REPUBLIC OF INDONESIA

MINISTORY OF MINES AND ENERGY
DIRECTORATE GENERAL OF MINES
DIRECTORATE OF MINERAL RESOURCES

REPORT ON GEOLOGICAL SURVEY OF WEST KALIMANTAN

PHASE I

GEOLOGICAL SURVEY

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FEBRUARY. 1980

METAL MINING AGENCY OF JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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Report on Geological Survey of West Kalimantan

Phase 1 Geological Survey February 1980

List of correction

page	line	error	modification
3	4	Surawesi	Sulawesi
3	15	from Japanese Government,	to Japanese Government
9	3	Dr.Wing Enston Loth (1920)	Dr.Wing Easton (1904) and Dr.Loth (1920)
9	15	Mandur	Mandor
9	21	Mandur	Mandor
9	23	giological	geological
10	7	,covering 1,500 Km^2 is	,covering 1,500 Km^2, is
11	8	Sungai Landak	Sungai Kapuas
11	14	sub-province	District
11	17	whole West Kalimantan area	West Kalimantan Province
12	7	jeratan	jelatang
12	19	Gunung Bawan	Gunung Bawang
15	25	Pemetaan National	Pemetaan Nasional
18	6	which, are probably	which are probably
18	11	Kampun Negare	Kampung Negare
21	6	pyroclastic rock, the old geological	pyroclastic rock, and the old geological
22	10	outer wards	outwards
22	12	Rajan Group	Rajang Group
24	17,18	uncomformably ,uncomformity	unconformably, unconformity
25	19	and alow the upper part	and along the upper part
27	9	gray had tufaceous	gray hard tufaceous
28	2	Sungai into	Sungai Into
32	2	actinolite, crystal	actinolite crystal
34	10	Kalimata	Karimata
56	4	1 ppm of less than 1 ppm	1 ppm or less than 1 ppm
56	19, 22,24	Bending point	Breaking point
57	9	bending point	breaking point
64	13	ratios of Cx-Cu and T-Cu (Cx-Cu/T-Cu)	ratios of Cx-Cu and T-Cu, (Cx-Cu/T-Cu),
66	12	40 litres	20 litres
67	5	bending point	breaking point
72	5	stratigraph	stratigraphy

Correction of spelling of place name

error	modification
Banyl	Banyi
Suntura	Sunturu
Sungaipunyu	Sungaipinyu
Sungai Punyu	Sungai Pinyu
Belang	Belango

Correction of error in chart and table

chart, table	error	modification
Table 3-1	Hormblende	Hornblende
Table 3-2	RP-20 Fe_2O_3 18.20	1.82

PREFACE

The Government of Japan, in response to the request extended by the Government of the Republic of Indonesia, agreed to conduct a metallic mineral exploration survey in West Kalimantan, and commissioned its implementation to the Japan International Cooperation Agency.

The agency, taking into consideration the importance of the technical nature of this survey, sought the cooperation of the Metal Mining Agency of Japan in order to accomplish the contempleted task.

The Government of the Republic of Indonesia appointed the Directorate of Mineral Resources to execute the survey as counterpart to the Japan team. The survey is being carried out jointly by experts of both Governments.

The initial phase of surveys consists of photo geological interpretation, geological survey and geochemical survey for metallic mineral exploration.

This report submitted hereby summarizes the results of an initial phase of surveys, and it will also form a portion of the final report that will be prepared with regard to the result to be obatined by the survey.

We wish to take this opportunity to express our gratitude to all sides concerned in the execution of the said initial survey.

February 1980

Prof. Dr. J.A. KATILI
Director General,
Directorate General of Mines,
Ministry of Mines and Energy,
Republic of Indonesia.

Keisuke ARITA
President,
Japan International
Cooperation Agency,
Japan.

Masayuki NISHIIE
President,
Metal Mining Agency of Japan,
Japan.

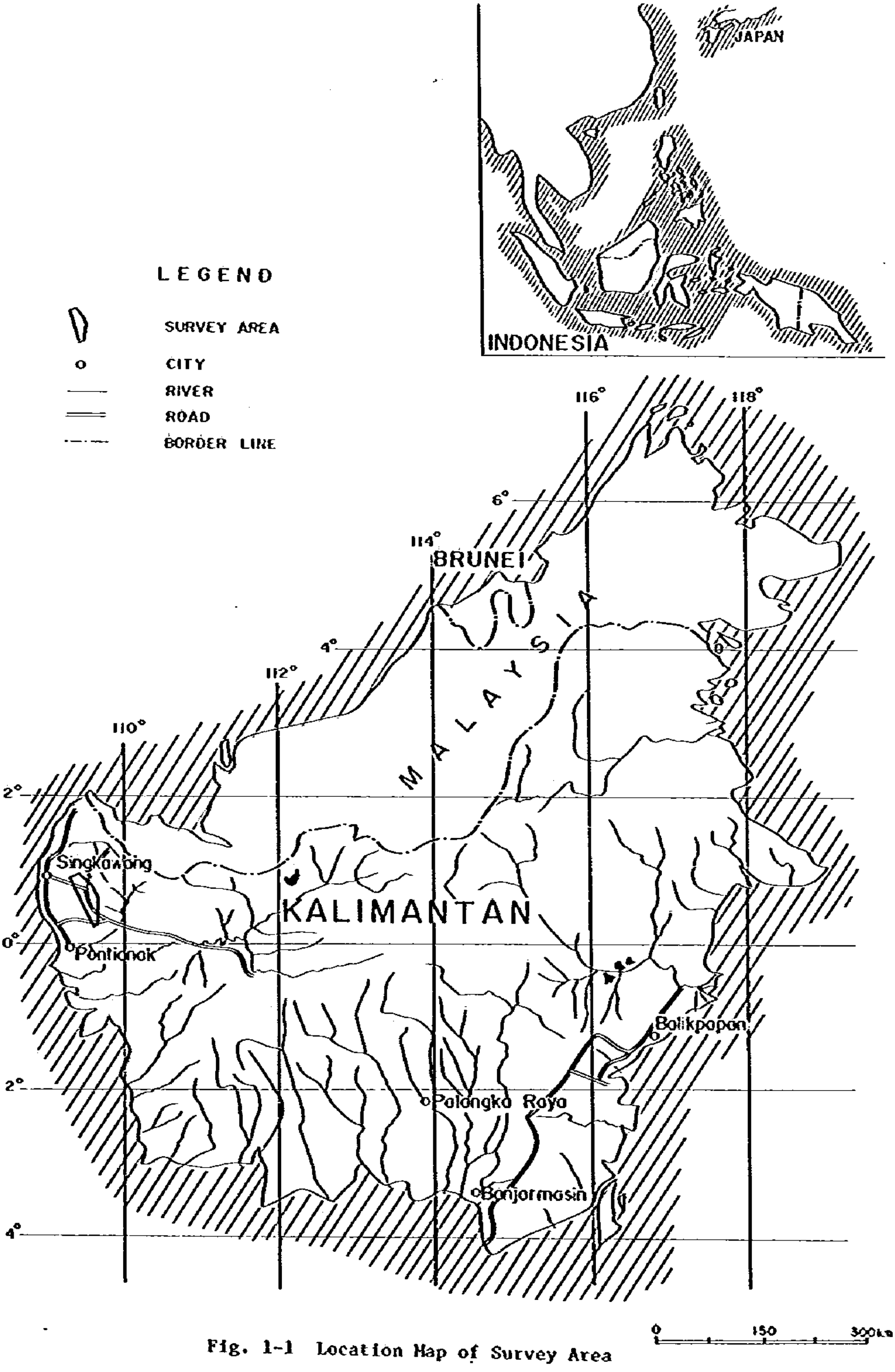

Fig. 1-1 Location Map of Survey Area

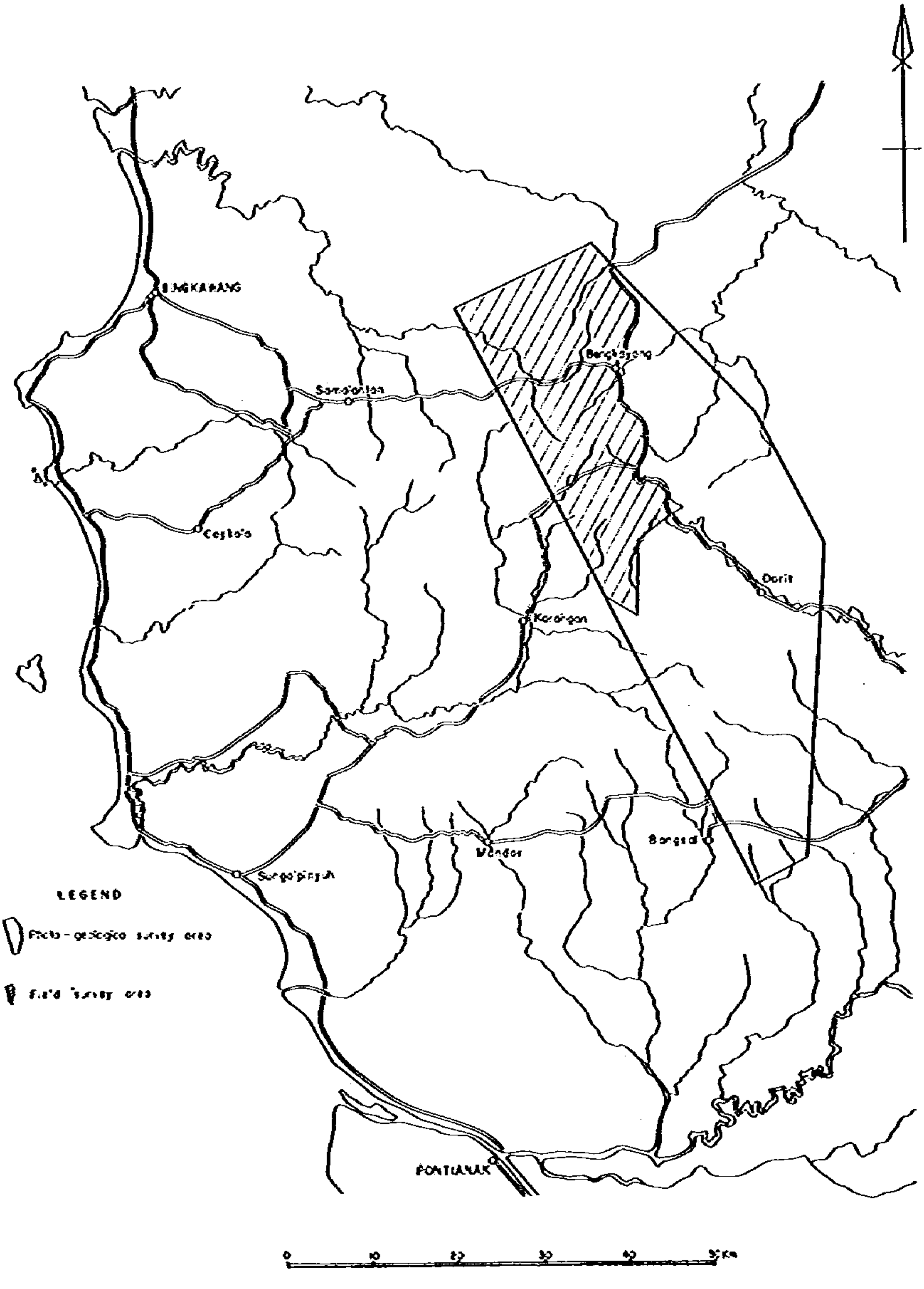

Fig. 1-2 Map of Survey Area

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ABSTRACT

The survey, consisting of photo-geological interpretation, geological survey, geochemical survey, placer gold prospecting and radioactive prospecting, was conducted in West Kalimantan, Republic of Indonesia, and was followed by various laboratory analysis. It is the first phase of the Collaboration Survey for Development of Mineral Resources, being carried out by the Indonesian and Japanese Governments.

The first phase survey was performed in an area of 500 km^2. Geology, stratigraphy, igneous rock, geological structure and mineralizations in the survey area have been revealed. They are summarized as follows:

(1) Bengkayang Group which consists of tufaceous sandstone, black shale, sandstone and alternating beds of sandstone, siltstone, and mudstone has been correlated with Late Triassic to Early Jurassic on the basis of newly discovered ammonite fossils.

(2) Granitoid rocks have extensive distribution and are classified into two groups by K-Ar absolute age dating, namely Gunung Raya granodiorite and Tiang quartz diorite group intruded in middle Cretaceous and Sirih tonalite and Banyi tonalite group intruded in Oligocene to early Miocene. Rocks of both groups belong to calc-alkali series of igneous rocks based on their chemical and mineralogical composition.

(3) The area is characterised by dome structure with anticline and syncline trending in the NWW-SEE direction, fault, quartz veins, and andesite dykes trending NNW-SSE all of which accompanied the intrusion of the younger granitoid rocks.

(4) Mineralizations of Cu-Mo, Au-Cu and Hg occur in or around Sirih

and Banyl tonalites, and Serantak decite, which belong to the younger intrusions.

These mineralized zones are associated with geochemical anomalies and gold placers. Accordingly, it is concluded that further detailed investigation in these mineralized areas is justified.

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Introductory Remarks

A cooperative mineral exploration project in the Repablic of Indonesia was conducted in Northern Surawesi (1970 - 1973) and in Central Kalimantan (1975 - 1978) by Geological Survey of Indonesia and Metal Mining Agency of Japan. Through these two projects, extensive and useful data on geology and ore deposits have been obtained. Moreover, these investigations have contributed effectively to the accumulation of data on geology and mineral resources and improvement of the Geological Survey of Indonesia's projects.

The Ministry of Mines and Energy of the Republic of Indonesia, re-organized the Geological Survey of Indonesia, and Directorate of Mineral Resources was newly established in 1978. Based on the above mentioned beneficial results, Directorate of Mineral Resources requested a third co-operative project in West Kalimantan area from Japanese Government, through Government of the Republic of Indonesia.

In response to this request, the Government of Japan dispatched a preliminary survey mission headed by Mr. Toyo Miyauchi, senior officer of the Overseas Department of Metal Mining Agency of Japan, on May 1979. The survey mission confered with staff of Directorate of Mineral Resources regarding the project area to be surveyed and work programme. After a deliberation, it was agreed to perform the co-operation project in an area of 1,500 Km^2 covering Gunung Bawang, Bengkayang, Darit, Pahuman, and Gunung Raya in West Kalimantan.

The following plan of the first phase, to be started on July 1979, was also agreed on:

(1) Photo geological interpretation work to be performed in the whole survey area covering 1,500 Km^2 in order to interpret outline of geology and geological structure, and to select an area of 500 Km^2 from the area of 1,500 Km^2 as a first phase of investigation programme.

(2) Reconnaissance investigation including geological and geochemical surveys, and gold panning prospecting in the selected area to be carried out to locate promising mineralization areas.

Reconnaissance survey of the remaining area of 1,000 Km^2 and detail survey of promising mineralization areas will follow in the second phase.

1-2 Outline of First Phase Investigation

1-2-1 Survey Area

The northern part of the whole project area was selected as first phase investigation area, based on photo geological interpretation and examination of existing data. The survey area covers 500 Km^2 including Gunung Bawang, Bengkayang and Gunung Raya, as Fig. 1 - 2 shows.

1-2-2 Method and Amount of Survey

(1) Photo Geological Interpretation

In order to determine the outline of geology and structural geology in whole project area of 1,500 Km^2, photo geological interpretation work has been performed by interpreting air photographs of 1/50,000 scale. The result of the work was used to select the survey area for first phase programme.

(2) Geological Survey

Geological survey was carried out along rivers by using topographic map of 1/50,000 scale, provided by Indonesian Government. Thus geological map of 1/50,000 scale was compiled. The actual survey area covered 543.9 Km^2.

(3) Geochemical Survey

Keeping pace with geological survey, sampling of stream sediments (using 80 mesh sieve) was carried out at each river and creak. Total number of samples reached 628, and 435 of these samples were sent for chemical analyses of total Cu, Zn, and Mo elements in assay laboratory. 102 samples were especially picked up from samples collected in high total Cu anomolous area to analyze cold extractable copper. This analysis was aimed at measuring the proportion of hydromorphic copper in total copper. At each sample site, pH value of river water was measured in order to find precipitation condition of cold extractable copper.

(4) Placer Gold Prospecting

Bengkayang and Lumar areas in the investigated area were famous placer gold prospecting and mining areas in the past. At present, some local inhabitants are mining placer gold on a very small scale in the intervals between their farm work. The placer gold prospecting carried out by panning at the same places as geochemical sampling, in order to survey placer gold resources, and prospect the relationship with primary mineralizations. Samples were collected at 629 points.

(5) Radioactive Prospecting

Complying with Indonesian request, reconnaissance survey for existence of radioactive minerals was carried out in the survey area. Scintillation counters Model TCS-121C were employed in the radioactive prospecting. Total number of measurements reached 319 points. However because the result was not promising it is reported only as a reference.

(6) Others

For laboratory analyses, following samples were examined:
93 rock samples and 11 ore samples for examination under microscope, 4 samples of plutonic rocks for determination of their absolute age, 11 samples of igneous rocks for analyses of chemical composition, 17 samples of ore for chemical analysis of metallic elements, 4 samples of fossils for identification and stratigraphic corelation.

1-3 Period of Survey

1-3-1 Preliminary Survey

In order to discuss the plan of Metallic Mineral Exploration Survey in West Kalimantan and settle the first year survey schedule, preliminary survey mission was dispatched as follows:

(1) Mission Schedule

May 15 to May 27, 1979

(2) Members of The Mission

Indonesian Side

Dr. Prof. J. A. Katili
Director General
Directorate General of Mines

Ir. Salman Padmanagara
Director
Directorate of Mineral Resources

Ir. P. H. Silitonga
Directorate of Mineral Resources

Ir. Yaya Sunarya
Directorate of Mineral Resources

Japanese Side

Toyo Miyauchi
Metal Mining Agency of Japan

Takashi Ono
Agency of Natural Resources and Energy

Hisamitsu Moriwaki
Japan International Cooperation Agency

Nobuhisa Nakajima
Metal Mining Agency of Japan

1-3-2 First Phase Survey

First phase survey has conducted during a period from June 22, 1979 to February 12, 1980. Survey Team was sent on the following schedule, and performed joint survey with Indonesian members.

(1) Survey Schedule in Indonesia

Photo geological interpretation work	From July 9 to August 9
Geological Survey and geochemical survey	From August 6 to September 28
Data processing work in Indonesia	From September 30 to October 27

(2) Survey Members

Indonesian Members		Japanese Members	
Ir. Yaya Sunarya	(D.M.R.)	Sakae Ichihara	(M.M.A.J.)
Ir. Koswara Yudawinata	"	Nobuhisa Nakajima	"
Subandi Widasaputra	"	Katsumi Hayashi	"
Idik Sumpena	"	Atsushi Takeyama	"
Tatto Sudharto	"	Atsumu Nonami	"
Simpwee Soeharto	"	Susumu Takeda	"
Deddy T. Sutisna	"	Daizo Ito	"
Johny R. Tampubolon	"	Katsuhiko Ozawa	(J.I.C.A.)
Danny Z. Herman	"		
Sukmana	"		
Yan Soalon Manurung	"		
Zulkifli	"		
A. Muchsin	"		
Wachyu III	"		
Muktamar	"		

M.M.A.J. Metal Mining Agency of Japan

J.I.C.A. Japan International Cooperation Agency

D.M.R. Directorate of Mineral Resources

1-4 Previous Survey

Geological reconnaissance survey in West Kalimantan was performed by Dr. Molengraff (1900), Dr. Wing Enston Loth (1920), and was continued by the survey of Dr. Zeylman Van Emminchoven. The results was compiled in geological maps on 1/250,000 scale by the above authors (1935 - 1939). Dr. Bemmelen edited Geology of Indonesia in 1949, and described geological stratigraphy and geological structure of West Kalimantan.

Recently, geological structure in West Kalimantan, malaysian Sarawak and Sabah has been studied by Dr. Katili, Dr. Haile, Dr. Hatchson and Dr. Hamilton from the Plate Tectonics point of view.

Concerning the economic geology of West Kalimantan, alluvium placer gold had been mined in Penombahan of Mempavah and Sambas area, called "Chinese District", from the 18th Century to early the 19th Century. Primary gold deposits of Lumar, Sentura, and Bengkayang, copper deposits of Mandur and molibdenite deposits of Gunung Bawang and Gunung Benaul had been surveyed and prospected, but detailed data and information have not been published.

In 1970, Geological Survey of Indonesia conducted geochemical reconnaissance survey in West Kalimantan. It covers approximately 10,000 Km^2 bounded by the 0° - 1° North latitude and 109° - 110° East longitude, including Pontianak, Bengkayang, and Mandur. The survey has collected one stream sediment per 5 Km^2, and discovered several geochemical anomalous areas. A survey including detailed giological, geochemical, and geophysical surveys, of Gunung lbu mineralization, situated 10 Km south east of Singkawang conducted under the auspices of technical cooperation of Indonesian and Belgian Government, took place from

1974 to 1978. At present, Directorate of Mineral Resource, Indonesia, is continuing the survey. Detailed geological and geophysical surveys have been performed in Sambas gold placer area and several other geochemical anomaly areas.

1-5 General Information

1-5-1 Location and Accessibility

The project area, covering 1,500 Km^2 is located in northeastern part of West Kalimantan Province, the Republic of Indonesia, (Fig. 1-1).

The north part of the project area is characterized by a mountain range trending northwest with Gunung Bawang the highest (1,490 m above sea level). There is also a mountain range trending east-west with peaks 1,000 m above sea level, such as Gunung Pandan Kecil, Gunung Genting Bakilok and Gunung Belakang in Central part and south part of the survey area. However generally the survey area is characterized by low land or plains with elevation ranging from 100 m to 500 m.

The survey area is accessible by two routes, namely through north route to Bengkayang area and through south route to Gunung Raya area. The north route starting from Pontianak runs 145 Km along seaside road to Singkawang, and reaches Bengkayang where base camp was set, 75 Km eastward from Singkawang. The entire road is paved, and it takes about 5 hours by car to reach Bengkayang from Pontianak, capital city of West Kalimantan Province.

The sourthern part of the survey area is accessible by two routes this is, from Sungai Punyu, and by eastern south road of the survey area passing through Bengkayang. The road along Sungai Punyu is unpaved and is usually muddy under rainy conditions, and even four wheel jeep has a hard time getting through.

There are many mountain roads and trails making the survey area accessible from the main road, but survey equipment, camping material, and food can be transported only by man's power.

Garuda domestic return trip flights are operated twice a day between Jakarta and Pontianak. Ferry boats transport passengers, cars, and goods to the Sungai Landak situated north of Pontianak. During traffic congestion, it is necessary to wait for a long time.

1-5-2 Circumstances of The Survey Area

Province of West Kalimantan covers an area of 146,760 Km^2, and has a population of 2,372,516 inhabitants, based on census of 1977.

Western West Kalimantan, including the survey area and covering Pontianak city, sub-provinces of Sambas and Pontianak, has been especially developed in plain area. 60 % of whole West Kalimantan population of 1,411,647 are living in the developed area covering 25 % of whole West Kalimantan area.

It is well-known that gold products were traded since the 13th century, and Mempawah, Montrado and Bengkawang which have been known as "Chinese District" were famous gold mining areas in the middle of the 18th century. However, the gold mining had rapidly decreased in the middle of the 19th century. At present, only local inhabitants are mining placer gold on a very small scale working during spare time when not engaged in their agricultural work. Agriculture is the main employment in West Kalimantan, especially harvesting rubber and pepper. Dayak people still cultivate land by burning slash agriculture.

Except for the City area of Pontianak and Singkawang, electrification and telephone facilities are not available in the countryside.

With the exception of snakes, no dangerous animals live in the survey area. Poisonous snakes such as green snake and cobra, a poisonous plant called jeratan, leaches and some infectious diseases from river water bothered and afflicted survey members during the field survey. As the area is in the tropics, malaria is also a common disease.

1-5-3 Climate and Vegetation

Climate of the area is characterised by high temperature and high humidity with plenty of rainfall, owing to location of the survey area on the equator. On the basis of the pretipitation record at Bengkayang from 1975 to June, 1979, shown in Fig. 1-3, rainfall averaged from 2,600 mm to 3,850 mm annually, from 100 mm to 200 mm per month during the dry season (June to August) and from 300 mm to 450 mm per month during the rainy season (September to May).

Mountain region ranging from Gunung Bawan to Gunung Mahmud has very high humidity, even during the dry season, and it is covered by thick clouds. Daily rain showers are common in the region. Accordingly, temperature in the region is so low at night that it is necessary to use a sleeping bag.

The climate of the area belongs to that of a tropical zone, and tropical plants have grown thick reflecting such a weather conditions.

Bushes and grasses in the plains are very dense and it is very difficult to enter into the field except by road or a big river.

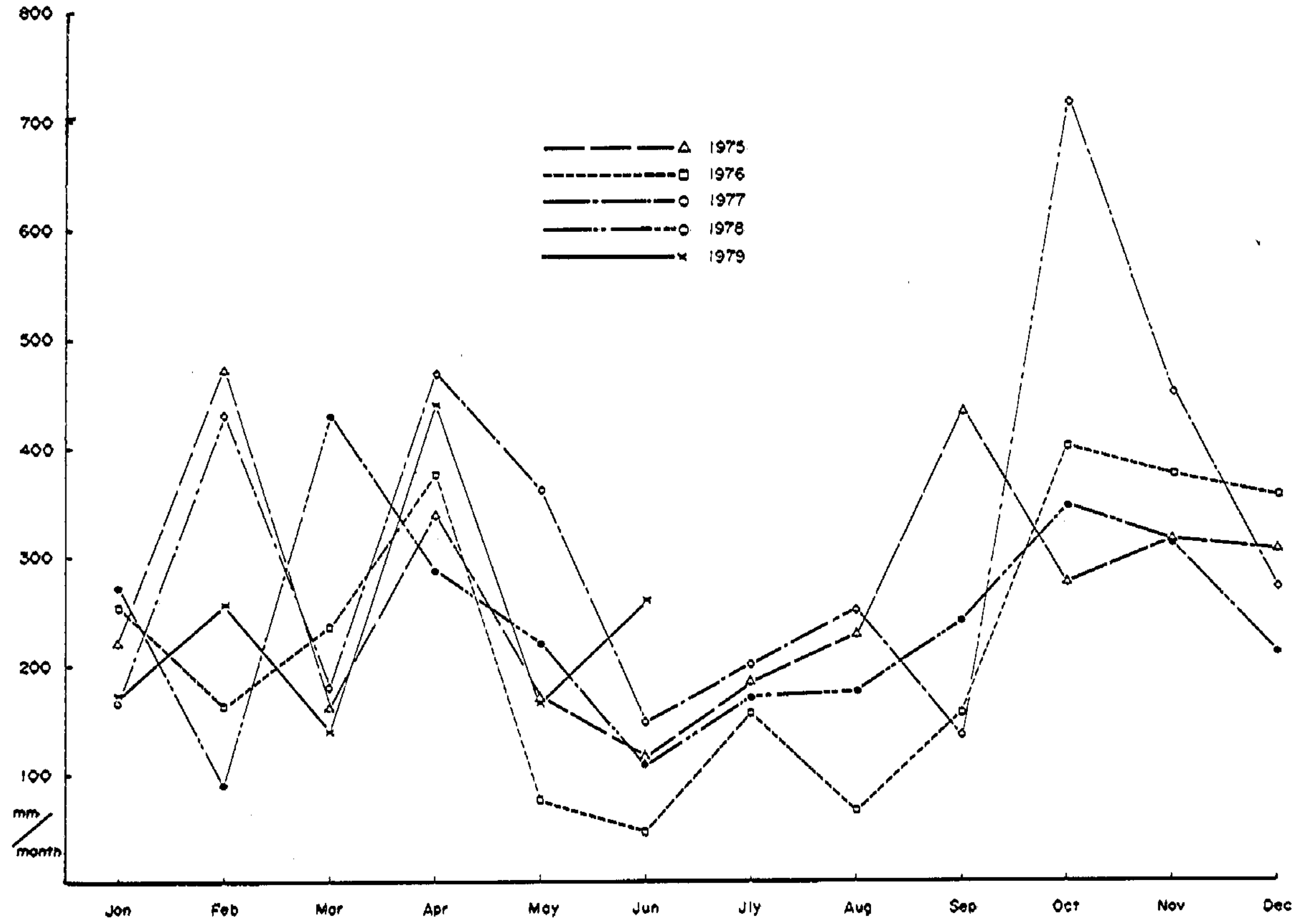


Fig. 1-3 Precipitation at Bengkayang

CHAPTER 2 PHOTO-GEOLOGICAL INTERPRETATION

CHAPTER 2 PHOTOGEOLOGICAL INTERPRETATION

2-1 Abstract

Photogeological interpretation was performed in order to interpret outline of geology and structural geology in the whole survey area (1,500 Km^2), and select a survey area of 500 Km^2 for the first phase survey. Air photographs on approximately 1/50,000 scale, covering the whole survey area, were interpreted and the result was compiled on topographic maps on 1/100,000 scale.

As a result of interpretation and study of already available geological information, geology of the area was divided into 16 units consisting of Mesozoic and Cenozoic sedimentary rocks, pyroclastic rocks, granitic rocks, quartz porphyry, and dacite.

Large scale fold and fault features were not apparent from the air photographs. But many lineaments, which are supposed to be due to small scale faults, joints, and strike and dip of sedimentary rocks have been observed. Predominant lineaments trending NNW-SSE in G_2, D_1 and D_2 geological units were interpreted as fault lines.

On the basis of the above mentioned photogeological interpretation and already known geological, geochemical, and mineralization information, first year geological and geochemical survey area, covering 500 Km^2, was selected, taking the following into consideration:

(1) In the comparison with broad granitic batholith in the southern part of the survey area, the northern part of the area has more complicated geology, namely sedimentary formations, and several intrusions.

