THE REPUBLIC OF INDONESIA
REPORT ON THE COOPERATIVE MINERAL EXPLORATION
OF
NORTHERN SUMATRA

PHASE 1

FEBRUARY 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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 Northern Sumatra, 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 the collaboration survey consists of geological and geochemical survey for metallic mineral exploration.

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

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

February, 1983

Prof. J.A. KATILI
Director 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

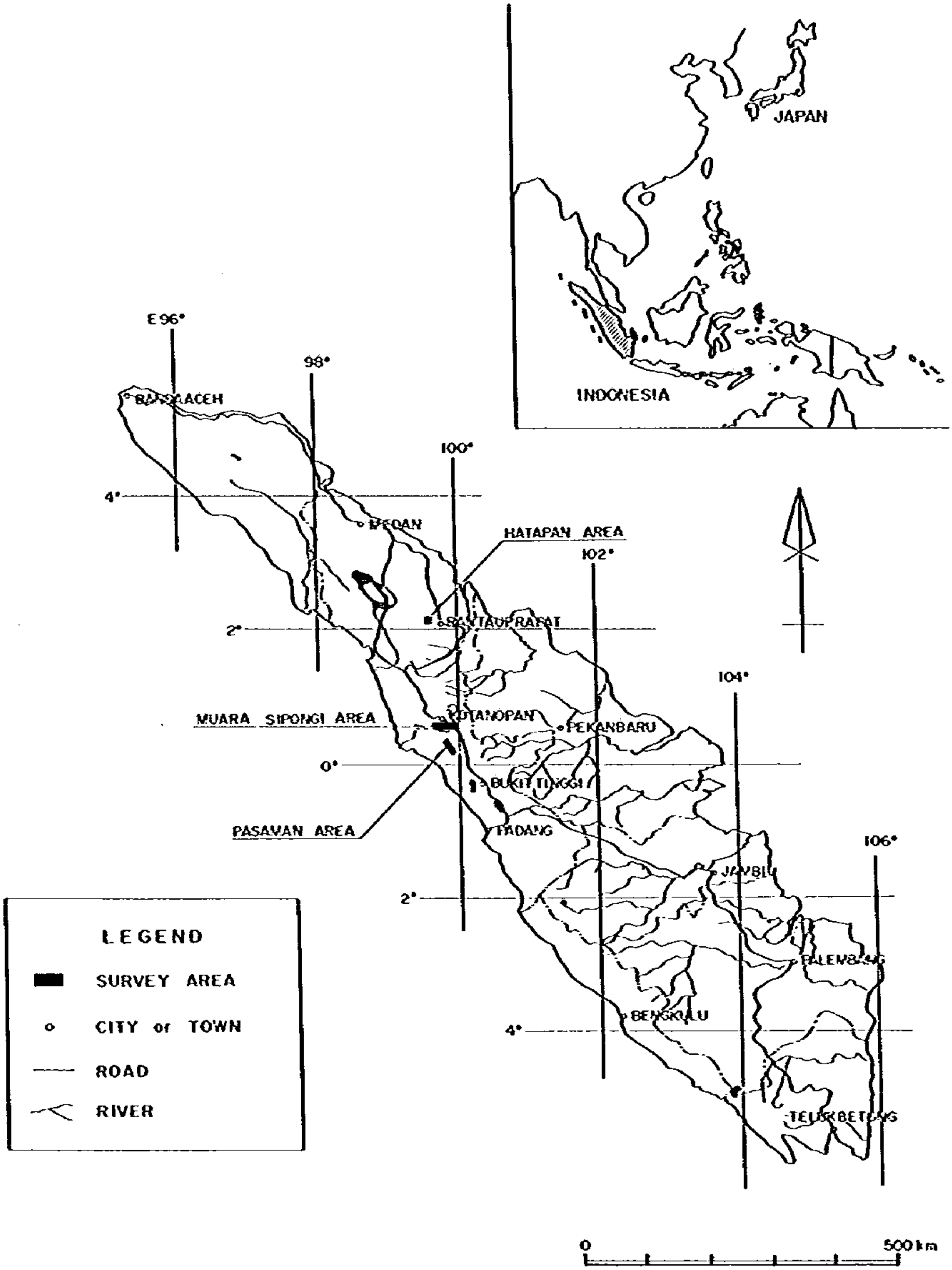

Fig I-1 Location Map of Survey Area

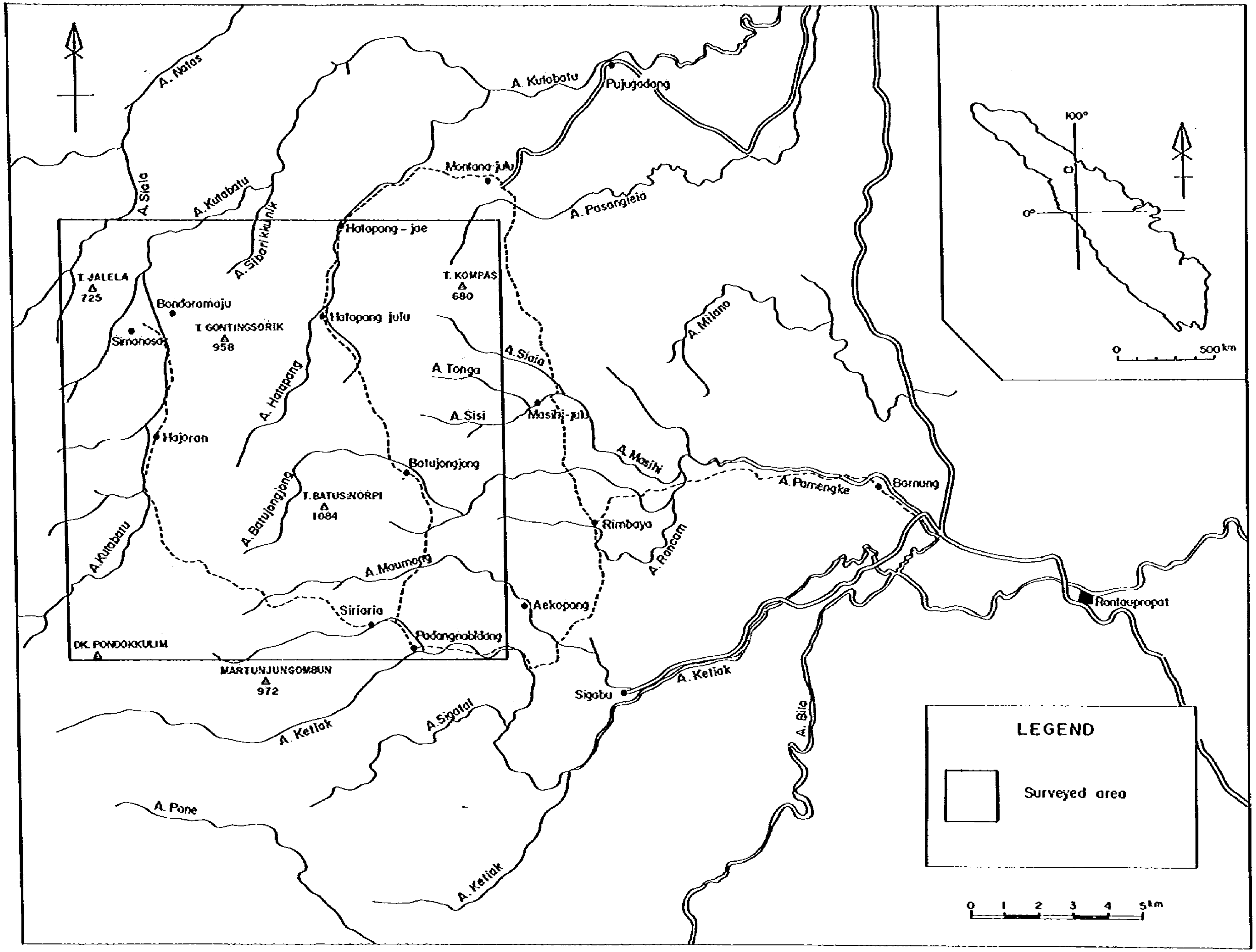

Fig I-2 Location Map of Hatapang Area

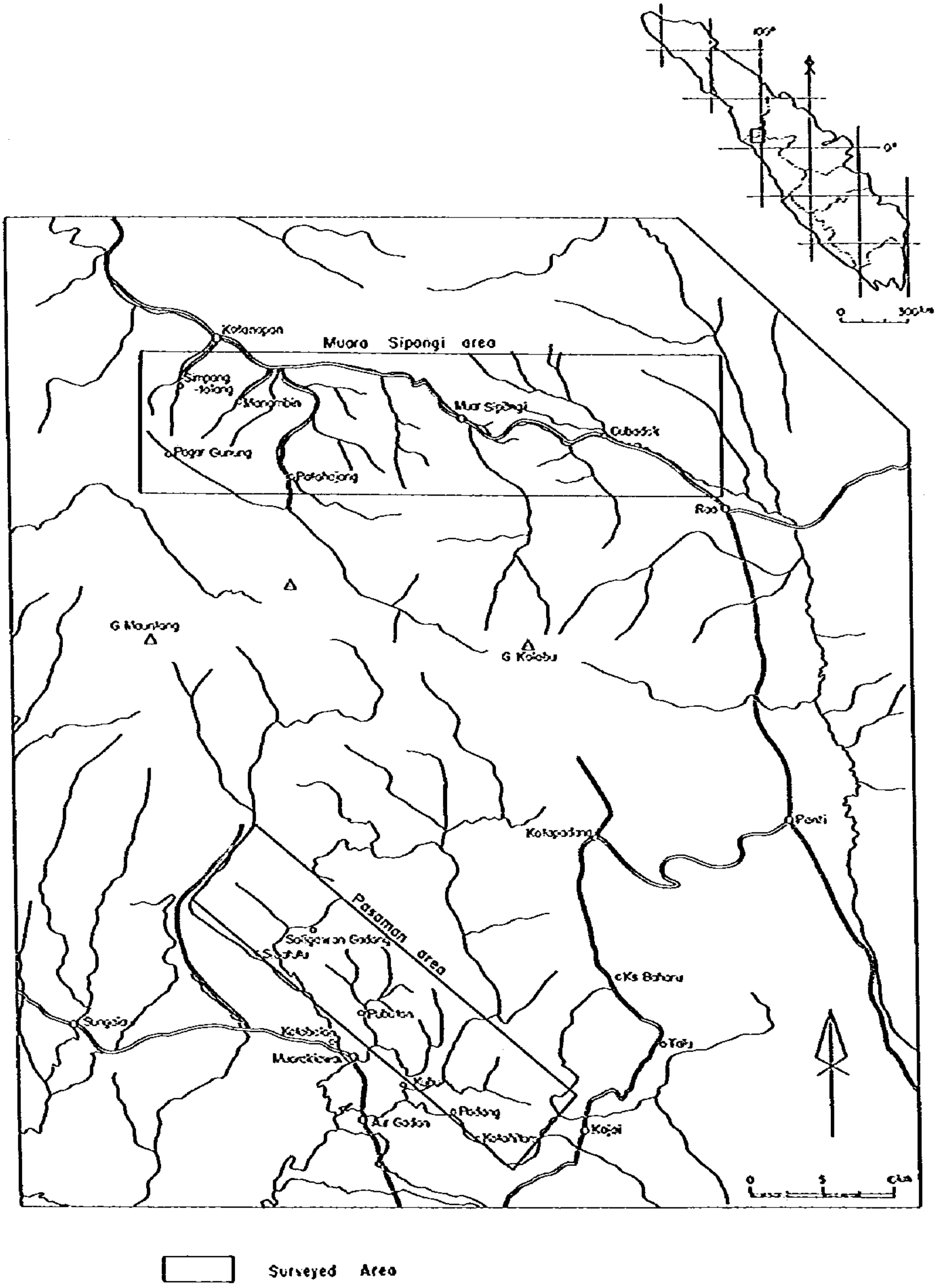

Fig I-3 Location Map of Muara Sipongi and Pasaman Area

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SUMMARY

The first phase of the Northern Sumatra Cooperative Mineral Exploration Project in the Republic of Indonesia focussed on three objectives: unravelling of tin and tungsten mineralizations in the Hatapang Area (169 km^2); a survey of gold, copper, lead and zinc mineralization zones in the Muara Sipongi Area (400 km^2); and a study into the possibility of chromatite emplacement in the Pasaman Area (200 km^2).

The survey project shed light on the relationship which geology, geological structure, and igneous activity has with mineralizations in each area, and several promising mineralization areas were found and selected.

The Hatapang Area is composed of Permian - Carboniferous system sedimentary rock (the Hatapang Formation ; correlative to the Bohorok Formation reported by the Indonesian - British Cooperative Survey), in which is distributed Hatapang granite stock over an area 6 km EW by 8 km NS. This Hatapang granite intruded during the later Cretaceous period and caused contact metamorphysm (hornfels) into the Hatapang Formation. The Hatapang granite consists of mainly coarse-grained porphyritic - medium, equi-granular biotite granites (adamellite), with distributions of fine-grained two mica granite which intruded during the following stage around the northern and eastern margins of the Hatapang granite intrusion.

The resemblance of these Hatapang granites to granite in the Phuket tin mineralization zone located at the southeasternmost margin of the Thai - Malaysian - Indonesian tin mineralization zone in terms of rock character, intrusion period (later Cretaceous period), and other factors, suggests that the Hatapang granite is part of this mineralization zone and is situated at its southern extension.

The tin content of fine-grained two mica granite is high in comparison with that of the porphyritic biotite granite which comprises the main body of the Hatapang granite. The northern and eastern margin zone of the Hatapang granite intrusion, where this granite is distributed, has been found to be the site of a large number of quartz veins; moreover, the geochemical survey revealed the distributing area of fine-grained two mica granite to be overlapped by anomalous areas of tin, tungsten, and fluorine as well as by regions containing substantial amounts of cassiterite placer ore. These circumstances mean that there is an extremely high probability that tin mineralization zones are distributed in this area.

The Muara Sipongi Area is composed of the Permian - Carboniferous system M. Batung Andesite and Patahajang Limestone and Pyroclastic Rock Formations (these Formations are correlative to the Silungkang Formation of the Peusangan Group). Calc-alkalic rock series Muara Sipongi granitoid rocks of the Jurassic period have intruded into these strata causing mineralization activity in the meta-andesite and limestone strata. Mineralization has formed two mineralization zones in this area, namely the Subun-Subun mineralization - Bt Pionggu mineralization zone - Si Ayu skarn zone composed of gold and copper (lead and zinc) ore deposits, and the Pagar Gunung mineralization - Patahajang alteration zone composed of massive lead and zinc skarn-type metasomatic ore deposits.

In the former, the type of ore deposit is dependent upon the host rock in which it is found: deposits originating in meta-andesite are fissure-filling quartz veins containing gold and copper (lead and zinc), while those originating in limestone are skarn-type copper (magnetite) deposits.

The geological structure of the Muara Sipongi Area has been deduced from its folds, synclinal and anticlinal structures, faults and the configuration of its granitoid intrusion to be primarily WNW -

ESE in direction. The area's mineralization zones are also controlled by this structure.

Geochemical and placer ore surveys yielded indications that varied according to the form of the mineralization involved. In the gold-rich Subun-Subun - Bt Pionggu mineralization zone, for example, gold anomalous areas revealed by the geochemical survey and regions abundant in placer gold were well consistent with mineralization zones, while in the Pagar Gunung deposit - Patahajang alteration zone, which holds copper, lead, and zinc massive ore deposits but is low in gold, it is the silver, copper, lead, and zinc anomalous areas revealed by the geochemical survey which are highly consistent with mineralization zones.

While the Pagar Gunung ore deposits are intermittent at surface level, they do possess outcrops of ore deposits extending over 200 m and form the richest mineralization zone in this area. Other mineralization zones worthy of note are the Subun-Subun and Bt Pionggu zones.

The Pasaman Area is composed of an ultrabasic rock mass having a scale of 8 km NS by 5 km EW, along with the upper Cretaceous system Woyla Group consisting of pelitic schist - slate, and green schist-green rock. Microscopic observation and geochemical study revealed that while this ultrabasic rock contains a very small distribution area of dunite it is composed almost entirely of harzburgite. Moreover, from the composition and texture of its olivine and pyroxenes, its equilibrium temperature (650°C - 750°C) obtained from the Fe - Mg partition in clinopyroxene and orthopyroxene, and other factors, the Pasaman ultra-basic rock is considered to form a part of the ophiolite and to be tectonite peridotite accreting from the upper mantle which appended to Sumatra when the island was closed off by the marginal sea during the later Cretaceous period.

The harzburgite contains 0.2% - 0.5% Cr_2O_3, but this is contained as chromium spinel showing a composition of Cr_2O_3 27% - 44%, Al_2O_3 27 - 47% and not contained as chromite; moreover, such cumulate - complex rocks as dunite, wehrlite, and gabbro which associate with chromitite are not present in this area. These factors make it highly unlikely that the Pasaman Area could contain chromite deposits of economic value.

PART ONE

INTRODUCTION

CHAPTER 1 OUTLINE OF SURVEY

1-1 Introduction

Cooperative Mineral Exploration projects in the Republic of Indonesia were conducted in Northwestern Sulawesi (1970 - 1974), in Central Kalimantan (1975 - 1978), and in West Kalimantan (1979 - 1981), and these three projects have made possible the compilation of extensive fundamental materials on the exploration of metallic mineral resources. Moreover, these surveys have contributed to the improvement of the survey techniques employed in projects by the Geological Survey of Indonesia and the Directorate of Mineral Resources of Indonesia, as well as having amassed a body of data on geological and mineral resources.

The Ministry of Mines and Energy of the Republic of Indonesia delivered to the Japanese Government a proposal for a new cooperative survey on metallic mineral resources in Northern Sumatra, and requested that the Japanese Government execute the survey. The Japanese Government responded to the request by dispatching a preliminary survey mission headed by Shōzō Sawaya of the Metal Mining Agency of Japan in July 1982. The survey mission conducted preliminary investigations as to the proposed survey sites, and, after discussions with the Directorate of Mineral Resources of the Indonesian Ministry of Mines and Energy, which is in charge of the project as the Indonesian counterpart, three sites were agreed upon as subject areas for the survey: Matapang (169 km^2), Muara Sipongi (400 km^2), and Pasaman (200 km^2), all in northern Sumatra.

Both sides agreed to conduct a geological and geochemical survey in the three areas with the aim of discovering promising areas of mineralization.

1-2 Survey Schedule and Survey Mission Members

1-2-1 Survey Planning and Consultation

A survey mission with the following schedule was dispatched to Indonesia in order to participate in preliminary field surveys and discussions required for the planning of Northern Sumatra Cooperative Mineral Exploration Survey, and to engage in planning sessions for the First Phase.

(1) Schedule for Field Planning and Consultation

7 July 1982 to 20 July 1982

(2) Survey mission members

Japan:	Leader	Shōzō Sawaya (M M A J)	
	Members	Masahiro Nagai (Agency of Natural Resources and Energy (M I T I)	
		Ken Nakayama (M M A J)	
		Tadaaki Ezawa (J I C A)	
Indonesia:		Prof. Dr. J. A. Katili	Director General Directorate General of Mines Ministry of Mines and Energy
		DIRECTORATE OF MINERAL RESOURCES :	
		Ir. Salman Padmanagara	Director
		Drs. Djumhani	
		Drs. Juliar Thaib	
		Ir. P.E. Silitonga M.Sc	
		Ir. Subandoro	
		Ir. Yaya Sunarya	
		Dra. Ellya Daman	
		Dra. Ratnawiduri S	

1-2-2 The First Phase Survey

The First Phase Survey was carried out from 20 August 1982 to 10 February 1983.

(1) Period of field survey

Geological and geochemical surveys: 24 August 1982 - 6 November 1982

Data processing in Indonesia: 7 November 1982 - 6 December 1982

Members of Survey Team

(a) Planning and Consultation

Indonesia	Japan
Ir. Salman Padmanagara Director (D M R)	Ken Nakayama (M M A J)
Ir. P.H.Silitonga (D M R)	
Ir. Yaya Sunarya (D M R)	

(b) Survey Team

Indonesian Team		Japanese Team	
Coordinator		**Survey leader**	
Ir. Yaya Sunarya (D M R.)		Sakae Ichihara (M M A J)	
Members		**Members**	
Suryono Msc	(D M R)	Hideo Suzuki	(M M A J)
Ir. Yan S. Manurung	(")	Haruo Watanabe	(")
Adin Simbolon	(")	Osamu Miyaishi	(")
Deddy T. Sutisna	(")	Mitsuru Suzuki	(")
Johnny R. Tampubolon	(")	Ikuya Hamada	(")
Danny Z. Herman	(")		
Sukmana	(")		
Hotma Simangunsong	(")		
Zulkifuli	(")		
Ir. Syamsuriezal Syafei	(R.O. Medan)		
M. Barus	(")		
Benteng Purba	(")		

Assistant

Atun Suryana	(")
Wachju III	(")
Mamat M.	(")

D M R :	Directorate of Mineral Resources
R.O. Medan:	Regional Office of Medan, Ministry of Mines and Energy
M I T I :	Ministry of International Trade and Industry
J I C A :	Japan International Cooperation Agency
M M A J :	Metal Mining Agency of Japan

CHAPTER 2 OUTLINE OF SURVEY AREA

2-1 Survey Sites

The following three sites were selected for the Northern Sumatra Cooperation Mineral Exploration Survey (Fig. I-1).

a) Hatapang

The Hatapang survey site is situated approximately 2°10' North Latitude by 99°37' East longitude and covers an area of 169 km^2 (13 km x 13 km). Tin and Tungsten ores are the subjects of the survey. (Fig. I-2)

b) Muara Sipongi

The Maura Sipongi survey site covers 400 km^2 and is bounded by the following coordinates (40 km EW x 10 km NS):

North latitude	0°30'	East longitude	99°38'
"	0°40'	"	99°38'
"	0°30'	"	100°02'
"	0°40'	"	100°02'

Gold, silver, copper, lead, and zinc ores are the subject of the survey. (Fig. I-3)

c) Pasaman

The Pasaman survey site is situated approximately 0°13' North latitude by 99°58' East longitude and covers an area of 200 km^2 (7 km x slightly less than 30 km). Chromite is the subject mineral of the survey. (Fig. I-3)

2-2 Previous Surveys

During the period of Dutch colonization, surveys were conducted in northern Sumatra by Schirman (1930), Bemmelen (1932, 1939), Westenveld (1947), Vanden Manal (1941, 1947, 1948), and Druif (1932, 1934, 1939), mainly in the Aceh, Medan, and Toba areas. The geology, geological structures, and mineral resources of these areas are covered comprehensively by Bemmelen in his Geology of Indonesia (1949). Geological maps have also been compiled in 1/1,000,000 and 1/250,000 scale.

The first integrated geological survey of all of northern Sumatra was conducted from 1975 through 1980 by a cooperative team composed of members from Indonesia (GSI · DMR) and Great Britain (IGS). The team performed regional geological and geochemical surveys. The project shed light upon the geology and geological structure of northern Sumatra and resulted in the discovery of a number of areas containing ore deposits. The results of the survey have been published in the form of a series of 1/250,000 scale geological maps by the Geological Research and Development Center (formerly the Geological Survey of Indonesia) of the Ministry of Mines and Energy.

Extensive research involving investigation of the geological structure of northern Sumatra from the standpoint of the plate tectonics theory has been published by Katili (1968 - 1982), Hamilton (1978), Cameron (1980), and others. These efforts have resulted in an ever-increasing clarification of the history of the geological tectonics of northern Sumatra.

In 1970, the Overseas Resources Development Co., Ltd. conducted surveys on the metallic mineral resources of the Kotanopan - Muara Sipongi areas of the southern Tapanuli region, which have long been known for their gold, copper, lead, and zinc ore deposits. Also known, among others, are the zinc ore mineralization zones of the Rokop region and the porphyry copper deposits (Tangse) and tin and tungsten mineralizations (Hatapang) discovered by the Indonesian - British Cooperative Survey team. P.T. Tambang Timah of Indonesia · Rio Tinto Group is now conducting surveys and prospecting works on the Tangse porphyry copper deposits.

The survey area for the present northern Sumatra Survey project was selected after a thorough consideration of the results of previous surveys, particularty those obtained from the Indonesian - British Cooperative Survey, the Overseas Mineral Resources Development Co., Ltd. survey, and some others. The total area of the three survey areas chosen is 769 km^2.

2-3 Conditions in the Survey Areas

2-3-1 Transportation

The Sumatra Traverse Road runs 880 km between Medan in North Sumatra Province and Padang in West Sumatra Province, connecting the three survey sites and making them easily accessible to one another (Fig. I-1).

The Hatapang site is reached by means of the Sumatra Transverse Road via Rantauprapat which lies 285 km south of Medan. The site's base camp, Hatapan Julu, is reached by four-wheel-drive vehicle as far as Monton Julu (16 km) and by foot for the remaining 8 km to the Hatapang base camp.

The Sumatra transverse Road runs along the northern border of the Muara Sinpongi site; this survey area can also be reached from Kotanopan to Patahajang and from Batas to Limau Manis on unpaved roads. Muara Sipongi is situated 631 km from Medan, while Padang lies 249 km from Muara Sipongi.

Pasaman is accessible by car via the Trans-Sumatra Road by travelling from Panti, 50 km to the south of Muara Sipongi, in the direction of Air Bangis on the West Sumatran Coast for 90 km as far as Air Gadang, Muara Kiawai. At Air Gadang, a ferry is boarded to cross the Pasaman River. The ferry may inoperable during low-water periods, however, thereby hindering the transport of vehicles and machines.

While the above-mentioned main roads can be used to reach the town or village nearest to each of the survey areas, human labor is required to transport the various pieces of survey equipment, camping gear, food supplies and other necessary articles over the footpaths and mountain roads that lead into the actual survey sites.

2-3-2 Field Conditions

Hatapang is located in North Sumatra Province, Muara Sipongi in North Sumatra and West Sumatra Provinces, and Pasaman in West Sumatra Province; each is under the executive juristiction of its respective Provincial Government.

The survey sites are all middle and high altitude areas - 200 m - 1,500 m above sea level - lying within the Barisan Mountain Range which runs longitudinally, like a spine, up the western part of the Island of Sumatra. Low and middle altitude areas, particularly those lying along main rivers, have already been extensively developed; they contain towns and villages and are largely cultivated, mainly with rice. There are also extensively developed plantations of coconut palms which are grown for their oil. Mountain and upland areas are covered with dense tropical rain forest, and travel by means other than road, mountain path, and river is difficult.

The region's climate is tropical with high temperatures and high humidity. The dry season lasts from May to August and the rainy season from August to April, according to past precipitation records. Data for Kotanopan show monthly rainfall to be 83 - 168 mm during the May - August dry season and 196 - 284 mm during the September - April rainy season. Average monthly rainfall is 147 mm. Rainfall is heaviest during the months of October and November when 300 mm have been recorded. But although the First Phase Survey was conducted during the rainy season months of September and October, almost no rain fell and drought conditions prevailed. This is thought to have been due to the effects of recent unusual climactic conditions throughout the world.

While temperatures remain consistently high in the lower altitudes, the higher regions experience falling temperatures at night, making the use of sleeping bags a necessity. Tigers and monkeys inhabit the forests, and fresh tiger tracks were discovered at Pasaman. The lowland areas are also home to numerous mountain leeches and poisonous grasses, and malaria is common.

CHAPTER 3 GEOLOGICAL OUTLINE OF NORTHERN SUMATRA

From 1975 through 1980, the Indonesian - British Cooperative Survey team conducted an integrated geological survey over a wide expanse of northern Sumatra covering some 190,000 km^2. The results of this survey have been reported in numerous research papers, and new material continues to be published in the form of a series of 1/250,000-scale geological maps. The following outline of the geology of northern Sumatra is based on these materials. (Fig. I-4)

The oldest strata known to exist in northern Sumatra are the Permian - Carboniferous system Tapanuli Group, which is made up of the Kluet Formation which is intercalated with thin layers of mudstone and siltstone in quartz arenite; the Bohorok Formation, composed of unsorted conglomerate wacke (pebble mudstone) which is contemporaneous heterotopic facies interfingered with the Kluet Formation and the Alus Formation which accompanies mainly limestone which covers the Kluet Formation. These are distributed in the Barisan Mountains and their eastern environs.

The Upper Permian - Triassic system Peusangan Group, which overlies the Tapanuli Group, is made up of the Silungkang Formation composed of semi-continental basic volcanic rock and Fusulina lime-stone, and the Kualu Formation composed of Triassic limestone, radiolarion chert, wacke sandstone, and siltstone. Kualu Formation overlies unconformably the Tapanuli Group and the Silungkang Formation.

The Silungkang Formation is distributed along the Takengkan tectonic line in central Aceh as well as in the Muara Sipongi region, and is correlative with the Silungkang Formation found south of the Equator (Silitonga, Kastowo; 1975). The Kaulu Formation is distributed within the slopes of the Barisan Mountains from Rankauoranat to Parapat.

The Upper Jurassic-Cretaceous system Woyla Group is made up of wacke, slate, and limestone in its lower member; basic an intermediate volcanic rock in its upper member and opholite, consisting of ultrabasic rock and radiolarian chart regarded as products of a marginal sea. They are distributed in the Ache and Natal regions.

During the Cenozoic era there was periodic volcanic activity, during which most of the sedimentary basins were formed. Among these basins are the Central Sumatran Basin, the North Sumatran Basin. the Northwest Ache Basin, and the West Sumatran Basin. In the Pleiocene epoch there were eruptions of large quantities of Toba tuff, mainly in the Toba subsidences where a great deal of magma had been discharged in the rift valleys that were formed by geoanticlinal movement. This Toba tuff is distributed over a wide area.

Igneous activity involved the intrusion of granitoid rocks during the Palaeozoic era, the Triassic period, the Jurassic-Cretaceous period, and the Tertiary era, resulting in copper, lead, and zinc replacement deposits by Jurassic granitoid rock, tin and tungsten mineralization by Cretacious granites and porphyry copper deposits by Tertiary intrusion.

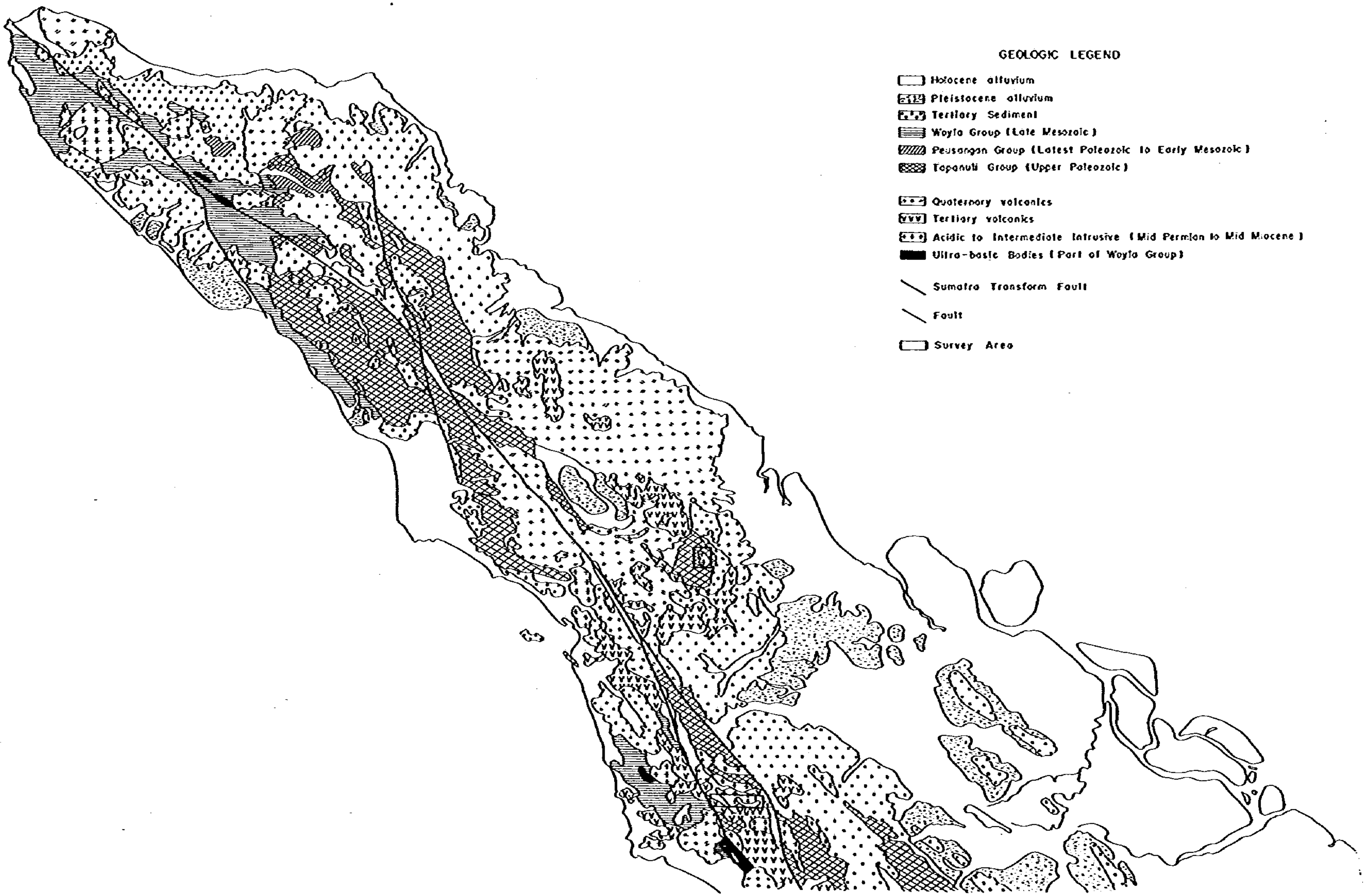


Fig I-4 Geological Map of Northern Sumatra (DMR / IES, 1980)

PART TWO

HATAPANG AREA

CHAPTER 1 - OUTLINE

1-1 Purpose of the Survey

This survey was intended to elucidate the relationship between granitic activity and the mineralization of tin and tungsten in the Hatapang granite intrusion and its marginal regions, and to study tin and tungsten concentrations and their concentrating process.

1-2 Previous Surveys

From 1975 through 1980, the Indonesian (DMR) - British (IGS) Cooperative Survey was conducted over a wide region of northern Sumatra. As part of this project, a geochemical survey was carried out on tin and tungsten, mainly from Hatapang granite, revealing the presence of tin and tungsten anomalous areas in that region. In addition, a continuing survey by the Mineral Resources Agency has discovered indications of cassiterite around the Hatapang River and the Batu Jongjong River basins (Clark and Suryono; 1982).

1-3 Survey Methods and Quantities

(1) Geological Survey

Topographical maps in 1/100,000 scale were enlarged to produce a topographical map in 1/25,000 scale. This was used in conducting a geological survey of areas lying alongside major rivers, and 1/25,000 - scale geological maps were compiled. The survey route covered a total of 141km.

(2) Geochemical Survey

Along with the geological survey, four samples of stream sediment from each 1 km of the major rivers were collected for the geochemical survey. The samples were divided into three portions and kept for analysis by the Japanese group and the Indonesian DMR and MRO. A total of 571 samples was collected, including preparatory samples. Of the total, 540 were used; these were analyzed for the elements tin, tungsten, molybdenum, fluorine, and arsenic as path-finders. The Indonesian DMR also analyzed for additional elements indicating copper and zinc.

(3) Tin and Tungsten Ores Placer Survey

A survey was conducted in order to determine the presence of cassiterite and tungsten ore placer contained in stream sediment. In order to seek out areas of tin and tungsten mineralization in the survey area, samples of heavy minerals were collected at the same points at which samples were collected for the geochemical survey. A total of 570 samples was collected. Cassiterite and tungsten ores were selected from the heavy menerals in order to trace the location of mineral regions.

(4) Other Items

The following samples were collected and analyzed for the survey by microscopic examination and chemical analysis: thin sections of rock (33 samples); polished sections of ore (12 samples); igneous rocks for age determination (3 sanples); rock analysis (31 samples); ore analysis (11 samples); and X-ray analysis (5 samples).

CHAPTER 2 GEOLOGY

2-1 Geological Outline

Permian and Carboniferous pebbly sandstone and mudstone (the Hatapang Formation) are widely distributed throughout the survey area, with intrusions of Late Cretaceous Hatapang biotite granite. The intrusion of Hatapang biotite granite caused thermal alterations in the Hatapang Formation resulting in hornfels. The Hatapang Formation is correlative with the Bohorok Formation of the Indonesian-British Cooperative Survey.

From the late Tertiary period through the early Quaternary period, volcanic activity in Toba caused by the great subsidence of Lake Toba resulted in pyroclastic rock (Toba tuff), sedimentized mainly around Lake Toba, overlying the Hatapang Formation and Hatapang granite along the rivers in the survey area. (PL II-1, 2)

Fig. II-1 shows a columnar section of the stratigraphic and geological structure, and igneous activity, of the survey area.

2-2 Geology

2-2-1 Sedimentary and Pyroclastic Rock

(a) Hatapang Formation

The Hatapang Formation found in this region is composed of poorly sorted shale, siltstone, and fine-grained sandstone and contains breccia and sub-breccia.

