REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE CATANDUANES AREA,
THE REPUBLIC OF THE PHILIPPINES

PHASE I

MARCH 1994

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

In the response to the request of the Government of the Republic of the Philippines, the Japanese Government decided to conduct a Mineral Exploration Project in the Catanduanes Area and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and the MMAJ sent to the Republic of the Philippines a survey team headed by Mr. Takehiro Sakimoto from September 14 to December 7, 1993.

The team exchanged views with the officials concerned of the Government of the Republic of the Philippines and conducted a field survey in the Catanduanes area. After the team returned to Japan, further studies were made and the present report has been prepared.

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

We wish to express our deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

February, 1994

Kensuke Yanagiya

President

Japan International Cooperation Agency

Takashi Ishikawa

President

Metal Mining Agency of Japan

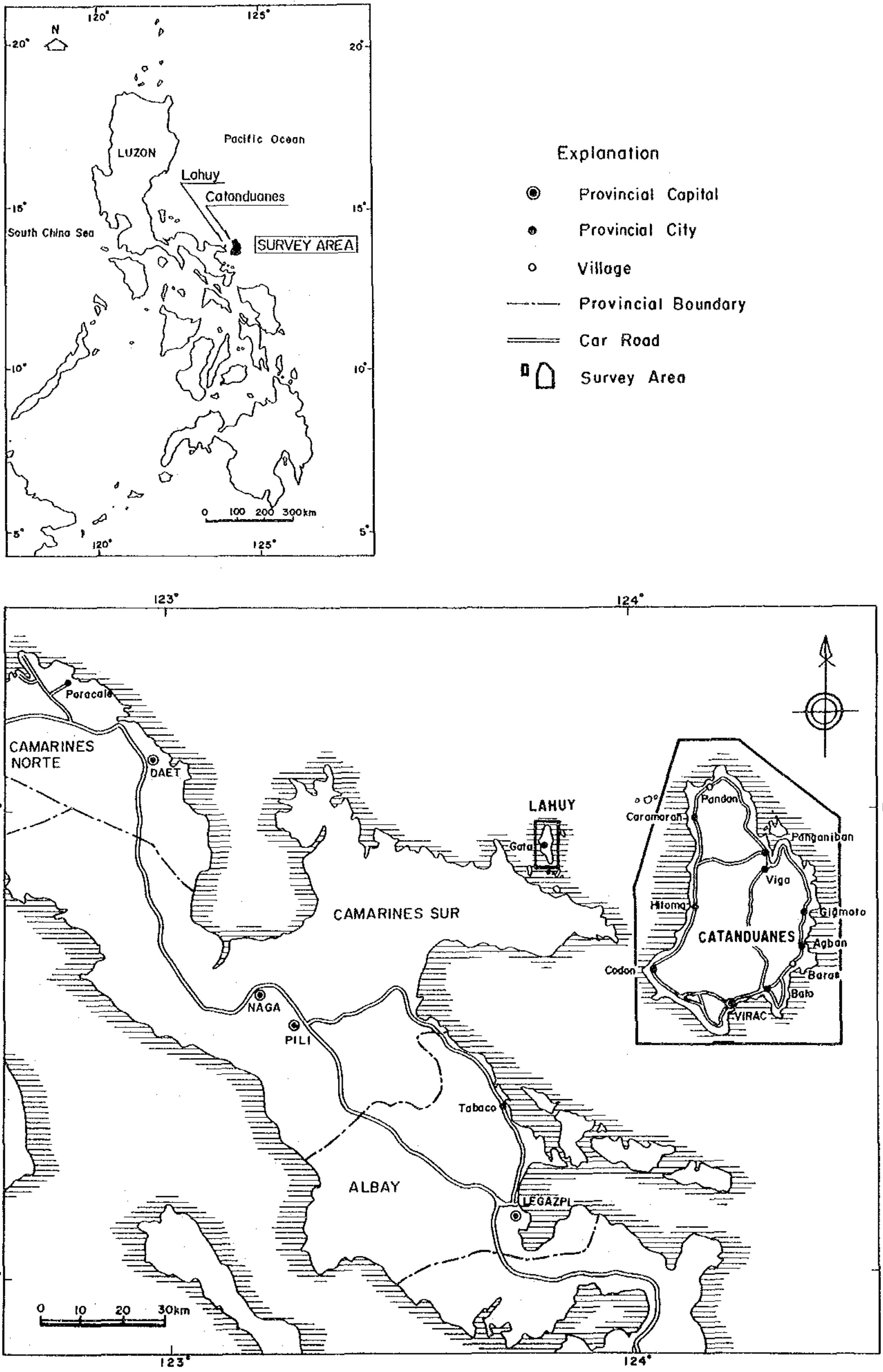

Fig.1 Location Map of the Survey Area

Summary

This report describes the first year's survey results of the Cooperative Mineral Exploration Project in the Catanduanes Area, Republic of Philippines. The objective of the survey is to evaluate the potential for gold and copper in the area.

The survey area is situated in Catanduanes Island in Catanduanes Province and Lahuy Island in Camarines Sur Province.

In Catanduanes Island, geological survey for the whole island and survey for known mineral occurrences have been performed to clarify the relation between the mineralization and geological structure. In addition, stream sediment geochemical survey has been performed to select potential zones for ores.

In Lahuy Island, detailed geological and rock geochemical surveys around known mineral occurrences have been performed to clarify the characteristics of the mineralization and the relation between the mineralization and geological structure in the Detailed Survey Area. In addition, a preliminary geological survey has been performed in some areas, followed by soil geochemical survey to select potential zones for ores in the RReconnaissance Survey Area.

Catanduanes Island is geologically divided into three blocks, northern, central, and southern blocks, by two thrust faults striking northwest to southeast and northwest-west to southeast-east. The island is underlain by the pre-Cretaceous meta-sedimentary rocks, Cretaceous volcanic and sedimentary rocks, post Cretaceous sedimentary rocks and Oligocene Batalay Intrusive Rocks.

It is thought that the gold and copper mineralization is brought by the Batalay Intrusive Rocks mainly comprising of granitic rocks. The intrusive rocks are extensively distributed in the type locality area, and some areas in the southern island as small-scale bodies. Following areas have been selected as potential areas based on the geological and stream sediment geochemical surveys.

(1) Carorongan Area: The area is situated in the central island, and underlain by the sandstone of the Catanduanes Formation. Large amounts of quartz vein floats are scattered around there. The geochemical survey results have revealed that many geochemical anomaly zones of Au, Ag, Cu, Mo, and Sb were there, and the area was of high potential for gold bearing quartz veins.

(2) East of Bato City Area: The area is situated near the type locality of the Batalay Intrusive Rocks, and the largest intrusive body in the island is distributed there. Many gold and copper occurrences are known around there. A large quartz float, 70 centimeters in diameter, has been found in the survey this time. Many geochemical anomaly zones of Au, As, Cu, Mo, and Sb have been found in the survey. It is judged that this area including Agban area is of high potential for quartz veins.

(3) Dugui Too Area: Gold placer occurrences along streams are known in the area. The survey results have revealed presence of many small-scale intrusive bodies, hydrothermal alteration zones in contact zones with intrusive bodies, and some pyrite. It is recommended to conduct further detailed geological survey program to fined primary source ores of the placer gold.

(4) East of the Bato River Area: Geochemical anomaly zones of Au, As, Zn, Hg, Mo, and Sb are overlapped in the mountainous area to the east of the Bato River, which flows down to the south from the center of the island. No sufficient survey has been performed for the area until now, therefore no mineral occurrence has been known. It is possible to fined new mineral occurrences by future surveys.

Lahuy Island is underlain by the Cretaceous Lahuy Formation, which is composed of andesitic, partly dacitic and basaltic, volcanic rocks, and partly intercalated by conglomerate, sandstone and shale layers. Grade of alteration in the southwestern island including Campo and Gata Mineral Occurrences, where have production records for gold and silver in the past and been surveyed in details this time, and that in an area to the east are much different. It is supposed that a thrust fault exists in between those areas, and western block has been uplifted by the fault.

The results of the detailed geological and geochemical surveys have revealed that silicification, potash feldspar alteration and sericitization were dominant in the area, and the mineralization in the area was characterized by gold and silver accompanied by copper, lead, and zinc. Strong geochemical anomalies have been found over the known mineral occurrences. It is thought that exploration and development will be accompanied

by difficulties. On the other hand, no hydrothermal alteration has been found in the Reconnaissance Survey Area, even floats of chalcedonic quartz vein are partly scattered there. Areas to the east of Gata Village, to the southwest of Gogon Village, and southern end of Lahuy Island have been selected as potential areas based on the geochemical survey results, however, the potential is not high because the values of path-finders are low. If ores exist, they are possibly deeply buried.

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PART I GENERAL REMARKS

PART I GENERAL REMARKS

Chapter 1 Introduction

1-1 Background and Objective

The Republic of the Philippines is one of the major mineral producing countries in Southeast Asia, and her production in 1990 is eighth for gold and eleventh for copper in the world. Ore reserves for both metals, however, are sixth and ninth respectively in the world. It means that she has large amounts of undeveloped resources.

The areas geologically mapped in the scale of 1 to 50,000 in this country are 130,000 square kilometers, 43 percent of the total land area. (ref. Resources Information Center of Metal Mining Agency of Japan, 1992) It indicates that she has possibility for new findings in accordance with progress of geological mapping and exploration activities.

The economical environment for mining in the Philippines in these years has been very severe, e.g. low metal prices, low mining grades, exhausting ore reserves, and natural disasters, and the amounts of gold and copper production tend to go down. Under these circumstances, the Government of the Philippines requested the Government of Japan to execute cooperative mineral resources exploration projects for acquisition of new mineral resources.

In response to the request, the Japanese government dispatched a preliminary survey mission to the Philippines, and discussed this matter with the relevant organization of the Philippines. Finally, both sides reached an agreement, and the Japanese representatives, the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ), and the Philippines representatives, the Mines and Geo-Science Bureau (MGB), Department of Environment and Natural Resources, Philippines, entered into an agreement on July 21, 1993. Based on this agreement, a three-year program of the Cooperative Mineral Resources Exploration in the Catanduanes Area, northeast offshore islands of the Bicol Peninsula was programmed to be conducted from 1993.

The objective of this project is to discover new ore deposits of gold, copper, and other useful minerals by means of clarification of the geology, geological structure, mineralization, and geochemical characteristics in the area and integrated interpretation of these data.

1-2 Contents of the Survey

1-2-1 Area and Objective of the Survey

The survey area is situated in Catanduanes Island, Catanduanes Province, and Lahuy Island, Camarines Sur Province, in Bicol Region.

Catanduanes Island is situated in the northeast offshore area of the Bicol Peninsula in an ovale shape, 60 kilometers north to south and 30 kilometers east to west, an area of 1,550 square kilometers, and administratively belongs to Catanduanes Province.

The objective of the survey in this island is to clarify the relationship between the geological structure and mineralization by means of preliminary geological, structural, mineral occurrences surveys for the whole island area, and to find potential areas for useful minerals by means of stream sediment geochemical surveys for whole island.

Lahuy Island is situated in the northeast offshore area of the Bicol Peninsula in a narrowly elongated shape, 9 kilometers north to south and 4 kilometers east to west, an area of 20.1 square kilometers, and administratively belongs to Camarines Sur Province.

The objective of the survey in this island is to clarify the relationship between the geological structure and mineralization by means of detailed geological survey for known mineralized areas, and to find potential areas for useful minerals by means of soil geochemical survey, clarification of geochemical dispersion patterns.

1-2-2 Contents of the Survey

The preliminary surveys consisting of geological and geochemical surveys for the whole area of Catanduanes Island, and associated laboratory works have been conducted this year.

The geological survey has been performed along some selected drainage systems in the areas underlain by the younger formations than Miocene, which are judged as mineral host horizons, together with stream sediment sampling.

Topographic maps scaled 1 to 10,000, enlarged from published maps scaled 1 to 50,000, have been used for the field surveys.

The geological survey results have been mapped in geological maps scaled 1 to 10,000, followed by summarized maps scaled 1 to 50,000. The geochemical survey results also have been shown in geochemical anomaly maps scaled 1 to 10,000.

The detailed geological survey has been performed in known mineralized areas in Lahuy Island together with rock geochemical surveys.

Topographic maps scaled 1 to 5,000, enlarged from published maps scaled 1 to 50,000,

Table 1 Content of Works

Content	Item	Quantity
Geological survey (Reconnaissance survey) Catanduanes Island	1) Preparation of thin section	31 pcs
	2) Preparation of polished section	10 pcs
	3) K-Ar dating of igneous rock	6 pcs
	4) Chemical analysis	
	(1) Stream sediment	717 pcs
Area surveyed	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn	
1,550km²	(2) Rock	34 pcs
Total length of	SiO_2,Al_2O_3,CaO,FeO,Fe_2O_3,K_2O,MgO	
routes 423km	MnO,Na_2O,P_2O_5,TiO_2,H_2O,LOI,	
	Au,Ag,As,Cu,Hg,Mo,Pb,S,Sb,Zn	
	(3) Ore	34 pcs
	Au,Ag,Cu,Fe,Mo,Pb,S,Zn	
Geological survey (Detailed survey) Lahuy Island	1) Preparation of thin section	22 pcs
	2) Powder X-ray diffraction analysis	53 pcs
	3) Measurement of homonization temperature	23 pcs
	4) K-Ar dating of igneous rock	4 pcs
Area surveyed	5) Measurement of resistivity and polarization	24 pcs
2km²	6) Chemical analysis	
Total length of	(1) Rock	104 pcs
routes 13km	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn	
	(2) Ore	21 pcs
	Au,Ag,Cu,Fe,Mo,Pb,S,Zn	
Geochemical survey Lahuy Island	1) Chemical analysis	
Area surveyed	(1) Soil	812 pcs
16km²	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn	

have been used, and topographic surveys have been performed in case it was necessary. The survey results have been summarized in geological maps and geochemical anomaly maps scaled 1to 5,000.

The soil geochemical survey for the whole island area has been conducted. The sampling has been performed based on the 100 x 200 meters grid system carefully designed in accordance with the topography and geological environment. The survey lines have been set up by a baseline survey. The soil samples have been collected from the soil "B" layer, and observation of rock fragments and mineral occurrences have been performed.

Topographic maps scaled 1 to 10, 000, enlarged from published maps scaled 1 to 50,00 0, have been used for the geochemical soil sampling programs, and the survey results have been summarized in geological maps scaled 1 to 50,000 and geochemical anomaly maps scaled 1 to 10,000.

Table 1 shows the contents of the survey in both islands and related experiments .

1-3 Schedule and Members of the Survey

1-3-1 Planning of the Survey and Negotiation

The preliminary survey mission was dispatched to the Philippines to discuss the survey plan and negotiate the first year's survey schedule on the Cooperative Mineral Resources Exploration Project in the Catanduanes Area. The schedule of the mission is as follows.

(a) Preliminary Survey, Negotiation of Agreement.

Period: from July 19 to July 23, 1993

(b) Members of the Mission

Japan

Takashi Tsujimoto	MMAJ
Hitoshi Yamada	MITI
Ken-ichi Takahashi	MMAJ
Tetsuo Suzuki	MMAJ, Manila

Philippines

Joel D. Muyco	MGB, Director
Salvador G. Martin	MGB, Deputy Director
Edwin G. Domingo	MGB
Romeo L. Almeda	MGB

1-3-2 First Phase Survey

(a) Period

From September 14 to December 7, 1993

(b) Members of the Survey Team

Japan

Planning and Coordination

Testuo Suzuki	MMAJ, Manila

Geological and Geochemical Surveys

Takehiro Sakimoto	Nittetsu Mining Consultants Co., Ltd
Shigeyuki Yamasawa	do.
Yasunori Ito	do.
Hirohisa Horiuchi	do.

Philippines

Planning and Coordination

Joel D. Muyco	MGB
Edwin G. Domingo	do.
Romeo L. Almeda	do.

Geological and Geochemical Surveys

Alvin M. Matos	MGB
Elcazar C. Mantaring	do.
Diosdado R. Dizon	do.
Brian Esber	do.
Ariel Bien	do.

Chapter 2 Geography

2-1 Location and Access

The survey area is situated in the northeast offshore area of the Bicol Peninsula, Republic of thePhilippines. Catanduanes Island, a part of the survey area, is situated at 124°02'to 124°25' east in longitude, 13°31' to 14°06' north in latitude, and Lahuy Island at 123°48' east in longitude, 13°53' to 13°59' north in latitude.

To reach Catanduanes Island, it takes about one hour from Manila to Legaspi City by Plane, another one hour from Legaspi to Tabaco Harbour by car, and four hours from Tabaco Harbour to Virac, the capital city of Catanduanes, by ferry boat. Flight service from Manila to Virac is available once a day, and from Legaspi to Virac three flights a week.

The Provincial Government is active for development of road systems in the island, and

the system is good condition at present. There exist an around-island road and cross-island roads from Bato to Viga and from Panganiban to Datag. The road between Calolbon and Bato is concrete paved. Roads inside urban areas and large municipalities are also paved. Other parts of the roads are unpaved and generally in bad condition, four-wheel-drive vehicles roads, however, partly are under construction for pavement. Damages and loss of roads by heavy rain are common, and no bridge crossing rivers somewhere, i.e. the Hitoma River, makes difficult to cross sometimes in heavy rainy occasions.

During the survey period, the road between Sicmil and Gigmoto in the east coast was closed because it was under construction, and between Panganiban and Datag also was closed because of collapse of the bridge.

It takes three hours from Codon in the west coast of Catanduanes Island to Lahuy Island by a banka boat. No vehicle exists in the island, and only way for transportation is walking inland and banka boats in the sea. Coral reefs are much developed around the island, and no large ship is accessible.

2-2 Topography

Catanduanes Island is 60 kilometers north to south and 30 kilometers east to west in size, having an area of 1,550 square kilometers including Panay and Plumbanes Islands, and the twelve largest island in the Philippines.

The island is topographically divided into four areas, northern, western, and eastern mountain areas, and southern lowland. Topography of the mountain areas is generally rugged, having deep V-shape valleys and many falls. The lowland occupies quite a small area, about 7 percent of the total area.

The northern island is underlain by the Yop and Payo Formations, and shows gentle topography. The boundary between the northern lowland and southern mountain area underlain by the Catanduanes Formation forms steep cliffs, showing clear contrast between them.

The central part of the island crossing from the west coast to the east coast is an area of rugged mountains, and the Bato and Oco Rivers divide the mountains the east from the west.

In the western mountain area, an tributary of the Bato River run down toward southeast-south and joins the Bato River at Pagsagnahan, and the Hitoma River run down toward northwest, in the northern area. The Maygnaway and Pajo Rivers form east to west and north to south drainage patterns in the southern area.

A radial drainage pattern from the central point of the area is seen in the eastern mountain

area. The east coast shows a complex coastal cliff lines.

The southern area from Calolbon and Virac is underlain by the Tertiary Sto Domingo Formation and alluvium, showing gentle low hilly topography. Other lowlands are in the areas southeast of Bato and north of Viga, forming swampy palm tree land.

The coastal lines in the east and west make clear contrast, complex in the east and smooth in the west.

Lahuy Island is 9 kilometers north to south and 4 kilometers east to west in size, having an area of 20.1 square kilometers. Topography of the island is characterized by a ridge stretching north to south in the western island. The eastern side of the ridge is relatively gentle, but the western side is rugged to the coast lines.

2-3 Climate and Vegetation

The survey area is in the tropical rain forest area, one of the largest precipitation area in the Philippines. It is known that the area is most frequently attacked by strong typhoons.

The average annual precipitation in Catanduanes Island from 1984 to 1991 is 2,500 millimeters, and monthly average is 204.1 millimeters. (Table 2)

It is rainy season from October to December, and average monthly precipitations from 19 84 to 1991 is 412.3 millimeters in October, 401.1 millimeters in November, and 333.2 millimeters in December(Table 3). Fig. 2 shows the monthly precipitations in Catanduanes Island.

Table 2 **Average Annual Rainfall in Catanduanes Island**

Year	1984	1985	1986	1987	1988	1989	1990	1991	Av.
Annual	2119	3800	2353	2414	2615	2706	1943	1540	2579
Mon.AV.	177	325	196	201	218	225	162	128	204

Unit is in mm

Table 3 **Average Monthly Rainfall in Catanduanes Island**

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.
Av.'93	69.1	126.8	34.3	47.6	20.9	324.9	151.6	196.4	226.0	585.7	334.1	—
Av.	208.6	72.6	108.1	127.8	146.9	227.9	249.0	124.1	167.4	412.3	401.1	333.2

AV.'93 is result of 1993 as of Nov. 21. Av. is average of '84-'90.Unit is in mm

Temperature varies a little through a year, being 26°C in annual average. Table 4 shows monthly average temperatures, and Fig. 3 shows their diagram. The annual average humidity is 80 percent.

Fig.2 Average Annual Rainfall in Catanduanes Island

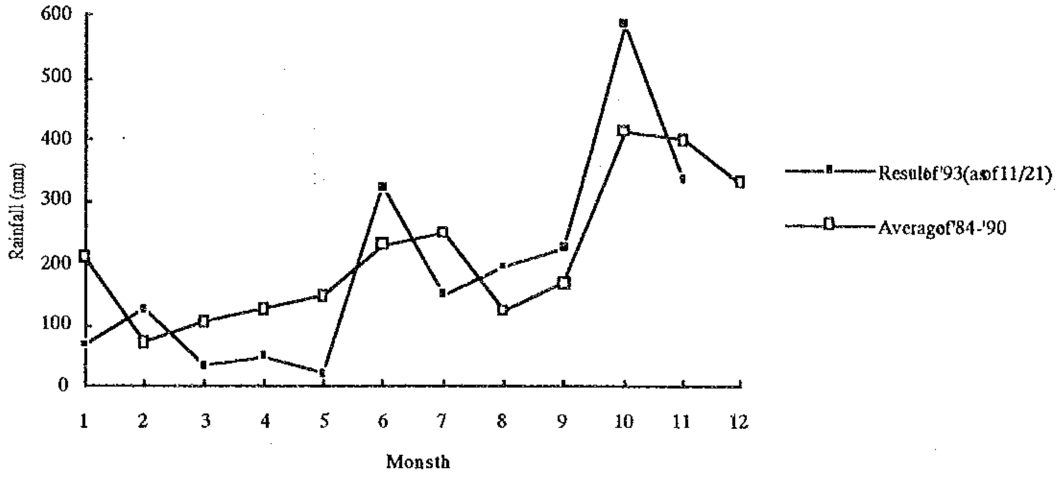
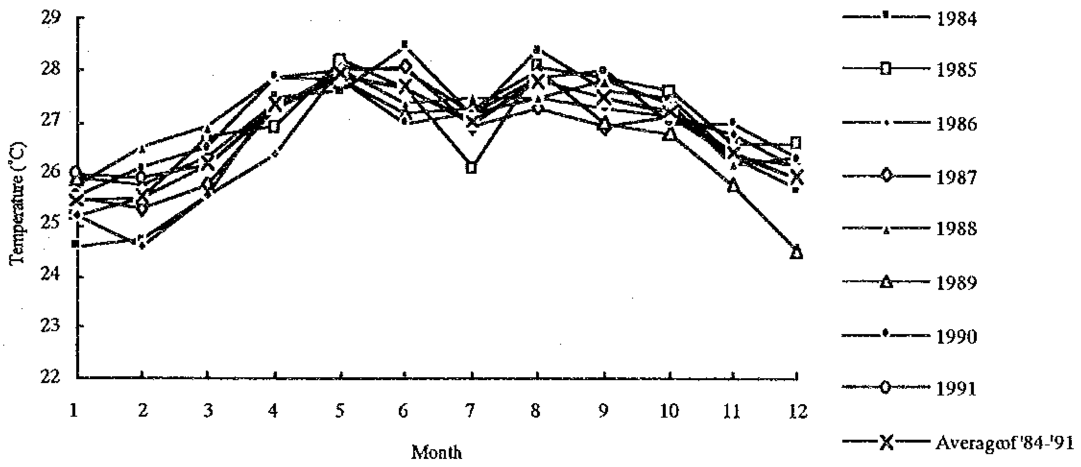


Fig.3 Average Monthly Temperature in Catanduanes Island



The highland area of the island is covered by typical tropical rain forest, which occupies 4 6 percent of the total land area. Dipterocarp and lauan are the most popular species in vegetation, and bamboos are seen around habitations. Abaca and coconut are planted in gentle slopes of the mountain areas. Palm trees grow in lowland swampy areas near Bato and Viga.

Seventy-five percent of the land area in Lahuy Island is grassy area covered by miscanthus etc, and only 25 percent of the island, in the southern end and northern end, is covered by tropical rain forests. Trees in the rain forests are virgin broad-leaf trees, and rattan

and runners heavily grow on the surface. Mangroves live in flocks in the lowland swampy areas near shore lines. Coral reefs extensively surround the island.

Many adits, pits, and trenches are seen in the mineralized area in Gata Village in the western side, and gossan is seen in striped lands. Gentle slopes are utilized for agriculture.

