such parts.

3-3-2 Stratigraphy

Succession of formation is shown in Fig. 10 which corresponds to the BMG geological map (1/50,000).

The general description of each formation from the lower to the upper units are as follows.

The basement formation of this area consists of basaltic and andesitic lavas named as the BF Formation and which is correlated as Cretaceous by the BMG.

The Eocene IL Formation which is primarily composed of limestone unconformably overlies the basement rocks. Upper Oligocene sediments, called here as the TC Formation, unconformably overlies the IL Formation. The lower Miocene DL Formation which is made up of limestone unconformably overlies the TC Formation. The DL Formation unconformably underlies the middle-upper Miocene CF Formation composed of sediments. Pliocene sediments (with limited limestone) grouped together as the KF Formation, unconformably overlies CF Formation. The CP Formation made up of Pleistocene andesite lava and its pyroclastics unconformably overlie the KF Formation. The Qal Quaternary unconsolidated sediments unconformably overlie all of the abovementioned formations.

Although the boundaries among all the formations are unconformities, fault contacts have also been observed.

Quartz diorite, diorite and andesite are the known intrusive rocks. Detail description for these formations are as follows:

1) BF Formation

Fig.-10 Schematic Columnar Section of West Negros Area

Geological Age			BMG (1981)	The Result of This Time		
Era	Period	Epoch	Stratigraphy of Negros	West Negros Area	Code	Rock Facies
Cenozoic	Quaternary	Recent	Quaternary Alluvium	Recent Sediemnt	Qal	Unconsolidated sand, gravel, silt
		Pleistocene	Sagay volcanics Calibing Limestone	CP Formation	CP	Andesitic tuff, Lava
	Tertiary	Pliocene	Paton-an Formation	KF Formation	KF	Sandstone, Siltstone, Limestone, Mudstone
				CF Formation	CF	Tuffaceous sandstone, Mudstone
		Miocene	Talave Formation Paghumayan Formationion Macasilao Formation	DL Formation	DL	Limestone
		Oligocene	Escalante Formation	TC Formation	TC	Sandstone, Siltstone, shale
		Eocene	Lsio Limestone	IL Formation	IL	Limestone
		Plaeocene	Basak Format			
Mesozoic	Cretaceous			BF Formation Ir	BF	Andestic, basaltic breccia, Lava, Metasedimentary rocks

Ir: Intrusive rocks consists of diorite, gabbro and andesite.

Ref. Geology & Mineral Resources of the Philippines, Vol 1, 1982, BMG

This formation is exposed in a broad area in the northwestern and southern survey area and in a limited area in the northeastern survey area. It consists of basaltic to andesitic tuff breccia, lapilli tuff and lava. Partially interbedded chert is also observed. Metasediments composed of shale, sandstone and conglomerate are observed at the northeastern part of the area. These rocks are altered generally by chloritization. Epidote spots have also been observed in places.

Basalt and andesite lavas are dark gray to dark greenish gray in color and are compact. The phenocrysts are chloritized and contain pyrite (-1 mm) spots.

Metasediments of shale, sandstone and conglomerate exhibit hard features. This formation is dated as Cretaceous by BMG.

(Whole rock analyses)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL (%)
BI-201	6.67	49.93	17.44	10.91	5.75	9.78	1.14	0.10	0.72	0.25	0.15	-0.01	0.34	96.52
FR-21	3.35	54.43	17.40	7.27	3.52	6.21	3.72	1.50	0.52	0.54	0.20	0.03	2.79	98.13
BK-55	5.26	48.43	16.89	10.69	6.06	10.18	1.96	0.20	0.64	0.33	0.21	-0.01	3.35	98.95

(Microscopic observation of thin section)

The sample collected 10 km east of Jinoba-an (west coast) (BL-201) is a basaltic tuff and contains clear polysynthetic twinned plagioclase, idiomorphic hornblende which included actinolite and orthopyroxene as phenocrysts (2 - 0.2 mm). Ground mass consists of magnetite, plagioclase, actinolite, biotite and quartz. The basalt is fine grained. The rock has undergone thermal metamorphism.

The sample collected at the midstream of Sipalay River (10 km east from west coast) (FR-21) is an altered basalt which contains plagioclase altered partially to epidote and quartz, orthopyroxene completely changed to chlorite, and mafic mineral (clinopyroxene) altered to epidote, chlorite and calcite as phenocrysts (2 - 0.2 mm). Groundmass consists of plagioclase, magnetite, chlorite, epidote and sphene. This sample shows intergranular texture.

2) IL Formation

This formation is distributed in a small range along the midstream of Cawayan River and downstream of Isit River in the northern part of the area. It is composed of stratified and pale yellow to white colored limestone.

Although it has a limited exposure, it appears that this formation unconformably cover the BF Formation on the basis of geological structure.

Geological age is correlated to Eocene by BMG.

(Results of microfossil identification)

No microfossil was yielded by this formation.

3) TC Formation

This formation is distributed widely in the eastern and northeastern part of the area and is composed of alternating sandstone and siltstone which partially interbeds with tuff. It seems that the TC and IL formations are unconformable (BMG 1982). The TC Formation had been dated as upper Oligocene.

(Microfossil identification)

The nannoplankton study for the sample (BR-70) collected 5 km SSW of Marongues Hill at the northeastern part of the area shows that the original age of this formation is correlatable to middle Eocene to lower Miocene.

4) DL Formation

This formation is distributed around Caliling River in the northwestern part, around Sipalay River in the western part, downstream of Pagatban River in the southern part of the area, and consists mainly of pink to white colored limestone interbedded with thin layers of sandstone and mudstone in places.
Its relationship with the TC Formation is an unconformity. Age is thought to be lower Miocene by BMG.

(Microfossil identification)

The sample (KRO-19) collected from the west side of Candoni (22.5 km ENE of Sipalay) contains Cellanthus (Benthos foraminifera) which defines a Pliocene to Recent age. The nannoplankton study for the same sample shows that the sample contained Oligocene to lower Miocene fossils.
Another sample (KR-020) collected near the above sample site gave a middle Paleocene to early Pliocene age nannoplankton study.
The sample (KR-027) collected 2 km east from the sample KR-019 gave an age of lower Miocene based on a nannoplankton study.

5) CF Formation

This formation is distributed in the northern and eastern part of the area, and is composed of alternating tuffaceous sandstone and mudstone interbedded acidic tuff and sandy tuff. Molluscs fossils are often observed in sandstone and mudstone. The DL Formation is covered unconformably by this formation. Hs age is correlated to the upper Miocene by BMG.

(Microfossil identification)

No microfossil was yielded by this formation.

6) KF Formation

This formation is limitedly distributed along the downstream portion of the Sipalay River in the western part and northeast coast of the area. In the western part, it is composed of sandstone, siltstone and mudstone and in the eastern part, is composed mainly of pale yellow to white colored limestone. Both of these limestones are considered as contemporaneous hetero facies.

The CF Formation is covered unconformably by this formation. Age is correlated to be Pliocene by BMG.

7) CP Formation

This formation is distributed around the upstream portion of Caliling River in the northwestern part of the area, and consists mainly of andesitic and basaltic coarse grained tuff which is interbedded with sandstone and mudstone.

The KF Formation is covered unconformably by this formation. Age is correlated to be pleistocene by BMG.

(Microfossil identification)

Nannoplankton determination of sample BM-36 from this formation collected 10 km SSW of Tuyan in the northern part of the area yielded middle Miocene age, but this formation is thought to be Pleistocene by synthetic judgment.

8) Qal Formation

This formation is distributed downstream along each river and coast line and is composed of unconsolidated gravel, sand and silt.

9) Intrusive Rocks

A) Diorite group

The diorite group is distributed along the Tayaban River and Pagatban Rive in the southwestern part of the area having a dominant NNW-SSE direction. Small scale outcrops are also observed around Sipalay River which have a NE-SW trend in the northwestern part of the area.

Medium-grained quartz diorite is the main facies of the diorite observed although porphyritic and gabbroic ones have also been noted.

Main minerals are hornblende, plagioclase and quartz in quartz diorite and hornblende and plagioclase in diorite and gabbroic rocks. The diorite group intruded the BF Formation and contained many xenolithes of BF Formation at the boundary part.

(Results of K-Ar dating)

K-Ar dating of diorites are as follows. These ages are different from BMG, but it seem to show the altered age of country rocks.