Rock facies: Black to dark gray shale is prevalent in the upper regions of the Kota Batu River in the western and north-western part of the survey area, and slate having fissility can be seen as well. Under microscopic observation (AR 15), the rock is poorly sorted siltstone containing grains of quartz and feldspar (0.3 mm in diameter) in the silt matrix. (Photo II-1)

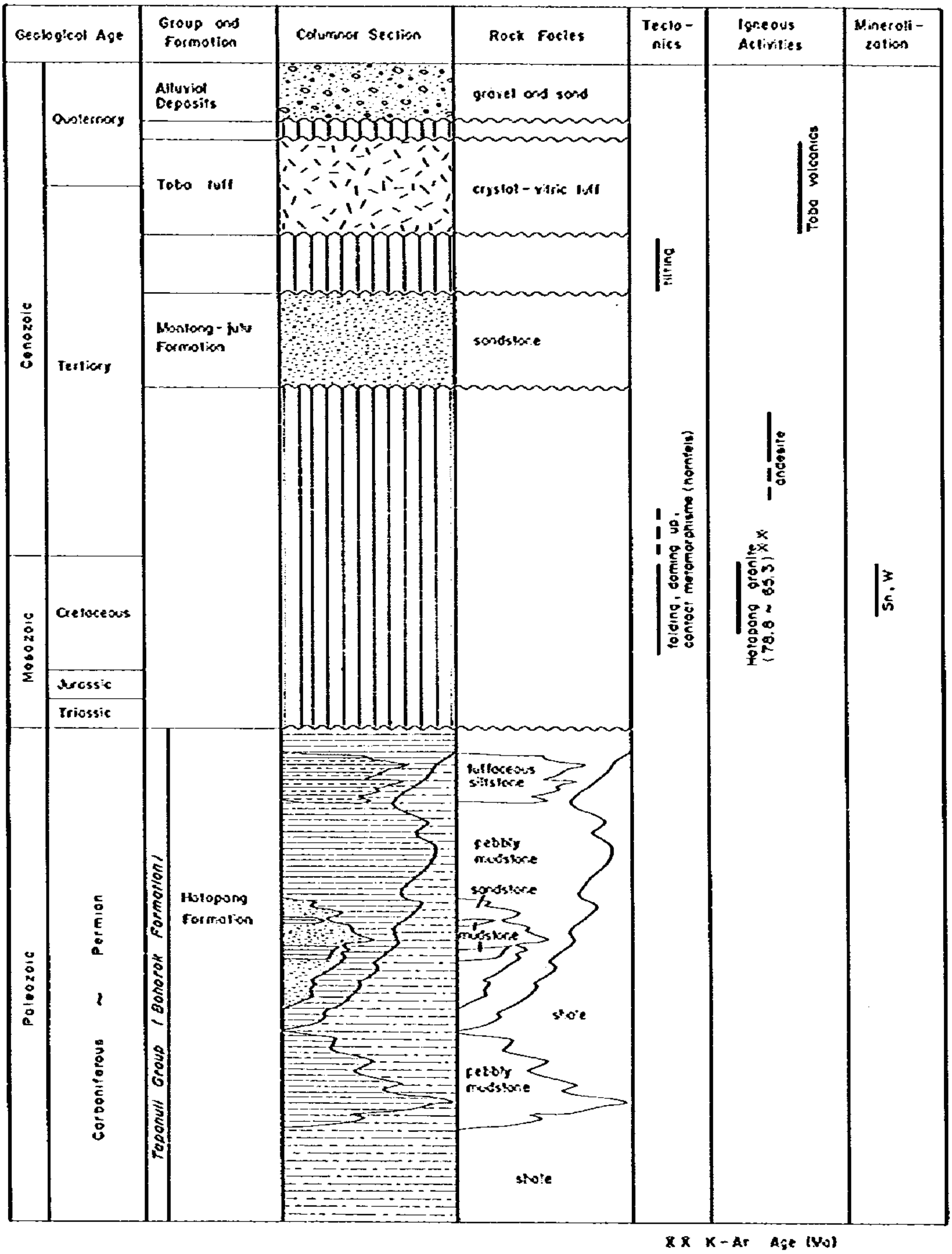


Fig. II-1 Generalized Stratigraphy of Hatapang Area

The Hatapang and Hasisi regions of the survey area are composed of pebbly mudstone universally containing small quantities of granite, sandstone, and mudstone breccia and sub-breccia (0.5 - 2 cm in diameter) and quartz and plagioclase flakes, which the southern region is composed of clear pebbly sandstone and siltstone. The mudstone and sandstone show interfinger relations.

A field survey in the downstream Batu Jongjong River region found tuffaceous rocks suggesting that the Hatapang Formation may contain a certain amount of pyroclastic rock.

Stratigraphic relationship: This Formation was determined by the Indonesian-British Cooperative Survey team to belong to the Bohorok Formation of the Tapanuli Group, in correlation with the Permian-Carboniferous System. The Formation is estimated to be over 3,500 m thick at the Mondou River.

Metamorphism: This Formation was intruded by Hatapang biotite granite during the late Cretaceous period, and within some 1 - 2 km from the points of contact is composed of hard, massive rocks of hornfels. A considerable amount of secondary biotite and quartz is visible under the microscope (Photo II-1) .

(b) Montong Julu Formation

This Formation is distributed at the Montong River in the northeast corner of the Area, and consists of pale green sandstone. The Formation is tentatively correlated with the Tertiary System, because the Formation inconformably overlies the Hatapang Formation and is overlain by the Tobo Tuff Formation.

(c) Toba Tuff Formation

Distribution: This is distributed along the lower reaches of the Kota Batu and Hatapang Rivers and their tributaries in the northern part of the survey area,and may occasionally form small plateaus.

Rock facies: These are made of light brown dacite tuff, a vitreous, crystal tuff which under the microscope reveals biotite and quartz fragments as well as small quantities of accidental lithic fragments. In some parts of the Pengalan River, in the upper reaches of the Kota Batu River, the rocks are composed of conglomeratic tuff containing pebbles of mudstone, granite, and other rock.

Stratigraphic relationship: This was found to be tuff which accompanied the Toba volcanic activity of the Pliocene and Pleistocene epochs of the late Tertiary - early Quaternary periods, unconformably overlying the Hatapang Formation.

2-2-2 Igneous Rock

(a) Hatapang Biotite Granite

Distribution: Hatapang biotite granite is distributed over an area 6 km EW by 8 km NS in the upper reaches of the Kota Batu, Hatapang, and Batu Jongjong Rivers in the central part of the survey area. A large amount of the same type of biotite granite is also found in the form of dikes around the main granitic stock.

Rock facies: Hatapang biotite granite is composed of coarse- to medium-grained biotite granite containing large porphyritic feldspar crystals, medium-grained and equi-granular biotite granite without porphyritic feldspar crystals, and fine-grained two mica granite.

Porphyritic biotite granite is the principal component of the Hatapang granite, comprising its central, eastern and southern portions. The equi-granular biotite granite is distributed along its western margin, namely along the Kota Batu River. Microscopic examination reveals both types to consist of plagioclase, potassic feldspar, quartz, and biotite. They are shown by mode counting to contain almost equal quantities of plagioclase and potassic feldspar, and are classified as granite (adamellite). Other minerals found universally attendant include topaz, fluorite, and zircon as accessory minerals.

Fine-grained two mica granite is distributed in the northern and eastern parts of the Hatapang granite, in the upper reaches of the Hatapang River, and north of Hajoran on the Kota Batu River. This rock intruded irregularly as dikes within porphyritic granite and equi-granular granite. It occasionally indicates heterogeneous parts of porphyritic or equi-granular granite, for example in northern Hajoran on the upper Kota Batu River. The two mica granite contains more tin than porphyritic and equi-grained granites as a minor element. This suggests that intrusion took place at the latter stage of the period. Observation under the microscope reveals the main rock-forming minerals to be plagioclase feldspar, potassic feldspar, quartz, and biotite; these are accompanied by muscovite, topaz, and fluorite as accessory minerals.

Intrusion period: Hatapang biotite granite altered the Hatapang Formation of the Permian - Carboniferous period, and is found as pebbles in the Toba Tuff Formation. Their ages were determined to be 76Ma - 78Ma by the K-Ar method indicating that their intrusion occurred in the late Cretaceous.

(b) Aplite and Pegmatite

Fine-grained white aplite intruded in the Hatapang granites and Hatapang Formation as dikes. The areas of aplite distribution are the upper reaches of the Batu Jongjong and Kota Batu Rivers. Microscopic examination (AR-6) reveals it to be composed of quartz, plagioclase, and potassic feldspar, accompanied by fluorite and sphane as accessories. Age determination was performed by the K-Ar method and found to be 65Ma; the dikes are from the latest stage of Hatapang granite, indicating late Crataclous in age.

Veins of pegmatite, accompanied by tourmaline, have been found in regions neighboring the Hatapang granite stock and with the small Hatapang granite dikes in those regions.

CHAPTER 3 CHARACTERISTICS OF HATAPANG GRANITE

3-1 Time of Intrusion

In order to determine the period in which the Hatapang granites intruded, three samples were selected and tested by the K-Ar method of age determination. One sample (CR-7) was selected from Hatapang Julu, one (ED-1) from the upper reaches of the Batu Jongjong River (both of these were porphyritic biotite granite), and one (AR-6) from aplite regarded as being the last intrusion of the Hatapang granite. Age determination was performed on biotite in the first two cases and on the whole rock in the last because it contained no biotite or horblende.

As shown in Table II-1, the determination proved the age of porphyritic biotite granite to be 78.8Ma and 76.2Ma and the age of the aplite to be 65.3Ma, indicating the time of intrusion to have been in the Late Cretaceous period. Hatapang granite is similar to Phuket tin-bearing granite which is located at the westernmost marginal of the Thailand - Malaysia - Indonesia tin mineralozation zone; they are porphyritic granite (adamellite) and indicative of the Late Cretaceous instrusions among the tin mineralozation zone. (Mitchell 1979, P. Nutalaya 1979, Ishihara 1979) This suggests that the Hatapang biotite granite is a southern extension of the tin-bearing granite zone of the Phuket - Phingnga - Krabi regions of southern Thailand. This relationship is illustrated in Fig II-2. (After Mitchell 1976, 1979)

3-2 Magnetic Susceptibility

An attempt has been made to classify granite into the ilmenite series which accompanies tin mineralization and the magnetite series which accompanies phorphyry copper mineralization (Ishihara 1977). Measuring the magnetic susceptibility of rock

Table II-1 Result of K-Ar Age Determination in Hatapang Area

No.	Sample No.	Locality	Rock Name	Mineral or Rock	40Ar/Rad sec/gm x 10^{-5}	4Ar/Rad %	K%	Age (m.y.)
1	AR-6	S. Manungal	Aplitic rock	Whole Rock	1.09 1.10 1.10	85.7 86.4 88.0	4.24 4.25	65.3±2.6
2	CR-7	A. Hatapang	Granite	Biotite	2.32 2.33 2.47	83.8 81.3 83.6	7.52 7.63	78.8±3.2
3	ED-1	A. Batujonjon	Granite	Biotite	1.73 1.79	76.0 80.1	5.79 5.85	76.2±3.0

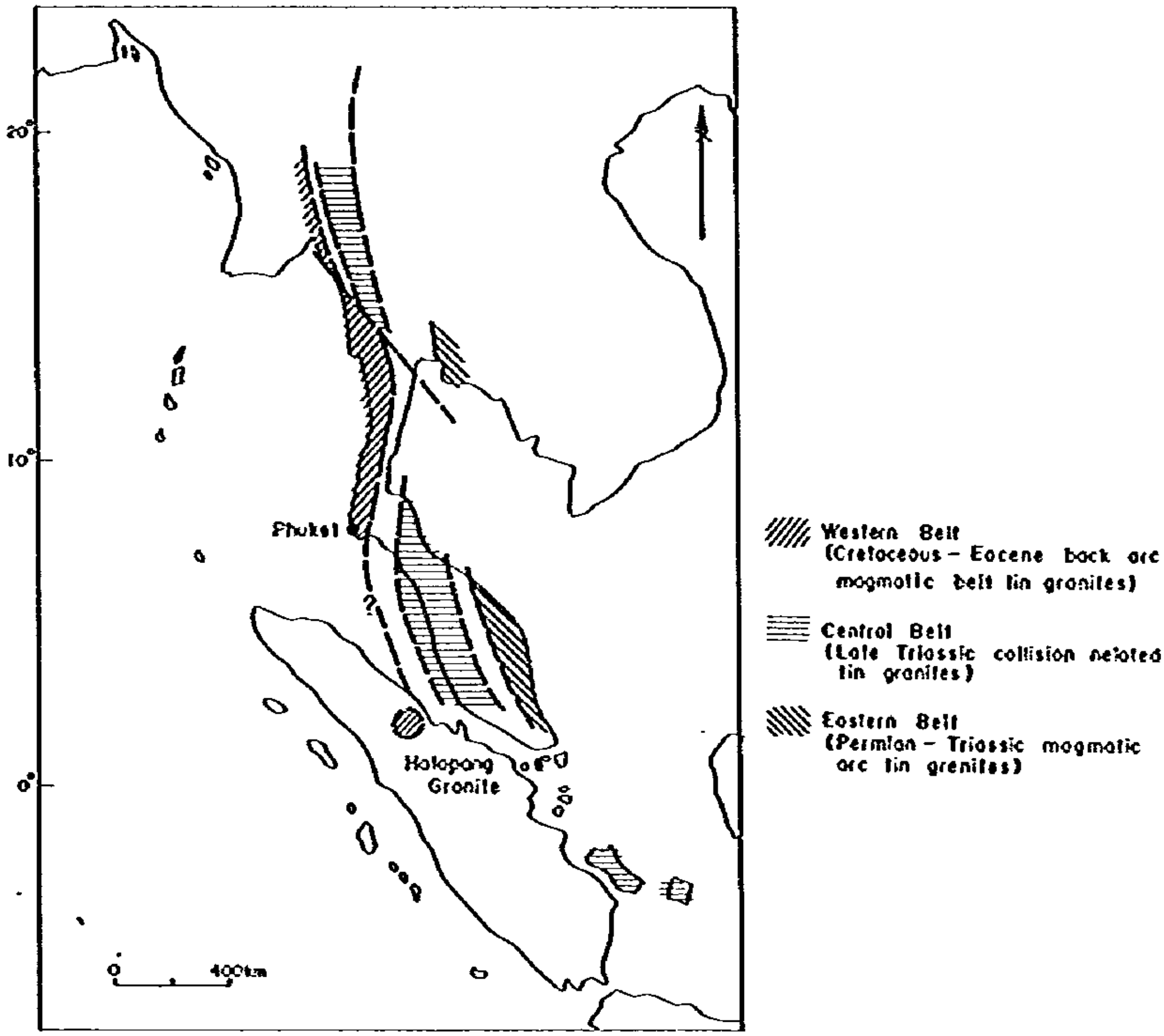


Fig. II-2 Possible Relationship with Hatapang Granite and Tin Belt Granites of Southeast Asia (modified from Mitchell 1979)

is a means by which the two series of granite may be classified. In the present case rock samples cut to 6 cm x 4 cm x 2 cm in size were used and tested for magnetic susceptibility with a Kappameter KT-5. Twenty-four samples were used in the test. The test results were 17 ∿ 1 × 10^{-5} SI units (average 4 × 10^{-5} SI units). Because the measured size of the samples was very small the error in their measurement value would normally need to be recalculated. However, since the measured figure is an extremely low 4 × 10^{-5} SI units, and the value for the granite at the division between the magnetite series and the ilmenite series is 40 × 10^{-3} SI units, it can be clearly concluded that Hatapang granite is of the ilmenite series.

3-3 Chemical Composition

Thirty-one rock samples were collected, as uniformly as possible, from the granite stock and such main and minor elements as tin, tungsten, molybdenum, fluorine, and lithium were analyzed. The samples collected included 12 from fine-grained two mica granite, 17 from porphyritic biotite granite, 1 from aplite, and 1 from pegmatite. Table II-2 shows the results of the analysis and gives the norm constitution of mineral calculated from the analysis results.

The Hatapang granites contain 73% - 77% SiO_2, and the differentiation index (the norm minerals quartz + albite + potassic feldspar) is most commonly 92 or above, making these acidic granite with high differentiation. The average grade of tin granite (Stomprokskovor; 1974) has been included for reference in Table II-2; the Hatapang granite is similar in the average grade.

Hatapang granite is plotted in the granite (adamellite) region on a modal and normative diagram of quartz - plagioclase (anorthite + albite) - potassic feldspar, showed in Fig. II-3,

Table II-2 Chemical Composition of Constitution Mineral of Granitic Rocks in Matapan Area

		1	2	3	4	5	6	7	8	9	10	11
	Sample No.	AR-10	BR-4	BR-16	BR-18	CR-7	CR-13	CR-21	ED-1	ER-15	ER-45	ER-50
	Location	Trench of [illegible]	A.Maunong	A.Kilibu-ng	A.Batu-jongjong	A.Hata-pang	A.Hata-pang	A.Hata-pang	A.Batu-jongjong	A.Merdua	A.Batu-jongjong	A.Batu-jongjong
	Rock Name	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr
Chemical Composition	SiO_2	73.94	77.55	75.82	75.73	75.30	74.26	75.46	76.05	76.37	75.48	75.54
	TiO_2	0.07	0.09	0.03	0.01	0.09	0.20	0.06	0.10	0.07	0.07	0.06
	Al_2O_3	12.91	12.64	12.95	13.49	13.12	13.62	12.81	12.40	12.98	13.03	13.45
	Fe_2O_3	0.16	0.24	0.12	0.01	0.18	0.28	0.20	0.12	0.19	0.18	0.14
	FeO	0.94	0.86	1.22	0.58	1.08	1.15	1.15	0.95	0.72	1.01	0.79
	MnO	0.03	0.03	0.03	0.02	0.04	0.03	0.02	0.01	0.01	0.04	0.01
	MgO	0.10	0.09	0.10	0.02	0.10	0.26	0.11	0.06	0.08	0.11	0.01
	CaO	0.61	0.25	0.80	0.44	0.73	0.95	0.70	0.79	0.75	0.71	0.60
	Na_2O	3.75	3.24	3.57	3.83	3.55	3.55	3.97	3.46	3.77	3.67	4.03
	K_2O	4.77	5.24	5.12	5.20	5.14	4.92	5.28	4.62	4.85	5.17	4.75
	P_2O_5	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02
	BaO	0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01
	LOI	0.82	0.69	0.84	0.58	0.68	1.09	0.83	1.06	0.74	0.78	0.79
	Total	98.14	100.96	100.69	99.95	98.97	100.34	100.62	99.65	100.57	100.35	100.21
	F	3350	1500	4650	2100	3850	4900	4650	3250	2650	4550	350
	Cl	200	<400	500	400	100	100	500	200	400	300	300
	Li	190	125	185	65	225	135	190	130	35	160	95
	W	21	24	12	33	18	17	17	170	20	6	15
	Sn	1	1	2	3	5	10	3	5	2	5	4
	Mo	1	1	1	8	1	1	1	2	1	1	1
C.I.P.W Norm	Q	33.79	37.45	32.73	32.19	32.54	32.88	30.09	35.86	33.74	31.98	32.12
	or	28.19	30.97	30.26	30.73	30.38	29.08	31.2	27.3	28.66	30.55	28.07
	ab	31.71	27.4	30.19	32.39	30.02	28.33	33.57	29.26	31.88	31.04	34.08
	an	2.9	1.11	3.84	2.05	3.49	4.53	1.55	3.79	3.59	3.39	2.65
	c	0.52	1.23	0.13	0.81	0.44	1.12	0	0.32	0.21	0.22	0.65
	di	0	0	0	0	0	0	1.63	0	0	0	0
	hy	1.86	1.58	2.39	1.07	2.09	2.45	1.31	1.68	1.33	2.02	1.29
	mag	0.23	0.35	0.17	0.14	0.26	0.41	0.29	0.17	0.28	0.26	0.2
	il	0.13	0.17	0.15	0.02	0.17	0.38	0.11	0.19	0.13	0.13	0.11
	ap	0.5	0.05	0.05	0.05	0.05	0.05	0.02	0.05	0.05	0.05	0.05
	ol	0	0	0	0	0	0	0	0	0	0	0
	hm	0	0	0	0	0	0	0	0	0	0	0
	Total	99.38	100.32	99.91	99.45	99.44	99.24	99.77	98.62	99.87	99.64	99.42
	Q+Or+ab	93.69	95.83	93.18	95.31	92.94	90.29	94.86	92.42	94.28	93.57	94.27
	D.I.	94.27	95.52	93.26	95.84	93.46	90.98	95.08	93.71	94.40	93.91	94.82
	Group age (my)											

		12	13	14	15	16	17	18	19	20	21	22
	Sample No.	ER-55	ER-57	ER-58	FR-14	FR-16	FR-20-2	AR-16	AR-24	BR-20	BR-22	BR-24
	Location	A.Batu-jongjong	A.Batu-jongjong	A.Batu-jongjong	Trench of [illegible]	Trench of [illegible]	[illegible]	[illegible]	[illegible]	A.Batu-jongjong	A.Batu-jongjong	A.Batu-jongjong
	Rock Name	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	Por-Gr	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr
Chemical Composition	SiO_2	76.17	75.33	76.23	75.42	76.85	76.21	77.18	77.35	75.80	74.79	75.43
	TiO_2	0.09	0.13	0.06	0.06	0.12	0.27	0.03	0.03	0.06	0.02	0.03
	Al_2O_3	13.75	12.96	12.78	13.42	12.34	10.96	12.58	13.10	12.90	14.62	13.60
	Fe_2O_3	0.17	0.32	0.16	0.23	0.40	0.89	0.10	0.16	0.17	0.20	0.35
	FeO	0.36	1.15	0.94	0.72	1.01	2.74	0.79	0.79	1.15	0.50	0.86
	MnO	0.01	0.04	0.03	0.04	0.02	0.07	0.01	0.03	0.03	0.01	0.03
	MgO	0.09	0.17	0.08	0.08	0.11	0.28	0.10	0.02	0.09	0.02	0.06
	CaO	0.19	0.72	0.73	0.77	0.32	0.61	0.43	0.13	0.73	0.39	0.56
	Na_2O	2.88	3.14	3.75	3.77	2.71	2.01	3.04	3.78	3.57	4.26	3.92
	K_2O	5.82	5.22	4.50	4.93	4.98	4.80	5.59	4.95	4.71	4.60	4.55
	P_2O_5	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	BaO	<0.01	0.01	<0.01	0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
	LOI	1.11	0.91	0.74	0.90	0.93	1.29	0.58	0.54	0.94	0.65	0.67
	Total	100.67	100.11	100.03	100.42	99.82	100.16	100.45	100.9	100.18	100.1	99.89
	F	1600	1900	3350	3350	620	3300	2500	1650	4900	2700	3600
	Cl	400	500	400	400	300	600	400	<300	500	300	200
	Li	50	100	185	125	85	285	100	230	135	85	125
	W	22	12	13	16	9	12	16	26	23	193	27
	Sn	2	6	23	7	2	4	3	17	4	3	13
	Mo	3	1	1	1	1	1	1	1	1	1	1
C.I.P.W Norm	Q	36.46	34.56	34.88	32.23	40.63	42.68	36.49	35.62	34.5	31.28	33.33
	or	34.4	30.85	26.6	29.43	29.43	28.37	33.04	29.2	27.84	27.19	26.89
	ab	24.36	26.55	31.71	31.68	22.92	17	25.71	31.97	30.19	36.03	33.15
	an	0.81	3.51	3.49	3.69	1.46	2.9	2	0.52	3.49	1.8	2.65
	c	2.42	0.86	0.46	0.48	1.96	1.4	0.8	1.35	0.65	1.97	1.26
	di	0	0	0	0	0	0	0	0	0	0	0
	hy	0.68	2.26	1.81	1.37	1.72	4.9	1.65	1.39	2.22	0.8	1.66
	mag	0.25	0.46	0.23	0.33	0.58	1.29	0.14	0.23	0.25	0.29	0.22
	il	0.17	0.25	0.11	0.11	0.23	0.51	0.06	0.06	0.11	0.04	0.06
	ap	0.05	0.02	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	ol	0	0	0	0	0	0	0	0	0	0	0
	hm	0	0	0	0	0	0	0	0	0	0	0
	Total	99.6	99.32	99.34	99.57	98.98	99.1	99.95	100.39	99.3	99.45	99.27
	Q+Or+ab	95.22	91.96	93.19	93.54	92.98	88.05	95.24	96.79	92.53	94.5	93.37
	D.I.	95.60	92.59	93.81	93.94	93.94	88.85	95.29	95.41	93.18	95.02	94.06
	Group age (my)											

		23	24	25	26	27	28	29	30	31	Average of Tin Granite of the wared, according to Stemprokskvor (1974)
	Sample No.	CR-11	CR-18	CR-20	CR-24	DR-10	DR-14	DR-25	AR-6	AR-17	
	Location	A.Hata-pang	A.Hata-pang	A.Hata-pang	A.Hata-pang	A.Mabar	A.Mabar	A.Mabar	[illegible]	[illegible]	
	Rock Name	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr	f-g-Gr	Aplite	Pegmatite	
Chemical Composition	SiO_2	75.65	75.22	74.99	75.26	75.24	75.07	73.48	73.62	75.26	
	TiO_2	0.05	0.04	0.07	0.02	0.04	0.07	0.02	0.01	0.01	0.21
	Al_2O_3	13.57	13.62	13.33	13.39	13.47	13.28	15.77	14.93	13.77	13.90
	Fe_2O_3	0.07	0.28	0.20	0.26	0.21	0.45	0.07	0.11	0.22	0.78
	FeO	0.79	0.86	0.86	0.86	0.94	0.94	0.72	0.22	0.50	1.34
	MnO	0.03	0.05	0.02	0.06	0.07	0.03	0.02	0.01	0.02	0.05
	MgO	0.02	0.06	0.14	0.02	0.05	0.06	0.01	0.06	0.09	0.52
	CaO	0.19	0.27	0.75	0.61	0.63	0.79	0.83	1.04	0.30	1.24
	Na_2O	4.03	4.19	4.15	4.77	4.56	3.83	5.27	5.72	2.06	3.28
	K_2O	4.21	4.28	5.20	4.17	4.19	5.07	3.15	4.05	7.81	4.57
	P_2O_5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
	BaO	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	LOI	0.59	0.59	0.77	0.76	0.68	0.83	0.65	0.91	0.56	
	Total	99.22	99.49	100.51	100.22	100.11	100.45	100.03	100.71	100.63	
	F	1750	2250	6500	5000	4550	4450	6050	4300	1950	(3,700 ± 1,500)*
	Cl	100	200	500	100	200	300	300	200	300	
	Li	150	235	145	385	350	195	125	20	70	(200 ± 100)*
	W	40	26	20	18	28	19	18	1	30	(7 ± 3)*
	Sn	93	18	11	91	57	17	5	3	2	(30 ± 15)*
	Mo	1	1	1	1	1	1	2	1	3	(4 ± 2)*
C.I.P.W Norm	Q	35.1	33.25	28.86	29.65	30.6	31.09	28.48	22.88	32.33	
	or	24.88	25.29	30.73	24.64	24.76	29.96	18.62	23.94	46.16	
	ab	34.08	35.43	35.1	40.34	38.56	32.39	44.57	48.37	17.42	
	an	0.81	1.21	2.39	2.82	3	3.79	3.93	3.11	1.36	
	c	2.09	1.65	0	0	0.34	0.11	2.23	0	1.43	
	di	0	0	1.03	0.07	0	0	0	1.63	0	
	hy	1.43	1.57	1.15	1.46	1.78	1.5	1.3	0.36	1.05	
	mag	0.1	0.41	0.29	0.39	0.3	0.64	0.1	0.16	0.32	
	il	0.09	0.08	0.13	0.04	0.08	0.13	0.04	0.02	0.02	
	ap	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
	ol	0	0	0	0	0	0	0	0	0	
	hm	0	0	0	0	0	0	0	0	0	
	Total	98.63	98.94	99.73	99.45	99.47	99.66	99.38	99.8	100.14	
	Q+Or+ab	94.06	93.97	94.69	94.63	93.92	93.44	91.67	95.19	95.91	
	D.I.	95.37	94.98	94.95	95.15	94.42	93.76	92.24	95.38	95.78	
	Group age (my)										

* Specialized Granites Proposed Average Content (ppm) by Tischendorf (1977)

Por-Gr: Porphyritic Granite
f-g-Gr: fine grained Granite

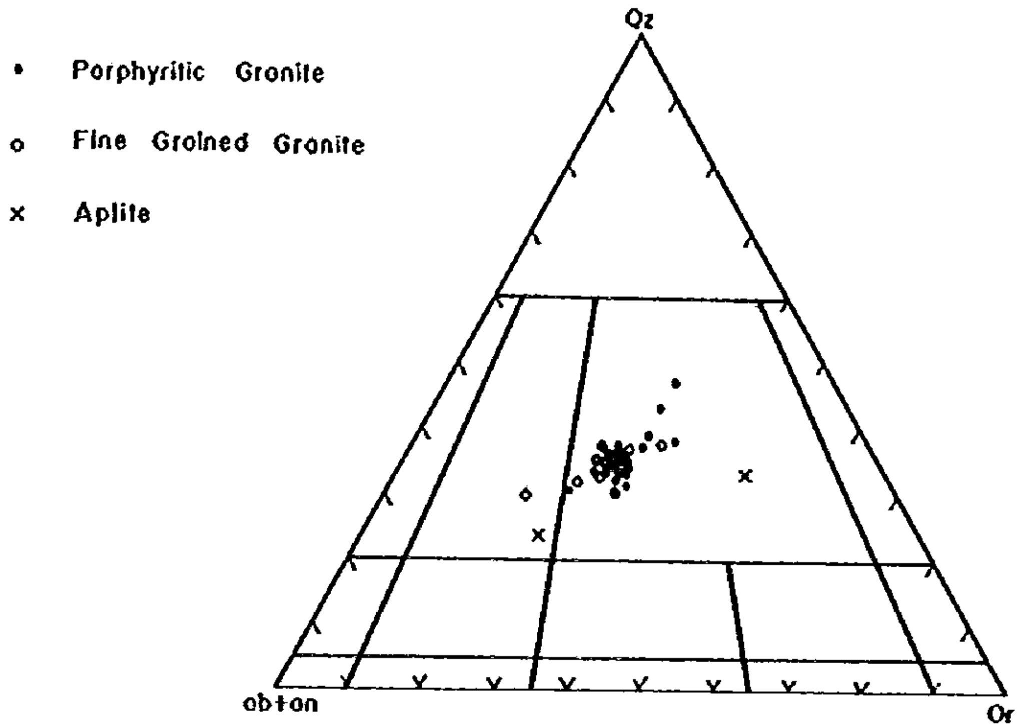


Fig. II-3 Normative Qz-(ab+an)-Or Diagram of Hatapang Granite

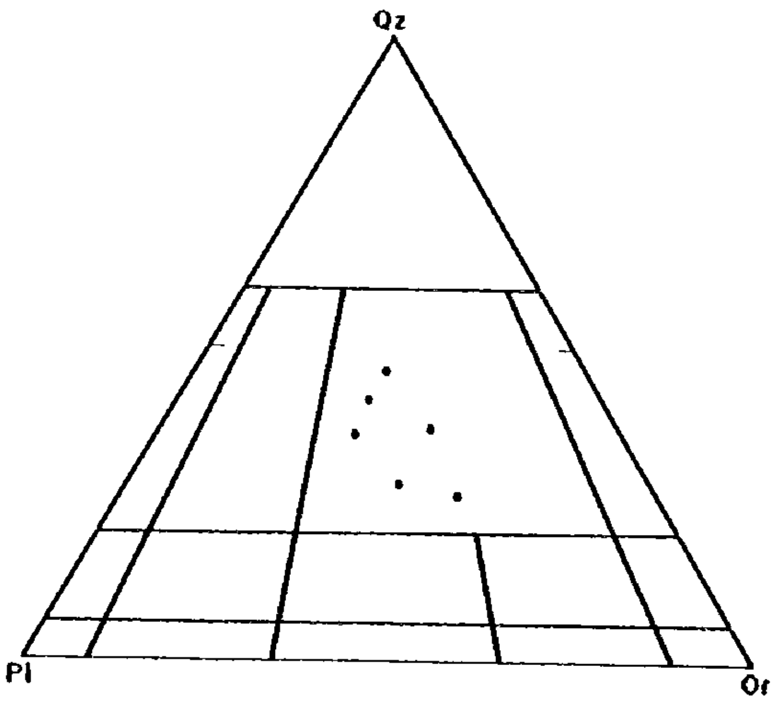


Fig. II-4 Modal Qz-Pl-Or Diagram of Hatapang Granite

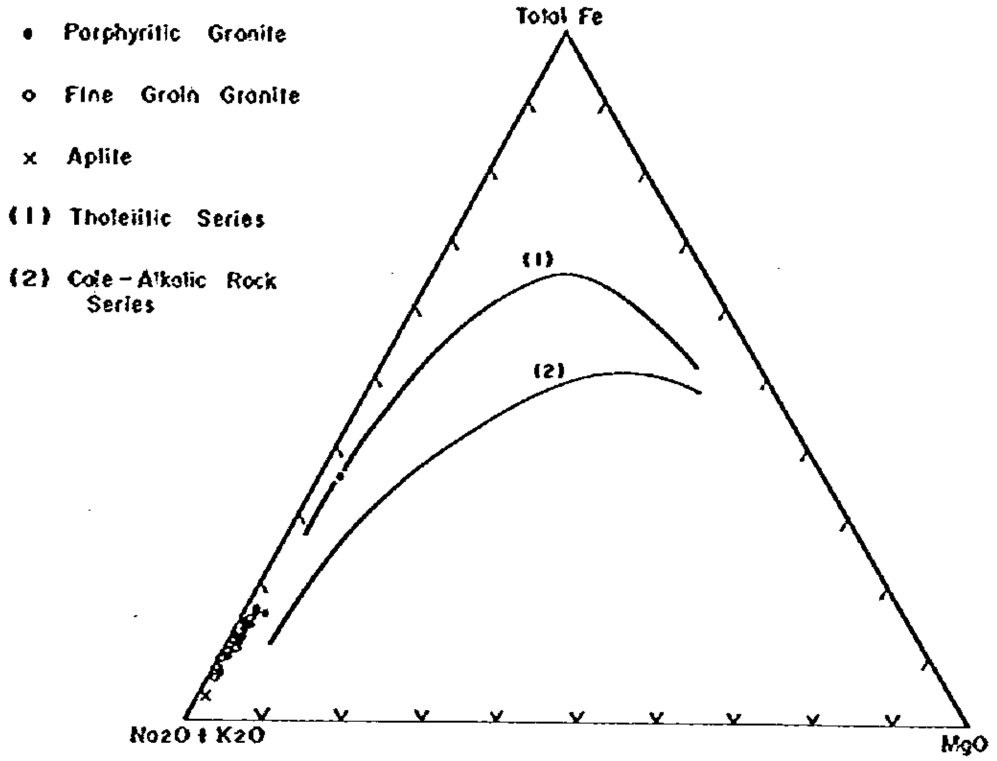


Fig. II-5 MgO-FeO-(Na_2O+K_2O) (mol %) Diagram for Hatapang Granite

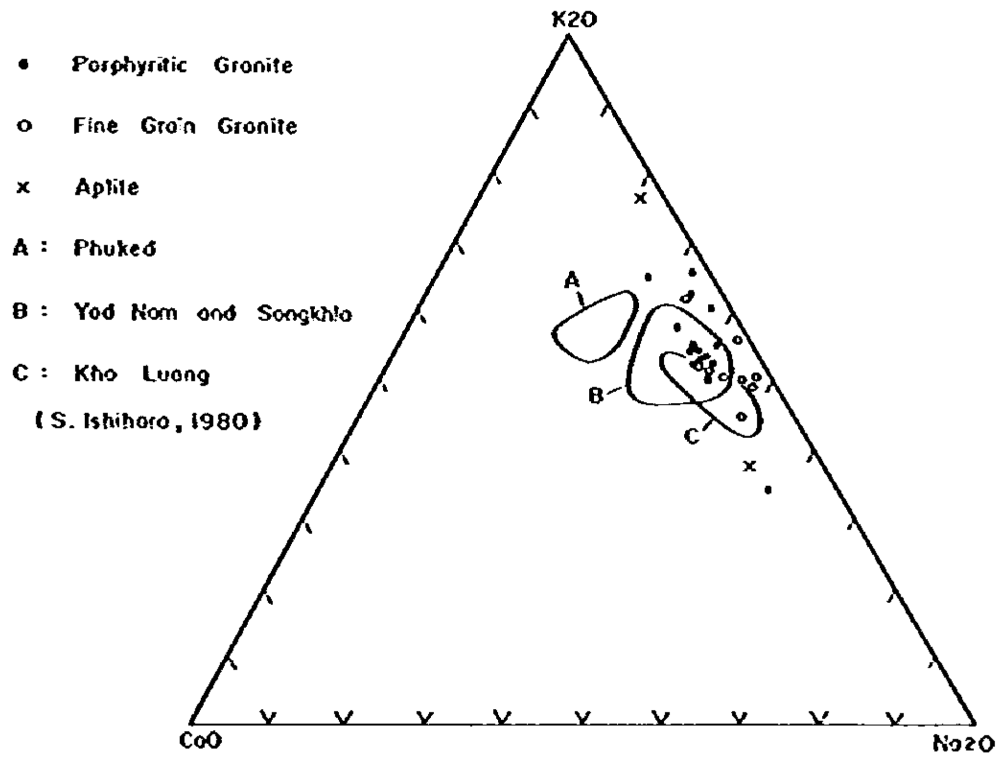


Fig. II-6 Alkali and Lime Ratio of the Hatapang Granites

Fig. II-4

On the M - F - A relationship diagram as well, this rock is almost all differentiated and gathered in the alkali ($Na_2O + K_2O$) corner (Fig. II-5).