Table 4 **Average Monthly Temperature in Catanduanes Island**

Month	1984	1985	1986	1987	1988	1989	1990	1991	Average
1	24.6	25.2	25.2	25.5	25.8	25.9	25.6	26.0	25.5
2	24.7	25.5	24.6	25.3	26.5	25.8	26.1	25.9	25.6
3	25.6	26.7	25.6	25.8	26.9	26.3	26.5	26.2	26.2
4	27.5	26.9	26.4	27.3	27.9	27.4	27.9	27.3	27.3
5	27.6	28.2	28.1	28.0	28.0	27.8	27.8	27.9	27.9
6	26.5	27.7	28.0	28.1	27.4	27.2	27.0	27.7	27.7
7	27.1	26.1	27.2	26.9	27.5	27.3	27.2	27.0	27.0
8	28.4	28.1	27.5	27.3	27.5	28.0	27.9	27.8	27.8
9	27.6	27.9	27.3	26.9	27.8	27.0	28.0	27.5	27.5
10	27.5	27.6	27.1	27.1	27.4	26.8	27.0	27.2	27.2
11	26.3	26.6	26.8	26.3	26.2	25.8	27.0	26.4	26.4
12	25.7	26.6	26.1	26.2	26.3	24.5	26.3	25.9	26.0

2-4 General Status

Catanduanes Island was separated from Albay Province in 1945, and became an independent Province "Catanduanes Province". Big towns in the province are Virac, Bato, Pandan, Panganiban, San Andres, Viga, Bagamanoc, Baras, Gigmoto, and San Miguel. The population of the island was 187,000 in 1990. The capital city Virac has 46,000 in population, and is possessed of the province government building, hospitals, post offices, banks, primary schools, middle schools, high schools, university, airport, harbour, etc. The city is the entrance of the island.

Virac city, in where the base camp for the survey team was set up, and Caramoran and Viga cities, in where sub-camps were set up, have markets, being big enough to get daily commodity, and electricity and water supply facilities. Hitoma Village, in where one of sub-camp was set up, however, has no market, electricity, and water supply facilities. Other small villages are in same condition.

Main industries in the island are agriculture for rice, abaca, coconut, etc., fishery, and forest. Mineral occurrences for gold, copper, manganese, heavy sands, phosphate, and coal are known in the island, which were mined in small scale before the second world war. No mine is in operation at present.

Lahuy Island belongs to Camarines Sur Province and comprising of Gata, Oring, Daraga, and Gogon Villages. The population of the island was 4,514 in 1990, and primary schools, middle schools, and general stores exist in the island. One general store exists in Gata Village, in where our base camp was set up, however, it is difficult to get daily commodity. No electricity and water supply facilities are available. Circumstances for living there is severe, and people in the island live in self-sufficiency.

Main industries in the island are fishery, livestock farming for cattle and water buffalo, agriculture for rice and coconut, etc., in addition to that small scale mining for gold in Gata and Campo mineralized zones in the western island is in operation by local people.

Chapter 3 Existing Geological Information

3-1 Previous Works

Philippine Bureau of Mines, now Philippine Bureau of Mines and Geo-sciences (MGB), has been active in preliminary surveys for mineral occurrences in Catanduanes Island. At the early stage of the program, Capistrano (1951a) and Capistrano (1952) described coal, manganese, and marble occurrences in the island. Crispin et al. (1955) also described coal resources in the Panganiban area, contemporary showed a stratigraphic succession in the island. Then, Miranda and Vargas (1967) performed detailed geological surveys in the whole area of the island, and established the stratigraphic succession, which is accepted for all at present. They also described mineral occurrences for coal, copper, gold, manganese, heavy sands, clay, etc. in the island, and show their geological maps covering the whole island area. MGB (1982a) noted their geological map and mineral occurrences in the island based on the Miranda and Vargas report (1967). MGB (1982b) described the geology and mineral occurrences of the island in comparison with surrounding area, based on the priory mentioned reports.

Geological maps, 1 to 50,000 in scale, MGB, 1983 (a, b, c, d, e, f, and g,)covering the survey area are available. These maps are revised from the maps of Miranda and Vargas (1967). Several papers published by MGB Legaspi branch office describe other mineral occurrences; Angeles and Teodoro (1980), Angels and Teodoro (1983), and Teodoro et al. (1988).

This year's survey has been based on the stratigraphic succession of Miranda and Vargas (19 67) and the geological maps by MGB (1983), and the geological maps have been modified based on the field survey.

In Lahuy Island, gold mining by Philippine Corp. was active at the Gata and Campo mineral

occurrences in Gata Village in the western island before the second world war.

The mineral occurrences at Gata Village was reported by MGB and Rajah, Lahuy Mining Company, however, no report can be in the possession of the team. Torres (1978) performed a survey and sampling of the adit tunneled by Pan Philippine Corp., and reported its assay results, then described the geology and mineral deposits in Gata Village.

A geological map of the Gigbos area, scaled 1 to 50,000 covering the survey area, MGB (1985), is available.

3-2 General Geology of the Surrounding Area

This area is geologically classified as the Bicol district in the Philippine Islands. The district is underlain by green-schist, ultramafic rocks, meta-volcanic rocks, clastic rocks of Cretaceous and early Tertiary ages, and characterized by thrust slices of limestones. Sedimentary and volcanic rocks of Oligocene to Miocene age overlies those rocks. The thrust faults in this area is parallel the Philippine Trench, and dip to the southwest (MMAJ Information Center, 1992). The Paracale area in Caramoan Peninsula, which is known as a gold area, and the survey area are geologically similar.

3-2-1 General Geology of Catanduanes Island

Catanduanes Island is, being based on MGB, 1983, underlain by the pre-Cretaceous Catanduanes Formation (meta-sedimentary rocks), Cretaceous Yop Formation (basaltic volcanic rocks) and Bonagbonag Limestone (conformably overlying and inter-fingering with the Yop), Eocene Payo Formation (sandstone, conglomerate, limestone, etc.), Oligocene Batalay Intrusive rocks (dioritic rocks), Miocene Buti Hill Limestone and San Vicente Formation (conglomerate), Miocene to Pliocene Sto Domingo Formation, and Pleistocene Viga Conglomerate.

The island is divided into three thrust slices by two thrust faults extending east to west and northwest-west to southeast-east. The northern slice is composed of the Yop and Payo Formations, the central slice is of the Catanduanes, Yop, and Payo Formations, and the southern slice is of the Catanduanes, Yop, Payo, and Sto Domingo Formations.

The gold and copper mineralization in this island is supposed to be brought by the Batalay Intrusive. The Batalay Intrusive are distributed mainly in an area of 6.5 x 1.5 kilometers around Bato and Baras, and intruded along some structural lines as sills or irregular shape bodies (Miranda and Vargas, 1967).

3-2-2 General Geology of Lahuy Island

No detailed geological description is available on Lahuy Island, but there is the geological map of the Gigbos Area, 1 to 50,000 in scale, published by MGB, 1985. Based on this map, the whole island is underlain by the late-Miocene Lahuy Formation comprising of andesitic volcanic rocks.

According to Torres (1978), the mineralized area of Gata Village is underlain by chloritized sedimentary rocks, which steeply dip to the east, at the lower in the south, overlying andesitic agglomerate in the north, and unconformably overlying sedimentary rocks comprising of conglomerate, sandstone, and shale, which dip 30 degrees to the east. The upper sedimentary rocks have been subjected to shearing, and intruded by quartz veinlets, 0.5 centimeters thick in average. Andesitic to basaltic volcanic flows overlie all mentioned sequences, dip 30 degrees to the west, and have been subjected to shearing and tension movement. Silicification and pyritization have overprinted in the sedimentary rocks. An andesitic intrusive body extending northeast to southwest exists at Tila Point and Panique Point, which are thought to be an ore bringer in the area.

3-3 Brief Mining History of the Survey Area

3-3-1 Catanduanes Island

Many mineral occurrences of Gold, copper, heavy minerals, manganese, limestone, phosphate, clay, etc. are known in the island, and exploration activities have been extensive until now. Some of the mineral occurrences were in operation in small scale before the second world war, however no large scale mining operation has been done. Occurrences actively operated in the past are Agban, Carorongan, Dugui Too, etc. which are of gold and copper. No operating mine exists at present.

Significant mining activity in the island was an exploration program by Boliden Company of Swedish and a local mining company, Canardico. They formed a joint venture, and performed a drilling program in Agban, Libjo, San Miguel, and San Pedro to find gold and copper deposits around the Batalay Intrusive.

MGB also performed geological and geochemical exploration programs for gold and copper in Guiamlong, Tilod (Angeles and Teodoro, 1980), Dugui Too (Teodoro et al., 1988), Kaglatawan (Angeles and Teodoro, 1983), etc., as well as a program for coal (Capistrano, 195 1b and 1952; Crispin, 1955).

3-3-2 Lahuy Island

An extensive gold mining operation was conducted by an American capital company, Pan Philippine Corp. in the mineral occurrences zone in Gata Village from 1939 to the time before starting the second world war. The activity was forced to cease by the Japanese invasion.

Their prussic acid processing plant was 200 tons per day in capacity in 1940, the ore reserves was 43.953 tons, and the grade of ores was 13.5 grams per tone in 1941. The mining facilities in the area were moved to Lapulapu Island by Japanese during the war (Torres, 1978). An american capital again came in the area from 1983 to 1984, and performed a drilling program consisting of about 100 drill holes and trenches, but the capital withdrew from the activity. An australian capital, Island Arc Company, performed a drilling program consisting of 15 drill holes in cooperation with Philippine National Oil Company(PNOC) during 1987 and 1988, however it is said by local people that the ore grade is high but the scale is not big enough.

Local people are still mining in small scale in the mineral occurrences in Gata Village these days, as well as panning for gold from beach sands.

Chapter 4 Comprehensive Discussion

4-1 Geological Structure and Mineralization Control

4-1-1 Catanduanes Island

The island is geologically divided into three blocks, northern, central, and southern blocks, by two thrust faults striking northwest-west to southeast-east and northwest to southeast. The Batalay Intrusive Rocks, which are thought to have brought mineralization in the area, are distributed in the type locality, southeastern end of the central block, as the largest body in the island, and other areas such as the southern part of the central block and whole area of the southern block as small-scale bodies. On the other hand, a few intrusive bodies are seen in the northern part of the central block and whole area of the northern block, apparently decreasing the numbers of the bodies toward the north. Based on this phenomenon, it is supposed that the intrusive bodies intruded after the thrust movement.

Many intrusive bodies have been found in areas of the Dugui Too, to the east of Bato City, and Agban, in the survey this time. These bodies are commonly accompanied by mineral occurrences. The center of the igneous activities is in the southeastern island, and the activities grade down toward the north, therefore the mineralization is probably weaken to the north, in accordance with the igneous activities. In other words, the potential in the southern island is higher

than other areas. However, many mineral occurrences, such as Carorongan, Hilacan, Manail, and Dulangan, are distributed in the northern part of the central block and whole area of the northern block, in spite of only a few intrusive bodies are seen there. It is, therefore, supposed that unknown intrusive bodies exist around there.

4-1-2 Lahuy Island

Pan Philippine Corp., an american capital, operated a mine in Gata Village from the 1930's until starting the second world war. The operation was active in the Gata and Campo Occurrences in a large scale.

The island is underlain by Cretaceous andesitic, partly dacitic and basaltic, volcanic rocks of the Lahuy Formation. It is supposed that the area of Gata Village, in the southwestern island, has been thrust up by a fault striking north to south, and deeper parts of the formation are presently exposed. Presence of floats of chalcedonic quartz and secondary manganese crust scattered in an area to the southwest of Gogon Village in the northern island and in the southern island suggests that the top parts of the mineralized zones are exposed there.

Gold occurrences are known in the Campo and Gata areas in the northern part of the dDetailed Survey Area in Gata Village Rocks around there have been subjected to significant hydrothermal alteration, dominated by silicification, potash feldspar alteration, sericitization. East-west to northwest-southeast striking veins are dominant in the Campo occurrence area, and north-south to northwest-southeast striking veins are in the Gata occurrence area. The veins are composed of quartz, amethyst, pyrite, galena, and sphalerite, and 30 centimeters thick in rich parts and less than 5 centimeters thick in poor parts. These rich and poor parts are about 1.5 to 2.1 meters long and repeatedly continue.

4-2 Geochemical Anomaly and Mineralization

4-2-1 Catanduanes Island

No highly significant principal component has been found in the analysis of the stream sediment geochemical survey performed in the island this time, however, copper mineralization has been expressed in the first principal component and gold mineralization in the third, fourth, and fifth components.

High point areas for the first principal component are areas around Pagsagnahan Village in the central island and areas situated along a tributary of the Bato River, which joins with the tributary in Pagsagnahan Village A copper mineral occurrence is known in the upper stream of the

Kaglatawan River, however, it is evaluated that the mineralization is weak judging from its weak alteration in the rocks around there.

High point areas for the third, fourth, and fifth principal components are the Carorongan Occurrence, occurrence to east of Bato City, Dugui Too Occurrence, and mountainous areas to the northeast of Pagsagnahan. The first three are known occurrences, therefore, it is recommended to perform further detailed surveys for them. The last has not sufficiently surveyed until now, and no mineral occurrence is known there. It is also recommended to perform further surveys to find new mineral occurrences.

4-2-2 Lahuy Island

The results of the rock and soil geochemical surveys in the Detailed Survey Area in Gata Village have revealed that the mineralization in the island was characterized by gold-silver bearing sulphide copper, lead, zinc, and molybdenum ores. The results of the preliminary soil geochemical survey for the whole island area have indicated that the second, third, and fourth principal components were effective as indications for the mineralization. High points for these components are concentrated in an area to the east of the Gata Village Detailed Survey Area, therefore, it is evaluated that the area is of high potential for same type of ores. One or two high points of above mentioned components are distributed in an area to the west of Gogon Village, southern end of the island, and it is evaluated that the arc is of high potential. Ores, if exists, would be buried in deep judging from known data, and the island is too small for mining, therefore there are some difficulties to prospect ores and develop a new mine.

4-3 Promising Area

4-3-1 Catanduanes Island

Following potential areas have been extracted based on the results of the geological and stream sediment geochemical surveys.

(1) Carorongan Area: The area is situated to the east of Viga Town, and underlain by sandstone of the Catanduanes Formation. Geochemical anomaly zones of Au, Ag, Cu, Mo, and Sb are distributed in this area, and it is evaluated that the area is of high potential for gold bearing quartz veins in the sandstone.

(2)East of Bato City Area: The area is situated near the type locality of the Batalay Intrusive Rocks, which is the largest intrusive body in the island. Many gold and copper occurrences are known around the intrusive body. A large float of quartz, 70 centimeters in diameter, has been

found in the survey. Geochemical anomaly zones of Au, As, Cu, Mo, and Sb are scattered around there, and it is evaluated that the area is of high potential and new ore veins to be discovered by further detailed surveys.

(3) Dugui Too Area: Gold placer deposits are known in the area, and many small-scale intrusive bodies accompanied by hydrothermal alteration zones, which are impregnated by pyrite, have been confirmed by the survey. The sandstone around the intrusive bodies have been subjected to skarnization. It is evaluated that the area is of high potential for primary ores of the placer gold, and recommended to perform further detailed geological survey.

(4) East of the Bato River Area: Geochemical anomaly zones of Ag and some others are distributed in the mountainous area to the east of the Bato River, which flows down from the central part of the island to the south. No sufficient survey has been performed in the area, therefore no mineral occurrence is known until now. It is, however, evaluated that the area is of high potential for new ores.

4-3-2 Lahuy Island

Strong geochemical anomaly zones have been found in the Campo and Gata Occurrences in the Detailed Survey Area. It suggests strong mineralization around there.

The results of the soil geochemical survey for the whole island have revealed that an area to the east of Gata Village, southwestern part of Gogon Village, and the southern end of the island were of high potential. Ores, if exist, are presumably in deep, and other conditions of the island together with deep buried ores would make difficult to develop new ores. It is recommend no further work to be performed in the island.

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

5-1-1 Catanduanes Island

Based on the results of the geological and stream sediment geochemical surveys, the Carorongan area, area to the east of Bato City, Dugui Too area, and mountainous area to the east of the Bato River have been extracted as high potential areas.

Even no Batalay Intrusive body is seen in the Carorongan area, a large number of quartz floats are scattered there, and many geochemical anomaly zones for various components are distributed there. It suggests that the mineralization in the area is strong and of large scale. Around

the Tinagan River, to the east of the Carorongan area, geochemical anomaly zones of Au and others are distributed. It is evaluated that the area including the Tinagan area is good target for further detailed geological survey to find new ores.

The largest intrusive body of the Batalay Intrusive Rocks is situated to the east of Bato City The rock is mainly composed of granodiorite, and accompanied by small intrusive bodies around there. Many mineral occurrences are also known around there, however, no detail information is available. It is evaluated that the area is worth to conduct an integrated survey to reveal scale and grade of ores, and properly evaluate its potential. It has high potential for new ores, and the known mineral occurrences could be re-evaluated.

The strongest Au anomaly in the island appears in the Dugui Too area. Placer gold deposits are known in the area, and many small-scale intrusive bodies of the Batalay Intrusive, accompanied by hydrothermal alteration zones, are distributed. It is thought that the mineralization in the Hicming and Danicop areas, near by the Dugui Too area, is in the same series of that of Dugui Too. It is evaluated that the area including the Dugui Too, Hicming, and Danicop is worth for further detailed geological survey.

Geochemical anomaly zones of Au and others are scattered in the mountainous area to the east of the Bato River. No sufficient survey has been performed in the area until now, therefore it is worth to perform further geological survey to find new occurrences.

5-1-2 Lahuy Island

A significant indication appears in the Gata Village Occurrence in the Detailed Survey Area in the island. The results of the principal component analysis for the geochemical survey suggest that gold bearing sulphide copper, lead, zinc, and molybdenum mineralization occurred there. No strong geochemical anomaly has been found in the geochemical survey for the whole island, however, a similar type of anomaly has been found in an area to the east of Gata Village, and other anomalies in an area to the west of the Gogon Village and in the southern end of the island. It is supposed, based on the geological survey results, that the area of the Gata Occurrence has been thrust up, and deeper parts of the formation are exposed there. It is evaluated that these three areas have potential for same type of ores as that of the Gata Village Occurrence. The potential for the area to the east of Gata Village is specially high.

5-2 Recommendations for the Second Phase Survey

5-2-1 Catanduanes Island

Carorongan Area: Many geochemical anomaly zones for various elements are overlapped in the area from the upper stream of the Manuria River to the Carorongan River, a tributary of the Manuria. A large number of quartz veins are in the area from the Carorongan River to Taganopol River. These phenomena suggest that high potential for quartz veins exists in the area. Geochemical anomalies for Au and other elements are recognized in the Tinagan River area, to the east of the above mentioned areas. It is , therefore, recommended to conduct further detailed geological survey program to reveal details of vein control, scale of ores, and its economical values. It is also recommended to perform a soil geochemical survey to find potential areas for ores in the area from the Taganopol River to Carorongan River, in where many quartz veins exist.

East of Bato City Area: The largest granodiorite body of the Batalay Intrusive Rocks and many mineral occurrences such as San Pedro, Libjo, Aroyao, and Tilod are distributed in the area. It is recommended to conduct a detailed geological survey program to reveal relations between each mineral occurrence, control factors for mineralization. This should lead to accurate evaluation for potential in the area, and eventually to discovery of new ores. The Agban area, in where the most prominent outcrop of quartz veins was found, is situated to the northeast of this area. Many intrusive bodies are presumably distributed in the area from the Agban area to this area, and it is evaluated that the area is of high potential for ores. It is also recommended to perform geological detailed surveys in the area around the Agban area.

Dugui Too Area: The most significant geochemical anomaly in the island has been recognized in the area. Furthermore, gold placer deposits are known in the area, and a large number of small-scale intrusive bodies of the Batalay Intrusive, accompanied with hydrothermal alteration zones, are distributed there. It is recommended to conduct detailed geological survey programs in the area including Hicming and Danicop to reveal details of ores.

East of the Bato River Area: The survey this time has revealed new bodies of the Batalay Intrusive in the eastern part of Pagsagnahan Village, in the central island, and also scattered geochemical anomaly zones of Au and others in a mountainous area to the northeast of Pagsagnahan Village The area is almost virgin for exploration activity, therefore it is recommended to conduct a concentrated, detailed geological survey program to find new mineral occurrences.

5-2-2 Lahuy Island

In the Detailed Survey Area, promising indications for ores have been found on the known mineral occurrences in the geological and soil geochemical detailed surveys this time. Other than above mentioned area, geochemical anomaly zones have been found to the east of the Gata Village, to the southwest of Gogon Village in the northern island, and in the southern end of the island. The assay values of those anomalies, however, are generally low. Conditions for new mine developing are tough in the island. It is supposed that ores, if exist, would be sit in fairly deep underground, and invasion of the sea water in mining site would be occurred due to the close location to the sea.

PART II DETAILED DESCRIPTION

PART II DETAILED DESCRIPTION

Chapter 1 General Geology

The Philippines can be geologically divided into two areas, the stable terrain in southwestern Philippines from Palawan to the Sulu Sea and the mobile belt in north to southeastern Philippines from Luzon Island to Mindanao Island. Earthquakes and volcanic activities are extensive in the mobile belt, and they are caused by subduction of ocean plates from the east and west. The Philippine Fault run in the central zone of the belt stretching northwest-north to southeast-south, left lateral in movement.

The mobile zone is divided into three sub-zones, western, central, and eastern sub-zones, and the eastern sub-zone is further divided into Sierra Madre, Bicol, Samar, and Diwata. The survey area belongs to the Bicol zone, and its geology is characterized by thrust faults parallel to the Philippine Trench.

Dioritic to granitic activities in the Philippines are classified into three ages, pre-Tertiary, Paleogene, and Neogene. The Paleogene and Neogene activities are supposed to be closely associated with mineralization (UN,1992).

There are five important gold areas in the Philippines, i.e. Baguio, Paracale, Masbate, Surigao, and Masara, which are concentrated along the Philippine Fault (MGB, 1986). Mitchell and Balce (1990), however, reported that there is no relation between the distribution of the hydrothermal deposits and the Philippine Fault.

The survey area is situated in a position a little apart from the Philippine Fault. It is, however, in an extensively active area for andesitic igneous activities in Paleogene (in Catanduanes Island) and Cretaceous (in Lahuy Island) ages, and geologically continues to the Paracale District and Caramoan Peninsula, which is known as gold and copper mineralized areas. It is, accordingly, judged that this are is of high potential for gold and copper.

The geology of Catanduanes Island is characterized by two thrust faults, extending east to west and northwest-west to southeast-east, and the land is divided into three blocks, northern, central, and southern blocks.

Each block is composed by the pre-Cretaceous Catanduanes Formation consisting of meta-sedimentary rocks, Cretaceous Yop Formation consisting of basaltic volcanic rocks, and Eocene Payo Formation consisting of sedimentary rocks. Neogene to Quaternary sedimentary rocks unconformably overlie above mentioned Formations. Oligocene dioritic Batalay