· Table 2-2 PHOTO-GEOLOGICAL INTERPRETATION CHART

UNIT	PHOTO CHARACT		TOPOGRAPHIC CHARACTERISTICS									VEGETATION	LITHOLOGY
			DRAINAGE			RESISTIVITY		LINEAMENT					
								FAULT JOINT					
	TONE	TEXTURE	PATTERN		DENSITY	ROCK	CROSS SEC	DIRECTION	INTENSITY	KINDS	BEDDING		
Q	light	smooth	meander		rare	very weak						large along stream	sand, gravel
S_9	gray	smooth	meander		rare	very weak					poor	large patchy	fine sedimentary rock
S_7	gray	fine smooth	dendritic		coarse	moderate					clear	small dence	sedimentary rock
S_6	light gray	fine	dendritic		dence	weak					clear	along stream	〃
S_5	gray	fine	dendritic		dence	weak					vague	patchy	〃 (silt, pyroclasitic rock)
S_4	gray	fine	dendritic		medium coarse	moderate weak					vague	patchy	〃 〃
S_3	gray	smooth	sub-parallel		medium dence	moderate		rare	medium	fault joint	clear	small	〃 (sandstne)
S_2	darkgray	rough	dendritic		dence	veryhigh		rare	medium	fault joint	clear	small	〃 (fine sandstone, silt)
S_1	darkgray	fine	parallel		rare	veryhigh		many	strong	fault joint	vague	dence	〃 (hornfels)
A_2	light	smooth rough	parallel sub parallel		medium dence	moderate		rare	weak	fault	vague	small	pyroclastic rock
A_1	dark gray	rough	dendritic		coarse	high		mainly 1	strong	fault		dence	andesite rock
D_2	gray dark gray	rough	dendritic / radial		coarse	veryhigh		many	strong	fault joint		large dence	dacite quartz porphyry
D_1	gray	rough	radial		coarse	very high		many	strong	fault		large dence	〃 〃
G_3	gray		radial		coarse	high		rare	weak	joint		small	granitic rock
G_2	dark gray	rough	dendritic		coarse	very high		many	strong	fault joint		dence	〃
G_1	dark gray	rough	dendritic		dence	weak		many	strong	fault joint		large dence	〃

(2) Many known mineralizations, that is molybdenum mineralization at Sungai Bamua and Sungai Sirih, and gold, copper, and molybdenum in Banyl area are known to be present in the north area.

2-2 Air Photographs

List of air photographs used in the interpretation work is shown in Table 2-1.

Table 2-1 List of Air Photographs Used for Interpretation

Run Number	Photo Number	Sheets	Direction
430	19 ~ 20	2	E - W
4265	20 ~ 26	7	"
"	154 ~ 160	7	"
"	185 ~ 190	6	"
4271	0022 ~ 0032	11	"
"	0045 ~ 0055	11	"
"	0092 ~ 0103	12	"
"	161 ~ 170	10	"
4283	110 ~ 112	3	"
4286	11 ~ 13	3	"
4294	148 ~ 157	10	"
"	171 ~ 176	6	"
"	230 ~ 236	7	"
196	49 ~ 54	6	NE - SW
Total		101	

These air photographs were taken for the "Badan Koordinasi Survey Dan Pemetaan National" project by Indonesian Government during the period from 1969 to 1971, and were prepared by Directorate of Mineral Resources.

2-3 Interpretation Procedure

Geological and geomorphological features such as drainage pattern, density, texture, resistance (relief energy and errosion), valley section, ridge pattern lineaments, geological boundaries, and strike and dip of bedding were noted. These features were drawn directly on the overlay of each photograph so that an interpreted chart was prepared. Classification of lithostratigraphic units and analysis of geological structure was thus obtained.

Results of interpretation were compiled on a 1/50,000 topographic map, reduced and used in the preparation of a photogeological map on 1/100,000 scale. The work was performed jointly by members of both Indonesian and Japanese team.

The photogeological map was prepared using supplementary geological data, kept by the Directorate of Mineral Resources, in order to clarify obscure boundary of each unit.

2-4 Geological Unit

2-4-1 Sedimentary Rocks

(1) Unit S_1

This unit is distributed around Gunung Mahmud in the northeastern part of the survey area. Its photographic characteristics are gray tone, and fine texture. It is topographically characterized by strong resistance to erosion, steep hills and parallel drainage. NW-SE lineaments predominate. It is covered by high and dense tree vegetation. Accordingly, it is identified as sedimentary rocks. The unit was regarded as hornfels in an old geological map.

(2) Unit S_2

This unit is widely distributed in northern part of the survey area. It is topographically characterized by high density and fine dendritic drainage, very weak resistance to erosion, and low ridges. Lineaments infered to be due to bedding are locally visible. Accordingly, it is identified as sedimentary rocks. This unit corresponds to the upper Triassic sedimentary rocks of the old geological map.

(3) Unit S_3

This unit occurs as a zone in the northern part of the survey area. Its photographic characteristics are gray tone and smooth texture. It is topographically characterized by medium dense, subparallel drainage, medium resistance to erosion, slightly elevated ridges, and a sharp cliff at the boundary with Unit S_2. Though this unit is regarded as the same group of Triassic sedimentary rocks, it is distinguished from Unit S_2 by different features of erosion resistance and profile of mountains.

(4) Unit S_4

This unit is distributed around Kampung Darit in central part of the survey area. Its photographic characteristics are gray tone and fine texture. It is topographically characterized by coarse, dendritic drainage, low resistance to erosion, low mountain relief and round shaped ridges. Lineament suggesting strike of bedding is locally present, though it is unclear. On the basis of the topographic features, this unit is infered to consist of pyroclastic rocks, despite the fact that this rock was regarded as quartz porphyry in the previous geological map, which included it in the Unit D_1 quartz porphyry.

(5) Unit S_5

The unit is distributed around Sungai Data in the central eastern part of the whole survey area. It is characterized by weak resistance to erosion, and dense dendritic drainage. Mountain relief is not high, but mountain profile shows comparatively sharp ridges. Lineaments which, are probably due to bedding, are locally observable. This unit is interpreted as consisting of pyroclastic rocks. It is separated from Unit S_4, based on difference of photographic characteristics. According to previous data, this formation is quartz porphyry.

(6) Unit S_6

The unit is distributed around Kampun Negare in eastern part of the survey area. Its photo-characteristics are gray tone and fine texture. It is topographically characterized by weak resistance to erosion, dendritic drainage, low relief and gentle ridges. Ridge topography is sometimes flat. Lineament due to bedding is recognizable. On the basis of the above facts, the unit is considered to consist of sedimentary rocks. Considering the difference of features, this unit is separated from S_7. Previous reports indicate that this unit is a Triassic Formation.

(7) Unit S_7

This unit is distributed east of S_6, outside of the survey area. It is characterized by medium resistance to erosion, coase dendritic drainage, and flat ridge topography. Boundary between Unit S_6 and Unit S_7 is sharply defined by a steep cliff. Bedding strike is clearly recognizable. It is interpreted to consist of sedimentary rocks. According to the previous geological map, it is a Triassic sandstone formation.

(8) Unit S_8

This unit is distributed along Sungai Menyuke in the central eastern part of the survey area. Drainage is characterized by low density and meander pattern of streams. Weak resistance to erosion and flat topped ridges characterise the topography. Accordingly, this unit is identified as sedimentary rocks. Previous geological map considered it a Cretaceous sandstone formation.

(9) Unit Q

This unit is distributed principally along big rivers in the area. It consists of terrace and alluvium deposits.

2-4-2 Igneous Rocks

(1) Unit G_1

This unit is distributed in the central and southern parts of in the survey area. It is characterised by weak resistance to erosion, dense dendritic drainage pattern, low relief and round shaped ridges. Trees are high and vegetation is dense. According to the old geological map, it is composed of granitic rock.

(2) Unit G_2

This unit is situated in the central and northern parts of investigated area. This unit has high resistance, steep topography and dense dendritic drainage pattern. Though the old geological map shows Unit G_1 and Unit G_2 as the same granitic rock, in this survey the area divided into two different granits, on the basis of different photogeological feature and pattern.

10

(3) Unit G_3

This unit is distributed in Bengkayang area as a small scale intrusive body. It is topographically characterized by high resistance to erosion, steep coned ridge, and dense radial drainage pattern. Based on these characteristics, this granitic rock is different from Unit G_1 and Unit G_2, and is probably a younger intrusive.

(4) Unit D_1

This unit is distributed in the central and southern part of the survey area. It is topographically characterized by coarse radial drainage pattern, very high resistance and steep ridges. This unit is quartz diorite or diorite, according to the previous geological map.

(5) Unit D_2

This unit is distributed in the west central part of the interpreted area. It is topographically characterized by coarse radial or dendritic drainage pattern, high resistance to erosion, and steep mountains. According to the old geological map, this unit is regarded as quartz porphyry, the same as Unit D_1. But in this study it is divided from D_1, because it is distributed in a separated area from Unit D_1.

(6) Unit A_1

This unit is distributed in the central part of the survey area. It is characterized by coarse dendritic drainage pattern, high resistance to erosion, round shaped mountains. It is interpreted as andesite.

(7) Unit A_2

This unit is distributed in the central part of the photo geological interpretation area. It is characterized by parallel or sub parallel drainage pattern, medium resistance to erosion, and gently sloping mountains. This unit has local lineaments, probably due to bedding. It is interpreted as andestic pyroclastic rock, the old geological map described it as andesite.

2-5 Geological Structure

Large scale fold and fault structures have not been observed on air photographs, but lineaments, suggesting small scale folding and faulting, are evident in many places. Lineaments interpreted as folding structure dipping generally S and SW are observed in Unit S_2 (Triassic sedimentary rock). In the area of Bengkayang, there are small scale syncline and anticline strucutres.

In Unit S_4, Unit S_5, Unit S_6, and Unit S_7, lineaments striking N - S, dipping gently E, are also present.

Lineaments supposed to be faults or joints are present in the whole area. The predominant lineaments in the area trend NNW - SSE and are comparatively large scale. The next most common are lineaments striking N - S and NE - SW. Lineaments trending NNW - SSE and supposed to be faults are especially observable in Unit G_2, D_1 and D_2 as faults.

CHAPTER 3 GEOLOGY

CHAPTER 3 GEOLOGY

3-1 General Geology

West Kalimantan, including the investigation area, is situated in the eastern marginal part of Sundaland which is the southern end of Asian Continent as Fig. 3-1 shows. Sundaland has become a craton after peak of igneous activity lasting from Carboniferous to Triassic, centering around metamorphic and gneissose rock area of the Schwaner Mountain, Central Kalimantan. By continuous addition of mesozoic sediments and igneous activity to the outside rim of the continent, Sundaland has grown outer wards from the Sundaland craton.

During a period from late Cretaceous to early Tertiary, thick sediments consisting of Rajan Group of flysh sediments were deposited in the North West Borneo Geosyncline and Bram Group of limestone and sandstone was deposited to the east and north of Sundaland margin, (Fig. 3-2), (Haile 1969). At boundary between Sundaland continent and North West Borneo Geosyncline Groups which passes nearly along the border line of Kalimantan and West Sarawak, there is the Lupar Chert Ophiolite zone, more than 250 Km long. From the point of view of place tectonics theory, the Lupar Chert Ophiolite zone is interpreted as a Subduction Zone of a continental plate (Sundaland) and an Oceanic plate (North West Geosyncline area) during the period from Late Cretaceous to middle Tertiary, (Haile 1973, Hutchison 1973 and Hamilton 1978).

In West Kalimantan and South West Sarawak, that is south of the Lupar Ophiolite zone, few acidic - intermediate calc-alkalic granitoid rocks, dated by radiometric dating Tertiary in age, are known up to

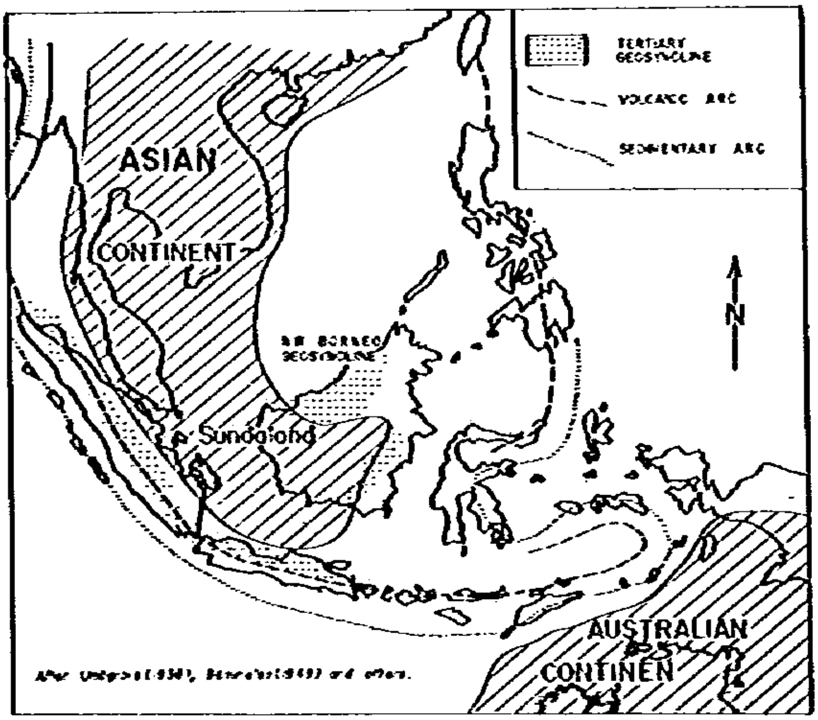


Fig. 3-1 Map of Sundaland

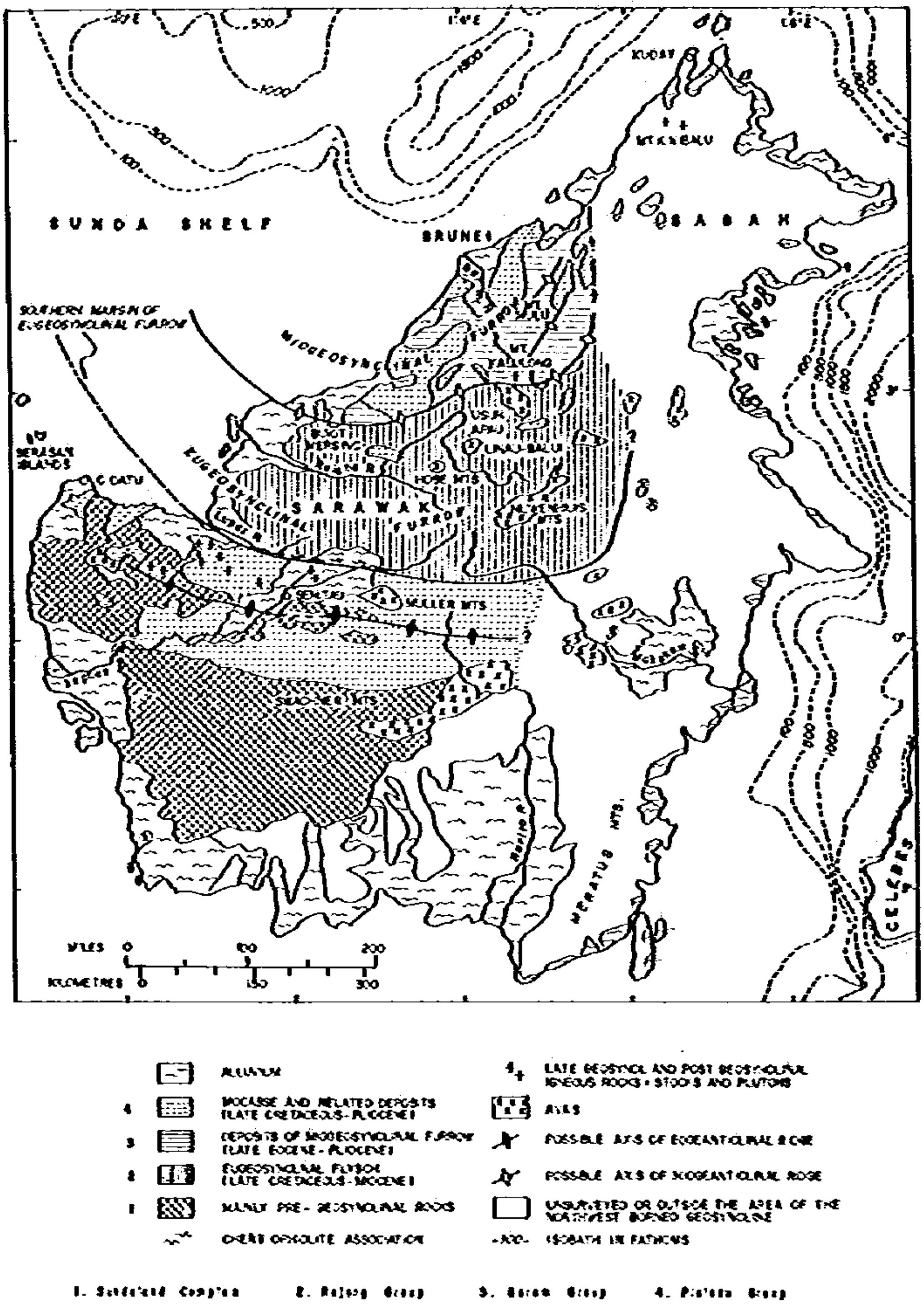


Fig. 3-2 Organizational Pattern of the
North-West Borneo Geosyncline

(Haile 1969, Pupilli 1973)

present. However, based on plate tectonics theory, it seems possible that Tertiary granitoid rocks are present in Sundaland complex. For an example, it is said that Bau Au-Ag and Sb-Hg mineralizations in Sarawak are related to Tertiary intrusious in Sundaland complex (Taylor and Hutchison 1978). In this investigation area, Cu-Mo mineralizations and Au-Hg-Sb mineralizations are distributed in or around intrusions of undetermined age. Some of these intrusions, accompanied by Cu-Mo and Au, are expected to be Tertiary intrusives. In this investigation tonalite intrusive accompanied by mineralization has been dated as Oligocene to early Miocene. The result is very important to interpretation of relationship between mineralization and igneous activity in West Kalimantan area.

3-2 Outline of Geology in The Survey Area

The survey area consists of Triassic - Jurassic sedimentary rocks, Mesozoic volcanic and pyroclastic rocks, Mesozoic plutonic rocks, Tertiary intrusive rocks, Tertiary volcanic and pyroclastic rocks and Alluvial deposits in ascending order. Fig. 3-3 shows generalized stratigraphy and igneous activities in the survey area.

The formation and igneous rock names used in the report are newly given on the basis of names of the place, mountain, or river where each type of rock or formation is exposed.

3-2-1 Upper Triassic - Lower Jurassic Sedimentary Rocks

The sedimentary rock group is divided into four formations from upper formation as follows:

Bengkayang Group

Sungaibetung Formation (alternating beds of sandstone, siltstone, and mudstone)

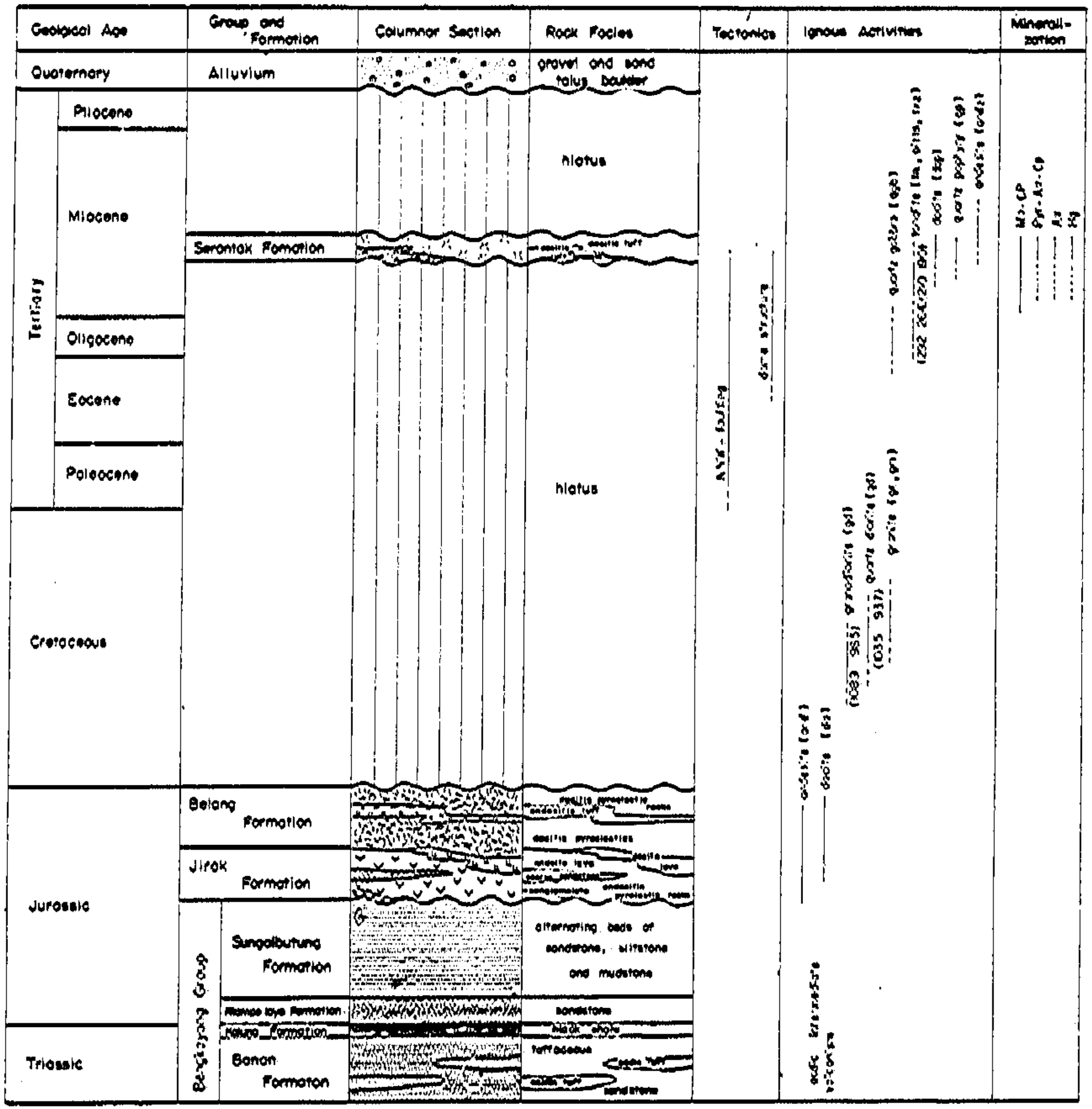


Fig. 3-3 Generalized Stratigraph of Survey Area

Riampelaya Formation (sandstone)

Kalung Formation (black shale)

Banan Formation (tufaceous sandstone)

The group has been correlated with the upper Triassic in age, based on existing data, but Sungaibetung Formation is newly correlated with Lower Jurassic (Lias, Toarcian) in age, because of new discovery of Lower Jurassic ammonite fossils. Thus the group is correlative with Upper Triassic - Lower Jurassic.

In northern mountain range ranging from Gunung Bawang to Gunung Mahmud, Bengkayang Group is characterized by prevalence of dome structures caused by intrusion of Tertiary tonalite. Some rock of Banan Formation have undergone slight thermal metamorphism by tonalite intrusion.

3-2-2 Mesozoic Andesite, Dacite and Dacitic Pyroclastic Rocks

(1) Jirak Formation

The Jirak Formation, which consists of andesite and its pyroclastic rocks uncomformably overlies the Sungaibetung Formation of Bengkayang Group. Thin fine conglomerate bed lies partly on the uncomformity. The Formation has been intruded by Gunug Raya granodiorite intruded at Middle Cretaceous time.

(2) Belang Formation

The Belang Formation consisting of dacitic pyroclastic rocks interbeded with andesitic pyroclastic rocks is widely distributed in Belang and Benting area along the road from Bengkayang to Darit. It may be infered that Belang Formation was deposited during a period from Middle Jurassic to Upper Jurassic (or Lower Cretaceous) time, the same as the Jirak Formation.

3-2-3 Old Granitoid Rocks

In southern part of the survey area, hornblende biotite granodiorite has an extensive distribution as a large scale batholith, and successive quartz diorite and granite have intruded into the granodiorite as stocks or dykes. These granitoid rocks were named Gunung Raya granodiorite, Tiang quartz diorite, granite 1 and granite 2, respectively. Gunung Raya granodiorite and Tiang Quartz diorite were determinded as Middle Cretaceous in age by K-Ar age dating.

3-2-4 Younger Granitoid Rocks

Two tonalite intrusives are distributed in northern survey area. One of them, named Sirih tonalite has intruded into Bengkayang Group, and another one, called Banyi tonalite, has intruded into Gunung Raya granodiorite. These tonalites have been dated as Oligocene and Lower Miocene, Tertiary, by K-Ar dating.

At Gunung Pandan situated south of Bengkayang, Pandang quartz gabbro has intruded into Sungaibetung Formation, and dolerite dyke or stock has cut Bengkayang Group at Doyo and alow the upper part of Sungai Cebol. Olivine bearing dolerite dyke has intruded along fault in Gunung Raya granodiorite at Sungai Sembuang, southern part of the survey area. These basic intrusive are regarded as younger igneous rocks.

3-2-5 Dacite, Dacitic Pyroclastic Rocks

Dacite intrusion having coarse quartz and plagioclase phenocrysts is distributed in Gunung Serantak and in western area of Gunung Bawang. Around this dacite, dacitic pyroclastic rocks composed of tuff breccia, lapilli tuff, and fine-sandy tuff have extensive distribution and unconformably overlies the Bengkayang Group. Some dacite stocks are found at Sansak, Gunung Semalo and east of Tiang Aping. Sansak dacite is accompanied by pyroclastic rocks like Serantak dacite.

3-2-6 Andesite Dykes

Andesite dykes striking NNW occur in Sirih tonalite and Gunung Raya granodiorite.

3-2-7 Quaternary

In the plain area of Sungai Raya and Sungai Ledo, Quaternary sediments consisting of unconsolidated gravels and sands are distributed along these rivers.

Talus deposit of granitic gravels is present on the left bank of Sungai Jago, south of Bengkayang.

3-3 Stratigraphy

3-3-1 Sedimentary Rocks (Bengkayang Group)

The Bengkayang Group has wide distribution in the north part of the survey area. It consists of tufaceous sandstone, black shale, sandstone, and thick alternating beds of sandstone, siltstone, and mudstone. The Group is consequently divided into four Formations as mentioned above.

(1) Banan Formation

Distribution : The Formation is chiefly distributed along the upper reaches of Sungai Ledo, Sungai Banan, Sungai Sansak, and around mountain area of Gunung Bawang and Gunung Mahmud.

Thickness : Thickness of the Formation is not exactly known because it is the lowest Formation in the area. But it is estimated to be over 1,500 m.

Rock Facies : This Formation is mainly composed of dark gray or light gray had tufaceous sandstone. Under microscope, tufaceous sandstone (RB-7, RB-15 and RB-19) composed of sands of dacite and andesite, clastic quarts, plagioclases,and green hornblendes, and fine tufaceous rock (RB-4 and RB-19) consisting of fine pyroclastics of plagioclase and quartz with some epidote were observed. This Formation contains much tufaceous sandstone.

Fossils and age : This Formation yielded no fossils. The Formation may be considered to be Late Triassic in age on the basis of previous information and stratigraphical correlation chart of Kalimantan and Malaysian Borneo (Pupilli 1973), mentioning existence of volcanic activity at Southwest Kalimantan in Late Triassic.

(2) Kalung Formation

Distribution : The Formation is exposed along Sungai Kalung, upstream tributary of Sungai Raya, Sungai Cebol, and Sungai Nasan surrounding Sirih tonalite and Banan Formation. The Formation is present along the dome structure, and conformably covers the Banan Formation.

Thickness : The Formation ranges in thickness from 100 m to 150 m, but upstream of the Sungai into the Formation thins out.

Rock facies : The Formation consists of black shale and black sandstone. Under microscope, the rock has graded texture with alternating parts of mud and sand as Photo (RB-62) shows. Sand components are quartz, plagioclase, chloritized mafic material, and clay.

Fossils : No fossil have been found up to present.

(3) Riampelaya Formation

Distribution : Type locality of the Formation is situated along upper reaches of Sungai Raya. This Formation conformably overlies the Kalung Formation, and is unconformably overlain by Tertiary dacitic pyroclastic rocks.

Thickness : Thickness of the Formation is estimated to be 300 m.

Rock Facies : This Formation is composed of pale gray, medium and coarse sandstone. At Sungai Kalung, and the upper part of the Sungai Sedate, discontinuous fine conglomerate containing black shale pebbles is observable at the boundary between the Kalung Formation and this Formation. This Formation is characterized by inclusion of andesite and dacite fragments in sandstone, apparent in microscopic observation of sample RB-60 and RB-61.

Fossils and age : No fossils have been found up to present.

(4) Sungaibetung Formation

Distribution : The Formation is widely distributed in the northern part of the survey area, at Lumar, Bengkayang and Sungaibetung area, being the upper most Formation of the Bengkayang Group. This Formation conformably overlies the Riampelaya Formation.

Thickness : The estimated thickness is from 2,000 m to 5,000 m.

Rock facies : The Formation consists of well stratified alternating beds of fine sandstone, black and gray mudstone and siltstone. Mudstone and siltstone become predominant in the upper horizon.

Fossils : The upper mudstone horizon of the Sungaibetung Formation yields ammonite fossils. These locations are as follows:

RD-7, Rℓ-2	1.5 Km west of Kampung Marikar
Rℓ-54	0.5 Km east of Bengkayang, facing the road to Darit from Bengkayang.

These fossils have been identified by Dr. Hiromichi Hirano, Ass. Professor of Waseda University.