Sample No.	Locality	Rock Facies	Isotopic Age	Geological Age
BL-48	6.5 km SE of Sipalay	Diorite	26.2±1.4 Ma	Late Oligocene
FR-04	2.5 km SE Capayasan Showing	Diorite	25.1±1.3 Ma	Late Oligocene
FR-32	6 km E of Damatan Valley	Diorite	28.0±1.4 Ma	Late Oligocene

(Whole rock analyses)

Sample No.	FeO	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	BaO	LOI	TTL	
BL-48	5.14	48.73	18.38	10.92	4.73	10.32	2.22	0.50	0.69	0.51	0.21	0.01	1.24	98.46	Diorite
BL-69R	5.68	46.29	19.25	11.82	6.26	11.12	2.34	0.30	0.64	0.30	0.21	-0.01	2.24	100.80	Gabbro
BL-200	3.91	58.47	16.41	7.58	3.14	6.53	2.95	1.10	0.57	0.29	0.16	0.02	1.46	98.68	Quartz diorite
BL-202	3.35	60.45	16.27	6.63	2.44	5.64	3.07	1.80	0.59	0.29	0.13	0.03	1.07	98.41	Diorite
BL-203	4.50	58.05	15.98	8.34	3.10	6.45	3.07	1.80	0.73	0.37	0.18	0.03	1.10	99.20	Diorite
FR-04	2.86	59.18	16.18	6.70	2.77	6.40	2.86	1.90	0.61	0.31	0.11	0.03	1.57	98.62	Diorite
FR-32	3.19	61.52	15.57	5.87	2.25	5.35	2.85	1.80	0.42	0.27	0.15	0.03	3.24	99.32	Diorite

BL-69R: Gabbro, BL-200 Quartz diorite
BL-48, BL-202, BL-203, FR-04, FR-32: Diorite

(Results of microscopic observation of thin sections)

1) Quartz diorite

The samples of this rock were collected near ore showings in Sangke, Paling Camay, Capayasan in the middlewestern part of the area. They have holocrystalline equigranular texture. Main forming minerals are quartz, K-feldspar, plagioclase, hornblende and biotite. Accessory minerals are magnetitie, clinopyroxene, orthopyroxene, apatite, sphene, chlorite, epidote and zircon.

Hornblende include clino or orthopyroxene and is partially changed to chlorite, epidote and sphene. Plagioclase show clear polysynthetic twinning and zonal arrangement. Fine sericite sometimes occur.

2) Gabbro

The sample (BL-48) collected 6.5 km SSE of Sipalay in the west coast is a hornblende gabbro. Main forming minerals are quartz, plagioclase and hornblende, accompanied by clino and orthopyroxene, magnetite, apatite, epidote and calcite. Texture is holocrystalline equigranular.

3) Diorite porphyry

The sample (FR-32) collected 5.5 km NE of Damaton Valley in the central part of the area has a holocrystalline porphyrytic texture, phenocryst minerals are plagioclase, hornblende, magnetite and apatite. Groundmass consists of quartz, K-feldspar, plagioclase, magnetite, chlorite, calcite and epidote. Strong magnetism is observed.

4) Spessartite

The sample (BL-69R) collected from a gabbroic rock area 2 km NNW of Damaton Valley in the central part of the area is a spessartite which has a holocrystalline texture and porphyrytic structure. Plagioclase, hornblende and magnetite are observed as phenocrysts. Matrix is composed of plagioclase, hornblende, magnetite, sphene, calcite and chlorite.
This spessartite seems to intrude into the gabbro body as a dyke.

B) Andesitic rocks

Small outcrops of massive andesite were noted at the upstream of Ilog River in the central part of the area. It has 1 - 3 mm size idiomorphic hornblende as phenocryst and dark gray groundmass.

3-3-3 Geological Structures

The geological structures of the area are characterized by the diorite intrusions and unconformable relationships between formations.

Some differences had been noted in the mode of occurrence of the diorite between the northern and southern areas. In the north, four small isolated intrusions are observed around Sipalay Mine while in the south, a 40 km long, NNW-SSE trending intrusive body. Such trend of diorite intrusion is also observed in eastern Panay and Masbate Isls.

Field observations had also shown that three parallel linear arrangements of intrusive bodies (NNW-SSE directions) are present in the southern part of the area. A NE-SW trending intrusive body, on the other hand, is recognized around Sipalay and Jinoba-an in the northwestern part of the area.

abovementioned facts suggest the existence of two dominant structural effects which could have resulted in the hidden block structures. These effects have a strong influence in the structural control of the basement formation in this area.

Apparent faults are not recognized in the area although most of the mineral showings investigated in this survey are accompanied by shear zones. These shear zones have often contained ore minerals such as pyrite. This suggest that a probable relationship exists between the shear zones and mineralization. Major trends of shear zones are NE-SW in Sipalay Area and to that of the intrusions. These shear zones have resulted due to complicated combinations of stresses and tensions from intrusion to the mineralization stage.

As for foldings, dips of the sedimentary rocks are low angled in general, making folding that of the flexture type.

The circular shaped DL Formation is distributed around the BF Formation and the diorite group. This suggests that the presence of a shallow water basin around an uplifted block of the BF Formation and diorite group is responsible for the deposition of the DL Formation.

3-3-4 Results of Mineral Showing Survey (Ref. Appendix 11)

The following nine mineral showings are investigated in the present survey (Fig. 11). Abstracts of these results are shown in Table-4.

Details of each mineral showing are as follows:

1. Calatong River II (Porphyry Copper Deposit)

   This mineral showing is located around the upstream portion of Calatong River (branch of Sipalay River) and is developed at the boundary between andesite (belonging to the BF Formation) and quartz diorite. Both country rocks had suffered strong silicification and other alterations. Malachite and pyrite accumulate along the sheared plane which developed in the mineralized zone.

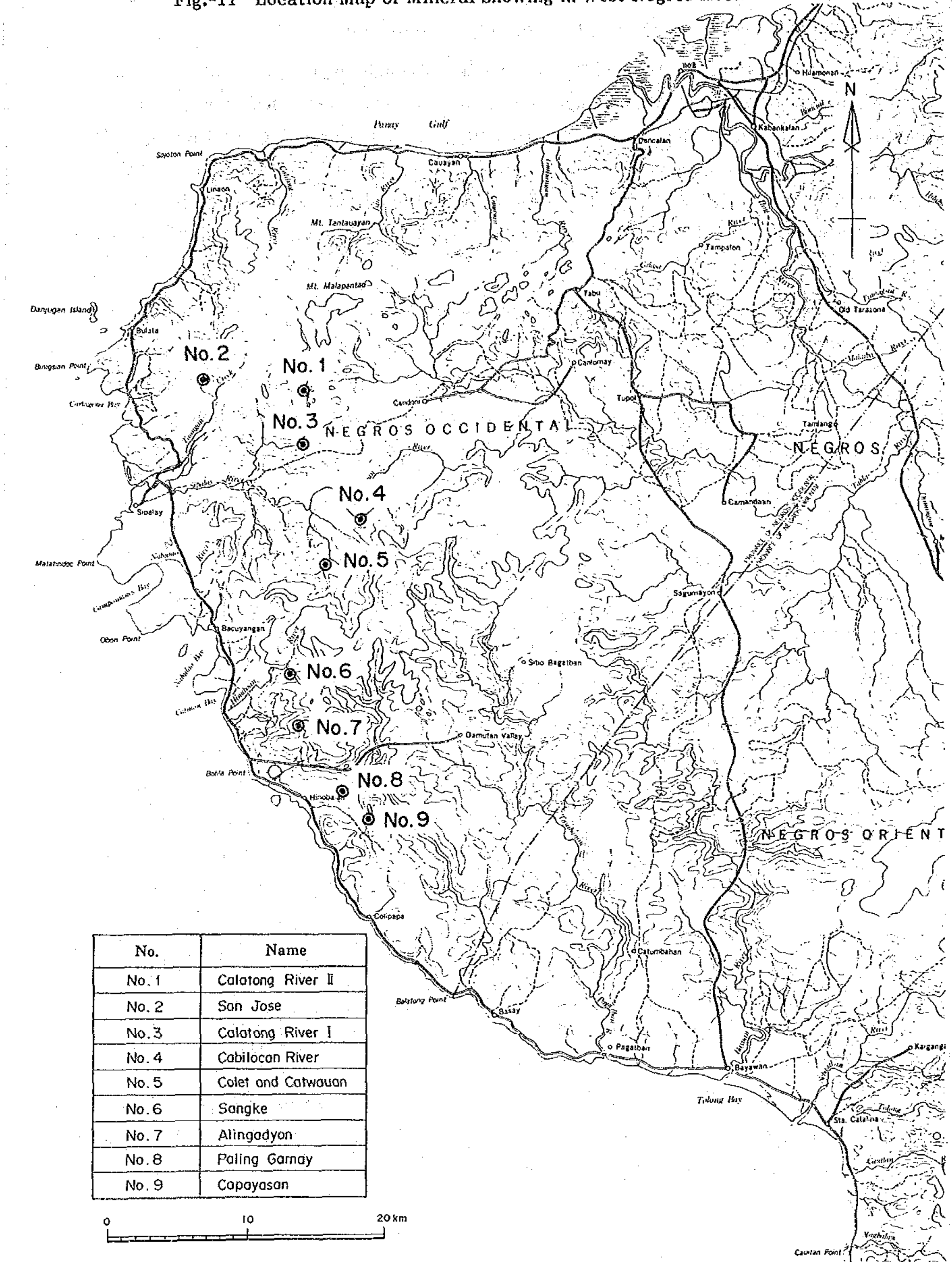
   (Result of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
SIBC-02	-0.01	-0.001	-0.01	-0.01	0.21

