No. 34

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

CONSOLIDATED REPORT

MARCH, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

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

The survey was carried out for three years from September 1993 to January 1996 and was brought to completion with the cooperation of the Government of the Philippines, in particular, the Mines and Geosciences Bureau (MGB), the Department of Environment and Natural Resources.

This final report summarized the results of Phase I, Phase II and Phase III surveys in the Catanduanes area.

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 with the Government of the Philippines for the close cooperation they extended to the team.

January 1996

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo Kiyotaki
President
Metal Mining Agency of Japan

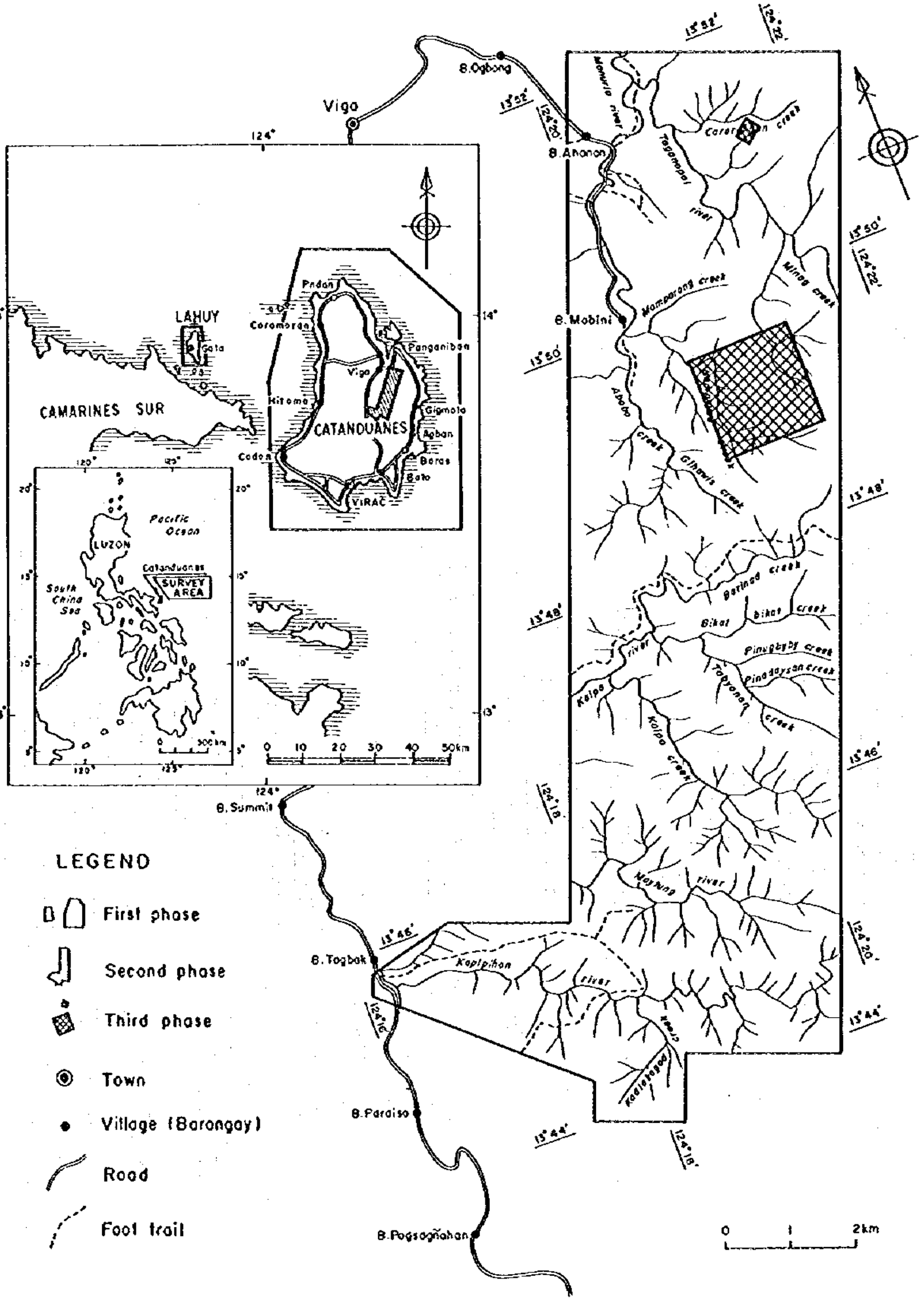

Fig. 1 Locations of the Survey Areas

SUMMARY

This survey corresponds to the Cooperative Mineral Exploration in Catanduanes Area, the Republic of the Philippines. The survey area is situated in Catanduanes Island and Lahuy Island. The objective of the survey is to evaluate the potential of gold and copper in the area.

The geology of this area is classified as the Bicol district in the Philippine Islands. The district is underlain by greenschist, ultramafic rocks, meta-volcanic rocks, pyroclastic rocks of Cretaceous and early Tertiary ages. Sedimentary and volcanic rocks of Oligocene to Miocene age overlie those rocks. The thrust faults in the area are parallel to the Philippine Trench, and dip to the southwest. The results of the survey are as follows;

1. Catanduanes Island

The First Phase Survey resulted in picking out Carorongan Area, East of Bato Area, Dugui Too Area and East of Bato River Area as the promising areas.

The Second Phase Survey was focused at Carorongan Area from the results of the First Phase Survey. Based on the results, the following areas were chosen as the potential areas for gold mineralization; Carorongan Mineral Occurrence, Taganopol Mineral Occurrence, Ananon North Area, Kadlakogod Area and Kampayas Area.

Based on the results of the past two years, trenching and drilling surveys for Carorongan Area and a detailed geochemical survey for Kampayas Area were carried out in the Third Phase Survey. The results of these surveys were as follows;

(1) Carorongan Area

It seems that the ore deposits recognized in Carorongan Area is sub-economical to develop at present because the deposits are slightly low gold grade as a whole and of limited size particularly concerning the high gold portions. It is notable, however, that the gold contents of metagabbro tend to be more than 0.1 g/t where the metagabbro was altered. Therefore, Carorongan Area and its vicinity must have a huge gold potential.

(2) Kampayas Area

The highest gold potential areas are believed to be near the ridge of peak 379 m and at the intersections of NNE-SSW and E-W oriented faults. In particular, the site for forming a gold deposit is preferable at the above-mentioned intersections of the faults because the big quartz veins of about 20 cm (0.3 g/t Au) to 1 m in width and geochemical high gold anomalies are observed near the intersections. Therefore, we recommend to continue the additional surveys such as a geophysical survey and/or a drilling survey.