The diagram of the relationship between K_2O - Na_2O - CaO shown in Fig. II-6 also shows the Hatapang granite to be low in CaO and to be gathered near the Na_2O line. The example of tin granite from the southern Thai peninsula (S.Ishihara et al. 1980), which has been figured in the diagram for reference, shows the same tendency.

In parallel with analysis of the principal elements, trace elements (tin, tungsten, molybdenum, fluorine, and lithium) were also analyzed. The results of the analysis are described in the following.

(a) Tin and Tungsten

The tin content of Hatapang granite was found to be from 1 ppm to 98 ppm. Three classifications of tin content were examined: 1 - 7 ppm (21 samples); 10 - 23 ppm (7 samples); and 57 - 98 ppm (3 samples). As Tischendorf (1974) determined the tin content contained in normal granites to be 1 - 8 ppm, Hatapang granite containing 10 ppm or more of tin was judged to represent an anomalous value. Pl. II-4 shows granites with a tin content of 10 ppm or more to be distributed over an area extending from the eastern to the northern margin of the Hatapang granite instrusion, with some found around the upper reaches of the Hatapang River. Granite containing at least 10 ppm of tin often tends to be fine-grained two mica granite.

Tungsten values are almost all from 12 ppm to 40 ppm, showing high back ground. Two high value points in tungsten were found at the upper reaches of the Batu Jongjong River, contained in granite with anomalously high values of 170 - 198 ppm. Sample B-22 taken from this area is fine-grained granite, but quartz veinlets have also been identified; such unusual values may perhaps be attributable to the existence of those quartz veinlets.

(b) Fluorine

With the exception of two samples (ER-50: 350 ppm; FR-16: 600 ppm), fluorine content ranged from 1,500 - 5,000 ppm, a high value in comparison with that for normal granite. Tischendorf (1977) stated the value for specialized granites containing tin mineral as 3,750 ± 1,500 ppm (250 - 1,500 ppm for normal granites). Judging from this comparison, the Hatapang granite exhibits the same values as granites containing tin mineral. No special interrelation has been found between fluorine and tin contents (Fig. II-7), but one is seen clearly between fluorine and CaO: this interrelation divides granite into two groups, granite with a higher content of tin tending to also be rich in fluorine (Fig. II-8). This is thought to be due to the fact that granite which is high in tin contains large amounts of fluorite and other minerals. Fluorite and topaz containing fluorine are minerals found universally throughout the Hatapang granite, under microscopic observation. (Fig. II-9, 10, 11)

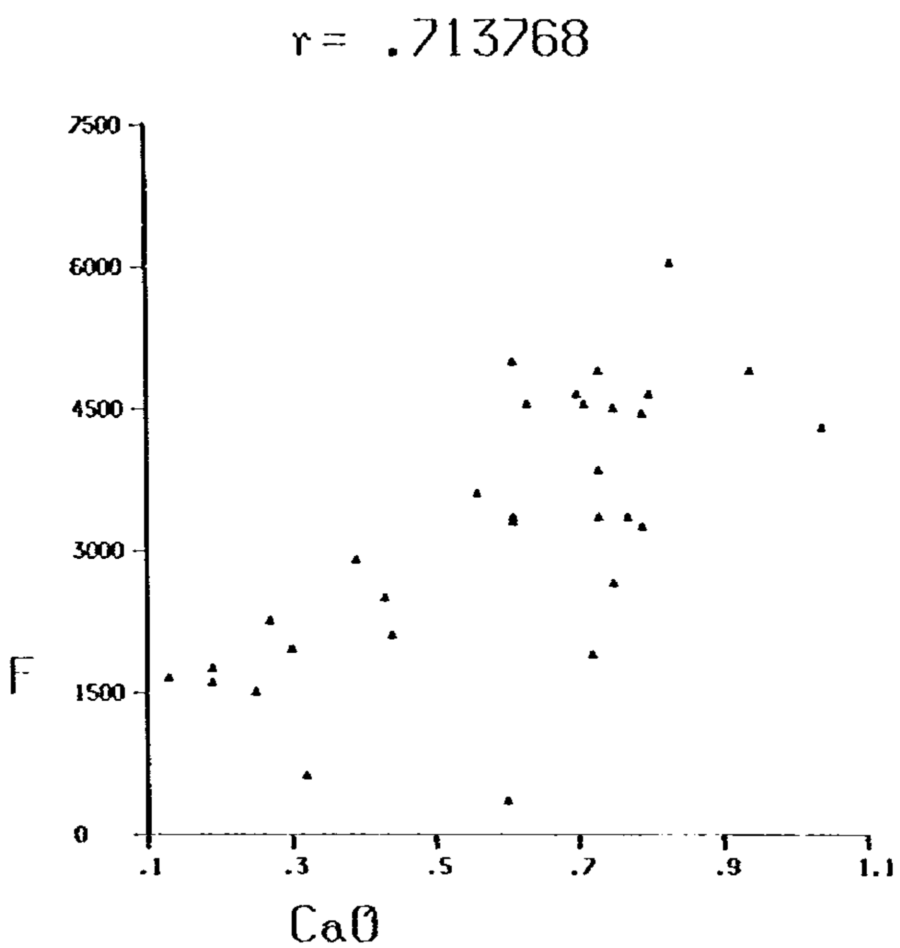


Fig. II-7 Coefficient of Correlation of F and CaO, Hatapang Granite

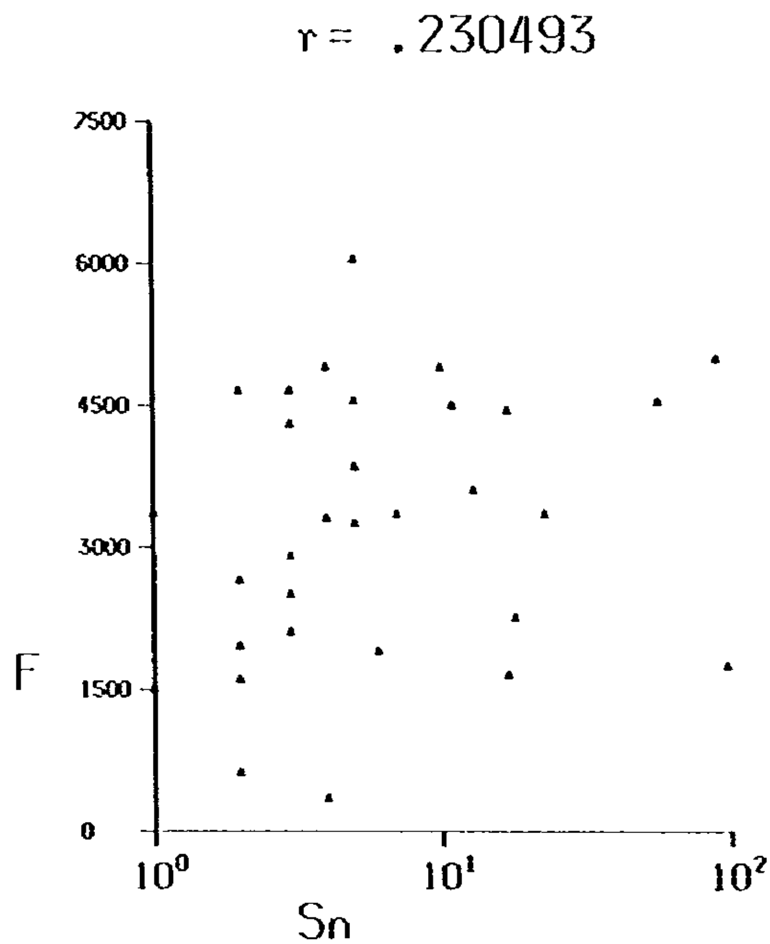


Fig. II-8 Coefficient of Correlation of F and Sn, Hatapang Granite

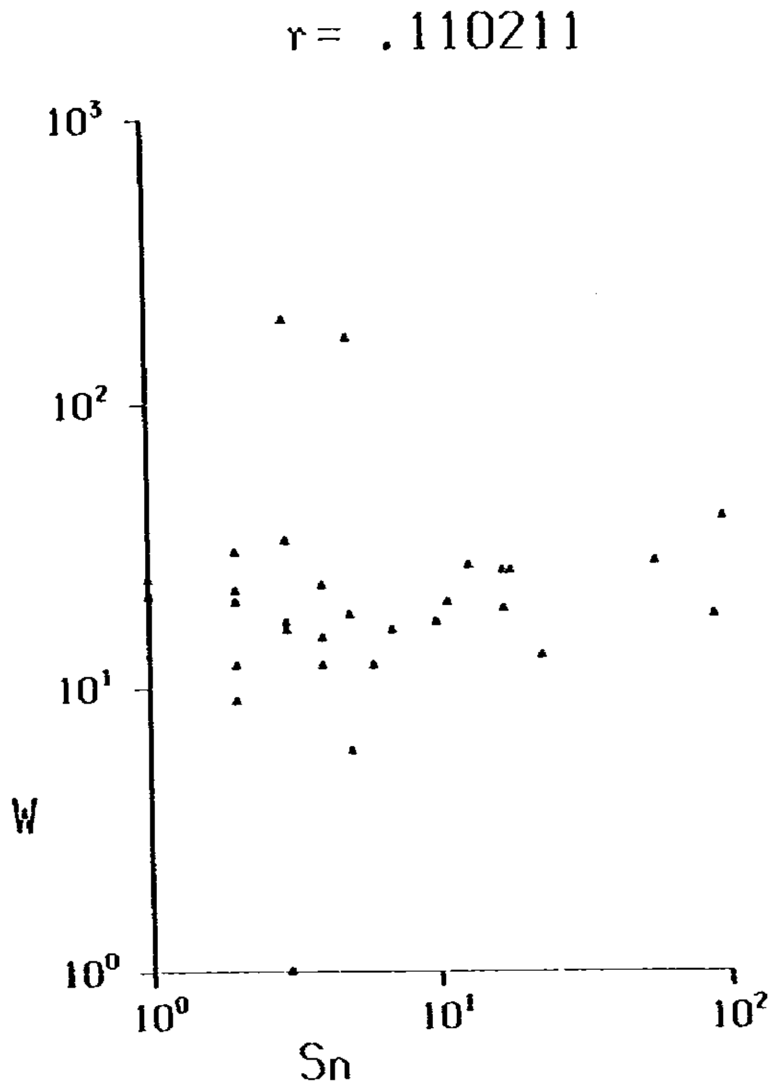
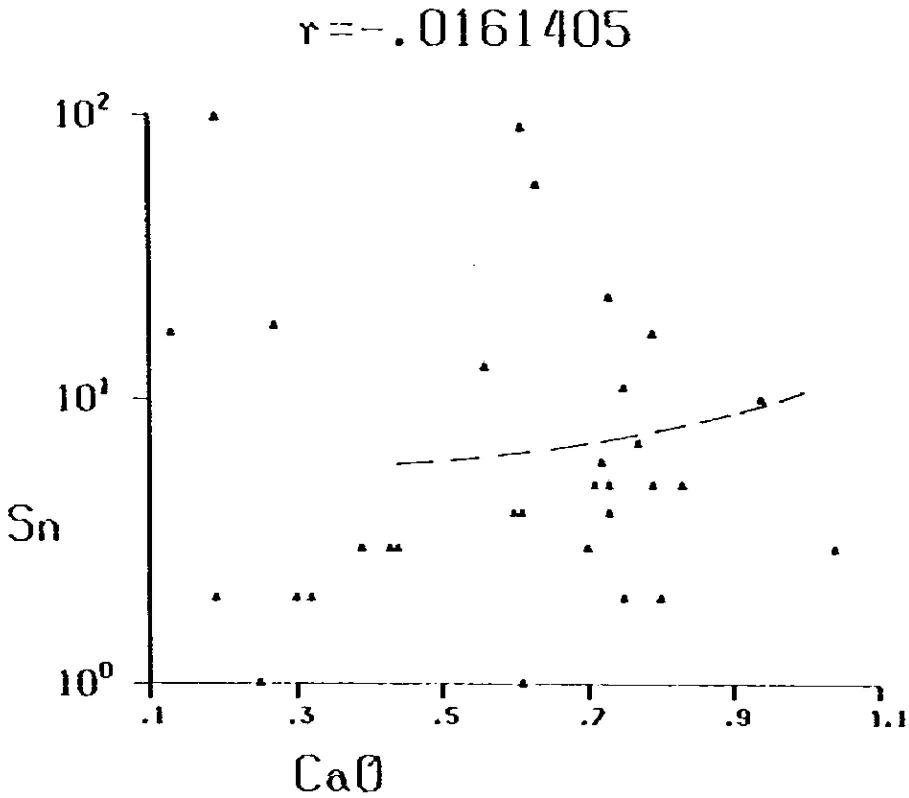


Fig. II-9 Coefficient of Correlation of W and Sn, Hatapang Granite



approximate boundary of tin bearing and non tin bearing granite in Phuket area, Thailand (S. Ishihara 1980)

Fig. II-10 Coefficient of Correlation of Sn and CaO, Hatapang Granite

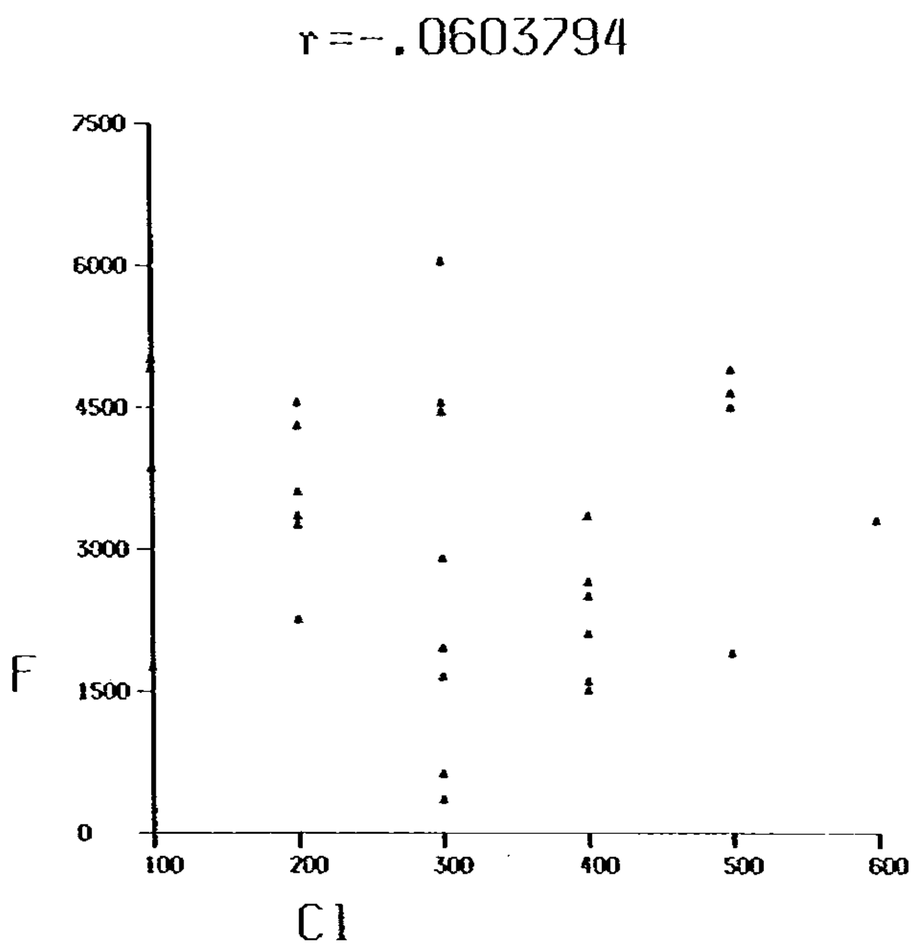


Fig. II-11 Coefficient of Correlation of F and Cl, Hatapang Granite

CHAPTER 4 GEOLOGICAL STRUCTURE

The Hatapang Area consists of Hatapang granite in its central region; this is surrounded by the Hatapang Formation and, to the north and northeast, the Monton Julu Formation and Toba tuff.

Hatapang granite controls the geological structure of this area. It is formed of an extended, oval-shaped stock covering 8 km in length and 6 km in width and running NW-SE on the exposure. It exhibits a clear intrusive relationship to the Hatapang Formation that surrounds it: the Hatapang Formation has metamorphosed into hornfels over an area extending 1 - 2 km from the boundary of its contact with the granite. While no obvious faults have been identified at such contact areas between the two types of rock, the Hatapang Formation shows a dome structure due to the intrusion of the Hatapang granite stock. This means that with the exception of localized disruptions in the structure, the Hatapang Formation dips 30° - 70° on the outer side of the Hatapang granite intrusion at granite's western, southern, and southeastern sides. At the northeastern side, however, the Hatapang Formation does not conform with this doming structure, its strike being N60° 0 80°E with a dip of 30° - 60° SE. This suggests that although the Hatapang granite intrusion was forceful it may have been stoped at its northeastern limits. The northeastern margin zone is the only distributing area of tin-rich, fine-grained two mica granite, quartz veins, and indications of tungsten ore, conditions considered attributable to the stoping-influenced intrusion structure of the Hatapang granites.

Similar granite dikes surround the main body of the Hatapang granite in a zone extending 1 - 2 km out from the granite's periphery. These are thought to be Hatapang granite that has possibly spread outward from the main stock.

With the exception of dome-structure zones at places of contact with granite, the Hatapang Formation generally strikes a NE ∿ NNW and dips 30° - 60° E ∿ SE, but the structure is unclear owing to the lack of any key bed.

No obvious faults were observed. While the northeastern margin region of the Hatapang granite stock does feature many fissures with a strike of N 60° E and a dip of 60° - 90° S as well as quartz veins that filled them, these are thought to be the results of segregation veins at the time of the rock's cooling (Pl. II-3).

CHAPTER 5 GEOCHEMICAL SURVEY

5-1 Outline

The geochemical survey on stream sediments (samples collected at intervals of 1 sample per 10 - 15 km^2), conducted in this survey area in conjunction with the British - Indonesian Cooperative Survey, centered on the Hatapang granite and identified anomalous areas of tin (2,4000 - 20,000 ppm), tungsten (15 - 45 ppm), Lithium (65 - 214 ppm), and other minerals. Especially strong anomalous areas of tin were found in the vicinity of the Hatapang granite's eastern zone, the first step toward the discovery of a tin mineralization.

Along with a geological survey, the present survey project involved a geochemical survey of samples of stream sediment; 4 samples were collected per every 1 km^2 along the rivers surveyed.

Using an 80-mesh sieve, samples were collected from the main streams and tributaries of rivers on the geological survey route, upstream from their points of divergence. The samples were packed in sample bags after having been sun-dried at sampling camps. 571 samples were collected. In order to provide for even collection density, these were re-adjusted and, in the end, 540 were chosen to serve as samples.

5-2 Data Processing and Interpretation

Sn, W, Mo, F, and As were selected and analyzed as pathfinders for tin and tungsten mineralization. The Directorate of Minerals and Energy of Indonesia separately carried out analyses of Cu, Zn, and Pb.

5-2-1 Data Processing

Analyzed values were standardized through logarithmic conversion, and a histogram and cumulative frequency distribution prepared for each element. The mean value, standard deviation, and correlation coefficient of each element were computed and anomalous areas analyzed (Figs. II-12, II-13, II-14).

(1) Correlation between Constituents

The correlation coefficients between the various constituents were obtained as given in Table II-3. As a result, it was found that correlation exists between Sn and W, Sn and F, and W and F, while virtually none was recognized for As and Mo.

(2) Anomalous Areas

From their correlation, the three elements Sn, W, and F were shown to be pathfinders for tin and tungsten mineralization. These three elements exhibit log normal distribution. Mean + σ and Mean + 2σ were made the threshold values, and values at or above those levels were held to be anomalous values of Grade 1 and Grade 2 respectively. Areas contiguous with at least two points with anomalous values were considered anomalous areas and indicated as such. Table II-4 shows the mean value, standard deviation, and threshold value ($M + \sigma$, $M + 2\sigma$) of each element.

(a) Sn Anomalous Areas (Pl. II-4)

A Grade 1 anomalous area having a maximum value of 3,100 ppm is situated at a spot 2 km upstream from the village of Hatapang Julu along the Hatapang River and extending out along the western tributaries. The vicinity possesses a large number of quartz veins, and 18 cm-wide quartz veins located here have been found to have a grade of 0.83%.

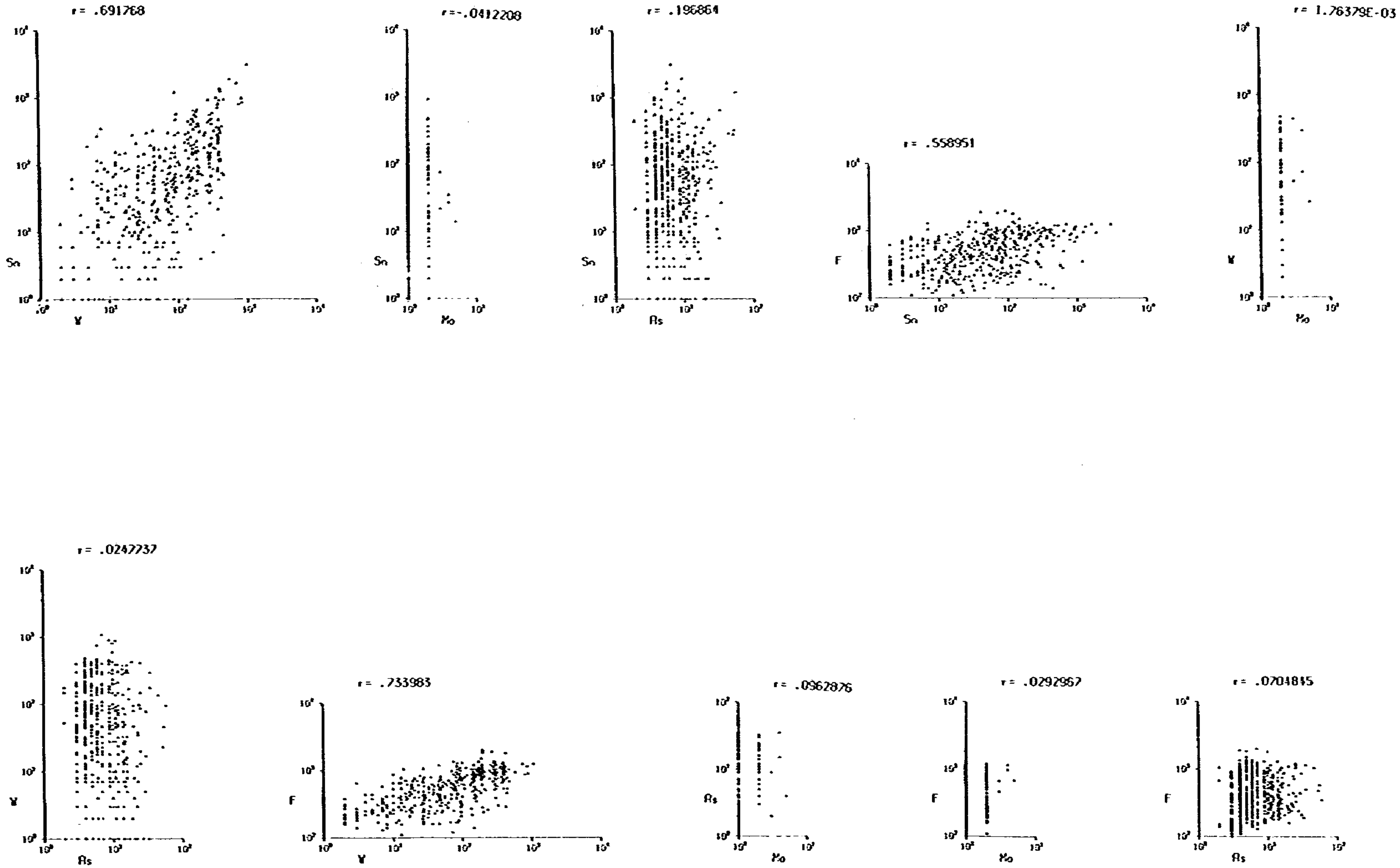
Table II-3 The List of Coefficients of Correlation between each Component on Geochemical Prospecting

	Sn	Mo	As	F
W	0.6918	1.7638	0.0248	0.7340
Sn		Δ0.0412	0.1969	0.5590
Mo			0.0963	0.2930
As				0.0705
F				

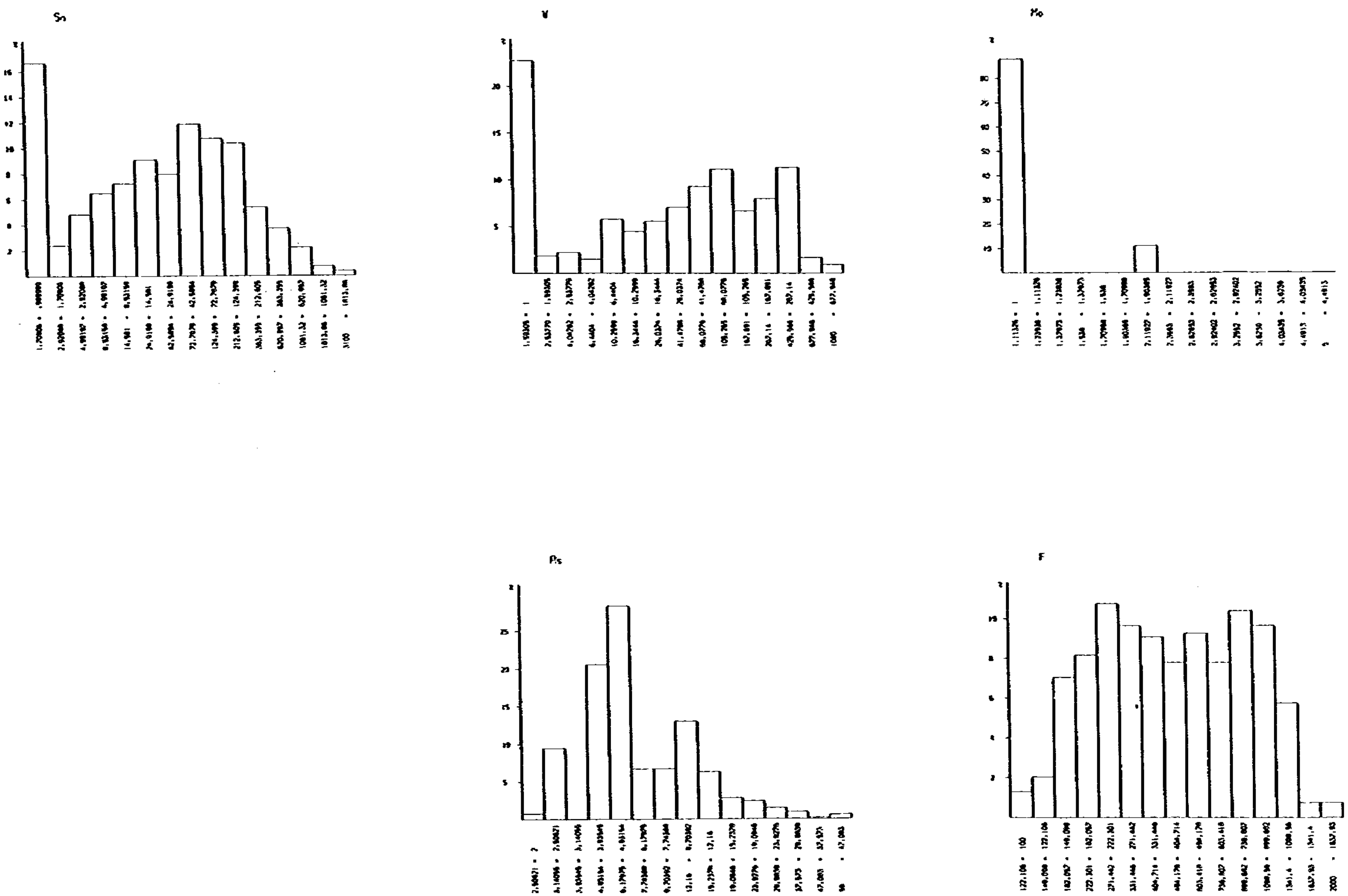
Table II-4 Background deviation and Threshold value

(Population: 540)

	Background value (M)		Standard deviation (a)	Threshold value	
				M + a	M + 2a
W	23	(ppm)	0.9198	192	1594
Sn	24	(ppm)	0.3676	174	1284
Mo	1	(ppm)	0.1080	1	2
As	7	(ppm)	0.2572	12	22
F	433	(ppm)	0.2812	827	1581



II-12 Coefficient of Correlation of Geochemical Samples in Hatapang Area



II-13 Histogram of Geochemical Analysis in Hatapang Area

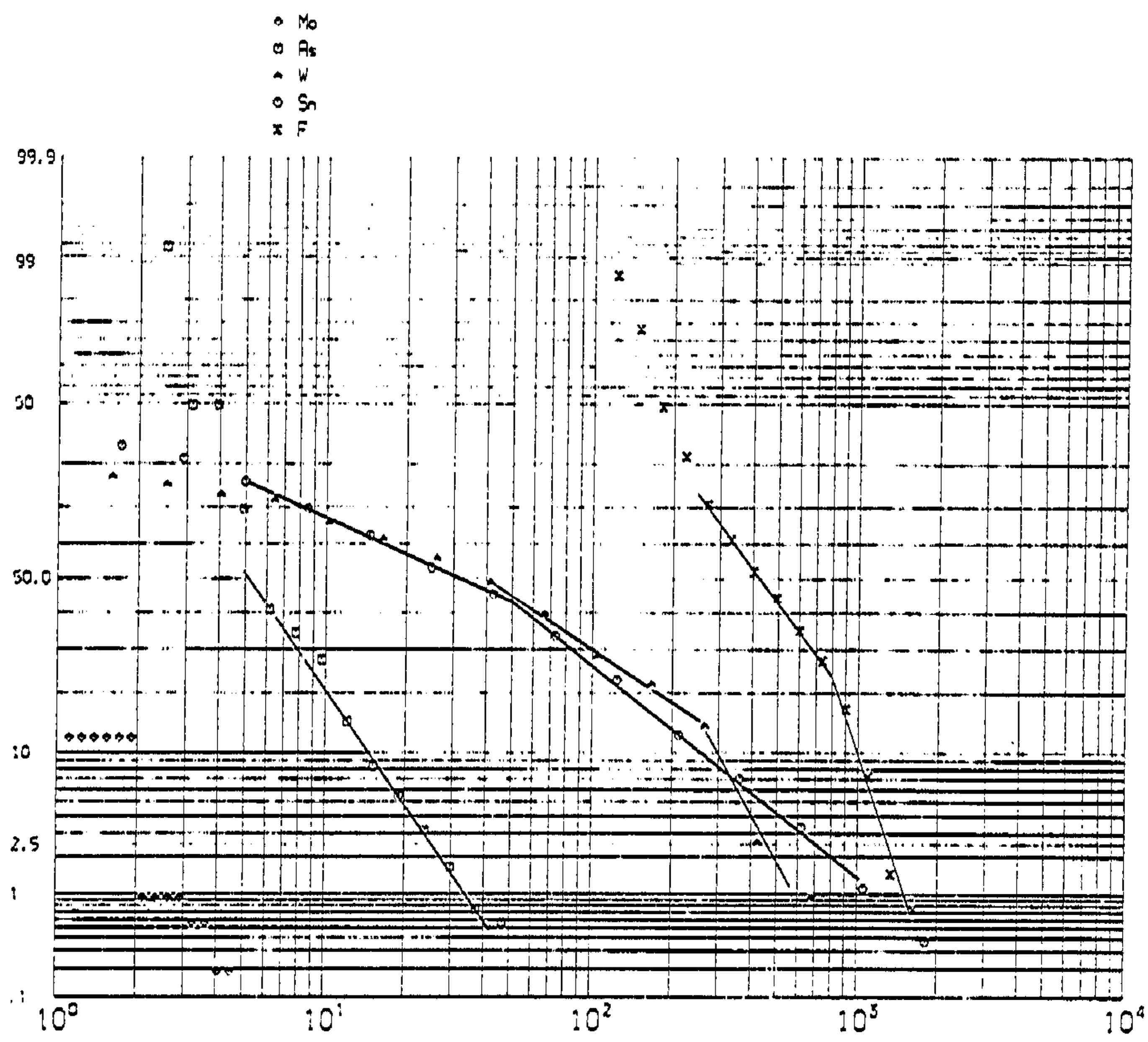


Fig. II-14 Cumulative frequency distribution in Hatapang Area

Grade 2 anomalous areas are distributed widely in the upper reaches of the Hatapang River, the upper reaches of the Habar River (a Hatapang River tributary), the middle reaches of the Kotahong River, and the lower reaches of the Batu Jongjong River. These anomalous areas correspond to the northern and northeastern margin zone of the Hatapang granite stock and are almost completely consistent with concentrated tin placer ore areas discovered by the heavy mineral survey, fine-grained two mica granite with high tin content, and areas abundant in quartz veins.

(b) W Anomalous Areas (Pl. II-4)

Grade 2 W anomalous areas are distributed along the upper reaches of the Batu Jongjong and Hatapang Rivers. In comparison with Sn anomalous areas, these are located somewhat toward the interior of the Hatapang granite stock, generally overlapping anomalous areas of Sn.

(c) F Anomalous Areas

Grade 2 F anomalous areas are found overlapping anomalous areas of Sn and W.

(d) As and Mo Anomalous Areas (Pl. II-5)

As anomalous areas are distributed along the outer northeast and outer southwest margins of the Hatapang granite stock. In all areas Mo exhibited a low analyzed value of 1 - 2 ppm which did not indicate any anomalous areas. For reference, however, areas that showed a distribution of 2 ppm (11% of the total) are scattered along the outer periphery of the Hatapang granite stock. Because As and Mo have a low correlation with Sn, W, and F, they are thought to be related to metamorphic aureale brought about by the Hatapang granite intrusion.

CHAPTER 6 TIN AND TUNGSTEN PLACER ORE SURVEY

6-1 Survey Purpose and Methods

As mentioned earlier in Chapter 5, on the geochemical survey, the Directorate of Minerals and Resources continued a survey begun by the Indonesian - British Cooperative Survey in mineralization zones of tin and tungsten discovered by the latter group. Concentrating on the Hatapang and Batu Jongjong River basins, the following survey discovered cassiterite and tungsten mineralizations in areas of content between Hatapang granite and the Hatapang Formation (Clark; 1981). The survey employed the method of panning along the Hatapang River resulting in the discovery of cassiterite placer ore. Because this method proved effective in conducting cassiterite placer ore surveys in attempting to trace mineralization zones, the present survey project also carried out a cassiterite placer ore survey in conjunction with geological and geochemical surveys.

Samples were collected from the same points at which they were collected for the geochemical survey. For each sampling, 2 pails (20 ℓ) of riverbed sediment were taken. Using a wooden pan (about 50 cm in diameter), the panning was employed to collect the heavy minerals.

Samples were taken to the Directorate of Minerals and Resources office in Bandon where selection for tin and tungsten ores was conducted by Indonesian members of the survey team.

The selection process involved first removing the magnetite from the heavy mineral by means of a hand magnet, then removing the remaining magnetic ores through isodynamics; a binocular microscope was then used to extract tin and tungsten ores from the remainder of the sample. The presence of cassiterite was determined by placing ore on a zinc plate, sprinkling the ore with dilute hydrochloric acid, and seeking a cassiterite/zinc reaction.

6-2 Data Processing and Interpretation

After the cassiterite had been selected out, the number of grains of cassiterite was counted; distribution areas were determined on the basis of the number of cassiterite grains distributed, and those areas were examined. The number of grains of cassiterite was roughly counted by eye in cases where cassiterite content was high; i.e. 500 grains or more.

Once counted, the cassiterite grains were classified into five grades by logarithmic distribution: 100 - 260 grains; 261 - 730 grains; 731 - 2,000 grains; 2,001 - 5,400 grains; and 5,401 - 15,000 grains. These were then indicated on a topographical map (Pl. II-4). Large distributions of cassiterite placer ore were found to exist around the Hatapang River and its tributaries, and around the middle reaches of the Batu Jongjong River (Pl. II-4).

CHAPTER 7 MINERALIZATION

While weak in comparison with other mineralization zones of this area, tin and tungsten mineralization zones have been found in the basin of the Mabat River, a Hatapang River tributary; in the upper reaches of the Hatapang River, and in the Batu Jongjong River basin.

(a) Mabat River Basin (Fig. II-15)

Quartz veins with a dip of N 60° E are found in quantity in an area 2,500 m EW by 1,000 m NS in the marginal area between the Hatapang Formation and the Hatapang granite. These quartz veins show stains of hematite and are also accompanied by tourmaline. Distributions of fine-grained two mica granite have been identified in this area, as have weak argillization areas. The maximum grades obtained in a chemical analysis of the quartz veins were Sn 630 ppm and W 410 ppm. An X-ray analysis of the weak argillization areas revealed universally distributed $2M_1$-type sericite (or muscovite) with good crystallinity.

(b) Upper Reaches of the Hatapang River (Fig. II-16)

Eight quartz veins ranging from 10 to 20 cm in width were found within a space of 20 m along a tributary of the Hatapang River branching off from the Hatapang River some 4 km upstream from the village of Hatapang Julu. Of the eight quartz veins, two were subjected to analysis. A value of Sn 0.83% was obtained from a vein 10 cm in width and 0.06% from one 15 cm in width. Mineralization in the Hatapang Area is thought to originate in quartz veins as well as in fine-grained granite.