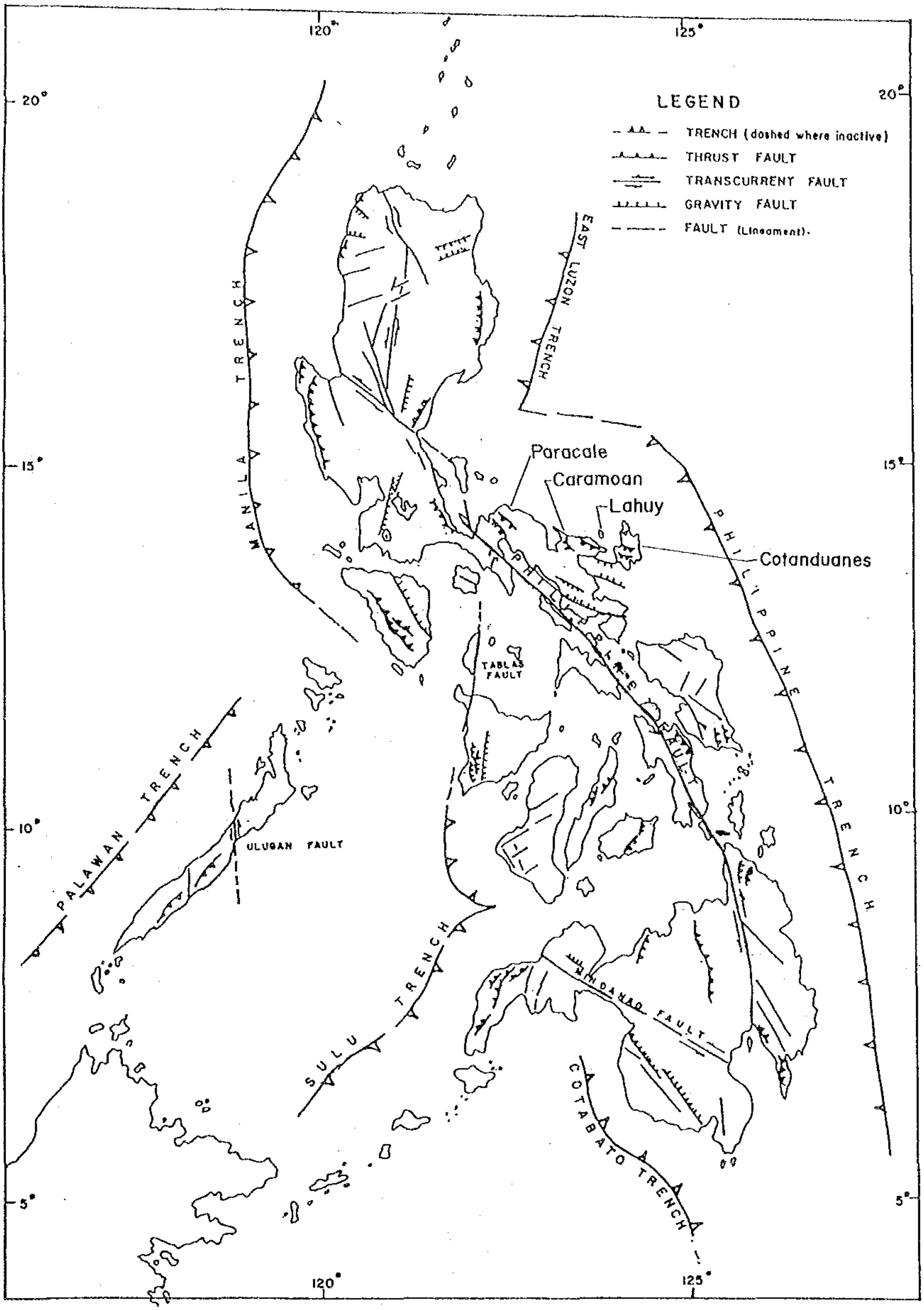


Fig.4 Crustal Fractures of the Philippines

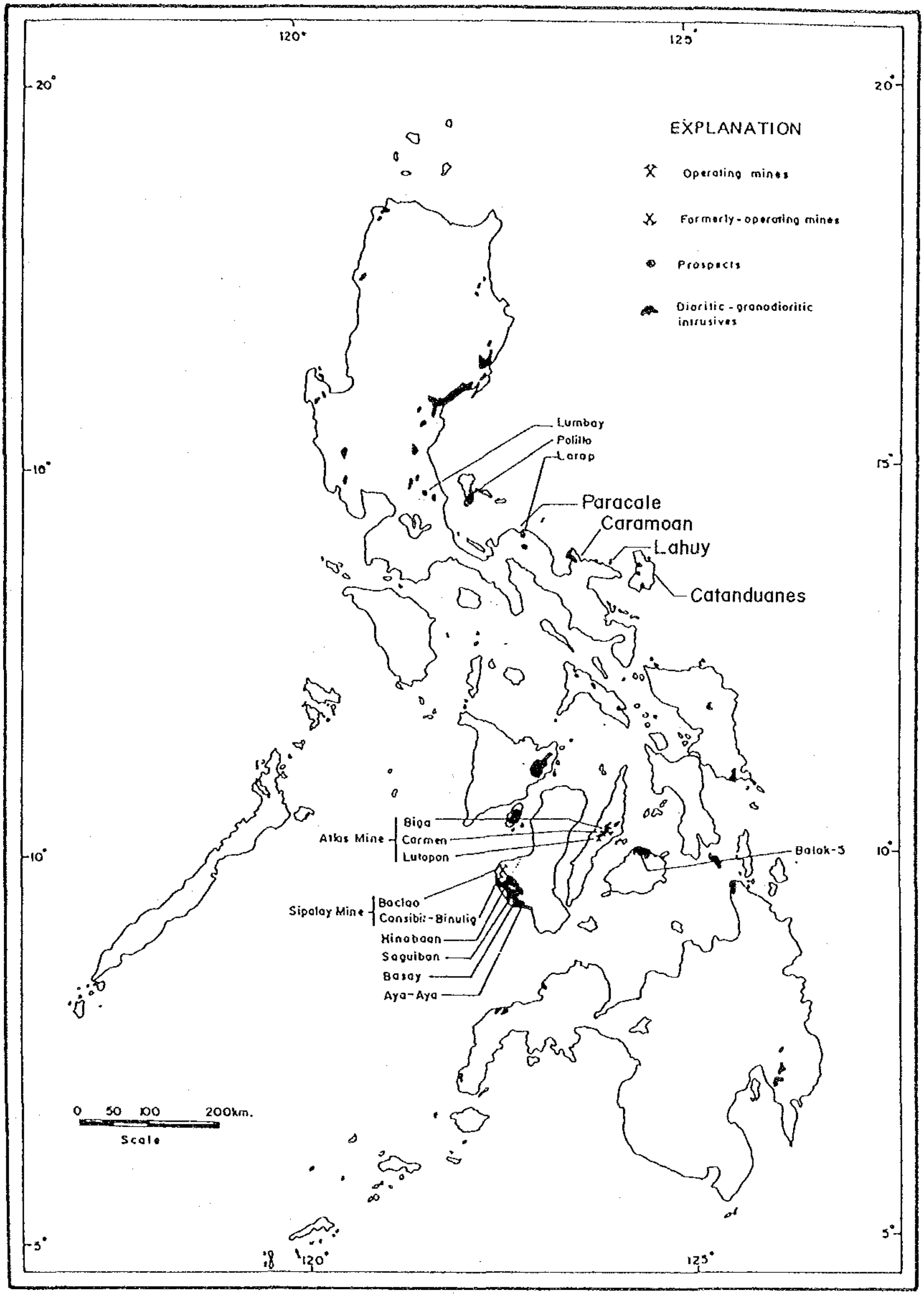


Fig.5 Cretaceous–Paleogene Dioritic–Granodioritic Intrusives and Associated Porphyry Copper Deposits of the Philippines

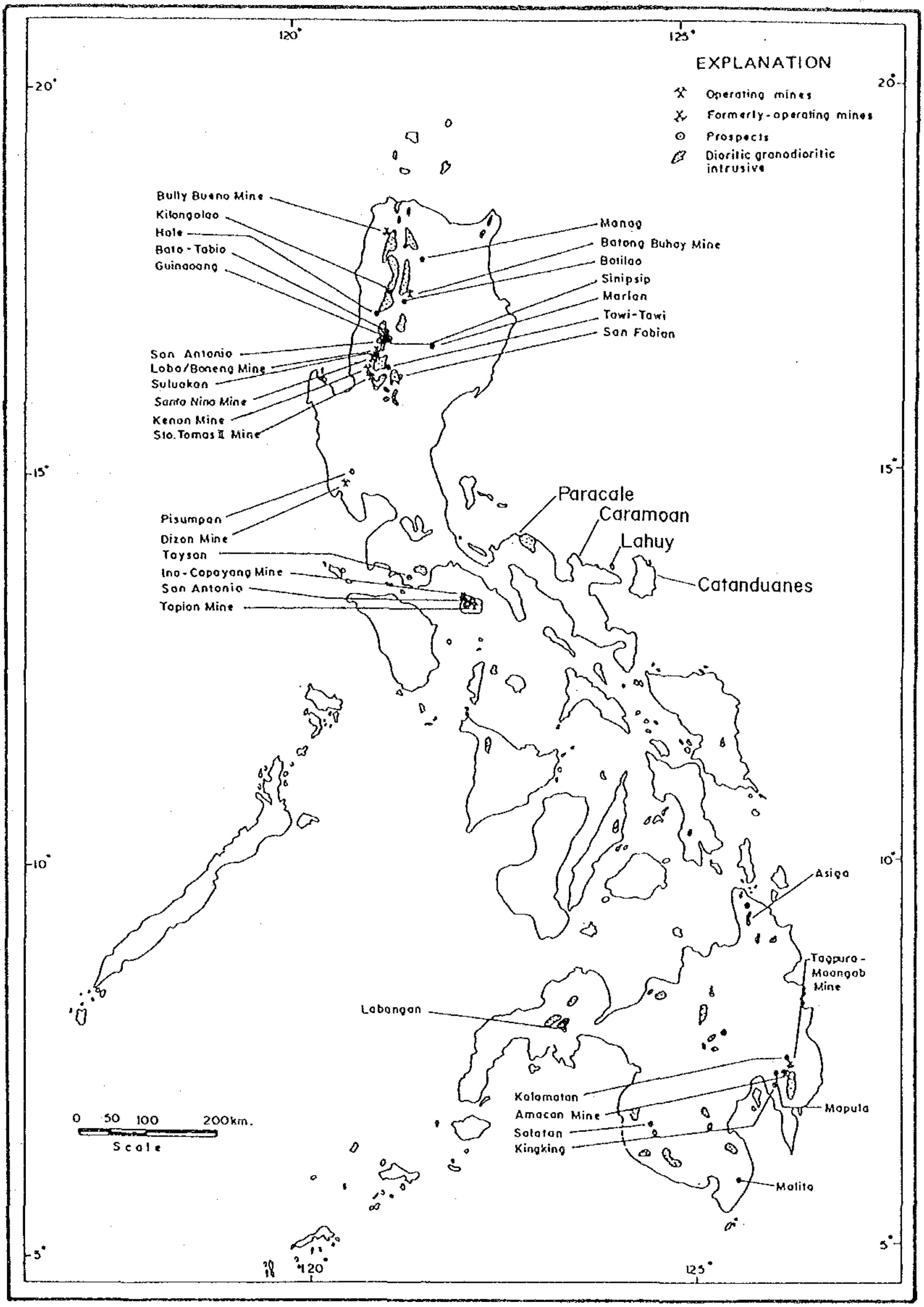


Fig.6 Neogene Diorite–Granodiorite Intrusives and Assosociated Porphyry Copper Deposits of the Philippines

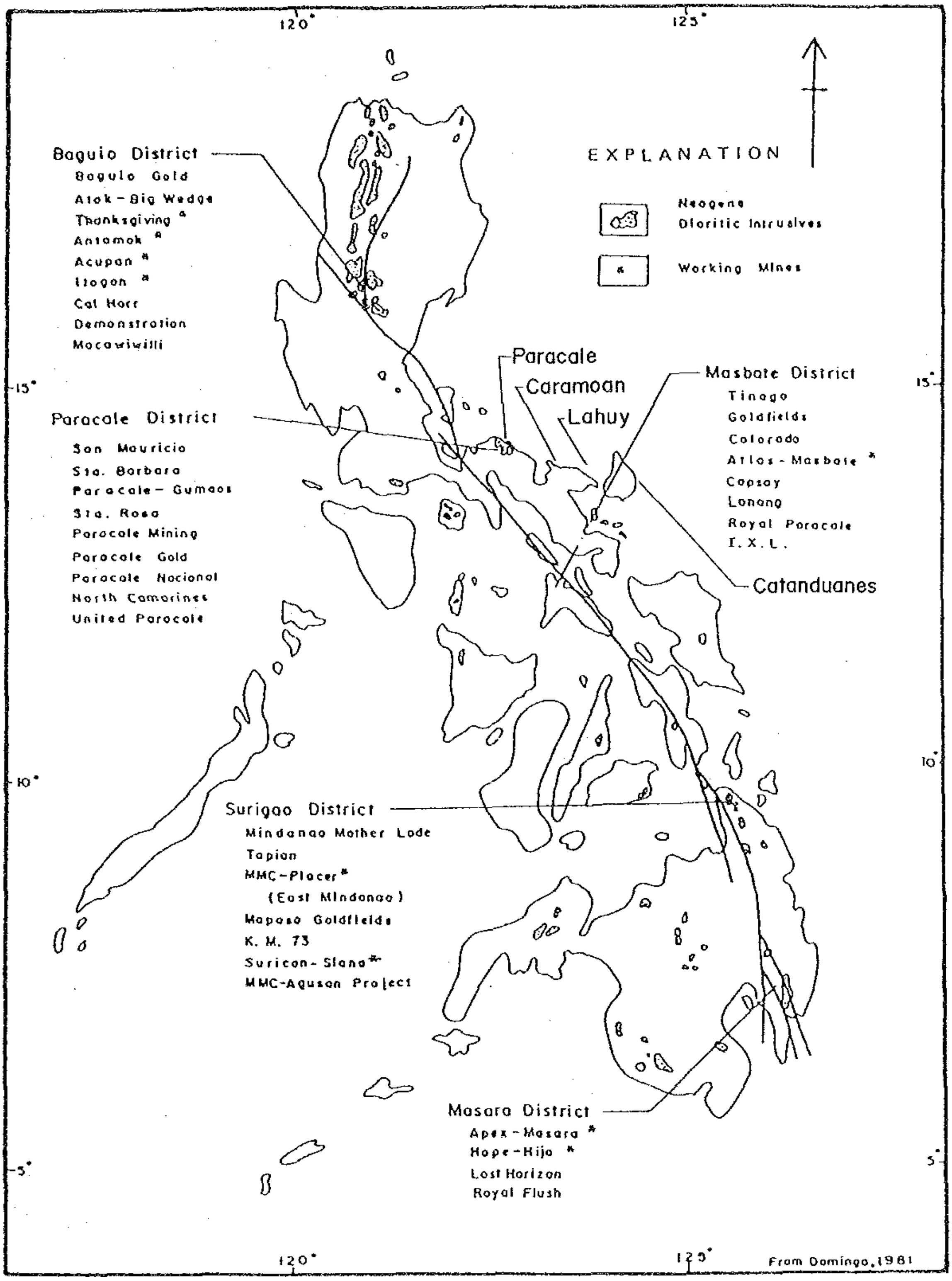


Fig.7 Gold Districts of the Philippines

Intrusives intruded into pre Eocene formations, and brought gold and copper mineralization. Aside from gold and copper, mineral occurrences of manganese, heavy sands, clay, coal, and phosphate are known in the island.

The whole of Lahuy Island is underlain by Cretaceous Lahuy Formation consisting of andesitic pyroclastic rocks. Gata Village in the western side of the island has been known as gold producing area, and an American capital, Pan Philippine Corp. operated a gold mine in a large scale before the second world war. The rocks of the mineral Mineral Occurrences in the Gata Village has been subjected to hydrothermal alteration,much different from those in the eastern island. It is suggested that the geological block of the mineral Mineral Occurrences thrusted up against the fresh eastern block.

Chapter 2 Catanduanes Island

2-1 Method of Survey

A preliminary geological survey has been performed for the whole area of the island, and its geological structure, and the relationship between the geological structure and mineralization have been revealed. The existing geological map, 1 to 50,000 in scale, published by MGB, 198 2, has been revised based on the survey results. Stream sediment sampling has been performed for the whole island, and potential areas have been selected.

Topographic maps, 1 to 10,000 in scale enlarged from published 1 to 50,000 maps, have been used for the field survey. The survey results have been compiled in enlarged maps, 1 to 2 5,000 in scale, and summarized in geological maps 1 to 50,000 and 1 to 100,000 in scale. The sampling points for stream sediments and rocks have been noted in topographic maps scaled 1 to 50,000.

The geological survey has been performed along some drainage systems carefully selected from a view of the island as a whole.

The stream sediment sampling program has been performed combined with the geological survey, and sampling points have been located in a well balanced pattern. Stream sediments have been collected from the center of the stream, and sieved out under 80 mesh in the field. Collected samples have been dried out, and divided into two, one for the Japanese team and one for the Philippine team. Each one sample has been provided for chemical assay. Total number of the sample is 717. PL-1 shows the locations of collected stream sediments and rock samples.

2-2 Geological Survey

2-2-1 Outline of Geology and Geologic Structure

Catanduanes Island is, based on the geological maps scaled 1 to 50,000, underlain by the pre-Cretaceous Catanduanes Formation consisting of meta-sedimentary rocks, Cretaceous Yop Formation consisting of basaltic volcanic rocks and conformably overlying or inter-fingering Bonagbonag Limestone, Eocene Payo Formation consisting of sandstone, conglomerate, limestone, etc., Oligocene dioritic Batalay Intrusives, Miocene Buti Hill Limestone and San Vicente Formation consisting of conglomerate, Miocene to Pliocene Sto. Domingo Formation, and Pleistocene Viga Formation consisting of conglomerate (MGB, 1983a,b,c,d,e,f and g). Figure 8 shows the geological map of Catanduanes Island, and Table 5 shows the stratigraphic succession.

The island is geologically divided into three blocks, i. e. northern, central, and southern blocks, by two thrust faults stretching east to west and northwest-west to southeast-east.

(1) Northern Block

The northern block is underlain by the Yop Formation and unconformably overlying Payo Formation, and shows relatively gentle hilly topographic feature.

The Yop Formation is distributed in the northern end and western part of the block, and partly in the lowland of the eastern part as an inlier surrounded by the Payo Formation.

The Payo Formation is extensively distributed in the central to eastern part of the block, and unconformably overlain by Pleistocene Viga Formation in the eastern end of the block.

(2) Central Block

The central block has been thrust over the northern block by the thrust fault stretching east to west, and the thrust fault shows steep cliffs dipping to the north. The block is underlain by the Catanduanes Formation, unconformably overlying Yop Formation, and further unconformably overlying Payo Formation, and shows a rugged mountainous feature.

The Catanduanes Formation is extensively distributed in the central to eastern part of the block. It is unconformably overlain by the Yop Formation in the southern part, by the Payo Formation in the eastern mountainous part, by the Yop Formation in an area about 4 kilometers east of the Bato River between Kilikilihan and Siai, by the Payo Formation at Ogbong in the northwestern part, by the Yop Formation at Buena Vista in the northeastern part, and by the Pleistocene Viga Formation at Viga. It has undergone strong folding and faulting, and its

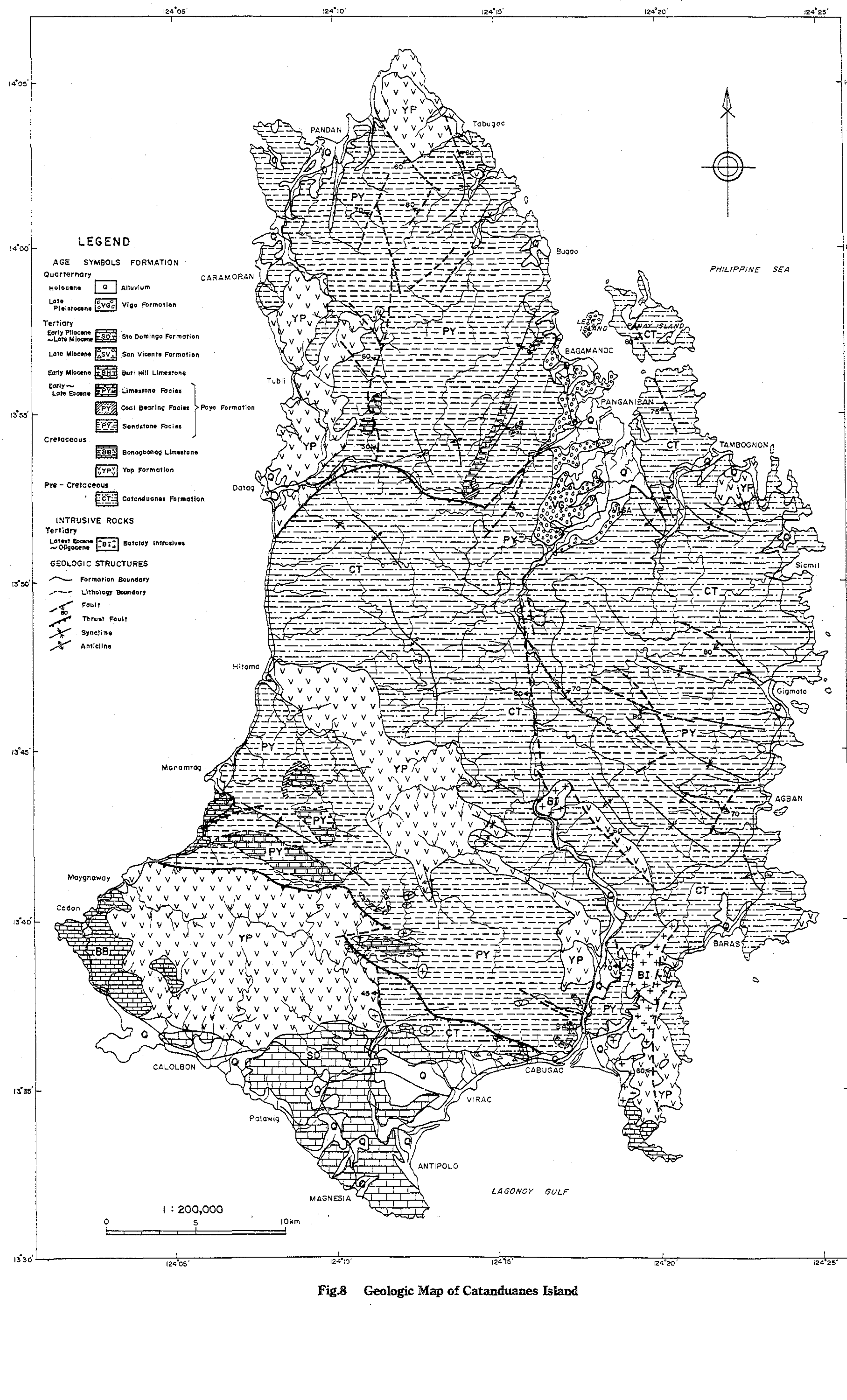


Fig.8 Geologic Map of Catanduanes Island

Table 5 Schematic Geologic Column of Catanduanes Island

Period	Epoch	Symbols	Formation	Lithology	Mineralization
Quaternary	Holocene	Q	Alluvium	Clay, Silt, Sand and Gravel	
	Late Pleistocene	VG	Viga Fm	Conglomerate, Sandstone, Siltstone	
Tertiary	Early Pliocene ~ Late Miocene	SD	Sto Domingo Fm	Coralline, Sandy and Marly Limestone, Tuffaceous Shale, Siltstone, Lignitic Coal	
	Late Miocene	SV	San Vicente Fm	Conglomerate, Sandstone	
	Eary Miocene	BH	Buti Hill Limestone	Coralline Limestone	
	Oligocene	BI	Batalay Intrusives	Diorite, Andesite Porphyry and Aplite	Cu, Au
	Eocene	PY	Payo Fm: Sipi Limestone	Limestone	
		PY	Payo Fm: Hitoma-Payo Coal Measure	Coal bearing Conglomerate, Sandstone Siltstone, and Limestone	
		PY	Payo Fm: Cabugao Sandstone	Sandstone, Shale, Conglomerete	
Cretaceous		BB	Bonagbonag Limestone	Limestone, (Shale, Siltstons)	Mn
		YP	Yop Fm	Basaltic Pillow Lava, Volcanic Breccia, Arkosic and Tuffaceous Sandstone, Chert	
Pre Cretaceous		CT	Catanduanes Fm	Sandstone, Claystone, conglomerate, Phyllite and Low Grade Schist	

geological structure is very complex. It has been intruded by the Batalay Intrusives in the southeastern part.

The Yop Formation is distributed in an area between Hitoma and San Miguel, stretching northwest to southeast and unconformably overlying the Catanduanes Formation. It is also distributed in an area about 4 kilometers east of the Bato River between Kilikilihan and Siai and at Buena Vista in the northeastern part, unconformably overlying the Catanduanes Formation. It is unconformably overlain by the Payo Formation in the southwestern part.

The Payo Formation is extensively distributed in the southwestern part stretching northwest to southeast, unconformably overlying the Yop Formation. It is also distributed in the eastern mountainous area, unconformably overlying the Catanduanes Formation. It has been intruded by the Batalay Intrusives in the southeastern part.

The geological structure of the block is complex, but it is generally controlled by a folding system, which has an axis stretching northwest to southeast.

The Batalay Intrusives are mainly distributed in the southeastern part, and at several spots in the mountainous area as small scale bodies.

The early Miocene Buti Hill Formation is distributed in the southeastern end of the block, unconformably overlying the Yop Formation and Bonagbonag Limestone.

(3) Southern Block

The southern block has been thrust over the central block by a thrust fault stretching northwest-west to southeast-east. The block is underlain by the Catanduanes, Yop, and Payo Formations, and unconformably overlying Sto. Domingo Formation. The Catanduanes and Yop Formations in the block have been intruded by many small bodies of diorite and andesitic porphyry of the Batalay Intrusives.

The Catanduanes Formation has fault contact with the Yop Formation, and is distributed to the east of Dugui Too.

The Yop Formation has fault contact with the Payo Formation in the central block through the thrust fault. The Bonagbonag Limestone conformably overlies or inter-fingers with the Yop Formation in this block. It is said by someone that the rocks of the Yop Formation in this block are parts of a melange.

The Catanduanes and Yop Formations have been intruded by many small bodies of diorite and andesitic porphyry of the Batalay Intrusives.

The late-Miocene to early Pliocene Sto. Domingo Formation unconformably overlies the

Catanduanes and Yop Formations in the block. The San Vicente Formation unconformably overlies the Catanduanes Formation at San Vicente in the southeastern part.

2-2-2 Detailed Geological Description

(1) Catanduanes Formation

Meek (1938) described the Catanduanes Formation as Agban Phyllites, and Capistrano (1951a) later designated it the pre-Tertiary fine grained facies of the Cabugao Sub-greywacke. Miranda and Vargas (1967) revised it as the Catanduanes Formation, because the distribution of the Agban Phyllite was quite local, and it was possible to stratigraphically separate the Agban Phyllite from Cabugao Sub-greywacke.

The formation is stratigraphically situated in the bottom in the area, and comprising of altered sandstone, mudstone, schist, and partly conglomerate. It is extensively distributed in the central block, from the east coast to west coast, and in the southeastern part of the southern block, having fault contact with the Yop Formation. The whole area of Panay Island situated to the northeast of Catanduanes Island is underlain by the formation.

The sandstone of the formation is generally hard, and shows grading texture in their beds. It is subjected to chloritization and epidotization, and turning to grayish green. The mudstone is grayish green to black, and commonly alternates with sandstone. In an area northeast of Viga in the southeastern part of the central block, the sandstone has metamorphosed to low grade schist having schistosity stretching northwest to southeast. Conglomerate has not been find in the survey this time, however, Miranda and Vargas (1967) reported that brownish thin layers of conglomerate which matrices consisting of epidote-cement and feldspar grains adhered basaltic granules, were seldom intercalated with alternation layers of sandstone and mudstone. In the formation near Danicop in the southern block, skarn-like rocks strongly epidotized are distributed. The formation has undergone strong folding and faulting around there, and the geological structure is complex. The formation in the central block apparently shows a folding structure stretching northwest to southeast.

No fossil has been found from the formation, therefore, some doubt exists on the age of the formation. Miranda and Vargas (1967) correlated this formation to the Mansalay Formation in Mindoro Island, which was reported by Teves (1949), and designated as Jurassic in age. They estimated the thickness of the formation to 3,000 meters.

(2) Yop Formation

The name of Yop Volcanic Rocks was named by Capistrano (1951a) for the volcanic rocks distributed in Yop Point in the northern end of the island. Miranda and Vargas (1967) defined the Yop Formation as a formation mainly consisting of volcanic rocks accompanied by arkose sandstone, tuffaceous sandstone, and chert.

The Yop Formation is mainly composed of sub-marine basaltic lavas and tuffaceous breccia, and intercalated by arkose sandstone, tuffaceous sandstone, and chert. An outcrop of gabbro has been observed at a stream 1.5 kilometers north of Calolbon in the survey this time, as well as floats of ultra-basic rocks at the road in between Hikming and Dugui Too.