   (Microscopic observation of polished section)

   The strongly silicified sample (SIBG-04) collected at the west branch of Calatong River include idiomorphic pyrite (grain size: 0.2 - 0.02 mm) and sphalerite (grain size: 0.05 - 0.01 mm) as impregnated form.

Fig.-11 Location Map of Mineral Showing in West Negros Area



No.	Name
No. 1	Calatong River II
No. 2	San Jose
No. 3	Calatong River I
No. 4	Cabilocan River
No. 5	Colet and Catwauan
No. 6	Sangke
No. 7	Alingadyon
No. 8	Paling Garnay
No. 9	Capayasan

Table-4 Abstract of Mineral Showing Survey in West Negros Area

No.	Name of Showing	Kind of Deposit	Ore Mineral	Country Rock	Evaluation	Summary	Results of Indoor Test
1	Calatong River II	Porphyry Copper	Cu	Andesite of the BF Formation, Quartz diorite	D	Strongly silicified, altered zone at the boundary between andesite and quartz diorite: Accumulated malachite, pyrite along sheared plane: Silicification, chloritization and sericitization.	(Microscopic observation) disseminated ore of idiomorphic pyrite (grain size 0.2 - 0.02 mm) and sphalerite (grain size 0.05 - 0.01 mm) as impregnated form
2	San Jose	Porphyry Copper	Cu	Andesitic pyroclastics, Quarty diorite, Dacite	D	Siplay Mine by Maricalum Mining Co: Crude ore production per day 30,000 t (0.54% Cu) from open pit (1,500 m × 200 m × 186 m): Chalcopyrite, primary bornite, pyrite, molybdenite as disseminations and network veinlets.	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) BA-01 0.96 0.012 -0.01 -0.01 0.14 BA-02 2.11 0.001 -0.01 -0.01 0.07 BA-05 0.29 0.265 -0.01 -0.01 -0.07
3	Calatong River I	Porphyry Copper	Cu	Andesite of the BF Formation	D	Strongly silicified, sheared (NNW-SSE direction) altered andesite: Chalcopyrite, pyrite and malachite	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) SIBG-02 -0.01 -0.001 -0.01 -0.01 0.21 (X-ray diffraction analysis) mixed layer clay mineral and anatase
4	Cabilocan River	Porphyry Copper	Cu	Andesite of the BF Formation	C	Silicified, chloritized andesite: Pyrite and chalcopyrite as disseminations	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) SIBM-01 -0.01 0.001 -0.01 0.01 -0.07 (X-ray diffraction analysis) chlorite and sericite as alteration minerals
5	Colet and Catwanan	Porphyry Copper	Cu	Andesite of the BF Formation	C	Silicified, chloritized and sheared andesite: Disseminated pyrite and chalcopyrite in sheared zone: Quartz as gangue mineral	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) SIBC-01 -0.01 0.001 -0.01 -0.01 -0.07 (X-ray diffraciton analysis) quartz, chlorite and sericite as alteration minerals
6	Sangke	Porphyry Copper	Cu	Quartz diorite	D	Sheared zone (N-S to NW-SE direction) bearing malachite, pyrite, small amount of chalcopyrite: Clay as gangue	
7	Alingadyon	Porphyry Copper	Cu	Andesite of the BF Formation	D	Sheared zone (NW-SE direction) at boundary between andesite and quartz diorite: Chalcopyrite, malachite and azurite as dissemination: Clay as gangue	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) A-01 0.01 -0.001 -0.01 0.02 -0.07
8	Paling Gamay	Epithermal Vein	Au	Quartz diorite	D	Gold bearing quartz veins in quartz diorite 3 km east of Jinoba-an: Strong oxidation	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) PD-00 0.03 0.02 -0.01 10.0 0.96 Geothite and lepidechrocite as iron hydroxide mineral
9	Copayasan	Porphyry Copper	Cu	Andesite of the BF Formation, Quartz diorite	C	Network of quartz and clay (N-S direction) at the boundary between andesite and quartz diorite: Malachite, azurite as ore minerals	(Ore assay) Cu (%) Mo (%) Pb (%) Zn (%) Au (g/t) C-01A 0.36 0.002 -0.01 0.10 -0.07 (X-ray diffraction analysis) quartz and chlorite as alteration minerals

Pyrite grain sometimes include micro-crystals of chalcopyrite and sphalerite (grain size: 0.03 - 0.005 mm).

(Results of X-ray diffraction analysis)

The sample (SIBG-04) is an altered andesite accompanying pyrite impregnation. Silicification, chloritization and sericitization are observed as wall rock alterations.

2. San Jose (Porphyry Copper Deposit)

This deposit is operated as Sipalay Mine by the Maricalum Mining Co., which is financed by the Central Bank of Philippines and Marubeni Corp., etc.
Daily production rate is 30,000 tons, 0.54% Cu in recent.
Ore body is located at the boundary between andesitic pyroclastics (BF Formation) and intruding quartz diorite and porphyritic dacite as porphyry copper deposit.
Mining method is open pit. Pit scale is 200 m × 1,500 m in area and 186 m in depth. Ore minerals are chalcopyrite, primary bornite, pyrite and molybdenite as disseminations and network veinlets. Generally, molybdenite is rich in upper part and decreases in the lower horizon. On the contrary, arsenic content increases in the lower part.
Country rock alterations are silicification, sericitization and biotitization. Sericitization is very visible while chloritization is only observed at the marginal parts of mineralization.

(Result of ore assays)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
BA-01	0.96	0.012	-0.01	-0.01	0.14
BA-02	2.11	0.001	-0.01	-0.01	0.07
BA-05	0.29	0.265	-0.01	-0.01	-0.07

(Microscopic observation of polished sections)

A chalcopyrite disseminated sample (BA-01) collected at the middle north part of the pit is composed of a lot of pyrite (1 - 0.1 mm size), medium amount of chalcopyrite (0.1 - 0.01 mm size) and rare amount of sphalerite (0.06 - 0.005 mm size) as ore minerals. Gangue mineral is basically quartz.
Chalcopyrite occurs as cementing material between the intergrain spaces of idiomorphic pyrites and as micro-crystal inclusions, also in pyrites.
The chalcopyrite and bornite veinlet sample (BA-02) collected at the middle north part of the pit is composed of small amount of chalcopyrite (0.5 - 0.01 mm size), bornite (0.5 - 0.01 mm size), titanium mineral (anatase?) as ore minerals and

quartz, calcite etc. as gangue minerals.

Molybdenite veinlet bearing sample (BA-05) collected at the middle north part of the pit is composed of small amount of platy or foliated molybdenite (0.1 - 0.05 mm length), rare amount of chalcopyrite which cements the intergrain spaces of molybdenite and very rare amount of tetrahedrite, bornite, sphalerite, pyrite as ore minerals. Quartz is the dominant gangue mineral.

(Results of X-ray diffraction analysis)

The sample (BA-01) is a chalcopyrite disseminated quartz diorite. Anhydrite, gypsum, chlorite and sericite are recognized as alteration minerals.

The sample (BA-05) is a molybdenite bearing quartz diorite. Anhydrite, gypsum, sericite and kaoline are recognized as alteration minerals.

3. Calatong River I (Porphyry Copper Deposit)

This showing is located in downstream of Calatong River (branch of Sipalay River). The country rock is andesite of the BF Formation which is strongly altered and silicified. Shear zone of NNW-SSE direction develops in the andesite.