Moreover, it is proposed that the geological and geochemical detailed surveys be conducted in the eastern extension of Carorongan Area and Kampayas Area because the geochemical high gold anomalies extend to the area.

2. Lahuy Island

The soil geochemical survey for the whole island area, the soil and rock geochemical surveys for the detailed survey area were conducted in parallel with the geological survey in the First Phase Survey. The results of these surveys were as follows;

A significant indication appears at the known mineral occurrences in the detailed survey area. The results suggest that a gold bearing sulfide copper, lead and zinc mineralization occurred there. It is supposed, however, that ores, if exist, would be sit in fairly deep underground, and the invasion of sea water in the mining site would be occurred due to the close location to the sea.

In the geochemical survey for the whole island, the anomalies that were similar to the detailed survey area were found at the East of the detailed survey area, the Southwest of the Gogon and the southern end of the island. The analyzed values, however, are low in content and the anomalies are not so strong as to indicate the existence of the deposit at the workable shallow depth.

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PART I GENERAL REMARKS

PART I GENERAL REMARKS

Chapter 1 Introduction

1-1 Area and Objective of the Survey

Japanese Government carried out the Cooperative Mineral Resources Exploration which was programmed to be conducted from 1993 in Catanduanes Area. The survey area is situated in Catanduanes Island, Catanduanes Province, and Lahuy Island, Camarines Sur Province, in Bicol Region (Fig. 1).

Catanduanes Island is situated in the northeast offshore area of the Bicol peninsula in an oval shape, 60 kilometers (km) north to south and 30 km east to west, an area of 1,550 km^2.

Lahuy Island is situated in the northeast offshore area of the Bicol peninsula in a narrowly elongated shape, 9 km north to south and 4 km east to west, an area of 20.1 km^2.

The objective of this project is to discover new ore deposits of gold, copper and other useful minerals through the studies of the geology, geological structure, mineralization and geochemical characteristics in the area.

1-2 Methodology and Contents of the Survey

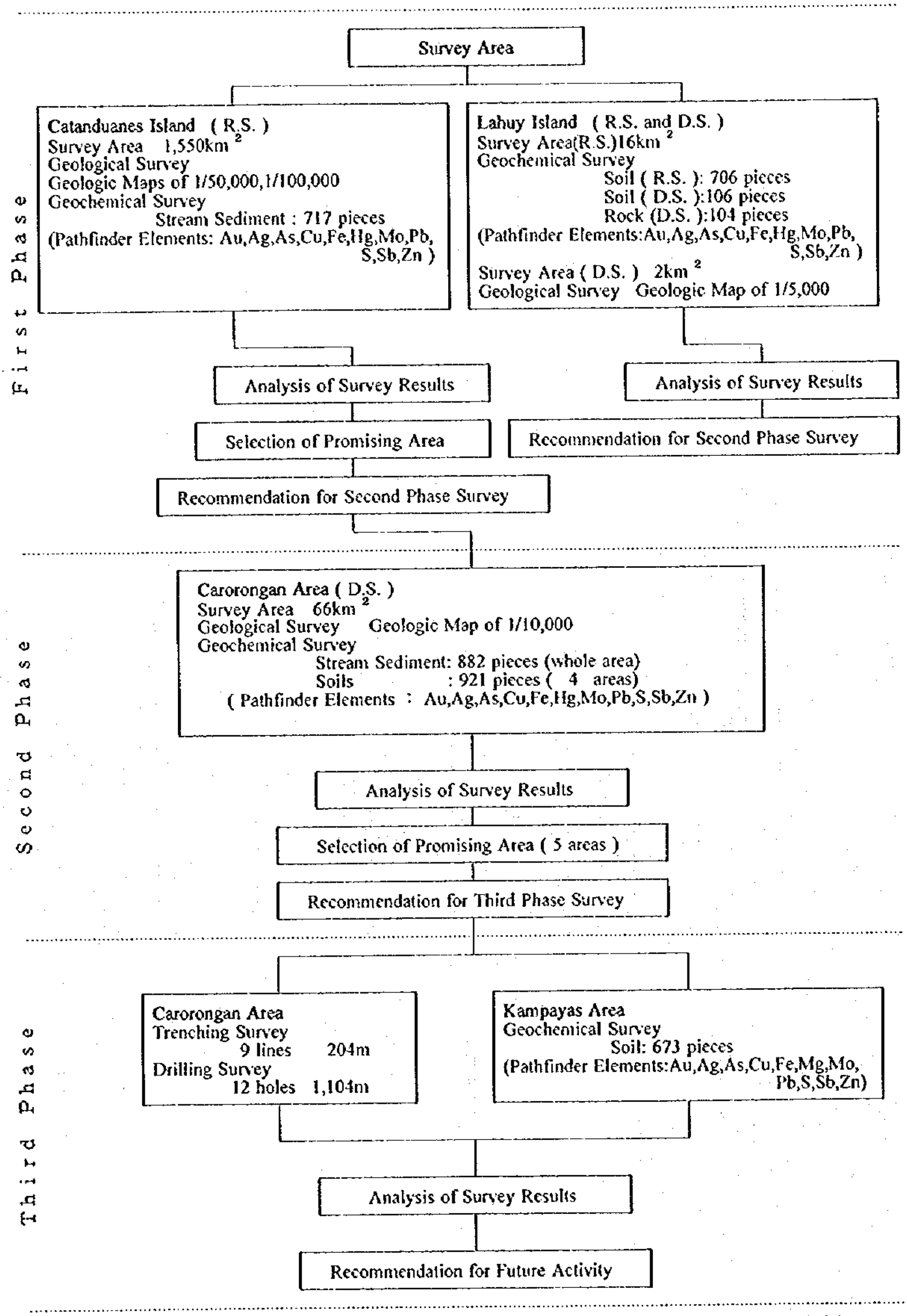
The preliminary surveys consisting of geological and geochemical surveys for the whole area of Catanduanes Island and Lahuy Island were conducted in the First Phase Survey. In the Second Phase Survey the detailed geological and geochemical surveys were carried out at Carorongan Area based on the results of the First Phase Survey. Based on the results of the past two years of surveys, trenching and drilling surveys for Carorongan Area and a detailed geochemical survey for Kampayas Area were conducted in the Third Phase Survey.