Most of the basalt are subjected to spilitization, fine to medium-grained, and show porphyritic texture having albite and augite phenocrysts. Plagioclase phenocrysts are 7 millimeters in size sometimes, and make a characteristic coarse texture. Fresh parts of the phenocrysts are green to dark green, and weathered parts altered into reddish brown. The formation is characterized by containing low grade manganese ores.

The formation unconformably overlies the Catanduanes Formation, and is conformably overlain or inter-fingered by the Bonagbonag Limestone. It is unconformably overlain by the Payo Formation in the northern and central blocks, and by the Sto. Domingo Formation in the southern block.

The formation is distributed in elongated belts, northwest-west to southeast-east, in the northern end and northwestern part of the northern block, an area from Hitoma to San Miguel in the central block, and an area from Bonagbonag Point to San Vicente in the southern block. It is also distributed in several places on the area of the Catanduanes Formation in the eastern island. In the area distributed by the Payo Formation in the northern block, basaltic lavas and tuffaceous breccia of the Yop Formation are exposed as inliers in some streams.

There is an idea that the rocks of the Yop Formation are of melange. Based on this idea, it is supposed that the Bonagbonag Limestone is an accidental rock block enclosed in the Yop Formation. Only floats have been observed in the survey this time, however it is said that ultra-basic rocks are intercalated in the Yop Formation near Hikming 1.5 kilometers east of Buyo (Narido, personal communication).

Table 6 shows the chemical assay results of volcanic rocks of the Yop Formation collected this time. SiO_2 contents are 47.54 to 62.96 %, and the average is 61.89 %. The results of K-Ar dating show that the age ranges from 38.7±0.9 to 67.7±2.1Ma, which indicate from late-Cretaceous to Oligocene. Table 8 shows the dating results. The two samples showing

Tertiary in age are possibly rejuvenated by the intrusion of the Batalay Intrusives.

The thickness of the formation is not clear in this stage.

(3) Bonagbonag Limestone

Santos, de los et al. (1955) named the limestone "the Bonagbonag Limestone" after the name of Bonagbonag Point, type locality, as the oldest rocks in the area. Miranda and Vargas (1967) followed this name.

The formation is composed of coral fossils, and of fine to medium grained stratified limestone, showing grayish white to pale brown in fresh parts and reddish brown in weathered parts.

The limestone is extensively distributed near the type locality of Bonagbonag, and in small areas in an upstream area of the Comagaycay River, an area near Hilawan underlain by the Payo formation in the central block, and an area near Danicop underlain by the Catanduanes Formation in the southern block.

No fossil has been collected in the survey, however, MGB (1982) reported that Orbitolina?, which indicates early Cretaceous in age, was found from the lower part of the formation, and Globotruncana, which indicates late Cretaceous in age, was found from the upper part of the formation. Capistrano (1951) estimated the thickness of formation to 300 meters.

(4) Payo Formation

Miranda and Vargas (1967) named the bottom part of the Tertiary formation, which is extensively distributed in Catanduanes Island, the Payo Formation. The type locality of the formation is the northeastern island.

The Payo Formation is composed of three members, the Cabugao Member (Cabugao Sub-greywacke), Hitoma-Payo Coal-bearing Member (Hitoma-Payo Coal Measure), and Sipi Limestone Member, and distributed in large areas of the northern block and partly in the central block, stretching northwest-west to southeast-east on the south of the Yop Formation area. It is also distributed in the eastern mountainous area of the central block, unconformably overlying the Catanduanes Formation. It is unconformably overlain by the Late-Pleistocene Viga Formation in the eastern part of the northern block.

Meek (1938) estimated the thickness of the formation in the type locality to be 1,500 meters. Miranda and Vargas (1967) gave the age of the formation Eocene.

(4-1) Cabugao Sandstone Member

Capistrano (1951a) named the sandstone the Cabugao Sandstone (Cabugao Sub-greywacke) of pre-Tertiary age. Miranda and Vargas (1967) redefined the member as the lowest member of the Tertiary because of its petrological features.

The rocks are clear in bedding, pale grey to reddish brown, and vary their petrological features, silty, feldspar rich, and quartz rich. Well concreted parts of the rocks are quite similar in appearance to the sandstone in Catanduanes Island. The member occupies a large part of the Payo Formation, and shows complex folding structure. The basal conglomerate, containing basalt pebbles of the Yop Formation, of the Payo Formation crops out in the middle stream of the Inipan River in the northern block, and it is transformed to alternating beds of sandstone and mudstone, showing graded bedding, to the upper. The member outcropping in a tributary of the Talahid River contains fragments of shell fossil. Miranda and Vargas (1967) estimated the thickness of the bed to be 225 to 1,320 meters.

(4-2) Hitoma-Payo Coal Measure

Miranda and Vargas (1967) designated the name Hitoma-Payo Coal Measure for the middle member of the Payo Formation. MGB has done some surveys on the member (Capistrano,1951b and 1952; Crispin et al.,1955). The member comprise conglomerate, sandstone, shale and limestone, and intercalates coal layers. Shale and limestone are dominant in the member. Conglomerate, sandstone are small in amount and confined to the lower part of the member. Coal layers' thicknesses range from 23 to 450cm in the Northern Block. Miranda and Vargas (1967) estimated the thickness of the member tobe 175m.

(4-3) Sipi Limestone

The name of the "Sipi Limestone" was designated by Capistrano (1951a) for coral-bearing limestone along the Sipi River, a tributary of the Bato River. The limestone is pale grey to dark grey, fine to medium grained, massive and non-bedding containing some fossils.

Miranda and Vargas (1967) estimated the thickness of the limestone to 30 to 250 meters.

(5) Batalay Intrusives

Capistrano (1951a) named the rocks distributed in the southeastern part of the island the "Batalay Andesite", however Miranda and Vargas (1967) renamed it the "Batalay Intrusives" because the rocks are petrologically composed not only of andesite.

The rocks are comprised of medium to coarse grained biotite diorite, amphibole-biotite porphyry (andesitic), basalt, and aplite, and mainly scattered in the southern island as small scale intrusive bodies. All outcrops of the rocks known by now are noted in the geological map scaled 1 to 50,000. The surrounding rocks of the intrusive bodies have undergone thermal alteration, i.e. pyritization, chloritization, silicification, and epidotization, and it is thought that the sulphide mineralization in the island has been brought by the igneous activities.

The intrusive body in the type locality crops out in an area 6.5 kilometers north to south, 1.5 kilometers east to west. Another relatively large-scale body, 2 kilometers north to south and 1.5 kilometers east to west, has been found in the survey this time to the east of Pagsagnahan in the middle of the Bato River. A number of small bodies intrudes in the Catanduanes, Yop, Bonagbonag Limestone, and Payo Formations near the type locality, and many gold and copper mineral occurrences, e.g. Agban, Vinticayan Point, Tilod, San Pedro, Libjo, Aroyao, and San Miguel, are distributed in this zone. A large number of intrusive bodies exist also in the Catanduanes, Yop, and Payo Formations around Dugui Too, and some mineral occurrences, e.g. Dugui Too and Danicop, are noted in this zone.

The results of the chemical assay for the intrusive rocks show that SiO_2 ranges from 47.94 to 69.22 % (Table 6), being coincident with the description by Miranda and Vargas (1967).

Three samples of the intrusive rocks have been measured their ages by the K-Ar dating method. Table 8 shows the results. The ages obtained range from 30.2±1.0Ma to 39.5±0.9 Ma, meaning from Eocene to Oligocene time.

(6) Buti Hill Limestone

The Buti Hill Limestone was designated by Miranda and Vargas (1967) to coral-bearing limestones cropping out in Buti Hill to the northwest of Nagumbuaya Point.

The limestone is pale grey, gentle dipping or horizontal thinly bedded rock, containing coral and foraminifer fossils. The limestone is of Miocene age, and unconformably overlying the Bonagbonag Limestone, Yop Formation, and Batalay Intrusives.

Miranda and Vargas (1967) estimated the thickness of the limestone to 100 meters.

(7) San Vicente Formation

Miranda and Vargas (1967) named the conglomerate and sandstone cropping out in the San Vicente Village, 3 kilometers east of Virac, the "San Vicente Conglomerate". MGB (1983a & b) renamed it the San Vicente Formation in its geological map scaled 1 to 50,000.

Miranda and Vargas (1967), and MGB (1983b) reported an area distributed by the San Vicente Formation at Cabcab to the west of Calolbon, however, it has not been found by the survey this time, only finding outcrops of diorite of the Batalay Intrusives.

The formation is distributed in a discontinuous lens shape, and its rocks contain pebbles of diorite of the Batalay Intrusives, Sipi limestone, Buti Hill limestone, basalt, sandstone, and chert. The formation unconformably overlies the Catanduanes Formation, and is overlain by the Sto. Domingo Formation. The age of the formation is correlated to the late Miocene, because the basement of the formation is overlain by the late Miocene Sto. Domingo Formation.

Miranda and Vargas (1967) estimated the thickness of the formation to be 50 meters.

(8) Sto. Domingo Formation

The Sto. Domingo Formation was first named the "Magnesia Limestone" by Capistrano (1951a), later renamed it the present name by Miranda and Vargas (1967), because it was possibly misunderstood as a dolomitic limestone.

The gentle hilly area extending to the south of the line between Virac and Calolbon is underlain by the formation. The rocks are coral bearing , sandy to marlitic limestones, and conformably overlain by tuffs and marlitic shale at the upper part. Miranda and Vargas (1967) reported that the shale was intercalated with bituminous coal layers.

The formation unconformably overlies the Catanduanes and Yop Formations, and yields fossils showing late Miocene from the limestone, and Pliocene from the tuffaceous shale (Miranda and Vargas, 1967).

The formation varies its thickness, but Miranda and Vargas estimated its average thickness to be 80 meters.

(9) Viga Formation

Capistrano (1951a) and Crispin et al. (1955) used the name "Viga Conglomerate" for conglomerates distributed in a surrounding area of Viga Town. MGB (1983c) renamed it the Viga Formation in their geological map scaled 1 to 50,000.

Rocks of the formation are characteristic in their reddish brown color. They contain rounded to sub-rounded pebbles and cobbles in their matrix, and are partly intercalated by thin lenses of sandstone and silt.

The formation unconformably overlies the Payo and Catanduanes Formations. Miranda and Vargas (1967), and MGB's geological map scaled 1 to 50,000 defined the formation as of

the late Pleistocene in age.

(10) Alluvium

The alluvial in the island is distributed along main rivers and coastal zones, comprising of unconsolidated gravel, sands, silt, and clay.

2-3 Igneous Activity

2-3-1 Chemical Composition of Igneous Rocks

The igneous rocks in Catanduanes Island are the basaltic volcanic rocks of the Cretaceous Yop Formation, and the diorite and andesite porphyry of the Oligocene Batalay Intrusives. 21 rock samples of above mentioned rocks and additional four samples of andesitic volcanic rocks from Lahuy Island have been assayed for their principal and minor components. The assayed minor components are Au, Ag, As, Cu, Mo, Pb, S, and Zn.

ICP-AES method has been applied for the assay of the principal component oxides and minor elements, however FeO has been assayed by the titration method, gold by the neutron radioactivation analysis, and sulfur by the high frequency furnace combustion method.

The detection limits are 1 ppb for Au, 0.2 ppm for Ag, 2 ppm for As, Pb, and Zn, 1 ppm for Mo, 0.001 % for S, and 0.01 % for principal component oxides.

(1) Principal Composition of Igneous Rock

Principal chemical composition and norm composition of igneous rocks are shownin Table 6. Harker, Normative QAP, Normative An-Ab-Or, ACF and AFM diagrams are used in data analysis.

Rock type numbers 1, 2, 3 and 4 represent the Batalay Intrusives, Yop Formation, Basaltic sandstone in the Yop Formation of the Southern Block, and the Lahuy Formation respectively.

Black basaltic sandstone (ACR-082) taken from the Yop Formation in the Southern Block has been excluded from the petrological discussion the rock is clastic in nature as it was observed to contain rounded granules of basalt under the microscopeIt showed the lowest SiO_2 content of 42.09% among the rock samples analysed.

Table 6 Chemical and Normative Compositions of Igneous Rocks (1)

Sample #	ACR-026	ACR-065	ACR-135	BCR-021	BCR-028	BCR-030	BCR-032	BCR-036	ECR-043	GCR-006	GCR-008	ACR-053	ACR-060	BCR-001	BCR-007	BCR-013	BCR-031
Rock Type	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
SiO2	63.40	68.38	69.22	65.84	62.96	62.63	62.60	60.08	60.40	47.94	56.58	51.68	50.72	56.10	51.79	52.17	48.33
TiO2	0.33	0.25	0.25	0.28	0.33	0.43	0.38	0.60	0.38	1.26	0.98	0.74	0.91	0.86	1.03	0.85	1.01
Al2O3	18.25	17.29	16.23	16.89	17.83	17.73	16.70	16.00	17.42	15.87	16.31	16.82	16.87	16.83	16.78	16.12	18.03
Fe2O3*	3.99	2.38	2.89	3.01	4.26	4.35	4.06	6.94	4.40	12.58	8.83	7.66	10.48	6.72	9.31	7.62	11.11
Fe2O3	2.27	1.60	1.53	1.48	2.38	2.12	0.73	5.98	1.74	4.98	2.70	6.06	4.91	3.41	3.84	3.53	5.81
FeO	1.55	0.70	1.22	1.38	1.69	2.01	3.00	0.86	2.39	6.84	5.52	1.44	5.01	2.98	4.92	3.68	4.77
MnO	0.05	0.03	0.04	0.08	0.09	0.09	0.10	0.10	0.08	0.23	0.23	0.15	0.22	0.13	0.22	0.21	0.21
MgO	1.60	0.95	1.29	1.11	1.77	2.32	2.39	0.90	2.51	4.94	1.90	3.54	3.93	2.05	2.19	3.98	3.75
CaO	4.89	2.51	3.23	3.49	4.56	3.99	4.64	2.64	4.51	7.76	4.47	8.20	11.88	4.11	6.67	5.39	6.32
Na2O	5.15	5.69	4.89	5.46	4.72	4.71	4.15	6.97	4.60	3.44	4.76	4.22	1.71	4.69	5.56	2.43	4.85
K2O	1.28	2.14	2.36	1.13	1.28	2.26	2.86	2.91	1.19	2.19	4.11	3.46	0.21	5.90	1.47	0.42	2.21
P2O5	0.14	0.09	0.09	0.09	0.13	0.17	0.11	0.17	0.18	0.32	0.71	0.32	0.16	0.64	0.60	0.10	0.65
S	0.10	0.45	0.01	0.05	0.04	0.01	0.02	0.00	0.00	0.04	0.01	0.00	0.07	0.02	0.02	0.01	0.02
Total	99.01	100.08	100.36	97.28	97.78	98.47	97.68	97.21	95.40	95.81	98.28	96.63	96.60	97.72	95.09	88.89	95.96
H2O+	0.92	0.99	0.67	1.30	1.06	0.98	1.48	0.65	2.33	2.24	1.86	1.10	0.80	1.34	2.25	4.84	2.78
LOI	1.56	1.70	0.84	3.10	1.48	1.34	2.42	2.17	4.58	2.45	1.81	3.64	0.78	1.85	3.12	9.78	3.10
CIPW.NORM																	
Q	16.03	20.55	22.88	20.47	18.25	14.43	13.13	3.65	15.07	-	1.12	-	11.68	-	-	17.95	-
C	-	1.26	-	0.55	0.70	0.69	-	-	0.80	-	-	-	-	-	-	2.11	-
or	7.56	12.65	13.95	6.68	7.56	13.36	16.90	17.20	7.03	12.94	24.29	20.45	1.24	34.87	8.69	2.48	13.06
ab	43.58	48.15	41.38	46.20	39.94	39.85	35.12	58.98	38.92	29.11	40.28	32.07	14.47	36.87	46.90	20.56	35.04
an	22.90	11.86	15.36	16.73	21.77	18.68	18.49	3.78	21.20	21.39	11.00	16.73	37.74	7.44	16.49	26.09	20.90
ne	-	-	-	-	-	-	-	-	-	-	-	1.97	-	1.53	0.08	-	3.25
di	0.33	-	0.05	-	-	-	1.89	4.84	-	8.26	2.45	7.00	12.04	3.35	6.05	-	3.84
hd	0.02	-	0.01	-	-	-	1.23	-	-	3.93	3.02	-	4.18	0.83	4.37	-	0.94
wo	-	-	-	-	-	-	-	0.83	-	-	-	5.37	-	1.47	-	-	0.09
en	3.83	2.37	3.19	2.76	4.41	5.78	5.08	-	6.25	0.55	3.60	-	4.21	-	-	9.91	-
fs	0.31	-	0.62	0.89	0.68	1.37	3.77	-	2.47	0.30	5.08	-	1.68	-	-	2.81	-
fo	-	-	-	-	-	-	-	-	-	5.55	-	3.90	-	2.49	1.86	-	5.30
fa	-	-	-	-	-	-	-	-	-	3.33	-	-	-	0.77	1.69	-	1.65
mt	3.29	-	2.22	2.15	3.45	3.07	1.06	1.36	2.52	7.22	3.91	2.98	7.12	4.94	5.57	5.12	8.42
ht	-	1.60	-	-	-	-	-	5.05	-	-	-	4.00	-	-	-	-	-
il	0.63	0.47	0.47	0.53	0.63	0.82	0.72	1.14	0.72	2.39	1.86	1.40	1.73	1.63	1.96	1.61	1.92
ap	0.32	0.21	0.21	0.21	0.30	0.39	0.25	0.39	0.42	0.74	1.65	0.74	0.37	1.48	1.39	0.23	1.51
py	0.18	0.84	0.01	0.10	0.07	0.03	0.03	-	0.01	0.08	0.02	-	0.13	0.03	0.04	0.02	0.04
Total	98.98	99.97	100.35	97.27	97.77	98.47	97.67	97.21	95.40	95.80	98.28	96.63	96.58	97.71	95.09	88.89	95.96
Felsic	90.07	94.48	93.57	90.63	88.23	87.01	83.64	83.61	83.02	63.44	76.68	71.22	65.13	80.71	72.15	69.19	72.25
Mafic	8.91	5.49	6.78	6.64	9.54	11.46	14.04	13.60	12.38	32.36	21.59	25.41	31.46	17.01	22.94	19.70	23.71

* total Fe as Fe2O3

Table 6 Chemical and Normative Compositions of Igneous Rocks (2)

Sample #	BCR-041	CCR-011	CCR-012	DCR-008	DCR-009	DCR-026	ECOR-002	ECR-006	FCR-002	GCR-002	GCR-004	GCR-013	ACR-082	ALR-071	ALR-075	BLR-001	BLR-028
Rock Type	2	2	2	2	2	2	2	2	2	2	2	2	3	4	4	4	4
SiO2	47.54	49.06	48.36	50.58	54.90	49.80	51.85	52.32	52.21	54.34	49.25	56.59	42.09	55.00	65.00	58.14	60.20
TiO2	0.74	0.80	0.79	0.90	0.65	1.13	0.73	0.81	1.02	0.91	1.01	0.72	0.66	0.79	0.43	0.70	0.51
Al2O3	13.79	18.10	18.47	18.23	19.02	17.98	16.15	16.54	17.11	17.41	17.56	17.63	12.52	17.29	16.41	16.82	16.40
Fe2O3*	9.55	10.52	10.64	9.18	7.34	10.30	7.53	7.92	9.67	8.33	10.69	6.45	5.96	6.56	4.04	6.29	4.99
Fe2O3	4.92	4.31	4.26	4.12	5.72	3.28	2.13	4.32	5.47	3.62	4.67	4.76	3.64	5.99	3.05	4.09	2.40
FeO	4.17	5.59	5.74	4.55	1.46	6.32	4.86	3.24	3.78	4.28	5.42	1.52	2.09	0.51	0.89	1.98	2.33
MnO	0.21	0.19	0.16	0.29	0.13	0.20	0.12	0.14	0.21	0.19	0.21	0.14	0.13	0.26	0.11	0.14	0.13
MgO	8.11	4.94	4.92	4.53	1.19	3.52	1.66	5.31	2.95	2.79	3.82	2.56	0.69	2.29	1.57	3.32	2.42
CaO	10.27	7.28	8.68	4.82	5.18	7.71	6.98	8.85	7.02	4.74	7.35	5.93	15.53	6.87	2.60	5.01	4.36
Na2O	2.75	3.81	3.36	4.15	5.32	5.01	4.48	4.75	4.19	5.68	3.68	6.17	2.54	4.51	6.04	4.94	3.91
K2O	1.02	2.25	1.31	3.74	3.96	1.27	1.41	0.65	3.12	3.14	2.85	2.63	2.84	2.03	3.29	0.92	2.46
P2O5	0.17	0.11	0.11	0.64	0.46	0.27	0.53	0.32	0.51	0.51	0.54	0.23	0.41	0.13	0.13	0.17	0.16
S	0.01	0.01	0.01	0.01	0.01	0.01	0.52	0.01	0.01	0.05	0.01	0.00	3.30	0.01	0.00	0.00	0.00
Total	93.70	96.45	96.17	96.56	98.00	96.50	91.42	97.26	97.60	97.66	96.37	98.88	86.44	95.68	99.52	96.23	95.28
H2O+	1.61	2.72	2.08	2.72	1.70	3.28	2.43	1.41	1.39	2.18	2.11	0.49	1.68	1.63	1.34	1.27	2.26
LOI	3.30	2.75	2.47	3.52	2.38	3.64	6.72	2.01	1.78	2.32	2.63	2.23	10.63	5.39	2.66	4.22	5.41
CIPW.NORM																	
Q	-	-	-	-	-	-	4.59	-	0.17	-	-	-	-	5.88	10.62	11.27	14.91
C	-	-	-	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-
or	6.03	13.30	7.74	22.10	23.40	7.51	8.33	3.84	18.44	18.56	16.84	15.54	-	12.00	19.44	5.44	14.54
ab	23.27	30.20	28.43	33.63	43.49	36.31	37.91	40.19	35.45	44.71	30.81	50.09	-	38.16	51.11	41.80	33.09
an	22.27	25.64	31.45	19.73	16.32	22.82	19.79	21.89	18.66	12.73	22.98	12.64	-	20.94	7.95	21.00	19.93
ne	-	1.10	-	0.80	0.83	3.30	-	-	-	1.81	0.18	1.15	-	-	-	-	-
di	19.45	5.61	6.18	-	1.35	6.48	4.56	14.44	8.96	4.15	5.60	6.76	-	9.57	3.19	2.13	0.42
hd	2.30	2.27	2.64	-	-	4.76	4.91	1.22	1.17	1.89	2.46	-	-	-	-	-	0.10
wo	-	-	-	-	1.94	-	-	-	-	-	-	2.75	-	-	-	-	-
en	7.33	-	4.03	-	-	-	2.02	6.36	3.19	-	-	-	-	1.27	2.43	7.28	5.83
fs	1.00	-	1.97	-	-	-	2.49	0.62	0.48	-	-	-	-	-	-	-	1.64
fo	2.70	6.80	3.75	7.91	1.64	4.04	-	0.12	-	3.52	4.85	2.27	-	-	-	-	-
fa	0.40	3.48	2.02	3.08	-	3.74	-	0.01	-	2.02	2.69	-	-	-	-	-	-
mt	7.13	6.25	6.18	5.97	3.22	4.76	3.09	6.26	7.93	5.25	6.77	3.25	-	0.17	1.97	4.80	3.48
ht	-	-	-	-	3.50	-	-	-	-	-	-	2.52	-	5.87	1.69	0.78	-
il	1.41	1.52	1.50	1.71	1.23	2.15	1.39	1.54	1.94	1.73	1.92	1.37	-	1.50	0.82	1.33	0.97
ap	0.39	0.25	0.25	1.48	1.07	0.63	1.23	0.74	1.18	1.18	1.25	0.53	-	0.30	0.30	0.39	0.37
py	0.01	0.02	0.02	0.02	0.01	0.02	0.98	0.02	0.02	0.08	0.02	0.01	-	0.01	-	-	-
Total	93.70	96.45	96.17	96.56	98.00	96.50	91.29	97.26	97.60	97.64	96.37	98.88	-	95.68	99.52	96.23	95.28
Felsic	51.57	70.24	67.62	76.39	84.04	69.93	70.62	65.92	72.72	77.82	70.81	79.42	-	76.98	89.12	79.51	82.47
Mafic	42.13	26.20	28.55	20.16	13.96	26.57	20.67	31.33	24.88	19.83	25.56	19.46	-	18.70	10.41	16.72	12.81

* total Fe as Fe2O3

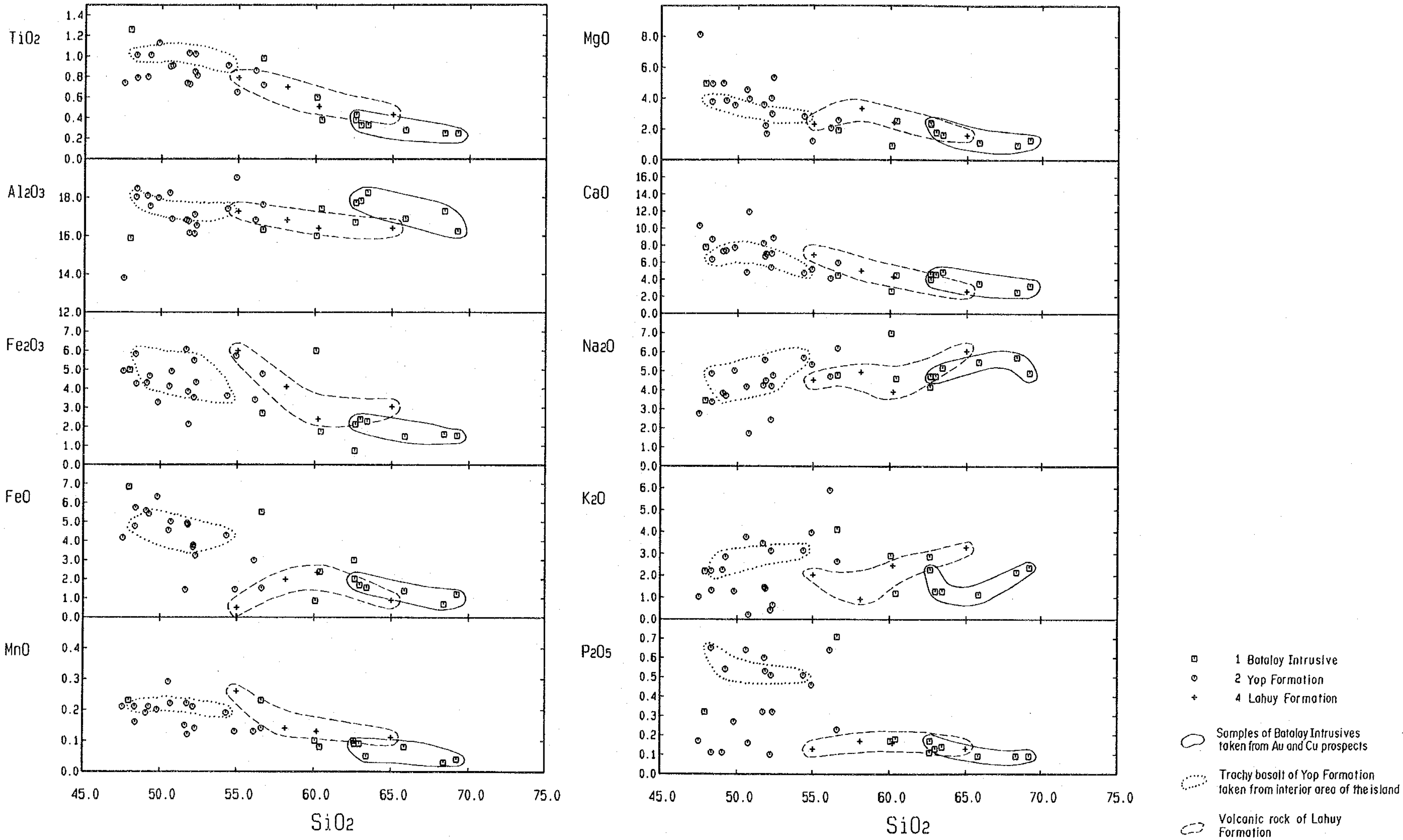
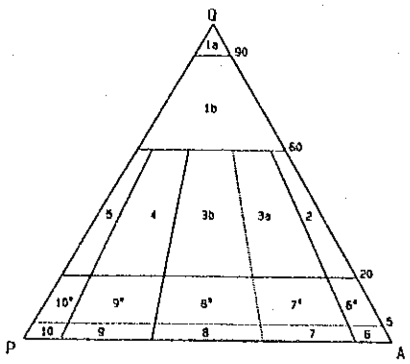


Fig.9 Harker Diagram



Classification of granitic rocks (IUGS, 1973)

Q – quartz ; A – alkali feldspar (including microcline, orthoclose, sanidine, anorthoclose, and perthites (including their plagioclase components), and plagioclase An-0-5) ; P – plagioclase other than An-0-5 ; F – feldspathoids (leucite and pseudoleucite, nepheline, sodalite, nosean, hauyne, cancrinite, analcime, etc.