Ore minerals are chalcopyrite, pyrite and bornite.

(Results of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
SIBG-02	-0.01	-0.001	-0.01	-0.01	0.21

(Microscopic observation of polished section)

In the strongly silicified sample (SIBG-02) collected at the foot wall of a NNE trending fault along Calatong River, small amount of idiomorphic pyrite (0.4 - 0.03 mm size) and rare amount of indefinite shaped sphalerite (0.05 - 0.01 mm size) are recognized. Gangue mineral is mainly quartz.

(Results of X-ray diffraction analysis)

The sample (SIBG-01) is a pyrite disseminated altered andesite. Sericite montmorillonite, identified as mixed layer clay minerals, and anatase are recognized as alteration minerals.

The sample (SIBG-02) is a pyrite bearing altered andesite. Silicification and kaolinization are recognized as wall rock alterations and anatase is identified as the alteration mineral.

4. Cabilocan River (Porphyry Copper Deposit)

This showing is located at the boundary of andesite of the BF Formation and quartz diorite around Cabilocan River (upstream of Sipalay River).

The andesite suffered silicification and chloritization, accompanied by pyrite and small amount of chalcopyrite as disseminations. Quartz occurs as gangue mineral.

(Results of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
SIBM-01	-0.01	0.001	-0.01	0.01	-0.07

(Microscopic observation of polished section)

The argillaceous sample (SIBM-01) collected at the south side of Cabilocan River is a chloritized and pyrite disseminated rock. Idiomorphic magnetite (0.6 - 0.1 mm size) assumed to be of igneous origin and idiomorphic or indefinite shaped pyrite (1 - 0.1 mm size) disseminations are recognized as ore minerals. Main gangue mineral is quartz.

(Results X-ray diffraction analysis)

Pyrite is identified as ore mineral. Chloritization and epidotization are recognized as wall rock alterations.

5. Colet and Catwanan (Porphyry Copper Deposit)

This showing is located in the andesite of the BF Formation around Binucawan River (branch of Sipalay River). The andesite had suffered silicification and chloritization. Sheared zone had developed also in it.
Ore minerals are chalcopyrite and pyrite disseminated in the sheared zones. Quartz occurs as gangue mineral.

(Results of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
SIBC-01	-0.01	0.001	-0.01	-0.01	-0.07

(Microscopic observation of polished section)

The sample (SIBC-01) is a medium-grained fractured andesite, collected at the north side of Binucawan River. Idiomorphic or indefinite shaped pyrite (0.03 - 0.005 mm size) which include micro-crystals of chalcopyrite and sphalerite in rare cases, and indefinite shaped sphalerite are recognized as dissemination minerals. In addition, indefinite or veinlet shaped hydrous iron mineral (mainly goethite) is observed as secondary mineral. Main gangue mineral is quartz.

(Results of X-ray diffraction analysis)

Silicification, chloritization and sericitization are recognized as wall rock alterations in the sample (SIBC-02).

6. Sangke (Porphry Copper Deposit)

This showing is located in the quartz diorite at Sangke Creek 10 km north of Jinoba-an. Sheared zone (N-S to NW-SE direction) develops in the country rock. Malachite, pyrite and small amount of chalcopyrite accumulate along the sheared zone. Clay minerals are also present as gangue minerals.

7. Alingadyon (Porphyry Copper Deposit)

This showing is located in the boundary of the andesite of the BF Formation and of the quartz diorite 5 km north of Jinoba-an. Ore minerals are chalcopyrite, malachite and azurite with quartz and clay as gangue minerals. NW-SE trending sheared zone develops in the country rocks.

(Results of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
A-01	0.01	-0.001	-0.01	0.02	-0.07

8. Paling Gamay (Gold bearing Quartz Vein)

This showing consists of gold bearing quartz veins in the quartz diorite 3 km east of Juinoba-an. Country rock suffered strong oxidation. Quartz veinlets are observed in places.

(Results of ore assays)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
PD-00	0.03	0.02	-0.01	10.0	0.96
PD-02	-0.01	-0.01	0.01	1.0	-0.07

(Microscopic observation of polished sections)

The sample (PD-00) is a strongly altered biotite diorite which is penetrated by quartz veinlet (1 cm width) in network structure.
geothite and lepidochrocite with colloform texture are observed as secondary minerals in the oxdized zone. Rare amount of pyrite, galena and sphalerite accompany the iron hydroxide minerals. Gangue mineral is quartz.
Small amount of magnetite with ilmenite band is recognized at the surface argillization zone (Sample No. PD-02). Extra fine mineral assumed as an ulvöspinel exsolution in magnetite has also been noted.
Ilmenite lamella sometimes accompany ilmenite-hematite mixture.

(Results of X-ray diffraction analysis)

Quartz is identified only in the sample (PD-00) which consists of limonite and quartz.

9. Capayasan (Porphyry Copper Deposit)

This showing is located in the boundary between the andesite of the BF Formation and quartz diorite at Capayasan Creek 5 km southeast of Juinoba-an. Sheared zone develops in quartz diorite in which network quartz veinlets (2 cm) cut in N-S direction.

Ore minerals are malachite and azurite which accompany quartz and clay minerals.

(Results of ore assay)

Sample No.	Cu (%)	Mo (%)	Pb (%)	Zn (%)	Au (g/t)
C-01A	0.36	0.002	-0.01	0.10	-0.07

(Microscopic observation of polished section)

In the quartz vein sample (C-01A) collected at the sheared zone in quartz diorite, small amount of magnetite assumed to be of country rock origin and altered partially to chalcopyrite, chalcopyrite which accompany bornite with secondary blue chalcocite and covellite at the marginal part, rare amount of hematite and very rare amount of sphalerite and galena are observed.

(Results of X-ray diffraction analysis)

In the sample (C-01A) collected from the copper mineral bearing quartz diorite, silicification and chloritization are observed as alteration results. Hornblende was identified as a relict mineral of the country rock.

Fig.-12 Schematic Columnar Section of Samar I~III Area

Geological Age			BMG (1981)	The Result of This Time		
Era	Period	Epoch	Stratigraphy of Samar	Samar I~III Area	Code	Rock Facies
Cenozoic	Quaternary	Recent	Quaternary Alluvium	Recent Sediemnt	Qal	Unconsolidated mud, silt, gravel
Cenozoic	Quaternary	Pleistocene	Calicoan Formation	Calicoan Formation	Cal	Porous reef coral
Cenozoic	Tertiary	Pliocene	Catbalogan Formation	Catbalogan Formation	Cat	Alternation of marl, sandstone, conglomerate
Cenozoic	Tertiary	Miocne	Daram Formation	Daram Formation	Dar	Lava with volcanic clastics, sedimentary rocks
Cenozoic	Tertiary	Oligocene	Diorite Intrusive	Intruded Diorite	Gd	Chloritized, Epidotized
Cenozoic	Tertiary	Eocene	Felsic Volcanics			
Cenozoic	Tertiary	Palaeocene		Felsic Volcanic Rocks	Fel	Dacitic lava Volcanic clastics Lapilli tuff
Mesozoic	Cretaceous		Balo River Series	Balo River Formation	Bal	Metasedimentary rocks
Mesozoic	Cretaceous		Camcuevas Volcanics	Camcuevas volcanics	Cam	Basalt~Andesite Dacitic clastics

Ref. Geology & Mineral Resources of the Philippines, Vol 1, 1982, BMG

3-4 Geology and Ore Deposits of Samar I~III Areas (Appendix 1-4)

3-4-1 General Summary

The survey areas are located in the southern and the eastern parts of Samar Is. and belong to the central Samar~Danao region (Sub Province) in the Eastern Physiographic Province.

Transportation to the survey areas from Manila is as follows: regular flight services are available from Manila to Tacloban in Leyte Is. or Catarman in Samar Is., and the survey areas are approximately 20 km away from Tacloban.

In the survey areas, the main transportation route is the national highway. Route 1 running through the western coastal area, and the only transverse route is the 56 km road (about 1 hr. 25 min.) from Wright in the western coast to Taft in the eastern coast.

The geographic situation is as follows:

Area	:	2.148 km^2
Elevation	:	0 m ~ 896 m
Highest peak	:	Mt. Capotoan (896 m)
Average temperature	:	27.2°C
Average annual precipitation	:	4,244 mm

The climate belongs to a tropical monsoon climatic zone of the western Pacific. Rainy season is between November and January, but dry season is not observed in these areas. Precipitations are different in the two sides of the anticlinal ridge running through the central area. The precipitations are approximately 4,300 mm in the northeastern side and 2,300 mm in the southwestern side.