The flow chart of the survey process and evaluation process were shown in Fig. 2 and Fig. 3. The contents of the surveys and the quantities of these works in each year are set forth in the following (Table 1).

1-2-1 The First Phase Survey in 1993

(1) Catanduanes Island (Survey Area: 1,550 km^2)

Geological Survey: A regional geological survey was made in parallel with the collection of geochemical samples. The results were summarized in the geologic maps on



R.S.:Reconnaissance Survey D.S.:Detailed Survey

Fig. 2 Flow Chart of the Exploration Program

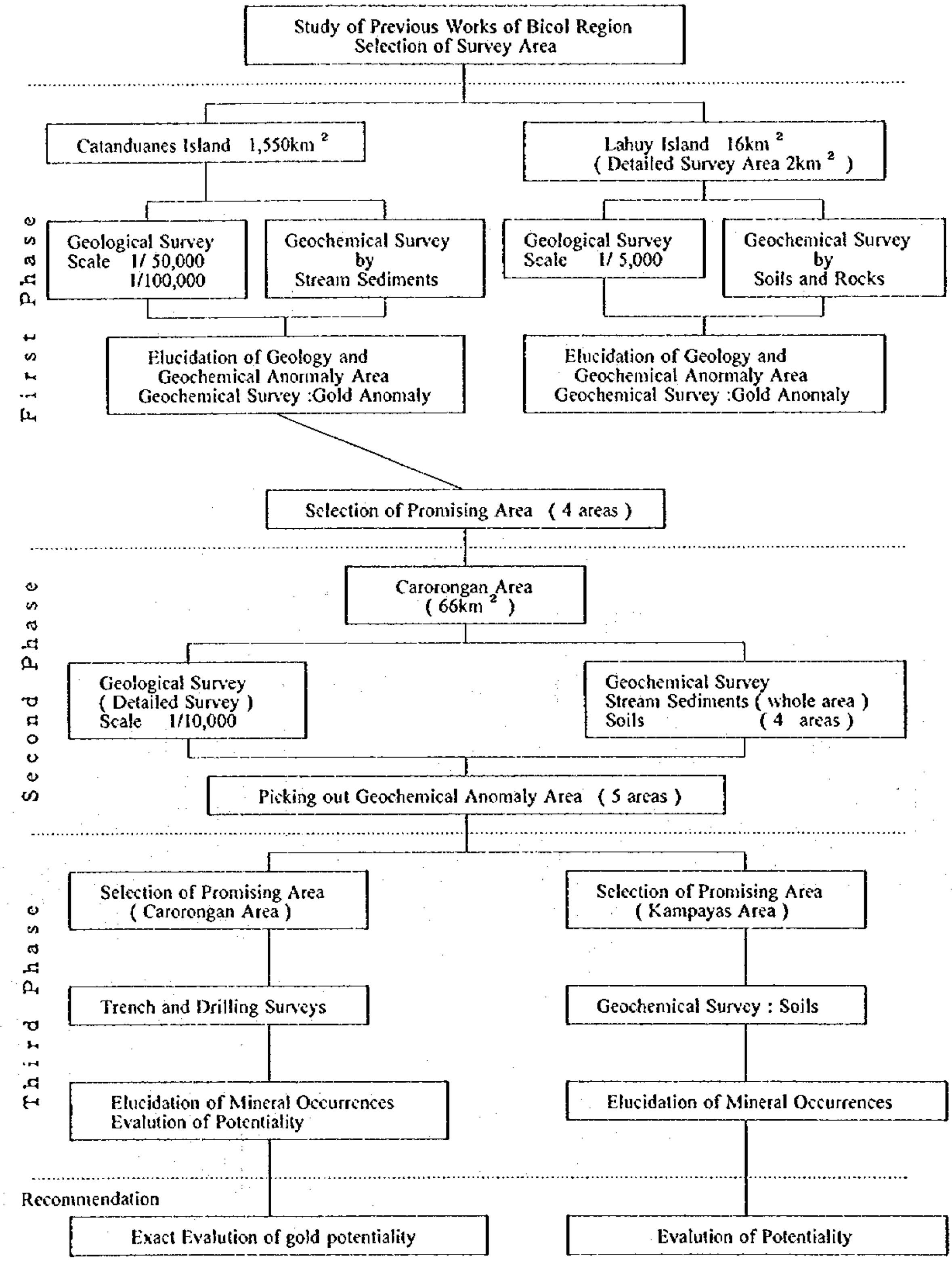


Fig. 3 Flow Chart of the Selecting Promising Area

Table 1 Contents of the Survey

Item \ Years			Phase I (1993)			Phase II (1994)	Phase III (1995)		
Kind of Survey			Geological Survey Geochemical Prospecting			Detailed Geochemical Survey Geochemical Prospecting	Detailed Geochemical Survey Drilling Survey		
Areas (km²) and Quantities			A:Catanduanes Island 1,550km² B:Lahuy Island 16km²			Catanduanes Island 66km²	Carorongan area Trenching 9 lines 204 m Drilling 12 holes 1099 m	Kampayas area 2.6km²	total
			A	B	total				
Indoor test		Thin section	31	–	31	–	1	9	10
Indoor test		Polish	10	22	32	44	39	13	52
Indoor test		X-ray diffraction	–	53	53	106	58	21	79
Indoor test		K-Ar dating	6	4	10	6	–	3	3
Indoor test		EPMA	–	–	–	–	11	2	13
Indoor test		RES* and FE*	–	24	24	31	–	–	–
Indoor test		Homogenization temp.	–	23	23	31	34	6	40
Indoor test	Chemical analysis	Stream sed.	717	–	717	882	–	–	–
Indoor test	Chemical analysis	Components for analysis	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn			Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn			
Indoor test	Chemical analysis	Soil samples	–	812	812	921	–	673	673
Indoor test	Chemical analysis	Components for analysis	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn			Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn	Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn		
Indoor test	Chemical analysis	REE samples	–	–	–	11	9	3	12
Indoor test	Chemical analysis	Components for analysis				Ba,Ce,Dy,Er,Eu,Gd,Ho,La,Lu,Nb,Nd,Pr,Rb,Sm,Sr,Tb,Tm,Y,Yb,Zr	Ce,Eu,La,Lu,Nb,Sm,Tb,Th,U,Yb		
Indoor test	Chemical analysis	Rock samples	34	104*	138	42	9	8	17
Indoor test	Chemical analysis	Components for analysis	SiO_2,Al_2O_3,CaO,FeO,Fe_2O_3,K_2O,MgO,MnO,Na_2O,P_2O_5,TiO_2,H_2O,LOI, Au,Ag,As,Cu,Hg,Mo,Pb,S,Sb,Zn (*:10 elements after Au)			SiO_2,Al_2O_3,CaO,FeO,Fe_2O_3,K_2O,MgO,MnO,Na_2O,P_2O_5,TiO_2,H_2O,LOI, Au,Ag,As,Cu,Hg,Mo,Pb,S,Sb,Zn	SiO_2,Al_2O_3,CaO,FeO,Fe_2O_3,K_2O,MgO,MnO,Na_2O,P_2O_5,TiO_2,H_2O^+,H_2O^-,LOI Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn		
Indoor test	Chemical analysis	Ore samples	34	21	55	241	541	92	633
Indoor test	Chemical analysis	Components for analysis	Au,Ag,Cu,Fe,Mo,Pb,S,Zn			Au,Ag,As,Cu,Fe,Hg,Mo,Pb,S,Sb,Zn	Au,Ag,Cu,Fe,Mo,Pb,S,Zn		