Sample Rℓ-54 has been identified as *Harpoceras (Harpoceras) SP.* and RD-7 and Rℓ-2 has been identified as *Dactyoceras (Orthodactyoceras) SP.* Previously P. Kraus (1896) reported to have found *Harpoceras* in Northern Gunung Bawang, but its exact location was not mentioned. Thus this new discovered fossils are the first whose exact location is recorded. These fossils, however, are not well preserved, and are very difficult to identify on the species level.

Harpoceras (Harpoceras) SP. is similar to *Harpoceras capellinii* (found in Italy), *Harpoceras mulgravium* (England), *Graphoceras rudis* (England and South France), *Harpoceras taleicostatum* (Italy).

*Dactylioceras (Orthodactylites) SP.*is also similar to *Dactylioceras (Orthodactylites) semicelatoides* (found in Southern France), *Dactylioceras (Orthodactylites) tenuicostatum* (Spain).

However both ammonite fossils could not be correlated with these fossils, because of poor preservation. Both ammonite fossils seem to belong to the Tethys fauna, and are correlative with the Lias Toarcian, Lower Jurassic. The same ammonite fossils have been found in Toyoura Group in Western Japan. The fauna of Sungaibetung Formation, Bengkayang Group, is important, because of connect between Europe fauna and Toyoura fauna through the Tethys Sea.

3-3-2 Volcanic and Pyroclastic Rocks

(1) Jirak Formation

Distribution : The Jirak Formation, consisting of andesite and andesitic pyroclastic rocks, overlies unconformably the Sungaibetung Formation and is distributed in area along the southern part of the road from Sungaibetung to Bengkayang. Fine conglomerate containing pebbles of mudstone overlies part of the unconformity in Keranji village.

This Formation has been intruded by Gunung Raya granodiorite. In Tian Tanjung village and Panso village, southern part of this survey area, the same andesite and its pyroclastic rocks crop out and have been intruded by Gunung Raya granodiorite. This rock is also correlative with the Jirak Formation based on similarity of rock facies and existence of thermal metamorphism.

Rock Facies:

a) Andesitic lapilli tuff (RD-12)

The rock is composed of andesite rock fragments and plagioclase clastics (larger than 2 mm) and mafic minerals which have been altered completely to epidote, chlorite and carbonates in a groundmass consisting of fine feldspar, quartz, and chlorite.

b) Andesitic lithic tuff (RD-23)

Andesite breccia up to 2-3 cm and aggregation of mineral clasts altered completely to epidote chlorite quartz and opaque minerals are the main components of the rock. The rock crops out near contact with Gunung Raya granodiorite.

c) Andesite (RD-14)

Phenocrysts of plagioclase altered to calcite, sericite and clay, and chloritized mafic minerals in a groundmass of lath shaped plagioclase, quartz, and chlorite. Chloritization and carbonitization are apparent in the rock.

d) Andesitic tuff in Tian Tanjung (RE-40)

This rock is composed of andesitic and quartzite rock fragments, epidotized plagioclase clastics in a groundmass consisting of fine grained quartz, epidote, and opaque minerals. (Lithic andesitic tuff)

e) Andesitic tuff in Panso village (RF-15)

Epidotized plagioclase, aggregation of epidote, quarts and a few andesitic and dacitic fragments (smaller than 1.5 cm in diameter) are the main clastic components in a groundmass of fine quartz, actinolite, epidote, and chlorite. This rock is characterized by existence of many fine actinolite, crystals and is regarded as a result of thermal metamorphism caused by Gunung Raya Granodiorite.

(2) Belang Formation

Distribution : This rock is widely distributed between Kampung Sumpuan and Kampung Tapang along the road from Bengkayang to Darit, and at Gunung Paninjin, along the western part of the road.

Rock facies : This Formation mainly consists of dacite and its pyroclastic rocks, interbeded with andesitic pyroclastic rocks. Tuff breccia, lapilli tuff containing dacite and andesite breccia, and lapilli compose for the most part the Formation. These rocks have generally been altered to chlorite, epidote and partly sericite.

a) Andesitic tuff (RF-48)

This rock is lithic tuff, composed of subangular andesitic clastics (having trachitic texture in some clastics), plagioclase and mafic minerals altered to sericite and some quartz, in a groundmass consisting of plagioclase, clay minerals (chlorite and sericite), epidote, quartz, and an iron mineral. Lithic and mineral clastics constitute 2/3 of whole.

b) Dacitic tuff (RF-8, RF-51, Rp-53 etc.)

Angular to subangular andesitic clastics, plagioclase, and fragments of plagioclase-epidote-chlorite aggregates are contained in groundmass consisting of quartz, plagioclase, and chlorite. Sample RF-8 contains biotite as an alteration mineral resulting from thermal metamorphism.

Stratigraphy : Some dacitic tuff has been affected by thermal metamorphism, for example dacite tuff croping out in Sungai Kersik has secondary biotite which is the product of thermal metamorphism by intrusion of Gunung Raya granodiorite. On the basis of the above fact and features of its distribution on the geological map compiled by this geological survey, this Formation is infered to be Late Jurassic in age having been deposited, after Bengkayang Group and before Gunung Raya granodiorite.

(3) Serantak Formation

The Formation is distributed in the plain area of Sungai Lumar to Gunung Serantak, west of Gunung Bawang and Sansak areas overlying unconformably Bengkayang Group as pyroclastic sediments derived from Serantak dacite.

This Formation consists of decitic lapilli tuff (RB-52), fine to sandy tuff with good bedding. Some of them contain pumiceous component. Neighbouring dacite intrusion, dacitic tuff breccia occurs, for example along Sungai Bonieng, tributary of Sungai Banan, and Sungai Sansak.

This Formation seems to be as much as 100 m thick. Because this Formation covers unconformably Bengkayang Group and is presumably member of Tertiary dacite stock (Serantak dacite), it is regarded as of Tertiary age.

3-3-3 Intrusive Rocks

(1) Ages of Plutonic Rocks

In order to find the intrusion time of the plutonic rocks in the survey area, absolute age determinations were done by K-Ar method. Four samples, namely Gunung Raya granodiorite (Rp-19), Tiang quartz diorite (RE-50), Banyi tonalite (RD-52), and Sirih tonalite (RB-24), were selected from among the samples which were analyzed chemically. Based on the results (shown in Table 3-1), these granitoid rocks can be classified into the following two age groups;

Middle Cretaceous	Gunung Raya granodiorite	(103.7 m.y.)
	Tiang quartz diorite	(98.6 m.y.)
Oligocene - Lower Miocene		
	Banyi tonalite	(27.8 m.y.)
	Sirih tonalite	(20.0 m.y.)

The former is infered to belong to Cretaceous intrusions distributed widely in West Kalimantan, that is Kalimata, Anambas, Natuna, and Central Kalimantan, as Fig. 3-4 shows. On the contrary, the latter, associated which are with mineralizations and determined as Tertiary intrusions, are found on the eastern margin of Sundaland. Interpreted by Plate Tectonics theory, it appears from the above that these intrusives had a close relation to Subduction zone along Lupar ophiolite zone during a period from early Cretaceous to Miocene.

(2) Chemical Composition of Igneous Rock

The eleven samples collected from plutonic rocks and hypabyssal rocks were chemically analysed to determine their chemical composition. These granitoid rocks were collected from Gunung Raya granodiorite, granite 1, granite 2, Pandan quartz gabbro, Banyi tonalite, and Serantak dacite. Table 3-2 summarises the results of chemical analyses and normative mineral (wt %) composition calculated from the results of these chemical analyses. SiO_2 contents of most samples ranges from 55 % to 70 %, and they thus belong to intermediate igneous rocks. Sample RF-32 is more acidic, and samples RE-50 and RD-28 show more basic igneous rock characteristics. Though these igneous rock were

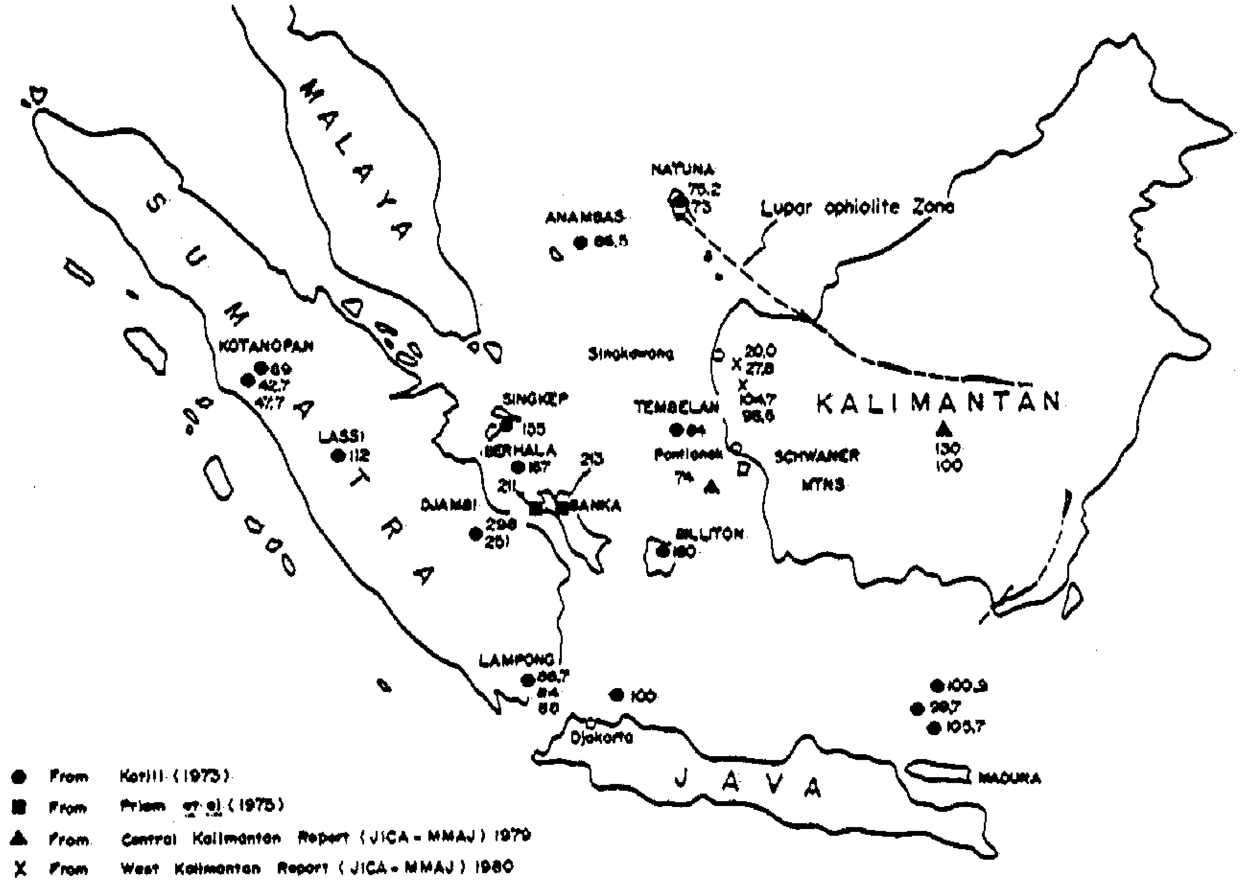


Fig. 3-4 Absolute Age of Granitoid Rocks in West Indonesia

Table 3-1 Result of K-Ar Dating

No.	Sample No.	Locality	Lithology	Mineral	$secAr^{40Rad}$/gm x 10^{-5}	Ar^{40Rad}%	K%	Age (m.y.)
1	RB-24	S. Bamua	S. Sirih Tonalite	Hornblende	0.213 0.223	48.3 48.9	2.80 2.79	20.0±1.0
2	RD-52	S. Boni	Banyi Tonalite	"	0.126 0.137	30.1 43.9	1.20 1.21	27.8±1.4
3	RE-50	S. Sakung	Tiang Quartz diorite	"	0.367 0.354	73.3 70.0	0.90 0.93	98.6±4.9
4	Rp-19	S. Bala	G. Raya Granodiorite	"	0.225 0.215	62.9 45.0	0.53 0.53	103.7±5.2

The constants for the age calculation are: $\lambda\beta = 4.962 \times 10^{-10} yr^{-1}$,

$\lambda\varepsilon = 0.581 \times 10^{-10} yr^{-1}$, $K^{40} = 1.167 \times 10^{-4}$ atom per atom of natural potassium.

Table 3-2 Chemical Composition of Granitoid Rocks

		Sample No.	Rp-19	RF-20	RE-30	RF-32	Rn-32	RE-50	RD-28	RB-24	RD-52	Rq-59	RB-72
		Location	S. Bala	S. Sembuang	S. Pehen	S. Sembuang	S. Semade	S. Pehen	G. Pandan	S. Banua	S. Bani	S. Setona	G. Serantak
		Rock name	gra-dio	gra-dio	gra-dio	gra-dio	gra-dio	qtz-dio	qtz-gab	tonalite	tonalite	gra-dio-por	dacite
Chemical composition		SiO_2 %	69.26	69.63	69.82	74.77	69.39	59.78	54.37	67.31	69.26	65.13	70.11
		TiO_2	0.41	0.40	0.40	0.20	0.49	0.63	0.63	0.48	0.47	0.57	0.35
		Al_2O_3	14.26	14.14	13.53	13.03	13.62	16.03	18.69	15.45	13.94	14.34	13.91
		Fe_2O_3	1.42	18.20	1.80	0.85	1.62	2.81	1.21	1.66	2.16	3.02	1.46
		FeO	2.37	1.91	2.04	1.09	2.04	4.81	6.23	1.91	1.66	2.73	3.22
		MnO	0.07	0.09	0.06	0.03	0.06	0.08	0.13	0.06	0.05	0.11	0.05
		MgO	1.11	1.07	1.17	0.45	1.07	3.29	3.93	1.61	1.20	2.00	1.35
		CaO	3.35	2.81	1.80	1.51	2.14	6.92	7.59	3.99	2.63	4.73	2.65
		Na_2O	3.56	3.95	4.02	4.05	4.23	3.00	3.78	3.84	4.19	2.79	5.32
		K_2O	2.40	2.42	3.12	2.64	2.66	1.06	0.63	2.40	1.95	1.85	0.27
		P_2O_5	0.09	0.09	0.09	0.00	0.08	0.09	0.08	0.12	0.09	0.08	0.11
		H_2O (+)	1.17	1.27	1.86	0.93	2.11	1.52	2.50	0.93	1.68	2.26	1.04
		H_2O (-)	0.23	0.36	0.12	0.29	0.23	0.12	0.36	0.19	0.36	0.34	0.05
		Total	99.72	99.96	99.83	99.84	99.74	100.14	100.13	99.95	99.64	99.95	99.89
C.I.P.W. norm		Q	29.6	29.3	28.5	36.9	28.2	18.0	5.8	24.6	30.2	28.0	29.3
		C	0.1	0.3	0.6	0.8	0.3	-	-	-	0.7	-	0.4
		or	13.9	14.5	18.4	15.6	15.6	6.1	3.9	14.5	11.7	11.1	1.7
		ab	29.9	33.6	34.1	34.1	35.7	25.2	32.0	33.0	35.7	23.6	44.6
		an	15.9	12.8	8.1	7.5	9.7	27.3	32.0	17.8	11.4	21.1	12.2
	di	wo	-	-	-	-		2.6	1.9	0.5	-	0.6	-
		en	-	-	-	-		1.5	0.1	0.3	-	0.4	-
		fs	-	-	-	-		0.9	0.1	0.1	-	0.1	-
	hy	en	2.8	1.2	2.9	1.1	2.7	6.7	9.6	3.7	3.0	4.6	3.3
		fs	2.6	3.6	1.7	0.9	1.7	4.5	9.4	1.5	0.5	1.7	4.1
		mt	2.1	2.6	2.5	1.2	2.3	4.2	1.9	2.3	3.2	4.4	2.1
		il	0.8	0.8	0.8	0.5	0.9	1.2	1.2	0.9	0.9	1.1	0.8
		ap	0.3	0.3	0.3	-	1.0	0.3	2.0	0.3	0.7	0.3	0.3
		Total	98.0	99.0	97.9	98.6	98.1	98.5	99.9	99.5	98.0	97.0	98.8
		Q+or+ab	73.4	77.4	81.0	86.6	79.5	49.3	41.7	72.1	77.6	62.7	75.6
		D.I	74.9	78.2	82.7	87.8	81.0	50.1	41.7	72.5	79.2	64.6	76.5

Abbreviation: gra-dio: granodiorite qtz-dio: quartz diorite
qtz-gab: quartz-gabbro gra-dio-por: granodiorite porphyry

Table 3-3 Modal Composition of Granitoid Rocks

Rock No.	Q	pl	kf	bi	ho	px	mt
RB-33	34.8%	45.4%	3.8%	13.0%	3.0%	-%	-%
RD-29	15.9	59.0	-	-	21.3	2.1	1.7
RD-35	33.4	53.2	5.0	3.6	3.4	-	1.4
RD-37	41.0	50.9	2.1	4.3	0.7	-	1.0
RD-48	17.6	60.8	-	-	18.0	*2.4	1.2
RE- 2	30.2	43.6	16.0	6.2	2.4	-	1.6
RE-80	31.2	40.3	22.6	3.3	1.4	-	1.2
RF-10	31.4	37.6	19.4	6.2	4.6	-	0.8
RF-25	30.8	44.6	14.2	4.6	4.4	-	1.4
RF-30	37.2	31.2	17.6	13.0	-	-	1.0
RF-45	26.6	55.6	6.2	4.0	7.0	-	0.6
RF-55	27.4	61.2	2.2	0.4	7.8	-	1.0
Rl-61	42.2	37.2	13.6	6.2	-	-	0.8
Rm- 1	31.2	52.0	1.6	5.0	8.4	-	1.8
Rm-23	31.4	54.0	5.2	9.4	-	-	-
Rm-25	15.0	56.2	-	14.8	12.0	-	2.0
Rn-38	27.8	47.9	23.0	0.5	0.3	-	0.5
Rn-61	26.0	58.2	10.8	2.4	1.6	-	1.0
Rn-66	16.6	54.2	3.6	5.0	19.2	-	1.4
Rp-41	39.4	32.0	18.2	5.6	3.0	-	1.8

* augite + hypersthen

separated into old granitoid rocks and younger granitoid rocks by K-Ar age dating, values of each oxide and I.D. (index of differentiation) of all samples were plotted together on the same graph, Fig. 3-5. Each oxide value shows a linear trend. In comparison with the average content of Japanese granitic rocks (Aramaki et al 1972), K_2O and Al_2O_3 values plot slightly below the line of average contents of Japanese granits. But the slope of the line is closely similar to that of Japanese granitic rocks.

Normative constitutions calculated from the chemical analyses and modal constitutions calculated by point counter are plotted in Q-Kf-Pl diagrams (Fig. 3-6, Fig. 3-7). On the basis of modal diagram, younger granitoid rock's constitutions range from tonalite to quartz diorite field, on the contrary the old granitic rocks occupy a broad range from granite to tonalite.

According to M-F-A diagram (Fig. 3-8), old granitoid and younger granitoid rocks are linked to the same magmatic differentiation process as that of the volcanic rocks of calk-alkalic series.

From the above mentioned chemical results and relationship between normative diagram, both old and younger granitoid rocks belong calk-alkalic igneous rock, characterized by decrease of FeO and rapid increase of SiO_2 as the magma differentiation progresses. Both granitoid rocks seem to have differentiated from magma sources of the same characteristics.

36

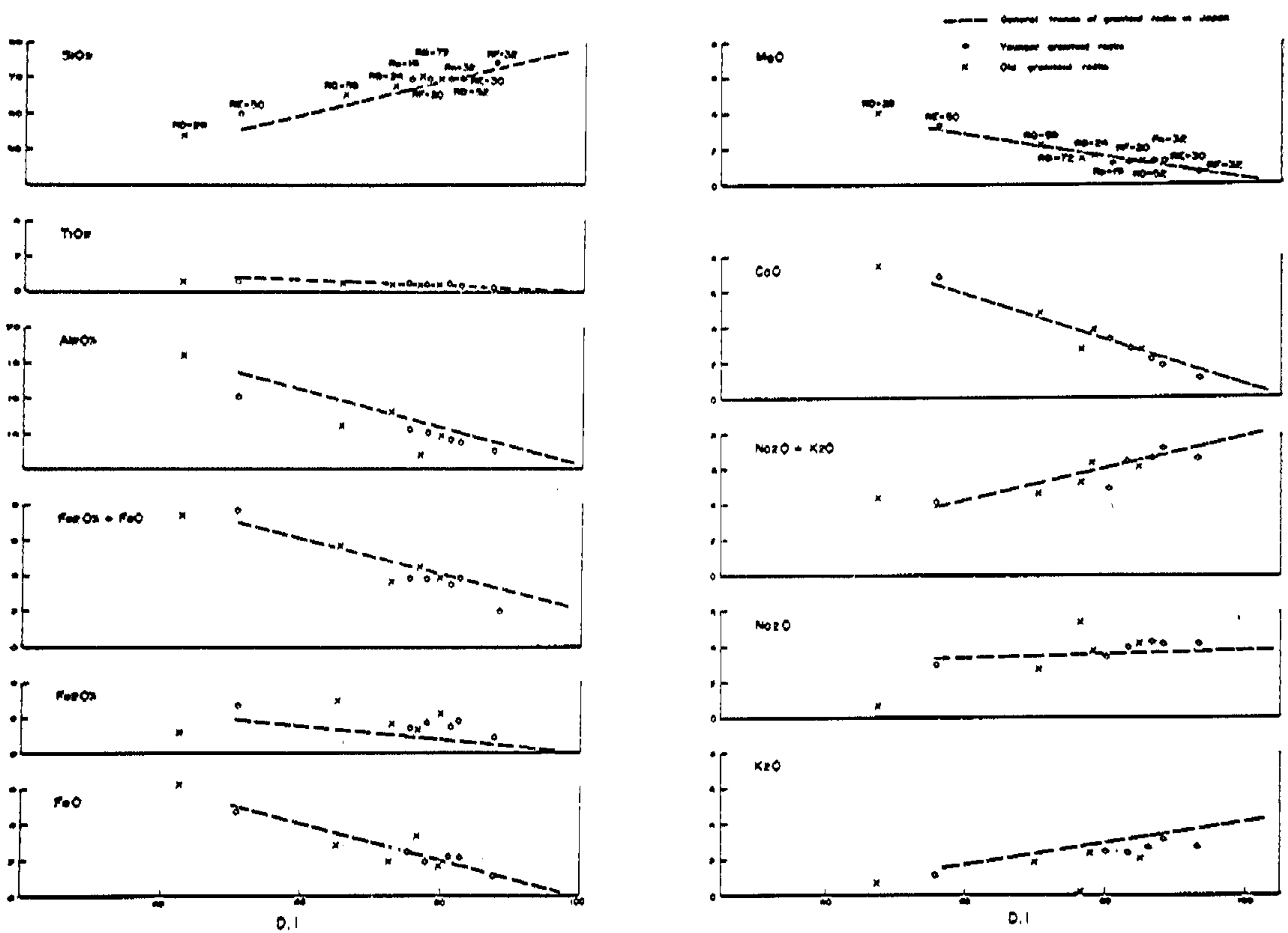


Fig. 3-5 Variation Diagram of Granitoid Rocks

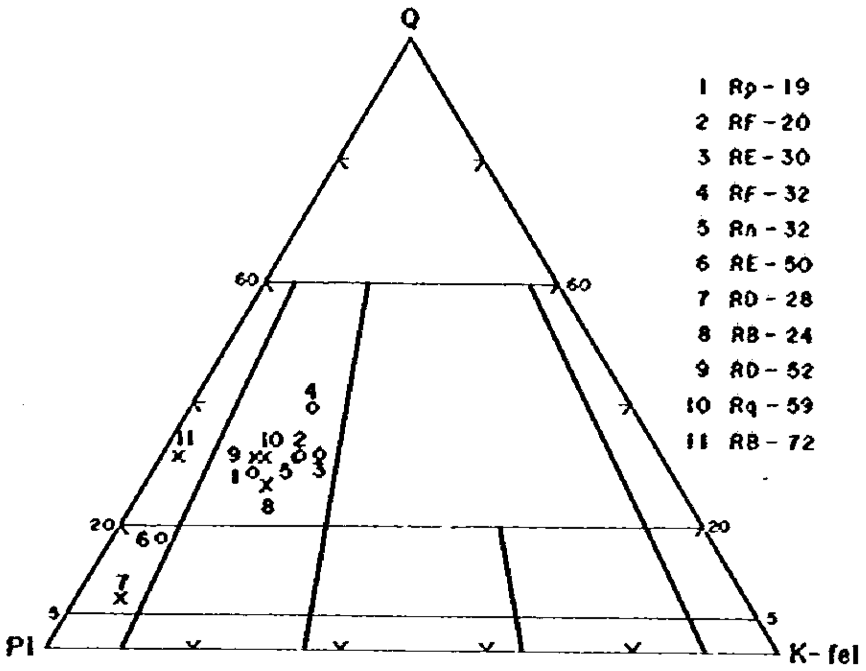


Fig. 3-6 Normative Q-Pl-Kfl Diagram of Granitoid Rocks

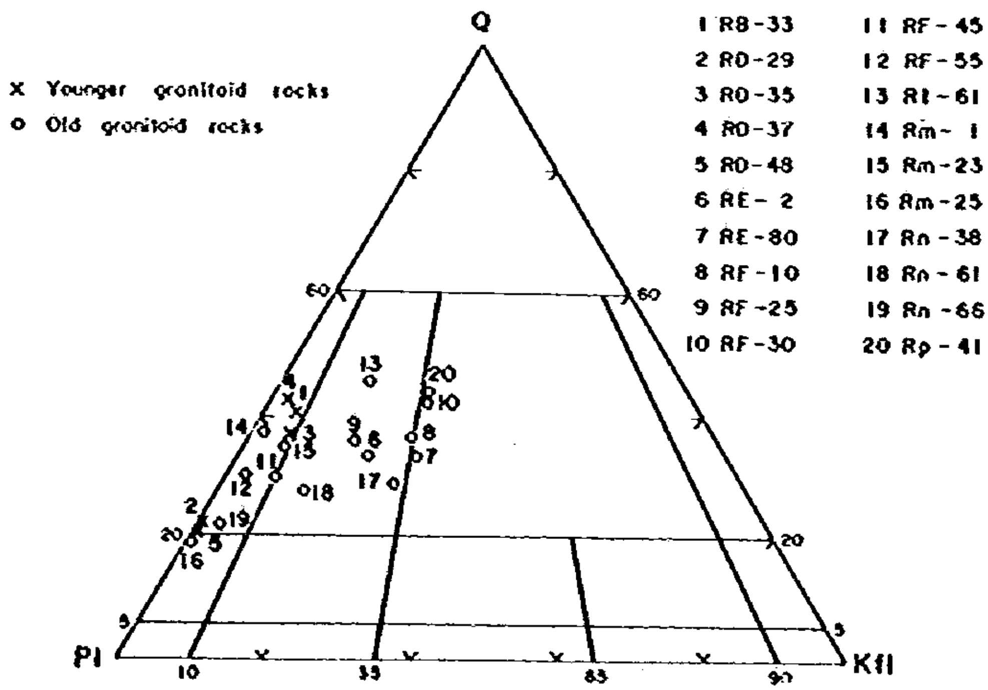


Fig. 3-7 Modal Q-Pl-Kfl Diagram of Granitoid Rocks

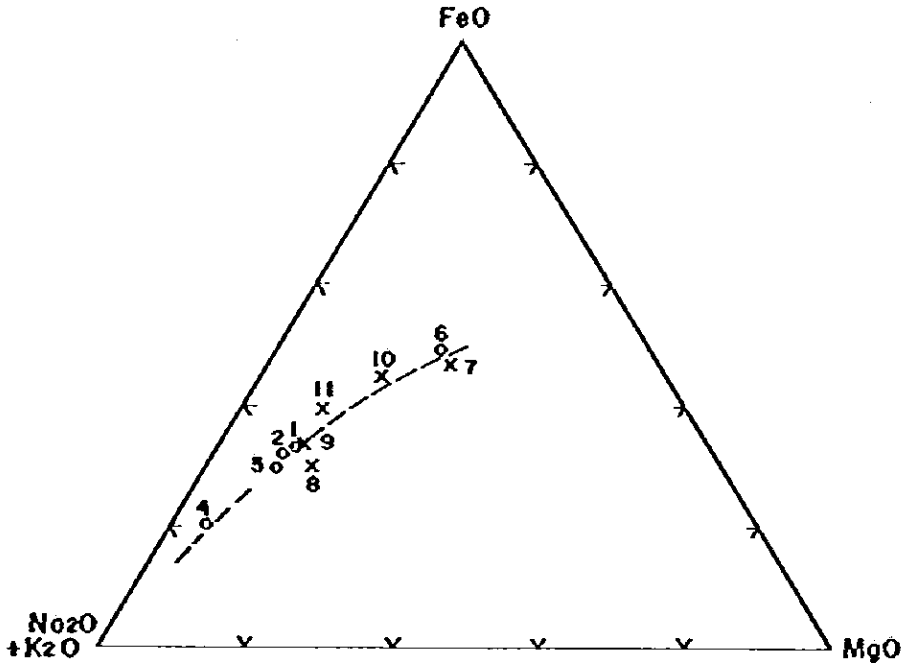


Fig. 3-8 M.F.A. Diagram of Granitoid Rocks

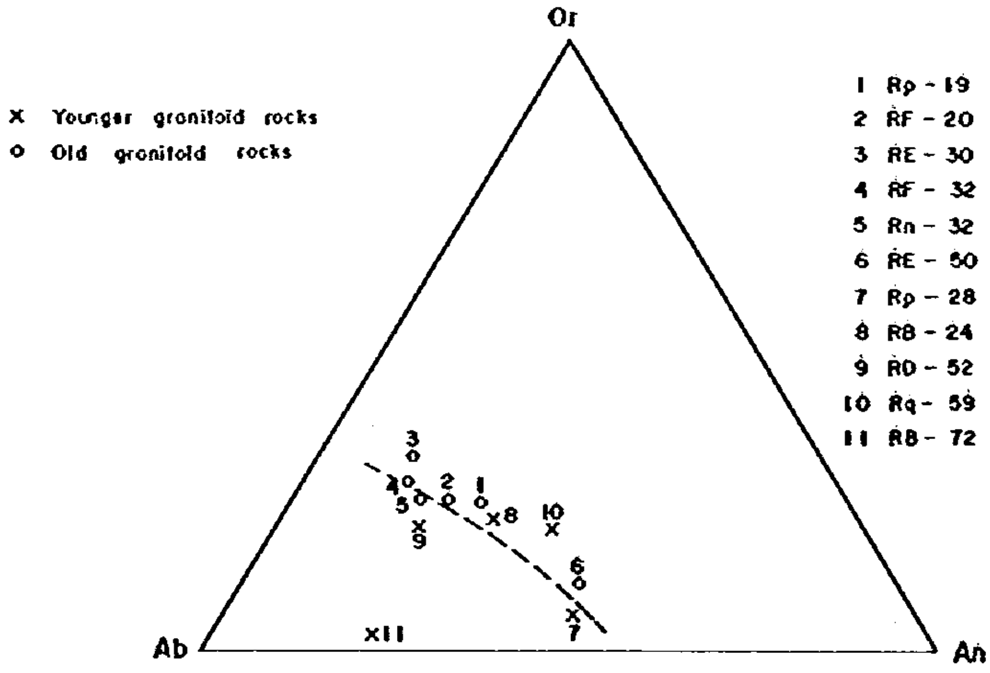


Fig. 3-9 Normative Or-Ab-An Diagram of Granitoid Rocks

(3) Old Granitoid Rocks

a) Gunung Raya granodiorite

Distribution : This rock occurs as a large scale batholith which has intruded the Sungaibetung Formation of the Bengkayang Group, the Jirak Formation, and the Belang Formation, and has a wide distribution in central and southern parts of the investigation area.