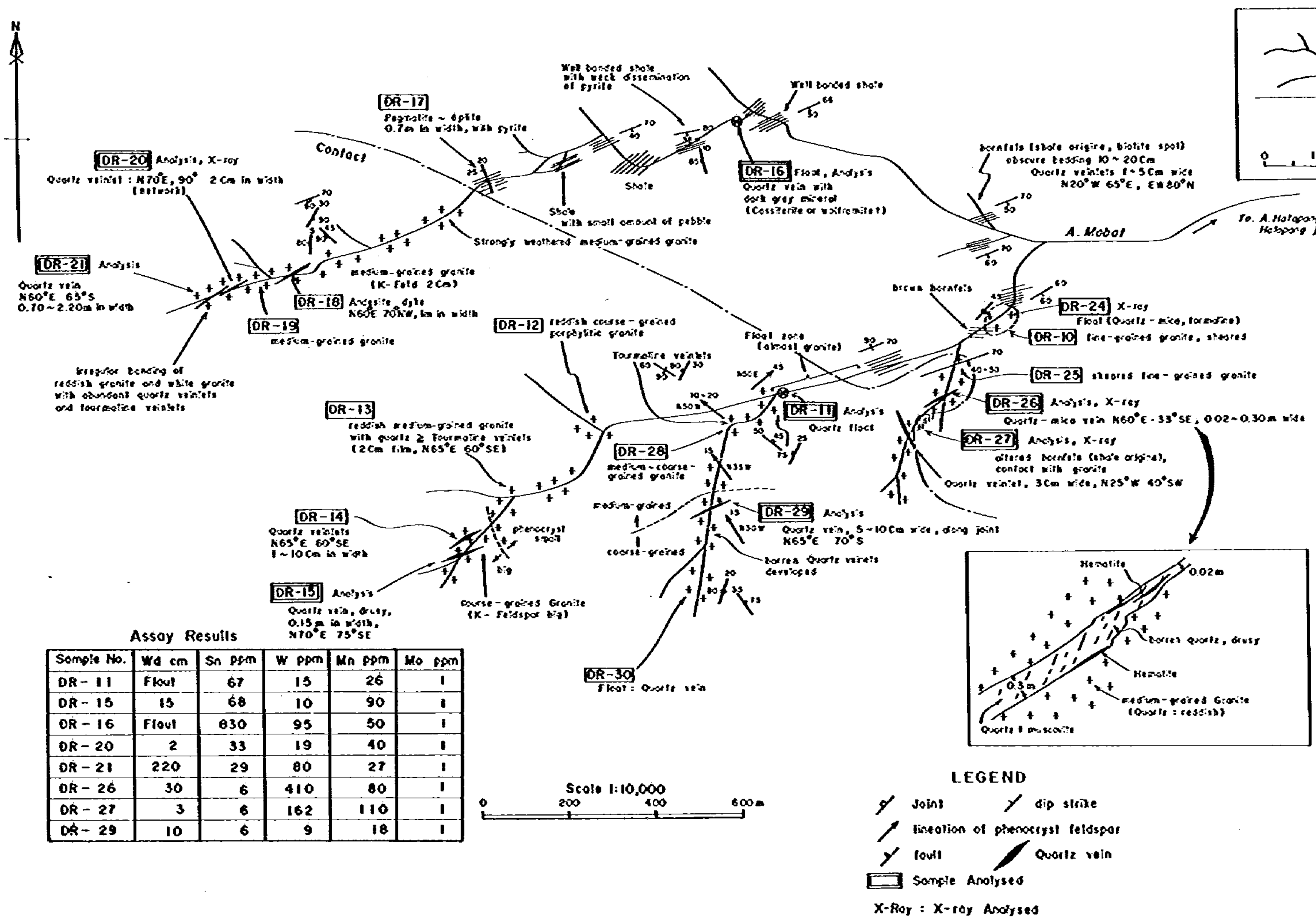
The survey conducted by the Directorate of Minerals and Resources resulted in the discovery of ores and boulders containing cassiterite and tungsten.

Table II-5 List of Assay Results of Ore Samples in Hatapang

Sample No.	Location	Occurrence	Assay Results			
			Sn	W	Mn	Mo
			ppm	ppm	ppm	ppm
AR-15	Haiaran	Qtz-vein	3	1	360	1
CR-4	A. Hatapang	Qtz-vein	8300	32	575	6
CR-14	A. Hatapang	Qtz-vein	685	111	740	1
DR-11	A. Sosapan	do	67	15	26	1
DR-15	A. Sosapan	do	68	10	90	1
DR-16	A. Mabar	do	630	95	50	1
DR-20	A. Mabar	Qtz-vein let	33	19	40	1
DR-21	A. Mabar	Qtz-vein	29	80	27	1
DR-26	A. Sosapan	do	6	410	80	1
DR-27	A. Sosapan	do	6	162	110	1
DR-29	A. Sosapan	do	6	9	18	1

(c) Along the Batu Jongjong survey route, quartz veins and dikes of fine-grained two mica granite become numerous some 200 m from the hornfels side of the Hatapang granite contact area. Although no cassiterite was found within the quartz veins, tourmaline was found universally. Fine-grained two mica granite was contained unevenly within dikes (about 3 m in width) or within coarse-grained granite. The Directorate of Mines and Resources Survey (1981) found signs of cassiterite in areas in which fine-grained granites were distributed.

The Hapatang Area thus holds substantial distributions of fine-grained granite and quartz veins, both having a connection with tin mineralization, in the Hatapang River basin and the lower reaches of the Batu Jongjong River; i.e. the northeastern sector of the Hatapang granite stock. From the results of the geochemical survey (pathfinders Sn, W, and F) and the cassiterite placer ore survey, which conform with those for anomalous areas, it is considered highly probable that this area is the mineralization zone of the Hatapang Area. Results of the chemical analysis of the mineralization zone are given in Table II-5.

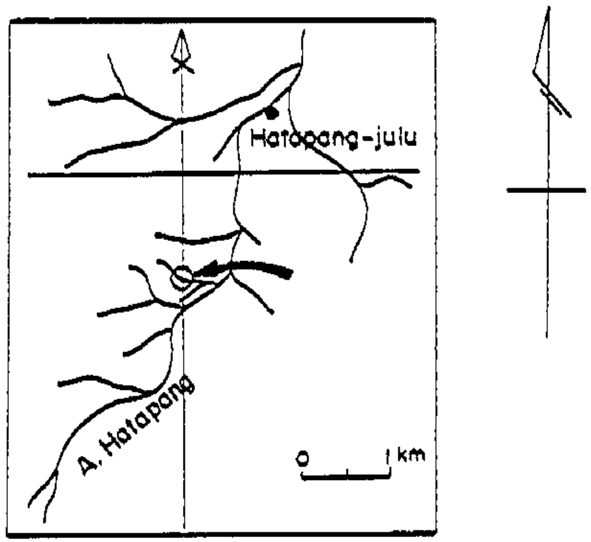


Assay Results

Sample No.	Wd cm	Sn ppm	W ppm	Mn ppm	Mo ppm
DR-11	Flout	67	15	26	1
DR-15	15	68	10	90	1
DR-16	Flout	830	95	50	1
DR-20	2	33	19	40	1
DR-21	220	29	80	27	1
DR-26	30	6	410	80	1
DR-27	3	6	162	110	1
DR-29	10	6	9	18	1

II-15 Route Map of Sn-Mineralization Area, Mabat River, Hatapang

	Sn ppm	W ppm	Mn ppm	Mo ppm
CR-4	8 300	32	573	6
CR-14	685	111	740	1
CR-24	91	18	-	1



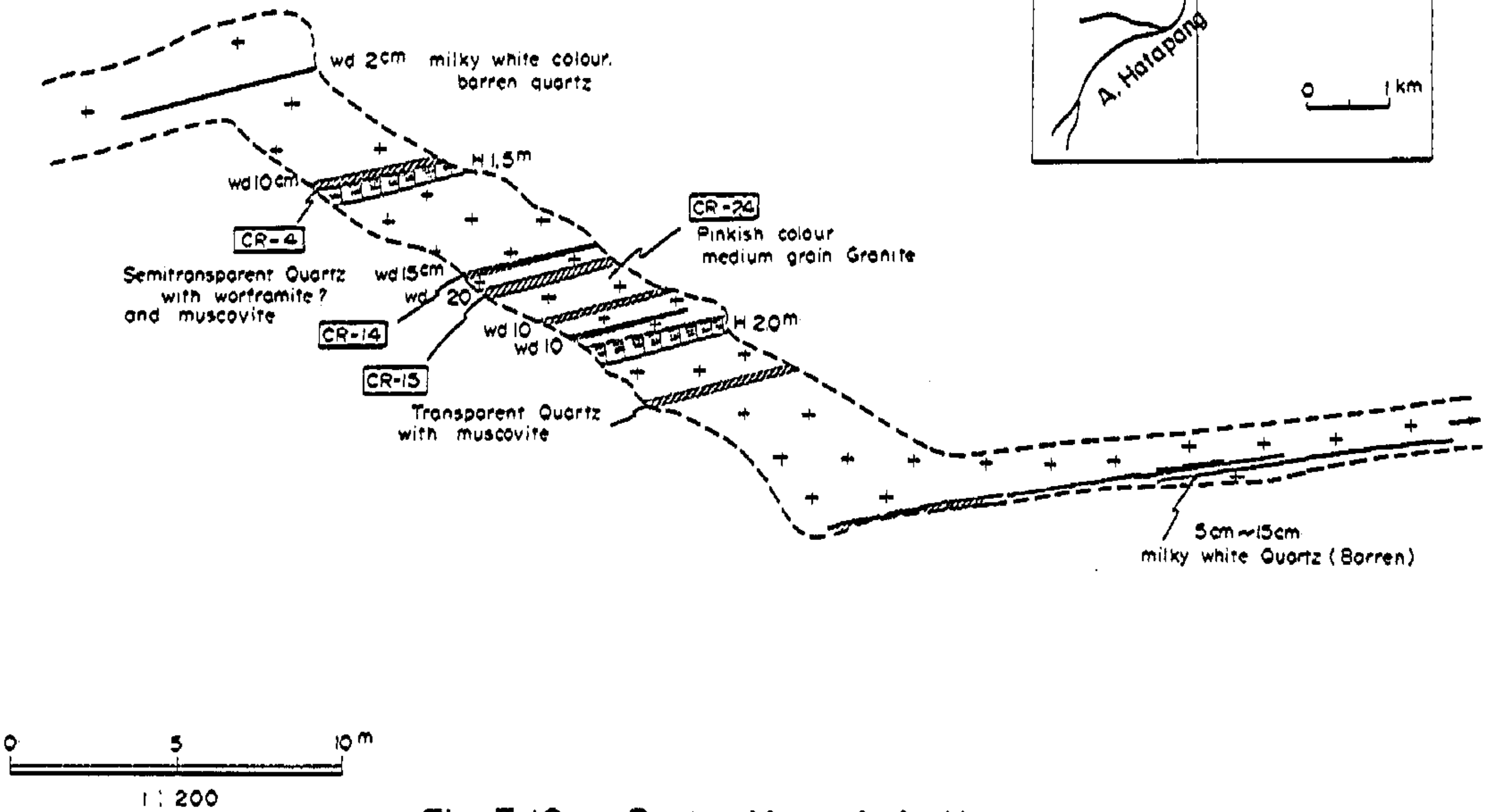


Fig II-16 Route Map of A. Hatapang

Appendix II-1 Assay Results of Geochemical and Panning Samples in Hatapan Area

(1)

Serial No.	Sample No.	Location	Assay Results (ppm)								Number of Cassiterite
		River or Creek	W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	
1	As) Ap 1	A. Kotabatu	28	13	1	3	320	5	13	28	(pcs)
2	" 2	do	1	2	1	3	360	4	15	35	
3	" 3	do	10	7	1	11	650	18	30	67	
4	" 4	do	12	4	1	7	400	5	23	54	
5	" 5	A. Paningoan	46	52	1	7	1200	11	35	61	79
6	" 6	do	20	10	1	6	740	6	22	40	192
7	" 7	do	10	20	1	10	880	26	16	55	6
8	" 8	do	27	66	1	14	750	23	17	54	48
9	" 9	do	13	74	2	12	780	24	18	53	218
10	" 10	do	27	53	1	6	1050	13	15	48	6
11	" 11	do	47	85	1	9	520	19	11	47	2
12	" 12	do	12	67	1	9	650	30	20	72	11
13	" 13	do	28	95	1	6	430	18	10	43	3
14	" 14	do	7	27	1	10	580	30	15	66	2
15	" 15	do	13	36	1	12	650	31	16	71	3
16	" 16	do	17	20	1	4	480	13	8	33	
17	" 17	A. Busama	1	55	1	10	230	12	14	46	227
18	" 18	do	55	15	1	9	390	15	16	53	8
19	" 19	do	1	19	1	5	190	11	20	41	4
20	" 20	do	43	26	1	9	450	13	16	47	2
21	" 21	do	47	29	1	7	440	8	16	47	
22	" 22	do	7	50	2	5	380	4	15	34	3
23	" 23	do	2	3	1	6	380	5	30	52	
24	" 24	do	32	77	1	12	570	8	17	43	236
25	" 25	A. Sibadak	35	145	1	23	790	6	26	58	
26	" 26	do	120	55	1	17	860	0	12	32	±1500
27	" 27	do	78	91	1	30	870	0	26	33	±600
28	" 28	do	87	59	1	25	1050	6	21	86	±800
29	" 29	do	95	150	2	20	1100	14	18	62	±900
30	" 30	do	16	90	1	16	620	9	28	56	250
31	" 31	do	1	16	1	9	420	8	20	40	
32	" 32	do	13	110	1	16	540	13	20	61	
33	" 33	A. Kotabatu	49	6	1	10	520	11	29	66	

x Analysed by DMR

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
34	As) Ap) 34	A. Kotabatu	7	1	2	14	320	14	28	69	
35	" 35	do	5	2	2	16	260	18	27	83	2
36	" 36	do	43	3	2	10	250	13	21	54	
37	" 38	do	2	1	2	19	270	18	36	96	
38	" 39	do	1	2	1	15	310	20	34	92	4
39	" 40	do	4	1	1	20	250	23	30	94	8
40	" 41	do	14	6	1	14	290	20	30	81	6
41	" 42	do	3	2	1	12	200	17	26	75	
42	" 43	do	5	3	1	7	240	9	22	62	
43	" 44	do	18	21	1	6	450	4	80	189	
44	" 45	do	1	3	2	9	240	25	24	69	3
45	" 46	do	1	2	2	20	230	22	30	85	8
46	" 47	do	7	12	1	12	330	10	81	291	50
47	" 48	do	1	1	1	5	300	9	38	110	8
48	" 49	do	3	2	2	22	240	32	30	82	6
49	" 50	do	2	2	1	11	190	25	45	112	
50	" 51	do	1	4	1	17	210	19	32	81	
51	" 52	do	17	11	2	30	210	28	31	83	
52	" 53	do	3	2	1	14	220	25	29	82	
53	" 54	do	5	1	1	12	230	20	25	78	
54	" 55	do	4	10	1	6	340	10	17	52	
55	" 56	do	28	1	1	4	260	8	12	35	
56	" 57	do	136	1	1	5	270	9	13	48	
57	" 58	do	34	1	1	5	290	9	13	44	
58	" 59	do	47	3	1	4	300	8	10	39	
59	" 60	do	50	6	1	3	240	4	12	26	
60	" 61	do	52	1	1	4	580	9	21	57	
61	" 62	do	19	1	1	3	560	2	14	23	
62	" 63	do	38	1	1	6	470	13	15	50	
63	" 64	do	49	1	1	9	430	10	14	39	
64	" 65	do	1	1	1	5	300	9	20	55	
65	" 66	do	1	2	1	10	340	13	21	60	
66	" 68	A. Busuk	15	3	1	5	710	8	20	49	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
67	As Ap) 69	A. Busuk	13	3	1	4	650	5	17	40	
68	" 70	do	14	7	1	6	1050	15	18	60	5
69	" 71	do	51	21	1	6	560	14	13	51	
70	" 72	do	22	9	1	6	700	10	18	60	70
71	" 73	do	23	18	1	6	600	10	10	46	40
72	" 74	do	75	20	1	6	520	12	10	42	
73	" 75	do	24	10	2	12	830	18	15	67	
74	" 76	do	47	3	1	5	540	15	15	47	8
75	" 78	A. Batupenggeng	400	120	1	3	920	2	45	27	
76	" 79	do	420	925	1	4	1100	1	38	20	
77	" 80	A. Pangalalan	15	36	1	5	370	10	14	45	
78	" 81	do	17	38	1	5	420	10	12	48	
79	" 82	do	8	23	1	6	410	12	14	46	
80	" 83	do	295	200	1	4	880	4	40	31	
81	" 84	do	26	14	5	4	680	3	38	44	
82	" 85	do	310	130	2	6	530	4	26	42	
83	" 86	do	27	43	1	7	480	12	13	43	8
84	" 87	A. Kotabatu	83	58	1	12	390	11	25	62	
85	" 88	do	45	59	2	4	590	4	27	46	
86	" 89	do	27	9	1	7	660	8	24	56	
87	" 90	do	3	45	1	10	650	6	19	53	
88	" 91	do	7	8	1	4	270	3	19	68	6
89	" 92	do	23	22	1	7	600	5	117	371	7
90	" 93	do	2	13	2	5	300	8	25	74	
91	" 94	do	32	28	1	6	570	4	93	388	9
92	" 95	do	1	1	2	20	260	23	33	76	
93	Bs Bp) 1	A. Hausong	378	85	2	14	660	6	51	55	
94	" 2	do	27	20	2	4	160	1	5	11	
95	" 3	do	295	27	4	35	1150	5	56	39	
96	" 4	do	27	71	1	4	170	2	6	11	
97	" 5	do	18	150	1	9	240	6	7	21	
98	" 6	do	48	110	1	12	400	10	10	34	
99	" 7	do	1	110	1	14	210	12	21	40	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
100	Bs) Bp) 8	A. Maumong	400	60	2	7	540	3	33	23	
101	" 9	do	290	39	1	10	520	5	41	49	
102	" 10	do	138	32	1	5	220	3	13	15	
103	" 11	do	72	35	4	15	980	41	20	57	
104	" 12	do	210	4	1	12	810	5	62	28	
105	" 13	do	108	3	2	7	540	5	28	43	
106	" 14	do	235	71	1	10	260	4	46	44	
107	" 15	do	92	4	2	11	750	2	65	36	
108	" 16	do	86	15	1	9	440	4	60	45	
109	" 17	do	320	5	1	16	590	2	105	29	
110	" 18	do	450	9	1	6	540	2	110	38	
111	" 19	do	1	3	2	5	230	5	15	49	
112	" 20	do	1	8	1	10	220	6	12	40	
113	" 21	do	162	260	2	6	350	5	19	49	
114	" 22	do	445	76	3	9	460	4	30	47	
115	" 23	do	57	135	1	4	310	4	17	42	
116	" 24	do	18	12	1	6	280	7	14	46	
117	" 25	do	73	62	2	5	380	4	13	34	
118	" 26	do	70	175	2	12	560	35	27	103	
119	" 27	do	18	83	2	7	540	11	16	46	
120	" 28	do	33	145	1	7	530	16	27	86	
121	" 29	do	1	8	2	32	190	17	39	43	
122	" 30	do	148	24	2	12	500	8	36	48	
123	" 31	do	1	15	1	7	200	16	29	47	
124	" 32	do	75	3	1	5	250	12	17	30	
125	" 33	do	13	1	2	3	110	5	8	16	
126	" 34	do	1	1	2	9	240	18	26	47	
127	" 35	do	1	6	1	4	260	11	13	28	
128	" 36	A. Batujongjong	405	470	1	7	880	2	46	26	8
129	" 37	do	1	10	1	5	180	13	12	33	6
130	" 38	do	2	6	1	14	200	15	22	42	6
131	" 39	do	1	10	1	6	150	10	14	30	
132	" 40	do	1	4	1	4	110	6	8	20	2

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
133	Bs/Bp) 41	A. Batujongjong	72	22	1	4	120	6	9	19	2
134	" 42	do	900	840	1	9	900	5	53	36	±1500
135	" 43	do	26	210	1	15	190	13	17	32	±500
136	" 44	do	810	800	1	10	880	5	58	31	±1500
137	" 45	do	96	96	1	6	240	4	21	22	±500
138	" 46	do	200	80	1	5	240	5	15	21	±500
139	" 47	do	67	115	1	6	170	5	8	15	±3000
140	" 48	do	400	260	1	9	700	6	42	36	2
141	" 49	do	89	62	1	5	180	6	14	18	3
142	" 50	do	1	9	1	4	130	8	11	17	11
143	" 51	do	155	58	1	7	890	7	36	30	8
144	" 52	do	1	31	1	4	150	7	20	20	220
145	" 53	do	46	2	1	3	160	2	8	13	6
146	" 54	do	285	150	1	14	900	7	40	34	6
147	" 55	do	310	69	1	12	740	14	40	35	6
148	" 56	do	300	190	1	12	750	15	30	30	4
149	" 57	do	8	7	1	6	140	6	12	26	8
150	" 58	do	96	130	1	12	210	11	20	32	12
151	" 59	do	295	49	1	15	980	20	34	43	±500
152	" 60	do	28	135	1	9	240	10	10	22	11
153	" 61	do	296	92	1	16	750	6	30	31	2
154	" 62	do	87	7	1	14	1300	14	64	43	3
155	" 63	do	140	87	1	14	670	13	20	27	6
156	" 64	do	138	65	1	11	750	15	28	34	4
157	" 65	do	1	29	1	12	180	8	7	12	9
158	" 66	do	13	100	1	7	160	10	8	24	54
159	" 67	do	1	62	1	14	180	11	12	28	30
160	" 68	do	12	17	1	22	290	25	34	53	20
161	" 69	do	6	10	1	9	170	12	13	28	2
162	" 70	do	20	87	1	25	400	40	52	74	18
163	" 71	do	13	44	1	25	300	30	49	40	
164	" 72	do	7	32	1	4	130	5	9	19	±500
165	" 73	do	47	68	1	14	420	14	17	32	8

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite
166	Bs) Bp) 74	A. Batujongjong	13	155	1	14	370	23	12	33	±500 (pcs)
167	" 75	do	75	74	1	12	540	21	13	37	±500
168	" 76	do	410	155	1	25	1150	22	40	68	6
169	" 77	do	385	88	1	11	950	35	60	67	3
170	" 78	do	168	61	1	17	880	14	46	67	
171	" 79	do	307	67	1	5	390	7	7	20	±500
172	" 80	do	148	65	1	7	800	4	38	25	
173	" 81	do	395	220	1	9	900	4	54	39	6
174	" 82	do	80	94	1	20	580	32	27	71	±10000
175	" 83	do	296	140	1	17	620	11	21	46	±15000
176	" 84	do	300	48	1	7	960	4	48	25	
177	" 85	do	55	170	1	14	420	17	17	42	7
178	" 86	do	7	82	1	9	340	17	11	30	±5000
179	" 87	do	38	54	1	23	440	20	18	42	110
180	" 88	do	47	180	1	20	420	20	17	42	±5000
181	" 89	do	18	48	1	12	580	30	20	67	7
182	" 90	do	8	44	1	9	220	15	12	27	±5000
183	" 91	do	425	300	1	19	290	34	52	65	±5000
184	" 92	do	15	49	1	15	460	50	23	62	±2500
185	" 93	do	7	12	1	7	250	17	22	55	6
186	" 94	do	2	3	1	5	220	17	14	44	4
187	" 95	do	3	3	1	9	180	13	12	32	
188	" 96	do	1	4	1	12	220	20	19	48	
189	Cs) Cp) 1	A. Hatapang	148	93	1	10	1050	22	25	45	450
190	" 2	do	95	185	1	6	350	7	9	19	±10000
191	" 3	do	450	370	1	9	780	13	33	32	
192	" 4	do	80	75	1	11	550	20	20	33	6
193	" 5	do	480	935	2	4	690	5	12	18	±500
194	" 6	do	150	300	1	6	830	3	32	31	140
195	" 7	do	595	1900	1	10	950	9	30	25	±5000
196	" 8	do	400	800	1	4	740	3	30	24	±2500
197	" 9	do	1080	3100	1	7	1250	9	22	27	±10000
198	" 10	do	425	1350	1	6	1150	7	23	35	±7500

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
199	Cs Cp) 11	A. Hatapang	168	480	1	9	860	2	29	23	
200	" 12	do	150	210	1	4	860	5	29	39	
201	" 13	do	195	225	1	7	1100	5	42	28	
202	" 14	do	168	155	1	6	880	19	28	40	2
203	" 15	do	320	410	1	10	1050	3	36	22	4
204	" 16	do	390	210	1	6	930	3	38	23	
205	" 19	A. Hatapang Nalamot	82	125	1	5	700	2	24	39	200
206	" 20	do	73	54	1	6	640	5	22	54	
207	" 21	do	58	130	1	4	640	3	23	38	6
208	" 22	A. Hatapang	87	150	1	10	1050	6	35	38	8
209	" 23	do	163	400	1	6	1050	5	30	41	7
210	" 24	do	170	175	1	7	990	7	41	47	±500
211	" 25	do	385	280	1	12	750	4	30	53	4
212	" 26	A. Hatapang	205	160	1	10	800	4	64	57	7
213	" 27	do	168	145	2	6	880	4	43	49	8
214	" 28	do	283	130	2	4	690	3	16	30	8
215	" 29	do	192	370	2	5	1050	5	21	32	±2400
216	" 30	do	250	275	1	4	1000	4	30	37	6
217	" 31	do	263	49	1	5	1200	3	25	37	1
218	" 33	do	85	150	1	6	1150	3	48	43	
219	" 34	do	147	240	1	7	960	4	45	37	
220	" 35	do	287	430	1	5	930	4	42	48	±6000
221	" 36	do	107	300	1	3	620	7	20	35	6
222	" 38	do	49	94	1	5	810	2	25	31	7
223	" 39	do	95	65	1	4	810	3	18	29	2
224	" 40	do	96	73	1	5	1000	3	28	32	1
225	" 41	do	310	150	1	5	1200	2	36	31	2
226	" 42	do	115	69	1	5	1100	3	35	34	1
227	" 43	do	420	330	1	5	1000	3	40	32	4
228	" 44	A. Hatapang Nalamot	378	360	1	16	1050	5	33	35	6
229	" 45	A. Hatapang	187	160	1	4	910	3	13	18	6
230	" 46	do	210	375	1	3	820	3	15	16	9
231	" 47	do	263	300	1	4	910	3	15	18	±500

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite
232	Cs) Cp) 48	A. Hatapang	435	1250	1	9	950	12	31	25	15000(pcs)
233	" 49	A. Hapesong	15	2	1	5	410	15	17	49	
234	" 52	do	1	1	1	4	370	6	18	42	
235	" 53	do	1	1	1	6	420	11	20	58	
236	" 55	do	1	1	1	11	520	15	24	66	
237	" 56	do	1	1	2	7	390	12	22	54	
238	" 57	do	1	1	1	7	490	16	26	72	
239	" 58	do	1	1	2	5	440	12	22	56	
240	" 59	A. Maranti	1	5	1	4	240	3	10	33	
241	" 61	do	1	1	1	11	320	4	20	46	4
242	" 62	do	1	1	1	6	320	4	12	31	
243	" 63	do	1	1	1	5	400	8	13	38	
244	" 64	A. Montong	1	1	1	4	150	5	8	27	
245	" 67	do	1	1	1	4	210	7	11	42	
246	" 69	do	1	1	1	5	220	6	11	31	
247	" 71	do	1	1	1	5	190	8	13	34	
248	" 72	do	8	1	1	4	210	7	12	35	
249	" 73	do	1	1	1	7	150	4	7	16	
250	" 74	A. Gambir	1	1	2	4	170	5	8	18	
251	" 76	do	1	1	1	5	220	6	11	29	
252	" 77	do	1	1	2	4	290	7	13	38	
253	Ds) Dp) 1	A. Katabong	48	170	2	12	360	8	16	37	
254	" 2	do	1	24	1	6	210	7	20	31	
255	" 3	do	1	150	2	22	310	16	20	49	
256	" 4	do	8	110	1	11	300	14	19	62	
257	" 5	do	175	645	1	35	500	13	16	41	
258	" 6	do	100	570	1	10	310	7	17	33	
259	" 7	do	7	115	2	23	280	8	22	44	4
260	" 8	do	330	585	1	14	300	8	23	55	3
261	" 9	do	23	280	1	53	480	19	16	65	2
262	" 10	do	46	325	1	55	580	19	12	36	6
263	" 11	do	148	210	1	25	1200	12	22	45	1
264	" 12	A. Horiara	1	30	1	9	560	28	18	37	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite
265	Ds) Dp) 13	A. Harlara	7	13	1	6	270	6	21	37	4(pcs)
266	" 14	do	1	1	1	5	240	7	14	33	1
267	" 15	do	1	1	1	6	270	10	18	37	
268	" 16	do	1	1	2	9	320	9	18	34	
269	" 17	do	1	1	1	7	250	9	25	34	
270	" 18	do	1	1	1	10	420	9	22	66	6
271	" 19	A. Gontingsorik	42	195	1	5	340	6	24	32	4
272	" 20	do	1	91	1	6	220	5	64	45	7
273	" 21	A. Mabar	300	460	1	3	600	4	18	23	
274	" 22	do	15	145	1	5	250	9	26	59	2
275	" 23	do	205	410	1	11	970	6	19	27	2
276	" 24	do	200	160	1	10	890	3	16	22	
277	" 25	do	138	165	1	6	870	3	16	22	
278	" 26	do	135	290	1	46	1050	16	16	40	
279	" 27	do	375	1000	1	4	800	2	30	16	
280	" 28	do	290	930	1	5	1050	2	21	22	
281	" 29	do	320	480	2	5	1200	3	21	30	
282	" 30	do	300	560	1	4	1200	1	30	24	
283	" 31	do	196	525	1	5	1200	2	28	33	
284	" 32	A. Gontingsorik	47	135	1	14	420	10	24	40	
285	" 33	do	75	300	1	9	630	6	24	58	
286	" 34	do	1	17	1	6	190	6	60	92	
287	" 35	do	1	6	1	4	200	4	21	34	
288	" 36	do	1	89	1	14	220	8	21	42	2
289	" 37	do	98	470	2	24	720	14	12	40	2
290	" 38	do	150	440	1	6	720	3	17	30	1
291	" 39	do	298	130	1	9	1300	4	11	25	7
292	" 40	do	320	250	1	5	920	3	19	30	9
293	" 41	do	217	310	2	4	960	2	19	34	
294	" 42	A. Hatapang	1	1	2	4	240	5	10	26	
295	" 43	do	87	1	1	3	170	3	10	23	
296	" 44	do	148	450	1	2	140	1	7	9	8
297	" 45	do	10	79	1	3	230	2	14	22	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
298	Ds Dp) 46	A. Hatapang	1	7	2	4	260	3	9	20	
299	" 47	do	11	17	1	4	170	2	12	16	
300	" 48	do	40	100	1	6	230	3	11	17	
301	" 49	do	195	625	1	3	280	2	11	11	
302	" 50	do	17	35	1	4	260	3	23	44	
303	" 51	do	96	280	1	7	320	4	20	31	6
304	" 52	do	28	81	1	6	360	5	17	29	
305	" 53	do	1	16	1	3	180	2	9	25	4
306	" 54	do	1	1	1	3	220	2	10	21	
307	" 55	do	1	1	1	3	180	4	9	18	
308	" 57	A. Torang	1	1	1	4	300	4	17	41	
309	" 58	do	7	15	1	3	350	3	11	26	
310	" 59	do	1	6	1	5	290	4	9	27	8
311	" 60	do	1	1	1	4	380	2	20	29	
312	" 61	do	1	1	1	12	380	13	24	69	
313	" 62	A. Hariaria	1	1	1	7	130	6	14	23	
314	" 63	A. Gontingsorik	150	70	1	6	390	8	20	21	
315	" 64	do	195	120	1	4	940	3	15	21	
316	" 65	do	76	28	1	6	1350	5	28	23	
317	" 66	do	200	660	1	7	1000	2	21	19	
318	" 67	do	183	550	1	4	840	3	21	19	4
319	" 68	do	1	200	1	4	970	2	17	18	
320	" 69	do	8	53	1	16	310	10	18	33	
321	" 70	do	1	78	1	6	200	6	13	30	
322	" 71	A. Sisi	1	23	1	7	190	8	13	33	
323	" 72	do	1	27	1	12	210	7	14	33	
324	" 76	do	1	46	1	4	170	4	10	25	
325	" 77	do	2	6	1	5	160	4	10	14	
326	" 78	do	1	1	1	4	160	4	11	19	
327	" 79	do	3	1	1	4	140	4	10	17	
328	" 80	do	1	1	1	4	150	4	12	36	
329	" 82	do	1	1	1	6	230	4	21	38	
330	" 83	do	1	1	1	6	250	6	32	42	