RES*:Resistivity, FE*:Frequency effect

the scale of 1 to 50,000 or 1 to 100,000.

Geochemical Survey: Selecting drainage systems from the whole survey area so that they are of nearly uniform density, a total of 717 stream sediment samples was collected from the systems and subjected to a chemical analysis. The chemical analysis of the stream sediments was for the 11 pathfinder elements. The chemical data were statistically processed (Monovariant and Multivariant Analyses), and the geochemical anomaly maps were drawn. Finally, the promising areas were selected based on the results of the geochemical survey.

(2) Lahuy Island (Survey Area: 20.1 km²)

Geological Survey: A regional geological survey was made in parallel with the collection of geochemical samples. The results were summarized in the geologic map on the scale of 1 to 50,000. The detailed geological survey was also performed at the known mineral occurrences in Lahuy Island in parallel with rock and soil geochemical surveys. The results were summarized in the geologic map on the scale of 1 to 5,000.

Geochemical Survey: The soil geochemical survey for the whole island area, the soil and rock geochemical surveys for the detailed survey area were conducted. A total of 916 (soil: 812, rock: 104) samples was collected and subjected to the chemical analysis. The chemical data were analyzed by the same method as Catanduanes Island.

1-2-2 The Second Phase Survey in 1994

The Second Phase Survey was focused at Carorongan Area on the results of the First Phase Survey. The survey area covered 66 km².

Geological Survey: A detailed geological survey was carried out at Carorongan Area. The results were summarized in the geologic map on the scale of 1 to 10,000.

Geochemical Survey: A geochemical survey by stream sediments was conducted at Carorongan Area in parallel with the geological survey. A total of 882 stream sediment samples was collected and subjected to the chemical analysis. The chemical analysis of the stream sediments was for the 11 pathfinder elements. The chemical data were statistically processed (Monovariant and Multivariant Analyses), and the geochemical anomaly maps were drawn. The promising areas were selected based on the results. Moreover, the detailed soil geochemical surveys were conducted for the four potential areas which were selected by the geological survey; Carorongan Mineral Occurrence, Taganopol Mineral Occurrence, Tagbak Area and Barinad Area. A total of 921 soil samples was collected and subjected to the chemical analysis. The chemical data were analyzed by the same method as the above-mentioned surveys.

1-2-3 The Third Phase Survey in 1995

The Third Phase Survey was focused at Carorongan Area and Kampayas Area based on the results of the past two years of surveys.

Trenching Survey: The survey was carried out at Carorongan Mineral Occurrence to verify the extension and the grade of the mineralized outcrops. Total length of the trenches was 204m and the trenches were dug at 9 places. The results were summarized in trench maps on the scale of 1 to 100.

Drilling Survey: The survey was carried out at Carorongan Mineral Occurrence to explore and assess the mineralization zones. The survey was undertaken by conducting the exploratory drillings in 12 holes on five sites totaling 1,104 m. The results were summarized in geologic columns on the scale of 1 to 200.

Geochemical Survey: The survey was executed in Kampayas Area to determine the geochemical anomalies through analyses of soil samples in order to assess the potential of the area and to select the prospective areas. A total of 673 soil samples was collected and subjected to the chemical analysis. The chemical data were analyzed by the same method as the above-mentioned surveys.

In each year' s survey microscopic observation, X-ray powder diffraction analysis, measurement of homogenization temperature of fluid inclusions, K-Ar dating, measurement of resistivity and polarization, EPMA and chemical analyses were carried out to verify the geological setting and mineralization as shown in Table 1.

1-3 Period and Members of the Survey

1-3-1 The First Phase Survey in 1993

(a) Period of the Preliminary Survey: from July 19 to July 23, 1993
Period of the Field Survey: from September 14 to December 7, 1993

(b) Members of the Mission

Planning and Negotiation of Agreement

Japan

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

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Planning and Coordination

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Testuo Suzuki	MMAJ, Manila

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Edwin G. Domingo	do.
Romeo L. Almeda	do.

Geological and Geochemical Surveys

Japan

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Yasunori Ito	do.
Hirohisa Horiuchi	do.

Philippines

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

1-3-2 The Second Phase Survey in 1994

(a) Period of the Field Survey: from July 18 to October 2, 1994

(b) Members of the Mission

Planning and Coordination

Japan

Jiro Oosako	MMAJ
Toyo Miyauchi	MMAJ
Nobuyasu Nishikawa	MMAJ
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Philippines

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

Geological and Geochemical Surveys

Japan

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Dr. Hiroyuki Takahata	do.
Yasunori Ito	do.
Hirohisa Horiuchi	do.
Shoichi Machida	do.

Philippines

Alvin M. Matos	MGB
Eleazar C. Mantaring	do.
Dr. Sevillo D. David Jr.	do.
Emmanuel Santos	do.
Brian Esber	do.
Diosdado R. Dizon	do.

1-3-3 The Third Phase Survey in 1995

(a) Period of the Field Survey: from July 4 to October 10, 1995

(b) Members of the Mission

Planning and Coordination

Japan

Kenji Nakamura	MMAJ
Nobuyasu Nishikawa	MMAJ
Yuichi Sasaki	MMAJ
Tetsuo Suzuki	MMAJ, Manila

Philippines

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

Trenching, Drilling and Geochemical Surveys

Japan

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Yasunori Ito	do.
Hirohisa Horiuchi	do.
Makoto Miyoshi	do.
Dr. Masanori Furuno	do.