Rock facies : The rock is hornblende biotite granodiorite with color index ranging from 10 to 20 and medium grained equigranular texture. This rock includes granitic, granodioritic and tonalitic rock facies, based on the proportion of main rock forming minerals determined by modal analysis as Fig. 3-7 shows.

General facies of the Gunung Raya granodiorite is leucocratic (C.I. 10) medium grained equigranular rock and contains much biotite. Under microscope, main minerals components of the rock are plagioclase, quartz, potash-feldspar, and hornblende with opaque minerals and apatite and zircon as accessory minerals. Most biotite has been altered chlorite.

In the granitic rock distributed at the Sungai Tahuban, the Sungai Sailo and Kampung Gamang potash-feldspar and biotite increase, and plagioclase decreases. In the Tonalite croping out along the upper reaches of the Sungai Bembeng, and Gunung Paninju potash-feldspar decreases, and hornblend increases. Gunung Raya granodiorite is infered to be an intrusive complex composed of several intrusions that have intruded within a not very long time interval.

Time of intrusion : This granodiorite has intruded into the Jirak Formation and the Belang Formation, presumably deposited during the Jurassic. From K-Ar absolute age dating sample Rp-19, the estimated date is 103.7 m.y., namely middle Cretaceous.

b) Tiang quartz diorite

Distribution : The rock crops out in Gunung Tiang, Gunug Pandan Kecil at Sungai Sembuang.

Rock facies : Its color index ranges from 20 to 30, and it is medium to coarse grained pyroxene bearing biotite hornblende quartz diorite. Under microscope, main components of the rock are plagioclase, quartz, hornblende, biotite and small amount of potash-feldspar, augite and some hypersthene with apatite and sphne as minor minerals. Most augite has been replaced by green hornblende. Quartz diorite exposed at Gunung Pandan Kecil and Sungai Sembuang has color index of 30 to 40 and is fine porphyritic biotite hornblende quartz diorite. Under microscope, the rock (sample 25) shows porphyritic texture and consists of plagioclase, hornblende, biotite phenocrysts and a plagioclase and quartz groundmass. Mafic minerals are usually altered chlorite and epidote.

Time of intrusion : Tiang quartz diorite has intruded in to Gunung Raya granodiorite. This rock also occurs as several small dykes trending N 0-10 W in the Sungai Sembuang, southern part of the Banyl mineralization area. A K-Ar absolute age dating of a specimen RE-50 indicates the rockage of 98.6 m.y., namely middle Cretaceous.

c) Granite 1

Distribution : Two localities of granite 1 are situated in the area from the Sungai Semade to the upper reaches of the Sungai Semade, and in Sungai Sembuang in the southern part of the survey area.

Rock facies : The rock of Sungai Semade and Sungai Benteng is leucocratic (C.I. about 5), medium - coarse grained, two mica granite. The rock contains characteristically minor amount of muscovite and quartz veinlets, and has been affected by epidotization, sericitization, strong silicification accompanied by formation of tourmaline quartz veinlets at its southern marginal part. Small amount of molybdenite accompanies the tourmaline quartz vein.

Another rock at the Sungai Sembuang is medium - coarse grained equigranular biotite granite having color index of 10 - 15. Generally the rock contains not only alteration but also mineralization. Under microscope, the rock is composed of plagioclase, quartz, orthoclase showing graphic texture, and biotite as main components, and apatite and opaque minerals as accessory minerals. Biotite has been altered to chlorite and epidote.

Time of intrusion : This granite has intruded in to Gunung Raya granodiorite.

d) Granite 2

Distribution : From the central part to the southern part of the survey area, small scale granite dykes are sporadicaly distributed at the Sungai Sakung the Sungai Semade and Sungai Anáu.

Rock facies : This rock is leucocratic (10 - 15 of C.I.) medium-coarse grained equigranular hornblende biotite granite. Main components are plagioclase, quartz, orthoclase, biotite accompanied by opaque minerals, apatite and sphene as accessory minerals. Rock exposed at Sungai Sakung is porphyritic granite which is composed of plagioclase, quartz, hornblende, and biotite phenocrysts, and a plagioclase, quartz, hornblende, potash-feldspar, and biotite groundmass. Biotite and hornblende have been usually altered to aggregation of chlorite, epidote and carbonate mineral. The rock has no mineralization.

Time of intrusion : The granite is infered to have intruded in to Gunung Raya granodiorite and Granite 1, though contact of these intrusives was not observed in the field.

(4) Younger Granitoid Rocks

a) Pandan quartz gabbro

Distribution : Quartz gabbroic intrusions occur in Gunung Pandan and Gunung Kelan in southern Bengkayang.

Rock facies : This rock is megascopically dark green (about 50 of C.I.) medium to coarse grained holocrystalline, quartz bearing pyroxene hornblende gabbro. Under microscope, rock forming minerals are plagioclase, hornblende, quartz, augite with minor amount of hypersthene. Some part of hornblende has been replaced by biotite, chlorite, and epidote. Augite has also been partly replaced by epidote. Small stock rock (RD-18) and marginal rock (RD-48) of the intrusive body has porphyritic texture.

Time of intrusion : This rock has intruded in to the Sengaibetung Formation and the Jirak Formation.

b) Banyl tonalite

Distribution : This tonalite has intruded into Gunung Raya granodiorite south of Bengkayang it extends 5 Km in west-east direction and 2.5 Km in north-south direction. Another small intrusion is found facing the road from Bengkayang to Darit.

Rock facies : This rock shows about 10 of C.I. and is a medium grained holocrystalline hornblende biotite tonalite. Under microscope, (sample RD-52 and RD-35) it shows medium grained equigranular texture, and is composed of euhedral and subhedral plagioclase, biotite, hornblende, anhedral perthite, and quartz occupying irregular intercrystalline spaces. Biotite has usually been altered to chlorite, and hornblende has been partly altered to biotite and chlorite. Sample RD-52 is observed to contain small round xenoliths (smaller than 6 cm in diameter) of hornblende quartz diorite porphyry. Melanocratic tonalite (Rm-61) cropping out at Sebintik is characterized by presence of porphyritic texture, with the same components as Banyl tonalite.

Time of intrusion : This rock has intruded into the Jirak Formation and Gunung Raya granodiorite. The sample (RD-52) has been dated as 27.8 m.y. by K-Ar age dating method. Banyl mineralization accompanies this tonalite.

c) Sirih tonalite

Distribution : This rock is distributed in Gunung Bawang and Gunung Mahmud mountain range area, it is 10 Km long and 4 Km wide trending in the NWW direction. This tonalite has intruded harmoniously in to Banan Formation of the Bengkayang Group and the Bengkayang Group has been domed up by the tonalite intrusion.

Rock facies :This rock is medium grained holocrystalline, and its color index is about 10. Under microscope (specimens RB-24 and RB-33), its rock forming minerals are plagioclase, quartz, biotite, hornblende and potash-feldspar in order of abundance. Biotite has been altered into chlorite and epidote, carbonate.

Time of intrusion : K-Ar absolute age dating of specimen RB-24 has indicated age of 20.0 m.y., namely Lower Miocene, Tertiary. This rock is contains by molybdenite bearing quartz veins.

d) Altered felsic rock

Distribution : This rock is exposed near its contact with south part of Sirih tonalite, at Sungai Buguruh and along upper reaches of Sungai Ledo. However, contact point between both rocks has not been confirmed yet by field survey.

Rock facies : This rock is fine grained leucocratic felsic rock. Microscopic observation of Specimen RB-23 revealed that the rock is composed of completely sericitized plagioclase, chloritized hornblende and quarts phenocrysts in a groundmass containing fine quartz, plagioclase, sericite and disseminated pyrite. Original rocks may have been dacite or tonalitic porphyry. X-ray refraction test detected that the rock has been altered to sericite and quartz by hydrothermal alteration. It is infered this rock has intruded after Sirih tonalite intrusion, and brought mineralization and hydrothermal alteration.

e) Quartz porphyry

The rock crops out at the contact of the Sirih tonalite and the Banan Formation at Sungai Banan. It cuts Sirih tonalite, and is gray colored prophyritic rock with abundant phenocrysts of plagioclase and quartz. Microscopic observation (specimen RB-10), revealed phenocrysts of plagioclase and quartz in a groundmass consisting of fine quartz, biotite, and chlorite.

f) Dolerite

Distribution : The rock crops out at two locations, namely at Sungai Cebol and Doyo as a dyke and a stock and at Sungai Sembuang as a dyke along a fault in Gunung Raya granodiorite. Many boulders of dolerite are scattered over 1 Km distance around Sungai Doyo, suggesting broad distribution.

Rock facies : Sample from Sungai Cebol (RC-27) is dark green fine grained slightly porphyrytic equigranular type. It shows microscopicaly dolerite texture consisting of phenocrysts of hornblende and plagioclase in a groundmass of equigranular plagioclase, pyroxene, mafic minerals,and some quartz.

Sample from Sungai Sembuang (Rp-25) is medium grained black green dyke rock. Under microscope, its main rock forming minerals are plagioclase, augite, olivine, and an opaque mineral, in doleritic texture as Photo (Rp-25) shows. Olivines have been altered to talc and chlorite.

3-4 Geological Structure

Geological structure in the survey area is characterized by intrusion of younger tonalite and by many faults, quartz veins, and andesite dykes. The principal trends are (1) N 60-90 W, (2) N 30 W and E - W.

(1) N 60-90 W System Structure

This structure is represented by intrusions of young plutonic rock. Sirih tonalite has an elongated shape trending N 60-80 W, and Banyl tonalite and Pandan quartz gabbro trend N 80-90 W. Dome structure caused by Sirih tonalite intrusion in the Bengkayang Group has anticline and syncline structure with a N 60-80 W trending axis.

This trend is parallel to the general trend of Northwest Borneo syncline of Tertiary and Lupar ophiolite line.

(2) N 30 W and E - W System Structure

This system is shown as faults, quartz veins and andesite dykes in or around younger intrusive areas. In the Sirih tonalite area, many quartz veins, andesite dykes and faults occur, and these quartz veins are accompanied by copper and molybdenum. Fissures striking NNW are also distributed around Banyl tonalite, and some of them are accompanied by gold quartz veins, molybdenite, and copper mineralizations. At the contact between Banyl tonalite and Gunung Raya granodiorite, Suren gold copper bearing vein occurs in E - W system fissure, and NNW shear veins in Banyl tonalite have some mineralization. It may be infered that these faults or fissures accompanied by mineralizations are shear fractures which have been formed by compression caused by cooling the intrusion. Mineralization resulted from sequent hydrothermal activity along these fracture surfaces.

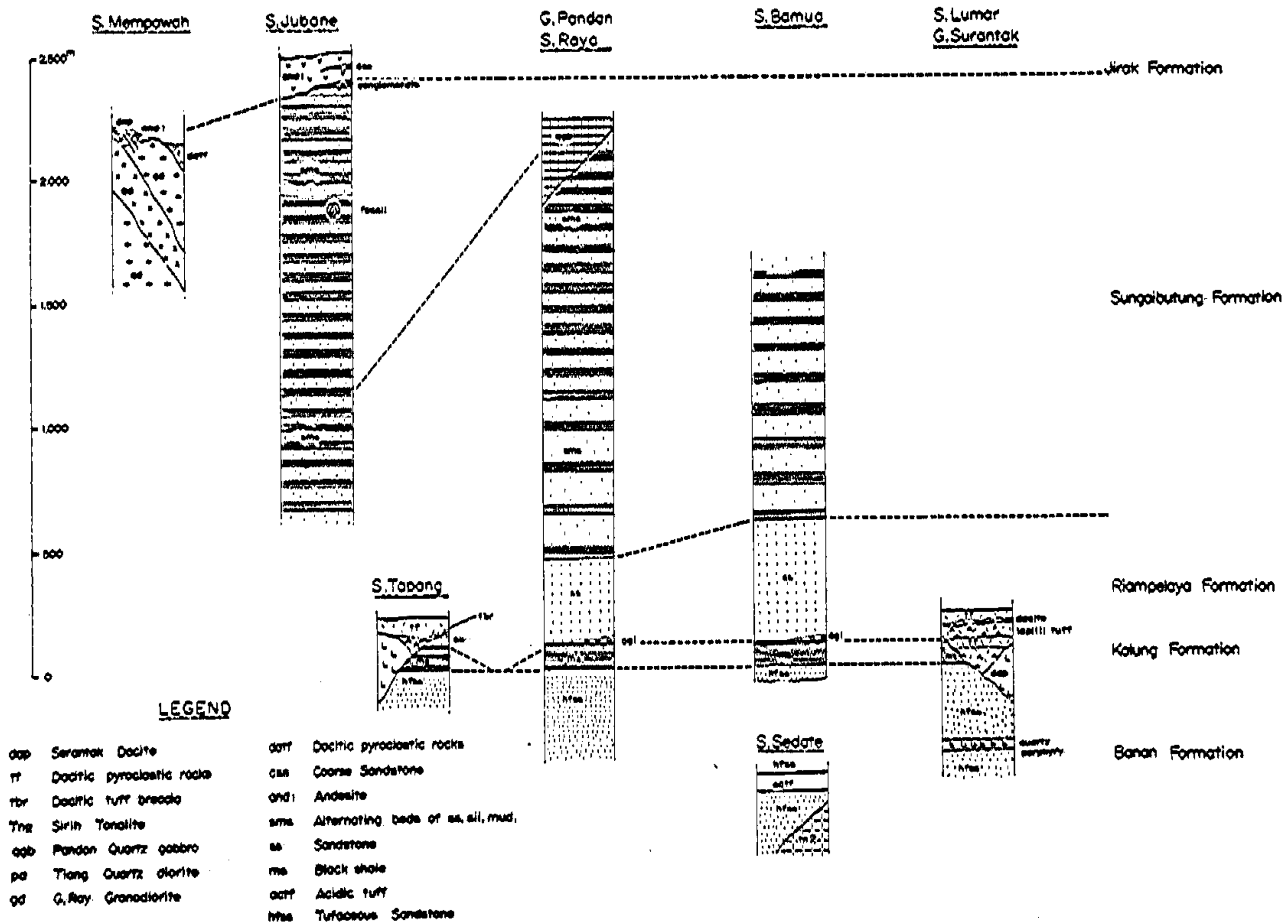
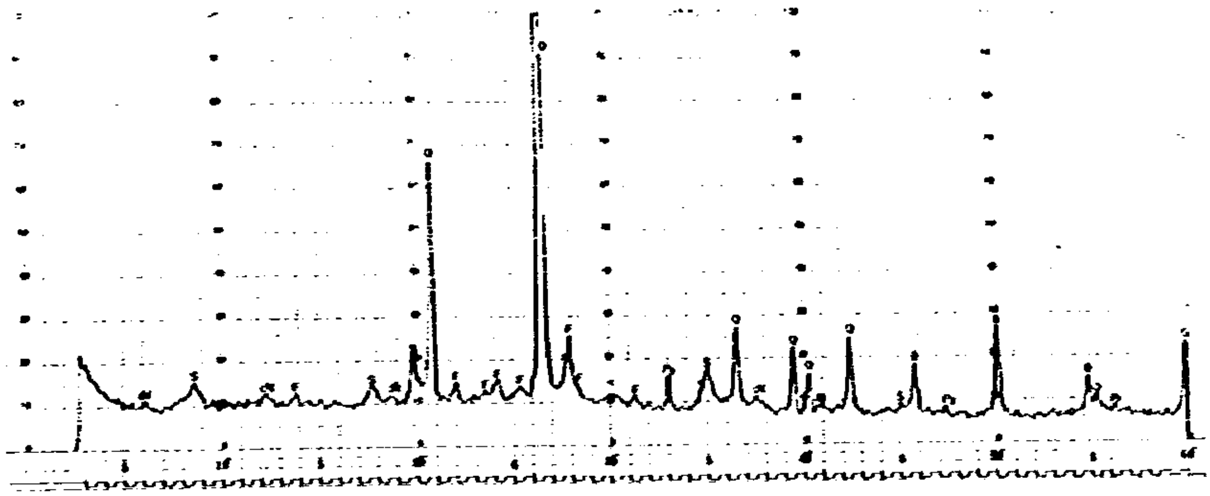


Fig. 3-10 Schematic Stratigraphical Column



Sample No.: RB-39

CONDITION

Target	Cu	Q----Quartz	: very strong
Filter	Ni	F----Feldspar	: clear
Voltage	30kv	S----Sericite	: weak
Current	15mA	Chl--Chlorite	
Scanning speed	2° /min	Py---Pyrite	
Time constant	2 second		
Divergency slit	1°		
Scatter slit	1°		
Receiving slit	0.3mm		
Chart speed	2cm/min		
Full scale	1000cps	Date : 4 December 1979	

Fig. 3-11 Chart of X-Ray diffractive analysis

CHAPTER 4 MINERALIZATION

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4-1 Outline

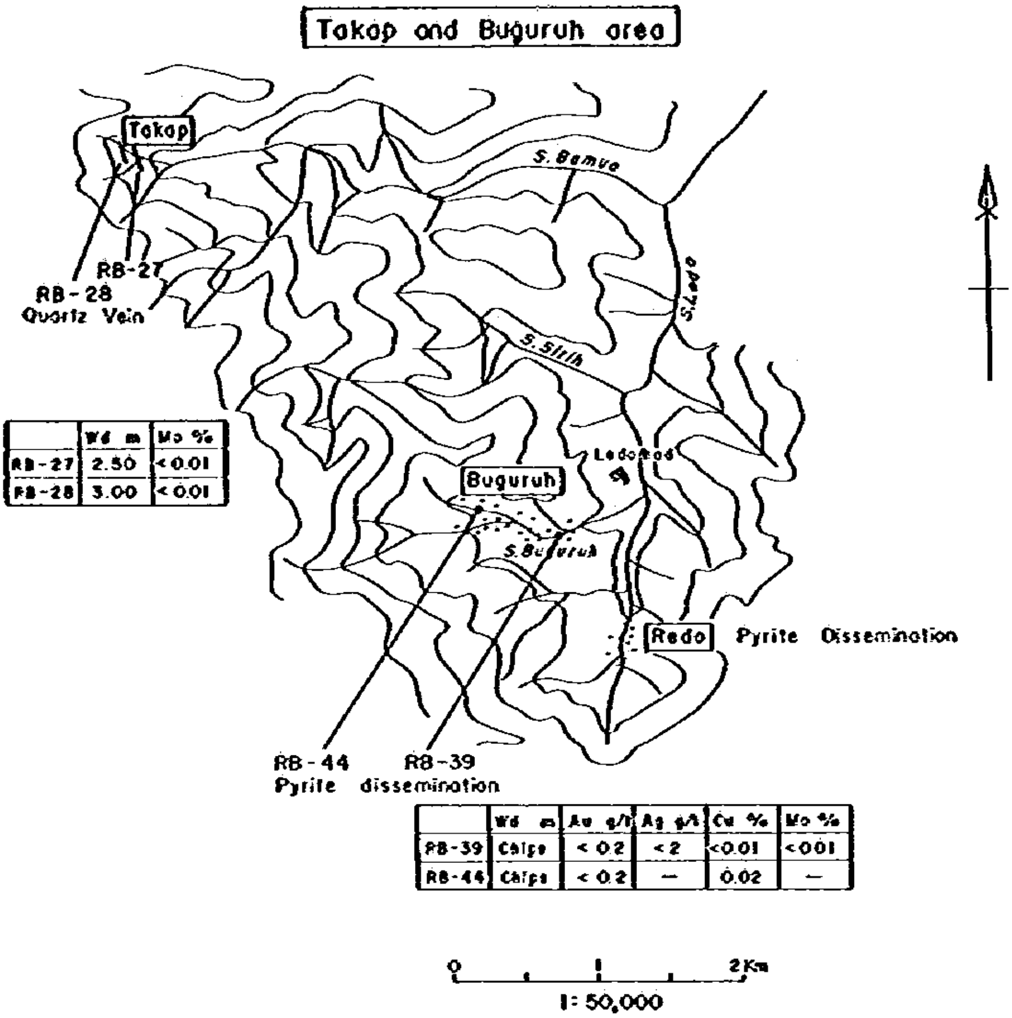
Several types of ore deposits and mineralized zones are known in the investigation area, namely chalcopyrite and molybdenite bearing quartz veins in Sirih tonalite, gold and chalcopyrite bearing quartz vein and a network molybdenite deposit in Banyl tonalite, gold bearing pyrrhotite deposit and gold bearing quartz vein surrounding Serantac dacite. It was pointed out that these ore deposits and mineralizations have a genetical relation to young igneous activity, because they accompany dacite and tonalite which is dated as Oligocene and Lower Miocene.

Several placer gold deposits are also known downstream from the above mentioned mineralizations,and they were operated in the past. Cinnabar was discovered by panning at several points.

4-2 Mineralized Zones and Ore Deposits

4-2-1 Molybdenite Mineralized Zone in Sirih Tonalite Area

Many quartz veins with N 30 W strike and ranging from several millimeters to several meters are embedded in hornblend biotite tonalite which intruded during the Lower Miocene. These quartz veins rarely contain some chalcopyrite and molybdenite. Polished sample (Photo RB-33) collected at the upper reaches of the Sungai Sirih contains sphalerite, chalcopyrite, and molybdenite in a thin quartz vein, but its grade is very low. For example, two Takap quartz veins having 2.50 m and 3.00 m in width contain less than 0.01 % of molybdenum. Sirih tonalite accompanied by these quartz veins has not been subjected to much hydrothermal alteration, and is very fresh.



	Wd m	Mo %
RB-27	2.50	< 0.01
RB-28	3.00	< 0.01

	Wd m	Au g/t	Ag g/t	Cu %	Mo %
RB-39	Chips	< 0.2	< 2	<0.01	<0.01
RB-44	Chips	< 0.2	—	0.02	—

Fig. 4-1 Sketch Map of Ore Deposit
(Takap and Buguruh Area)

This fact shows that this mineralization is simply chalcopyrite and molybdenite bearing quartz vein. However, there is an anomalous area of Cu and Mo detected by geochemical prospecting survey, not only of stream sediment by this survey but also soil geochemical survey conducted by Geological Survey of Indonesia. It thus seems possible that either Sirih tonalite has itself high background value of Cu and Mo or mineralization is present.

Altered felsite intrusive which may be tonalite porphyry or dacite and is exposed at the Sungai Buguruh and along the upper reaches of the Sungai Ledo has mostly been altered into sericite and quarts, proving hydrothermal alteration with pyrite dissemination, though its Cu and gold grade are very low on the basis of trial analysis. It may be inferred that the tonalitic porphyry intruded after intrusion of Sirih tonalite, and was itself affected by hydrothermal alteration, which probably resulted in chalcopyrite-molybdenite-quartz mineralization.

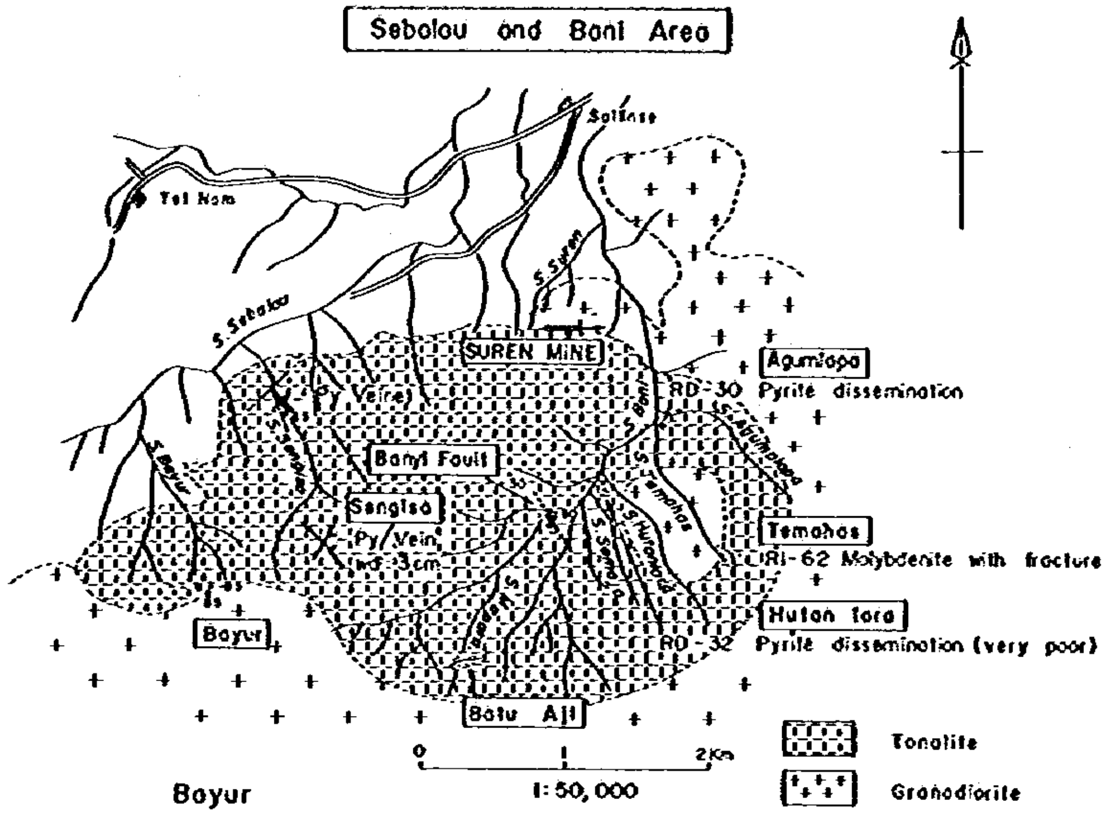
4-2-2 Banyl Mineralized Zone in Banyl Tonalite Area

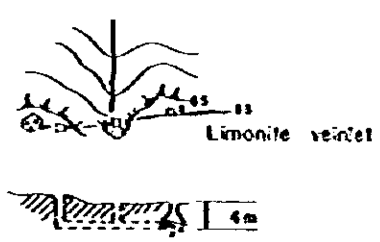
This mineralized zone occurs along the upstream of the Sungai Sebalau, and Sungai Bani, 5 Km south of Bengkayang. The mineralization is characterized by vein, veinlets and dissemination with gold, pyrite, chalcopyrite and rare molybednite. Following mineralized zones were revealed by this investigation (Fig. 4-2).

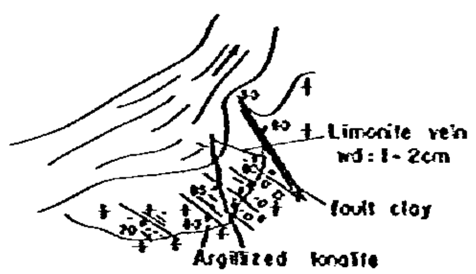
a) Fissure filling vein at contact of Gunung Raya granodiorite and Banyl tonalite.

Suren old mine, Bayur vein.

b) Vein, network or disseminated mineralization in Banyl tonalite.







	Au g/t	Ag g/t	Cu %	Mo %
Bolu Aji	1.0	3	0.13	0.02
RI-62	<0.2	< 2	0.01	0.08

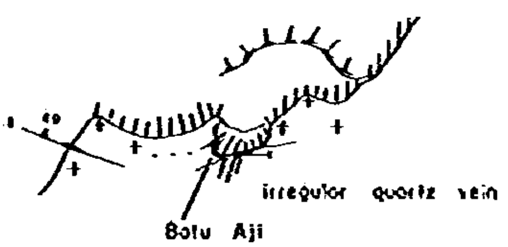


Fig. 4-2 Sketch Map of Ore Deposit
(Sebalau and Bani Area)

- Agumulapa, and Hutan lara mineralized area as disseminated
- mineralization
- Sengisa as vein mineralization
- Temahas as network molybdenite mineralization
- Mineralization along a fault

Banyi tonalite has also been dated as 27.8 m.y. old, by K-Ar method, and these mineralizations were cause by younger igneous activity like Sirih tonalite.