Serial No.	Sample No.	Location	Assay Results (ppm)								Number of Cassiterite (pcs)
		River or Creek	W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	
331	Ds Dp) 84	A. Sisi	1	9	1	9	270	6	41	30	
332	" 86	do	1	1	1	3	130	2	8	17	
333	" 87	do	37	300	1	9	160	3	12	25	
334	" 88	do	1	18	1	6	160	4	11	33	
335	" 89	do	1	1	1	3	100	2	11	16	
336	" 90	do	1	16	1	3	110	1	7	13	
337	" 91	do	1	1	1	6	160	6	16	26	
338	" 92	do	1	1	1	4	160	5	13	28	
339	" 93	do	2	1	1	7	220	5	11	26	
340	" 94	do	1	5	1	3	220	5	10	25	
341	" 95	do	8	350	1	20	160	7	12	20	
342	" 96	do	6	56	1	15	220	5	32	69	
343	" 97	do	9	20	1	4	230	8	16	46	
344	" 98	do	95	1200	1	59	350	15	21	54	
345	" 99	do	7	270	1	15	340	10	30	65	
346	" 100	A. Tonga	1	69	2	6	210	6	20	38	
347	" 101	do	1	1	1	3	120	3	8	12	
348	" 102	do	1	1	1	3	150	3	5	12	
349	" 103	do	1	13	1	5	180	10	8	20	
350	" 104	do	1	1	1	5	210	5	8	20	
351	" 106	do	1	1	1	6	200	5	10	27	
352	" 107	do	1	1	1	4	140	3	6	16	
353	" 108	do	1	1	1	9	290	7	12	25	
354	" 109	do	1	1	1	6	230	7	13	28	
355	" 111	do	1	1	1	6	190	3	7	14	
356	" 112	do	1	1	1	5	230	5	11	25	
357	" 113	do	1	1	1	9	270	8	21	64	
358	" 114	do	3	62	1	11	270	10	370	276	
359	" 116	do	4	1	1	6	220	7	27	48	
360	" 117	do	6	1	1	5	310	6	57	70	
361	" 118	do	5	190	1	29	440	16	51	127	
362	" 119	A. Siala	2	1	1	6	310	6	15	26	
363	" 120	do	1	1	1	5	290	6	13	22	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
364	Ds Dp)121	A. Siala	1	1	1	4	210	5	11	25	
365	" 122	do	1	1	1	4	180	3	8	20	
366	" 124	do	1	1	1	6	240	5	13	18	
367	" 126	do	1	1	1	4	290	8	13	31	
368	" 127	do	1	1	2	6	290	8	17	36	
369	" 128	do	1	1	1	6	350	8	15	38	
370	" 129	do	1	1	1	4	230	5	10	33	
371	" 131	do	1	1	1	6	240	6	11	24	
372	" 132	do	1	1	1	4	210	6	13	28	
373	Es Ep) 1	A. Merdua	18	20	1	6	250	4	9	22	±2000
374	" 2	do	1	4	1	5	210	5	9	23	
375	" 3	do	9	88	1	5	240	4	9	21	±2400
376	" 4	do	32	14	1	4	230	3	9	19	
377	" 5	do	27	2	1	5	210	2	8	24	
378	" 6	do	45	27	1	11	610	8	15	36	
379	" 7	do	100	17	1	4	310	2	8	26	12
380	" 8	do	31	11	2	4	200	3	7	16	
381	" 9	do	47	44	1	11	400	11	12	38	8
382	" 10	do	80	13	1	3	170	2	7	15	
383	" 11	do	82	24	1	7	380	11	18	41	
384	" 12	do	23	10	1	7	400	7	12	32	
385	" 13	do	47	69	1	5	370	4	8	21	
386	" 14	do	50	1	1	4	330	3	13	28	
387	" 15	do	32	5	1	3	250	3	13	26	
388	" 16	do	26	33	1	6	420	5	16	37	
389	" 17	do	82	4	1	11	510	7	26	43	
390	" 18	do	19	3	1	5	700	6	18	48	
391	" 19	do	49	17	1	4	530	3	18	38	
392	" 20	do	36	2	1	6	620	6	25	73	
393	" 21	do	50	1	1	4	370	3	17	41	
394	" 22	do	87	3	1	6	450	5	24	73	
395	" 23	do	60	6	1	6	600	4	28	124	
396	" 24	do	63	7	1	9	330	6	17	48	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite
397	Es Ep) 25	A. Merdua	28	83	1	10	360	5	12	28	7(pcs)
398	" 26	do	25	17	1	4	310	5	9	26	11
399	" 27	do	50	20	1	12	300	4	16	32	
400	" 28	do	95	40	1	9	290	6	16	28	
401	" 29	do	10	41	1	16	260	9	9	37	
402	" 30	do	1	45	1	4	140	2	7	17	
403	" 31	do	62	83	1	11	280	4	12	31	
404	" 32	do	1	8	1	3	120	1	6	13	
405	" 33	do	13	36	1	15	260	7	17	49	
406	" 34	do	20	24	1	7	300	8	15	41	
407	" 35	do	8	22	1	11	300	8	18	46	
408	" 36	do	1	21	1	3	130	2	14	19	
409	" 37	do	27	8	1	14	260	7	20	43	
410	" 38	do	1	1	1	3	150	2	8	26	
411	" 39	do	3	6	1	3	140	0	6	10	
412	" 40	do	1	1	1	2	150	1	8	15	
413	" 41	do	26	13	1	14	240	8	14	38	
414	" 42	do	7	6	1	10	260	7	16	40	
415	" 43	do	52	16	1	11	250	8	15	48	
416	" 44	A. Maumong	2	1	1	4	170	3	9	23	
417	" 45	do	186	41	1	9	460	2	27	25	
418	" 46	do	12	1	1	4	180	3	10	20	
419	" 47	do	1	1	1	4	160	2	6	18	
420	" 48	A. Batujongjong	310	41	1	6	920	1	74	38	714
421	" 49	do	395	270	1	6	1300	0	54	24	8
422	" 50	do	410	360	1	5	1000	0	48	23	
423	" 51	do	280	150	1	7	1150	2	31	31	
424	" 52	do	360	175	1	6	1150	1	77	25	
425	" 53	do	295	120	1	5	1350	0	35	26	
426	" 54	do	173	35	1	4	1350	0	44	29	
427	" 55	do	430	120	1	10	1800	2	116	29	
428	" 56	do	200	73	1	5	1850	3	68	35	
429	" 57	do	470	71	1	6	1050	0	37	21	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
430	Fs/Fp) 58	A. Batujongjong	430	32	1	4	750	1	24	23	
431	" 59	do	420	115	1	4	1000	0	67	23	6
432	" 60	do	100	46	1	5	1300	1	58	32	
433	" 61	do	390	710	1	5	1250	0	47	36	5000
434	" 62	do	400	240	1	4	1100	0	72	25	2500
435	" 63	do	175	340	1	6	1100	1	41	21	
436	" 64	do	270	41	1	4	1900	1	70	27	
437	" 65	do	200	94	1	7	2000	1	70	39	9
438	" 66	do	190	150	1	5	1500	2	55	32	
439	" 67	do	385	80	1	6	1050	0	126	36	
440	" 68	do	160	17	1	5	810	1	68	27	8
441	" 69	do	385	22	1	5	960	1	57	24	
442	" 70	do	162	82	1	4	410	1	40	15	9
443	" 71	do	68	29	1	3	380	4	9	26	10
444	" 72	do	43	21	1	3	350	3	10	22	
445	" 73	do	350	320	1	6	1100	1	62	25	±1500
446	" 74	do	750	1650	1	6	1250	1	46	35	11
447	" 75	do	290	51	1	6	1300	0	30	38	6
448	" 76	do	178	200	1	5	960	0	31	26	9
449	" 77	do	150	45	1	6	780	0	112	20	5
450	" 78	do	295	105	1	6	1150	1	50	30	1
451	" 79	do	400	140	1	6	1150	1	62	44	6
452	" 80	do	885	980	1	11	1150	2	102	37	±1000
453	" 81	do	150	36	1	9	690	2	62	36	8
454	Fs/Fp) 1	A. Kotabatu	220	73	1	4	510	2	21	35	3
455	" 2	do	47	44	1	12	400	14	28	60	4
456	" 3	do	28	17	2	11	390	15	26	66	100
457	" 4	do	86	47	1	4	890	2	18	29	1
458	" 5	A. Talunjilok	5	12	1	3	380	1	15	29	
459	" 6	do	75	38	1	4	610	2	19	30	
460	" 7	do	132	215	1	3	610	2	28	32	
461	" 8	do	96	57	1	4	800	2	16	30	
462	" 9	A. Paxingoan	10	33	1	10	530	11	15	41	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite
463	Fs) Fp) 10	A. Paxingoan	45	39	1	3	420	4	16	31	4(pcs)
464	" 11	do	1	110	1	27	240	10	24	41	2
465	" 12	do	13	27	1	9	410	6	15	35	1
466	" 13	do	4	18	1	10	440	9	14	36	6
467	" 14	A. Kotabatu	28	19	1	15	580	14	27	70	4
468	" 15	do	10	30	1	14	420	8	20	45	
469	" 16	do	33	91	1	14	470	13	20	62	
470	" 18	A. Sibarikkunik	1	6	1	6	320	8	16	42	
471	" 19	do	1	31	1	11	410	12	21	58	
472	" 20	do	1	62	1	10	380	11	15	50	
473	" 21	do	1	1	1	4	350	3	12	27	
474	" 22	do	1	29	1	6	330	8	14	42	3
475	" 23	do	1	31	1	5	330	4	12	31	8
476	" 24	do	1	1	1	5	360	5	15	30	2
477	" 25	do	1	57	1	5	300	4	13	35	8
478	" 26	A. Kotabatu	33	7	1	16	360	14	26	59	4
479	" 27	do	10	14	1	9	330	11	23	48	2
480	" 28	do	1	3	1	3	280	2	8	26	8
481	" 29	do	26	13	1	15	320	12	25	56	7
482	" 30	do	335	87	1	5	940	15	29	61	7
483	" 31	A. Busuk	20	16	2	14	510	14	27	68	8
484	" 32	A. Kotabatu	310	200	2	4	860	2	38	34	7
485	" 33	A. Batupenggeng	165	66	1	4	970	1	43	32	9
486	" 34	A. Kotabatu	47	29	1	14	400	12	28	70	6
487	" 36	A. Batupenggeng	50	16	1	15	370	2	28	29	11
488	" 37	do	85	10	1	4	660	2	48	38	
489	" 38	do	320	205	1	4	920	1	45	36	
490	" 39	do	110	99	1	4	810	2	68	34	
491	" 40	do	70	43	1	4	440	2	46	31	6
492	" 41	do	162	195	1	4	510	1	73	32	10
493	" 42	do	157	60	1	4	520	1	60	23	
494	" 43	do	68	51	1	4	640	1	44	35	
495	" 44	do	105	110	1	3	770	2	54	34	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
496	Fs) Fp) 45	A. Batupenggeng	89	33	1	4	600	1	57	40	
497	" 46	do	337	180	1	5	770	1	57	37	10
498	" 47	do	75	13	1	4	890	2	73	34	
499	" 48	do	148	69	1	3	910	2	53	44	
500	" 49	do	195	185	1	3	810	1	46	25	
501	" 50	do	188	19	2	3	740	2	39	40	
502	" 51	do	83	19	1	4	950	1	48	53	
503	" 52	do	176	440	1	2	1050	2	23	23	8
504	" 53	do	200	96	1	4	1050	2	54	38	
505	" 54	do	8	1	1	3	280	1	14	21	
506	" 55	do	250	180	1	4	750	2	52	28	
507	" 56	do	195	37	2	4	610	2	38	36	6
508	" 57	do	98	10	1	4	750	1	83	40	
509	" 58	do	210	92	1	4	520	1	40	36	
510	" 59	do	49	7	1	3	730	1	58	33	
511	" 60	do	89	52	1	3	880	1	53	34	
512	" 61	do	150	125	1	3	570	1	42	38	
513	" 62		48	6	2	3	730	1	187	40	
514	" 63		68	31	1	4	650	1	52	45	
515	" 64		139	13	1	5	490	1	142	50	
516	" 65	A. Batupenggeng	18	20	1	3	620	1	47	33	
517	" 66	do	40	9	1	3	580	1	51	44	
518	" 67	do	53	22	3	2	670	0	68	36	
519	" 68	do	47	6	1	3	430	1	60	42	
520	" 69	do	38	5	1	3	610	0	50	36	
521	" 70	do	195	59	1	4	770	1	51	24	
522	" 71	do	83	94	2	4	800	1	65	43	
523	" 72	do	97	47	1	4	630	0	73	41	
524	" 73	do	64	55	1	4	710	0	79	40	
525	" 74	do	89	10	1	4	720	1	91	56	
526	" 75	do	46	14	1	4	690	1	91	53	
527	" 76	do	52	6	1	4	600	1	113	46	
528	" 77	do	20	6	1	5	760	1	101	80	

Serial No.	Sample No.	Location River or Creek	Assay Results (ppm) W ppm	Sn ppm	Mo ppm	As ppm	F ppm	*Cu ppm	*Pb ppm	*Zn ppm	Number of Cassiterite (pcs)
529	Fs) Fp) 78	A. Batupenggeng	38	12	1	5	520	1	111	60	
530	" 79		153	11	1	4	430	1	86	47	
531	" 80	A. Kotabatu	16	9	1	4	380	5	17	25	
532	" 81	do	29	10	1	3	400	0	14	23	
533	" 82	do	28	30	1	3	420	4	16	26	
534	" 83	do	52	4	2	4	600	1	26	16	
535	" 84	do	190	155	2	5	770	1	76	40	
536	" 85	do	100	5	1	4	410	1	79	30	
537	" 86	do	92	43	1	5	910	1	50	54	
538	" 87	do	33	3	1	3	540	1	55	34	
539	" 88	do	28	15	1	6	790	1	117	59	
540	" 89	do	177	91	2	6	990	1	129	42	

Appendix II-2 List of X-ray diffractive analysis, Hatapang area

Sample No.	Location	Minerals											Rocks
		qz	Se	Kao	Kf	Pl	Ca	Py	ch	Zi	Tp		
DR-20		◎	o			o							Hatapang Granite, weak mineralization in Hatapang granite
DR-24		○	◎			?	o	?			o ?		" detected topas like minerals
DR-26		◎	o		?	o							"
DR-27		◎	◎										"
FR-11		o	◎			o				?			"

Condition

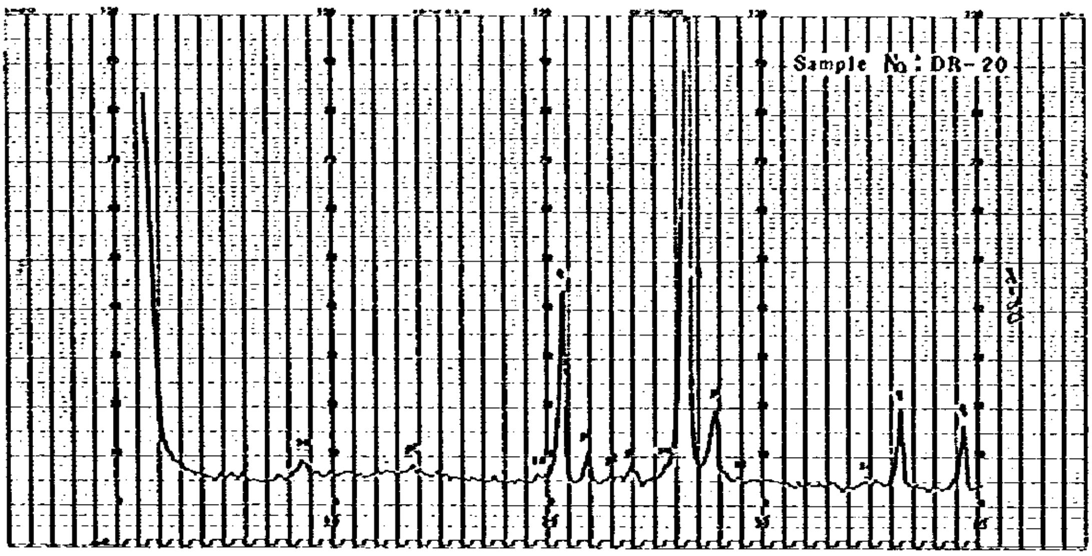
Target	Cu	qz	: quartz
Filter	Ni	Se	: muscovite or sericite
Voltage	30 kV	Kao	: Kaoline
Current	15 mA	Kf	: Potassic feldspar
Sending speed	4°/min	Pl	: Plagioclase
Time constant	2 sec	Ca	: Calcite
Divergency slit	1°	Py	: Pyrite
Receiving slit	0.5 mm	ch	: chlorite
Scatter slit	1°	Zi	: Zircon
Chart speed	4 cm/min	Tp	: Topaz
Full scale	800 cps		

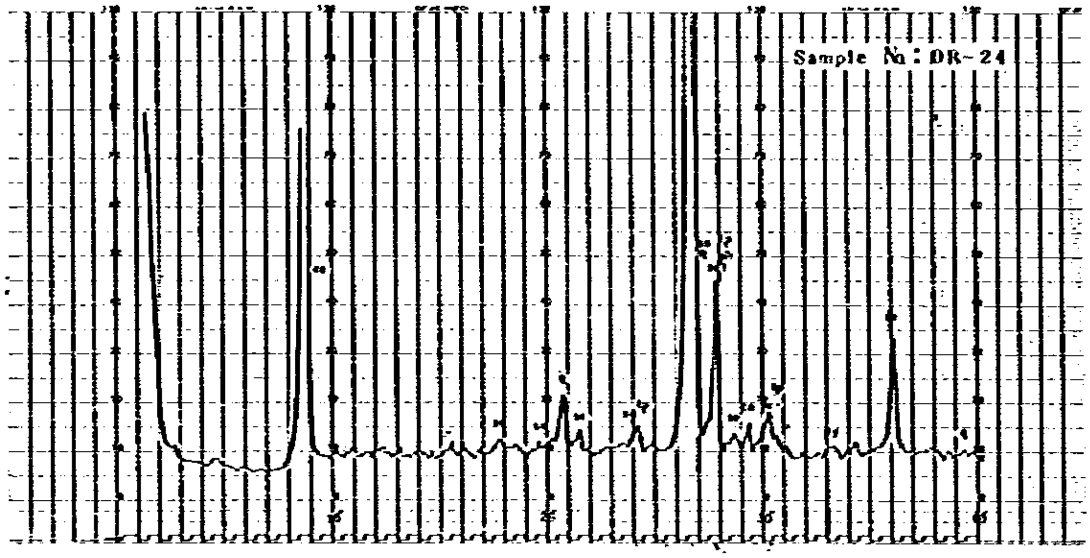
Appendix II-2 List of X-ray diffractive analysis, Hatapang area

Sample No.	Location	Minerals											Rocks
		qz	Se	Kao	Kf	Pl	Ca	Py	ch	Zi	Tp		
DR-20		◎	o			o							Hatapang Granite, weak mineralization in Hatapang granite
DR-24		O	◎			?	o	?			o ?		" detected topas like minerals
DR-26		◎	o		?	o							"
DR-27		◎	◎										"
FR-11		o	◎			o				?			"

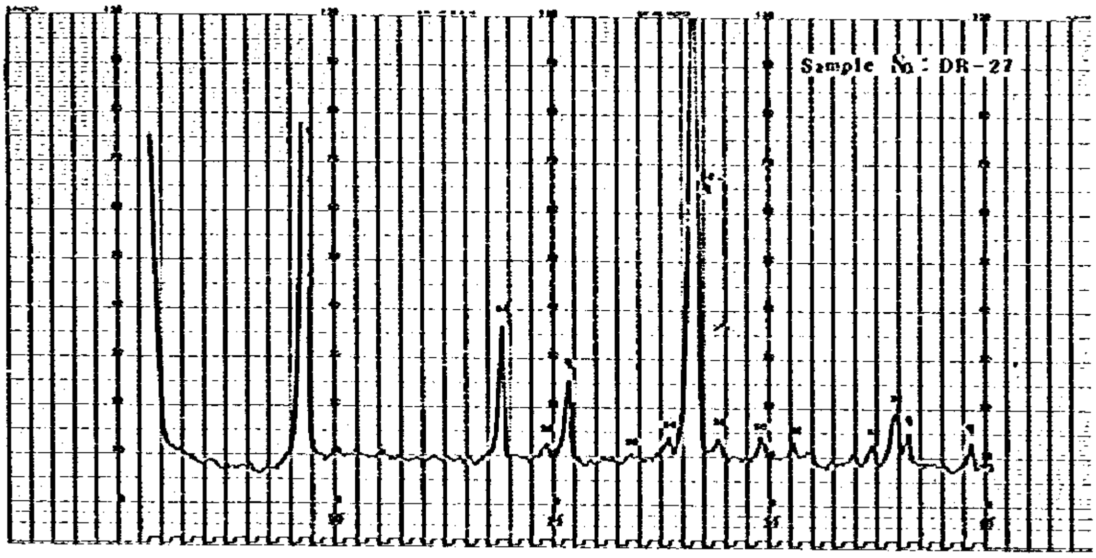
Condition

Target	Cu	qz :	quartz
Filter	Ni	Se :	muscovite or sericite
Voltage	30 kV	Kao:	Kaoline
Current	15 mA	Kf :	Potassic feldspar
Sending speed	4°/min	Pl :	Plagioclase
Time constant	2 sec	Ca :	Calcite
Divergency slit	1°	Py :	Pyrite
Receiving slit	0.5 mm	ch :	chlorite
Scatter slit	1°	Zi :	Zircon
Chart speed	4 cm/min	Tp :	Topaz
Full scale	800 cps		





Appendix II-2 Charts and List of X-Ray Diffractive Analysis in Hatapang Area (1)



Appendix II-2 Charts and List of X-Ray Diffractive Analysis in Hatapang Area (2)

Appendix II-3-(1) Microscopic Observation of Thin Section in Hatapang Area

Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	k-f	pl	Bt	Hb	Au	Hy	Ol	Op		Q	Si	k-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kao	Bt	Act	Epi	Tau	Op	Py		
Toba tuff																																					
	Dacitic vitritic tuff	Pyrocras	○		○	○	●																Volcanic glass ◎														
Hatapang Formation																																					
AR 15	Pebbly siltstone	Silt	◎	●	○							Lith O	◎											○				○						○			bad sorted
BR-7	Siltstone	"	◎		○																		clay				○										
DR-6	Pebbly siltstone	"	◎	●	●							Lith 1																									bad sorted
DR-22	Silt stone	"	◎		●																		clay														good sorted
DR-31	Silt stone	"	◎	●	●							Chert Granite																									Rock fragments are abundantly
AR-13	Biotite Hornfels	Re-crys	◎		●							Lith 1	◎										ser ○							○							
BR-5	"	"	◎		●																						○			◎							
BR-8	"	"																						◎						◎						Muscovite ○	recrysalline
BR-21	"	"	◎		●							Chert												o			o			◎							Slaty
FR-5	(Biotite) Hornfels	"	◎	o	o						○	Chert andesite															●			●							
Hatapang Granite		"																																			
AR-6	Aplite	Hol crys	◎	◎	◎							Flo sphe															●										
AR-10	Granite	"	◎	◎	◎	◎						Top Flo															●	○									
AR-24	Two mica Granite	f.G. Hol crys	◎	◎	◎	o						Mus Flo Top															●	○									rich fluorite
BR-18	Granite	"	◎	◎	◎	◎						Top Sph Zir															○	○									

Re-crys: Recrystal　　Lith: Lithic　　Sphe: Sphane　　Flo: Fluorite　　Zir: Zircon
Hol-crys: Hollo crystal　　Top: Topaz　　Ap: Apatite　　Mus: Muscorite
◎ Abundant　　○ Common　　● Rare

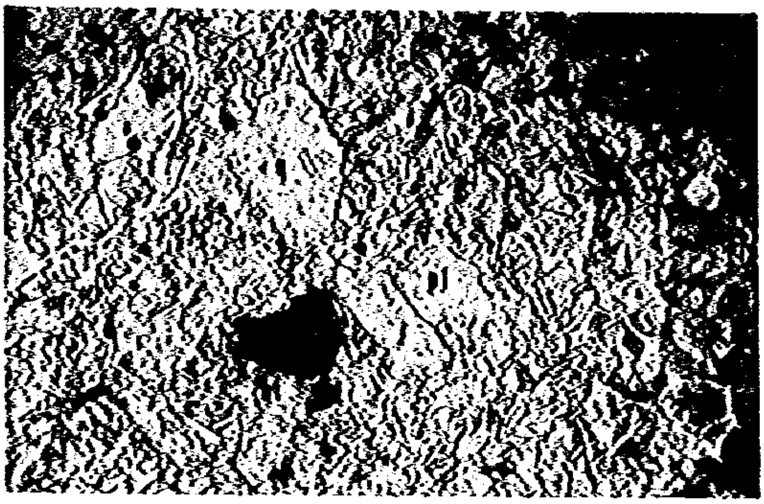
Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	k-f	pl	Bt	Hb	Au	Hy	Ol	Op		Q	Si	k-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kao	Bt	Act	Epi	Tau	Op	Py		
BR-24	Two mica Granite	f.G Hol crys	◎	◎	◎	∘						Top Ap Mus Flo															●	●									
CR-7	Granite	Hol crys	◎	◎	◎	◎						Flo Zir Sphe															●	●									
CR-11	Granite	f.G Hol crys	◎	◎	◎	●						Top Zir															●	●									rich tapaz
CR-20	Granite	"	◎	◎	◎	∘						Top															●	●									
DR 10	Granite	Hol crys	◎	◎	◎	●						Top Flo												◎			●	●									Recrystalized quartz are abundant. Silicification
DR 19	Granite	f.G Hol crys	◎	◎	◎	○						Zir Sphe Flo															∘	∘									
DR 25	Granite	f.G Hol crys	◎	◎	◎	◎						Top Flo																									Topaz are rich
ED 1	Granite	"	◎	◎	◎	○						Zir, Mus Flo, Sphe															●	●									
ER 15	Granite	"	◎	◎	◎	○					●	Zir, Mus Flo, Sphe															●	●									
ER 50	Granite	"	◎	◎	◎	○						Flo, Zir Sphe															●	∘									
ER 57	Granite	"	◎	◎	◎	○					●	Sphe Flo															●	∘									
FR 14	Granite	"	◎	◎	◎	○						Top, Zir															●	●									
FR 20-2	Granite	"	◎	◎	◎	○					●	Mus Flo, Sphe															∘	∘									
Dyke Rock																																					
BR 6	Andesite	Porph			◎	●	(?)	(?)					∘			◎						∘				∘											mafic mineral are all altered
DR 18	Augite Andesite	"						○								○			○							∘		∘									
ED 46	Augite Andesite	"			◎		○	○								◎			◎									∘									
Others																																					

Appendix II-3-(2) Microscopic Observation of Polished Section, Hatapang

	Location	Mineral							Remarks
		Py	Lim	Hem	Tour	W	Cas		
CR-4	Hatapang River			●					
CR-14	Hatapang River		●	●					
DR-11	Mabut River				?				
DR-15	"			●					
DR-16	"		o	o		?			
DR-20	"			o					
DR-21	"			●					
DR-26	"		●	●					
DR-27	"	●							
Batu Jong Jong	Batu Jong Jong						○		Out crop collected by DMR
BP-86	Batu Jong Jong						○		Panning sample
AP-27	North of Bandar Maju						○		"

Py: Pyrite   Hem: Hematite   W: Wolframite
Lim: Limonite   Tour: Tourmaline   Cas: Cassiterite

○ : Common   ● : Rare
o : Present   ? : Probably



Sample No.: AR-1

Location : Kota Batu River

Rock Name : Toba Tuff
(dacitic vitric tuff)

q : quartz
pl: plagioclase
bt: biotite
matrix is volcanic glass

open nicol

0 0.5 mm

Sample No.: CR-11

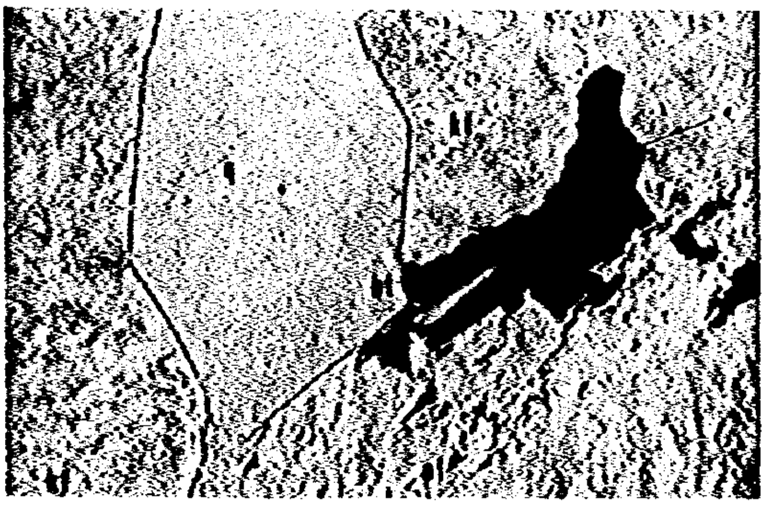
Location : Hatapang River

Rock Name : Hatapang Granite

q : quartz
pl: plagioclase
bt: biotite
kf: potassic feldspar
tp: topaz

open nicol

0 0.5 mm



Sample No.: FR-14

Location : East of Hajoran

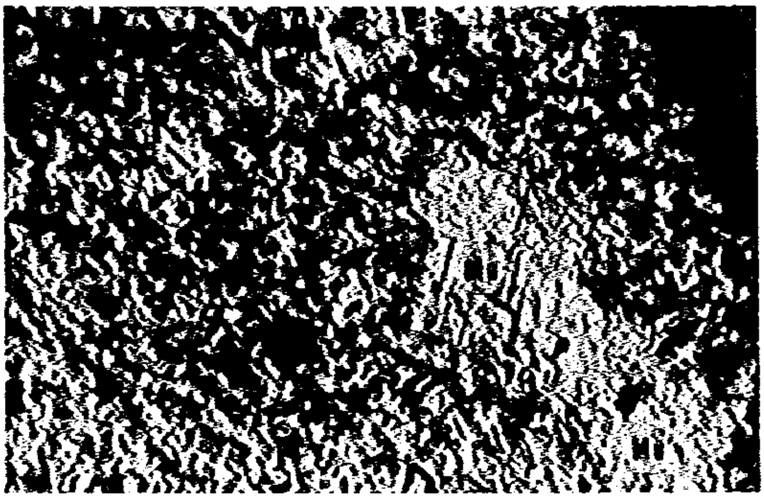
Rock Name : Hatapang
Porphyritic Granite

q : quartz
pl: plagioclase
kf: potassic feldspar
bt: biotite

open nicol

0 0.5 mm

Appendix II - 4 Photographs of Microscopic Observation of Thin Section and Polish section, Hatapang Area



Sample No.: BR-8

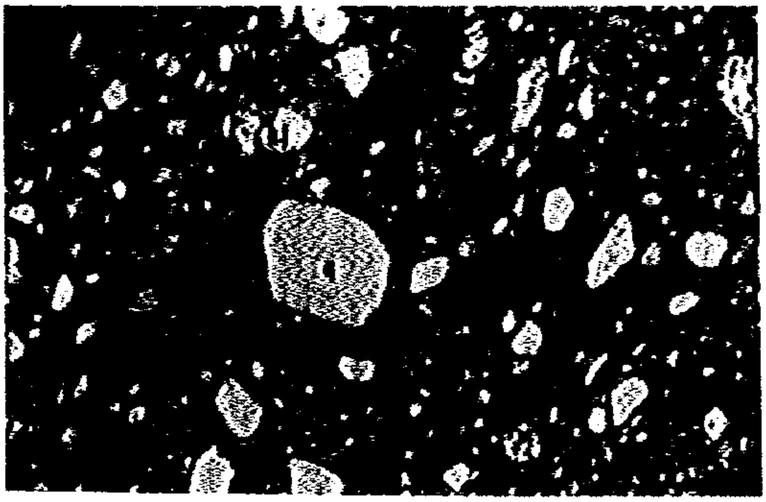
Location : Haumong River

Rock Name : Biotite Hornfels

Mu: muscovite
bt: biotite (columner crystal)
q : quartz (matrix)

open nicol

0 0.5 mm



Sample No.: DR-6

Location :

Rock Name : Silt Stone (Hatapang Formation)

q : quartz
kf: potassic feldspar

open nicol

0 0.5 mm

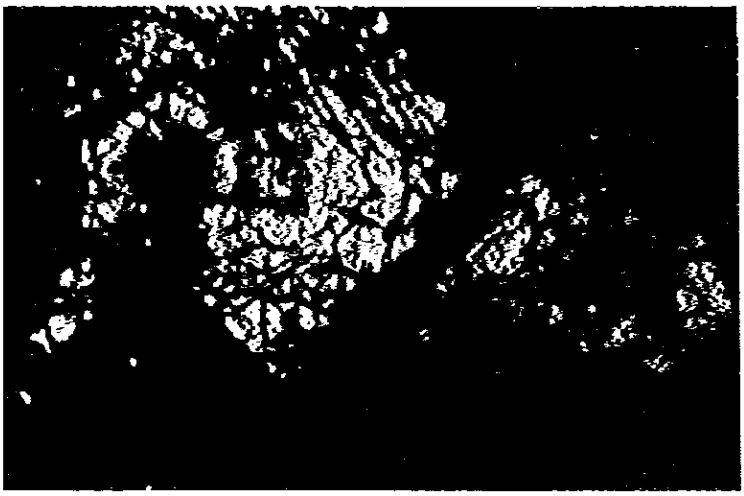
Sample No.: Panning BP-82

Location : S.Batu Jong Jong

Rock Name : Cassiterite

open nicol

0 0.2 mm



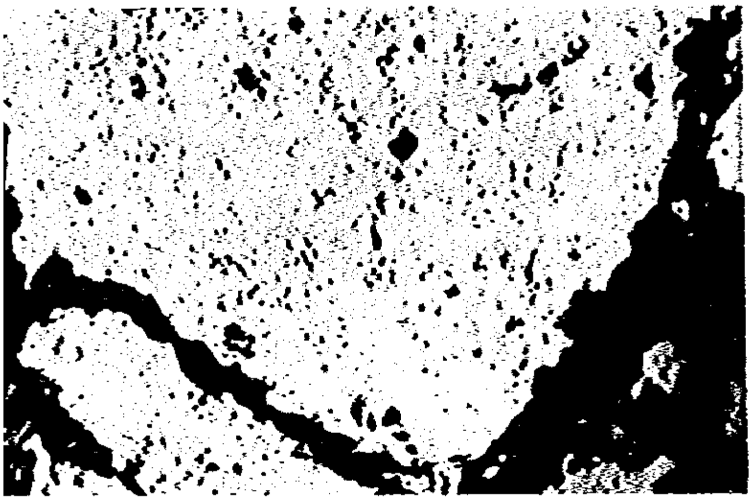
Sample No. : Panning BP-82

Location : S.Batu Jong Jong

Sample Name: Cassiterite

cross nicol

0 0.2 mm



Sample No. : Batu Jong Jong (outcrop)

Location : Batu Jong Jong

Sample Name: Cassiterite (polish sample)

0 0.2 mm

PART THREE

MUARA SIPONGI AREA

CHAPTER 1 OUTLINE

1-1 Purpose of the Survey

This survey was intended to shed light upon the mineralization zones of gold, silver, copper, lead, and zinc distributed in the survey area; to elucidate the survey area's geology, geological structure, and igneous activity, and to explore their mutual relationship in order to study prospecting possibilities in the mineralization zones.

1-2 Previous Surveys

In 1970, the Overseas Mineral Resources Development Company conducted a prospecting survey on metallic mineral resources in the Muara Sipongi Area, from a regional survey of block No. 5. The Indonesian (DMR) and British (IGS) Cooperative Survey also performed an integrated geological survey from 1975 to 1980, and compiled a 1/250,000 scale geological map of the Natal Quadrangle (Rock et. al.; 1980).

1-3 Survey Methods and Quantities

(1) Geological Survey

Existing topographical maps in 1/40,000 scale were enlarged to 1/20,000 scale; these were employed in conducting a geological survey along the major rivers. In addition, sketches of mineral deposits in appropriate scale were made for each mineralization zone. Geological maps in 1/40,000 scale were compiled. The survey covered an area of 400 km^2, with the total extent of the geological survey and exploration being 241km.

(2) Geochemical Investigation

Along with the geological survey, a geochemical investigation was carried out in which samples of stream sediment were taken from each of the major rivers and tributaries by means of an 80-mesh sieve, and these samples were subjected to geochemical analysis. In total, 523 samples were collected, including spare samples. Of the total, 500 samples of gold, silver, copper, lead, zinc, molybdenum, and arsenic were analyzed as pathfinder elements. The samples were divided into three portions to be retained by the Japanese team and the Indonesian DMR and MRO respectively.

(3) Placer Gold Survey

Because existing literature indicated the presence of gold in the mineralization areas distributed in the survey area, a survey was carried out in order to prospect placer gold in stream sediment. The placer gold survey, conducted by means of panning, was intended to investigate the connection between the distribution of placer gold and primary ore deposits in the area. Total samples collected numbered 522.

(4) Other Items

The following samples underwent analysis for the survey: rocks (microscopic analysis, 54 samples); ores (microscopic analysis, 22 samples); granites (complete analysis, 20 samples); ores (analysis, 24 samples); granites (age determination, 3 samples) X-ray analysis, (10 samples). In addition, 4 samples were selected from those collected by panning for the survey of placer gold within the survey area; these, along with one sample of placer gold from West Kalimantan, were subjected to an electron probe microanalyzer test to determine the comparative content of gold, silver, and trace elements.

CHAPTER 2 GEOLOGY

2-1 Geological Outline

The geology of the survey area can be roughly grouped, beginning with the lower strata, into sedimentary and volcanic rock strata from the Permian-Carboniferous systems, granites from the Jurassic period and andesite and dacite pyroclastics from the Tertiary system; and the Quaternary system. Figure III-1 generalizes stratigraphs, geological structure, and igneous activity in the survey area. (PL III-1)

The names of formations and rocks used in the report are newly given according to the name of the places, mountains or rivers where those strata and rocks are extensively distributed, in order to avoid confusion with the names of strata and rocks in other existing literature.

2-2 Geology

2-2-1 Paleozoic Sedimentary and Volcanic Rocks

(a) S. Ranya Formation

Distribution: The oldest formation within the survey area, these are widely distributed at the survey area's northeast edge, mainly around the Ranya River.

Rock facies: The rock is composed of coarse-grained, light gray quartz arenite intercalating fine-grained sandstone and siltstone. This fine-grained sandstone and siltstone is deposited with good graded bedding. Some quartz arenite grains are revealed under microscopic examination (RA 107) to have been altered in places by contact with porphyritic biotite granite and to have recrystallized.

Thickness of strata: While as yet unconfirmed, the lower part of the thickness of the Formation is estimated at 2,000 m.

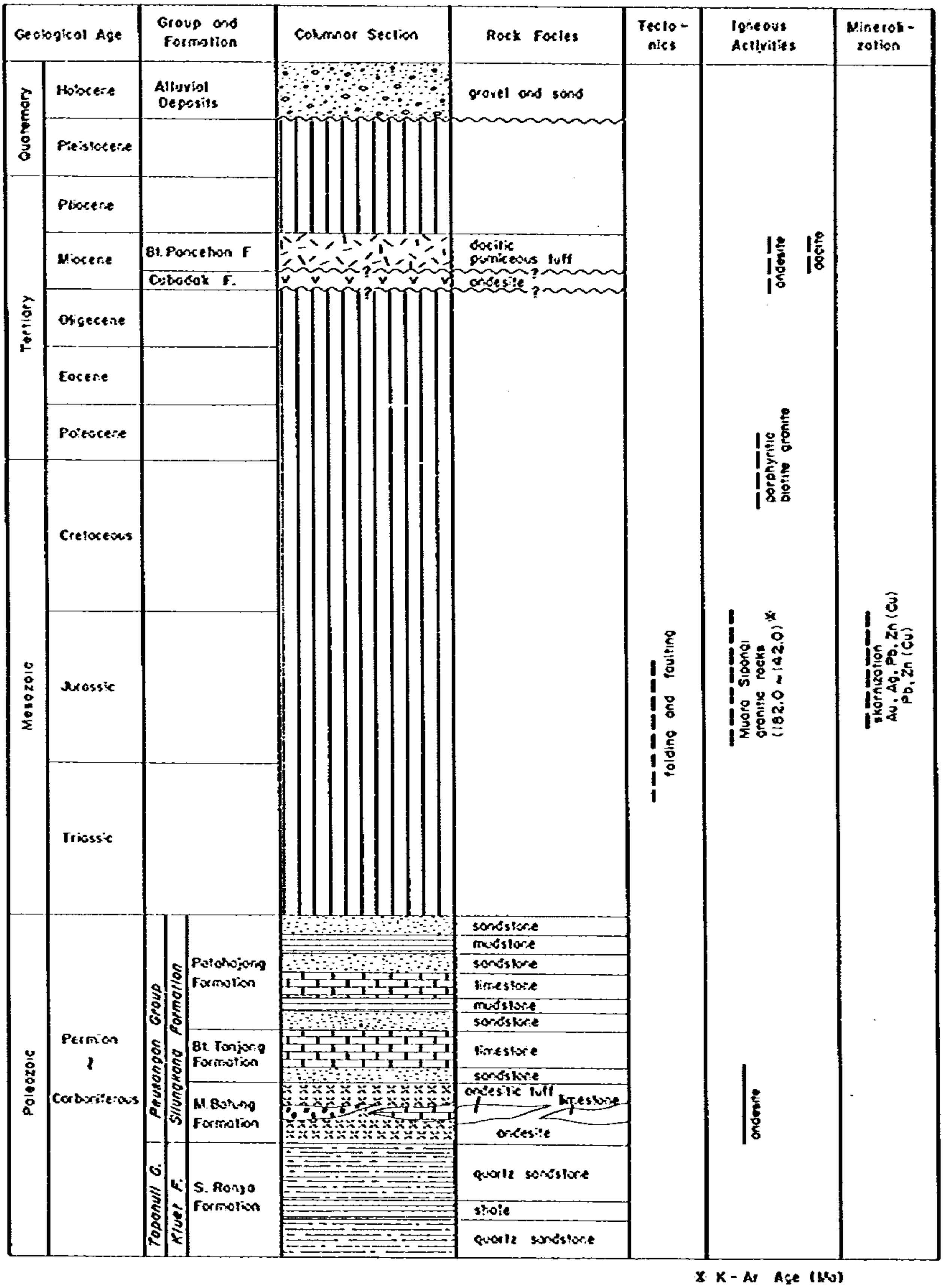


Fig. III-1 Generalized Stratigraphy of Muara Sipongi Area

Geological structure: From east to west, the strike and dip of the strata change from N 10°∿70°W NE dip to N10°∿70°W SW dip suggesting an anticline structure.