Philippines

Dr. Sevillo D. David Jr.	MGB
Joselito Velasquez	do.
Emmanuel John M. Carranza	do.
Jose Marcel S. Laud	do.

Chapter 2 Geological Information

2-1 Previous Works

Philippine Bureau of Mines, now Mines and Geosciences Bureau (MGB), has been active in preliminary surveys for the 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) described coal resources in 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. They also described the mineral occurrences for coal, copper, gold, manganese, heavy sands, clay, etc., and showed their geologic maps covering the whole island area. MGB (1982 a) noted their geologic map and mineral occurrences in the island based on the Miranda and Vargas (1967). MGB (1982 b) described the geology and mineral occurrences of the island in comparison with the surrounding area, based on the priory mentioned reports.

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

Rangin et al.(1988), in his report of the Bicol district, described the results of age determination made on the intrusive rocks of Catanduanes Island.

David Jr. (1994) stated the stratigraphy, geochemistry, age and geological structure of Catanduanes Island.

In Lahuy Island, a gold mining by Pan Philippine Corp. was active at Gata and Campo Mineral Occurrences in Gata Village before the second world war. The mineral occurrences were reported by MGB and Rajah Lahuy Mining Company. Torres (1978) performed a survey of the adit tunneled by Pan Philippine Corp., and reported its results, then described the geology and ore deposits in Gata. A geologic map of Gibgos Area on the scale of 1 to 50,000 (MGB, 1985) covering the survey area is available.

2-2 General Geology

Catanduanes Area is geologically classified as the Bicol district in the Philippine Islands. The district is underlain by greenschist, ultramafic rocks, meta-volcanic rocks, pyroclastic rocks of Cretaceous and early Tertiary ages, and characterized by thrust slices of limestones. Sedimentary and volcanic rocks of Oligocene to Miocene age overlie those rocks. The thrust faults in the area are parallel to the Philippine Trench, and dip to the southwest (MMAJ,1992). The geological setting of Catanduanes Island is said to be similar to that of the Caramoan peninsula.

The geology of Catanduanes Island is composed of the Pre-Cretaceous or Cretaceous Catanduanes Formation, the Cretaceous Yop Formation and the Bonagbonag Limestone, the Eocene Payo Formation, the Miocene Buti Hill Limestone and the San Vicente Formation, the Miocene to Pliocene Sto. Domingo Formation, and the Pleistocene Viga Conglomerate (MGB, 1983 a, b, c, d, e, f, g). These volcano-sedimentary rocks are cut by dolerite and gabbro of Cretaceous ages and by andesite porphyry and diorite of Oligocene Batalay Intrusives. Catanduanes Island is divided into three thrust slices by two thrust faults extending east to west (E-W) and west-northwest to east-southeast (WNW-ESE).

The geology of Lahuy Island consists of the Cretaceous Lahuy Formation. The Lahuy Formation is mainly composed of andesitic volcanic rocks with tuffaceous sandstone, shale and conglomerate. An andesitic intrusive body, extending northeast to southwest (NE-SW) exists at Tila Point to Panique Point, thought to be an ore bringer in the area.

Chapter 3 Situation of Survey Area

3-1 Location and Accessibility

The survey area is situated in the northeast offshore area of the Bicol peninsula, the Republic of the Philippines. Catanduanes Island 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' to 123° 51' east in longitude, 13° 53' to 13° 59' north in latitude.

To reach Catanduanes Island, it takes about one hour from Manila to Legazpi by plane, another one hour from Legazpi to Tabaco by car, and about four hours from Tabaco to Virac, the capital town of Catanduanes, by ferry boat. Flight service from Manila to Virac is available once a day, and from Legazpi to Virac two flights a week.

The Provincial Government is active in the development of road systems in the island, and the system is in good condition at present. There exist peripheral-coastal roads and across-island roads throughout the province. The survey area is accessible through a principal road running in north-south direction interconnecting Virac and Viga.

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

3-2 Environment of the Survey Area

3-2-1 Topography

Catanduanes Island is 60 km north to south and 30 km east to west in size, having an area of 1,550 km² including Panay and Plumbanes Islands, and the twelfth largest island in the Philippines. The island is topographically divided into four areas; northern, western and eastern mountain areas, and southern lowland area. Topography of the mountain areas is generally rugged, having deep V-shape valleys and many falls. The lowland area occupies quite a small area, about 7 percent of the total area.

The coastal lines in the East and West make clear contrast, complex in the East and smooth in the West.

Lahuy Island is 9 km north to south and 4 km east to west in size, having an area of 20.1 km². Topography of the island is characterized by a ridge stretching north to south. The eastern side of the ridge is relatively gentle, but the western side is rugged to the coast lines.

3-2-2 Climate

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

The average annual rainfall in Catanduanes Island from 1984 to 1991 is 2,500 millimeters (mm), and monthly average is 204.1 mm (Table 2). It is rainy season from October to December, and average monthly rainfall from 1984 to 1991 is 412.3 mm in

October, 401.1 mm in November, and 333.2 mm in December (Table 3). Fig. 4 shows the variation of average monthly rainfall 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

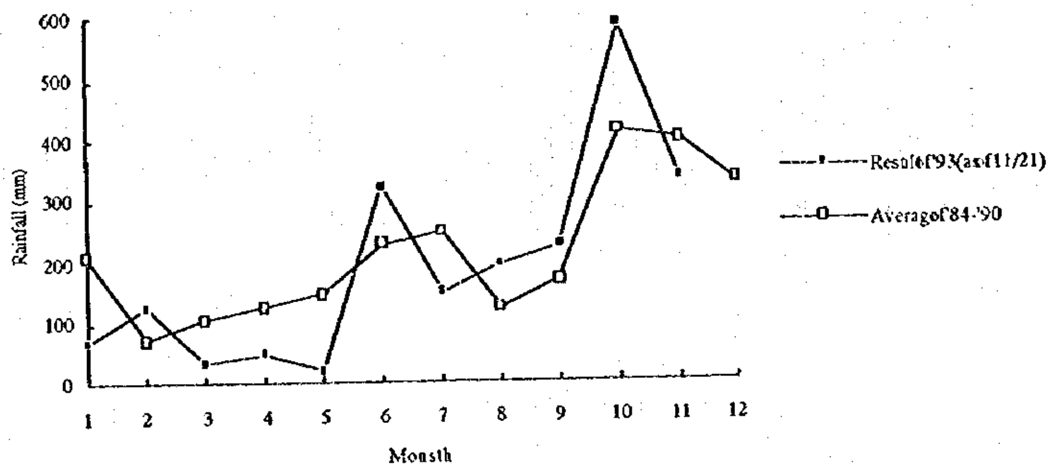
Unit is in mm

Table 3 Average Monthly Rainfall in Catanduanes Island (1984-1990)