1a, quartzolite (silexite) ; 1b, quartz-rich granitoids ; 2, alkali-feldspar granite ; 3, granite ; 4, granodiorite ; 5, tonalite ; 6*, quartz alkali-feldspar syenite ; 7*, quartz syenite ; 8*, quartz monzonite ; 9*, quartz monzodiorite/quartz monzogabbro ; 10*, quartz diorite/quartz gabbro/quartz anorthosite ; 6, alkali-feldspar syenite ; 7, syenite ; 8, monzonite ; 9, monzodiorite/monzogabbro ; 10, diorite/gabbro/anorthosite

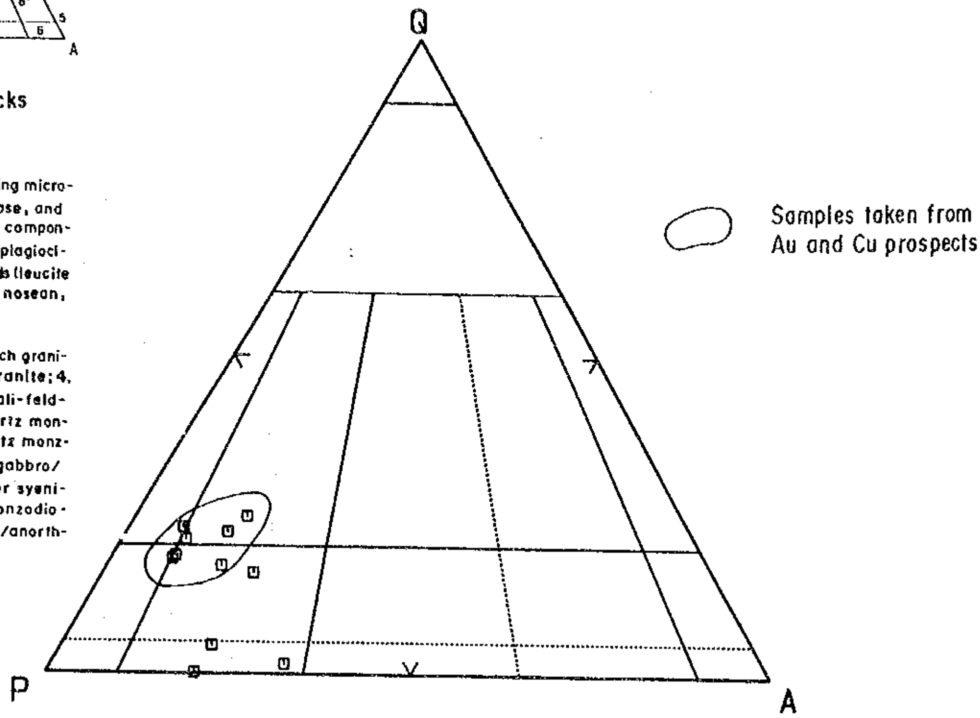


Fig.10 QAP Diagram (the Batalay Intrusives)

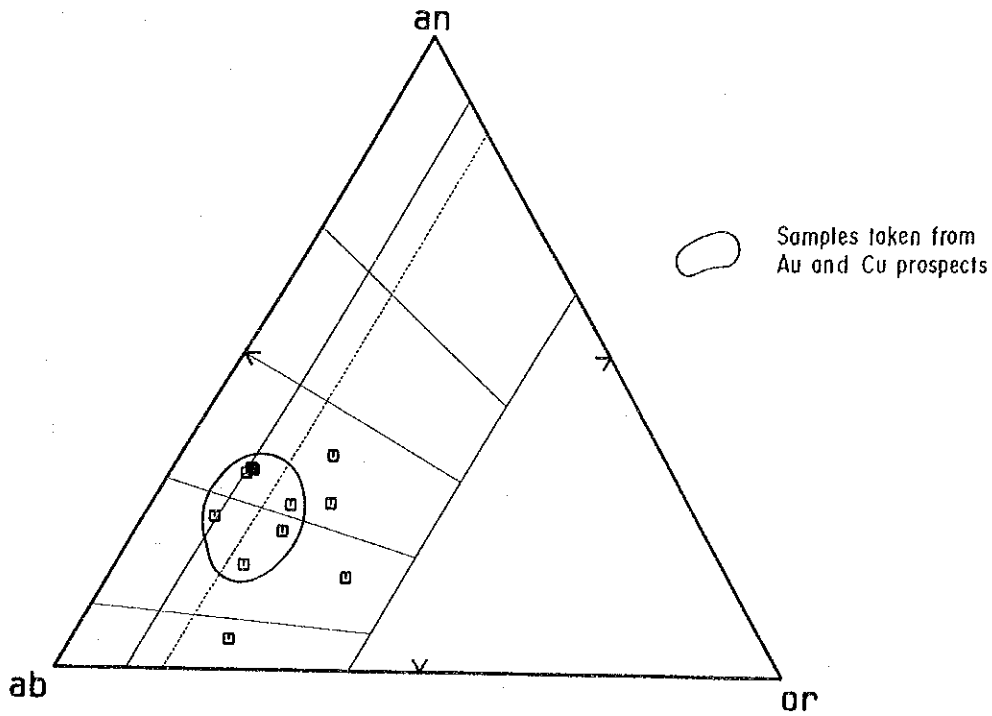


Fig.11 An–Ab–Or Diagram (the Batalay Intrusives)

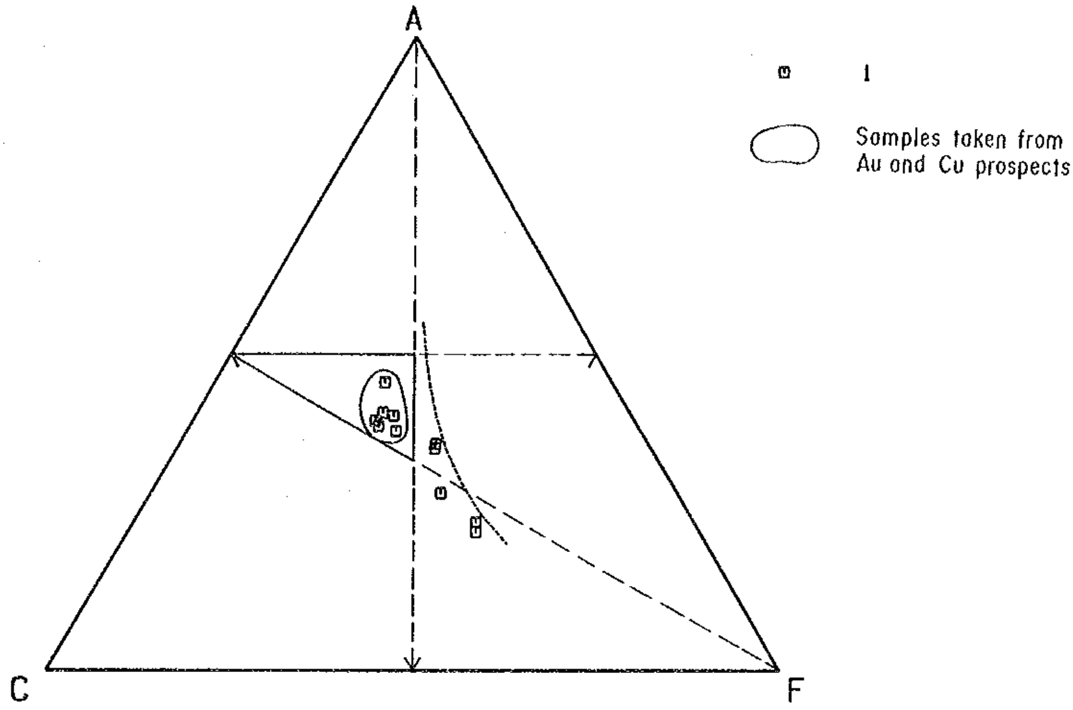


Fig.12 ACF Diagram (the Batalay Intrusives)

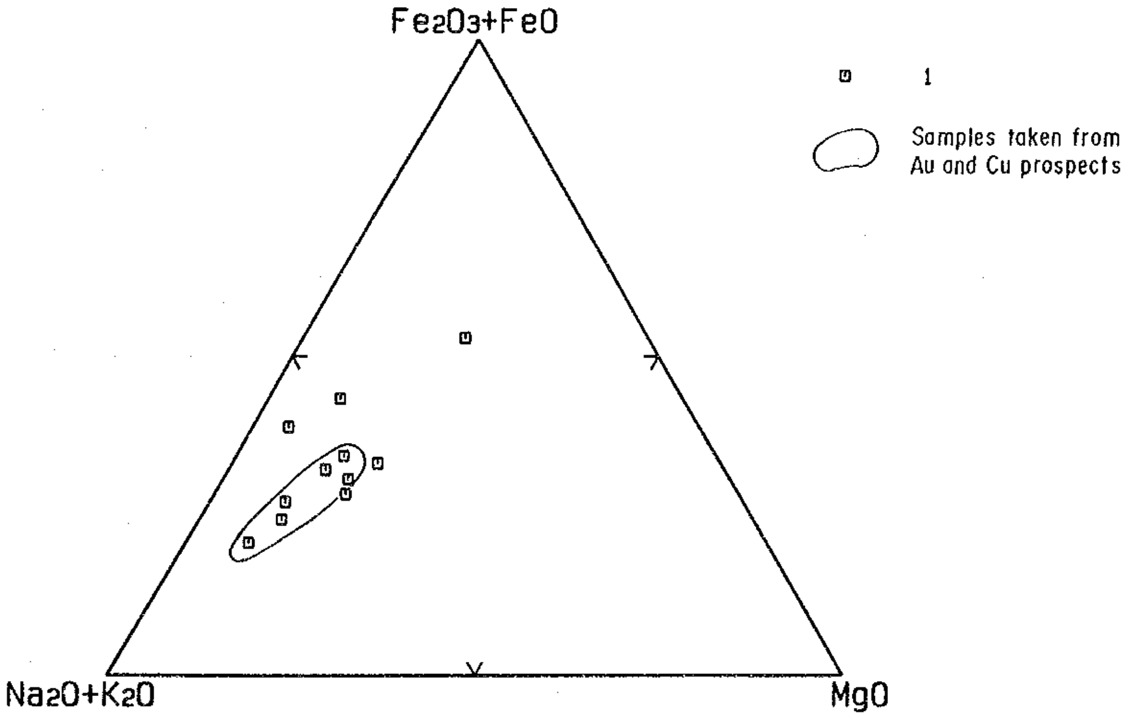


Fig.13 AFM Diagram (the Batalay Intrusives)

(1-1) Batalay Intrusives

Seven samples of the Batalay Intrusives show SiO_2 content higher than 60.3%. These samples are plotted in the area of granodiorite, tonalite, quartz monzonite, and quartz diorite as shown in Fig.10. They are plotted on the same trend in Harker and AFM diagrams (Fig.9 and Fig.13). They are classified as I type in ACF diagram defined by White and Chappell (1970).

On the other hand, three samples which have lower SiO_2 content than 60.30% are classified as Monzo-diorite (BCR-36), Monzonite (GCR-008) and Gabbro (GCR-006) in QAP diagram (Fig.10). In Harker diagram these samples are plotted on different trend than that of seven samples above mentioned in some components. In AFM diagram (Fig.13) these samples are plotted on a different trend closer to the Fe end than that of the seven samples. In ACF diagram, all of them are plotted in the I type area significantly near the boundary.

Samples taken from Au or Cu occurrences and surrounding areas have SiO_2 content higher than 62.6%. All of these samples are plotted in the area Q>or in QAP diagram, i.e. the area of granodiorite or its vicinity. In AFM diagram (Fig.13) they are plotted on the lower trend showing various alkali contents. In ACF diagram these samples are plotted in a very small area restricted by conditions A<0.5 and A>C and C>F.

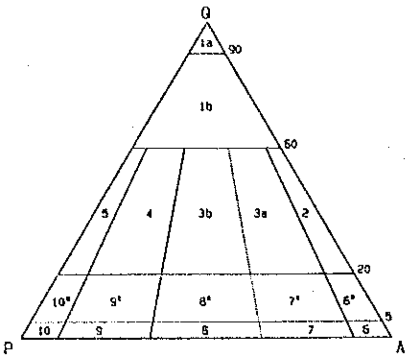
(1-2) Yop Formation

Samples from the Yop Formation have SiO_2 content ranging from 47% to 57%. They are compositionary classified as trachybasalt or basalt (An-Ab-Or diagram) except for two samples (ACR-060, BCR-013). Structurally they are classified as basalt or dolerite. In Harker diagram, they show various compositions and are plotted in wide ranges. But four samples taken in the interior area of the island (BCR-031, FCR-002, GCR-002, GCR-004) are classified as trachybasalt and show a linear trend in Harker diagaram.

Two samples excluded from the description above (ACR-060, BCR-013) have more than 10% of normative quartz and classified as dacite. But they might have been altered compositionally because they look like andesite or basalt and they were taken from the vicinities of mineral occurrences.

(1-3) Lahuy Formation

Volcanic rocks of Lahuy Island have SiO_2 content ranging from 55% to 65% and classified as andesite or dacite. In Harker diagram, they are plotted on a linear fractional trend in TiO_2, Al_2O_3 and CaO, whereas they show bended distribution in other components. In QAP



Classification of granitic rocks (IUGS, 1973)

Q – quartz ; A – alkali feldspar [including microcline, orthoclase, sanidine, anorthoclase, and perthites (including their plagioclase components), and plagioclase An-0-5] ; P – plagioclase other than An-0-5 ; F – feldspathoids (leucite and pseudoleucite, nepheline, sodalite, nosean, hauyne, cancrinite, analcime, etc.

1a, quartzolite (silexite) ; 1b, quartz-rich granitoids ; 2, alkali-feldspar granite ; 3, granite ; 4, granodiorite ; 5, tonalite ; 6*, quartz alkali-feldspar syenite ; 7*, quartz syenite ; 8*, quartz monzonite ; 9*, quartz monzodiorite/quartz monzogabbro ; 10*, quartz diorite/quartz gabbro/quartz anorthosite ; 6, alkali-feldspar syenite ; 7, syenite ; 8, monzonite ; 9, monzodiorite/monzogabbro ; 10, diorite/gabbro/anorthosite

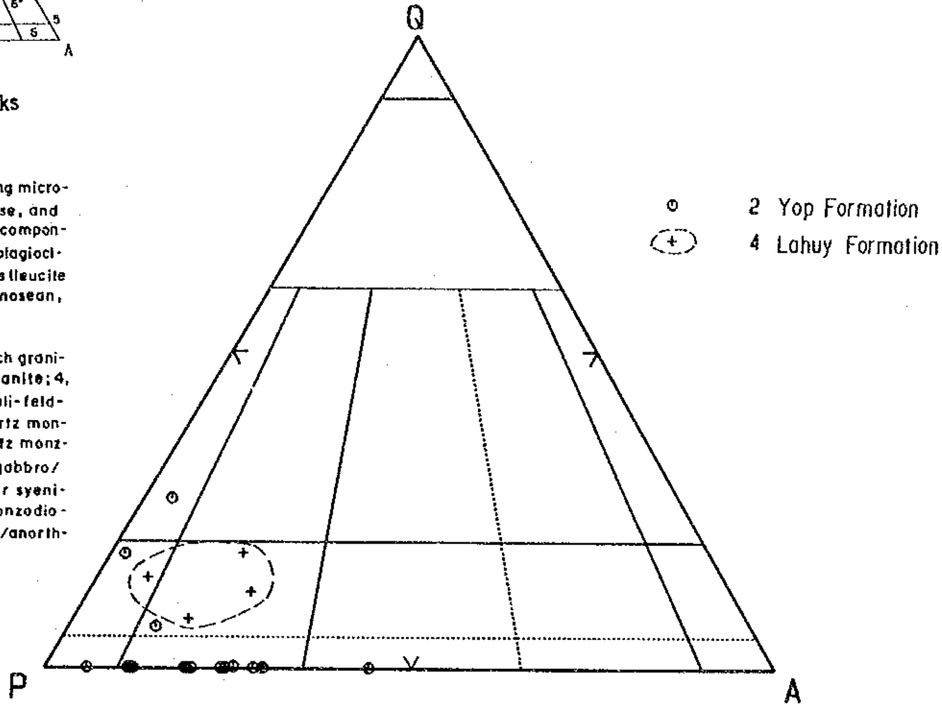


Fig.14 QAP Diagram (the Yop Formation, the Lahuy Foemation)

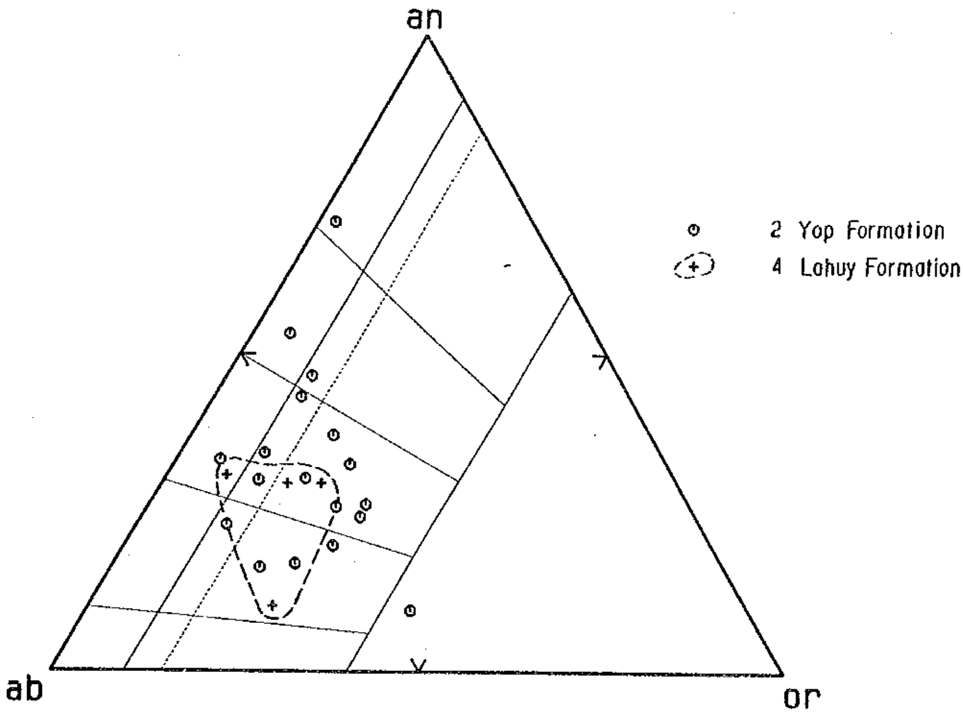


Fig.15 An–Ab–Or Diagram (the Yop Formation, the Lahuy Foemation)

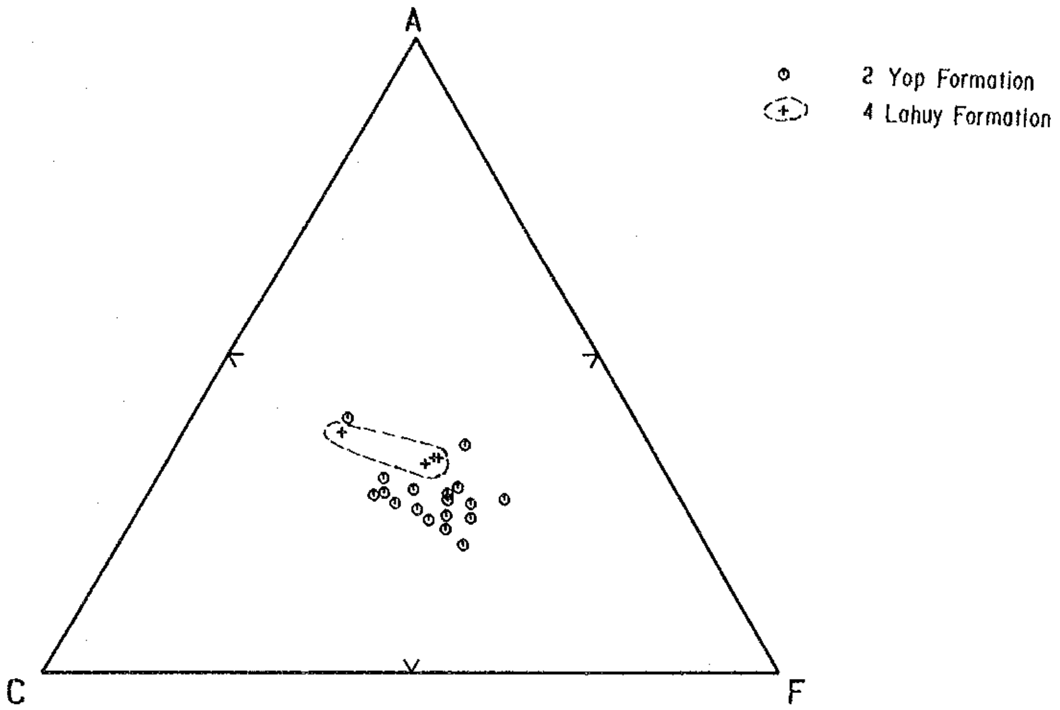


Fig.16 ACF Diagram (the Yop Formation, the Lahuy Foemation)