Stratigraphy: Because the formation is correlative with the Kluet Formation in terms of the rock facies, the Indonesian-British team determined that these strata are correlative to the Kluet Formation of the Tapanuli Group.

(b) Muara Batung Meta-andesite Formation

Distribution: The type locality for the Formation is M. Batung Village, where it is widely distributed around the M. Batung River. It is also commonly found to the east, around the Bubungan River south of the village of Limau Manis, and to the west, as far as the northeastern Pagar Gunung region and the Si Ayu River region. Also included within these strata because of its close similarity is the Meta-andesite Formation widely distributed in the Si Binol River region in the northeast of the survey area, north of the Muara Sipongi granitic intrusion.

Rock facies: These strata are composed mostly of massive, dark green andesite lava. In addition, andesite pyroclastic rock is found especially in the upper reaches of the M. Batung and Sipongi Rivers, and pebble andesite tuff strata, containing andesite pebbles, are distributed around the upper reaches of the Cubadak River.

Andesite lava is hard and massive, with strikingly developed joints, and contains phenocrysts of colored mineral hornblende. In the highly altered, massive andesite outcrops are parts which appear to be fine-grained holocrystalline diorite. Microscopic observation (B136, E116 etc.) reveals that plagioclase and colored mineral phenocrysts are embedded in ground mass consisting of plagioclase and clay minerals, but the plagioclase and colored minerals have been altered into sericite, chlorite and epidote. The rock has been altered into meta-andesite.

The andesitic pyroclastic rock includes dark green tuff breccia and lapilli tuff, and is accompanied in places by fine-grained tuff. Andesite pebbles (2 - 5 cm) accompanying conglomerate tuff have been identified in the upper reaches of the Cubadak River.

Under the microscope (CR-48), the andesites distributed widely around the Si Binol River to the northeast of the Muara Sipongi granitic rocks, are revealed to have been altered in the same way as those of M. Batung meta-andesite and are grouped as a member of the M. Batung Meta-andesite Formation.

Pyrite is universally disseminated around the contact areas of these strata with granites.

Thickness of strata: 1,300 m+

Stratigraphy: These strata are, along with the Patahajang Limestone and Clastic Rock Formation reported on next, correlative with the Permian - Carboniferous Silungkang Formation of the Peusangan Group distributed in Central Sumatra (Katili 1968, Silitonga, Kastowo 1975).

(c) Patahajang Limestone and Clastic Formation

Distribution: The limestone and clastic Formation which overlies the M. Batung andesite Formation has been named the Patahajang Formation. It is widely distributed to the east of Ranjau Batu, around the upper reaches of the Cubadak and Gadis Rivers, and in the area between Pagar Gunung and Patahajang.

Limestone strata which is directly accompanied by M. Batung meta-andesite is especially called the Bt Tanjang Limestone Formation.

Rock facies: The Formation distributed south of Ranjau Batu (along the Cubadak River) is composed of white limestone, calcareous siliceous rock, sandstone, and mudstone; some of the siliceous rock is tuff-like. Around the upper reaches of the Cubadak River, thin layers of conglomerate are intercalated between the formation and M. Batung meta-andesite. The limestone had undergone saccharoidal recrystallization at contact areas with granite. Outcrops of pebbly limestone containing limestone pebbles are found along the road leading from Ranjau Batu to Cubadak.

Sandstone and mudstone beds of the Formation found in Patahajang have been deposited with graded beddings. The Formation intercalated beds of pale gray tuff and calcareous layer.

Geological structure: The Formation distributed along the Cubadak River from Ranjau Batu strikes generally N 70°W, and dips 70°SE. Several isoclinal foldings with WNW folding axes show drag folding brought about by the synclinal structure of the Formation.

Stratigraphic correlation: This Formation overlies conformably with the M. Batung Meta-andesite Formation, and is correlative with the Silungkang Formation of the Peusangan Group, distributing at West Sumatra because of similar rock facies, namely the Meta-andesite and Limestone Formation.

2-2-2 Younger Dacitic Tuff Formation

Distribution: This Formation is commonly found unconformably overlying Permian-Carboniferous system and M. Sipongi granite along the southern marginal area of the survey area, in the south area of the Pagar Ganung to Patahajang region, in the area of the upper reaches of the M. Batung River into the upper reaches of the Simpang Datur and Tabar Rivers, and from the upper reaches of the Cubadak River into the Lao region.

Rock facies: These strata are formed mainly of dacitic tuff and pumiceous lapilli tuff, the latter being the principal member of the Formation. Pale green or gray in color, they are revealed under the microscope (ER-132) to contain rock lithic fragment pumice, quartz, feldspar, and biotite fragments within the vitreous matrix.

Thickness of strata: 1,500 m+

Stratigraphic relationship: Uncomformably overlying Permian-Carboniferous sedimentary and meta-andesite Formations and Jurassic granitic rocks, it is considered to belong to the mid-Tertiary Pyroclastic Formation which is distributed widely in northern Sumatra.

2-2-3 Tertiary Andesite

Fresh dark gray andesite is distributed in east Cubadak and in the northeastern part of Tolang. The microscope observations reveals phenocrysts of plagioclase and small quantities of pyroxene, quartz within matrix filling mostly small plagioclase.

2-2-4 Alluvium System

This is alluvium sediment composed mostly of unconsolidated pebbles, sand, and silt. It is distributed in the lowland Lao region and in the major river basins.

CHAPTER 3 MUARA SIPONGI GRANITOID ROCKS

3-1 Muara Sipongi Granitoid Rocks

Distribution: These granitoid rocks are widely distributed over an area 2 - 5 km wide and over 20 km long from Kotanopan in the central survey area through Muara Sipongi and into Ranjau Batu. They are also commonly found in the northern part of Pagar Gunung which lies in the western survey area.

Rock facies: These are composed primarily of medium-grained holocrystalline hornblende granodiorite and quartz diorite, with occasional small distributions of diorite. The main rock forming minerals under the microscope are quartz, plagioclase, and hornblende, with smaller quantities of biotite and potassic feldspar. Fresh rocks are rare and most minerals are slightly altered; namely, plagioclase and hornblende have often been altered into sericite, chlorite, and other minerals.

Intrusion time: As indicated in the following, the absolute age of the granitoide rocks has been determined by the K-Ar method to be 182 - 142 Ma. The Muara Sipongi granitoid rocks therefore intruded during the Jurassic period.

3-2 Time of Intrusion

Three samples were taken of Muara Sipongi granitoid rocks in order to determine their intrusion period. The absolute age of hornblende within the samples was measured by means of the K-Ar method. Measurement results are shown in Table III-1.

The results indicated the Muara Sipongi granitoid rocks to be from 182 Ma - 142 Ma in age and to have intruded during the Jurassic period.

Table III-1 Result of K-Ar Age Determination in Muara Sipongi Area

No.	Sample No.	Locality	Rock Name	Mineral or Rock	40 Ar/Rad sec/gm x 10^{-5}	40 Ar/ Rad%	K%	Age (m.y.)
1	BR-213	Tandjang Aiai	Granodiorite	Hornblende	.214 .217	39.8 40.2	.37 .38	142±7
2	ED-3	A. M. Batung	Quartz Diorite	Hornblende	.106 .108 .111	28.3 17.4 20.6	.16 .16	166±20
3	FR-226	Barlan	Granodiorite	Hornblende	.302 .314 .323	48.6 51.5 41.3	.42 .42	182±7

3-3 Chemical Composition

Twenty samples were selected from points evenly distributed within the Muara Sipongi granitoid rocks. These samples were analyzed for their main components (13 components) and minor elements of fluorine and chloride. Table III-2 shows the results of the analysis and norm minerals as calculated from their analyzed values.

The results of the analysis showed half of the samples (10) to be intermediate and composed of 62% - 70% SiO_2. Of the remainder, 7 were slightly basic and composed of 53% - 62% SiO_2 while 3 were basic and composed of 43% - 53% SiO_2. Fig. III-2 shows the relationship of the norm minerals quartz - plagioclase (anorthite + albite) - potassic feldspar as calculated from the results of chemical analysis. According to this relationship, the granitoid rocks can be grouped into the following categories: granodiorite - quartz diorite - diorite by classification of IUGS. Dioritic and quartz diorite are distributed adjacent to a mineralization zone extending from the Subun-Subun deposit to the Bt Pionggu zone and into the Si Ayu skarn zone.

According to the variation diagram indicating relation between each oxide differentiation index shown in Fig. III-4, all oxide components indicate a linear change. Al_2O_3 and FeO are somewhat low and Fe_2O_3 somewhat high when compared with the average tendency of Japanese granitoid rocks of the Cretaceous age (Aramaki 1972), but in general there exists an extremely close relationship. This small discrepancy in Al_2O_3, FeO, and Fe_2O_3 is also found with regard to granitoid rocks in West Kalimantan (MMAJ · JICA / DMR 1979 - 1981), but the Muara Sipongi granitoid rock is considered to be similar to West Kalimantan granites in tendency. The K_2O - Na_2O - K_2O relationship included for reference (Fig. III-5) also resembles the relationship of granitoid rocks in Japan.

Table III-2 Chemical Composition of Constitution Mineral of Granitic Rocks in Muara Sipongi Area

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Sample No.	AR-51	AR-55	AR-77	AR-100	BR-185	BR-192	BR-213	DR-84	ED-2	ED-3	ER-222	ER-233	ER-237	FR-208	FR-226	FR-229	FR-237	FR-243	FR-248	AR-105
	Location	Pinyoget	S.Moliti	A.Si Bu-bungan	A.Cubadak	Simpang Tinggo	S.Nanga-ton	Tandjung Alai	Tolang	A.Tabur	S.Manga-mpo	Tobang	A.Simpo-ng Kamar	Kota Tinggi	A.Si Am-bok	A.Barlan	A.Simpa-ng	A.Si Aju	B.Pung-kut	A.Kaya	A.Hago
	Rock Name	Gr-dio	Gr-dio	Gr-dio	Gr-dio	Qz-dio	Qz-dio	Gr-dio	Gr-dio	Qz-dio	Qz-dio	Gr-dio	Gr-dio	Gr-dio	Gr-dio	Gr-dio	Gr-dio	Qz-dio	Dio	Gr-dio	Granite
Chemical Composition	SiO_2	55.94	60.26	58.56	65.55	58.01	53.22	64.65	70.17	47.61	56.61	58.21	62.58	63.53	70.62	62.80	62.10	50.50	43.39	67.92	66.19
	Al_2O_3	17.36	16.58	17.10	15.36	15.79	18.00	15.39	15.67	17.98	18.20	17.03	15.70	15.91	16.37	15.91	16.29	19.21	17.11	15.26	15.01
	CaO	7.06	6.23	6.51	3.80	10.45	8.60	4.51	3.03	10.35	7.21	6.80	5.10	5.10	3.15	5.00	4.52	9.43	13.97	2.32	3.13
	MgO	3.91	3.32	2.93	1.89	2.26	4.64	2.43	0.76	6.82	3.38	3.62	2.59	2.62	0.57	2.41	2.65	4.88	8.01	1.00	1.39
	Na_2O	2.91	2.95	3.69	3.81	0.31	2.50	3.28	4.23	2.46	3.64	3.03	3.84	3.19	4.50	3.56	3.82	3.26	1.60	3.34	2.65
	K_2O	1.48	1.72	1.41	2.43	0.80	1.19	2.47	2.90	0.58	0.73	1.56	2.33	2.21	1.39	2.05	1.82	0.77	0.07	2.55	4.02
	Fe_2O_3	2.80	2.27	3.78	1.82	4.98	2.74	2.06	1.30	4.06	4.17	2.63	2.71	2.22	1.13	2.17	2.48	4.15	1.57	0.90	0.99
	FeO	4.32	3.89	3.10	2.66	1.58	5.69	2.81	1.15	5.76	3.53	4.25	2.66	3.02	0.72	3.24	3.10	4.75	6.55	2.16	3.89
	MnO	0.18	0.13	0.12	0.09	0.43	0.17	0.10	0.06	0.17	0.16	0.14	0.11	0.11	0.05	0.11	0.11	0.16	0.15	0.06	0.10
	TiO_2	0.61	0.61	0.52	0.43	0.64	0.73	0.56	0.33	0.60	0.64	0.70	0.58	0.56	0.19	0.60	0.58	0.60	0.21	0.41	0.74
	P_2O_5	0.13	0.11	0.09	0.07	0.12	0.15	0.09	0.05	0.10	0.16	0.15	0.10	0.10	0.03	0.12	0.10	0.13	0.04	0.09	0.19
	BaO %	0.05	0.06	0.07	0.07	0.02	0.04	0.07	0.08	0.03	0.05	0.05	0.06	0.05	0.08	0.07	0.05	0.03	0.02	0.04	0.11
	LOI	2.98	1.94	2.24	1.81	4.74	2.22	1.84	0.73	3.09	1.90	2.26	1.97	1.56	1.45	1.85	2.42	2.32	3.02	3.83	1.66
	Total	99.73	100.07	100.12	99.79	100.13	99.89	100.26	100.46	99.61	100.38	100.43	100.33	100.18	100.25	99.89	100.04	100.19	95.71	99.88	100.07
	F ppm	150	210	260	340	380	230	340	280	100	150	270	260	310	280	410	320	120	70	300	640
	Cl ppm	200	100	200	100	100	100	400	100	200	100	200	100	700	100	700	200	300	<200	<400	300
C.I.P.W. Norm	q	11.44	17.20	14.02	22.22	29.06	7.48	22.26	26.73	0	12.36	13.90	17.26	21.07	31.56	19.33	18.27	1.65	0	31.33	24.75
	or	8.75	10.17	8.33	14.36	4.73	7.03	14.60	17.14	3.43	4.31	9.22	13.77	13.06	8.21	12.12	10.76	4.55	0.41	15.07	23.76
	ab	24.61	24.95	31.21	32.22	2.62	21.14	27.74	35.77	20.80	30.78	25.62	32.47	26.98	38.06	30.11	32.30	27.57	13.53	28.25	22.41
	an	29.94	26.92	25.94	17.64	39.33	31.38	19.98	14.70	36.31	31.17	28.27	18.73	22.57	15.47	21.38	21.77	35.52	39.30	10.92	14.29
	c	0	0	0	0	0	0	0	0.19	0	0	0	0	0	1.81	0	0.06	0	0	3.00	1.06
	di	3.43	2.65	4.6	0.61	9.47	5.95	1.46	0	11.56	2.83	3.64	4.73	1.68	0	2.14	0	8.37	24.11	0	0
	hy	13.02	11.48	7.04	7.24	3.69	15.94	8.07	3.09	14.99	9.34	11.98	6.08	8.70	2.03	8.33	11.56	12.73	10.32	5.93	9.84
	rhag	4.06	3.29	5.48	2.64	4.64	3.97	2.99	1.88	5.88	6.04	3.81	3.93	3.22	1.64	3.15	3.59	6.01	2.28	1.30	1.43
	il	1.16	1.16	0.99	0.82	1.22	1.39	1.06	0.63	1.14	1.22	1.33	1.10	1.06	0.36	1.14	1.10	1.14	0.40	0.78	1.41
	ap	0.31	0.26	0.21	0.17	0.28	0.36	0.21	0.12	0.24	0.38	0.36	0.24	0.24	0.07	0.28	0.24	0.31	0.09	0.21	0.45
	ol	0	0	0	0	0	0	0	0	2.15	0	0	0	0	0	0	0	0	6.23	0	0
	hm	0	0	0	0	1.78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	96.72	98.08	97.82	97.92	96.82	97.64	98.37	100.25	96.50	98.43	98.13	98.31	98.58	99.17	97.98	99.65	97.85	96.67	96.79	99.40
	Q+Or+ab	44.80	52.32	53.56	68.80	36.41	35.65	64.60	79.64	24.23	47,45	48.74	63.50	61.11	77.83	61.56	61.33	33.77	13.94	74.65	70.92
	D.I.	46.31	53.34	54.75	70.26	37.61	36.51	65.67	79.44	25.11	48.21	49.67	64.59	61.99	78.48	62.83	61.55	34.51	14.42	77.13	71.35
	Group																				
	age (my)							142±7			166±20					182±7					

An M-F-A relationship diagram was prepared in order to understand the differentiation tendency of the granitoid rocks and the result is shown in Fig. III-3. This differentiation tendency agrees with the average differentiation tendency for calc-alkaline rock series, suggesting that the Muara Sipongi granitoid rocks are calc-alkaline rock series granitoid rocks of the island-arc.

The minor elements fluorine and chlorine were assayed and the Muara Sipongi granite found to contain 100 - 700 ppm of chlorine and 70-380 ppm of fluorine. The content of fluorine, while dispersed, is tending to increase in proportion to SiO_2 (increasing in proportion to the progression of differentiation); chlorine shows no tendency. Granitoid rocks indicating a particularly high value (400 - 700 ppm), however, tend to be distributed at the adjacent mineralization zone.

In order to determine the oxidation - reduction conditions for granite, the relative amounts of FeO, Fe_2O_3, and TiO_2 (mol%) were plotted on a triangular diagram. These four lines were the oxygen reaction lines, and any change taking place along these lines results only from fluctuations in the oxygen quantity (Tsusue, Ishihara; 1974). The granitoid rocks in this area were plotted in the same region as the magnetite-series San-in Shirakawa granite of Japan (Tsusue, Ishihara; 1974), and strongly resembles magnetite series granite (Fig. III-6, 7, 8, 9).

3-4 Bt Ruruk Raru Granite

In the survey area's northeastern part, the upper reaches of the Ranya River, and at Bt Ruruk Raru in the upper reaches of the Kanal River, is located the S. Ranya Quartz Arenite Formation in the form of small intrusions of porphyritic biotite granite. Microscopic observation (Ar-105) reveals it to be holocrystalline and to consist of quartz, plagioclase, potassic feldspar, and hornblende, as well as by some biotite and a small amount of

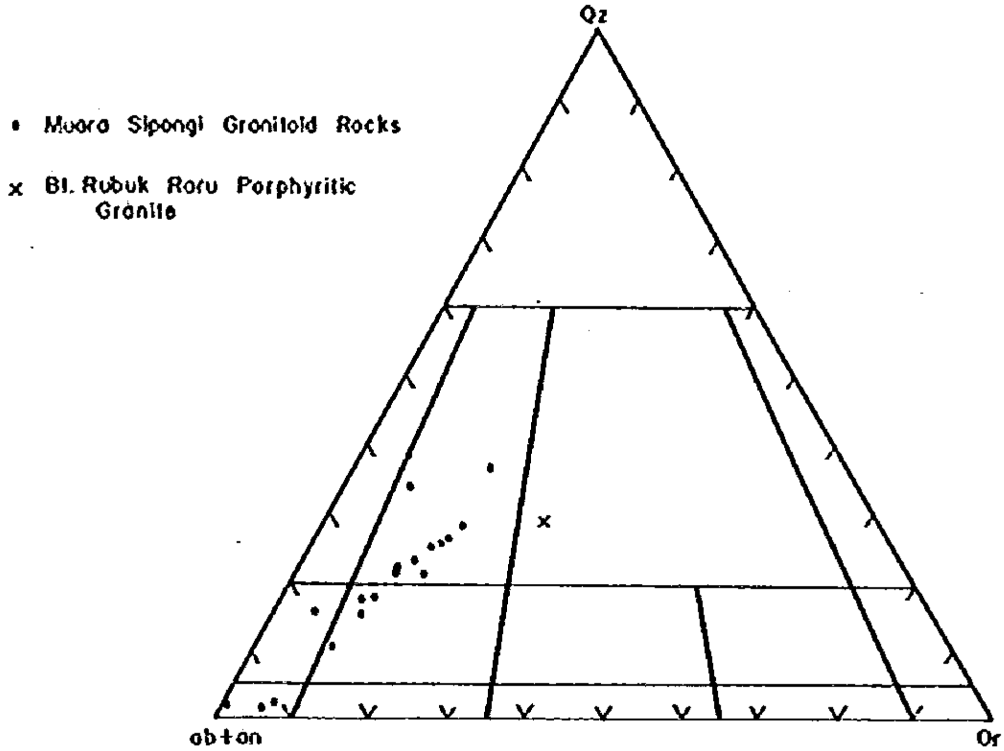


Fig. III-2 Normative Qz-Pl(ab+an)-Or Diagram of Muara Sipongi Granitoid Rocks

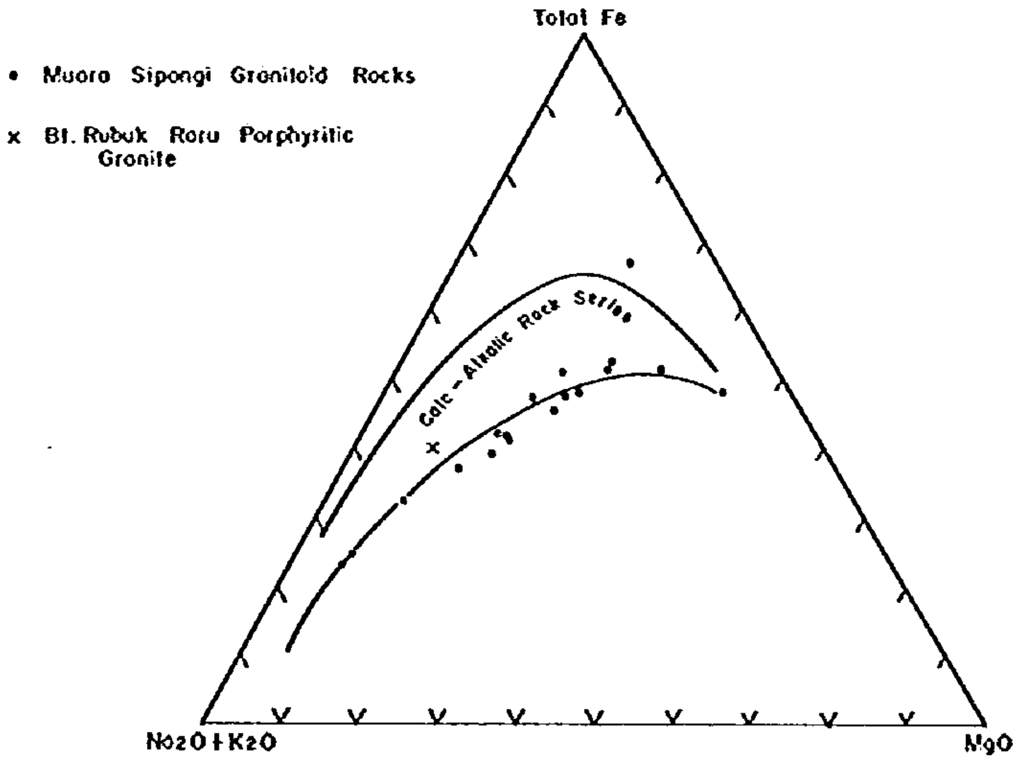


Fig. III-3 M-F-A Diagram of Muara Sipongi Granitoid Rocks

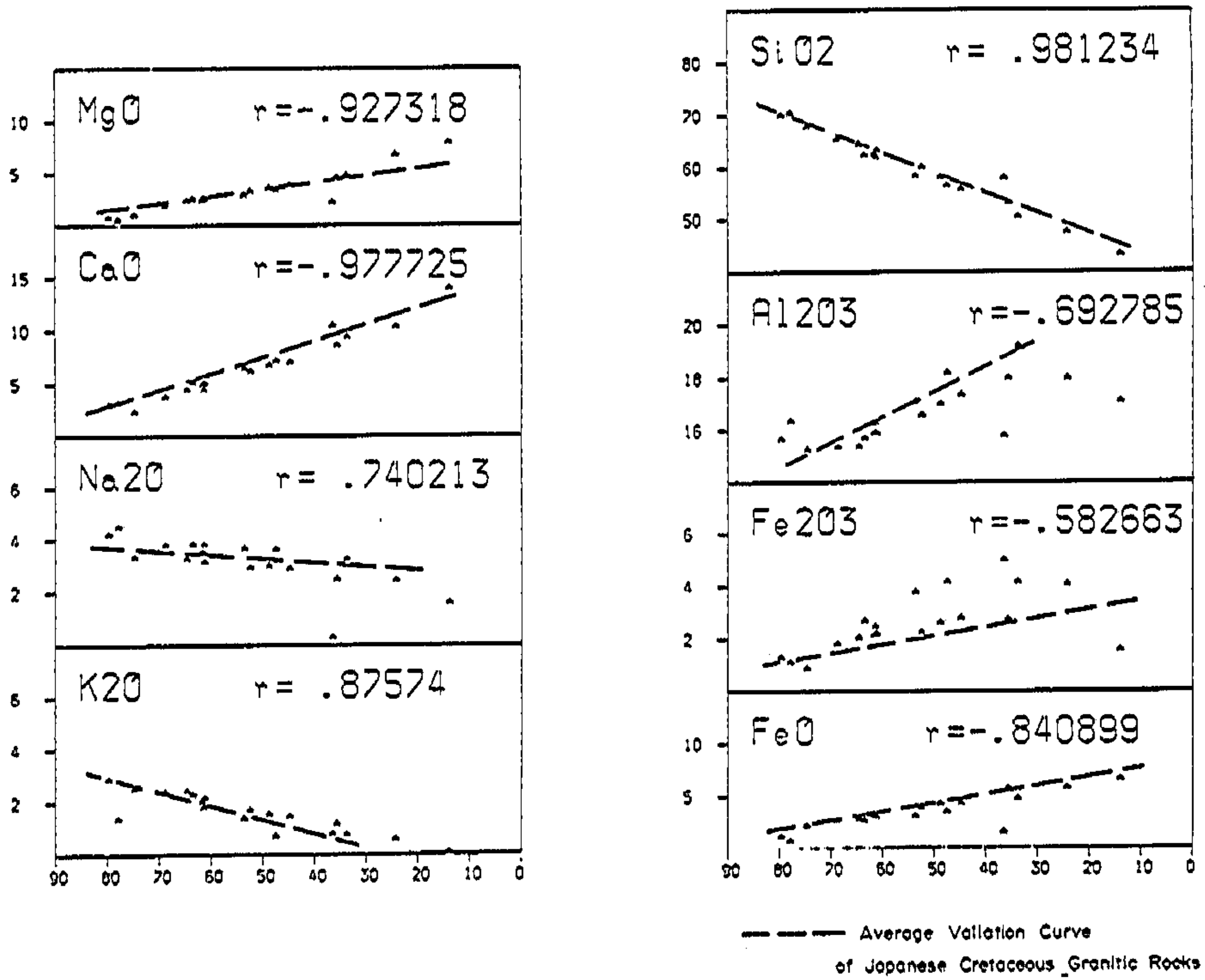


Fig Ⅲ-4 Variation Diagram of Granitic Rocks in Muara Sipongi Area

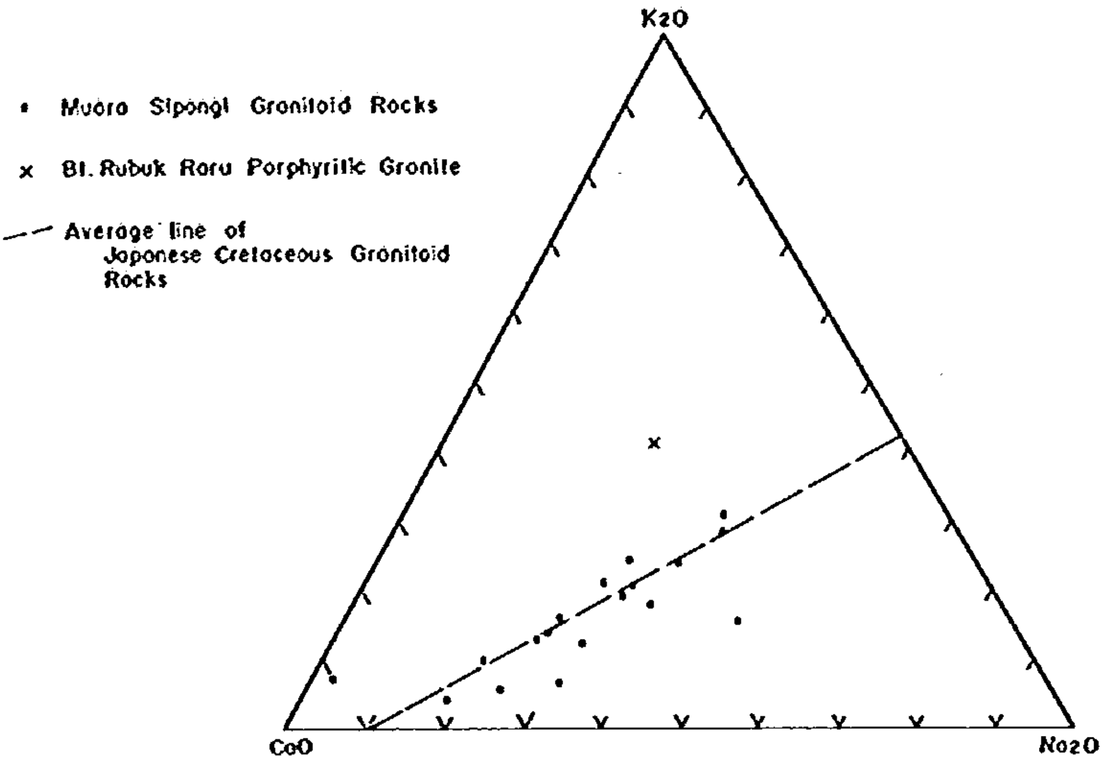


Fig. III-5 Alkali and Lime Ratio of the Muara Sipongi Granitoid Rocks

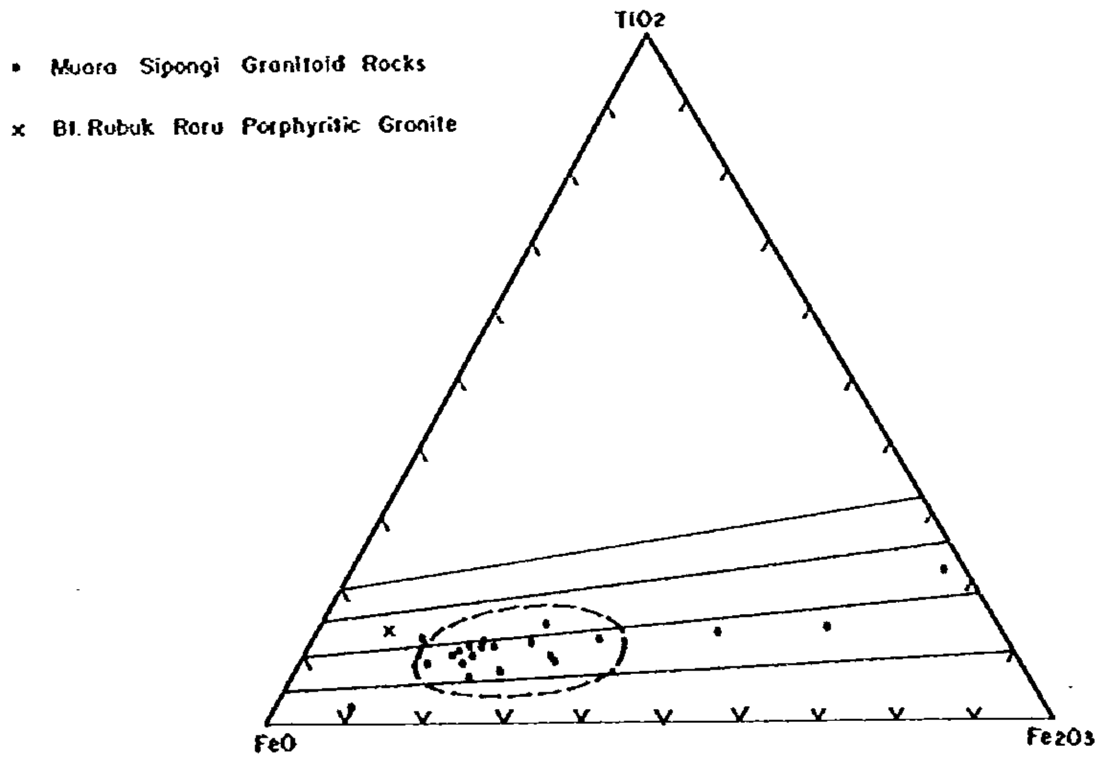


Fig. III-6 TiO_2-FeO-Fe_2O_3 (mol %) Diagram for Muara Sipongi Granitoid Rocks

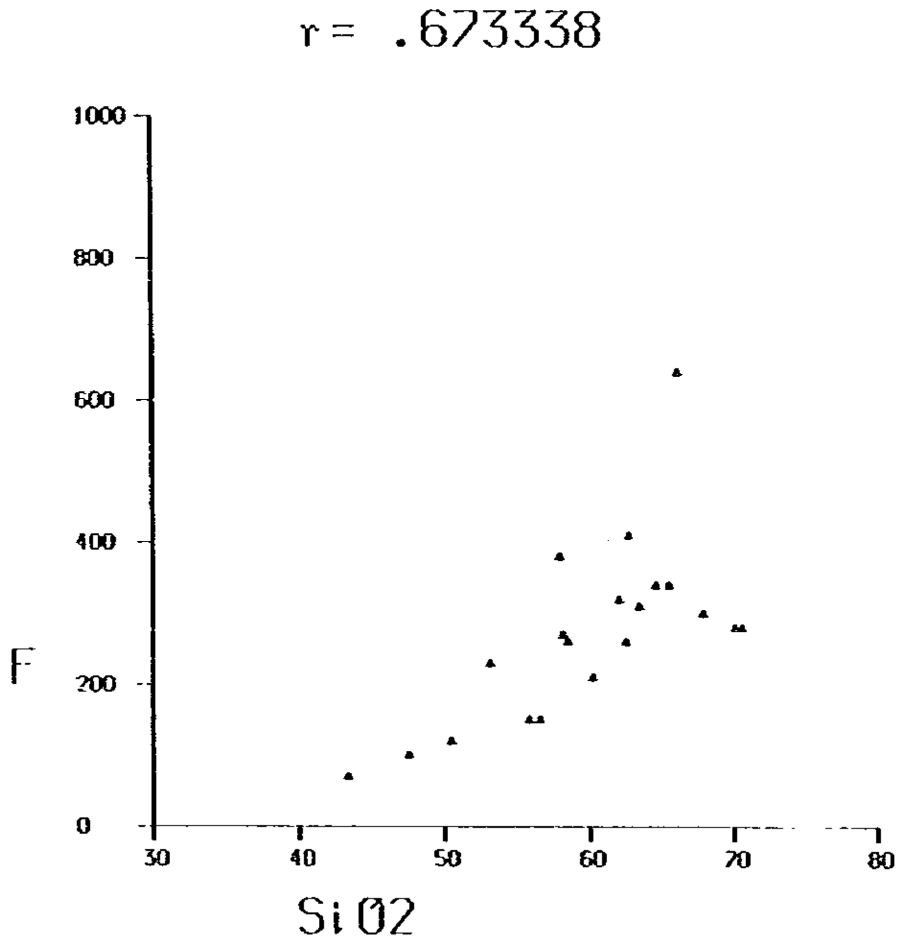


Fig. III-7 Coefficient of Correlation of F and SiO_2, Muara Sipongi Granitoid Rocks

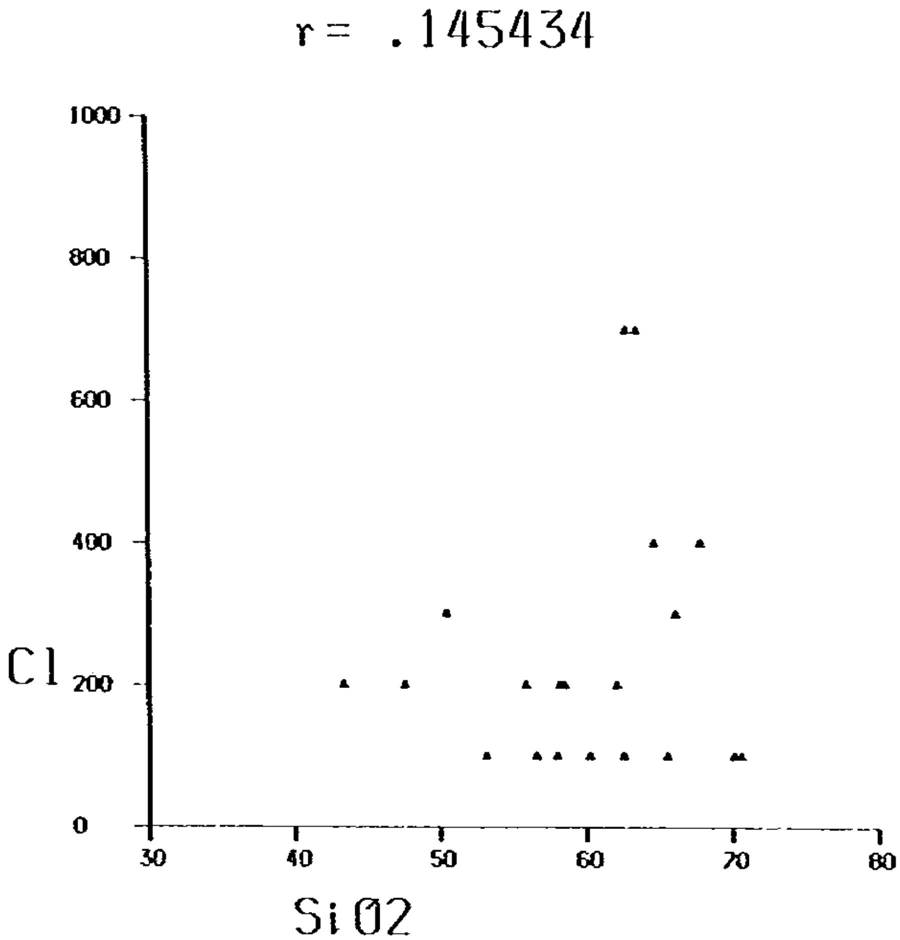


Fig. III-8 Coefficient of Correlation of Cl and SiO_2, Muara Sipongi Granitoid Rocks

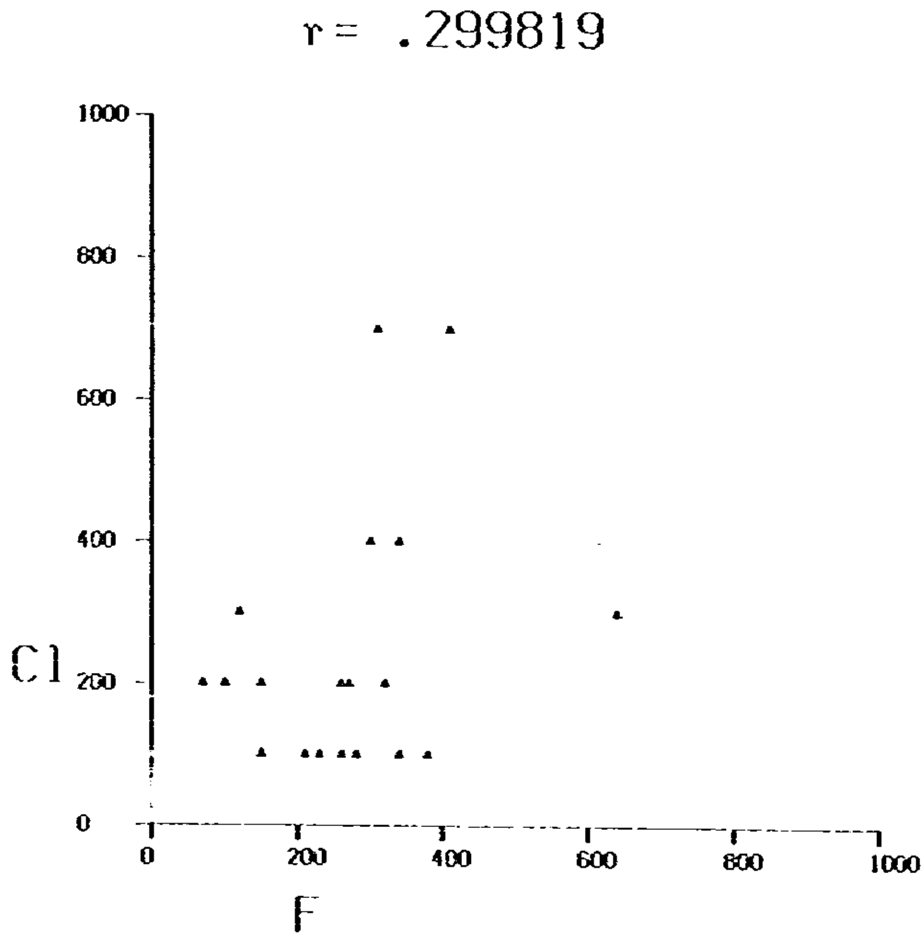


Fig. III-9 Coefficient of Correlation of F and Cl,
Muara Sipongi Granitoid Rocks

apatite. Its porphyritic texture resembles that of Hatapang granite. On a triangular diagram of the normal minerals quartz, plagioclase, and potassic feldspar, calculated by chemical analysis (RA 105), it is plotted within the granite (adamellite) region; for this reason, it is considered to fall within the Hatapang granite rather than the Muara Sipongi granitoid rock group. Differentiation, however, is not as far advanced as in Hatapang granite (D.I. 71.3%, SiO_2 66.19%), according to the results of chemical analysis.