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. Unit is in mm

Fig. 4 Variation of Average Monthly Rainfall in Catanduanes Island

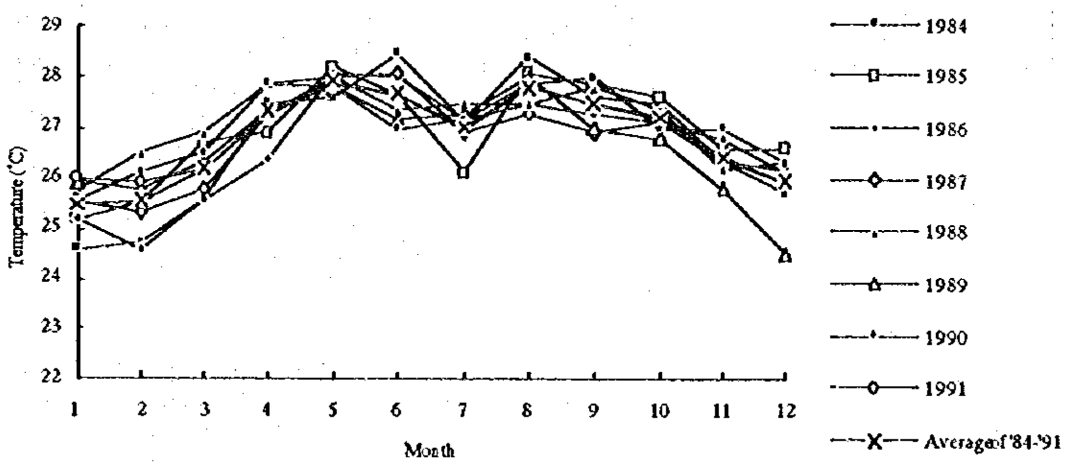


Temperature varies a little through a year, being 26°C in annual average. Table 4 shows the average monthly temperatures and Fig. 5 shows their diagram. The average annual humidity is 80 percent.

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

Fig. 5 Variation of Average Monthly Temperature in Catanduanes Island



3-2-3 Vegetation

The highland area of Catanduanes Island is covered by typical tropical rain forest, which occupies 46 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 broadleaf 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 at the mineral occurrences in Gata, and gossan is seen in striped lands. Gentle slopes are utilized for agriculture.

3-2-4 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, San Andres, Caramoran, Viga, Pandan, Bato, San Miguel, Bagamanoc, Baras, Gigmoto and Panganiban. 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, colleges, airport, harbor, etc.. The city is the entrance of the island.

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 is composed of Gata, Oring, Daraga and Gogon. 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 where our base camp was set up, however, it is difficult to get daily commodity. No electricity and water supply facilities are available. Circumstance 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., and that small scale mining for gold in Gata and Campo Mineral Occurrences in the western island are in operation by local people.

3-2-5 Brief Mining History of the Survey Area

(1) Catanduanes Island

Many mineral occurrences of gold, copper, heavy sands, manganese, limestone, phosphate, clay, etc. are known in the island. 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. The mineral occurrences actively operated in the past are Agban, Carorongan, Dugui Too, etc. which are of gold and copper.

Significant mining activity in the island was an exploration program by a local mining company, Canardico and Boliden Company of Swedish. 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 Batalay Intrusives.

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, 1951b and 1952; Crispin, 1955).

(2) Lahuy Island

An extensive gold mining operation was conducted by an American capital company, Pan Philippine Corp. at the mineral occurrences in Gata from 1939 to the time before starting the second world war.

The prussic acid processing plant was 200 tons per day in capacity in 1940. The ore reserves was 43,953 tons. The ore grade was 13.5 grams per tone (g/t) in 1941. The mining facilities in the area were moved to Lapulapu Island by Japanese during the war (Torres, 1978). An American capital company came in the area from 1983 to 1984 again, and performed a drilling program consisting of drill holes and trenches, but the company withdrew from the activity. An Australian capital, Island Arc Company, performed a drilling program consisting of 15 drill holes in during 1987 and 1988, however, it is said that the ore grade is high but the scale is not big enough then.

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

PART II DETAILED DESCRIPTION

PART II DETAILED DESCRIPTION

Chapter 1 Regional Geology

The Philippines can be geologically divided into two areas; the stable terrain in southwestern Philippines from Palawan to 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 oceanic plates from the east and the west. The Philippine Fault runs in the central zone of the belt stretching north-northwest to south-southeast (NNW-SSE), left lateral in movement.

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

The activities of dioritic to granitic intrusives in the Philippines are classified into three ages; pre-Tertiary, Paleogene and Neogene. The Cretaceous to Paleogene and Neogene activities are supposed to be closely associated with mineralization.

There are five important gold areas in the Philippines, i.e. Baguio, Paracale, Masbate, Surigao and Masara, which are concentrated along the Philippine Fault (Fig. 6). Mitchell and Balce (1990), however, reported that there is no relation between the distribution of the hydrothermal deposits and the Philippine Fault.

Catanduanes Area is situated in a position a little apart from the Philippine Fault. It is, however, in an area for igneous activities in Cretaceous and Paleogene ages, and geologically continues the Caramoan peninsula which is known as gold and copper mineralization areas. It is, accordingly, judged that this area is of high potential for gold and copper. Aside from gold and copper, mineral occurrences of manganese, heavy sands, clay, coal and phosphate are known in the island.