Typhoons are often formed in the Pacific Ocean, southeast of Samar Is. and it is said that about 40% of typhoons hitting the Republic of the Philippines strike the eastern Visayas Area which include the Samar Is.

3-4-2 Stratigraphy (Fig. 12)

The stratigraphy in these areas is described starting from the lower formation as follows:

1) Camcuevas Volcanics

This formation which is composed of argillized dacitic pyroclastic rocks in the lower part and basaltic-andesitic volcanic rocks in the upper part is approximately 650 m thick. It is widely distributed in the inland places such as Bagacay and

Hinabangan. On the basis of the stratigraphy in the area, this formation is thought to be of Cretaceous age and is the oldest in the surveyed areas.

(Assay Results)

(Results of radiometric dating by K-Ar Method)

The sample collected at 12 km northwest of the central Bagacay area (WK012R) gave a 98.7±4.9 Ma. (Cretaceous) age.

(Results of microscopic observations)

(HK01R) : This sample was taken 42 km northeast of western Catbalogan and is a hyalopilitic aphyric andesite composed of plagioclase, clinopyroxene magnetite, orthoyroxene, quartz and ilmenite.
It is magnetic and is slightly choritized.

(NG02R): This sample was collected 27 km west of Dolores in the northeastern coast and is an intergranular basalt containing phenocrysts of plagioclase and orthopyroxene. It is magnetic and plagioclase is remarkably altered to zeolites.
Albite, chlorite and calcite are observed as alteration minerals.

(NG05R): This sample was taken 28 km west of Dolores in the northeastern coast and is an aphanitic dacite containing phenocrysts of quartz, plagioclase and magnetite. Zeolite stockwork (width: ±0.1 mm) is generally observed. Chlorite and zeolite are also observed as alteration minerals.

(NK08R): This sample was taken 33 km northeast of Catbalogan in the western part and is an intergranular basalt containing fresh phenocrysts of plagioclase, orthopyroxene and clinopyroxene.
It is magnetic.

(NK34R): This sample was collected 40 km northeast of Catbalogan in the western part and is an intergranular basalt containing phenocrysts of platioclase and mafic minerals. The plagioclase are albitized and chlorite was observed as the dominant alteration mineral.

(WK012R): This sample was sampled 12 km northwest of Bagacay in the central part and is a dacite containing phenocrysts of quartz, plagioclase, potassium feldspar and magnetite.
Alteration is observed remarkably so that the original texture of the groundmass is not clear.

Quartz, chlorite, epidote, sericite and zeolite are observed as alteration minerals.

(WN003R): This sample was taken 3 km northeast of Osmeña in the southwestern edge and is a basalt containing phenocrysts of plagiocalse, clinopyroxene and orthopyroxene. Chlorite and sericite are observed as alteration minerals.

2) Balo River Series

This formation is a 400 m thick steeply dipping metasedimentary rock unit distributed in the eastern part of Samar Is. such as General MacArthur, Bagacay and Sulat. This rock unit unconformably overlies the lower formation. Limestones included in this formation yielded an upper Cretaceous age on the basis of foraminiferal fossils.
The formation period is considered upper Cretaceous with fossil foraminifera in limestone contained in this formation.

(Assay Results)

EJ01: coarse-grained andesite

(Results of microfossil identifications)

(EN03): Nannoplankton determination of a sample collected 5 km west of Rongan in the eastern coast yielded an upper Cretaceous age.

(FWS003): Nannoplankton determination of a sample collected 6 km north of Balangiga in the southern coast yielded an upper Cretaceous age.

(NK06R): Nannoplankton determination of a sample collected 35 km northeast of Catbalogan in the western part yielded an upper Cretaceous age.

(Results of microscopic observation)

(EJ01): This sample taken 6 km northwest of Borongan in the eastern coast and is a coarse - grained two - pyroxene andesite containing phenocrysts of plagioclase, clinopyroxene and orthopyroxene.
It shows intersertal texture. The plagioclase and clinopyroxene crystals are fresh, but orthopyroxene is completely replaced by chlorite and calcite.

3) Felsic Volcanics

This rock unit is characterized by an alternation of dacitic lavas, volcanic breccias and lapilli tuff strata and overlies unconformably the lower formation. This rock unit is widely distributed in the central part of Samar Is. On the basis of stratigraphic relationships with the overlying and underlying rock units, this formation is thought to be of Palaeogene age.

4) Daram Formation

This 1,000 m thick formation is composed of steeply dipping volcanic rocks and pyroclastic rocks. Limestone, mudstone and shale layers had been noted intercalated with these volcanic rocks. This formation is widely distributed in the central-western portion of Samar Is. and Daram Is. On the basis of foraminiferal fossils, this formation is thought to have been deposited during the upper Oligocene to middle Miocene period.

(Assay Results)

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Bao
EN02	46.41	1.43	5.32	1.62	1.53	0.35	0.98	0.04	0.23	29.93	2.31
EN09	1.98	0.68	0.60	0.63	52.00	0.29	0.42	0.02	0.03	0.43	0.03
WL014R	72.17	13.45	3.13	2.23	3.01	3.58	0.79	0.42	0.11	0.29	0.03
WN003R	51.61	15.40	9.73	5.84	6.64	5.22	0.95	0.56	0.08	0.17	<0.01

EN02: manganese dioxide EN09: limestone WL014R: andecite WN003R: basalt

(Results of microfossil identification)

(EQ2R): Nannoplankton determination of a sample collected 7 km north of General MacArthur in the southeastern coast yielded an upper Eocene to lower Oligocene age.

(Results of microscopic observation)

(EN09): This sample collected 3 km south - southeast of Bagacay in the central part and is a limestone containing foraminifera 0.1 ~ 0.2 mm in diameter.
A large amount of irregular - shaped calcite is observed.

(WG005): This sample was taken 9 km west - northwest of Bagacay in the central part and is an altered andesite containing phenocrysts of plagioclase and mafic minerals.
Alteration is observed remarkably, so that the original texture of the groundmass is not clear. Plagioclase is albitized and mafic minerals is completely replaced with chlorite, calcite, titanite and epidote.

5) Catbalogan Formation

This more than 500 m thick formation is composed of gently undulating clastic rocks which include marls, siltstone, sandstone and conglomerates. Unconformably overlying the lower formation, it is widely distributed north of Catbalogan in the western coast and the northern portion of the eastern coast. This formation is thought to have been deposited during the upper Miocene to lower Pliocene period.

(Results of X-ray diffraction analysis)

(WE006R): This is a tuff sampled 4 km north of Marabut on the southwestern edge.
A large amount of quartz and feldspar, a medium amount of loumontite and a small amount of chlorite and calcite had been detected.

(WK013R): This is a dacitic tuff breccia sampled 13 km northwest of Bagacay in the central part.
A large amount of quartz and feldspar, a medium amount of chlorite and a small amount of mica had been detected.

6) Calicoan Formation

This formation is made up of porous limestones which includes a lot of shells and corals. It is mainly distributed in the southeastern edge of eastern Samar and Calicoan Is. and covers the lower formations unconformably. This rock unit is thought to have been deposited during the upper Pliocene to Pleistocene period.

7) Recent Sediments

The Recent Sediments are characterized by unconsolidated silts, gravels and muds generally distributed along floodplains.

The intrusive rocks observed in these areas are as follows:

8) Ultramafic Rocks

The ultramafic rocks composed of serpentinized periodotite, dunite and gabbro are distributed as irregular blocks along the NW-SW trending thrust encountered in the southeastern part of Samar Is. These rocks are thought to be part of the Bicol-Eastern Mindanao ophiolite zone. Time of emplacement is thought to be during the Cretaceous time.

(Results of X-ray diffraction analysis)

(EH3R): This is a serpentinized peridotite sampled 13 km west-northwest of Llorente in the southeastern coast. A large amount of magnetite and a very small amount of pyrite had been detected.

(EQ3R): This is a troctolite sampled 6 km north of General MacArthur in the southeastern coast.
A large amount of amphibole, a medium amount of prehnite and a small amount of chlorite had been detected.

(WF002R): This is a serpentinized peridotite sampled 15 km northwest of Giporlos on the southern edge. A large amount of serpentinite and a small amount of calcite and pyrite had been detected.