(1) Suren Old Mine

This old mine is situated at the Sungai Suren, one of the tributaries of the Sungai Banyi, 5 Km south of B ngkayang. According to local inhabitants, this mine had been explored and exploited for gold and copper by Europeans during colonial times. But details are not clear because there are no data and no written information. There are several old tunnels, old stoping places, and collapsed holes of a mining operation. Ore deposit is fissure filling gold bearing pyrite chalcopyrite quartz vein, occuring at contact of Gunung Raya Granodiorite and Banyi tonalite, it strikes N 80 W, dips 60 s, and is 0.5 ~ 1.0 m wide. Based on the geological survey in accessible tunnel and on surface, length of the lode is about 300 m and average mined depth is approximately 20 m. Ready-mined ore reserve is estimated at about 15,000 ton of crude ore according to the survey result. [That is 300 m (L) x 20 m (D) x 0.9 m (W) x 2.8 ≑ 15,120 t]. The sketch map of Suren ore deposit is presented in Fig. 4-3, 4-4. The vein contains Au 1.4 g/t, Ag 13 g/t, Cu 0.8 %, Pb 0.02 %, Zn 0.01 %, Mo less than 0.01 % with average width 1.18 m in tunnel No. 1, Au 1.4 g/t, Ag 8 g/t, Cu 0.58 %, Pb 0.01 %, Zn 0.01 %,

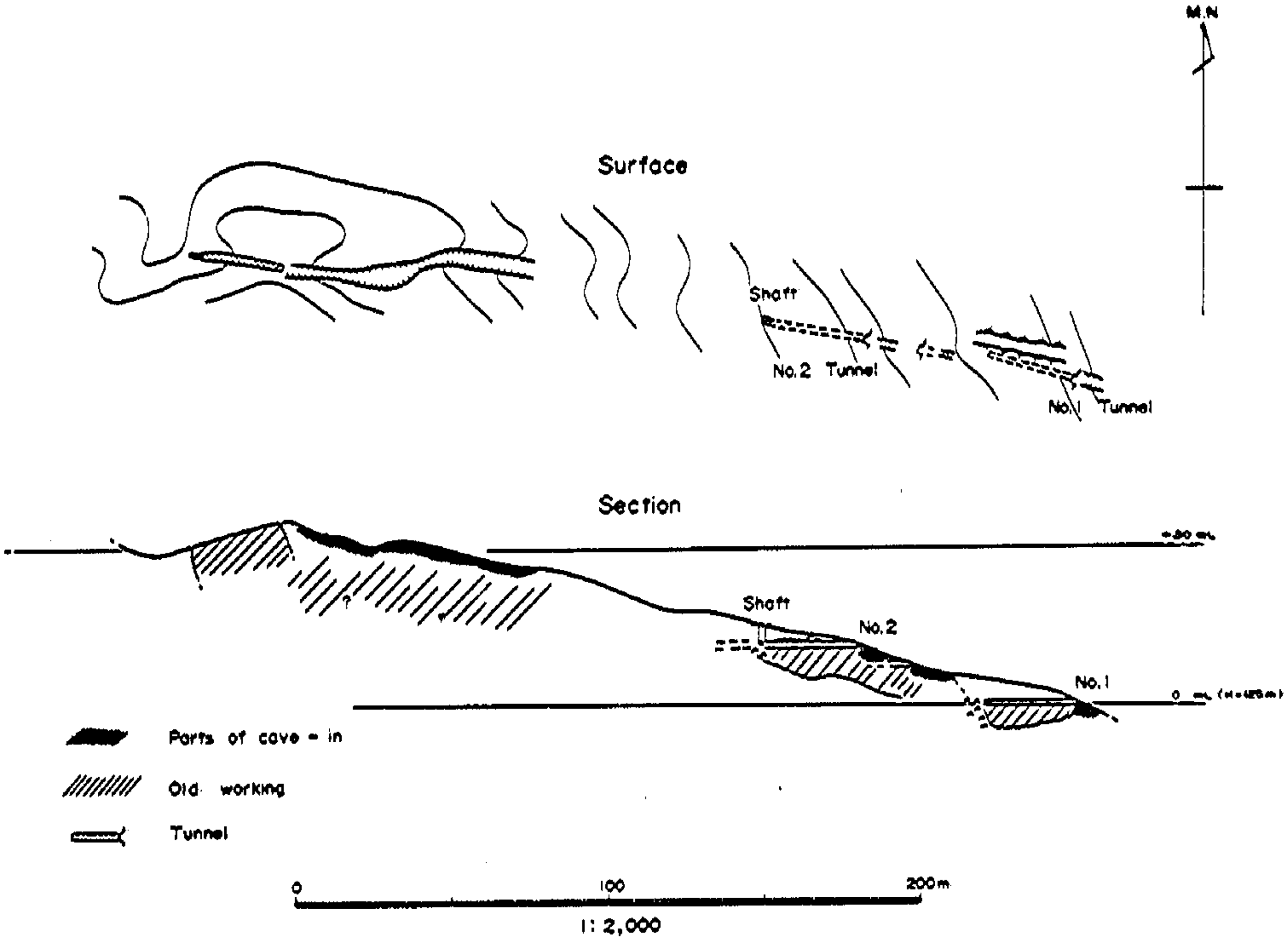
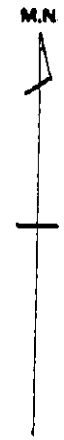
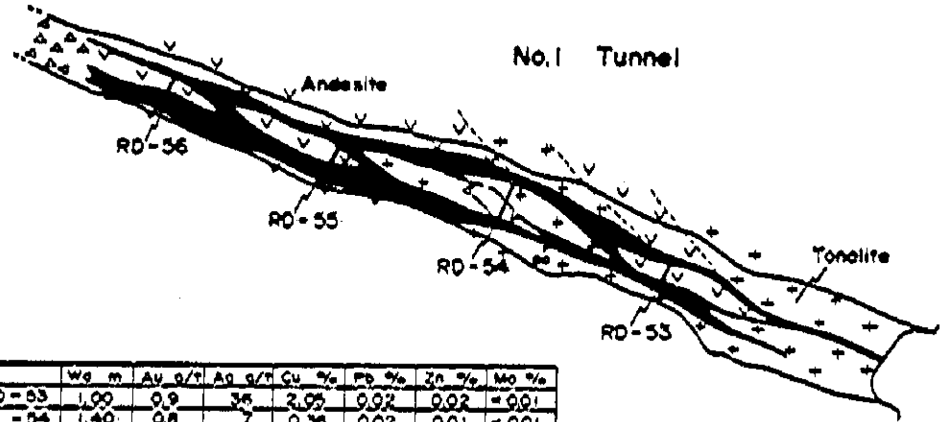


Fig. 4-3 Sketch Map of Suren Mine

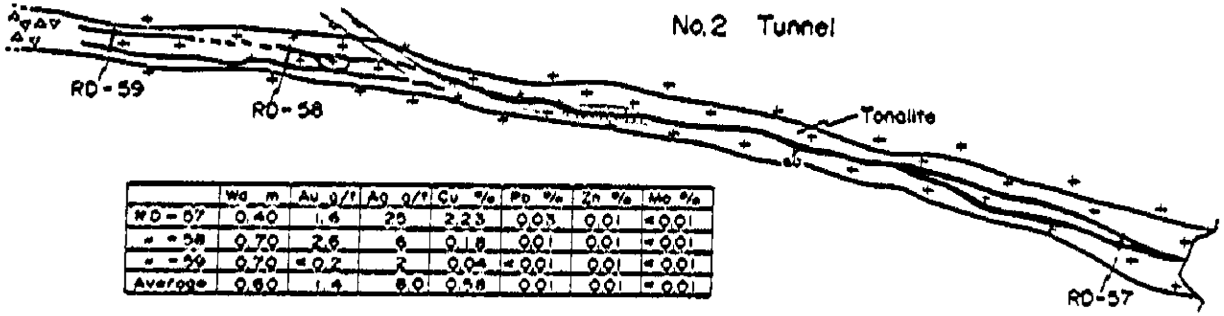


No.1 Tunnel



	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
RD-53	1.00	0.9	36	2.05	0.02	0.02	<0.01
〃 -54	1.40	0.8	7	0.36	0.02	0.01	<0.01
〃 -55	1.30	3.3	13	0.90	0.03	0.01	<0.01
〃 -56	1.00	0.2	<2	0.09	<0.01	0.01	<0.01
Average	1.18	1.4	13.8	0.81	0.02	0.01	<0.01

No.2 Tunnel



	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
RD-57	0.40	1.6	20	2.23	0.03	0.01	<0.01
〃 -58	0.70	2.6	6	0.18	0.01	0.01	<0.01
〃 -59	0.70	<0.2	2	0.04	<0.01	0.01	<0.01
Average	0.60	1.4	8.0	0.58	0.01	0.01	<0.01

Fig. 4-4 Ore Vein Map of Suren Mine

Mo less than 0.01 % with average width 0.60 m in No. 2 tunnel.

(2) Banyl Mineralization along a Fault

This mineralization is located 1.5 Km south from Suren old mine, and the mineralization shows N 30 W strike and 60 s dip, and is 5 m wide. The mineralization contains limonized pyrite which has been oxidized along the fault.

(3) Batu Aji Mineralization

This mineralization is located upstream of the Sungai Bani and occurs at contact of Gunung Raya Granodiorite and Banyl tonalite. It is also a regular network limonite bearing quartz vein. Collapsed old pit, prospected for gold, is present. The ore contains Au 1 g/t, Ag 3 g/t, Cu 0.13 %, Mo 0.02 %. Under microscope, network limonite (goethite) is observed. Green copper stained blocks are scattered in Swall area neiboring an old pit. Under microscope disseminated hematite, chalcopyrite and chalococite were observed in sample (Photo Rk-25).

(4) Bayur Mineralized Zone

Three old pits at 15 m intervals are arranged in the eastward direction at 600 m above sea level, along the upper stream of Sungai Bayur. The mineralized zone has E-W strike, 85 S dip, 5 ~ 10 cm in width. It is pyrite bearing quartz vein. Pyrite has been altered into limonite by oxidation.

(5) Sungisa Mineralized Zone

This mineralized zone is located at the Sungai Sungisa, tributary of Sungai Sebalau, and is characterized by thin fissure filling

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pyrite vein striking NE-SW and NW-SE, in Ban 1 tonalite. Width of the vein is mostly less than 1 cm, though it occasionally reaches 3 cm. Chalcopyrite is not megascopically contained in the mineralized vein.

(6) Temahas Mineralized Zone

The molybdenite is embedded in BanYl tonalite, as network veinlets in shear zone. This mineralized zone is located along the Sungai Temahas, tributary of the Sungai Bani.

Photo Rl-62 shows molybdenite filling with quartz in a veinlet.

(7) Rian Mineralized Zone along a Fault

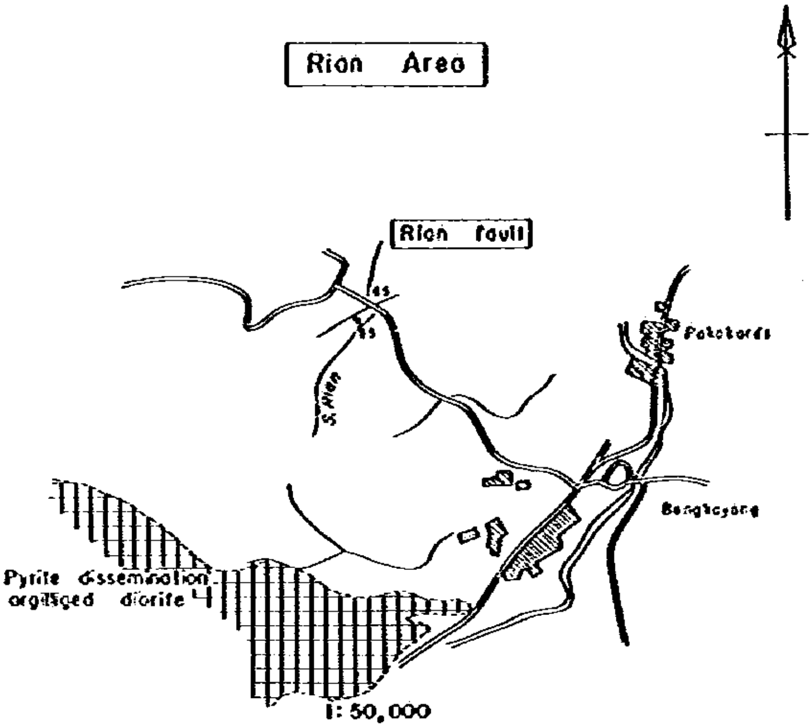
This mineralized zone is located 2 Km northwest from Bengkayang, facing paved road from Bengkayang to Singkawang. This pyrite-quartz vein is formed along a fault, showing N 65 E strike, 85 S dip. But this pyrite has become limonite by oxidation.

(8) Agumlapa Pyrite Disseminated Zone

This mineralized zone is located along, upstream from the confluence of Sungai Bani - the Sungai Agumlapa, and at the confluence of Sungai Bani - the Sungai Hutan Lara. The pyrite disseminations, are above 50 m, but the amount of pyrite is generally low and it contains no copper minerals.

4-2-3 Sungai Menyuke Mineralized Zone

Several mineralizations are distributed at southern Gunung Centing Bakilok mountain area.



Section of Rianfault

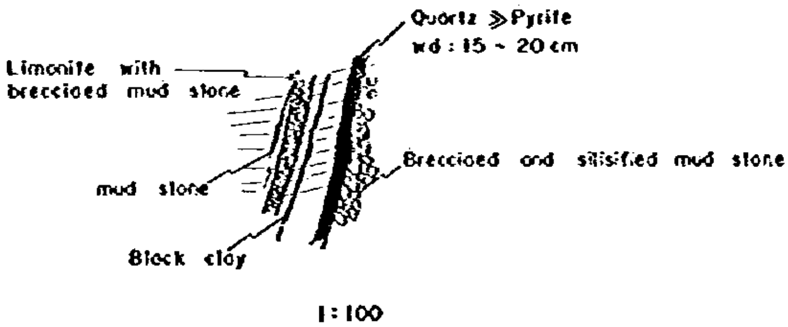


Fig. 4-5 Sketch Map of Ore Deposit
(Rian Area)

(1) Sekeh Mineralization

This mineralization lies along zone of fracturing at lithologic contact between tonalite intrusive and Gunung Raya granodiorite. In the field, dissemination of chalcopyrite and pyrite was found, but microscopic examination of Sample Rm-25, revealed chalcopyrite and chalcocite (Photo Rm-25).

(2) Maha Mineralization

Quartz network which has 40 cm wide mineralized zone accompanied by molybdenite crops out at the Sungai Maha, tributary of Sungai Semade. These mineralizations are embedded at shear and fracture line of lithologic contact between Gunung Raya granodiorite and Tiang quartz diorite or between Gunung Raya granodiorite and granite. But it appears that these mineralizations may be related to younger igneous rocks like other mineralization in the investigated area.

(3) Lao Mineralization

Dissemination of molybdenite, pyrite and chalcopyrite is known along a fault striking NNW at upstream part of Sungai Lao, south flank of Gunung Gunting Bakilok. Microscopic observation (RE-71), revealed the existence of dissemination of chalcopyrite and pyrite.

(4) Tourmalinization Area

Altered rock (Rn-58), distributed at contact between Gunung Raya granodiorite and granite 1 (at upper stream of Sungai Semade), is accompanied by tourmalline. Microscopic observation reveraled that, plagioclase has been altered to sericite, and mafic mineral is chloritized and biotitized. Strong silicification has altered the rock so

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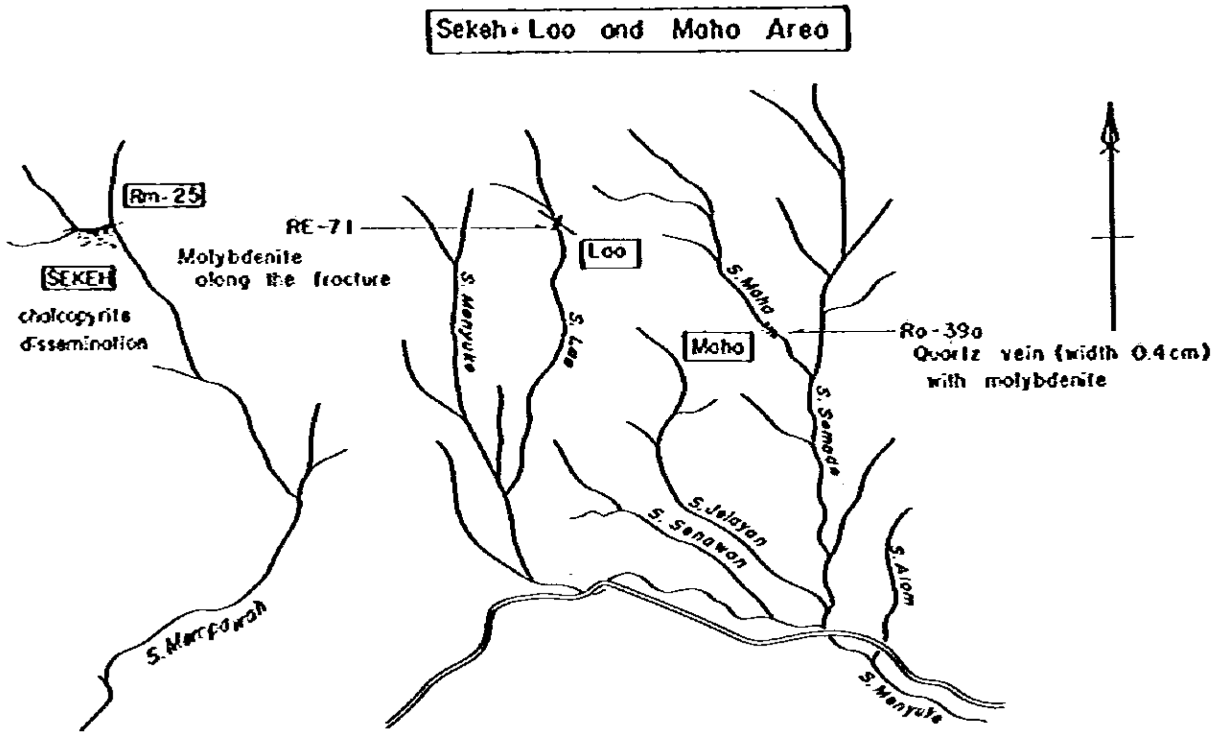


Fig. 4-6 Sketch Map of Ore Deposit
(Sekeh Lao and Maha Area)

much that it is not possible to identify the original rock. Tourmalline accompanies potash feldspar-quartz vein or is present as lath crystals in quartz. Mo-Cu mineralization (Maha mineralization) is know near the tourmalline mineralization.

4-2-4 Mineralized Zone Accompanying Serantak Dacite

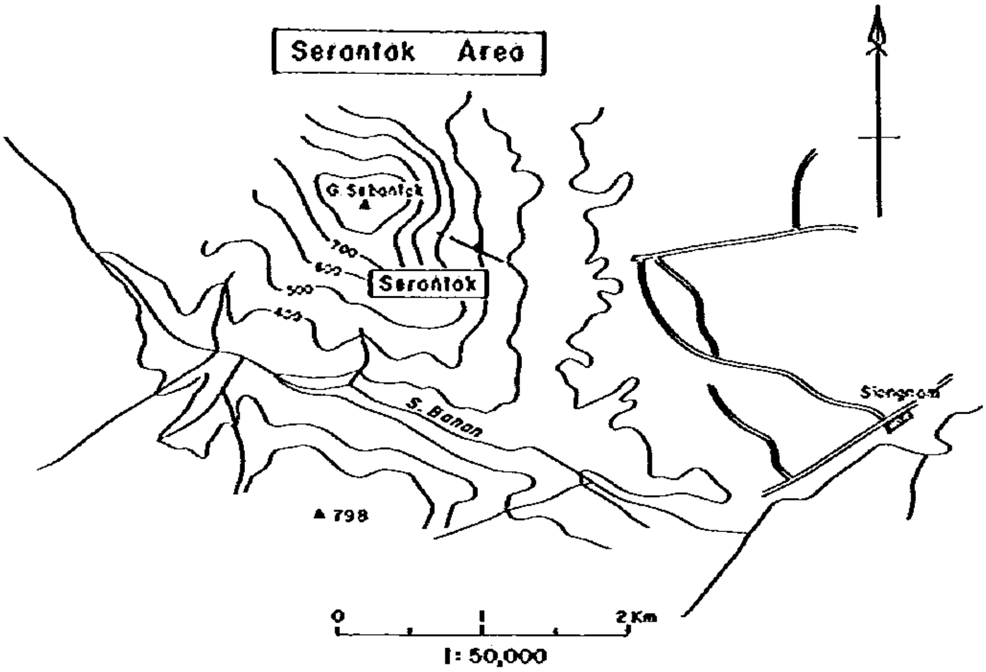
From Gunung Serantak to Sungai Banan, Serantak dacite has intruded into the Bengkayang Group.

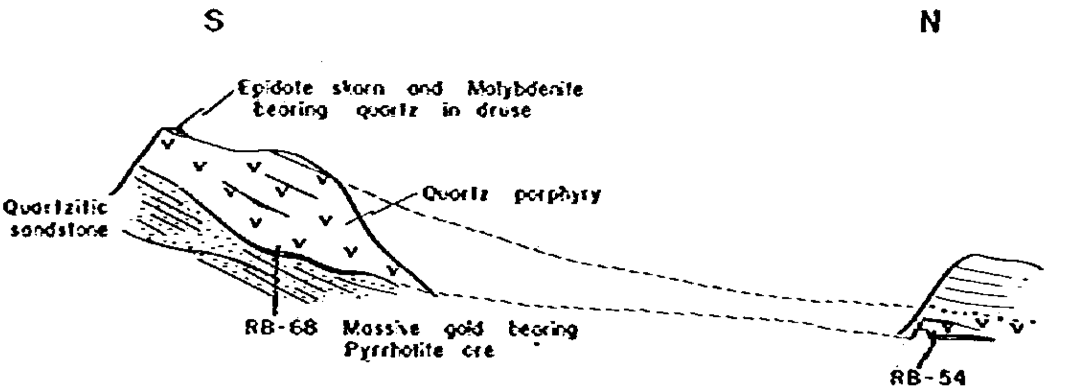
Two ore deposits explored for gold are located around the Serantak dacite which intruded into the Bengkayang Group from southern the Gunung Serantak to northern the Sungai Banan.

(1) Serantak Ore Deposits

Gold bearing pyrrhotite ore outcrop is located at a mountain side of Gunung Serantak, at 400 m above sea level. The deposit is embedded in a lithological contact between quartz porphyry and sandstone of the Banan Formation, and has 90 cm in maximum width and length of more than 20 m at this outcrop. This pyrrhotite has been identified as hexiagonal pyrrhotite with three prominent X-ray diffraction peaks: 2.07, 2.65, 1.72 d(Å). Under refractive microscope, some chalcopyrite and quartz as gangue mineral accompanies pyrrhotite. Some molybdenite has been found in small quartz druse at hanging wall part of quartz porphyry. Chemical analysis shows its grade: Au 0.2 g/t, Ag less than 2 g/t, Cu 0.12 %, Mo less than 0.01 %.

This ore deposit has been explored by Europeans during Dutch colonial time, but no information remains. Gold bearing limonitic





	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %	Ni ppm
RB-54	0.60	7.0	—	—	—	—	—	—
RB-68	0.90	0.2	< 2	0.12	< 0.01	< 0.01	< 0.01	90

0 — 50m

1:1,000

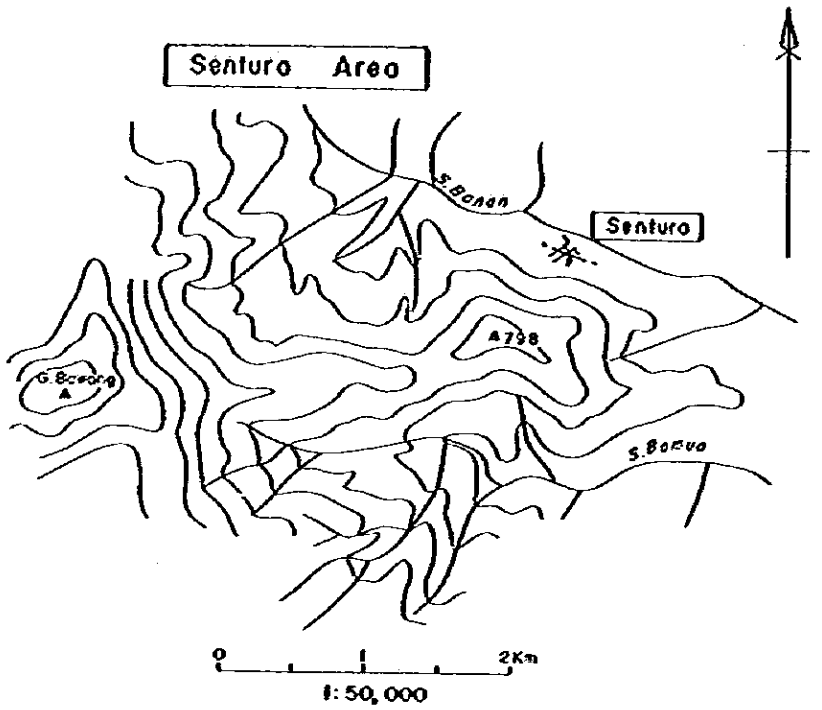
Fig. 4-7 Sketch Map of Ore Deposit (Serantak Area) gossan occurs at 50 m west from the pyrrhotite outcrop. Oxidation of the gold bearing pyrrhotite ore deposit enriched high gold rich gossan, with Au grade 7 g/t and 60 cm in thickness. Small scale operation is producing gold from the mine at present.

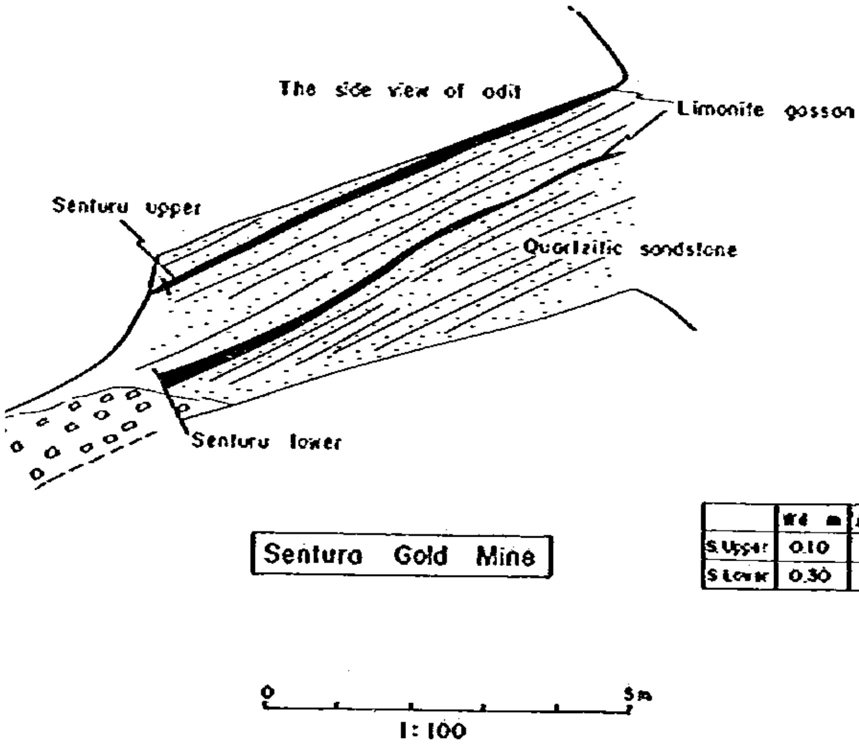
(2) Sentura Old Mine

Sentura old mine is located on the right bank of the middle part of the Sungai Banan. Its ore deposits become two thin limonite quartz by oxidation veins at near surface of old tunnel. But its grade shows Au 0.7 g/t (10 cm in width) and Au 0.2 g/t (30 cm in width). There are many old tunnels, but most tunnels have collapsed and it is impossible to enter the tunnel.

(3) Tian Aping Cu Mineralization

Dacite stock which occurs east at Tiang Aping, intruded into Gunung Raya granodiorite. Small mineralization is accompanied by pyrite and chalcopyrite as evident from microscopic observation (Photo Rn-4).