3- 5 Plagioclase Quartz Porphyry

Quartz porphyry containing plagioclase phenocrysts are distributed as dikes around Bt Dulang, east of Limau Manis. In the upper reaches of the Cubadak River, this rock exhibits a strike and dip of N 20° E 90°.

CHAPTER 4 GEOLOGICAL STRUCTURE

In this survey area are distributed the sedimentary rock strata of the S. Ranya Formation, Bt Tanjang Formation, and Patahajang Formation; volcanic lava and pyroclastic strata of the M. Butung Meta-andesite Formation and Bt Pancehan Dacitic Tuff Formation; and intrusive rocks consisting of Muara Sipongi granitoid rocks, Ruruk Raru granitoid rocks, and others. The tectonic factor which controls all of these individual geological units is WNW - ESE directionality. This is also the direction of granitoid rock intrusions, large faults, folding axes, and mineralization/alteration zones. (PL III-2)

In its eastern part, the S. Ranya Formation has a strike of N 10° E 90°; its dip changes variously, but because this formation exhibits a NE dip on its eastern side and a SW dip on its southern side it is presumed to have an anticline structure with a NW axis.

The Bt Tanjang Limestone Formation is found along with the M. Batung Meta-andesite Formation in the east-central part of the survey area; in the vicinity of the Subun-Subun ore deposits it exhibits a slight anticline structure in a WNW -ESE direction. To the east of the Gadis River, a syncline is assumed to exist along the region marginal with the Muara Sipongi granitoid rocks. The Bt Tanjang Formation exhibits an approximately EW strike in the neighborhood of the Pungkat River.

The Patahajang Formation is distributed in two parts of the survey area: its east and south parts and its western part. In the area of the Patahajang Formation distributed around the Batas-Limau Manis Road which runs along the Cubadak River in the southeastern part are found small folds having WNW folding axes, thought to be drag folds of the larger structure. Moreover, an anticlinal structure is exhibited to the north of the Subun-Subun Mine; these and other factors indicate that this area has a synclinal and anticlinal structure with a WNW - ESE axis and as a whole comprises a synclinorium structure.
A synclined structure with a WNW - ESE axis also occurs in the

southwestern Patahajang region.

The M. Batung Meta-andesite Formation where it is accompanied by Bt. Tanjung limestone is elucidated to be controlled by an anticlinal structure trending WNW - ENE. But the structure of meta-andesite strata without the limestone strata is difficult to interpret, because the meta-andesite has undergone propylitic alteration and does not retain its original texture. It is inferred that the Bt Batung Meta-andesite Formation is folded in the same form as the monoclinical folding of the Bt Tanjung limestone, with many change of strike and dip in meta-andesite strata.

The Tertiary Dacitic Tuff Formation is distributed widely in the southern part of the survey area, and overlies unconformably various lower strata and igneous rocks. The original sedimentation structure is comparatively distinct and its strike and dip are easy to measure. Its strikes and dips within the Formation are quite changeable and a synclinal structure is shown in places. But the structure on the whole is monoclinal, dipping gradually toward the south.

Murara Sipongi granitoid rocks are distributed widely in the western and eastern parts of this survey area. In the southern part are distributed small stocks of granitoid rock. Both of these extend in a WNW - ESE direction, their intrusions having been controlled by the main geological structure of this area. The Muara Sipongi granitoid rocks brought thermal metamorphism and mineralization activity to the strata into which they intruded, and faults run in the WNW - ENE, N - S, NNE - SSW, and other directions in their border zones.

Bt Ruruk Raru porphyritic granite, found sporadically in the upper reaches of the S. Ranya River, is distributed in the form of oval-shaped outcroppings some 2.5 km in length. The regularity of its distribution is unclear, but its similarity to tin-bearing Hatapang granitoid rocks in terms of its rock facies makes it highly likely that Bt Ruruk porphyritic granite is Cretaceous intrusive rock situated at the western margin of the tin granite.

Dikes of plagioclase quartz porphyry are distributed in the Bt Dulang area in the eastern upper reaches of the Cubadak River and extend in a NNE-SSW direction.

Most of the faults in this survey area strike in the WNW - ESE direction, while others strike N - S and NNW - ESE. Of those faults that strike WNW - ESE, the most pronounced are one striking between Pagar Gunung and Simpang Pinang at the western end of the survey area and one passing through Bt Piluban in the east. While both faults are inferred to exist because of the distribution of the strata, the former in particular exhibits the clear topographical features of a fault and is thought to be a branch fault of the Sumatra Transcurrent Fault (Katili; 1967, 1970). Faults in other areas include one striking WNW - ENE direction in the vicinity of the border with the Muara Sipongi granitoid rocks.

Two faults extending some 8 km in a N - S direction are presumed to exist in the area's western region. These have both been deduced due to different distribution in the geology of the region along the inferred fault, which includes the flowing of hot spring water and hydrothermal alteration with pyrite dissemination. These two faults act as block faulting to displace the Muara Sipongi granitoid rocks, the M. Batung Meta-andesite Formation, and the Patahajang Formation with WNW - ESE faults, and they form this area into fault block.

A summary of this area's geological structure would thus place the WSW - ESE direction as the main tectonic line, the one which controls the intrusion of Muara Sipongi granitoid rock, fold-structure, and faults. NNW - SSE fissures emplacing ore deposits are also attributable to the intrusion of granitoid rocks controlled by this structure. WSW - ESE tectonic lines are thought to have been intermitted until after Tertiary dacitic tuff sedimentation.

CHAPTER 5 MINERALIZATION

5-1 General Outline

The Si Lopo copper, lead, and zinc deposits, the Subun-Subun copper deposit, the Bt Pionggu (copper) lead and zinc deposits, and the Si Ayu skarn zone are distributed along the southern border of the Muara Sipongi granitoid rocks extending over an area of 20 km EW. In addition, the southwestern part of the survey area contains the Pagor Gunung copper, lead, and zinc deposits and the Patahajang alteration zone. (PL III-2, Table III-3)

5-2 Mineralization

5-2-1 Subun-Subun Mineralization Zone

These deposits are located 750 - 1,000 m above sea level on the right bank of the Gadis River some 5 km southeast of Muara Sipongi (Fig. III-10).

According to past resource report (Minerals and Mining in Indonesia), before the Second World War this mine was operated by the Mining Company Muara Sipongi Ltd. with the mining of gold and copper as its objective. From 1936 to 1939, 227 tons (of copper) were produced, and a copper grade of 0.21% was recorded for the crude ore. The mine was closed in 1940.

The geology in the neighborhood of the mine is composed of M. Batung meta-andesite, Bt Tanjang limestone Formation, Patahajang limestone and clastic rocks Formation, and Muara Sipongi granitoid rock. The ore deposits are emplaced in meta-andesite and limestone which have been subjected to thermal alteration due to intrusions of Muara Sipongi granitoid rocks. This has meant that in part, the lava facies of the meta-andesite have changed into fine-grained holocrystalline rock due to re-crystallization, while the limestone has recrystallized in fine-grained saccharoidal crystals. The meta-andesite had originally

Table III-3 List of Assay Results of Ore Samples in Muara Siponge Area

Sample No.		Location	Mineral	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %
AR-86	Subun-Subun - Bt. Pionggu - Si. Ayu zone	Si Topo	Cp-Pb-Zn Ore	<0.1	4.1	0.47	0.79	0.84
BR-201		Subun-Subun	Cp-Ore	0.5	47.5	30.00	0.01	0.08
BR-202		do	Magnatite green copper	31.3	3.0	9.81	<0.01	0.01
BR-203		do	Skarn	<0.1	0.3	0.37	<0.01	0.01
BR-206		do	Magnetite Malachite	0.4	6.0	1.86	<0.01	0.01
ER-175		A. Tabur	Zn>Pb Ore	1.2	13.9	0.38	0.13	15.30
ER-200		Sim Pang Kangampo	Massive Ore	76.3	113.6	0.35	4.20	6.10
ER-208A		Bt. Ponggu	Skarn, Ore	3.5	3.3	1.28	0.05	0.09
ER-209		Bt. Ponggu	Sulfide Ore	35.4	19.4	0.04	0.01	0.03
ER-232		A. Sindungung	Skarn	0.4	1.6	0.35	0.01	0.31
FR-242		A. Pungkut	Skarn	0.2	1.2	0.02	0.02	0.04
DR-83	Pagar Gunung ~ Patahajang zone	Patahajang	Pyrite-Ore	<0.1	0.7	0.04	<0.01	0.04
DR-119		Pagar Gunung	Pb-Zn-Ore	0.1	105.5	0.54	11.10	13.90
DR-120		do	Ore, Skarn	<0.1	19.5	0.31	3.56	5.64
DR-129		do	Pb-Zn Ore	0.1	146.7	0.64	13.90	13.50
DR-131		do	Pb>Py, Zn Ore	<0.1	19.9	0.11	2.74	5.14
DR-132		do	Pb-Skarn Ore	<0.1	18.5	0.08	1.77	2.06
DR-133		do	Py-rich Ore	<0.1	91.9	0.20	7.01	7.30
DR-136		do	Pssr. Ore	<1	42.0	0.06	3.24	1.20
DR-137		do	Py, Pb-Ore	<1	58.0	0.12	8.33	7.94
DR-139		do	Py, Pb-Ore	<1	83.0	0.14	8.93	7.49
DR-140		do	Massive Ore	0.4	77.1	0.24	7.08	8.69
DR-141		do	do	0.2	64.2	0.09	5.70	6.41
DR-142		do	Skarn, diss.	<0.1	4.8	0.08	0.62	1.46

Cp: Chalcopyrite, Pb: Galena, Zn: Sphalerite
Mag: Magnetite, Mal: Malachite, Py: Pyrite

undergone propylitic alteration over a broad area, but has actually received hydrothermal alterations in the form of silicization and pyritization in the vicinity of the deposits.

Muara Sipongi granitoid rocks are distributed in a zone some 1.5 km wide extending from 2.5 - 4.0 km EW in the northern part of the Subun-Subun deposits. Small granitic diorite stocks are found extending NW - SE in the eastern and southeastern parts of the ore deposits; these are distributed so as to surround the Subun-Subun deposits. Among other factors, the contact metamorphism of the limestone and andesite in the neighborhood of the deposits raise the strong possibility that granitoid rocks intrusions lie buried in the shallower sections of the same area.

A 1970 survey by the Overseas Mineral Resources Development Co., Ltd. (OMRDC) revealed the location of 10 old adits and pits. Most of these were found to be situated in regions of meta-andesite, while some were situated in limestone regions closely bordered by meta-andesite. At present, all of these old adit and pits lie collapsed or buried, and none of them can be entered. Determining the exact location of many would prove impossible.

Mineralizations have been confirmed by the present survey at points A, B, C, and D in Fig. III-3 showing the vicinity of contact between limestone and meta-andesite.

(a) Type A Ore, Outcrop A

Medium to large massive block ore consisting of magnetite and hematite with samll amount of green copper (malachyte) are scattered over a mountain ridge 930 meters above sea level. Under microscopic examination (BR202), the long prismar hematite within the magnetite is arranged in flow texture, but contains no copper minerals. (Photo III-1). The results of the analysis on this are Au 31.3 g/t, Cu 9.81%.

(b) Outcrop B

There is an old collapsed adit with a N 60° E direction located 20 meters west of outcrop. Green metamorphosed rocks containing copper and pyrite crop out around the adit, and in the past, it may have been explored by tunneling, Under an observation of this section (BR 20) this ore is skarn consisting of quartz epidote, epidote and clineopyrozene. Under an ore microscope (BR 203), the minerals are seen to be disseminated chalcocite, and covelline. The results of the chemical analysis of this ore (BR 203) are Au 0.3 g/t, Cu 0.37%.

(c) Outcrop C and D (old adit #1 and #3 in OHRDC report)

In total there are 7 old adit, which are located about 1000 meters above sea level and may have been explored on a 55 meter east - west extention in limestone along contact between limestone and meta andesite. (Fig. III-11) of these 2 sites (outcrop C and D) were confirmed to have massive ores.

There is a 55 cm wide massive ore vein in the limestone extending 2 meters up from the adit entrance ceiling at outcrop C. The ore is of massive replacement ore, and is emplaced in saccharoidal crystallized limestone as host rock, but no skarn was found. Under a microscope (BR 206) the ore was observed to be made up of magnetite and hematite, but with no copper ore present. Despite this, analysis of grab samples showed Cu 1.86% (Fig III-12).

Ore at outcrop D is emplaced in saccharoidal limestone, forming a vein of maximum width 2 meters. The vein's strike is N80°W - N80°E, the dip 20° - 50°N. Just like ore at outcrop C this ore consists of magnetite and hematite but green copper ore (malachite) was found in fissures of ore in the surface outcrops (Fig. III-18).

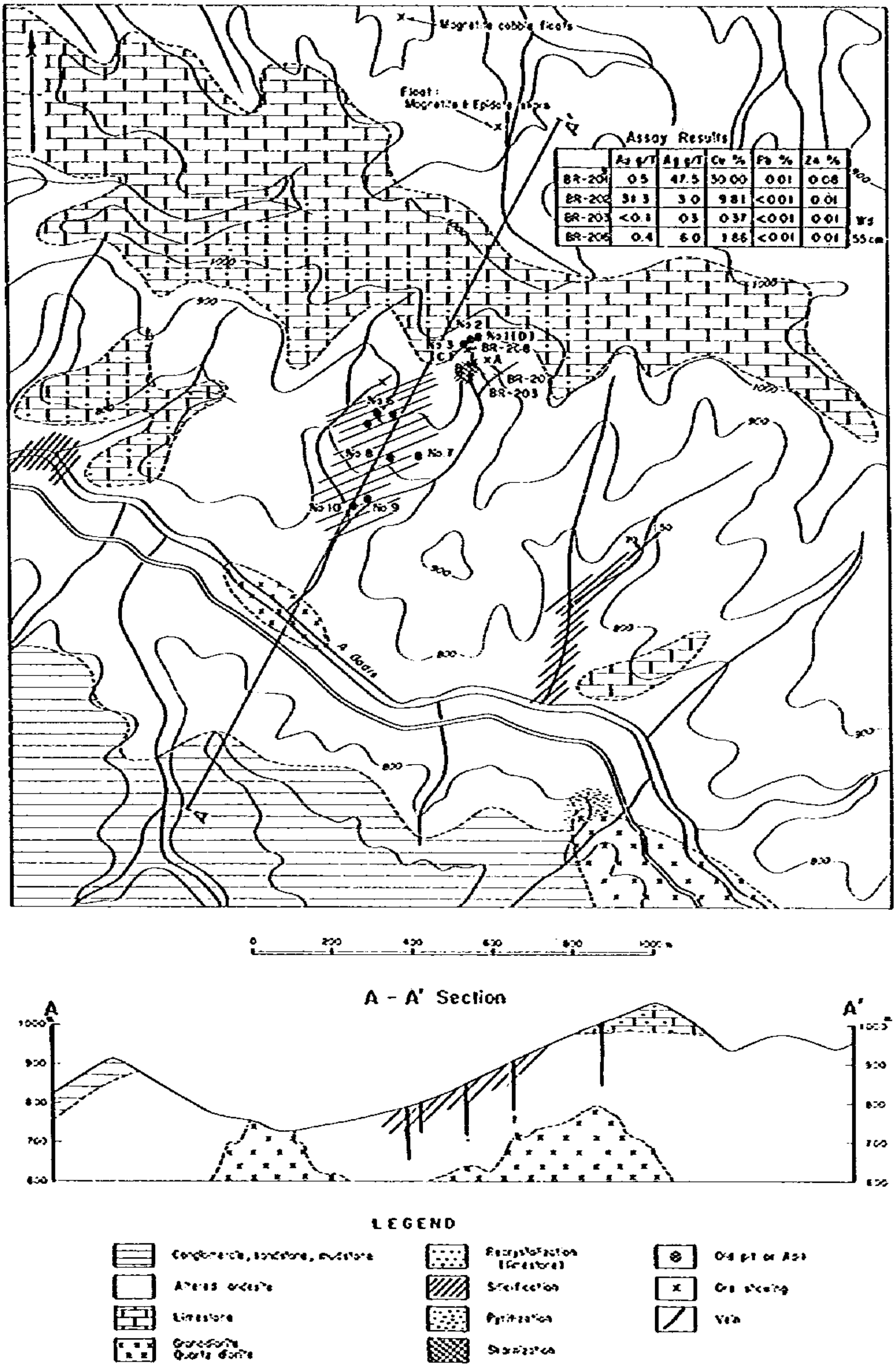


Fig. III-10 Mineralization and Geological Map and Profile, Subun-Subun Area

Table III-4 Observation of old prospect of Subun-Subun Mine

Name of Adit	Strike	Dip	Width	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Wall Rock	Remarks
No 1'	N10°E	-20°							?	excavation only
No 1	N70°W	20°N	0.5 m±			1.5(Average) 3(high grade)			limestone	Cu bearing quartz vein is originatedin the fault breccia parallel withbedding plane of limestone.
No 2				5.2	5	3.75(high grade part) 1.6 ~ 1.8(average)			"	Hem>Green copper band ore. Py. Cp spot
No 6	N55°W	80°NE	0.3 m	14.8	6	2.92	0.04	0.05	Porphylite (and esite)	Malc, Qz, Py, Cp Quartz vein
No 7				9.7 (grab samples)	66 (grab samples)	3			"	Qz, Py, Malc, Cp, Ore (pilled ore)
No 8,9				21.5 (grab samples)	97 (grab samples)	2.84			"	Qz-Malc-Cp Ore (pilled ore)
No 10						1.26			"	Qz-Mal-Cp Ore (pilled ore)

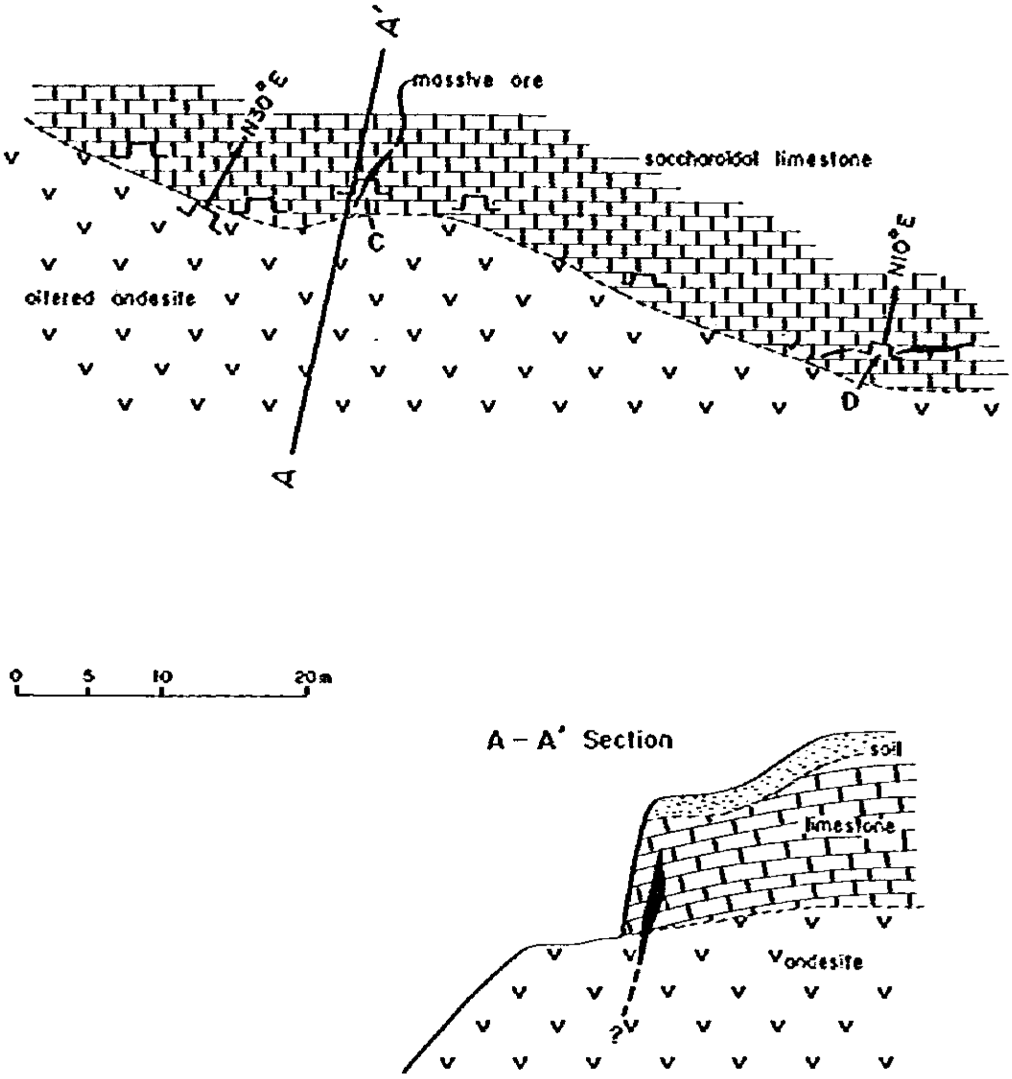


Fig. III-11 Geology of Mineralized Zone C and D in Subun-Subun Mine

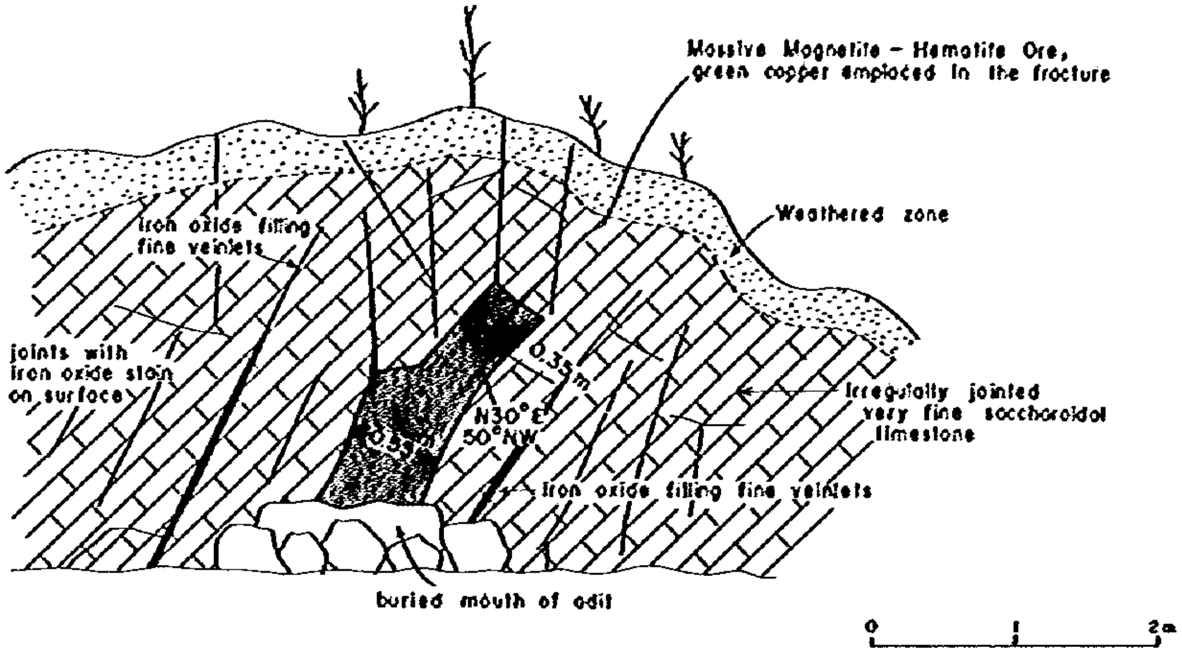


Fig. III-12 C-Outcrop of Subun-Subun Mine

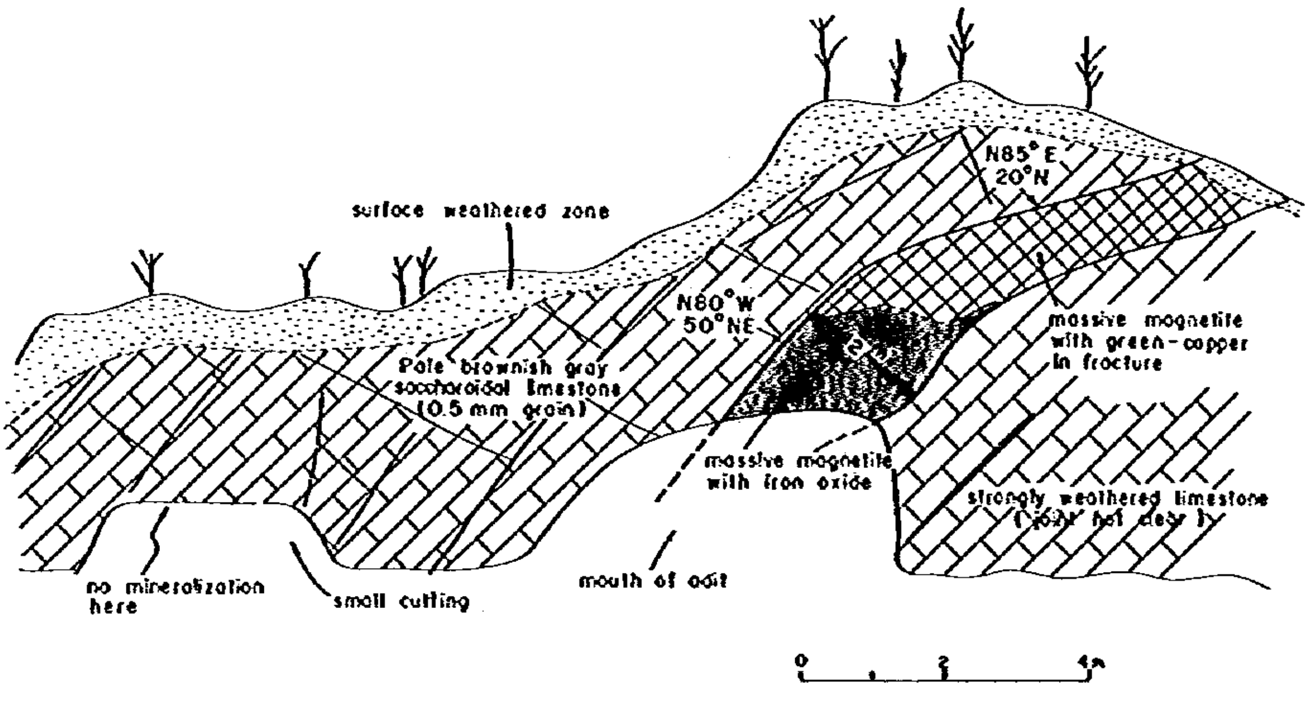


Fig. III-13 D-Outcrop of Subun-Subun Mine

(d) Referring to data from OMRDC with regard to another mineralization, data from No. 6 adit to No. 10 adit are reported as and describe their chemical analysis, as shown in table III-4. Likewise data on their ore is in the same table. Judging from the analyzed data of these ore deposits, gold- silver- and copper-bearing quartz veins filled in fissures in the meta-andesite.

When the present survey results and the existing data are combined and studied, it is clear that the Subun-Subun ore deposits are vein type ore deposits or metasomatic ore deposits causing the intrusion of granodiorite or quartz diorite. The ore deposits also consist of quartz veins containing gold and copper or massive magnetite ore containing gold and copper.

5-2-2 Bt Pionggu Mineralization Zone

In this mineralization zone there are eleven old adits in area ranging 3 kilometers east-west and 1 kilometer north-south centering on M. Batung village in the middle reaches of the M. Batung River. According to old records, exploration was carried out here between 1902 and 1912 while the area was under Dutch rule. Information from the local inhabitants indicated that in 1974 for about a year the Sinar Mas Company conducted a little exploration and mining. It was said that 9 adits of the 11 old adits were opened by the Dutch and 2 adits by Sinar Mas. Co.

Between the mountain slopes to the west of M. Batung River and the mountain ridge there is an old mining road which is still used by the local people. Also there is a mountain road running along the M. Batung River, but it is not accessible by automobile, and it requires about two hours on foot to go from M. Batung situated on the Sumatra Transverse Road to M. Batung. In the mountains northeast of M. Batung there are the remains of a heliport used by the Sinar Mas Company to ship in supplies.

In this survey the old adits have been labelled alphabetically for convenience. The ore deposits have been recorded based on these names (Fig. III-14).

(a) Adit A

This is located 400 meters west of M. Batung Village on the west bank of the Tabur River. The geology of the area has obvious massive (horneblende) andesite with many hard, compact, joints belonging to the M. Batung Meta-andesite Formation. The ore vein is emplaced on the hanging wall of the small normal fault (fault width 15 cm, faultdip slip over 5 meters) which lies striking N 18° W, dipping 83 W in the center of outcrops in the adit area. In the 180 cm wide silicification belt there is a strong silicification part of 10 to 30 cm accompanied by massive pyrite chalcopyrite and sphalerite (Photo III-1). The ore vein strikes N 26° - 45° W and dips 40° - 53° SE. The result of analysis of ore (BR 209) from the outcrop is as follows; width 15cm, Au 35.4 g/t, Ag 19.4 g/t, Cn 0.04%, Zn 0.03%, Ph 0.01%. (Fig. III-15, III-16).

(b) Adit B

This is located 500 meters from M. Batung Village along the Tabur River. The geology of the area is made up of the M. Batung Meta-andesite Formation with strong epidotization in parts. The ore deposit is a fissure-filling vein type, with vein width of 20 - 30 cm and consisting of chalcopyrite, sphalerite, pyrite and quartz. This strike and dip is N 25° W, 6 NW. The ore grades(ER 175) are; Au 1.2 g/t, Ag 13.9 g/t, Cu 0.38%, Pb 0.13%, Zn 15.30%.

(c) Adit C

This is located on the mountain slope about one kilometer from M. Batung village. This area consists of skarn composed of a lot of garnet, vesuvianite pyroxene, and epidote, but no ore. The adit seems to be dug in N 30° E direction.

(d) Adit D

This is located about 1.2 kilometers west of the M. Batung Village on the southern slope of Bt Pionggu's eastern mountain range. According to the information from the local inhabitants, in 1974 - 1975 the Sinar Mas Company explored and mined a little ore. There are 2 inclined shaft and an adit. However, since the mine shafts have collapsed the conditions inside the adit are unobservable.

The geology in the area is crystallized limestone, in outcrops at the adit entrance, and there are many cracks of strike N 60° W, and dip 60° NW. In the mountain range northeast of the adit there are large quantities of malachite to the surface of limestone outcrops.

Lumped ore (ER 208) that had been previously mined which was found at the adit entrance, under a microscope showed copper pyrite and small amounts of galena, sphalerite, bornite, and azurite. The results of analysis of this ore were; Au 3.5 g/t, Ag 3.3 g/t, Cu 1.28%, Zn 0.09%, and Pb 0.05%.

(e) Adit E

This is located on a slope on the left bank of the Tabur River (about 20 meters above the river bed) 1.2 kilometers west of the village of M. Batung. The exposure at the adit entrance is skarnized limestone. Skarn with adhering malachite was found in waste rock around the adit entrance. However, since the adit has collapsed the ore deposit conditions are unobservable.

(f) Adit F

This is located on the right bank of the Tabur River 1.2 kilometers west of the village of M. Batung. However, the mine has completely collapsed and the exposed areas are also severely weathered, so the state of the ore deposit is unclear.

(g) Adit G

This is located 400 meters upstream from Adit F on the left bank of a tributary to the Tabur River. Rock around the adit entrance is garnet skarnized limestone with adhering malachite.

(h) Adit H

This is located further upstream from Adit G on the right bank of the Tabur River tributary 900 meters above sea level. At the adit entrance there is crystallized limestone, however, judging from geological conditions in the area it is probable that exploration work was conducted at the contact zone between limestone and the Muara Sipong quartz diorite. However, because the adit has collapsed, details are unobservable.

(i) Adit I

This is located 800 meters upstream on the Simpang Mangampo River, a tributary of the M. Batung River. At the adit entrance a number of small veins (width 1 - 3 cm) which include pyrite are observable in the meta andesite. In the river bed near the adit boulders were discovered that included chalcopyrite, sphalerite, galena, and pyrite. Analysis results of these showed; Au 26.3 g/t, Ag 113.6 g/t, Cu 0.35%, Zn 6.10%, and Pb 4.20%.

(j) Characteristics and Origins of the Bt Pionggu Mineralization Zone

It appears that the emplacement of the Bt Pionggu mineralization zone was caused by the intrusion of Muara Sipongi granitoid rock (quartz diorite) within M. Batung meta-andesite and

Bt Tanjang limestone. In the case of the meta-andesite, mineralization is embedded which filled the fissures that appeared in the andesite,associated with copper, lead and zinc ore. When the mother rock was limestone, the mineralization is skarn type replacement deposit consisting of garnet epidote, and pyroxene as skarn minerals.