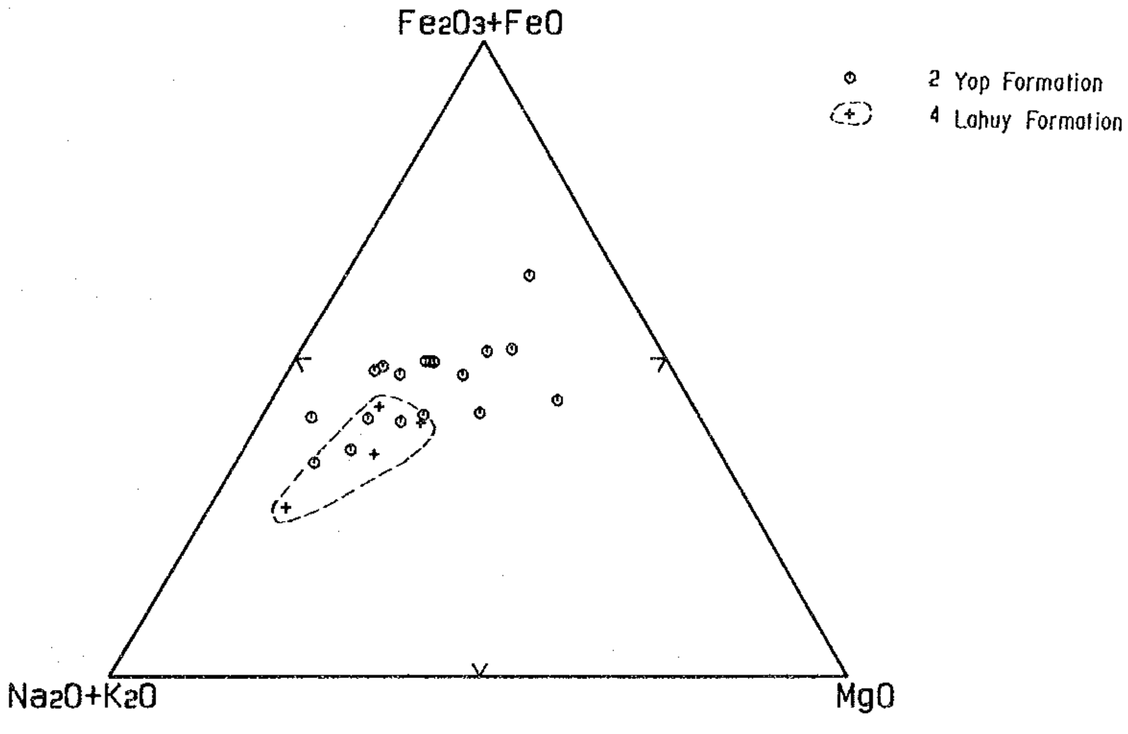


Fig.17 AMF Diagram (the Yop Formation, the Lahuy Foemation)

Table 7 Trace Element Analysis of Igneous Rocks (Catanduanes Island)

NO.	Rock Type	Au (ppb)	Ag (ppm)	As (ppm)	Cu (ppm)	Mo (ppm)	Pb (ppm)	S (%)	Zn (ppm)
ACR-026	1	<1	<0.2	<2	10	<1	4	0.097	20
ACR-053	2	2	<0.2	<2	138	<1	<2	0.001	68
ACR-060	2	4	<0.2	<2	150	<1	<2	0.071	24
ACR-065	1	1	0.2	<2	164	125	<2	0.451	12
ACR-082	3	<1	1.2	<2	129	1	2	3.300	74
ACR-135	1	<1	<0.2	<2	22	<1	<2	0.005	28
BCR-001	2	2	<0.2	<2	287	<1	8	0.017	68
BCR-007	2	<1	<0.2	<2	240	<1	<2	0.024	112
BCR-013	2	2	<0.2	<2	76	<1	14	0.009	804
BCR-021	1	<1	<0.2	<2	43	<1	<2	0.052	44
BCR-028	1	2	<0.2	6	31	<1	<2	0.040	54
BCR-030	1	<1	<0.2	<2	82	<1	<2	0.014	56
BCR-031	2	30	<0.2	10	566	<1	<2	0.022	94
BCR-032	1	<1	<0.2	<2	55	<1	<2	0.018	44
BCR-036	1	<1	<0.2	<2	16	<1	<2	0.001	52
BCR-041	2	39	<0.2	<2	75	<1	<2	0.008	64
CCR-011	2	3	<0.2	<2	162	<1	<2	0.009	72
CCR-012	2	3	<0.2	2	182	<1	<2	0.009	74
DCR-008	2	<1	<0.2	<2	234	<1	<2	0.010	92
DCR-009	2	<1	<0.2	<2	51	<1	2	0.007	68
DCR-026	2	17	<0.2	<2	196	<1	<2	0.012	94
ECR-006	2	3	<0.2	<2	200	<1	<2	0.009	62
ECR-043	1	<1	<0.2	<2	22	<1	<2	0.003	48
ECOR-002	2	6	<0.2	366	82	<1	4	0.523	102
FCR-002	2	4	<0.2	4	344	<1	4	0.013	90
GCR-002	2	<1	<0.2	2	251	<1	<2	0.045	102
GCR-004	2	4	<0.2	<2	323	<1	<2	0.012	92
GCR-006	1	22	<0.2	<2	604	<1	<2	0.041	78
GCR-008	1	<1	<0.2	<2	122	<1	2	0.012	94
GCR-013	2	6	<0.2	<2	67	<1	2	0.004	86
ALR-071	4	<1	<0.2	<2	36	<1	<2	0.008	64
ALR-075	4	<1	<0.2	<2	34	<1	<2	0.002	34
BLR-001	4	<1	<0.2	<2	32	<1	<2	0.002	70
BLR-028	4	11	<0.2	<2	17	<1	<2	0.001	50

and An-Ab-Or diagrams they are plotted close to each other although ALR-071 is plotted away from the trend the other samples form in ACF and AKF diagrams.

(2) Minor Element Composition of Igneous Rock

Minor element composition of igneous rocks are shown in Table 7. The same rock type numbers as shown in Table 6 are used in Table 7. Half value of lower detection limit has been used in the calculation of average content, in case the content was lower than the detection limit.

Only few samples exceeded the lower detection limit in the analysis of Ag, As and Mo.

Three samples of the Batalay Intrusives exceeded the lower detection limit in Gold content. These three include samples from San Pedro Mineral Occurrence (ACR-065,BCR-028) and a sample taken along the tributary of the Bato River which joind the Bato River at Pagsagnahan Village. Samples from the Yop Formation have the gold content ranging from <1 to 39ppb, average being 6.72ppb. Only one sample from the Lahuy Formation (BLR-028) has gold content above the lower detection limit, i.e. 11ppm.

Only two samples (ACR-65,ACR-82) exceeded the detection limit of Ag.

As for arsenic, one sample from the Batalay Intrusives and five samples from the Yop Formation exceeded the lower detection limit. A sample (ECOR-002) from the Yop Formation taken in the vicinity of Dugui Too Mineral Occurrence gives the highest As content of 366ppm.

Cu contents of the the Batalay Intrusives range from 10 to 604ppm, average content being 106.5ppm. The Yop Formation shows Cu content ranging from 51 to 566ppm, average being 2 01.3ppm. Cu contents of Lahuy Island fall in small range from 17 to 36ppm.

As for Mo only two samples (ACR-065,ACR-082) exceeded the detection limit .

As for Pb, two samples from the Batalay Intrusives and six samples from the Yop Formation exceeded the lower detection limit.

S content of the Batalay Intrusives is in the range of 0.003 to 0.451%, average being 0.0 42%. Volcanic rocks of the Lahuy Formation has low S content ranging from 0.001% to 0.00 8%, average being 0.003%.

As for Zn content the Batalay Intrusives show rather narrow range of 12 to 94ppm, whereas the Yop Formation show wider range of 24 to 804ppm. Lahuy Formation showed very narrow range of 34 to70%.

2-3-2 K-Ar Dating

K-Ar dating has been measured on six igneous rock samples of the island. Decay

constants used are as follows after Steiger and Jaeger (1977):

$\lambda e = 0.581 \times 10^{-10}/Y$

$\lambda \beta = 4.962 \times 10^{-10}/Y$

^{40}K content in K is $^{40}K/K = 0.01167$ atom%

Error estimation has been done after Nagao et al. (1984)

The results are as follows.

Table 8 **K-Ar Dating of Igneous Rocks (Catanduanes Island)**

Sample No.	Rock Type	K-Ar Age(Ma)
ACR-026	Andesite Porphyry	30.5±1.0
ACR-135	Diorite	30.2±1.0
CCR-011	Gabbro	67.7±2.1
DCR-008	Basalt	47.8±1.1
GCR-004	Basalt	38.7±0.9
GCR-006	Diorite	39.5±0.9

The samples from the Batalay Intrusives show the ages between 30.3±1.0 to 39.7±0.9 Ma, which means the end of Eocene to Oligocene. The ages well coinside with that showed by Miranda and Vargas (1967).

The samples from the Yop Formation show variable ages between 38.7±0.9 and 6 7.7±2.1 Ma. CCR-011 is taken from the Southern Block and gives the age of 67.7±2.1 Ma, which means late Cretaceous. DCR-008 and GCR-004 are from the Northern Block and Central Blocks respectively, give the ages 47.8±1.1 Ma and 38.7±0.9 Ma. These samples microscopically contain secondary minerals such as calcite, chlorite, sericite, and pyrite. The ages of these rocks, therefore, might have been influenced by the intrusions of the Batalay Intrusives. The Yop Formation in the Southern Block might be different from that of the North and Central Blocks.

2-4 Mineralization

2-4-1 Main Mineral Occurrences

Miranda and Vargas (1967) listed up one gold, five copper, nine manganese, four coal, four phosphate, two heavy sands, and seven clay mineral occurrences in the islandMGB (1986) noted one gold, 29 copper, three manganese, three phosphate, and one clay occurrences.

Gold and copper are the main target for the survey this time, and other minerals such as non-metals except clay, manganese, phosphate, and heavy sands are excluded for the target.

Some important mineral occurrence areas have been selected for the survey based on the existing data, on-site information, and planed stream sediment sampling routs. Table 9 shows the survey results for the mineral occurrences.

Seventeen gold and copper occurrences including sixlisted by Miranda and Vargas (1967) have been surveyed. Five out of seven clay occurrences listed by Miranda and Vargas (1967) also surveyed, four in the Quaternary sand and gravel beds, two of hydrothermal.

Au, Ag, Cu, Fe, Mn, Pb, Zn, and S for ore samples have been assayed. the assay methods applied are the neutron activation analysis for gold, induction furnace method for sulfur, and ICP-AES method for other six elements. The detection limits are 0.001 oz/t for gold, 2 ppm for silver, 0.01 % for iron, 0.001 % for other elements.

(1) Agban Mineral Occurrence

An outcrop, which contains more than ten quartz veins, exposes in a road cutting about 5 00 meters north of the Agban, the southeast coast of Catanduanes Island. Two old adits are seen near by. The area is underlain by green sandstone of the Catanduanes Formation, and granodiorite and aplite dikes intruded into the green sandstone. The granodiorite dike extends northeast to southwest in the road cutting, and is 50 centimeters thick. A granodiorite body is situated in the coast 20 meters downward of the road.

The ore deposits are copper bearing quartz veins in the granodiorite dike and surrounding sandstone, N45°E in strike, 85° NW in dip. The quartz veins are thicker in the granodiorite dike, maximum 1.4 meters.

Two old adits exist around there, one nearby a rice field, and one in the coast, about 20 meters downward of the road. They are seemed to hit the extension of the quartz vein in the cutting. Figure xx shows the situation.

According to the local people, the adit near by the rice field was tunneled during 1932 to 1936. There are a shaft, which is 20 meters in depth and collapsed at present, and an adit situated 10 meters apart from the shaft, which extends about 200 meters and is buried under water at present. Their openings are in the strongly silicified granodiorite body being accompanied by quartz veinlets. The waste rocks are underneath the rice field, and can not be seen.

The adit in the coast was tunneled during 1948 to 1951 by man power, again according to the local people. The opening was collapsed by the land-slide in a tycoon 1984. It is said that the adit was tunneled 10 meters to the north, then 50 meters to the northeast along an ore vein.

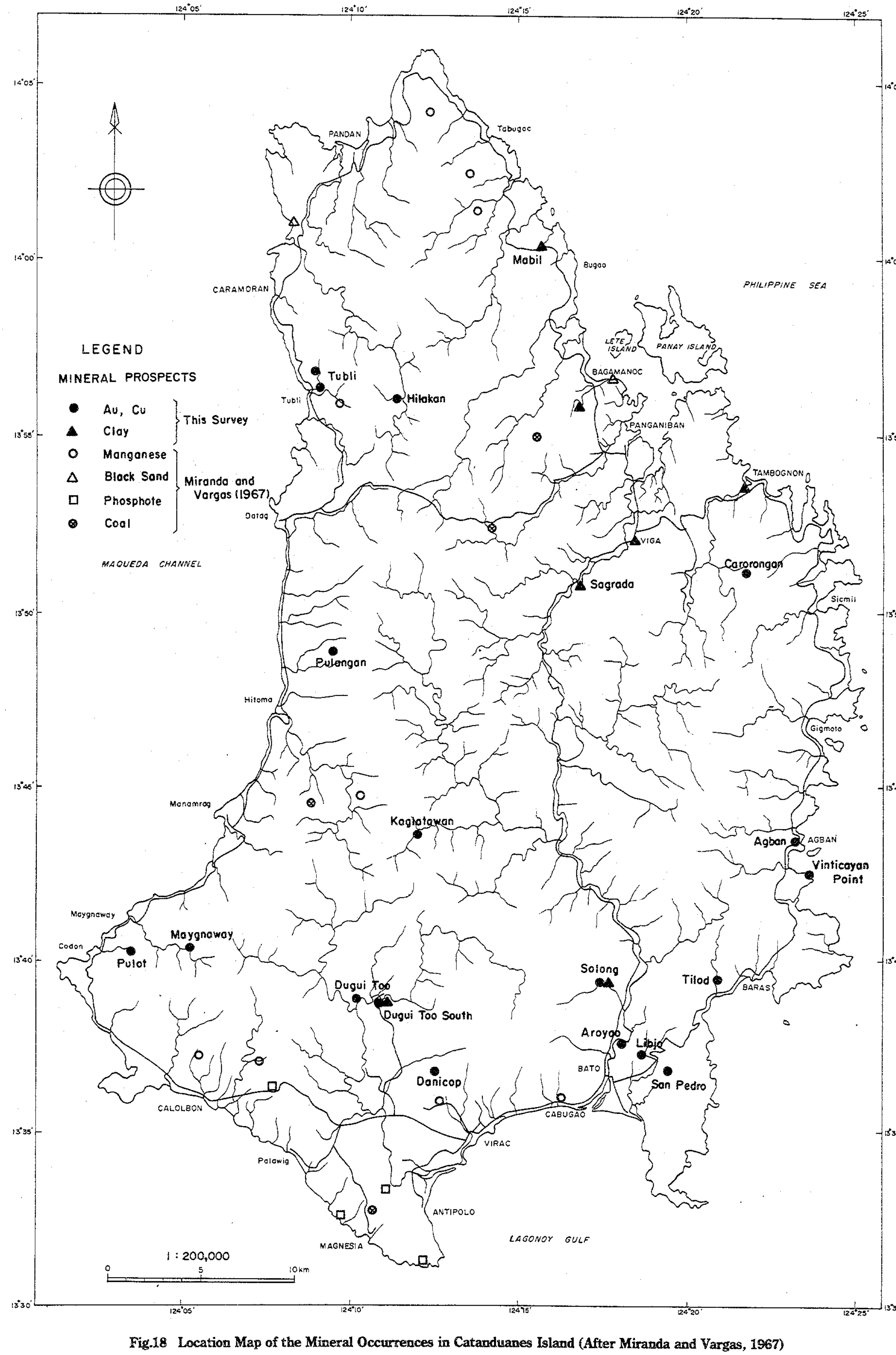


Fig.18 Location Map of the Mineral Occurrences in Catanduanes Island (After Miranda and Vargas, 1967)

Table 9 Mineral Occurrences in Catanduanes Island (1)

No.	Name of Mineral	Location	Type of Ore	Former Exploration and Development	Result of Survey in 1994		Remarks	Rank
					Geology and Mineralization	Result of Survey		
1	Agban	M:Baras B:Agban	Au Cu	1932～1936:Shaft(20m)and adit(200m). 1948～1951:Local people dug an adit(60m) at sea side. 1967:M&V surveyed the Agban Area. Analysis;Cu 1.5%,Au nil,Ag 5.5g/t. 1975～1977:Canardico Co.drilled 8 holes, Depth about 60 ft(?). Detail unkown	(G):Ss(Catanduanes F.), Gd·Aplite dyke(Batalay Intrusives) Strike and Dip of Gd; N45° E, W=50m (D):Cu bearing Qv, more than 10 veins, W=0.1～1.4m (M):Cp,Py,Mal	Now shaft is collapsed and adit is submerged under water. Adit on the coast is impassable. Analysis of 7 samples; Au nil, Ag nil～2g/t, Cu 0.06～1.445%.	Qv here is large and promising. Geological survey around Agban Area including Vinticayan Area is recommendable.	A
2	Vinticayan	M:Baras B:Agban Located 1.7km SW of Agban Min.Indicat.	Au Cu	1967:M&V mentioned the mineral indication.	(G):Ss(Catanduanes F.)? (D):Steep sea cliff is stained with green copper at 2 places for 10m each. Villagers say there is gold at the site.	Unaccessible by land route. High wave prevented the approach to the place.	The reconnaissance geologic survey in the area is recommendable.	A
3	San Pedro	M: Bato B: San Pedro	Au Cu	1970's:Canardico Co. drilled 2 holes, one of which was said to be over 100m long.	(G):Gd(Batalay Intrusive), Ss(Yop F.) (D):Many floats of Qv (M):CP,Hm,Mo	Villager says distribution of Qv floats extends 1.5km in diameter.In rice paddy surrounded by hills, there exist many big Qv floats up to 70cm in diameter. It may implies the existence of Qv near the site.	It is strongly advisable to carry out the detailed geological and geochemical survey in the area, focussing onthe rice paddy where large Qv floats are distributed.	A
4	Libjo	M:Bato B:Libjo	Au Cu	1967:M&V described the two Qvs at the road cut between Bato and Baras. W=0.15m and 0.5m, Analysis;Cu 0.28～8.96%,Au 0.0～0.1 g/t,Ag 5.5～41.5g/t This outcrop was not found in this survey.	(G):Gd(Batalay Intrusives) (D):Py·Lm floats (M):Py,Lm,Cp	Intense pyritization and limonitization was found at the drill site and fist size float of massive Py·Lm was obtained in the area. Villager say there are many floats of similar rock in the mountainous area.	It is recommended to make geological survey around the area.	A

Abbrebiations:(G);geology,(M);mineralization,Qv;quartz vein,Py;prite,Cp;chalcopyrite,Bo;bornte,Lmi;limonite,Mo;molibdenite,Mal;malachite,Gd;granodiorite,Ss;sandstone,Ls;limestone, F.;formation,L;length,W;width,M;municipal,B;village,M&V;Milanda and Vargas(1967),Co.;company

Table 9 Mineral Occurrences in Catanduanes Island (2)

No.	Name of Mineral Occurence	Location	Type of Ore	Former Exploration and Development	Result of Survey in 1994		Remarks	Rank
					Geology and Mineralization	Result of Survey		
5	Aroyao	M:San Miguel B.Aroyao~ San juan	Au Cu Zn	Villagers say Canardico Co.drilled about 10 holes (depth 20~30 ft). Deatails unknown. They also say there are floats of skarn and Py·Lm ore to the south of the road between B.Aroyao and B.San Juan	(G):Gd(Batalay Intrusives) Ss, thin layer of Ls (partly skarnized,Payo F.) (I):Floats of mineralized skarn with Cp·Sp·Py·Hm·Lm	Floats of mineralized skarn are found near the road about 500m east of B.Aroyao Analysis(1 sample): Au:0.964g/t,Ag:22g/t, Cu:1.35%,Pb:nil,Zn:21.6%	Gd of Batalay Intrusives and floats of Qv,mineralized rock and skarn are distributed in the area including B.Ayorao, B.Libjo and B.San Pedro. It is advisable to conduct detailed geological, geochemical(and geophysical)survey	A
6	Solong	M:San Miguel B:Solong	Au Cu	1975?:Canardico Co. drilled about 10 holes.Depth of each hole seem less than 100m . Details are unknown.	(G):Ss(Catanduanes F.), basaltic rocks(Yop F.),Gd dyke of Batalay Intrusives. Dyke is pyritized. (M):Floats of Qv and silicified rock.	There are floats of intensely silicified rock with qv at one of the drill site and floats of Qv in a tributary of Sorong River. Analysis(3 samples): Au;nil~0.093g/t, Ag;nil, Cu;0.022~0.030%		B
7	Tilod	M:Baras B:Tilod	Au Cu	1980:MGB conducted geochemical survey Area;800×3,000m, grid;100×100m namber of sample;585 Results;anomalies were small and not concentrated	(G):Ss(Catanduanes F.), Gd(Batalay Intrusives)	Gold grain of 2mm was obtained by panning from the Stream sediments of the Tilod River		B
8	Danicop	M:Virac B:Danicop	Au	1967:M & V confirmed 5Qvs in Ss,N45° W/90°~30° ,W=0.3m, Ore mineral;py,cp,bo Analysis:Au;nil~2.0g/t,Ag;2~24g/t, Cu;0.63~5.92%	(G):Ss(Catanduanes F.), Bonagbonag Ls, Gd and Po dyke (Batalay Intrusives) (M):placer Au,floats of skarn	Floats of skarn are scattcred along the IR Villager says floats of Qv are scattered densely in a tributary of the Iri River	It is recommended to make geological survey of the area from Danicop to Dugui Too.	A
9	Dugui Too South	M:Virac B:Dugui Too	Au	As of Dec.1993 under operation intermittently. Shaft 13m, adit 30m. Analysis by the owner of mine : 30g/t	(G):Ss(Catanduanes F.,Payo F.) Ls(Payo F.),basaltic Ss (Yop F.) (M):Au in Ls(?)	Ore is grey Ls with white calcite veinlets.	It is located near the Dugui Too Mineral Occurrence, but mineralization here seems not so promising.	C

Table 9 Mineral Occurrences in Catanduanes Island (3)

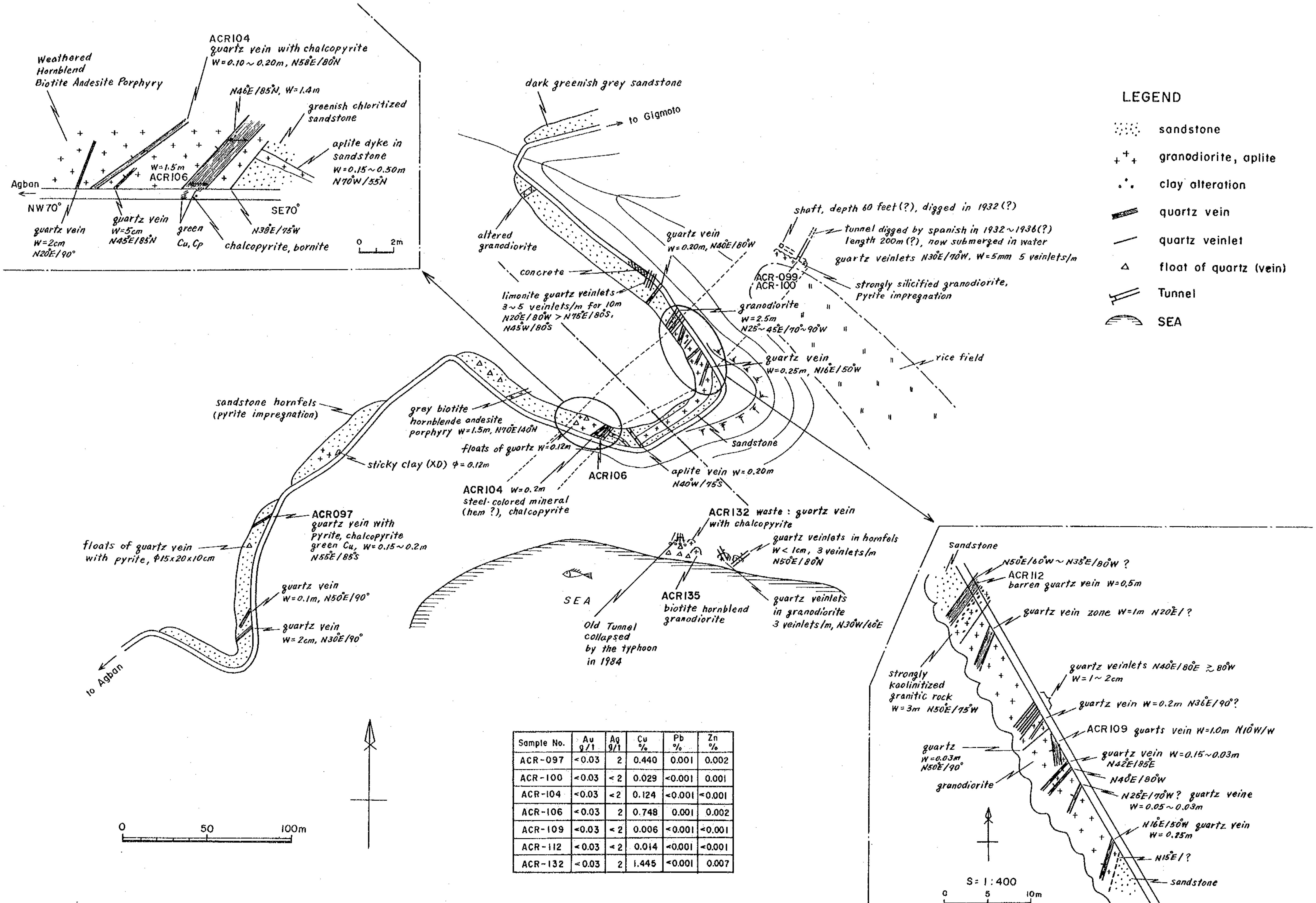
No.	Name of Mineral Occurence	Location	Type of Ore	Former Exploration and Development	Result of Survey in 1994		Remarks	Rank
					Geology and Mineralization	Result of Survey		
10	Dugui Too	M:Virac B:Dugui Too	Au	Before 1988: 4,000 panners gathered here to get placer gold. 1988:Geological and heavy mineral survey by MGB. Qv up to 20 cm wide. *Silificatin, argillitization,* pyritization. Analysis:Au;0.04∼5.02g/t,Ag;1∼2g/t, Cu;0.03∼0.229% MGB advised to do geological and soil geochemical and geophysical surveys in the area including Dugui Too, Hikming, Buyo and Danicop	(G):Ss(Catanduanes F.), Ls(Payo F.),basalt(Yop F.) Gd(Batalay Intrusives) Gd and its host rocks have *been altered(kaolinitized,* pyritized)	Another Qvs from the ones described by MGB are found. Analysis:Au;nil, Ag;nil, Cu;0.003∼0.016% *Gd dyke and the host rock* are hydrothermally altered and pyritized.	It is recommended to make geological and geochemical surveys in the areas including Dugui Too, Buyo, *Hikming and Danicop.*	A
11	Carcrongan	M:Viga B:Ananong	Au	1930∼1945:Aurora Mining Co. and Virma-gold Co. made exploration. Old shallow adits remain.	(G):Ss(Catanduanes F.) (M):Out crop of Qv,many floats of Qv.	Qvs along the Carorongan River are recognized. Many floats of Qv are found along the river. Ss underwent silicification and pyritization around Qv.	This is one of the most promising area in this survey. Au and related geochemical anomalies are found in this area. It is strongly advised to make detailed geological and geochemical surveys.	A
12	Hilacan	M:Caramoran B:Tubli∼ Mabini	Cu	Before 1940:Old workings of pits and a trench by the tributary of the Hilakan River. 1967:Miranda and Vargas *Confirmed Py veins on the river bed* W=1m, L>10m. Analysis: Cu;0.06∼6.8% 1970:Japanese company surveyed for two month by 100×100m grid sampling.	(G):Ss(Payo F.), andesite porphyry (Batalay Intrusives) (M):Py impregnation in silicified rock	Analysis of 2 samples: Au;0.062∼0.015 g/t Ag;nil, Cu;0.006∼0.008%	Four hours' walk from B.Tubli to the site by foot trail. Exploration is difficult because it is *located in the remote place.*	B
13	Tubli	M:Caramoran B:Tubli	Cu	After1965:Some exploration, old workings of a trench and a pit.	(G):Basalts(Yop F.) (M):Green copper, some q veinlets, some epidotization	Judging from around old working,mineralization here is in small scale		C