	Wd m	Au g/t
S.Upper	0.10	0.7
S.Lower	0.30	0.2

Fig. 4-8 Sketch Map of Ore Deposit
(Sentura Area)

Table 4-1 List of Mineralized Zone and Chemical Analysis of Ores

Group of Mineralization	Name of Mineralized Zone	Location: Grid of Map	Location: River	Mode of Occurrence	Kind of Ore	Sample Ore	Sampling width (m)	Assay: Au (g/t)	Assay: Ag (g/t)	Assay: Cu (%)	Assay: Pb (%)	Assay: Zm (%)	Assay: Mo (%)	Assay: Ni (P.Pm)
Sirih Tonalite	Takap	20-100	S. Bamua	Vein	Qt	RB-27 RB-28	2.50 3.00	-	-	-	-	-	<0.01 <0.01	
	Buguruh	20-95	S. Buguruh	Dissemination	Py	RB-39 RB-44	Chips Chips	<0.2 <0.2	<2 -	<0.01 0.02			<0.01 -	
	Redo	20-95	S. Redo	Dissemination	Py									
Banyi Tonalite	Surem mine	25-85	S. Surem	Vein	Au.Cp.Py.Qt.	Tunnel 1 Tunnel 2	1.18(Av) 0.60(Av)	1.4 1.4	13.8 8.0	0.81 0.58	0.02 0.01	0.01 0.01	<0.01 <0.01	
	Bany fault	25-85	S. Bani	Network	Li.Py.									
	Batu Aji	25-80	S. Mopara	Network	Cp.Py.Qt.	Batu Aji	Chips	1.0	3	0.13			0.02	
	Bayur	25-80	S. Bayur	Vein	Qt.									
	Sengisa	25-85	S. Sengisa	Veinlet	py.									
	Temahas	25-80	S. Temahas	Veinlet	Mo.	Ri-62	Chips	<0.2	<2	0.07			0.03	
	Agumlapa	25-85	S. Bani	Dissemination	Py.									
	Hutan lara	25-85	S. Bani	Dissemination	Py.									
Northern Area at S. Menyuke	Sakeh	25-80	S. Mempawah	Dissemination	Cp.	Rm-25								
	Maha	30-80	S. Maha	Vein	Mo.Qt.	Rm-38								
	Lao	25-80	S. Lao	Vein	Mo.	RE-71								
	Serantak	20-100	G. Serantak	Massive	Au.Pyr.Qt.	RB-54 RB-68	0.60	7.0 0.2	(Gossan) <2	0.12	<0.01	<0.01	<0.01	50
	Sentura	20-100	S. Banan	Vein	Li.Qt.	Upper Lower	0.10 0.30	0.7 0.2						
Other	Rianfault	25-90	S. Rian	Vein	Li.Py.Qt.									
	Tiang Aping	20-75	S. Mempawah	Dissemination	Py	Rn-4								
	Semade Tourmalization	30-80	S. Semade	Dissemination	To									

Py: Pyrite Cp: Chalcopyrite Mo: Molybdenite Li: Limonite Pyr: Pyrrhotie Au: Gold Qt: Quartz

CHAPTER 5 GEOCHEMICAL SURVEY

CHAPTER 5 GEOCHEMICAL SURVEY

5-1 General Remarks

Geochemical reconnaissance survey of stream sediment was performed jointly with geological survey in first phase survey area of 500 Km^2. Cu, Zn, and Mo were selected as the indicator elements because Au, Cu, and Mo mineralization are expected in the survey area. Results of the chemical analysis were statistically treated to detect geochemical anomalies.

In order to investigate behavior of cold extractable copper (Cx-Cu) as hydromorphic copper toward total copper, some samples which were selected from high total copper anomaly area were analyzed for Cx-Cu element. pH values of river water were measured paralleling the collection of stream sediments to find circumstances of cold extractable copper precipitation.

On the basis of geological characteristics of this area it was divided into two geological units, the results of chemical analyses were treated stastically, and a histogram, cumulative frequency distribution and coefficient of correlation were made for each geological unit. As result of this study, geochemical anomalous zones were detected in the survey area as Table 5-3 and Pl 9 show.

5-2 Sampling, pH Measurement and Analysis

5-2-1 Sampling

Sampling work was carried out jointly with geological survey on the same route. 628 samples were collected from the whole survey area, and 435 samples were selected to be analyzed chemically after

Table 5-1 Number of Geochemical Samples

Block	Geological unit	Covered area (km^2)	Number of sample	Average density of assayed samples
A	Northern sedimentary rocks unit	250.0	189	$0.76/km^2$
B	Southern granitoid rocks unit	293.9	246	$0.84/km^2$
	Total	543.9	435	$0.80/km^2$

they were checked to be evenly distributed in the survey area. 102 samples for Cx-Cu analyses were chosen from total Cu anomalous areas to investigate effectively behavior of Cx-Cu element. Table 5-1 summarizes number of samples and average density of analyzed samples at each geological unit.

Sediment passing through 80 mesh was collected by direct sieving under water. After drying them at camp site or base camp, each sample was divided into two packs, one for chemical analyses in Japan, the other for Directorate of Mineral Resources.

5-2-2 pH Measurement of River Water

pH value of river water was measured at each sampling point of stream sediment to find precipitation condition of Cx-Cu. This measurement was performed by using pH test papers as follows;

Toyo rolling pH test paper	(pH 0.0 - 14.0)
Toyo No. 20 pH test paper	(pH 5.0 - 8.0)
Toyo 8 conbined pH test paper	(pH 0.4 - 13.6)

Results are given in Pℓ 5.

5-2-3 Chemical Analysis

Samples dryed in a dryer were ground to - 200 mesh size, and 2 grams were weighted for dissolution. Assays were done by atomic absorption method for Cu and Zn contents, and by colorimetric method for Mo. The lower limits of chemical analysis for each element are Cu 1 ppm, Zn 5 ppm, and Mo 1 ppm. Assay values obtained are shown in Appendix 8, and are plotted in Pℓ 6-1, 6-2, 6-3.

5-3 Interpretation of Geochemical Assays

5-3-1 Classification of Blocks by Geological Unit

Based on geology of sampling site, all analyzed results were divided into two geological units, which were processed statistically.

A block (250 Km^2) northern sedimentary formation area

B block (293.9 Km^2) southern plutonic rock area

A block consists mainly of Bengkayang Group, Sirih tonalite, Serantak dacite, and its pyroclastic rock Formation. B block consists of Gunung Raya granodiorite and other intrusive rocks, the Jirak Formation and the Belang Formation.

5-3-2 Data Processing

(1) Data Processing

Histogram, cumulative frequency distribution of each element in each geological unit, and coefficient of correlation between pairs of elements were obtained first. Geochemical assay results were statistically treated to choose geochemical anomaly areas by calculating and studying mean value, standard deviation, and coefficient of correlation.

Fig. 5-2, 5-3 shows cumulative frequency distribution and histogram in logarithmic graph, and Fig. 5-5 also shows coefficient of correlation. Mean value of each element was calculated by statistic formula, not by a graph method. Assay results showing less than 1 ppm of Mo, were considered as 1 ppm, which is regarded as the lowest reliable limit of chemical assay for Mo.

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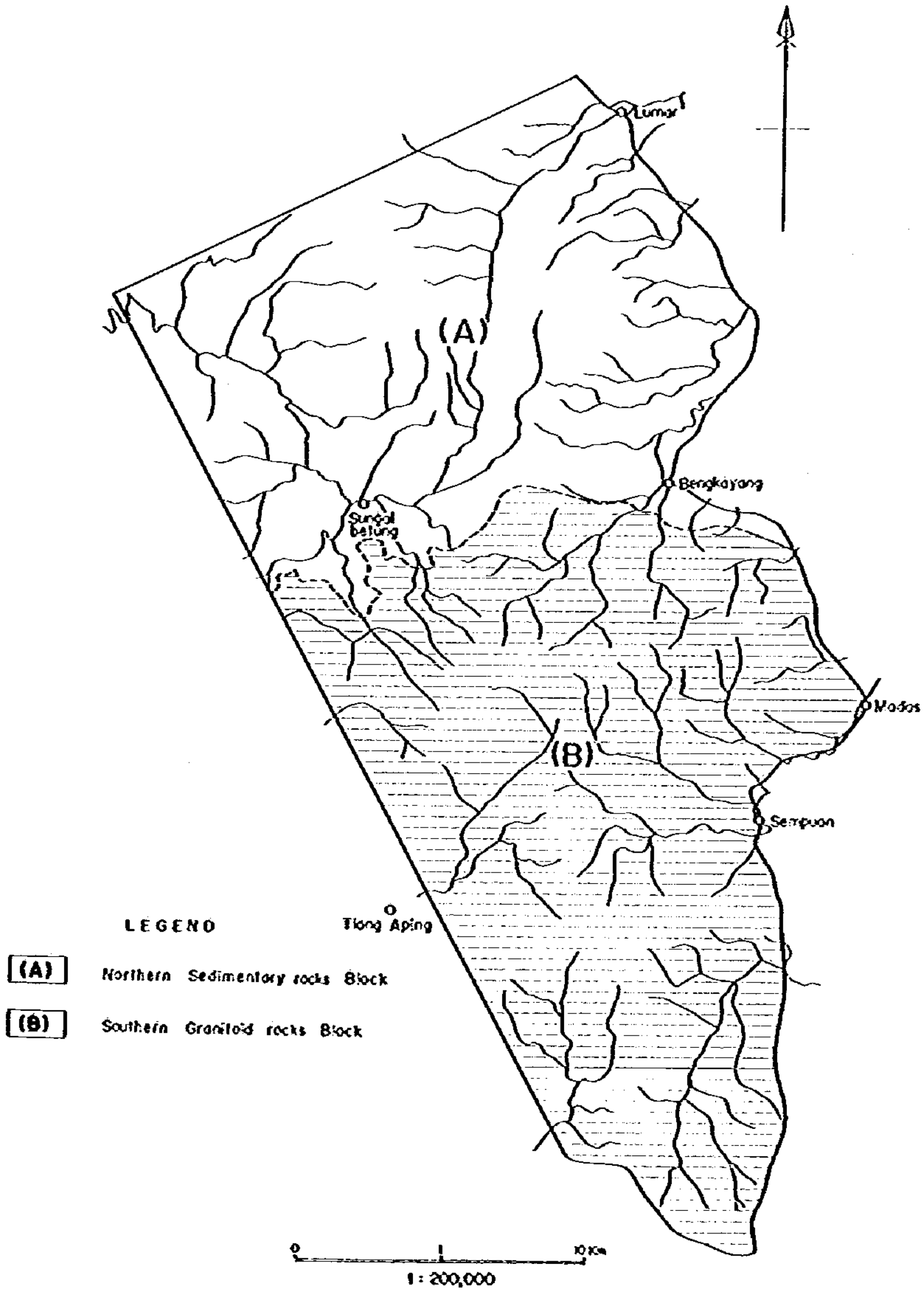


Fig. 5-1 Geological Block for Geochemical Interpretation

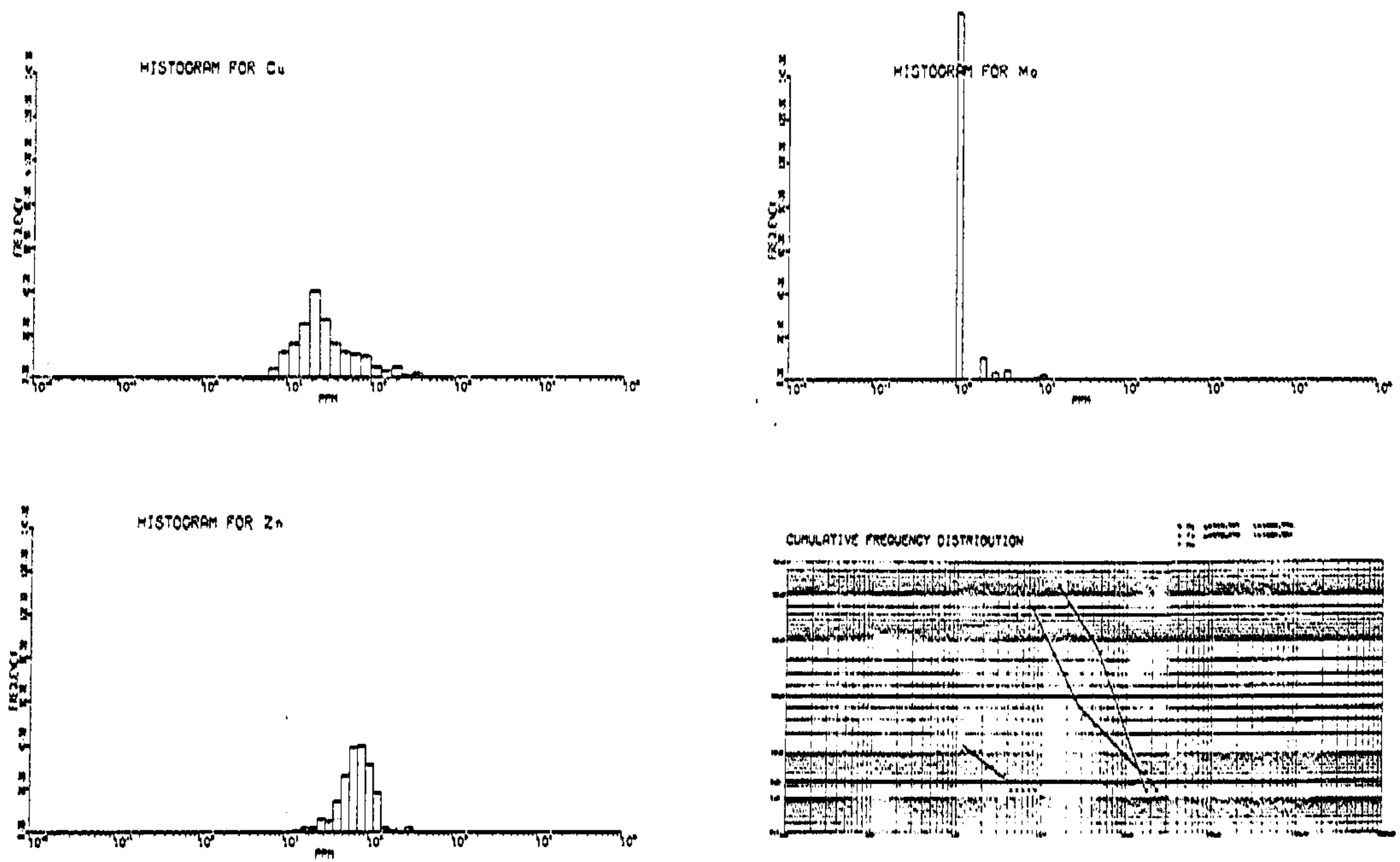


Fig. 5—2 Histogram and Camulative Frequency of Geochemical Analysis in Geological (Block A)

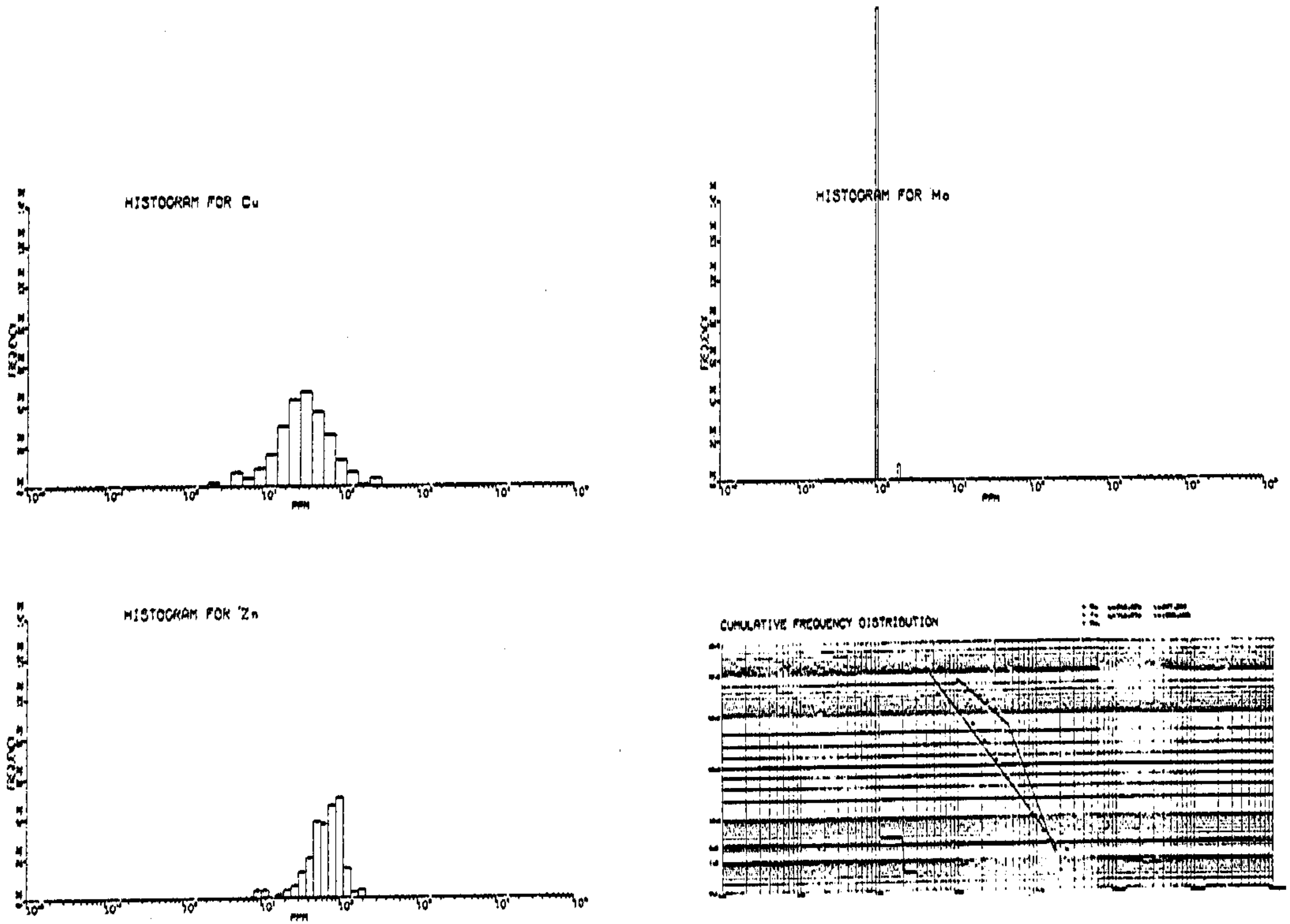
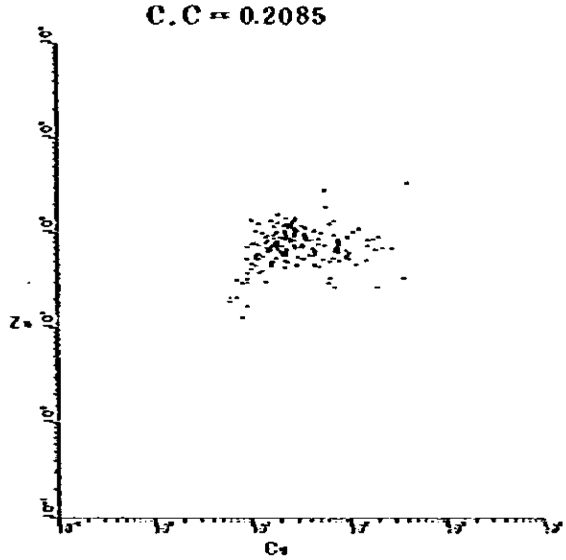


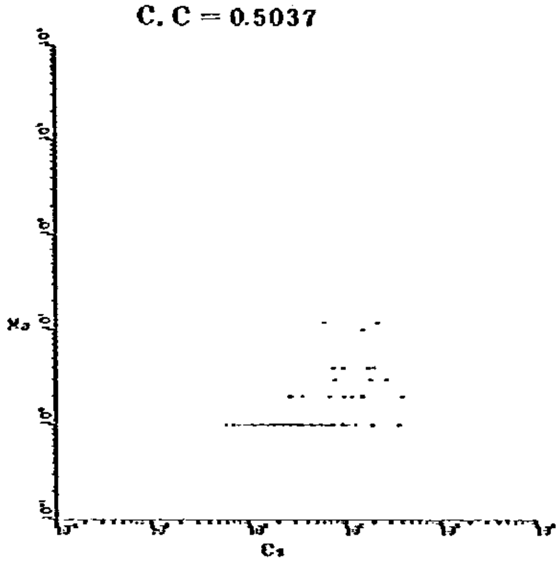
Fig 5—3 Histogram and Cumulative Frequency of Geochemical Analysis in Geological (Block B)

(Block A)

C.C = 0.2085

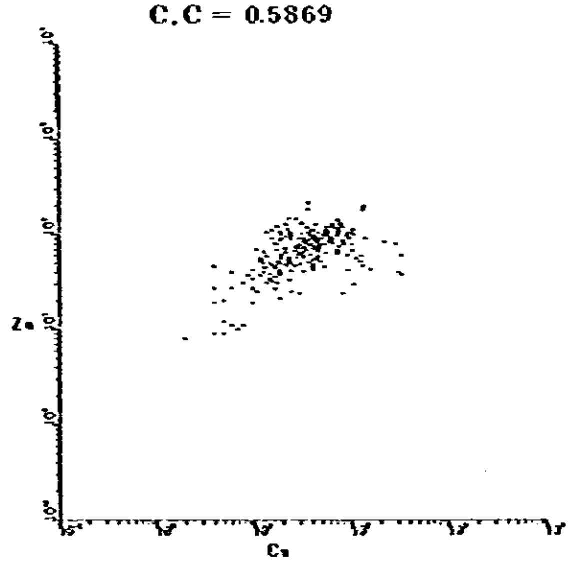


C.C = 0.5037



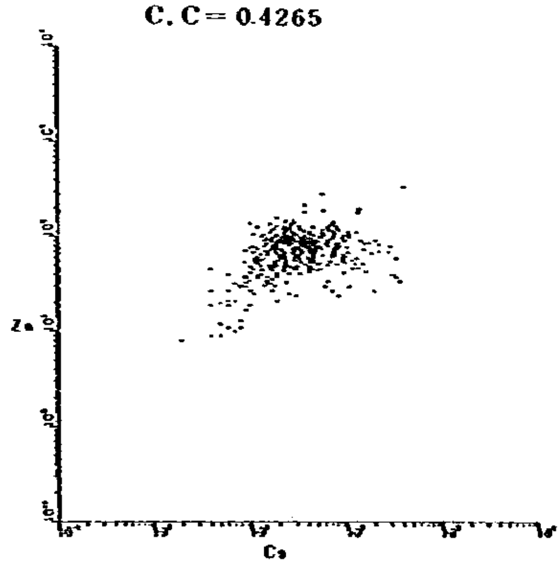
(Block B)

C.C = 0.5869



(Whole Block)

C.C = 0.4265



c.c: Coefficient of Correlation

Fig.5-4 Correlation of Geochemical Elements

(2) Coefficient of Correlation between Geochemical Elements

Coefficient of correlation of geochemical elements is shown as Fig. 5-4. Assay result of Mo element in B block is very one-sided to low grade of 1 ppm of less than 1 ppm containing 93.34 % of the whole amount of assayed samples. Thus Mo is not convenient for obtaining coefficient of correlation with Cu and Zn.

In A block, the coefficient of correlation between Cu and Zn is + 0.2085, meaning weak correlation, and between Cu and Mo is + 0.5037, giving slightly better correlation. In Serantak-Berasi, Cu and Mo anomalous areas overlap each other, suggesting a close relation.

In B block, on the contrary coefficient of correlation is + 0.0064, meaning no correlation, correlation of Cu and Zn is + 0.5869, showing slightly good correlation.

(3) Study of Population

Similarities and differences of cumulative frequency distributions of each element and each geological unit can be summarized as follows ;

Cu : Bending point is situated at 43.0 % of cumulative frequency distribution, which is higher than 40 % of mean value calculated statistically in A block. This means that the population is one-sided to low Cu value. Bending point in B block is lower than 2.5 % of $\bar{x} + 2\sigma$.

Zn : Bending point of both A and B blocks is situated at 86.5%, 84.0 % of each cumulative frequency distributions, which is much higher than 2.5 % of $\bar{x} + 2\sigma$ calculated statistically. It means that the population is also distributed at lower assay value.

Mo : Assay values of Mo in A and B geological units were extremely low in comparison with other elements, their cumulative frequency distributions are one sided lower limit of chemical analysis. Namely, distribution of 1 ppm and lower values is 94.7 % of A block, and 96.4 % of B block in whole Mo assay results. This population is one sided in very low Mo grade.

(4) Determination and Classification of Anomalous Values

As mentioned above, bending point of Cu, Zn, and Mo are remarkably higher than standard deviation calculated statistically. Accordingly, Threshold can not be set by method of C. Lepeltier. In the report Thresholds were calculated statistically, namely first anomalous value is settled at limit of $x \geq \bar{x} + 2\sigma$. In addition, in order to evaluate the anomaly extensively and to analyze tendency of anomaly arrangement, limit of $x \geq \bar{x} + \sigma$ is adopted as secondary anomaly class. In case of Mo value, only limit of $x \geq \bar{x} + 2\sigma$ is settled for anomalous value, because analyzed value of Mo is very low as compared with other elements. Threshold and mean value of each block and each element are shown in Table 5-2.

5-4 Anomalous Areas

5-4-1 Extraction of Anomalous Areas

Based on Threshold obtained by above stated data processing and interpretation, first class anomalous areas were extracted from each geological unit separately for each element, provided more than two points make one group. By the same processing, second class anomalous areas were extracted. As a result of the examination,

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Table 5-2 Values of Mean Standard Deviation and Threshold

(Classified in elements)

Elem.	Block	n.	M	M + σ	M + 2σ *	Threshold ** value	Max.	Min.
Cu	A	189	28.33537	64.66443	147.5714	26.72803	405	6
	B	246	32.26240	74.77809	173.3213	165.8779	339	2
	whole	435	30.49340	70.37952	162.4377	60.68546	405	2
Zn	A	189	71.85697	113.8003	180.2263	158.3996	341	13
	B	246	63.01767	110.4523	193.5917	153.8334	217	8
	whole	435	66.71611	112.6238	190.1209	149.9209	341	8
Mo	A	189	1.129676	1.693210	2.537862	1.1802	12	<1
	B	246	1.027375	1.182611	1.361303	1.44225	3	<1
	whole	435	1.262976	1.431984	1.915295	1.417885	12	<1

(Note)

* : Levels of x + 2σ adapted for thresholds.

** : Thresholds values based on bending points in graphs of cumulative frequency distributions.

10 anomalous areas were drawn in the survey area, as Table 5-3 shows.

5-4-2 Interpretation of Anomalous Areas

(1) Block A

a) Serantak-Berasi anomalous area

This anomalous area is distributed at area extending 7 Km in NW-SE direction and 6 Km in NE-SW, centering on Gunung Berasi. First class Cu and Mo anomalous areas overlap each other, and the second class anomalous areas surround the first class anomalous areas. Another first class Mo anomaly is present southwest of the above anomaly.

This anomaly area consists geologically of Bengkayang Group of younger Triassic and Sirih tonalite accompanied by chalcopyrite molybdenite quartz veins, and Serantak dacite associating gold bearing massive pyrrhotite ore deposit and gold bearing quartz veins.

The anomalous area covers many chalcopyrite molybdenite quartz veins distributed at Sungai Takap, Beguruh, and Ledo; Sentura and Serantak mineralizations are distributed outside the anomalous area. The anomaly is the most prominent one among all anomalies.

Second class Zn anomalous area, existing north of Serantak dacite, probably shows refracting mineralization of either Serantak area of Sirih area.

Table 5-3 Summary of Anomalous Area

Block	Name of Anomalous area	Area Km × Km	Elements	Class of Anomalous area	Number of samples in the area	Max. Value	Mean Value	Remarks
A	Serantak-Burasi	5.0 × 2.5 1.0 × 0.5 1.5 × 0.5	Cu	1.2	26	278	123	Total of 3 area
		S × 1.0 2.5 × 0.5	Zn	2	9	191	139	Total of 2 area
		1.0 × 5.0	Mo	1.2	13	12	5	
	Sansak	3.0 × 1.5	Zn	2	5	341	199	
	Semidan	1.5 × 0.5	Zn	2	2	136	136	
B	Pandan	2.0 × 2.0	Cu	2	3	312	172	
	Banyl	5.0 × 2.5	Cu	2	12	339	156	
	Semade	1.5 × 0.5	Zn	2	2	127	120	
	Benawan	1.0 × 0.5	Zn	2	2	122	116	
	Salung	2.5 × 1.0	Zn	2	4	147	136	
	Semalo	1.5 × 0.5	Zn	2	2	130	129	
	Riampavun	2.5 × 2.5	Cu	2	7	339	132	

b) Sansak anomalous area

This anomalous area, composed of first and second anomalous classes of Zn is distributed in northeastern part of Kampung Sansak, and is 3.0 Km x 1.5 Km large. A high copper value of 405 ppm and two second class Mo values are associated in the anomaly. This anomaly seems to reflect Sansak mineralization which occurs along a fault as pyrite dissemination. A point at upper stream of Sungai Kersik inside the anomalous area shows high Cu, Zn and Mo values, supposing to be a part with chain of Sansak mineralization.

c) Semidan anomalous area

The anomaly distributed at Sungai Tampingan, northern part of Kampung Semidan is a second class anomaly of Zn having area of 1.5 Km x 0.5 Km. This area consists geologically of sandstone and mudstone bed of the Bengkayang Group, and small dacite intrusive which occurs along a fault trending NW-SE. Cinnabar grains were collected from river sediment by panning and there is an old mining place where cinnabar had been mined known as Udu Malakos cinnabar mineralization 2.5 Km northwest from the anomaly area. It might be stated that the anomaly is related to the cinnabar mineralization along the fault.

(2) Block B

a) Pandan anomalous area

This anomalous area being a second class Cu anomaly is distributed in area of 2.0 Km x 2.0 Km of Pandan quartz gabbro. There is no mineralized area according to the survey result.

to

Anomalous Cu values are counted sporadically only at three points in the anomalous area.

b) Banyl anomalous area

This anomalous area, composed of second class large scale Cu anomalous area coming after Sirih anomalous area, covers in an area of 5.0 Km x 2.5 Km.

This anomalous area covers Suren gold and chalcopyrite vein, Bayul and Batu Aji chalcopyrite and gold bearing mineralized areas, Temahas network molybdenite mineralized area, and Sengisa, Hutan Lara, Banyl fault mineral showings. Several first class Cu anomalous values are sporadically present at downstream area of Bayur, Batu Aji and Temahas, though they do not make a concentrated anomalous area.