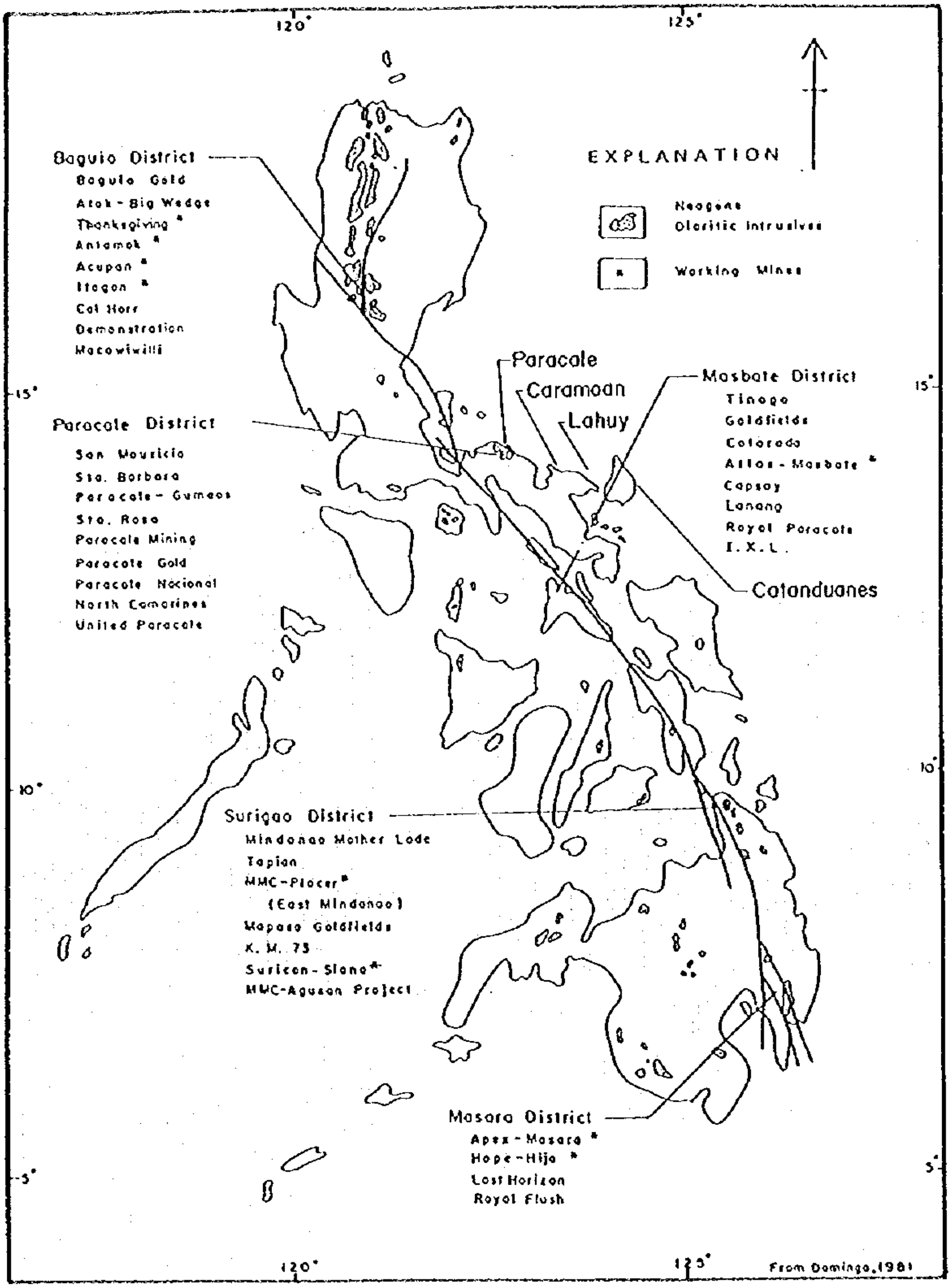


Fig. 6 Gold Districts of the Philippines

Chapter 2 Catanduanes Island

2-1 Geology

2-1-1 Outline of Geology and Geologic Structure

The geology of Catanduanes Island is characterized by two thrust faults, extending E-W and WNW-ESE, and the land is divided into three blocks; northern, central, and southern blocks.

Each block is composed of the pre-Cretaceous or Cretaceous Catanduanes Formation consisting of meta-sedimentary rocks, the Cretaceous Yop Formation consisting of basaltic volcanic rocks and conformably overlying or interfingering the Bonagbonag Limestone, the Eocene Payo Formation consisting of sandstone, conglomerate, limestone, etc., the Miocene Buti Hill Limestone and the San Vicente Formation consisting of conglomerate, the Miocene to Pliocene Sto. Domingo Formation and the Pleistocene Viga Formation consisting of conglomerate (MGB,1983 a, b, c, d, e, f, g). These rocks are cut by dolerite and gabbro of Cretaceous ages and by andesite porphyry and diorite of Oligocene Batalay Intrusives.

The geologic map of Catanduanes Island, the geologic map of the Second Phase Survey and the stratigraphic classification of Catanduanes Island were shown in Fig. 7, Fig. 8 and Fig. 9, respectively.

(1) Northern Block; The northern block corresponds to the northern area of the thrust fault which has run from Datag to Panganiban, and is widely underlain by the Yop and Payo Formations.

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 the 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 E-W trending thrust fault, and the thrust fault shows steep cliffs dipping to the north. The block is underlain by the Catanduanes Formation, unconformably overlying the Yop Formation and further unconformably overlying the Payo Formation, and shows a rugged mountainous feature.