(Assay Results)

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Bao
EF01R	39.61	0.92	8.17	35.23	0.35	0.17	0.21	0.02	<0.01	0.10	<0.01
EH4R	39.27	1.60	8.15	35.88	2.36	0.17	0.28	0.03	<0.01	0.12	<0.01

EF01R, EH4R: peridotite

(Results of microscopic observations)

(EQ03R): This sample was taken 5 km north of General MacArthur in the southeastern coast and is a hornblende gabbro mainly composed of plagioclase, amphibole and tremolite.
It shows holocrystalline - equigranular ~ holocrystalline - porphyritic texture.
Plagioclase is replaced by sericite while the magnetic amphiboles were replaced by tremolite. Stockwork of tremolite is observed (width 0.1 ~ 0.7 mm).

(EF01R): This sample was taken 4 km north - northeast of General MacArthur in the southeastern coast and is a peridotite mainly composed of olivine and orthopyroxene. Secondary minerals included chlorite, magnetite and talc.
It shows holocrystalline - equigranular texture. Olivine had been serpentinized remarkably.
Serpentine, bustamite and tremolite are observed as alteration minerals.

(EH04R): This sample was collected 12 km west - northwest of Llorente in the southeastern coast and is a two - pyroxene peridotite containing phenocrysts of orthopyroxene, olivine and clinopyroxene.
It shows a holocrystalline-equigranular texture and remarkable

serpentinization. Groundmass is composed of granular picotite and magnetite networks.

(WF003R): This sample was collected 15 km northwest of Giporlos in the southern edge and is a hornblende gabbro mainly composed of plagioclase and amphibole. Titanite, magnetite and ilmenite were also observed. It shows holocrystalline - equigranular texture. Plagioclase is altered remarkably Pumpellyite had also been noted.

(WF002R): This is a serpentinized peridotite sampled 15 km northwest of Giporlos on the southern edge.
Microscopic observation of polished sample showed the presence of a small amount of chromite (granular, irregular - shape, rarely idiomorphic, size 0.05 ~ 0.3 mm) and a negligible amount of pyrite (idiomorphic, irregular - shape, size 0.005 ~ 0.03 mm).

9) Diorite

This coarse-grained diorite is composed of plagioclase, pyroxene and amphibole. It is partially chloritized or epidotized. It intruded the Cretaceous series in Camcuevas in the southern part of eastern Samar, Bagacay in central Samar and Wright in western Samar. Period of intrusion is thought to be during the Palaeogene. This intrusive body is considered part of the Palaeogene Samar diorite/granite intrusive belt.

(Assay Results)

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Bao
WL010R	48.51	12.63	6.19	3.25	15.36	2.57	0.51	0.53	0.08	0.22	0.03
WN001R	49.91	15.46	9.52	5.91	10.07	3.19	1.53	0.55	0.12	0.19	0.03

WL010R: altered diortie WN001R: micro-diorite

(Results of microscopic observations)

(WE001R): This sample was taken 4 km north of Marabut in the southwestern edge and is a holocrystalline - equigranular quartz diorite mainly composed of quartz, plagioclase, clinopyroxene and amphibole.
The volume of quartz amounts to 8 ~ 10%.
Chlorite and sericite are observed as alteration minerals.

(WE009R): This sample was collected 7 km north of Osmena in the southwestern edge and is a holocrystalline - equigranular diorite mainly composed of plagioclase, clinopyroxene, orthopyroxene and amphibole.
Although alteration is rarely observed, amphibole had been noted to be partially or completely chloritized.

(WL010R): This sample was taken 14 km northwest of Bagacay in the central part and is a diorite porphyrite containing fresh plagioclase and phenocrysts of amphibole. It shows holocrystalline - porphyritic texture. Alteration is slightly observed, and a small amount of chlorite, epidote and sericite are observed.

3-4-3 Results of Mineral Showing Survey (Appendix - 11)

In Samar I~III areas, the survey was carried out in the following five showings.

Classification into deposit types are given as follows:

a) Kuroko type deposit

1) Bagacay 2) Pasiko Creek 3) Tiga Creek 4) Uli Creek

b) Vein type manganese deposit

1) San Jose

Locations of these mineral showings are shown in Fig. 13, and the sketch and data sheet of each showing are shown in the Appendixes.

(Results of microscopic observation of polished ore)

Bagacay: Sample (EN06) is a quartz - pyrite ore mostly composed of pyrite. Pyrite is granular, irregular - shape and sometimes idiomorphic and its size is 0.05~0.5 mm. The sample contains a negligible amount of chalcopyrite (0.005~0.03 mm) or sphalerite (0.005~0.04 mm). The gangue mineral is a large amount of quartz.
Sample (EN07) is a massive pyrite ore mostly composed of pyrite. Pyrite is idiomorphic and occurs as aggregations. The sample contains a negligible amount of sphalerite.
Sample (EN08) is pyrite ore. Pyrite is generally idiomorphic and irregular - shaped. It sometimes contains a small amount of chalcopyrite (0.001~0.04 mm) and a negligible amount of sphalerite. The gangue mineral is a large amount of quartz.
Sample (EJ08) is the aggregation of coarse - grained pyrite (0.2~2.5

mm) and barely contains fine - grained sphalerite (0.005~0.04 mm), galena (0.01~0.03 mm) and rock - crystal (0.005~0.003 mm).

The gangue mineral is a small amount of quartz.

Sample (EJ10) is the aggregation of pyrite. Pyrite is generally idiomorphic. It does not contain chalcopyrite, but contains a negligible amount of sphalerite and hematite.

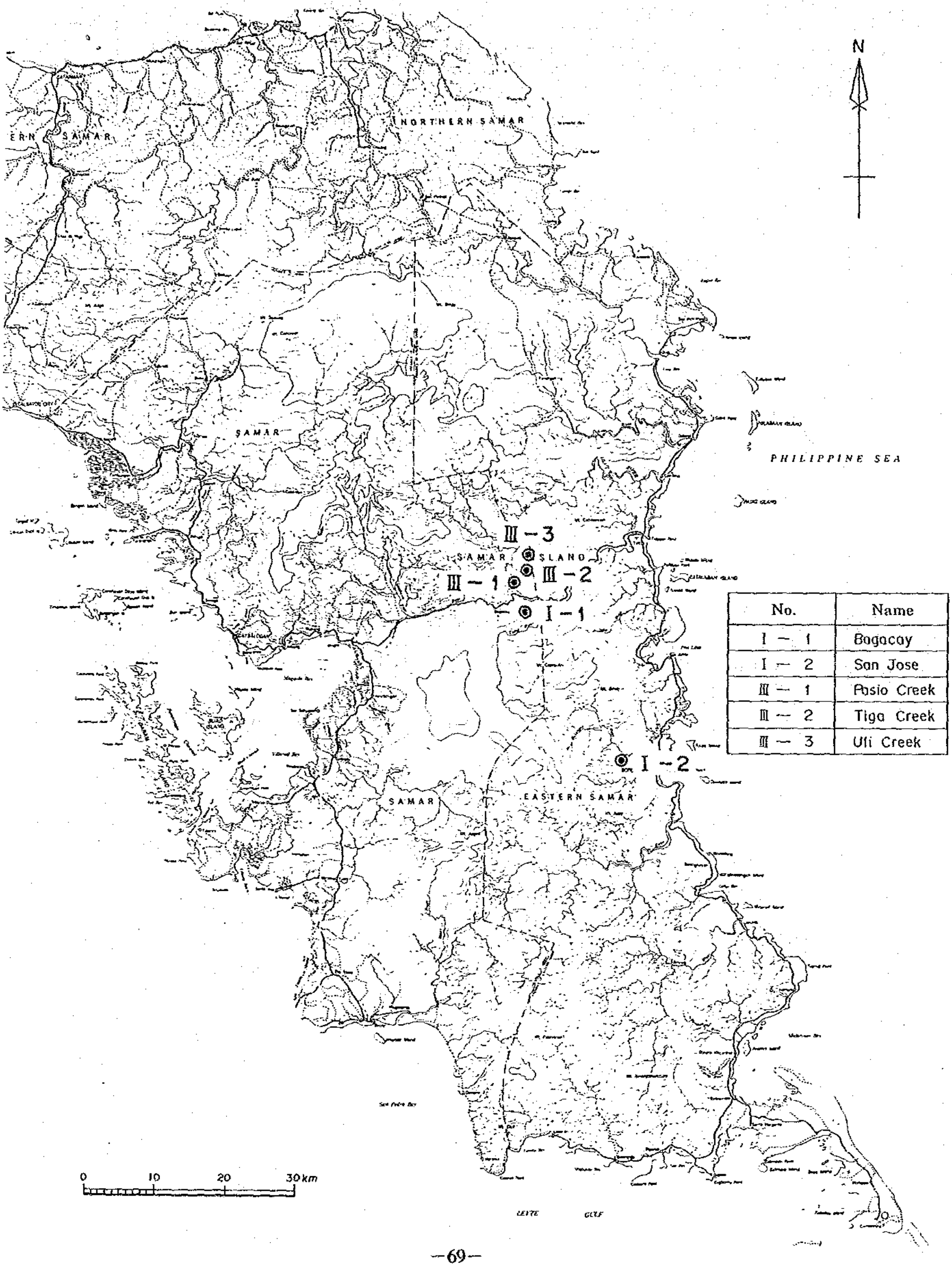
Pasiko Creek: Ore minerals in the sample (Spot Nol) are a large amount of sphalerite (irregular - shape), pryrite (idiomorphic, size 0.03~0.15 mm, and a small amount of fine - grained ones: 0.001~0.015 mm), a medium amount of chalcopyrite (irregular - shape, mostly occurring with fiene - grained pyrite), tetrahedrite (irregular - shape, size 0.01~0.2 mm, occurring with sphalerite) and a negligible amount of covellite as a secondary mineral. The sample is similar to Kuroko. The gangue minerals are small amounts of quartz and barite.