Mean value of Cu in this anomalous area is 156 ppm. This value is larger than 123 ppm of Cu mean value in Serantak-Berasi anomalous area. It means that this area's Cu anomaly reflects Banyl mineralized area which has extensive Cu mineralization distribution.

c) Semade and Benawan anomalous areas

Second class Zn anomalous areas lie scattered at Semade, southeastern from Banyl anomalous area, and at Benawan, eastern part of Banyl anomalous area in an area of 1.5 Km x 0.5 Km. Semade anomalous area extends along a fault line trending in the NW-SE direction, but Benawan anomalous area has not a clear relation with mineralization, because there are no remarkable mineralized zones. Considering difference of dispersion between Cu and Zn elements, this Zn anomalous area might be distributed outside of Cu anomalous area.

d) Salung anomalous area

At western part of Kampung Salung, seocnd class Zn anomalous area is distributed in an area of 2.5 Km x 1.0 Km covering andesite lava (and ι) Gunung Raya granodiorite and tonalite. There are no mineralizations around the anomalous area, but tonalite like Banyl tonalite has been intruded in the anomalous area, and some placer gold was found in the area by panning. Thus mineralization may be present in the area.

e) Semalo anomalous area

This is a second class Zn anomalous area in an area of 1.5 Km x 0.5 Km at southern part of Gunung Semalo. Only 2 points of anomalous Zn value compose the anomalous area, and there is no mineralized area. However as dacite porphyry like Serantak type dacite has intruded in the area, it is probably to have some mineralization.

f) Rianpavun anomalous area

Second class Cu anomalous area, covering in area of 2.5 Km x 2.5 Km is situated at Kampung Rianpavun. This area consists of Gunung Raya granodiorite, and the anomalous area is present along a fault trending in the NW-SE direction.

It is not obvious what the anomalous area is due to, because there is no evidence of mineralization around the anomaly. It is not probable that there is a mineralization in the anomalous area.

5-5 Geochemical Survey by Cold Extractable Copper Method

5-5-1 Purpose

Cu anomalous value obtained by geochemical survey for metallic minerals of stream sediment consists of clastic Cu anomaly and hydromorphic Cu anomaly. The former includes fragments of primary minerals, insoluble secondary minerals, and clay residual, and the latter includes Cu adhering to the surface of organic material,clays, rocks, or mineral grains in the form of ion or soluble salts.

This geochemical survey atempts to distinguish hydromorphic Cu from clastic Cu, and compares both Cu anomaly locations to find their geochemical anomaly roles. Hydromorphic Cu is called cold extractable Cu (Cx-Cu), because it is analyzed after treatment by weak acid or sodium acetate.

Total Cu is obtained by adding clastic Cu and Cx-Cu values.

5-5-2 Selection of Assayed Samples

Some samples were selected from total Cu anomaly area, namely Serantak-Berasi area and Banyl area. Total of 102 samples were selected,that is, 41 samples from Serantak-Berasi area and 61 samples from Banyl area.

5-5-3 Measurement of pH

Precipitation of Cx-Cu is affected by pH condition of river water. Thus pH value was measured by a pH test paper at each stream sediment sampling point. The average pH value of 430 sampling points is 6. The pH values were divided into 8 drainage groups, and the tendency of pH values in each drainage group is shown in Table 5-4.

Further, the results were divided into two geological groups, northern part (sedimentary area) and southern part (igneous rock area). The northern area, consisting of sedimentary rocks and tonalite intrusions, has a pH value ranging from 5.1 to 6.0 and the southern area, representing granodiorite batholith, has a pH value ranging from 6.1 to 6.5.

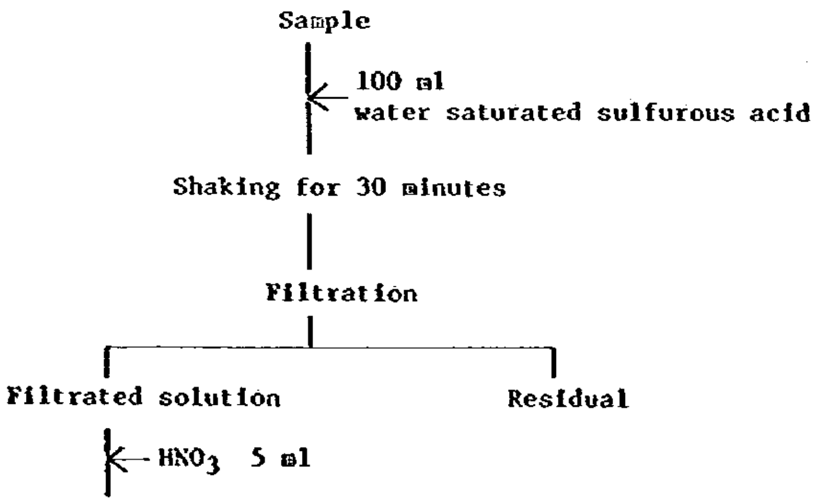
When pH tendencies in both areas, are compared the former has a pH slightly more acidic than the latter.

This probably means that the former area has many mineralization areas, and the latter, on the contrary, is occupied by a granodiorite batholith without any prominent mineralizations.

5-5-4 Chemical Analyses and Interpretation of The Results

(1) Chemical Analyses

One gram of sample was taken and shaken with 100 mℓ of water saturated sulfurous acid for 30 minutes. After filtering, the solution was analyzed by atomic absorption method. Analysis flow sheet is as follows:



Evaporation

← H_2O 20 ml

← HCl 4 ml

Move to a flask

Measure volume of liquid

Measure by atomic absorption

Fig. 5-5 Analysis flow sheet of Cx-Cu

(2) Interpretation of Results

Cx-Cu distribution was interpreted by drawing a map with a Cx-Cu value contour line, not by applying statistical methods. The result is shown in Fig. 5-6, 5-7.

In both areas, Cx-Cu anomaly area overlies the T-Cu anomaly area. Average ratios of Cx-Cu and T-Cu (Cx-Cu/T-Cu) are as follows:

	Mean ratio of all samples	Mean ratio in T-Cu anomaly area
Serantak Area:	28.2 % (41 samples)	26.2 % (38 samples)
Banyl Area :	30.2 % (61 samples)	32.9 % (20 samples)

There is almost no difference in the mean ratio of Cx-Cu and T-Cu between Serantak area and Banyl area, except that the ratio tends to decrease near mineralization.

Generally, Cx-Cu value is low near a mineralized zone, on the contrary total Cu is high, because hydromorphic copper corresponding with Cx-Cu value is hardly deposited under low pH value in river water caused by oxidation of sulphide ores. Therefore a comparison

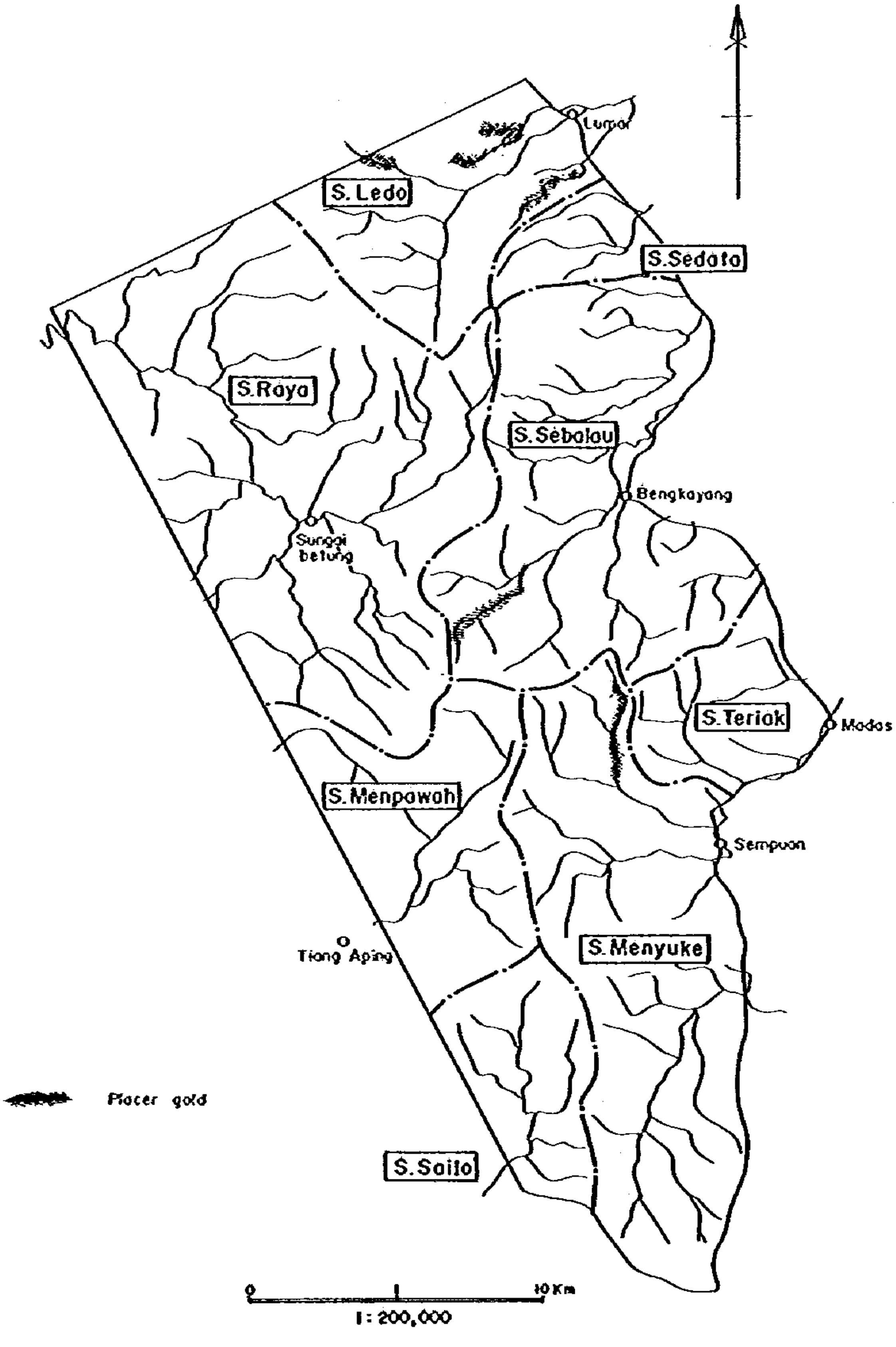


Fig. 5-6 Drainage Map

Table 5-4 Frequency Distributions of pH Values in Each Drainages

pH	Northern Area				Southern Area				Total
	S. Sebalau	S. Raya	S. Sedata	S. Ledo	S. Menyuke	S. Teriak	S. Mempawah	S. Sailo	
5.0		1							1
5.2	2	3							4
5.4	2	16		1	1				20
5.6	24	29	1	12	1	1			68
5.8	38	24	2	13	12	3	4	1	97
6.0	4	34	1	12	28	3	5	5	92
6.2		5		22	21	14	19	6	87
6.4			1	3	19	7	4	2	36
6.5								2	2
6.6					2			1	3
6.8				1	1		3	5	10
6.9					1				1
7.0								2	2
7.2							4	2	6
7.3								1	1
Total	70	111	5	64	86	28	39	27	430
Mean value	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.5	6.0
	5.8				6.2				

of Cx-Cu/T-Cu ratio was made among these assay result to know Cx-Cu tendency under weak acidic condition ranging from pH 5.7 to 6. Fig. 5-8, and 5-9 show the result.

Additionally, a area covering Banyl, Lao, and Sekeh mineralized zones is selected as further exploration area from result of Cx-Cu geochemical prospecting.

In Serantak-Berasi area, points with Cx-Cu/T-Cu ratio under 20 are located near Takap Molibdenite mineralization area, and if addopting a ratio up to 30 is addopted, the area covers Takap and Sirih mineralization areas.

In Banyl area, points with the Cx-Cu/T-Cu ratio under 20 also cover this area's mineralizations, namely Batu Aji, Suren, and Lao mineralization. As a result, it can be stated that ratio of Cx-Cu/T-Cu is useful in prospecting for mineralization areas.

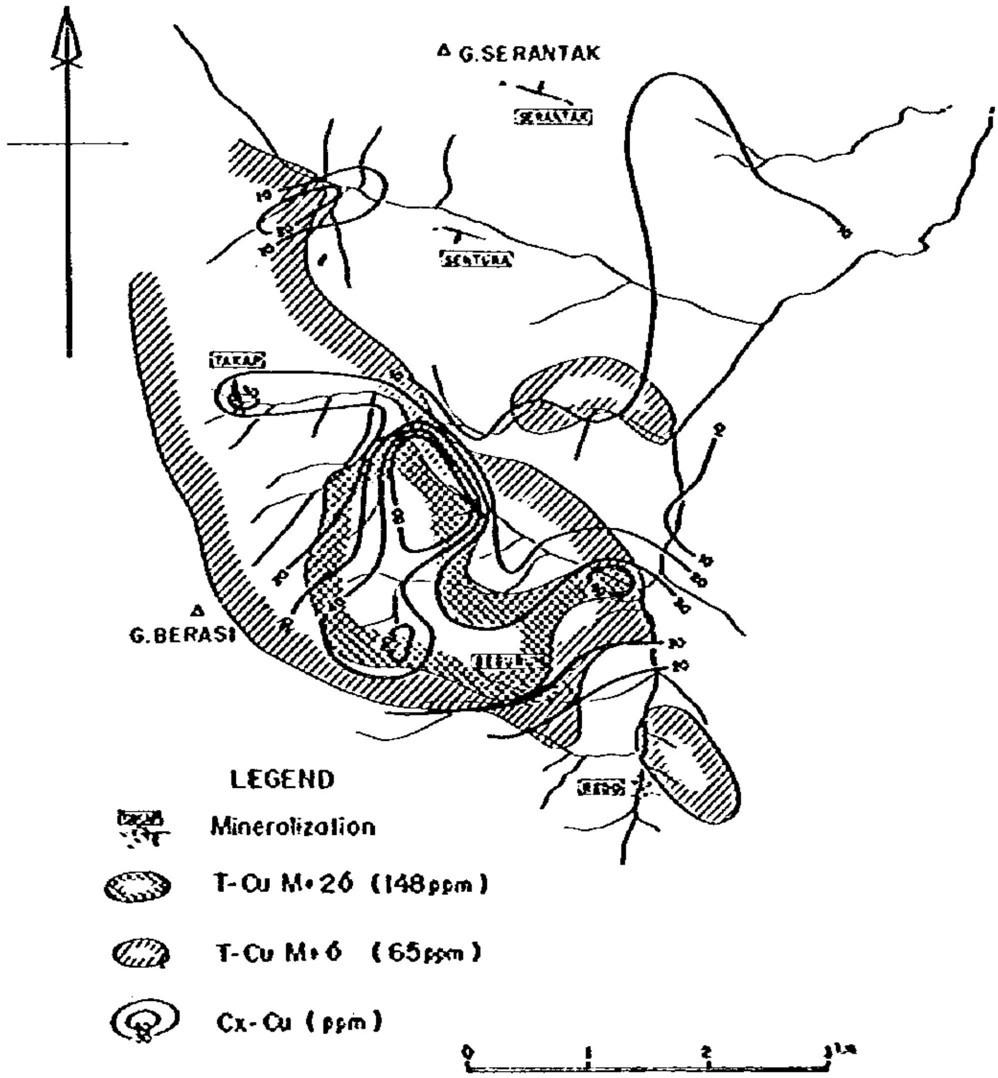


Fig. 5-7 Distribution Map of Cx-Cu
(Surantak-Berasi Area)

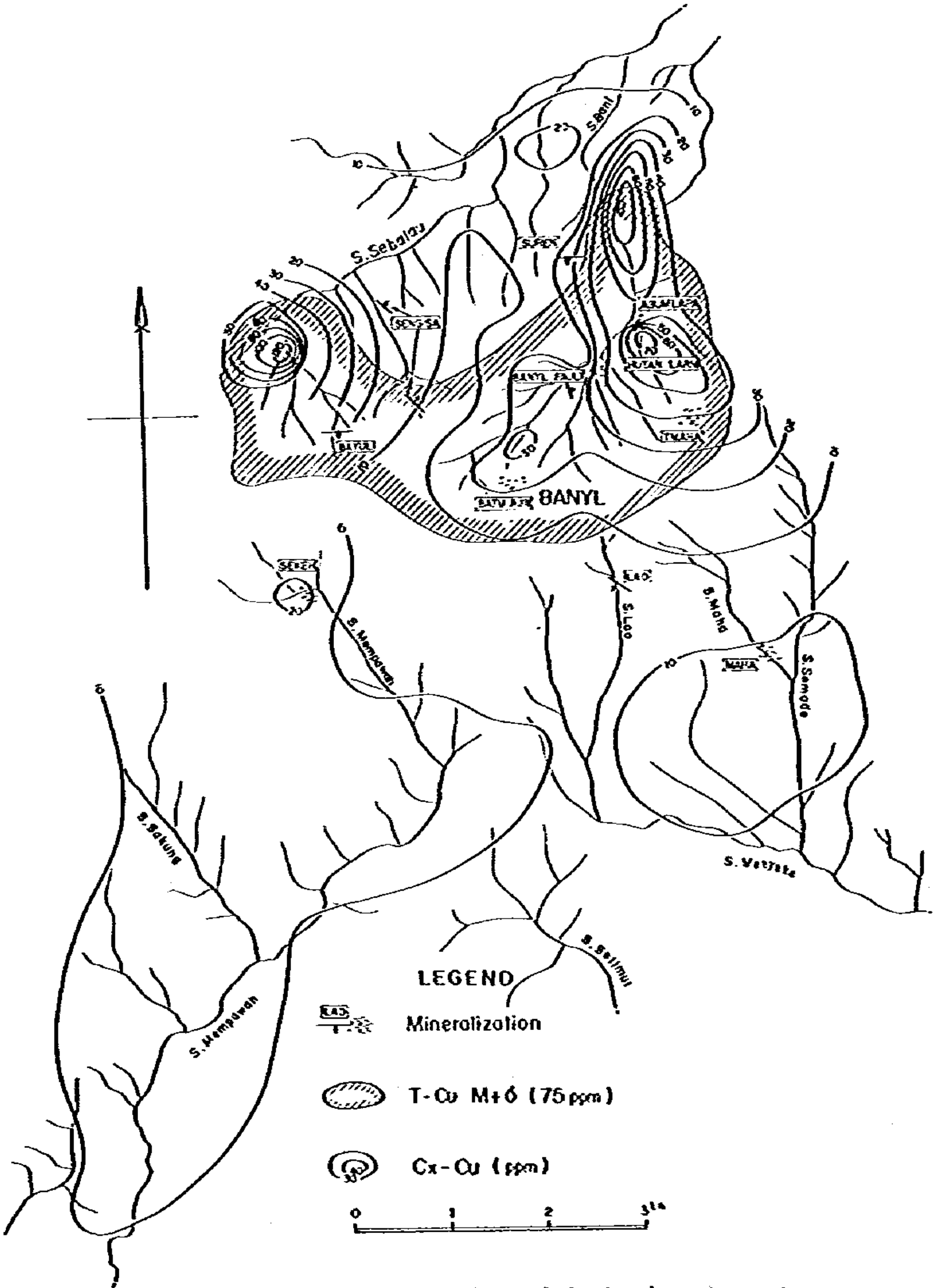


Fig. 5-8 Distribution Map of Cx-Cu (Banyl Area)

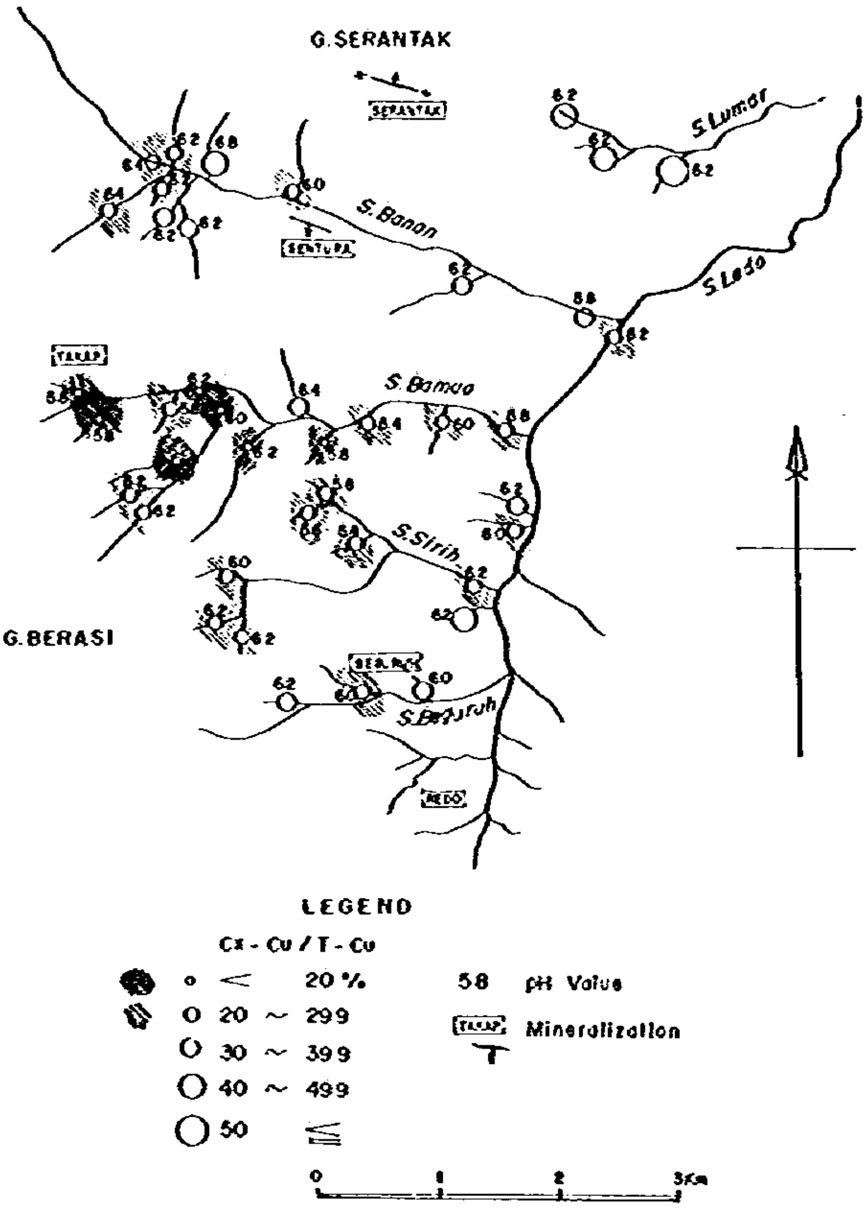


Fig. 5-9 Relation Map of Cx-Cu/T-Cu-Mineralized Zone (Serantak-Berasi Area)

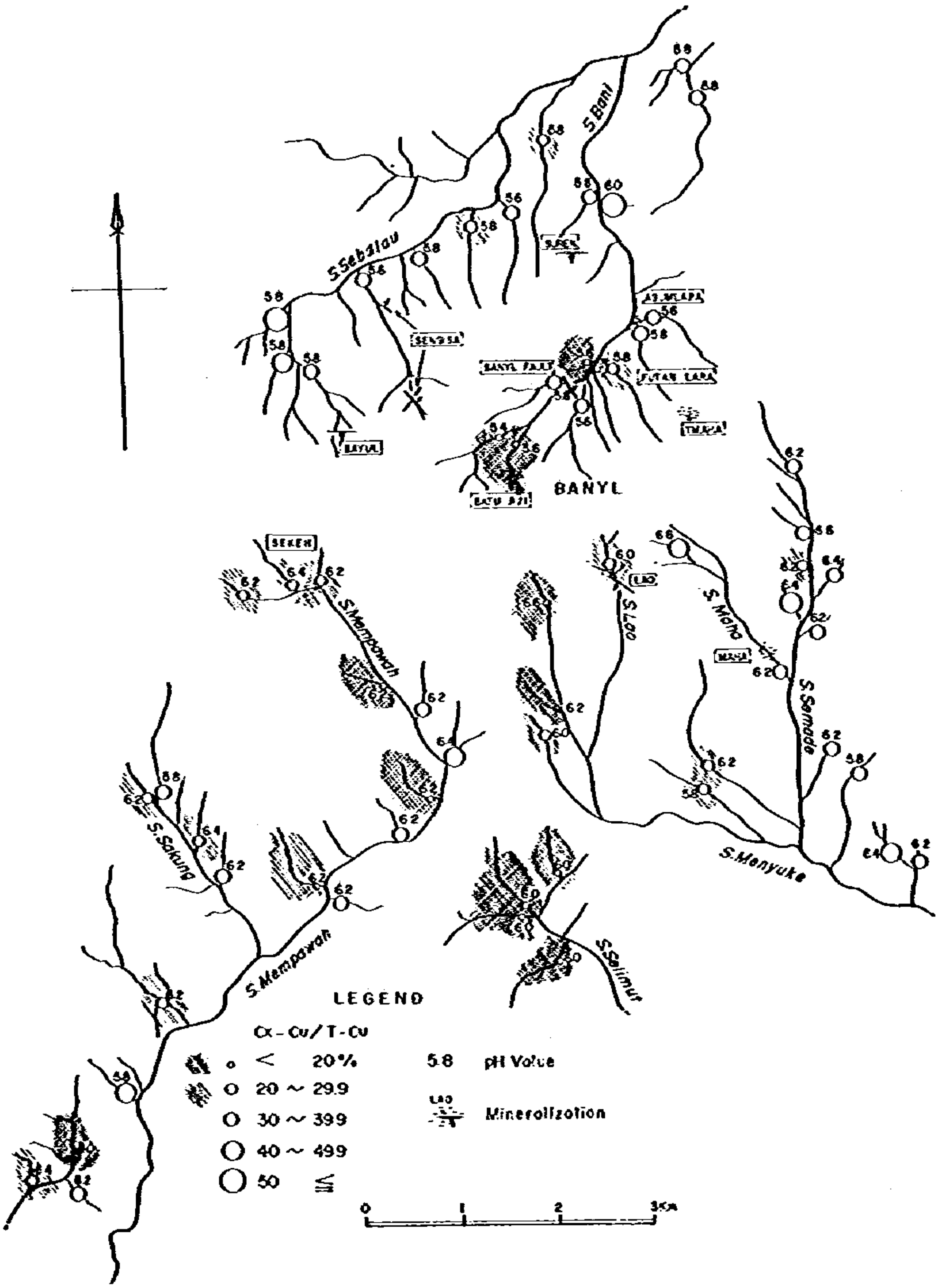


Fig. 5-10 Relation Map of Cx-Cu/T-Cu-Mineralized Zone (Banyl Area)

CHAPTER 6 PANNING PROSPECTING

CHAPTER 6 PANNING PROSPECTING

6-1 Purpose of the Prospecting and Method

The survey area has well known placer gold deposits in Alluvium sediments. Placer gold had been mined during a period in the 19th Century at Sungai Sebalau and Sungai Lumar. At present, local inhabitants are mining gold on a small scale when not engaged in farmer work. Gold panning prospecting work was performed together with stream sediment sampling for geochemical survey at the same sampling points in order to prospect for alluvium placer gold deposits and primary mineralizations, which are the source of placer gold. Survey points reached 629 points.

Two pails of sand and gravel, amounting to 40 litres, were sampled from river bed, and panned to collect placer gold grains. The grains were megascopically counted. Based on the frequency distribution of number of gold grains, the grain counts were divided into 5 classes, and gold content was plotted in the form of a class sign (a circle with size proportional to the number of gold grains) on a 1/50,000 map.

6-2 Analyses of the Gold Prospecting Results

Collected gold grains were counted megascopically at panning place based on 5 grain size classes, such as vf (very fine), f (fine* $\phi < 0.5$ mm), m (medium* ϕ 0.5-1 mm), c (coarse* ϕ 1-2 mm), vc (very coarse* $\phi > 2$ mm). However, in the analysis of the results grain counts were lumped together without consideration of grain size classes, because most gold grains are in f and m classes.

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* approximately defined by naked eye observation in the field.

In order to plot distribution of gold content on a map, 5 gold content classes were determined by drawing a histogram and cumulative frequency distribution of the number of grains per sample. Threshold of gold anomaly was obtained as 16 grains of gold at bending point of the line as Fig. 6-1 shows. Based on the Threshold, 5 classes of gold content range, namely 0, 1-4 grains, 5-16 grains, 17-69 grains, and more than 70 grains were established. Distribution according to these classes was plotted on the map as a circle with diameter proportional to the gold content.

Points over the threshold value (more than 16) were classified as placer gold anomalous areas, and 5 areas have been chosen as anomalous area.

(1) Sungai Lumar Area

Anomaly points of placer gold are distributed in the Sungai Lumar area extending 3 km. At the upper stream of Sungai Lumar, Serantak gold bearing pyrrotite ore deposit which has high gold content in its gossan part is situated, and Tertiary dacitic pyroclastic rocks are present in the Sungai Lumar area. It appears that a large amount of placer gold was transported from these mineralizations related to Tertiary volcanic activity of Serantak dacite.

(2) Sungai Cebol Area

This area is a small gold anomalous area located at the Sungai Cebol basin area. Gold mineralization is not known in the area, but because the Serantak Formation, consisting of Tertiary pyroclastic rocks, is distributed in this area, some gold mineralization was presumably imbedded in the Formation.

(3) Sungai Banan Area

This anomaly area (4 km west from Serantak mineralization) is situated at the upper reaches of the Sungai Banan. Sentura and Serantak gold mineralizations are known surrounding dacite stock. The placer gold anomaly is also distributed at marginal part of Serantak dacite. It is possible that undiscovered gold mineralization is present around the Serantak dacite.

(4) Sungai Sebalau Area

This anomaly is probably due to minerals transported from mineralizations in Banyi tonalite. But large gold placer anomaly was not found in the river sediments, though many gold grains were expected to be collected by panning prospecting. The fact that a large amount of placer gold grains has been mined in the past and the deposit almost exhausted, may be the reason. At present, local inhabitants are still collecting a small amount of gold from the area through very small scale mining activity.