Table 9 Mineral Occurrences in Catanduanes Island (4)

No.	Name of Mineral Occurence	Location	Type of Ore	Former Exploration and Development	Result of Survey in 1994		Remarks	Rank
					Geology and Mineralization	Result of Survey		
14	Dulangan	M:Caramoran B:Guiamlong	Au	1965～:Two sites of ming(A,B) A:Shaft 56feet,Already buried. B:Clay Vein. 1980:MGB explored the area and found 10 Qv and 2 silicified zones. Geochemical Data are unavailailable.	(G): Ss (Catnduanes F) (M): Au bearing Qv and Qz bearing Clay veins, width of which is 0.3m.	Analysis (2):Ore stock Au:22.706～28.024g/t Ag:nil～4 g/t Cu:0.002～0.003%		B
15	Pulot	M:San Andres B:Guiamlong	Au	1934～1936:Associated Mines Co.of America explored the area. 100 pits and exploratory tunnels were excavated.	(G): Basaltic Rocks (Yop F) (M): Calcite Vein.	Analysis (1) Au:nil.Ag:2 g/t.Cu:0.023% Potential is small.		C
16	Maygnaway	M:San Andres B:Maygnaway	Au	1993～:Mr.Rey B.Sarmiento of Virac is now exploring the place by tunnelling	(G):Basaltic Rocks (Yop F) (M):Qv in basaltic Rocks. W=0.03m	Analysis (2):Tunnel Au:nil～0.249g/t.Ag:nil Cu:0.007～0.026% Potential is small.		C
17	Kaglatawan	M:San Miguel B:Kaglatawan	Cu	1981:Exploration by MGB. Soil geochemical survey was carried out in the area of 3×4Km. 636 samples were analysed for the elements Cu,Pb,Zn,Au,Ag. Small geochemical anomalis are scat tered in the area. The fact implies the occurrence of mineralizasion deep under the ground. Geological and I.P surveys are recommended.	(G):Ss (Catanduanes F) Basaltic Rocks (Yop F) (M):Qv	Potential seems not big.		C
18	Mabil	M:Bagmanoc B:Mabil	Clay		Along road cutting between Carmoran and Viga for 1Km. (G):Hydrothermal Clay originaled from the Pay Fm.	Road become impassable in rainy season. Hydrothemal alteration clay barren mineralization. Small scale. No industrial value.		C
19	Tambongan	M:Viga B:Tamogan	Clay		Gray Alluvial Clay at the month of the Manuria River. W=1m	Alluvial Clay.Small sccale No industrial value.		C
20	Bagmanoc	M:Bagmanoc	Clay	His said that the Clay was used for the bricks for cnstrnction of the church in spanish Ls.	Alluvial brown Clay on the rig ht brack of Sabang River. Surrounding is rice paddy.	Alluvial Clay.Small sccale No industrial value.		C

Table 9 Mineral Occurrences in Catanduanes Island (5)

No.	Name of Mineral Occurence	Location	Type of Ore	Former Exploration and Development	Result of Survey in 1994		Remarks	Rank
					Geology and Mineralization	Result of Survey		
21	Viga	M:Viga	Clay	It is said that the clay was used for bricks for construction of church in the spanish time.	Alluvial clay nearby rice paddy. It is situated 100m west of the center of Viga city.	Alluvial clay No industrial value		C
22	Sagrada	M:Viga B:Sagrada	Clay		Alluvial brown clay. It is located on the right bank of the Viga River.	Alluvial clay small scale No industrial value		C
23	Solong	M:San Miguel B:Solong	Clay		Alluvial brown clay. nearby the rice paddy.	They say that the clay is associated with Au mineralization. But this type clay is not confirmed in this survey because of overburden and vegetation. No industrial value		C
24	Dugui Too	M:Virac B:Dugui Too	Clay		(G):Ss(Ctanduanes F.) Gd(Batalay intrusives) Gd:dyke W=10m (M):white clay (Ka,Qz,Py) hydrothermal alteration Product	There are many small stocks and dykes of Gd in this area which brought gold mineralization and hydrothermal alteration.	Same as Mineral Occurrence No.10.	A



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
ACR-097	<0.03	2	0.440	0.001	0.002
ACR-100	<0.03	< 2	0.029	<0.001	0.001
ACR-104	<0.03	<2	0.124	<0.001	<0.001
ACR-106	<0.03	2	0.748	0.001	0.002
ACR-109	<0.03	< 2	0.006	<0.001	<0.001
ACR-112	<0.03	< 2	0.014	<0.001	<0.001
ACR-132	<0.03	2	1.445	<0.001	0.007

Fig.19 Sketch Map of the Agban Mineral Occurrence

Many quartz floats containing copper minerals several per cent in grade are scattered around the opening. The ore minerals in the area are mainly composed of "chalcopyrite ?", and being accompanied by a small amount of chalcopyrite, bornite, and green coppers.

Again, according to the local people, Canardico conducted a drilling program in an area, 3 kilometers east to west and 2 kilometers north to south, on the southeast of the Agban Village, in the years 1975 and 1976. Total eight holes, 60 feet in depth, were drilled. The holes are distributed 1 kilometer apart each other. No drill hole is situated within i kilometer from road cutting.

Miranda and Vargas (1967) described that Catanduanes Gold Mining Co. performed an exploration program in the area 1936. Meek (1938) and Capistrano (1952) surveyed the mineral occurrences in the area. Miranda and Vargas (1967) noted this area as copper occurrences, and reported the assay results of the waste rocks in the coast, 1.5 % for Cu, nil for Au, and 5.5 g/t for Ag. The assay results for the samples collected in the survey this time are as follows. The sample ACR-100 is from the strongly silicified granodiorite accompanied by quartz veinlets near by the rice field, ACR-132 is from the waste rocks of copper bearing quartz veins near by the old adit in the coast, and all others are from the quartz vein in the road cutting.

Table 10 **Assay Results of the Agban Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
ACR-097	nil	2	0.440	1.27	0.059	0.001	0.002	0.278
ACR-100	nil	nil	0.029	0.90	0.008	nil	0.001	0.129
ACR-104	nil	nil	0.124	0.93	0.033	nil	nil	0.102
ACR-106	nil	2	0.748	1.70	0.024	0.001	0.002	0.014
ACR-109	nil	nil	0.006	0.90	0.001	nil	nil	0.003
ACR-112	nil	nil	0.014	0.77	0.001	nil	nil	0.005
ACR-132	nil	2	1.445	1.71	0.025	nil	0.007	1.350

No gold is contained in the quartz veins in the area, however, some ores contain copper in some grade. Under the microscope, chalcopyrite and minor amounts of molybdenite are seen in the quartz veins, and edges of chalcopyrite grains have been altered to covelin and bornite.

This area and the following Vinticayan Point Mineral Occurrence are promising areas for minable ores in the island.

(2) Vinticayan Point Mineral Occurrence

The mineral occurrence is situated in Vinticayan Point 1.7 kilometers southeast of the

Agban Mineral Occurrence, and green copper impregnation is seen on the cliff surface facing the sea. The secondary copper minerals are distributed.in two spots in a belt extending 50 meters long and 10 meters wide. Host rocks of the occurrences are not known.

The zone is on the steep cliff, and it is unable to access from the land. Also access from the sea was impossible during the time of this survey because the sea was too rough.

According to the local people, the Mineral Occurrences contain gold, and Canardico conducted an exploration program in an area about 1.5 kilometers west of the Mineral Occurrences 1972.

Miranda and Vargas (1967) described that a quartz vein existed in a road cutting between Baras Town and Agban Village, parallel to a granodiorite body intruded in the sandstone and phyllite.

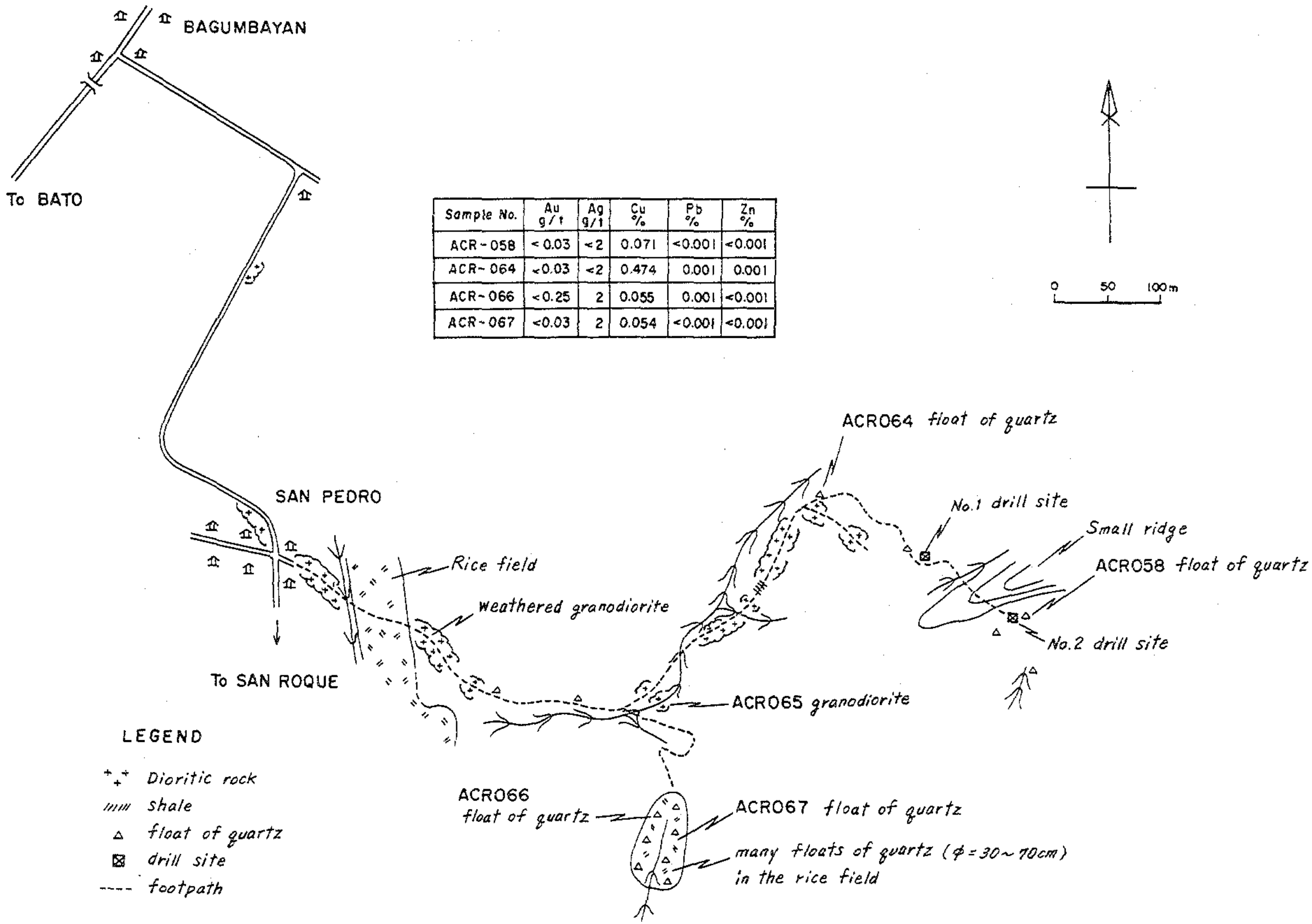
(3) San Pedro Mineral Occurrence

The Mineral Occurrence is situated in San Pedro about 2 kilometers northeast of Bato Town, and the Mineral Occurrence is of quartz floats about 70 centimeters in diameter. The area is dominantly underlain by the granodiorite of the Batalay Intrusive Rocks, but it is supposed that there are green sandstones judging from the floats around there.

According to the local people, Canardico conducted a drilling program consisting of two holes, one is over 100 meters in depth, for gold 1970, however no detail is known. Figure xx shows a drill hole position, and the quartz floats are distributed in an area within 1.5 kilometers radius centering the drill point.

Around the sampling point of ACR-066, many large quartz floats, 30 to 70 centimeters in diameter, are distributed in an area 100 meters x 60 meters centering a rice field along a stream. It strongly suggests that in-site quartz veins exist in the area. The floats are of white and semi-transparent quartz, and contain chalcopyrite, pyrite, and minor amounts of molybdenite, which are seen by naked eye. Edges of the chalcopyrite grains have been altered to bornite, covelin, and limonite.

Table 11 shows the assay results of four float samples. The maximum value is 0.249 g/t for Au, 0.474 % for Cu, and 0.137 % for Mo in ACR-066. The assay results of a soil sample, ACR-072, collected from "B" horizon near the drill site are 13 ppb for Au, <2 ppm for As, <2 ppm for Sb, 1 ppm for Hg, 507 ppm for Cu, 14 ppm for Mo, 30 ppm for Pb, and 32 ppm for Zn.



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
ACR-058	<0.03	<2	0.071	<0.001	<0.001
ACR-064	<0.03	<2	0.474	0.001	0.001
ACR-066	<0.25	2	0.055	0.001	<0.001
ACR-067	<0.03	2	0.054	<0.001	<0.001

Fig.20 Sketch Map of the San Pedro Mineral Occurrence

Table 11 **Assay Results of the San Pedro Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
ACR-058	nil	nil	0.171	0.70	0.137	nil	nil	0.180
ACR-064	nil	nil	0.474	1.51	0.022	0.001	0.001	0.344
ACR-066	0.249	2	0.055	0.51	0.097	0.001	nil	0.082
ACR-067	nil	2	0.054	0.83	0.052	nil	nil	0.054

(4) Libjo Mineral Occurrence

The Mineral Occurrence is situated about 2 kilometers northwest of San Pedro. Miranda and Vargas (1967) described the geology of the area, and reported two main quartz veins, striking N80°E and dipping 55° to the south, 50 centimeters and 15 centimeters in thickness respectively, and veinlets in a road cutting between Bato Town and Baras Town. Green stains by malachite azurite are seen in the veins. Miranda and Vargas (1967) also reported assay results of three samples from the main veins as follows, 0.28 to 8.96 % for Cu, 0 to 1.0 g/t for Au, and 5.5 to 41.5 g/t for Ag. The veins, however, have not noted by the survey this time.

According to the local people, Canardico conducted a drilling program in an area from the Libjo Mineral Occurrence to the Aroyao Mineral Occurrence during 1970's. More than ten holes were drilled, and their depths were from 20 to 30 feet. Floats consisting of pyrite and limonite are scattered in the area, and it is said that dense concentration of floats are seen in some zones.

It has been observed by the survey team this time that the sandstone of the Catanduanes Formation at a drill site, 1 kilometer north of Libjo, has been subject to strong pyritization and limonitization. Figure xx shows the drill site. A float consisting of pyrite and limonite, 10 centimeter in diameter, has been seen in an area 300 meters to the north of this area. Result of microscopic observation has revealed that the float, sample of ACR-075, was composed of pyrite, limonite, and small amounts of hematite and magnetite. Assay results of the sample is 0.513 % for Cu, and of the sample from the soil "B" zone are 19 ppb for Au, 20 ppb for As, <2 ppm for Sb, <1 ppm for Hg, 9 ppm for Mo, 6230 ppm for Cu, 26 ppm for Pb, and 640 ppm for Zn. shows. The values of Au, As, Mo, Cu, and Zn suggest some geochemical anomalies for mineralization.

It is advisable to conduct further exploration programs for the Libjo, Aroyao, and San Pedro areas.

Table 12 **Assay Results of the Libjo Mineral Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
ACR-075	nil	14	0.513	34.4	0.003	nil	0.006	8.97

(5) Aroyao Mineral Occurrence

The area is situated about 2 kilometers north of Bato Town, and underlain by sandstone, intercalated by impure limestone thin layers, of the Payo Formation, and Batalay granodiorite intrusive body. Skarn floats containing sphalerite are scattered there.

Large floats, 1 to 2 meters in diameter, containing garnet and green skarn have been found at the road side about 500 meters east of Aroyao in this survey. Hematite, pyrite, sphalerite, limonite, and small amounts of green copper are seen in the floats with the naked eye. Under the microscope, garnet and clino-pyroxine are observed in the samples ACR-151-1 and ACR-151-2. Table 13 shows the assay results of the skarn float, ACR-150.

According to the local people, skarn and mineralized floats are scattered to the south of the road connecting Aroyao and San Juan. It is recommended to conduct further detailed surveys for gold and base-metals there.

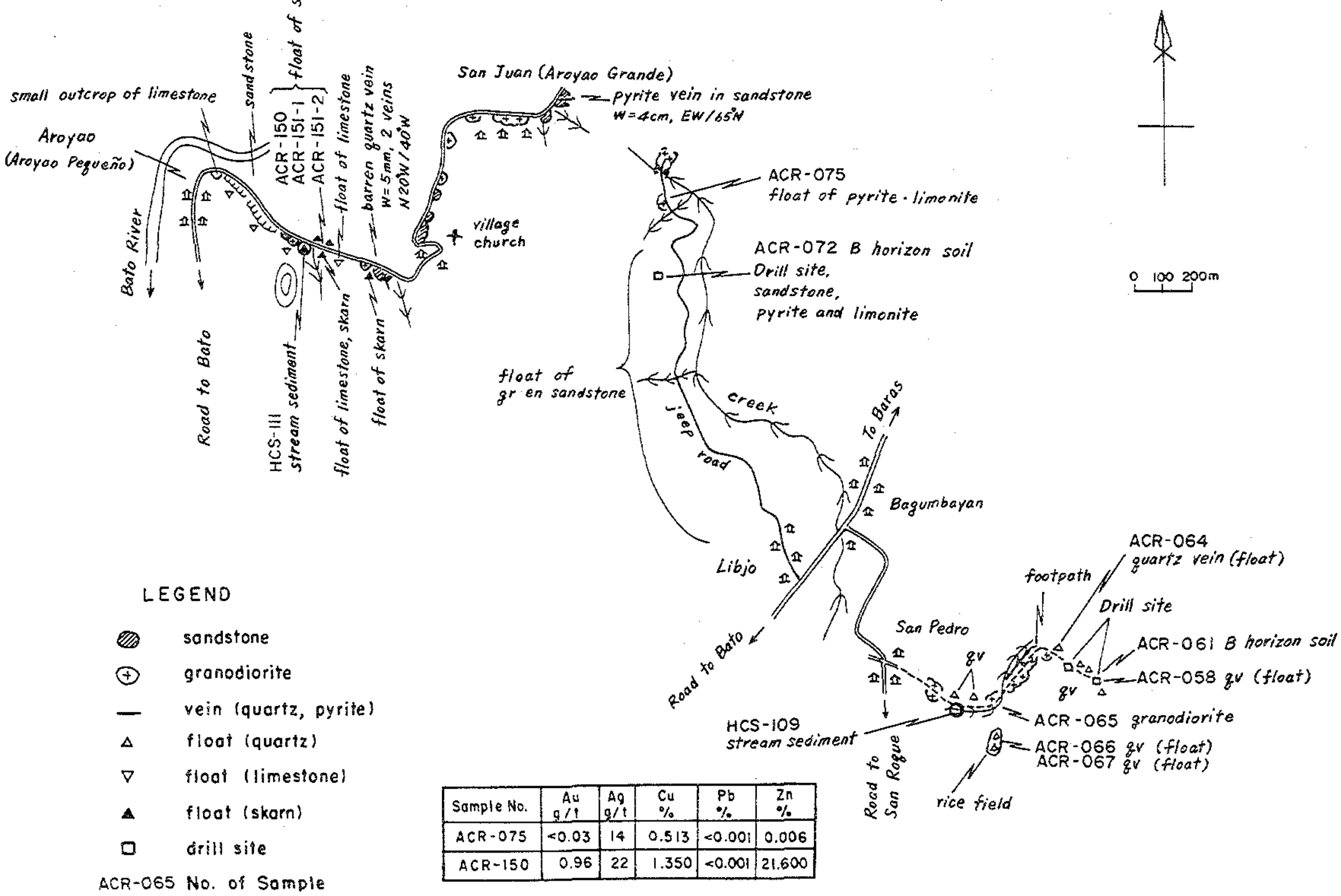
Table 13 **Assay Results of the Aroyao Mineral Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
ACR-150	0.964	22	1.35	16.3	nil	nil	21.6	11.4

(6) Solong Mineral Occurrence

The area is situated in Solong in a tributary of the Bato River, which is joined by the tributary in San Miguel Town, and underlain by basaltic volcanic rocks of the Yop Formation and diorite and andesitic porphyry of the Batalay Intrusive Rocks. Some quartz floats are scattered along some streams. It is said that Canardico conducted a drilling program on the north of the tributary 1975, and drilled about ten holes, shallower than 100 meters. No detailed information is available. Table 14 shows the assay results of the samples from the area. ACR-0 11 is of kaolinized argillite, ACR-015 is of amphibole diorite impregnated by pyrite of the Batalay Intrusive Rocks, and ACR-020-2 is of quartz vein.

The assay results of a "B" horizon soil sample from the old drill site are as follows; 27 ppb for Au, 2 ppm for Ag, 2 ppm for Sb, <1 ppm for Hg, 8 ppm for Mo, 24 ppm for Pb, and 36 ppm for Zn. The values of gold, molybdenum and copper indicate good sign for underneath mineralized zones.



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
ACR-075	<0.03	14	0.513	<0.001	0.006
ACR-150	0.96	22	1.350	<0.001	21.600

Fig.21 Sketch Map of the Aroyao, Libjo and San Pedro Mineral Occurrences

Table 14 **Assay Results of the Solong Mineral Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
ACR-011	nil	nil	0.022	2.59	nil	nil	0.002	0.006
ACR-015	nil	nil	0.033	4.59	nil	nil	0.006	0.244
ACR-020-2	0.093	nil	0.030	0.96	0.004	0.001	nil	0.047

(7) Tilod Mineral Occurrence

The area is situated in Tilod, 7 kilometers northwest of Bato Town. MGB conducted geological and soil geochemical surveys in the area (Angeles and Teodoro, 1980), and reported small-scale copper, lead, and zinc anomalies scattered there. The Catanduanes Formation in the area has been intruded by andesitic porphyry intrusive bodies. A heavy mineral sample gained by panning from stream sediment at the point ACS-001 contains a gold grain, 2 millimeters in diameter, however no quartz vein has been seen around the point.

(8) Danicop Mineral Occurrence

The area is situated 4 kilometers northwest of Virac, and underlain by sandstone of the Catanduanes Formation, Bonagbonag Limestone, and andesitic porphyry of the Batalay Intrusive Rocks. The sandstone of the Catanduanes Formation has been partly subjected to epidotization and garnetization, and altered to skarn.

According to the local people, gold mining by panning was very active in the area during the years from 1960 to 1993. A japanese and an american geologists performed a geological survey through a week 1977. It is said that some quartz floats are scattered in some streams. Gold panning was forced to stop by an order of the Village head may 1993.

Miranda and Vargas (1967) reported following assay results of five samples from this area: 0.63 to 5.92 % for Cu, nil to 2.0 g/t for Au, 5.0 to 24 g/t for Ag, and nil to 0.16 % for Mo. No ore sample has been collected from the area this time, however, it is judged that this area is of high potential for gold and base metals because of the existence of the skarn floats and gold panning activity.

(9) Dugui Too South Mineral Occurrence

The area is situated in a sloop, about 700 meters south of Dugui Too Village, and underlain by sandstone, phyllite, limestone, and basaltic tuffaceous sandstone. In the area, gold prospecting in limestone is presently in active. The limestone is several meters thick. A 13 meters deep shaft, and an adit from the downward of the shaft to connect to the shaft are

presently in work. The bottom of the shaft and the end face of the adit are in dark grey limestone. The part from the opening to 27 meters in the adit is in basaltic sandstone. Ore is in the limestone patched by calcite veinlets, and no alteration is seen.

According to the property owner, ores from the shaft contain 30 g/t of gold. The assay results of the sample, ACR-081, collected this time, however, show no gold as shown in Table 15.

It is recommended to conduct further detailed survey in the area, because there are many small-scale intrusive bodies of the Batalay Intrusive Rocks, and streams in the area are known as placer gold producing areas.