Tiga Creek: Ore minerals in the sample (Spot No. 2) are a small amount of pyrite (idiomorphic, irregular - shape and granular, size 0.05~0.07 mm), chalcopyrite (occurring minutely with pyrite; irregular - shape), a very small amount of bornite (irregular - shape, size 0.03~0.3 mm, some part occurs with pyrite and chalcopyrite), a negligible amount of sphalerite (irregular - shape, size 0.01~0.04 mm) and a small amount of covellite as a secondary mineral.

Uli Creek: Ore minerals in the sample (Spot No. 3) are a medium amount of pyrite (idiomorphic, irregular - shape and granular, size 0.05~1 mm), a small amount of chalcopyrite (irregular - shape, occurring with pyrite and sphalerite) and sphalerite.

The gangue mineral is a large amount of quartz.

Fig.-13 Location Map of Mineral Showing in Samar I~III Area



No.	Name
I－1	Bagacay
I－2	San Jose
III－1	Pasio Creek
III－2	Tiga Creek
III－3	Uli Creek

No.	Location	Topographic map (No) co-ordinates	Description	Evaluation
I-1	Bagacay Hinabangan W. Samar	Wright (40553) X: 25400 Y: 14200	Kuroko-type deposit in tuff of Oligocene ~ Miocene age. (Results of X-ray diffraction analysis) (EJ02): A medium amount of pyrite, a large amount of quartz, and a small amount of marcasite and palagonite had been detected. (EN08): A large amount of pyrite and quartz and a very small amount of sericite had been deteacted. (Assay Results) Cu(%) Pb(%) Zn(%) Au(ppb) Ag(g/t) EJ10 0.12 <0.01 <0.01 177 2.0 EN06 0.01 <0.01 <0.01 47 1.5	A
I-2	San Jose Borongan E. Samar	Borongan (40541) X: 14100 Y: 12300	Manganese vein in limestone of Oligocene ~ Miocene age. (Results of X-ray diffraction analysis) (EN02): A large amount of quartz and a very small amount of todorokite, pyrolusite, hematite and geothite had been detected. (Assay Results) Cu(%) Pb(%) Zn(%) Au(ppb) Ag(g/t) EJ10 0.01 <0.01 <0.01 71 2.0 EN08 <0.01 <0.01 0.01 48 1.0	D
III-1	Pasiko Creek Casandig, Wright W. Samar	Lawaan (40554) X: 13360 Y: 02360	Conglomeratic kuroko in felsitic volcanic rock (Assay Results) Cu(%) Pb(%) Zn(%) Au(ppb) Ag(g/t) MNRPST1 5.08 11.10 28.6 510 980.0	D
III-2	Tiga Creek Lawaan Wright W. Samar	Lawaan (40554) X: 14580 Y: 04450	Kuroko vein in dacite (Assay Results) Cu(%) Pb(%) Zn(%) Au(ppb) Ag(g/t) MNRPST2 6.92 0.10 0.21 19 45.0	D
III-3	Uli Creek Lawaan Writht W. Samar	Lawaan (40554) X: 14550 Y: 06600	Kuroko vein in dacite (Assay Results) Cu(%) Pb(%) Zn(%) Au(ppb) Ag(g/t) MNRPST3 0.14 0.03 0.09 50 4.8	D

4. GEOCHEMICAL SURVEY

4. Geochemical Survey

4-1 Survey Method

Geochemical survey was undertaken mainly to analyze the microchemical contents of the elements of stream sediments and heavy mineral samples.

Sampling error was checked by taking duplicate samples from the same place of the original sampling point at approximately every 50 stream sediment samples collected.

All geochemical samples were analyzed by the Mines and Geo-Sciences Bureau analytical laboratory (hereinafter called PETROLAB) by atomic absorption method.

Processing of geochemical data was done by the Overseas Mineral Resources Development Co., Ltd. (hereinafter called OMRD). Analyzing method utilized is the univariate analysis for the whole samples (except Samar I~III Area).

4-1-1 Sampling Location

Sampling was carried out along active stream channels by the same method as before. The density of sampling is approximately one stream sediment sample per every 1 to 2 km^2. Sampling points are pre-determined in a 1/50,000 scale map prior to the start of the survey (Ref. PL-2, 3, 4, 5).

4-1-2 Sampling Method

Samples collected are wet shieved by using stainless sieve to -30 mesh fraction in situ by which they amount to about 500 grams. They are washed thoroughly to remove dirt and clay fractions before they are placed in properly marked water resistant kraft bags. An accompanying data sheet card (Fig.-14) is filled up to record observations like location, grid coordinates, feature of stream, pH, Eh, and topography etc. Then samples are transported to the base camp for drying and sieving to -80 mesh.

Heavy mineral samples are collected using wooden pans at pre-determined sampling points.

About 20 grams of heavy mineral fractions are collected from each point and are placed in plastic tubes. These samples are sent to the laboratory through the base camp. Similar to stream sediment samples, a corresponding data sheet form is filled up to describe the place where the sample was taken.

Stream sediment samples transported to each base camp are sun-dried and are sieved to -80 mesh by stainless sieve. Then samples are put in remarked kraft paper bags and sent to PETROLAB.

Fig.-14 Field Data Sheet of Geochemical Survey

AREA:

SAMPLE NO.	SAMPLE TYPE	EASTING	NORTHING	STREAM Ord.	Width-m	Depth cm	Flow	PH	EH	BANK Type	Ht-m	SEDIMENT OR SOIL SIZE	ORGANIC MATTER	PRECIPITATE
1 5	6	7 10	11 14	15	16 17	18 20	21	22 23	24 25	26	27 28	29	30	31

CONTAMINATION	MINERALIZATION	ALTERATION	ROCK TYPE	OTHER SAMPLES
32	33	34	35 36	37

REMARKS:

CODES:

Cols.1-5 Sample number.

Col.6 Sample type. Enter one of the following codes:
- 1-stream sediments
- 2-soil
- 3-rock
- 4-heavy mineral concentrate (note original concentrate panned under REMARKS column)
- 5-duplicate sample (corresponding to preceeding sample number)

Cols.7-14 Coordinates.

Col.15 Stream order.

Cols.16-17 Stream width(m). Enter width of active channel; (enter 99 if > 99).

Cols.18-20 Water depth (cm).

Col.21 Flow. Enter one of the following codes:
- 0-dry
- 1-stagnant
- 2-slow
- 3-moderate
- 4-fast
- 5-artificial

Cols.22-23 PH. Leave blank if not recorded: if measurement is 6.4 enter 64.

Cols.24-25 Conductivity ($\mu s / cm$)

Col.26 Bank type:
- 1-colluvial
- 2-alluvial
- 3-scree
- 4-bedrock
- 5-colluvial and bedrock

Cols.27-28 Bank height(m).

Col.29 Sediment or soil size. Record grain size of material sampled (whether sediment or soil) using one of following codes:
- 1-coarse
- 2-medium (sandy)
- 3-fine (silty)
- 4-clayey

Col.30 Organic matter. Note presence and amount (abundant, moderate, minor). Use code 1 if present and 0 if absent.