(5) Sungai Semade Area

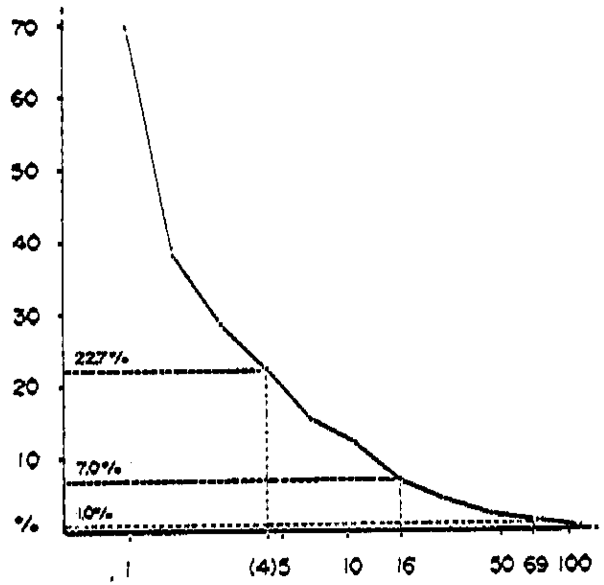
This placer gold anomaly area of 5 km southern from Sungai Sebalau is situated along the Sungai Semade and its tributary. Geology of this area consists of Gunung Raya granodiorite batholith, and associated granitic intrusion. Known mineralization is only the Maha mineralization, but the anomaly is included in the same area as Zn second class geochemical anomaly. The mineralization in this area is infered to be located in a NW-SE trending fault or shear zone.

Table 6-1 Frequency Distribution Analyzed Results of Placer Gold Survey

Class No.	Class range of log	Noumber of gold grains	Frequency of each class	Cumulative frequency Cumulation	%
0			384	629	100.00
1	0.2049218	0 ≤ 1.60 (1)	64	245	38.95
2	0.4098436	2.57 (2)	38	181	28.78
3	0.6147654	4.12 (4)	44	143	22.73
4	0.8196872	6.60 (5∿6)	23	99	15.74
5	1.0246090	10.58 (7∿10)	32	76	12.08
6	1.2295308	16.96 (11∿16)	17	44	7.00
7	1.4344526	27.19 (17∿27)	12	27	4.29
8	1.6393744	43.59 (28∿43)	8	15	2.38
9	1.8442962	69.87 (44∿69)	4	7	1.11
10	2.049218	112.00 (70∿112)	3	3	0.48

(Note)

log 112 = 2.049218



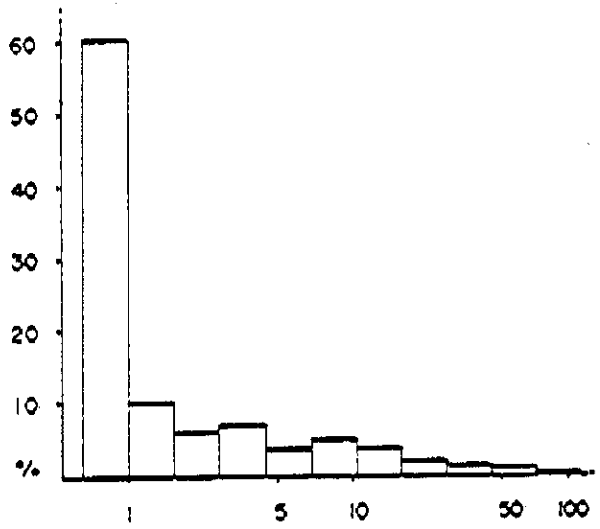


Fig. 6-1 Frequency Distribution Analyzed Results of Placer Gold Survey

CHAPTER 7 RADIOACTIVE PROSPECTING SURVEY

CHAPTER 7 RADIOACTIVE PROSPECTING SURVEY

7-1 Outline of Radioactive Survey

The Indonesian team proposed radioactive prospecting survey, because plutonic rock are extensively distributed in the survey area, in order to get general information on radioactive minerals.

This reconnaissance survey was performed jointly with the geological and geochemical survey. Radioactivity of outcrops of igneous and sedimentary rocks, and faults was measured by a portable scintillation counter.

7-2 Instrument and Method

7-2-1 Instrument

TCS - 121C scintillation counter (ALOKA)

7-2-2 Survey Method

At first, scintillation counter detector tube was turned toward the sky to measure radioactive background value in the atmosphere. Radioactive values of igneous and sedimentary rocks, and faults were measured by bringing the scintillation detector in contact with clean face of the object measured. Measured point reached 319 points, ploted on a topographic map of 1/50,000 scale. (PL 8)

7-3 Survey Results

Four geological units were used to divide radioactive values into appropriate populations, as follows:

70

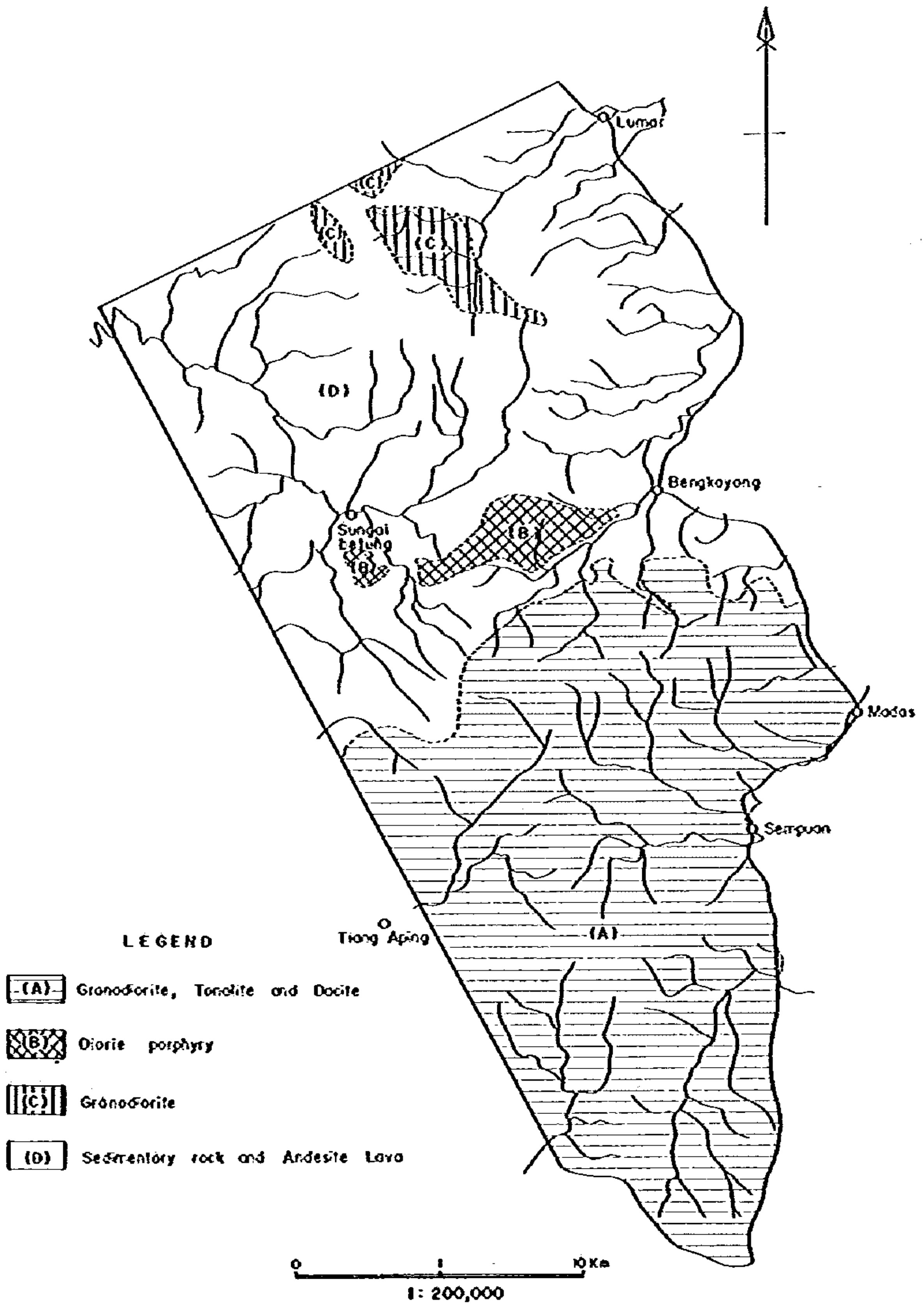


Fig. 7-1 Geological Unit Map for Radioactive Analysis

A unit	Raya granodiorite, Banyl tonalite and Belang pyroclastic rock Formation
B unit	Pandan quartz gabbro
C unit	Sirih tonalite
D unit	Bengkayang Group and Serantak Dacite and its pyroclastic rocks

Table 7-1 shows the results.

Table 7-1 Summary of Radioactive Intensity

(Measured by TCS-121C)

Unit	Outcrop*		Background		Number of Measured Points
	Range of R.I.	Mean Value	Range of Readings	Mean Value	
	(μR/h)	(μR/h)	(μR/h)	(μR/h)	
A	0 - 6	1.4	1 - 11	3.8	198
B	0 - 2	0.7	2 - 5	3.3	7
C*	0 - 8 (0 - 28)	3.9 (4.7)	2 - 9 (2 - 11)	5.7 (5.9)	35
D	0 - 10	1.6	1 - 20	4.6	79

* The value of outcrop is calculated from the difference between reading value of outcrop and background of atmosphere. One point of anomalous reading was disregarded in unit C.
But ( ) is included the high anomalous point.

R.I.=radioactive intensity.

Radioactive intensity of Sirih tonalite (C unit) is slightly higher than that of other units, namely Sirih tonalite has mean value of 3.9 μR/h (in radioactive intensity) in comparison with the mean value of radioactive intensity of other units which ranges from 0.7 - 1.6 μR/h. It may be infered that these values represent the natural radioactivity of rocks in each geological unit. The only comparatively high value, showing 28 μR/h, which is about 7 times of mean value, was found at andesite dyke in Sirih tonalite of C unit. It may be an accidental local anomaly, because other dykes and shears near the anomaly did not have such a anomalous values.

Table 7-2 Frequency Distribution of Radioactive Intencity

Unit μR/h	A		B		C		D		Hole Unit	
	F·BG	F·R·O	F·BG	F·R·O	F·BG	F·R·O	F·BG	F·R·O	F·BG	F·R·O
0		35		3		1		21		60
1	9	84		3		4	6	28	15	119
2	37	47	1	1		3	10	18	48	69
3	55	22	4			6	12	4	71	32
4	30	8	1			5	11	2	42	15
5	45	1	1		3	7	22	2	71	10
6	11	1			2	3	9	2	22	6
7	6				4	4	3		13	4
8	4				1	1			5	1
9					1		1		2	-
10					9		4	2	13	2
11	1				4				5	
12					7				7	
13					1				1	
14					2				2	
15										
20							1		1	
28						1				1
39					1				1	
Total Number	198		7		35		79		319	

F·BG : Frequency of Background value

F·R·O: Frequency of Radioactive Intensity on Outcrops (Readings value on outcrop - Background value)

CHAPTER 8 GENERAL DISCUSSION AND CONCLUSION

CHAPTER 8 GENERAL DISCUSSION AND CONCLUSIONS

Stratigraphy, geology, mineralization, and geological structure revealed by this investigation are discussed below:

8-1 Stratigraphy and Igneous Rocks

8-1-1 Stratigraph

Sedimentary formations distributed in the northern part of the survey area were considered to be late Triassic based on a previous survey. But the Bengkayang Group was divided into four Formations as follows:

Sungaibetung Formation	(alternating beds of sandstone, siltstone, and mudstone)
Riamperaya Formation	(sandstone)
Kalung Formation	(black shale)
Banan Formation	(tufaceous sandstone)

The Sungaibetung Formation yielded ammonite fossils correlated with Jurassic Lias Toarcian. Thus, the Bengkayang Group is late Triassic to early Jurassic age. The Banan Formation, consisting of andesitic and dacitic tufaceous sandstone, could be correlative with the Serian Formation which is distributed in southwestern Kalimantan and south Sarawak, and consists of pyroclastic rocks of later Triassic age. (Pupilli 1975)

The Bengkayang Group is characterized by the prevalence of dome structure caused by intrusion of younger granitoid rocks.

8-1-2 Igneous Rocks

Igneous rocks were emplaced in two stages. K-Ar absolute age dating has determined the age of Gunung Raya granodiorite and Tiang quartz diorite as middle Cretaceous, and Sirih and Banyi tonalites as Oligocene and Younger Miocene. Older granodiorite is a part of granitic batholith distributed extensively in West Kalimantan, but younger tonalites are small scale NWW-SEE trending intrusions accompanied by a dome structure. Younger intrusions are accompanied by mineralizations.

8-2 Geological Structure

Geological structure of the survey area is characterized by faults and dykes of quartz and andesite trending NNW-SSE and E-W, dome structure with anticlines and synclines trending N60-80W, caused by younger intrusives. The fault are the sites of mineralization.

8-3 Mineralization

Mineralizations in the survey area can be divided into four groups: chalcopyrite, molybdenite bearing quartz veins embedded in Sirih tonalite; gold quartz veins and molybdenite network deposits in or around Banyi tonalite; gold and chalcopyrite bearing massive pyrrhotite deposit; and a gold bearing quartz vein around Serantak dacite. Lao, Maha, and Sekeh mineral showings of chalcopyrite and molybdenite are known around small tonalite or granite intrusions in Gunung Raya granodiorite.

These mineralized zones are also situated at places of geochemical anomalies and places with concentrated placer gold.

8-4 Geochemical Survey and Placer Gold Prospecting

As a result of the geochemical survey and placer gold prospecting, and after considering mineralizations clarified by geological survey, following areas are recommended for detailed survey:

(1) Serantak Dacite Area

Around southern part of Serantak decite intrusive, area of concentrated placer gold and geochemical anomaly area of Zn are distributed. In this area, there are gold quartz veins and a gold and chalcopyrite bearing massive pyrrhotite deposit. Northern part of the area is not surveyed yet, because it is outside the survey area. It seems possible that a mineralized area exists in the northern part of the Serantak dacite intrusive.

(2) Sirih Tonalite Area

Cu and Mo anomalous area and low ratio area of Cx-Cu/T-Cu are present in Sirih tonalite intrusive. In this area, there are many chalcopyrite, molybdenite bearing quartz veins in the tonalite intrusive.

(3) Banyl Tonalite and its Surrounding Area

Geochemical anomaly of Cu and area of concentrated placer gold overlap, centering on Banyl tonalite. In the area of Gunung Pandan Kecil and Gunung Centing Bakilok, southern part of Banyl tonalite, area of concentrated placer gold and low ratio area of

Cx-Cu/T-Cu are distributed. This area has gold-chalcopyrite bearing quartz vein and chalcopyrite, molybdenite minieralization.

8-5 Future Prospects and Conclusion

The Collaboration Survey for Development of Mineral Resources in West Kalimantan was started in the 1979 fiscal year. In the first phase, geological survey, geochemical survey, placer gold prospecting and radioactive mineral prospecting have been performed. As a result of these surveys, stratigraphy, igneous rocks, geological structure, and mineralizations are revealed.

When the survey is extended to northern and southern areas, search for younger intrusive rocks such as Sirih and Banyl tonalites type and Serantak dacite type, supposed to be associated with mineralization, geochemical survey of stream sediment for Cu, Mo, Zn and Cx-Cu and placer gold prospecting will be most effective. It is hoped that it will be possible to expand the survey area toward the north of the survey area, because Sirih tonalite and Serantak dacite accompanied by mineralization are also extended to the northern area.

Detailed survey of Serantak gold and chalcopyrite bearing pyrrhotite deposit, Banyl Cu-Au-Mo mineralized area, and Sekeh, Lao, and Maha Cu-Mo mineral showings, can be recommended.

SUPPLEMENT

Supplement

Au-Cu-Mo mineralizations related to granitoid rock intrusions are distributed in West Kalimantan, and distribution of Sn-W mineralizations accompanies granitoid rocks croping out from the Malay Penninsula to Bangka, Belitung Islands of East Sumatra. In order to compare these two types of mineralization, classification of granitoid rock divided by content of opaque minerals was done. From Dr. Ishihara's study, granitoid rocks can be divided into magnetite-series granitoid rock and ilmenite-series granitoid rock, based on containing magnetite or ilmenite (Ishihara 1977). It proposes that Sn mineralization is related to ilmenite-series granitoid rock, and porphyry copper type minerlization (Cu-Mo) has a relation to magnetite-series granitoid rock (Ishihara 1977).

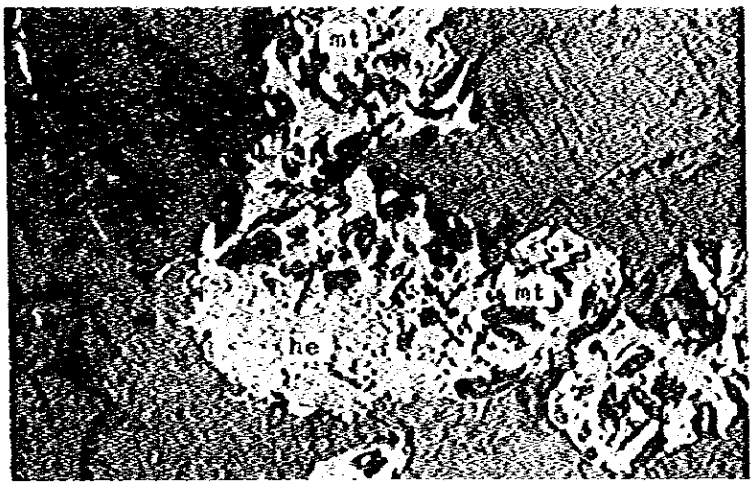
As a result of study about opaque minerals by microscopic observation, Banyi tonalite and Sirih tonalite are classified into magnetite-series, on the basis of existance of magnetite, small amount of ilmenite and hematite, as photo shows.

Both tonalites and Gunung Raya granodiorite could be detected magnetism by using hand magnet while field survey was carried out. The survey result shows that these granitoid rocks have magnetism, and contain magnetite.

On the relationship's point of view between granitoid rock series and associated mineralization, it is infered that West Kalimantan is characterized by Cu-Mo mineralization (porphyry copper deposit type ?), with magnetite-series granitoid rock in contrast with Sn-W mineralization with ilmenite-series granitoid rocks in the Malay Penninsula and East Sumatra.

Further study about this matter shall be continued in next year survey.

Microphotographs of Polished Samples
(Opaque Minerals in Granitoid Rock)



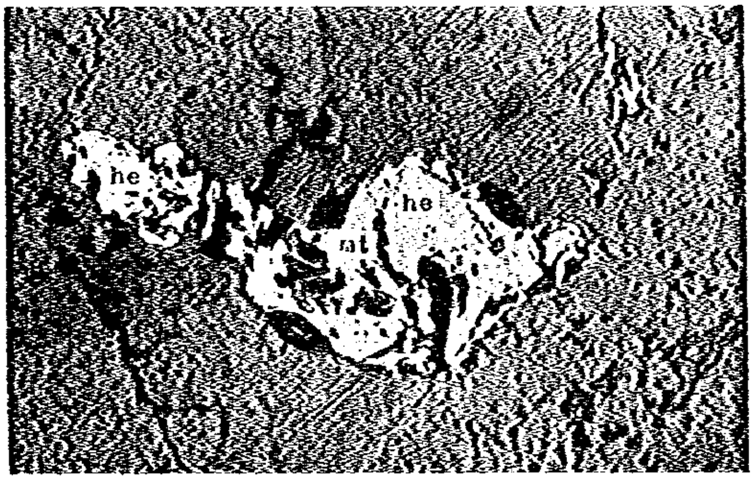
Sample No.: BB-24

Locality : S. Bamua

Name
of Rock : Sirih Tonalite

mt: magnetite
he: hematite

0 1 2 3 mm



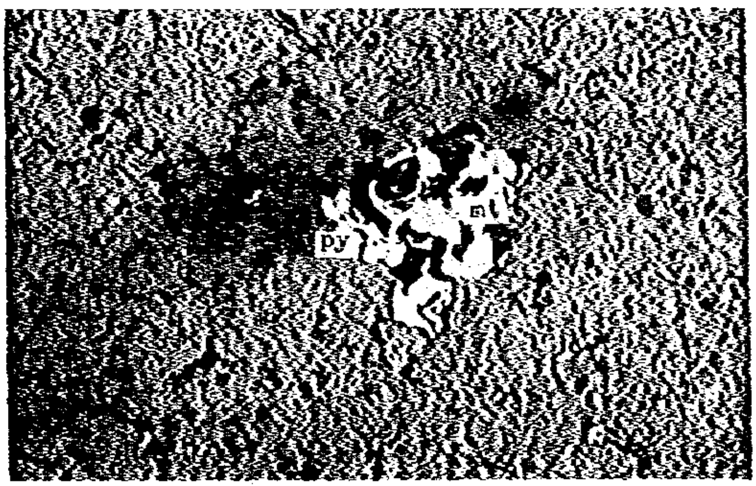
Sample No.: RB-24

Locality : S. Bamua

Name
of Rock : Sirih Tonalite

mt: magnetite
he: hematite

0 1 2 3 mm



Sample No.: RB-24

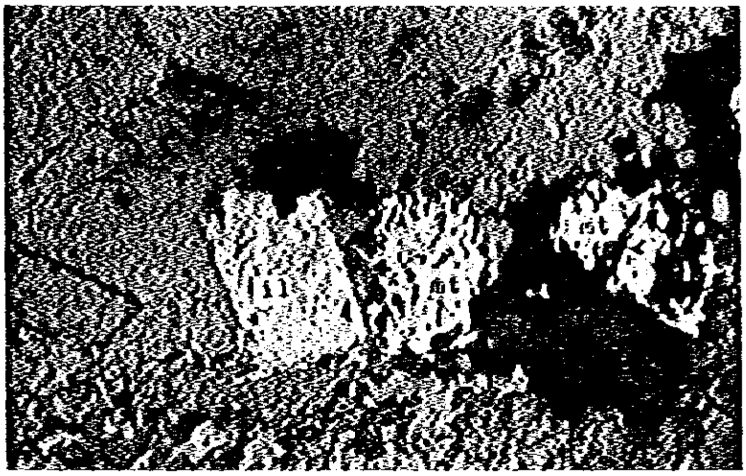
Locality : S. Bamua

Name
of Rock : Sirih Tonalite

mt: magnetite
py: pyrite

0 1 2 3 mm

Microphotographs of Polished Sample
(Opaque Minerals in Granitoid Rock)



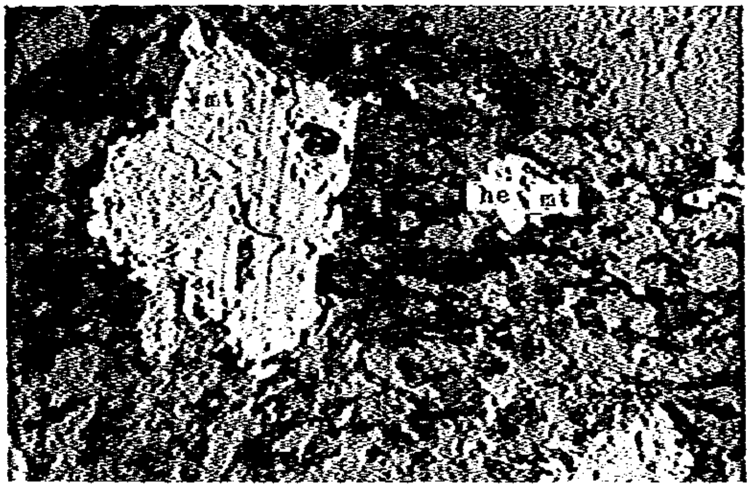
Sample No.: RD-52

Locality : S. Bani

Name
of Rock : Banyl Tonalite

il: ilmenite
mt: magnetite

0 1 2 3mm



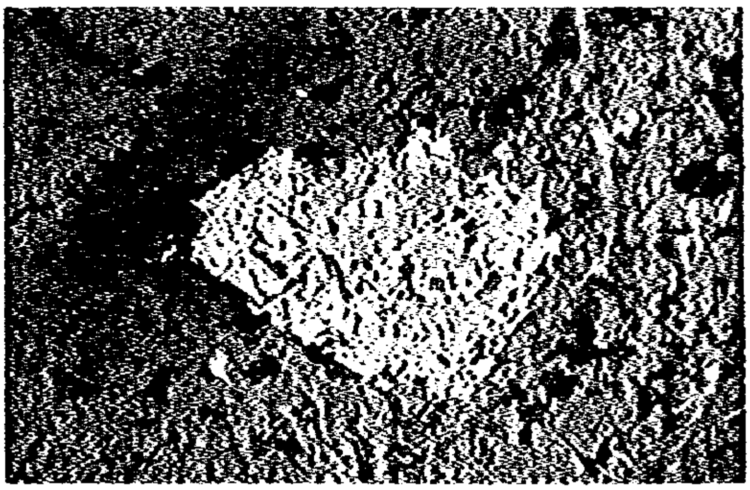
Sample No.: RD-52

Locality : S. Bani

Name
of Rock : Banyl Tonalite

il: ilmenite
mt: magnetite
he: hematite

0 2 4 6 8mm



Sample No.: RD-52

Locality : S. Bani

Name
of Rock : Banyl Tonalite

mt: magnetite
he: hematite

0 1 2 3mm

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APPENDICES

Appendix 1 Precipitation in Bengkayang

1975 Bengkayang

Date \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	59			5	40			23		7	
2	15	4	21		34				37		3	
3	5	34										
4	10	23				2	1		9		3	
5	10		6	31		3		28	7			
6		17	6	54	1		5	24	8	24		13
7	16		13	1	3		12	5		14	15	11
8	30	5									16	
9	15	45	26	11					42	3	42	
10		1	11	42	11				36	17	9	1
11		8		34	7				9	11	29	21
12	7			14			5		3	19	2	21
13	7			27	27		4		19	40		
14		3	15							8		
15			6	4	17		3	46			17	5
16		9	9	23	1	11				2	25	21
17				40		25	17	7			34	12
18			1	4			5			19		1
19		1	17	4		12	15	13	120	10		1
20		8					5	10		12	3	
21		9		8							13	22
22	5	62	21				4	2			25	7
23	7	131			13		9	43	14	6	3	137
24		15		3	10		4	1	4		2	
25	17			14	18		31		5	34	11	3
26	23	24		9	3		35			14		
27	21	12		1	21	3	22	19	20	4	29	
28		1	10				1		70	14	13	26
29	26			13			6			4	15	
30	3			1		21		28	3	8		
31								3		13		3
Total	220	471	162	338	171	117	184	229	429	276	316	305

1976 Bengkayang

Month / Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1			7		16				20	16	25	14
2				32	11					9	41	
3			3	2			27	6		36	2	22
4				6								28
5				14		5	3			5	38	
6	7				10		7		30	12		
7	9					3	8		3	31		
8	4		9							35		
9	32		30	6	3	1		3	33	42	23	
10	92		5	19			23		10	1	4	
11	5				4	12					7	62
12	20							2		20		17
13	40	46		70	19	2		12		11	9	
14	12	51	40	33		2	25	3			2	76
15			36	1		1					5	29
16										23	14	2
17		4								3	13	10
18			2	71						9	55	17
19				2						28	9	
20		16	11							15	3	5
21		5										
22		32		18		1			6	5	1	
23		3		5						16	18	7
24			82	2				3		6	2	21
25	12					10		2		9	21	12
26	19			21		6	5	16	15	7	12	
27	1		1	13			26	4		17	33	12
28		5		9				11	32		25	
29			8	37	10			3			13	11
30			2	13			5		5	37		
31					3		26			8		10
Total	253	162	236	374	76	43	155	65	154	401	375	355

1977 Bengkayang

Month / Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	11	10		30		34				5	38	8
2	14	11		4	90	9				89	25	22
3	6			14	17		38			90	7	28
4	21	25		55		4				15	37	13
5	24	2		51	9	60	30	9		42		17
6	17	42		9	17		30			25	4	2
7		8					9	8			27	35
8		60			40	7	33			9	45	
9	7	12		61	5			19		3		
10	5	9			34					15		
11		58			41	16		2		114		13
12		1	116		2		18	34	16	41	18	5
13			1		25		14	30	5		1	20
14		3			4			10		15	19	8
15		11			1	3					68	
16		9		55	4					20		16
17	3		15			4					4	5
18	8	17			25				11	20	12	
19		18		6							3	
20	13	31			9			19		1	30	21
21	9	15			1	1	6			13		
22	9	32		21				45		13	5	
23	1		1		4		15			36		5
24		42	1				2	28		18	13	
25		9		18	32		3		3	70	19	
26		5		20	2					4	40	10
27			2				2	25	7	25	17	7
28			2	21				22			17	30
29			8	104					21	31	42	6
30	3		34			10			72	1	8	
31	15									2		
Total	166	430	180	469	362	148	200	251	135	717	499	271

1978 Bengkayang

Date \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	44							31	4		56	6
2	3						20		12	16	47	
3			5	16	6		7	7		4	7	
4			6	35		4						10
5			5			21		15	1		23	2
6	14		17						48		9	
7	39	9			77	1			13			22
8	23	4			11	8	5		1			11
9		5	44		6		69		6	11		6
10	2		6	139	17	1	3		4		8	
11	18	20		4					23			
12	6	8		3	7	23	28				5	
13	9	2	51	14	59	22			11		10	
14			8		2					10	18	14
15			27	5			21	74			9	6
16	16	1	45							9	1	2
17	5		8	9	5		6	48	13		5	22
18			9	16					1	6	5	
19	13	7		20			10			29	50	16
20	10		47	4					28	20	11	17
21		1	42		1					3		
22	7		9								3	6
23	57								70	54	8	
24	2		6						4	65	10	
25		6	23				2			7	3	
26		9	3	7		28				21		37
27	3			15						18	7	26
28		17	10		5					11	18	3
29			3		22					5		5
30			54							16		
31	1				1					41		
Total	272	89	428	287	219	108	171	175	239	346	313	211