Table 15 **Assay Results of the Dugui Too South Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
ACR-081	nil	nil	0.003	1.18	nil	nil	0.003	0.134

(10) Dugui Too Mineral Occurrence

The watershed of the Buyo River around Dugui Too, 9 kilometers northwest of Virac, including Dugui Wala, Buyo, and Hicming, and the watershed of the Iri River, west of Danicop, were gold rush areas in 1988. Four thousand minors gathered in the areas to mine 26 placer gold spots (Teodoro et al. 1988).

The area is underlain by the Catanduanes, Yop, and Payo Formations, and small intrusive bodies of diorite and andesitic porphyry of the Batalay Intrusive Rocks. The Batalay intrusive bodies and intruded formations have partly undergone hydrothermal argillization. Pyrite impregnation is partly seen in the rocks. Quartz veins, several to 20 centimeters wide, have been found in the area, and their mother rocks have been subjected to strong silicification and pyritization (Teodoro et al. 1988).

Under the microscope, the ore is mainly composed of magnetite, and accompanied by small amounts of chalcopyrite, pyrite, and goethite, and minor amounts of sphalerite. The chalcopyrite is closely associated with magnetite. The pyrite has been altered to goethite in its edge.

Teodoro et al. (1988) reported assay results of 11 samples from the quartz veins as follows: 0.04 to 5.02 g/t for Au, 1 to 2 g/t for Ag, 29 to 229 ppm for Cu, 43 to 495 ppm for Zn, 10 to 533 ppm for Pb. Table 16 shows the assay results of the sample collected this time. No high grade quartz vein has been found this time, however, it is judged that this area has

some potential for ores. Because their past record shows high gold concentration, 4.80 and 5.0 2 g/t for Ag, as shown by Teodoro et al. (1988), and there are many intrusive bodies and hydrothermally altered rocks in the area.

Table 16 **Assay Results of the Dugui Too Mineral Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
HCOR-003	nil	nil	0.016	5.76	nil	nil	0.015	1.23

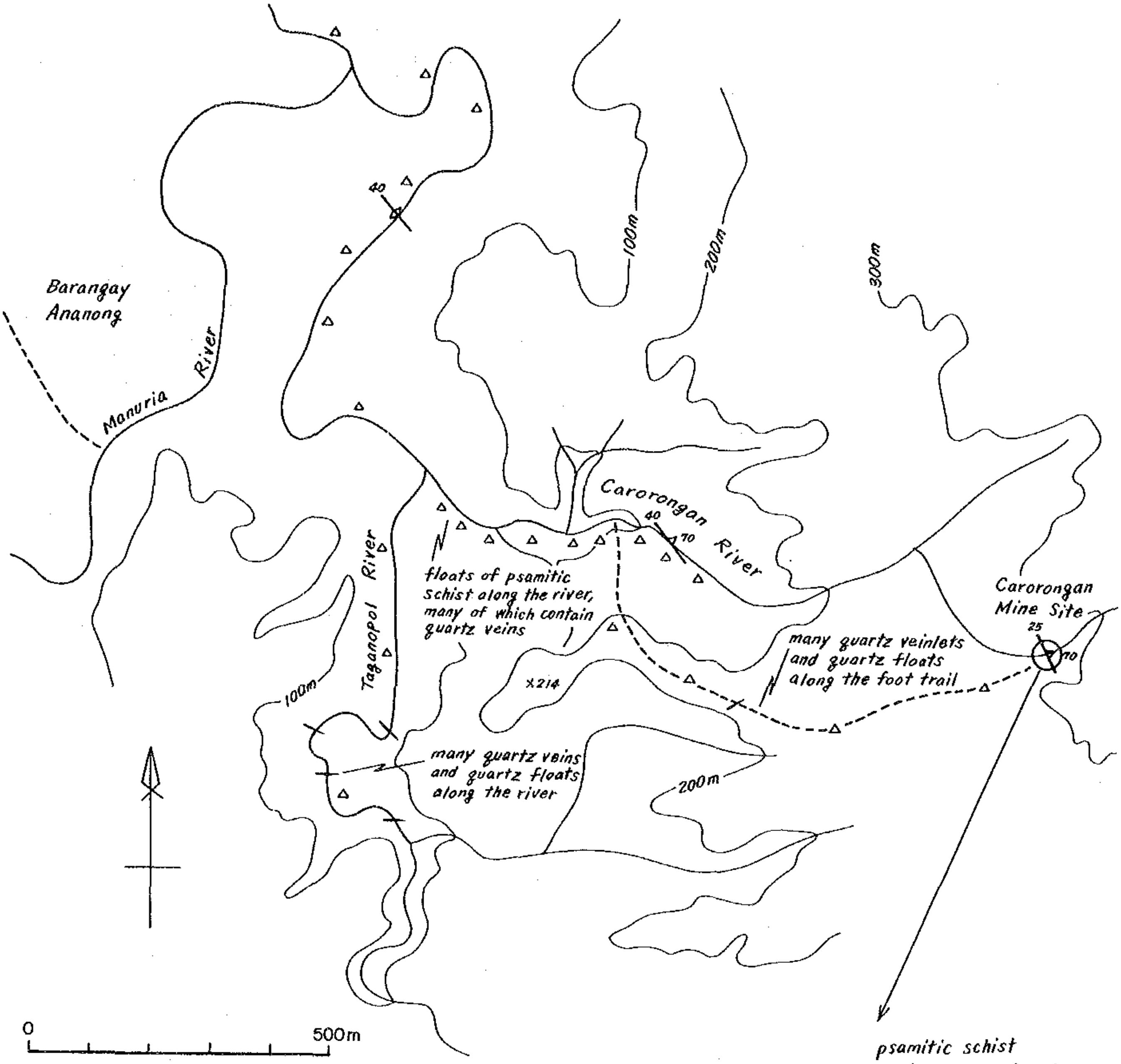
(11) Carorongan Mineral Occurrence

The area is situated in the upper stream area of the Carorongan River, a tributary of the Manuria River, 1.5 kilometers east of Viga Town. Aurora Mining Company and Virmagold operated gold mines in the area in 1945. it takes about two hours from Ananong Village through a rough walking trail. The occurrence is on a stream floor, about 2 meters wide, and consists of many short length quartz veinlets, about 2 centimeters thick, containing pyrite in sandy schist of the Catanduanes Formation. The sandy schist penetrated by quartz veins have been subjected to silicification, and disseminated by fine, 2 millimeters in diameter, pyrite grains. The floor was dug before, therefore there is a small waterfall, about 2 meters high, in the site. Many quartz floats in various sizes are scattered along the Carorongan River, therefore it is supposed that there are many quartz veins around there.

Miranda and Vargas (1967) reported assay results of five quartz samples from the Mineral Occurrence as follows; nil to 21.5 g/t for Au, 0.03 to 0.08 % for Cu. Table 17 shows the assay results of the samples collected this time. BCOR-014 is of silicified sandy schist penetrated by quartz vein and disseminated by pyrite, BCOR-014-1 is of 2 centimeters thick quartz vein mined out in the old working time, BCR-044 is of quartz vein cropping out in the downstream of the Carorongan River, and FCOR-002 is of quartz vein out cropping in the Taganopol River, which is a tributary of the Manuria River. It is judged that significant numbers of quartz veins exist in the area, and the area is of high potential for gold.

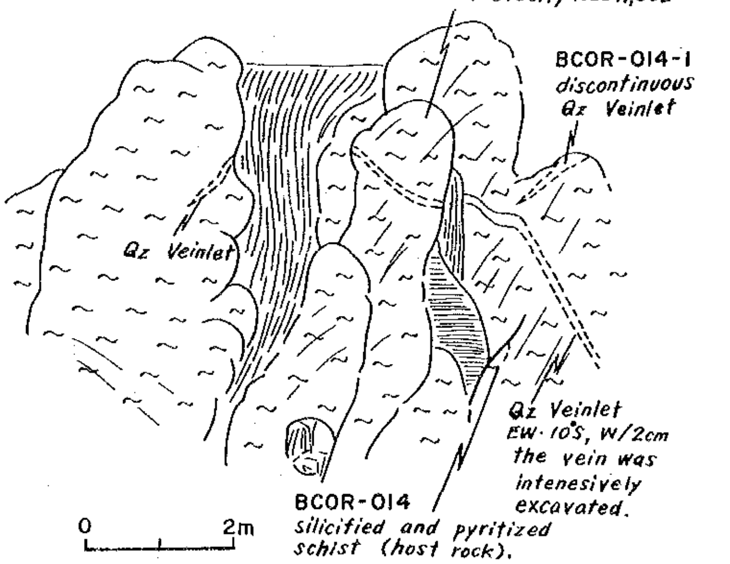
Table 17 **Assay Results of the Carorongan Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
BCOR-014	1.711	nil	0.009	6.75	nil	nil	0.035	2.940
BCOR-014-1	0.684	nil	0.008	5.09	nil	0.001	0.074	1.910
BCOR-017	nil	nil	0.002	0.55	nil	0.001	0.017	0.020
BCR-044	nil	2	0.010	0.81	0.074	nil	0.016	0.053
FCOR-002	nil	nil	0.002	0.74	nil	nil	0.017	0.013



LEGEND

- Schist
- / Quartz vein
- △ Quartz float



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
BCOR-014	1.71	<2	0.009	<0.001	0.035
BCOR-014-1	0.68	<2	0.008	<0.001	0.074

quartz veinlets of various strikes and dips are scattered in psamitic schist of Catanduanes Formation.

Fig.22 Sketch Map of the Carorongan Mineral Occurrence

(12) Hilacan Mineral Occurrence

The area is situated in the upper stream of the Hilacan River, and accessible from Tubli, 3 kilometers south of Caramoran Town, through a trail. It takes about four hours by walking. According to the local people in Tubli, a sampling program, 100 m x 100 m grid system, was performed by some company through two months some time in 1970s. It is said that the name of the company sounds like japanese, but it is not clear.

There are two pits in the sloop of the right bank of the Hilacan River, which is flowing to the east. Figure 23 shows the situation. A 4 m x 4 m size shaft is in the upper pit, and a 8 meters long, 1 m x 1 m section trench extends to N60°E. In the lower pit, a trench, 3 meters high and 8 meters wide, was dug on the sloop. Strongly silicified sandstone of the Payo Formation has been significantly impregnated by pyrite in the area, and same kind of altered rocks expose downward river beds. Red gossan floats of the sandstone are scattered in 20 meters long along the stream.

Under the microscope, grained pyrite and minor amounts of goethite and leucoxene are observed in the samples, BCOR-006 and BCOR-007. Minor amounts of chalcopyrite and sphalerite are enclose in pyrite grains.

Miranda and Vargas (1967) reported assay results of the rock from the area as 0.06 to 6.8 % for Cu. Table 18 shows the assay results of the samples collected this time. No high value has been obtained this time.

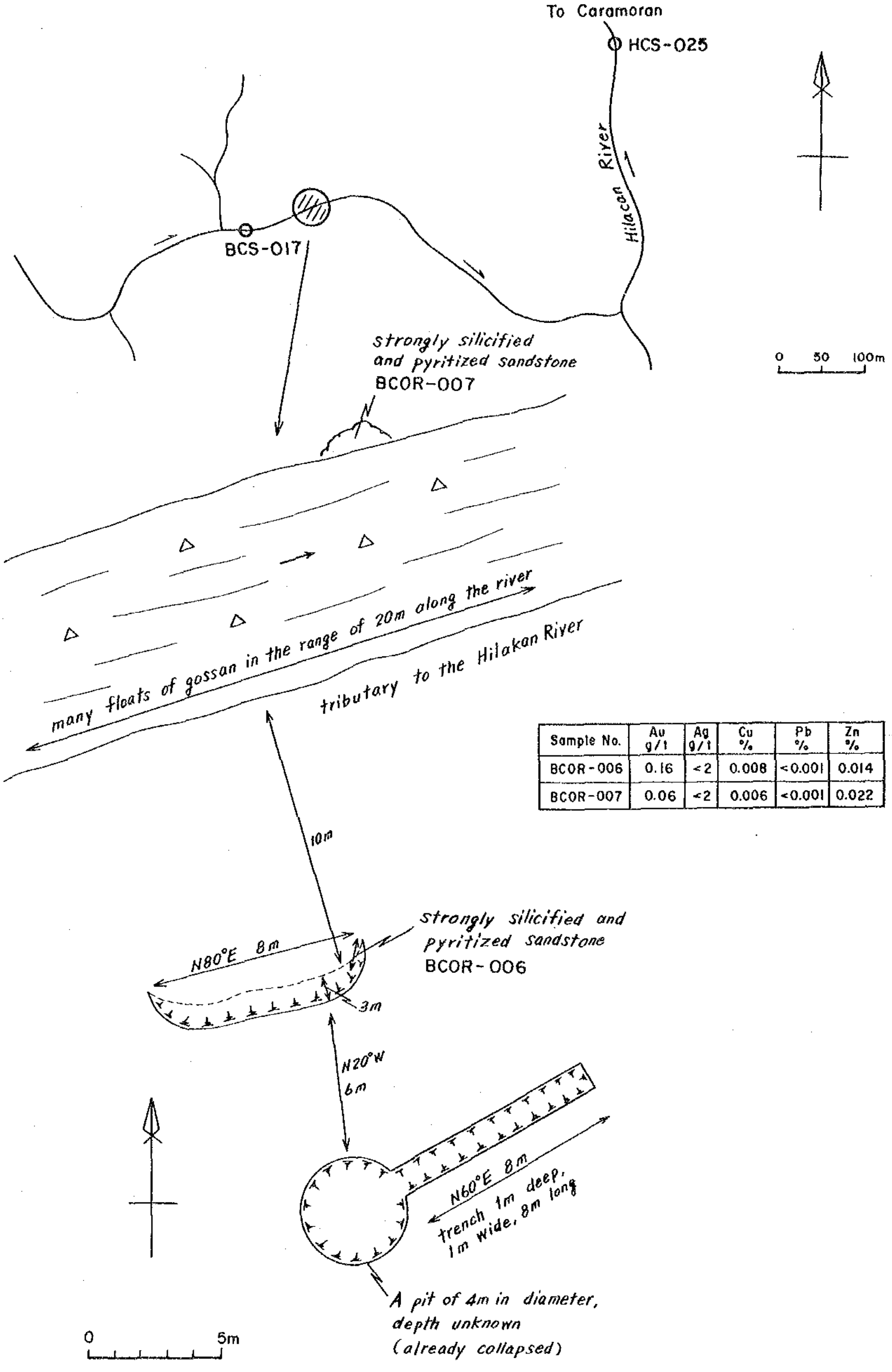
Table 18 **Assay Results of the Hilacan Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
BCR-006	0.156	nil	0.008	5.05	0.001	nil	0.014	2.470
BCR-007	0.062	nil	0.006	4.81	0.003	nil	0.022	3.750

(13) Tubli Mineral Occurrence

The area is situated in Tubli, northwestern island, and there are two old mining sites for copper on the bank of the Tubli River flowing to the south.

One site is situated in the right bank sloop of the river, 50 meters above the river and 1.2 kilometers upper stream from Tubli. A pit, 1.5 m x 1.5 m x 2 m in size, is there, but it is collapsed at present. Judging from waste rocks around there, the ore is presumably of a copper bearing quartz vein in basalt. The basalt has been subjected to epidotization, and disseminated by native copper and green copper minerals. Table 19 shows the assay results of the mineralized waste rock, ACR-030.



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
BCOR-006	0.16	<2	0.008	<0.001	0.014
BCOR-007	0.06	<2	0.006	<0.001	0.022

Fig.23 Sketch Map of the Hilakan Mineral Occurrence

The other site is situated in a sloop about 200 meters east from the river, 300 meters upper stream from Tubli. It is a trench, 8 m x 3 m in size, and 3 to 4 meters deep. Waste rocks of basalt stained by green copper minerals mainly consisting of malachite are scattered around there.

Judging from the status of the pit and trench, and geological environment, mineralized zone in the area is probably small.

Table 19 **Assay Results of the Tubli Mineral Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
ACR-003	nil	2	1.495	5.36	nil	nil	0.007	0.007

(14) Dulangan Mineral Occurrence

The area is situated 3 kilometers upstream of a northward tributary of the Guiamlong River, about 1 kilometer north of Hitoma. It takes about four hours from Guiamlong in the coast through a trail by foot. The area shows rugged topography, V-shape valleys and many water falls.

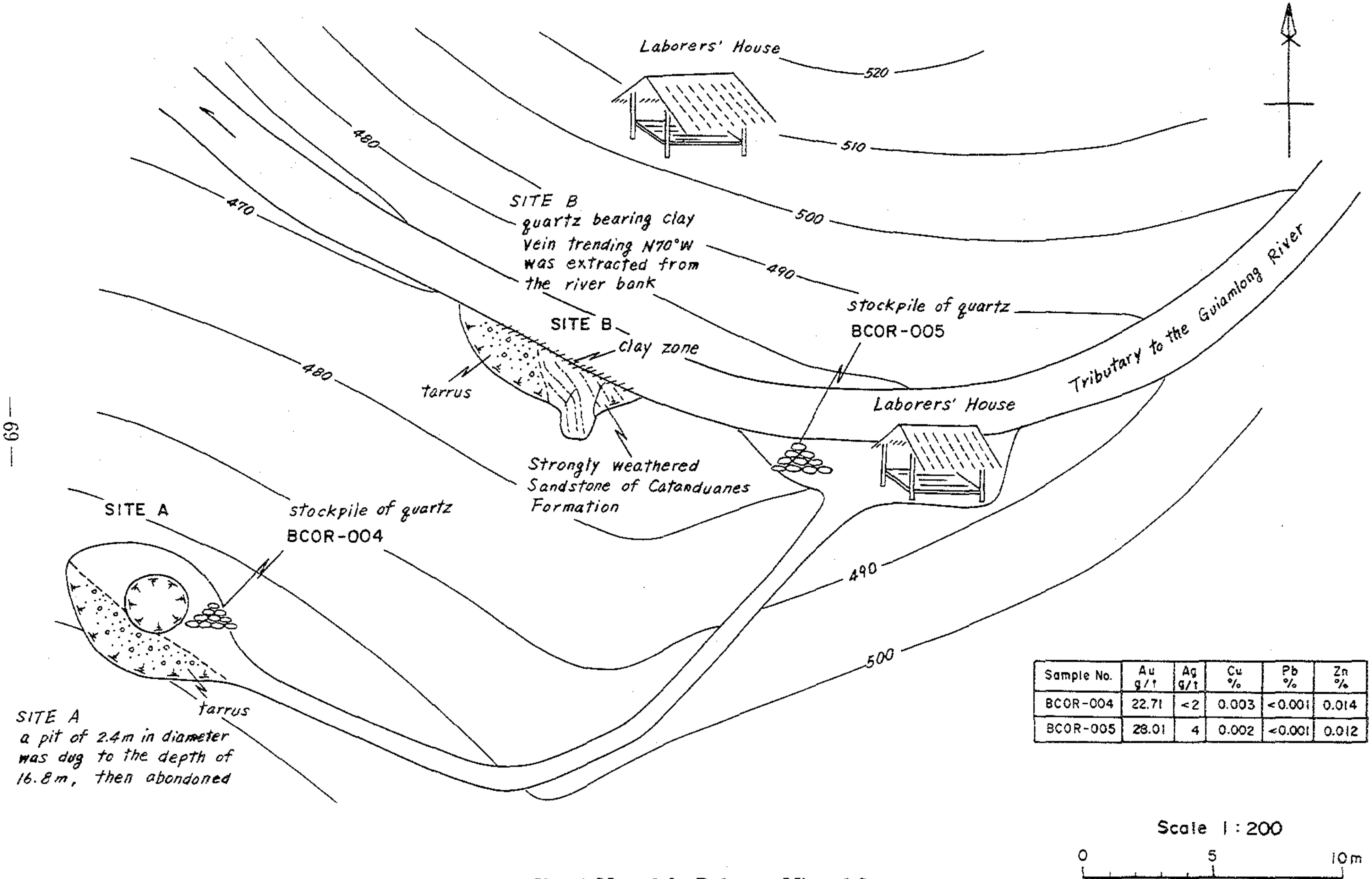
The area is underlain by greenish grey fine to medium sandstone of the pre-Cretaceous Catanduanes Formation, which strike N75°W, and dip 70° to the southwest. It is reported that the sandstone is penetrated by many quartz veins (Angeles and Teodoro, 1980).

Two old workings are in site, the upper and lower. According to the local people, who worked for the mine, the mining started in 1965 and ended in 1992. The working is, however, too small in scale for such long time working period. The mine was named as "Dulangan Mine", and ten people were employed for the mine. It is said that the workers carried 20 kilograms of ores two times a day from the mine site to Guiamlong.

The two old workings are on the left bank of a tributary of the Guiamlong River, "A" site in the upper and "B" site in the lower. Figure xx shows the site status.

The "A" site is situated on the left bank sloop of the upper stream of the tributary of the Guiamlong River, about 20 meters above from the river, and was mined from 1978. A shaft, 8 ft x 8 ft in size, was dug, and it was quit at the depth of 56 feet due to tough conditions. It has been collapsed since then. It is supposed that working was done by hand to mine weathered residual quartz in weathered soil sandstone.

The "B" site is situated on the left bank of the upper stream of the tributary of the Guiamlong River, and was started mining in 1965. The vein strikes N70°W, dips vertical, 30



Sample No.	Au g/t	Ag g/t	Cu %	Pb %	Zn %
BCOR-004	22.71	<2	0.003	<0.001	0.014
BCOR-005	28.01	4	0.002	<0.001	0.012

Fig.24 Sketch Map of the Dulangan Mineral Occurrence

centimeters thick, and has undergone argillization. Hard blocks of quartz were picked up, and washed for further processing. The host rock of the vein is sandstone of the Catanduanes Formation.

Table 20 shows the assay results of the quartz vein.

Table 20 **Assay Results of the Dulangan Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
BCOR-003	22.706	nil	0.003	1.67	nil	nil	0.014	0.500
BCOR-005	28.024	4	0.002	1.09	nil	nil	0.012	0.275

BCOR-004 is a sample collected from an ore storage in the "A" site, BCOR-005 is a sample of a float in a storage on the river side. It is the fact that the assay values of these samples are highest in those of the all other samples from the island, however, it seems that the scale of the veins is of small scale judging from the survey results of the site.

(15) Pulot Mineral Occurrence

The area is situated 1.5 kilometers east of Codon Village, in a mountainous region. Capistrano (1952) described the occurrence. According to the local people, an exploration program was conducted in the area during a period from 1934 to 1936. It is a long time ago, so that the details are not clear, but it is said that Associated Mines Co., an American company, conducted the program, and more than 200 workers were employed for the work.

Around 100 pits and adits were excavated in the area of about 4 hectare, however only one adit has been preserved until now. The adit is situated on the right bank of a tributary of the Pulot River, and directs to N10°E in a length of 20.4 meters. The rocks around there are strongly weathered brownish basalt, and many calcite veinlets, about 3 millimeters thick, fill joints in the rocks in various directions. No sulfide minerals are seen in the adit with naked eye. Relics of drill and blasting are seen in the adit. It is said that Associate Mines was bankrupted after two years operation. According to Capistrano (1952), the activity was failed. Table xx shows the assay results of a sample collected from the adit this time. The values of Au and Ag are low enough for promising potential.

Table 21 **Assay Results of the Pulot Mineral Occurrence**

	Au(g/t)	Ag(g/t)	Cu(%)	Fe(%)	Mo(%)	Pb(%)	Zn(%)	S(%)
BCOR-017	nil	2	0.023	5.6	<0.001	0.001	0.074	0.015

(16) Maygnaway Mineral Occurrence

The area is situated on the right bank of 2 kilometers upstream of the Maygnaway River, and underlain by basalt of the Yop Formation. Opening of an adit was started by Mr. Ray B. Sarmiento, who lives in Virac, in August, 1993. The prospecting adit has been excavated 20 meters to the north then 5 meters to the northwest as of October 10, 1993. A quartz vein, 3 centimeters thick and horizontal, is on the face of the adit, but its continuity is poor. The basaltic lava around there has been partly subjected to silicification and pyritization. Table 22 shows the assay results of the samples from the adit. BCOR-008 is the sample of the quartz vein, and BCOR-009 is of silicified and pyrite stained mother rock.

Table 22 **Assay Results of the Maygnaway Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
BCOR-008	0.249	nil	0.007	2.01	nil	nil	0.008	0.224
BCOR-009	nil	nil	0.026	6.89	nil	0.001	0.095	3.710

(17) Kaglatawan Mineral Occurrence

The area is situated 6 kilometers west of Pagsagnahan Village, in the middle stream area of the Bato River. MGB performed a soil geochemical survey program in the area (Angeles and Teodoro, 1983).

The area is underlain by basaltic lavas of the Yop Formation, and quartz veinlets are seen in the rocks. The assay results of the quartz vein samples collected this time are as follows.

Table 23 **Assay Results of the Kaglatawan Occurrence**

	Au g/t	Ag g/t	Cu %	Fe %	Mo %	Pb %	Zn %	S %
FCOR-004	nil	nil	0.010	4.49	nil	nil	0.027	1.020

(8) Clay Occurrences

Six clay occurrences, Mabil, Tambongon, Bagamanoc, Viga, Sagrada, Solong and Dugui Too have been surveyed. But only two occurrences, Mabil and Dugui Too are tof hydrothermal clay and others are of alluvial clay.

Clay of the Dugui Too Occurrence is exposed for 10m along the road cutting between Hikming Village and Dugui Too Village. The clay is light grey to white and good quality for industrial use. Placer gold deposits and quartz veins are known to exist in this area (Teodoro et al., 1988). The clay is originated from granodiorite dykes of the Batalay Intrusives which have been kaolinitized in the course of the mineralization in this prospect.