Col.31 Precipitates. Note precipitates present, using codes:
- 0-absent or not detected
- 1-Iron (red or brown stains)
- 2-manganese (black stains)
- 3-sulphur (yellow stains)
- 4-carbonate
- 5-other (specify)

Col.32 Contamination. Note presence and type. Use code 1 if present and 0 if absent.

Col.33 Mineralization. Note presence and type (sketch on reverse). Use code 1 if present and 0 if absent.

Col.34 Alteration. Note presence and type. Use code 1 if present and 0 if absent.

Cols.35-36 Rock type. Use one of the codes given on the reverse.

Col.37 Other samples. Note other samples collected at the same site. Use one of the following codes:
- 0-none
- 1-stream sediment
- 2-soil
- 3-rock
- 4-heavy mineral concentrate
- 5-duplicate
- 6-several types (specify)

Remarks. Enter any other pertinent information about the sampling locality

4-1-3 Method of Indoor Testing

1) Adjustment method of analytical samples

Stream sediment and heavy mineral samples sent to PETROLAB are divided into 20 gram samples for analysis and the rest as spare samples. In the analytical laboratory, 1 gram of stream sediment sample and 10 grams of heavy mineral sample are weighed for AAS analysis. Excess samples are stored for further use.

2) Microchemical analytical method

Weighed samples are analyzed by atomic absorption method according to the attached flow chart (Fig.-15) (Foot Note).

The analyzed elements for stream sediment samples are as follows:

Area	Analyzed Elements												
Palawan V (Busuanga)	Cu	Pb	Ag	Zn	Mn	As	Sb	Hg	Sn	W			
Palawan VI (Quezon-Rio Tuba)	Cu	Pb	Ag	Zn	Mn	As		Hg			Co	Ni	Cr
West Negros	Cu	Pb	Ag	Zn	Mn	As		Hg		W	Co	Ni	
Samar I~III	Cu	Pb	Ag	Zn	Mn	As		Hg			Co	Ni	Cr

The analytical data of stream sediment samples are shown in Appendix-9.

Heavy mineral samples are analyzed for Au, Ag and Ga in all areas. The detection limit of these elements are shown in Table-5.

In PETROLAB, 4 sets of atomic absorption spectrometer are utilized. Three sets are made by Varian Tectron Co. (one of them is flameless type model GTA-95 while the other two AS-1475) and one set is made by Shimazu Model AA-670 which is used for heavy mineral sample analysis.

Table-5 Detection limit of AAS at PETROLAB

(Unit; ppm)

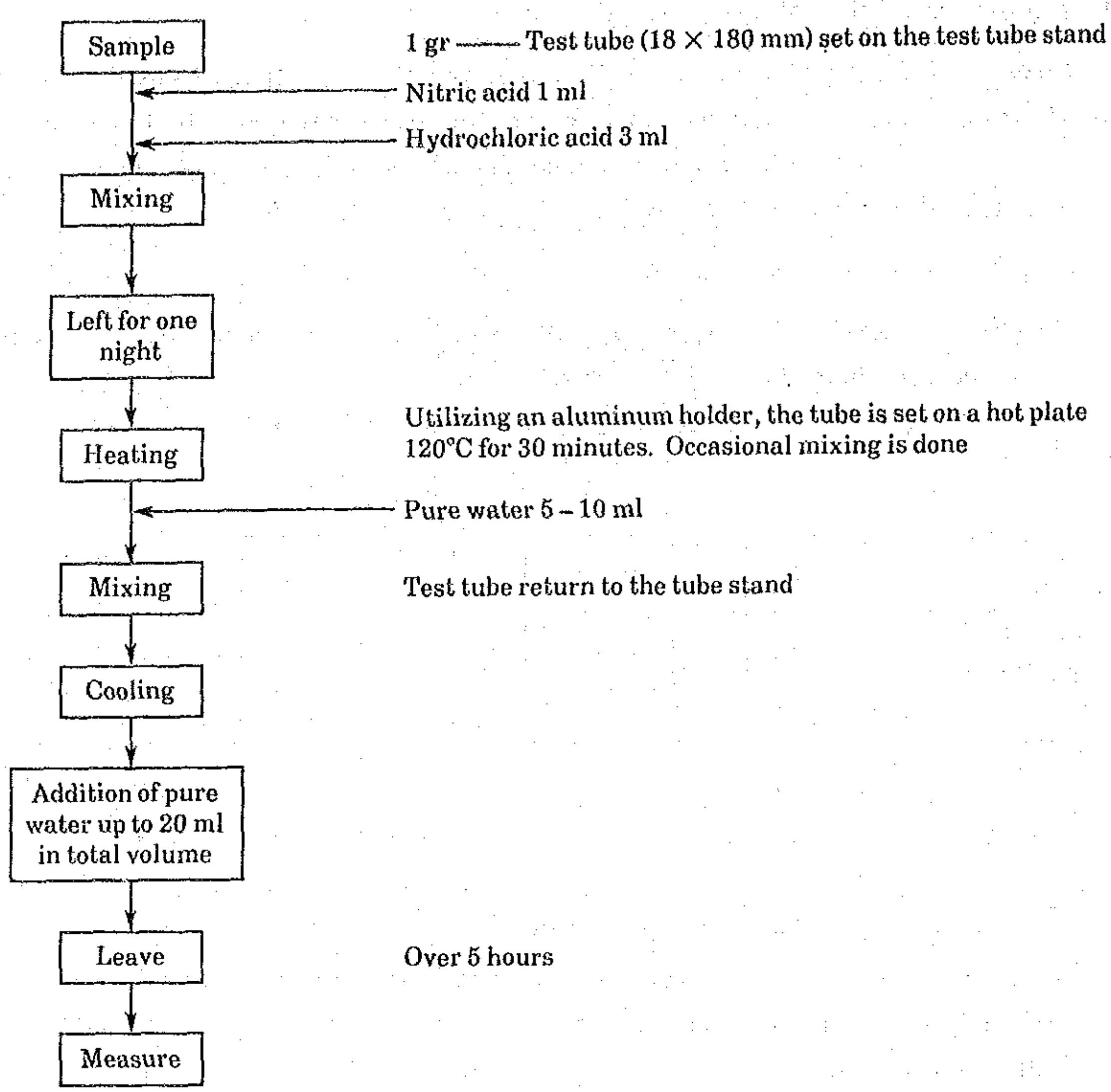
Element	Cu	Pb	Zn	Ag	Ni	Co	Mn	As	Hg	Mo	Cr	Sn	W	Sb
Detection Limit	2	10	2	1	3	3	50	0.5	0.04	2	1.00	1	3	0.05

(Foot Note)

This microchemical analysis method uses a direct aqua-regina extraction from -80 mesh samples without further grinding, consequently some amount of elements included in quartz or other mineral grains may still remain even after extraction.

However, since geochemical surveys do not require absolute data but comparable values from each sample, such method is acceptable.

Fig.-15 Flow Chart of Stream Sediment Preparation



Element	Measuring Method	Flame	Wave Length (mm)
Ag	Direct Atomic Absorption	Air-C_2H_2	328.1
Cu	"	"	324.7
Mn	"	"	403.3
Pb	"	"	217.0
Zn	"	"	213.7
Mo	"	N_2O-C_2H_2	313.0
Hg	Reduction vapor – A.A.S.	Flameless	253.7
As	Hydration – A.A.S.	"	197.4

3) The method of statistical analysis for geochemical results

The statistical analysis for geochemical results are applied in all area (except Samar I~III Area) using the univariate analytical method to each population group utilizing the procedure of C. Lepeltier (1969).
A computer was used for calculation. Procedure of analysis are as follows.

Previous Procedure of Data

1) Determination of lithological population

Country rocks which predominated in the sampling were divided into different lithological populations with reference to the microchemical component of the rocks (generally 8 - 12 populations in one area).

2) Making data file

Data file were made on sample number, elements and analytical results in each lithological population.

3) Checking dispersion of results of microchemical analysis between original and duplicate samples.

Univariate Analysis

1) The resulting data were rearranged in the order of value in each population and element.

2) Mean value, threshold value, standard deviation value, maximum value, minimum value and variance and other statistical values were calculated.

3) Histograms and Cumulative Frequency Curves for each population and elements were made.

4) Logarithmic data table were made for each population and elements.

5) 95% level student (t), and Senedecor (F) certification for variance of data were carried out between different populations.

If data variance range among some populations are the same, these populations were consolidated.

6) Lists are made to pick up anomalous data.

7) Correlative coefficients between all populations and elements were calculated.