The Bt Pionggu ore deposits group is distributed in the same direction as the extention of the Muara Sipongi granitoid rock intrusion. Already, it extends WNW for 3 kilometers with a width of 1 kilometer centering on M. Batung Village, suggesting that this regional geological structure which forms these old deposits is limited. The andesite in the area has many fissures and joints, and the results of projecting the strike and dip of the fissures and joints in Schmidt's Net (Fig. III-18) shows that the strikes and dips are concentrated to N 30° E 50° SW, indicating perpendicular or oblique fissures against the regional geological structure (WNW direction). It appears that the ore vein is also a fissure-filling ore deposit that filled this same tension fissure (N 25° - 45° W dip 40° - 55° SW). Although no prominent ore deposit crops out in the skarn belt, according to information from a former Sinar Mas Company employee, the ore deposit was a vein with a strike of N 60°W. This skarn belt continues further west to the Si Ayu area. There is abundant galena and sphalerite in veins filling fissures in meta andesite, while chalcopynite and magnetite are found in the limestone skarn.

5-2-3 Si Ayu Skarn Zone

In the upper reaches of the Si Ayu and B. Punkut Rivers in the west part of the Bt Pionggu mineralization zone the skarn outcrops are recognized in three places. (Fig. III-19)

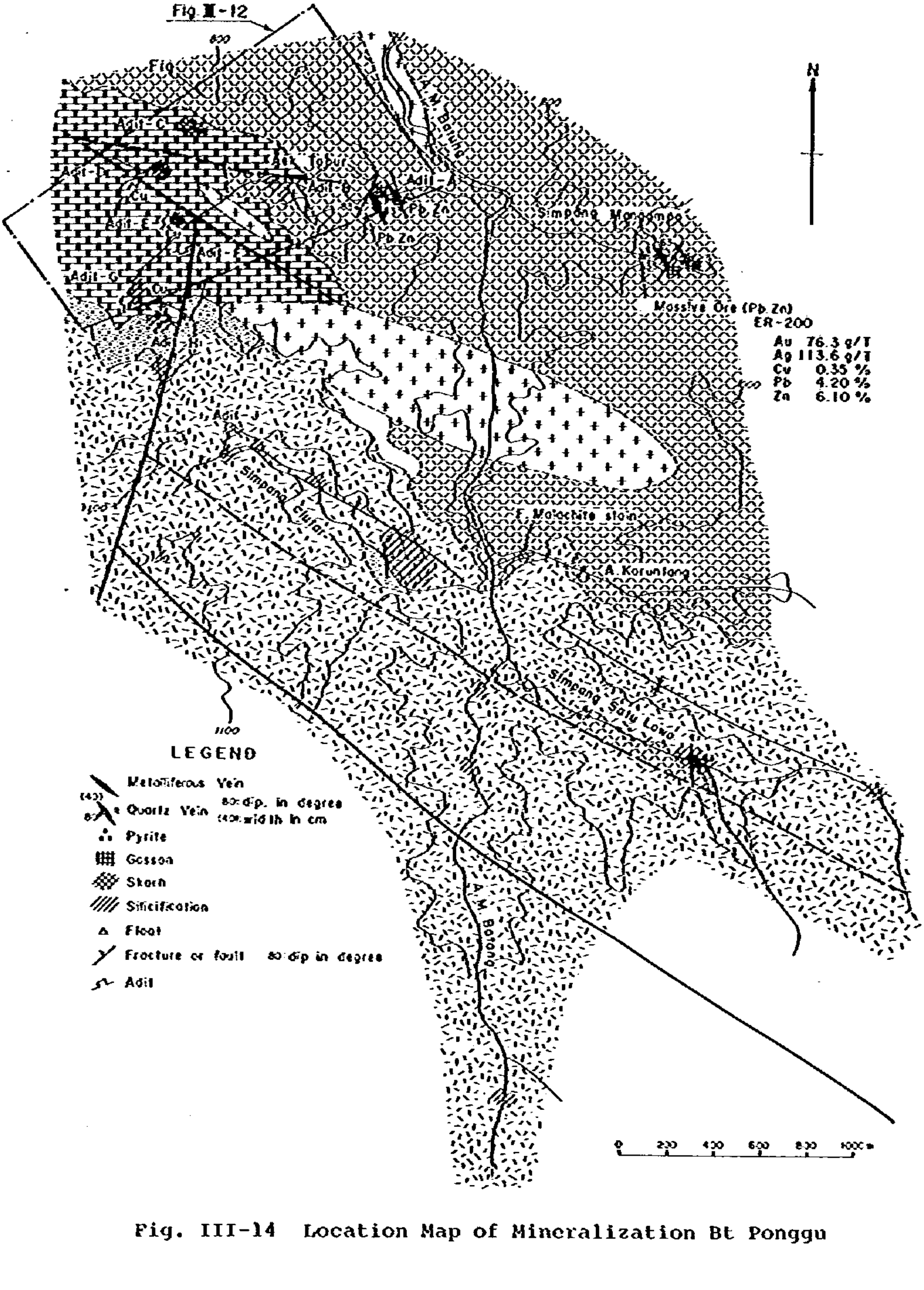


Fig. III-14 Location Map of Mineralization Bt Ponggu

	Au	Ag	Cu	Pb	Zn
	g/t	g/t	%	%	%
ER-208A	3.5	3.3	1.28	0.05	0.09

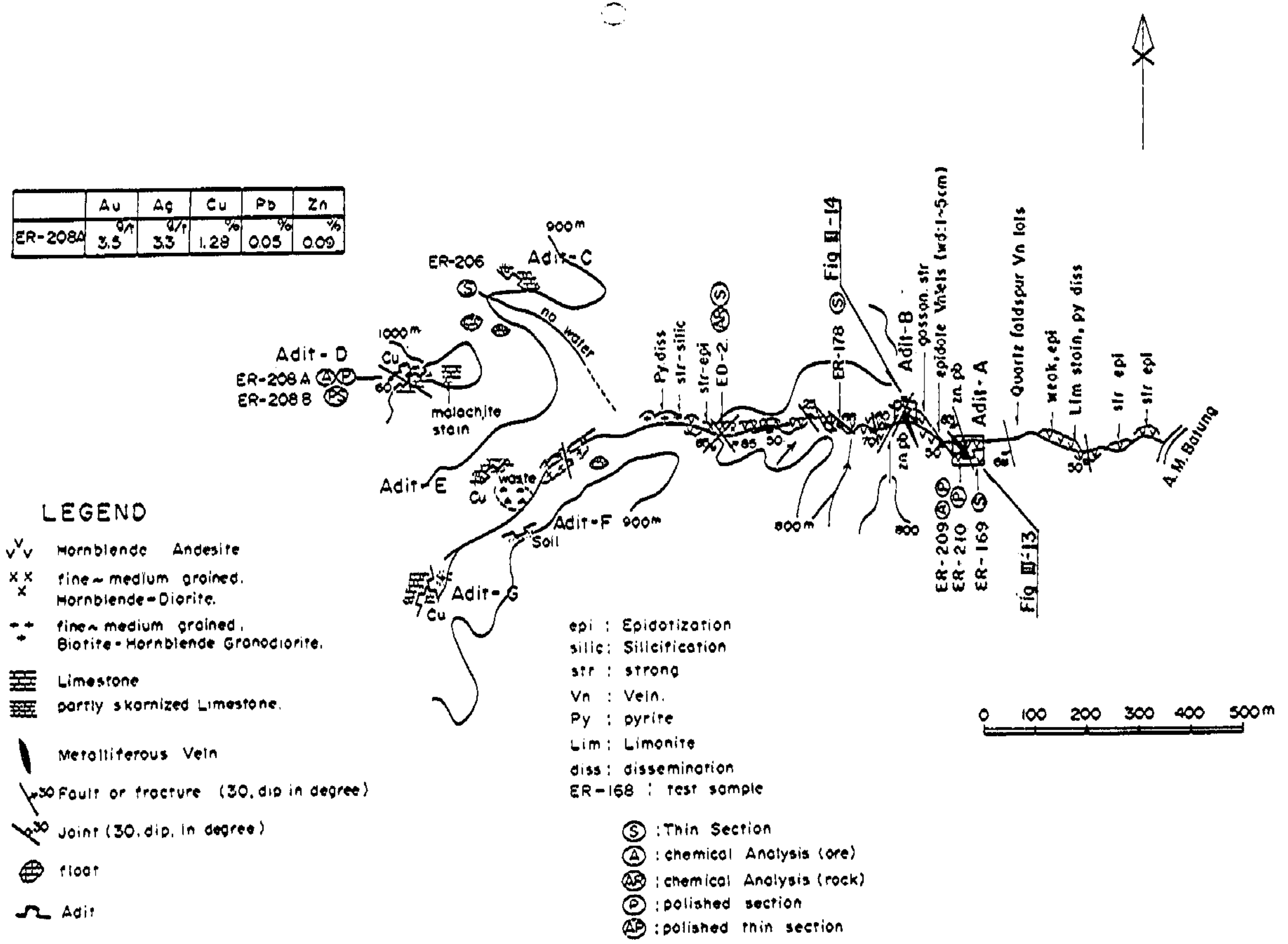


Fig III-15 Route Map of Aek Tabur Area, Bt Ponggu

	Wd	Au	Ag	Cu	Pb	Zn
ER-209	0.5 m	35.4 g/t	19.4 g/t	0.04 %	0.01 %	0.03 %

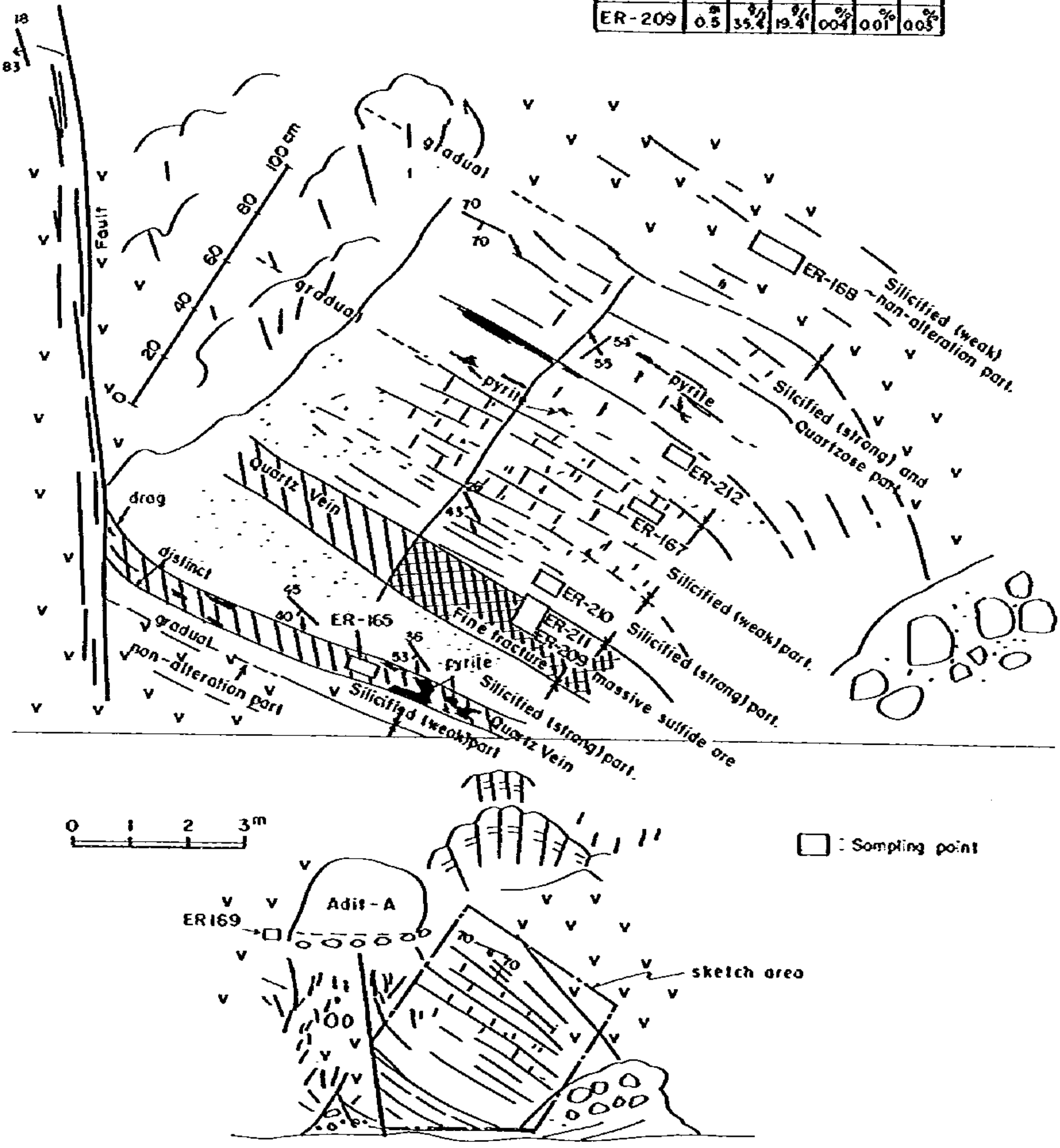
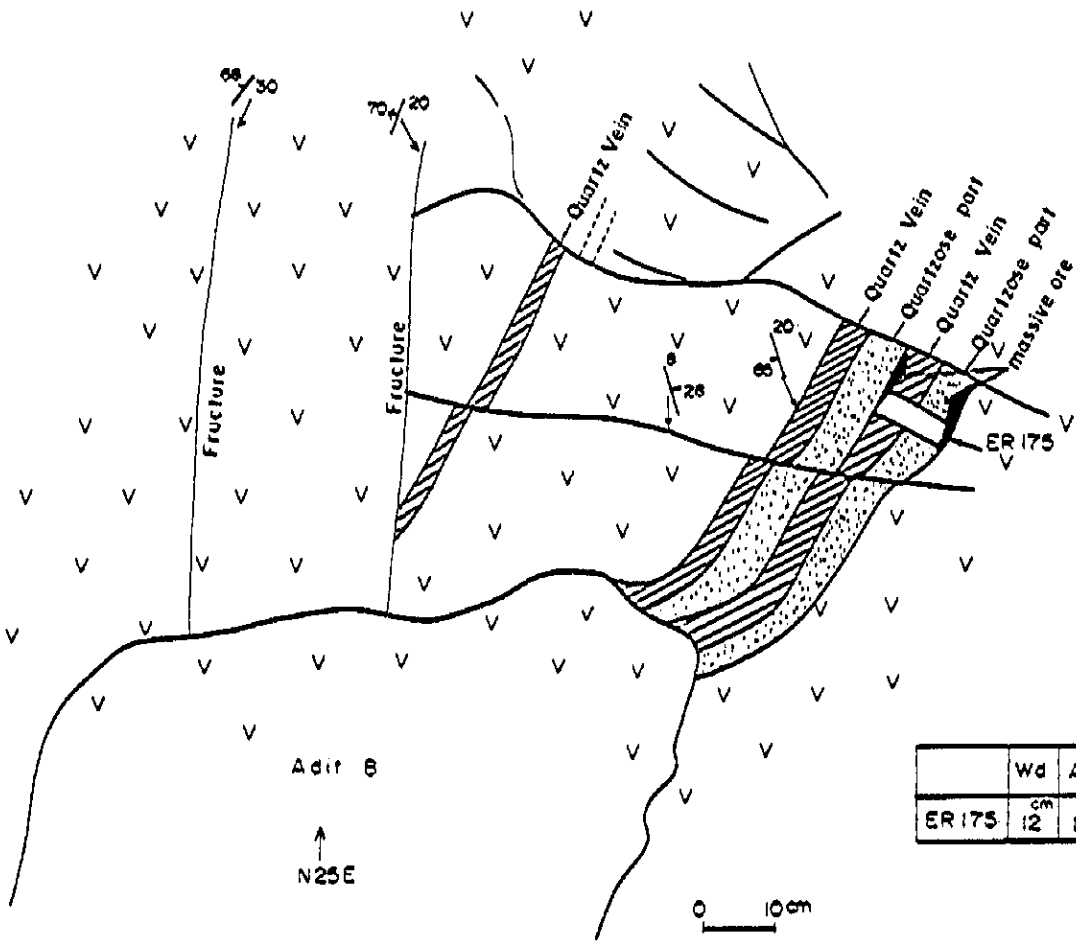


Fig III-16 Sketch Map of Ore at Adit - A



	Wd	An	Ag	Cn	Pb	Zn
	cm	g/t	g/t	%	%	%
ER 175	12	1.2	13.9	0.38	0.13	15.30

Fig III-17 Sketch Map of Ores at Adit - B

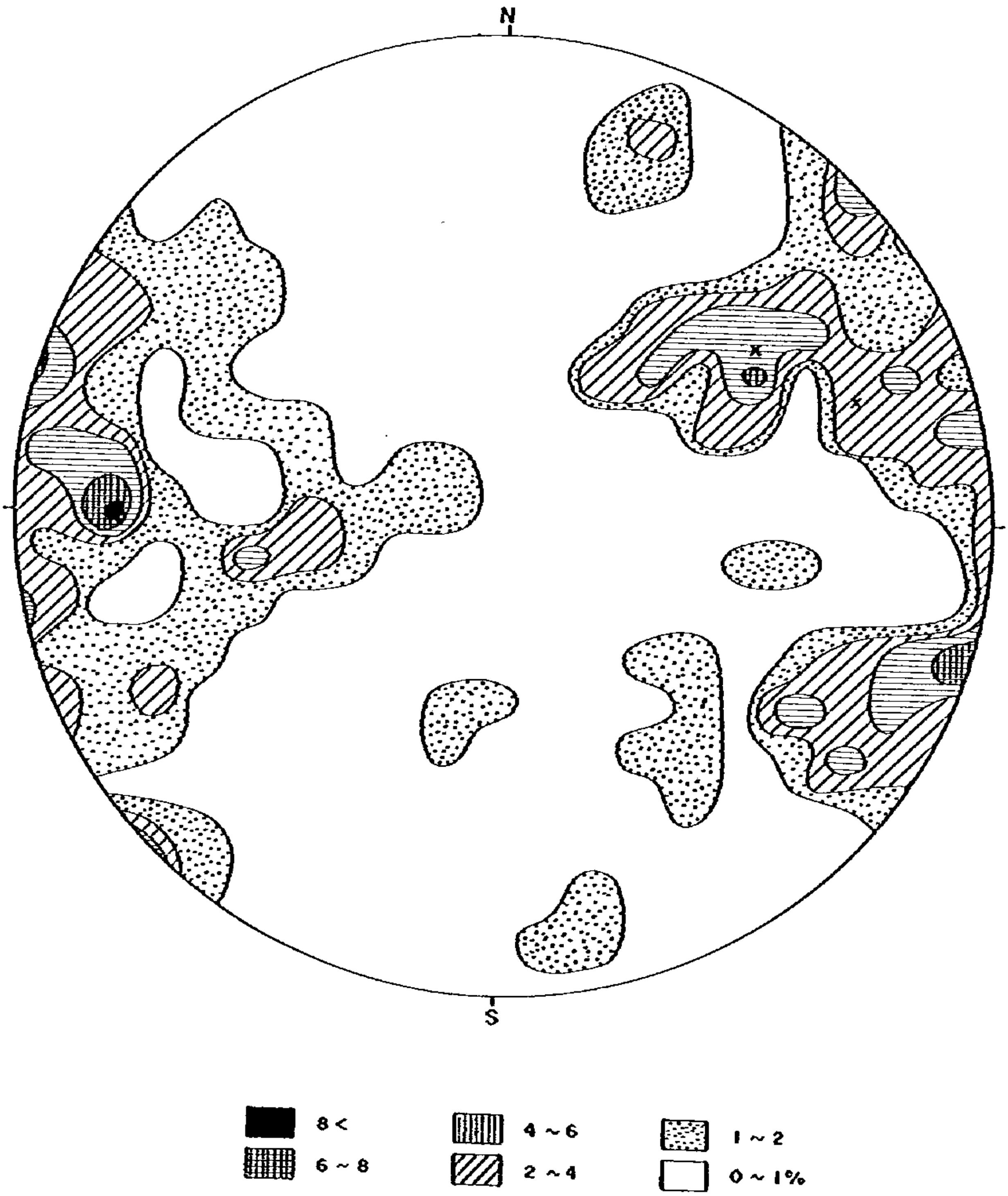


Fig. III-18 Contour Diagram of Fractures in M. Batung Area, Muara Sipongi (plotted on lower hemisphare)

(a) Sindungung River Skarn Ore Belt (outcrop FO-1)

This is distributed at the junction of the Si Ayu and Sindungung Rivers. At the contact point of the limestone and grandiorite both are skarnized. Under a microscope, the limestone skarn is composed of garnet, vesvianite, and wollastonite, with a little accompanying pyrite, chalcopyrite, and sphalerite (Fig.III-20).

(b) Si Ayu Skarn Zone (outcrop FO-2)

This rock is distributed at a point 1000 meters upstream on the Si Ayu River from its junction with the Sindugung River. Skarnized limestone and granitoid rock continue along the river for over 30 meters. Limestone is recrystallized and skarnized to garnet - orthopyroxene- epidote, but no ore minerals are found. (Fig. III-21).

(c) Pungkut River Skarn Zone (outcrop FO-3)

Around T. Kulit Manis on the upper reaches of the Pungkut River a limestone layer intercalated in meta-andesite is distributed. A small quartz diorite dike has intruded in the limestone and caused skarn. The skarn consisting of garnet and orthopyroxene skarn continues along the river for over 50 meters. Where skarn comes in contact with the quartz diorite, it abounds in orthopyroxene, where it is far removed from contact with granodiority the skarn is garnet rich. In places it is accompanied by magnetite. (Fig. III-22).

(d) Emplacement of the Skarn Zone

The Si Ayu skarn zone is located in the west northwest extension of the Bt Pionggu mineralization zone. It occurs in places where small intrusions of granitoid rocks in limestone are distributed. The skarn zone is also situated as an extended part of Bt Pionggu, with the same geological structure. In this area skarn is accompanied by large amounts of garnet, but is not

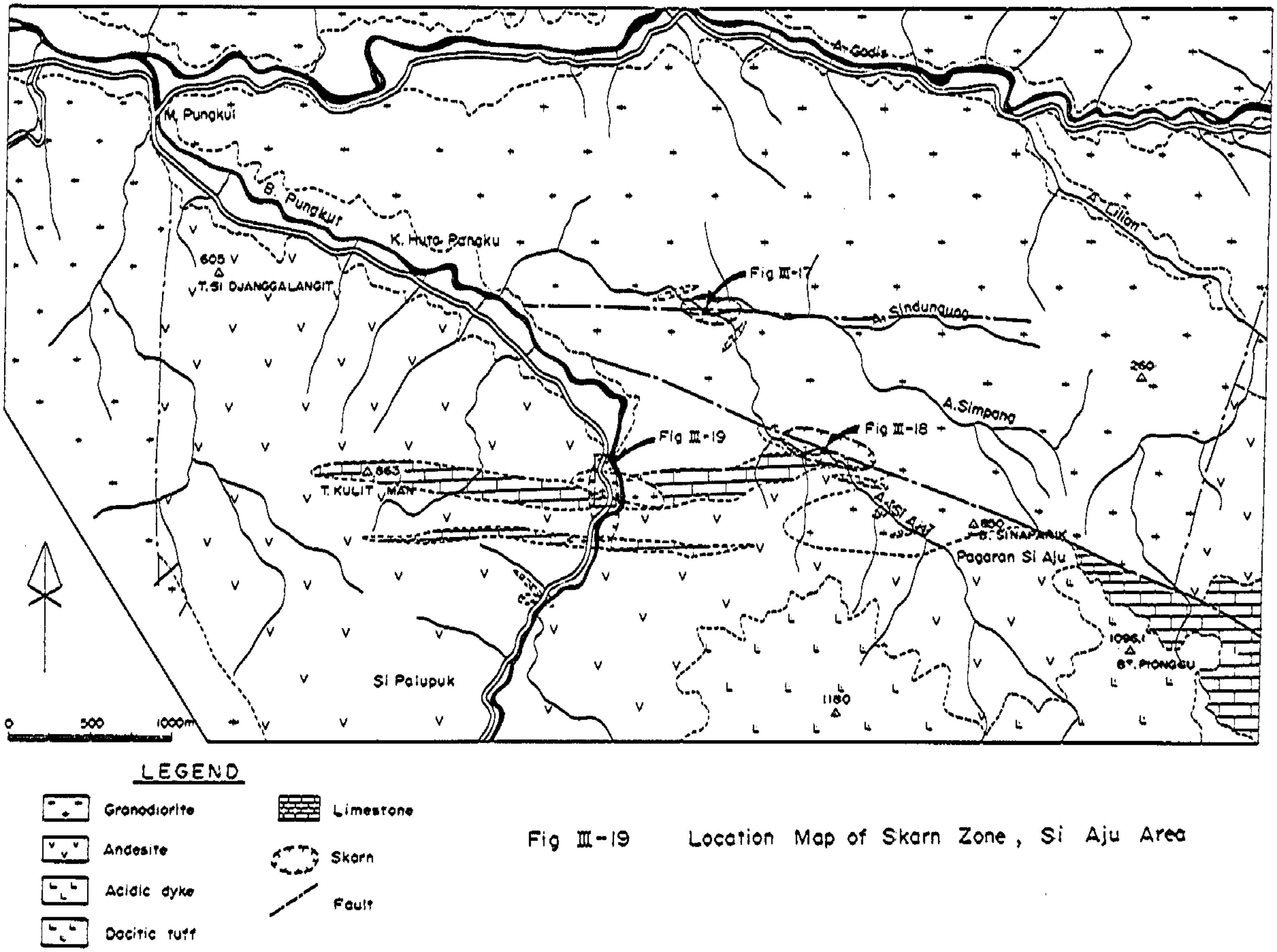
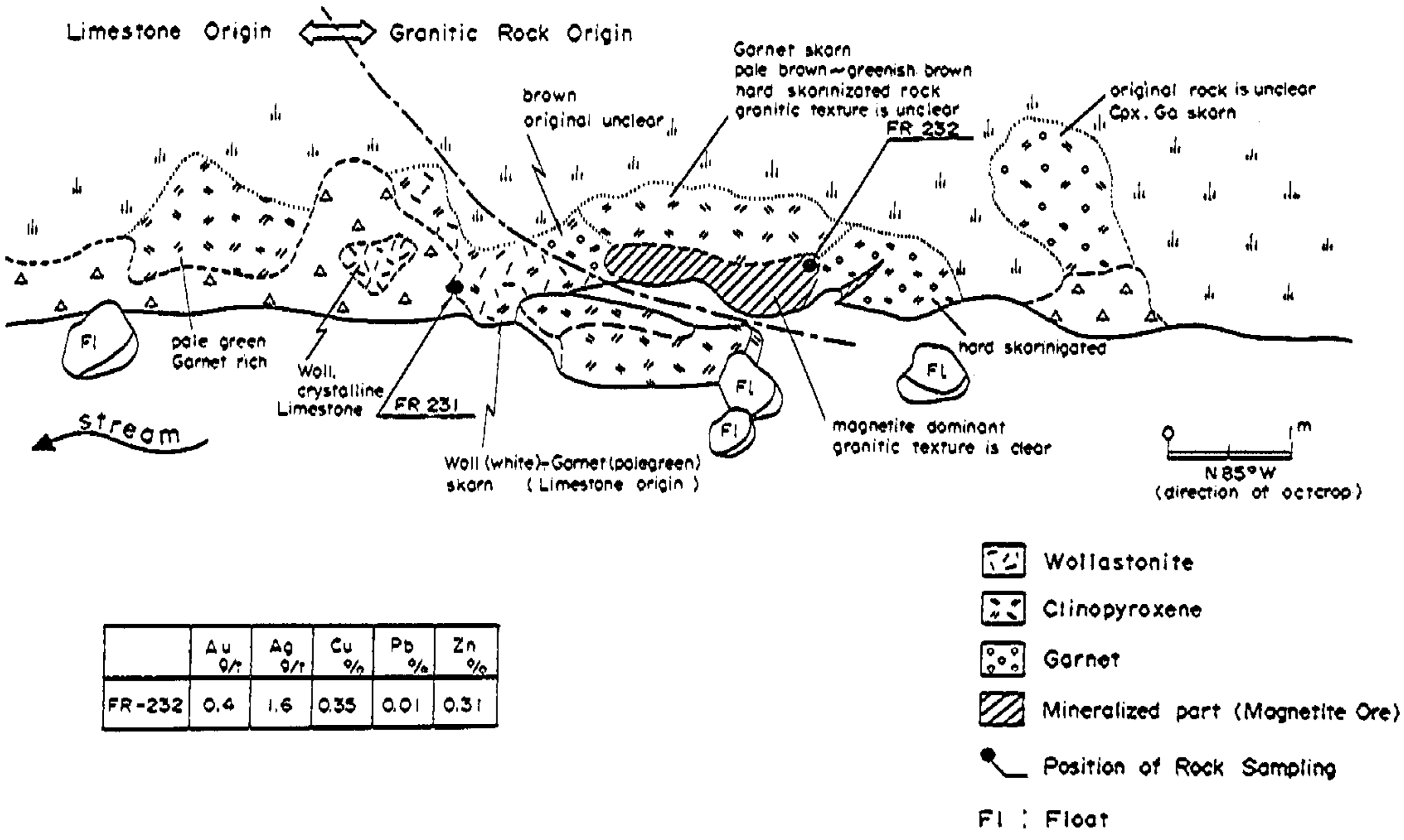


Fig III-19 Location Map of Skarn Zone, Si Aju Area



	Au g/t	Ag g/t	Cu %	Pb %	Zn %
FR-232	0.4	1.6	0.35	0.01	0.31

Fig Ⅲ-20 Sketch Map of Outcrop・FO－1

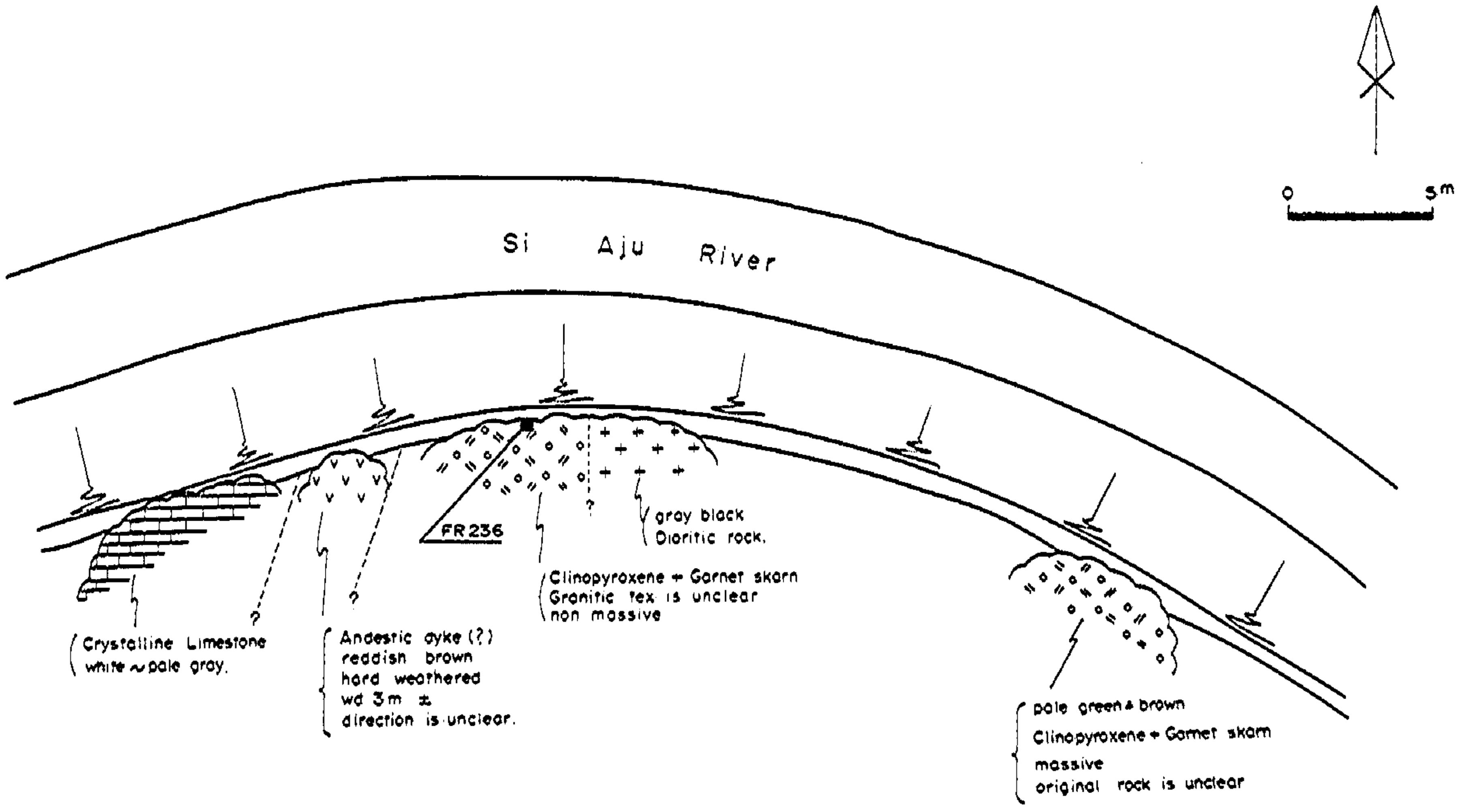


Fig Ⅲ-21 Sketch Map of Outcrop FO-2

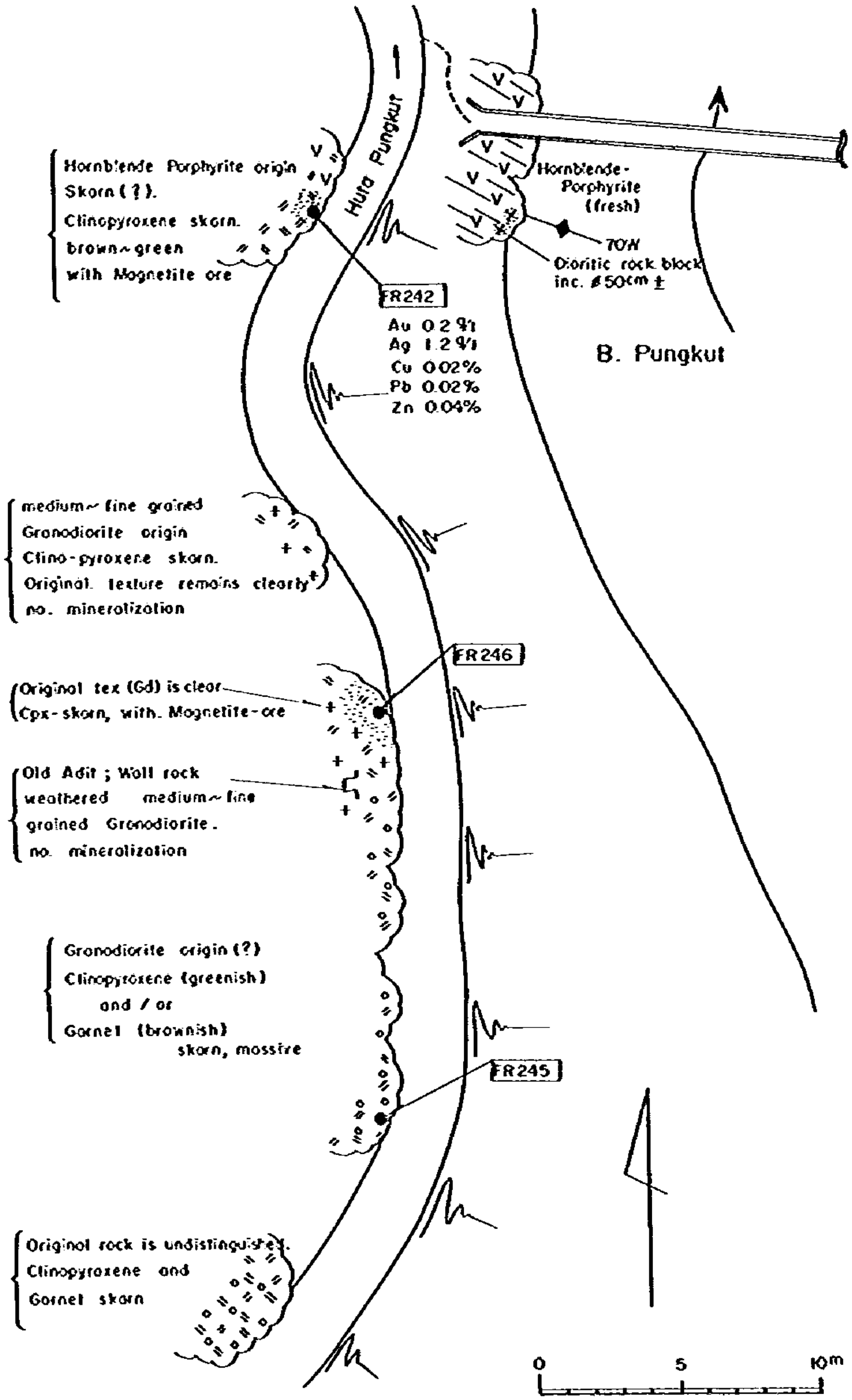


Fig Ⅲ-22 Sketch Map of Outcrop FO-3