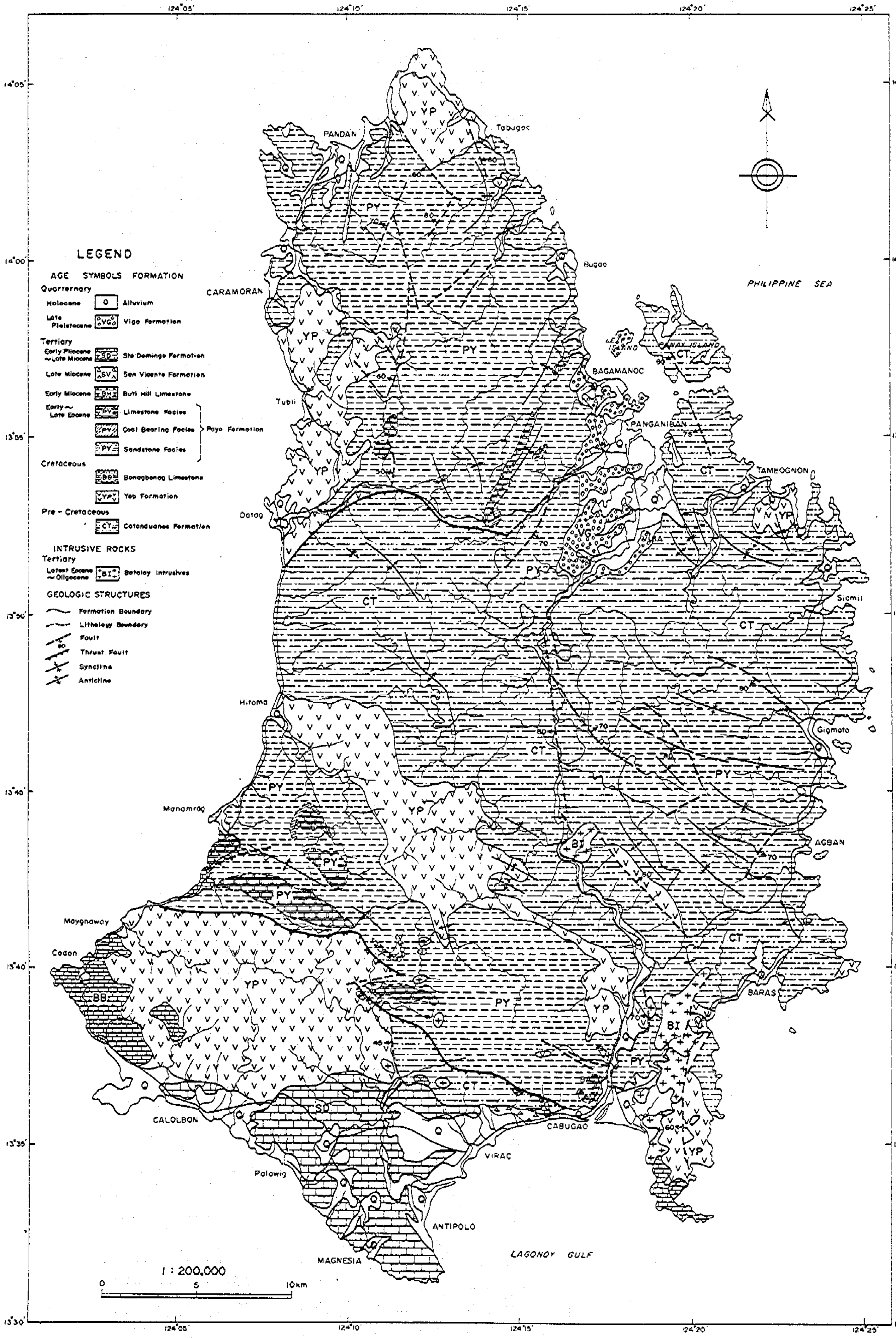


Fig. 7 Geologic Map of Catanduanes Island

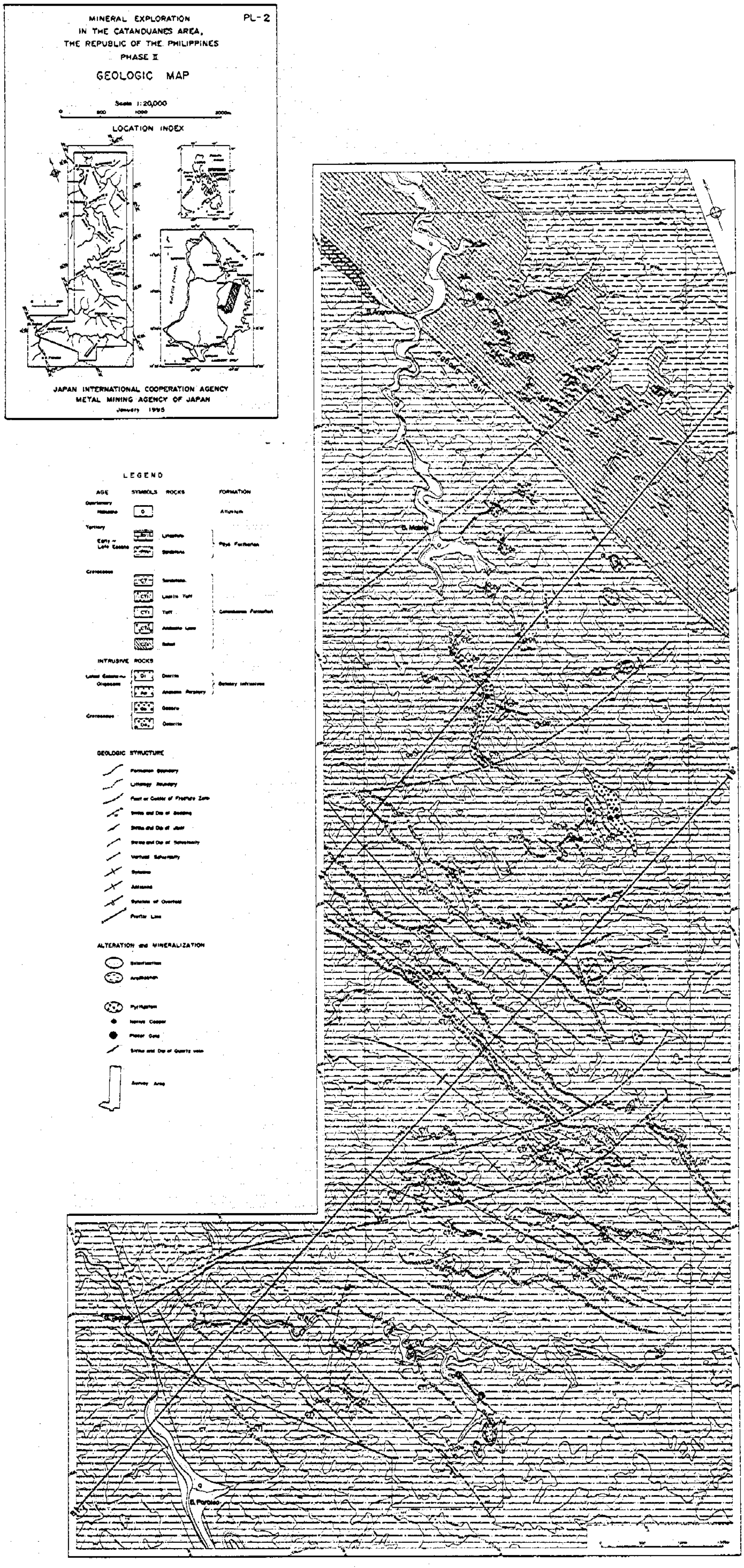


Fig. 8 Geologic Map of the Second Phase Survey

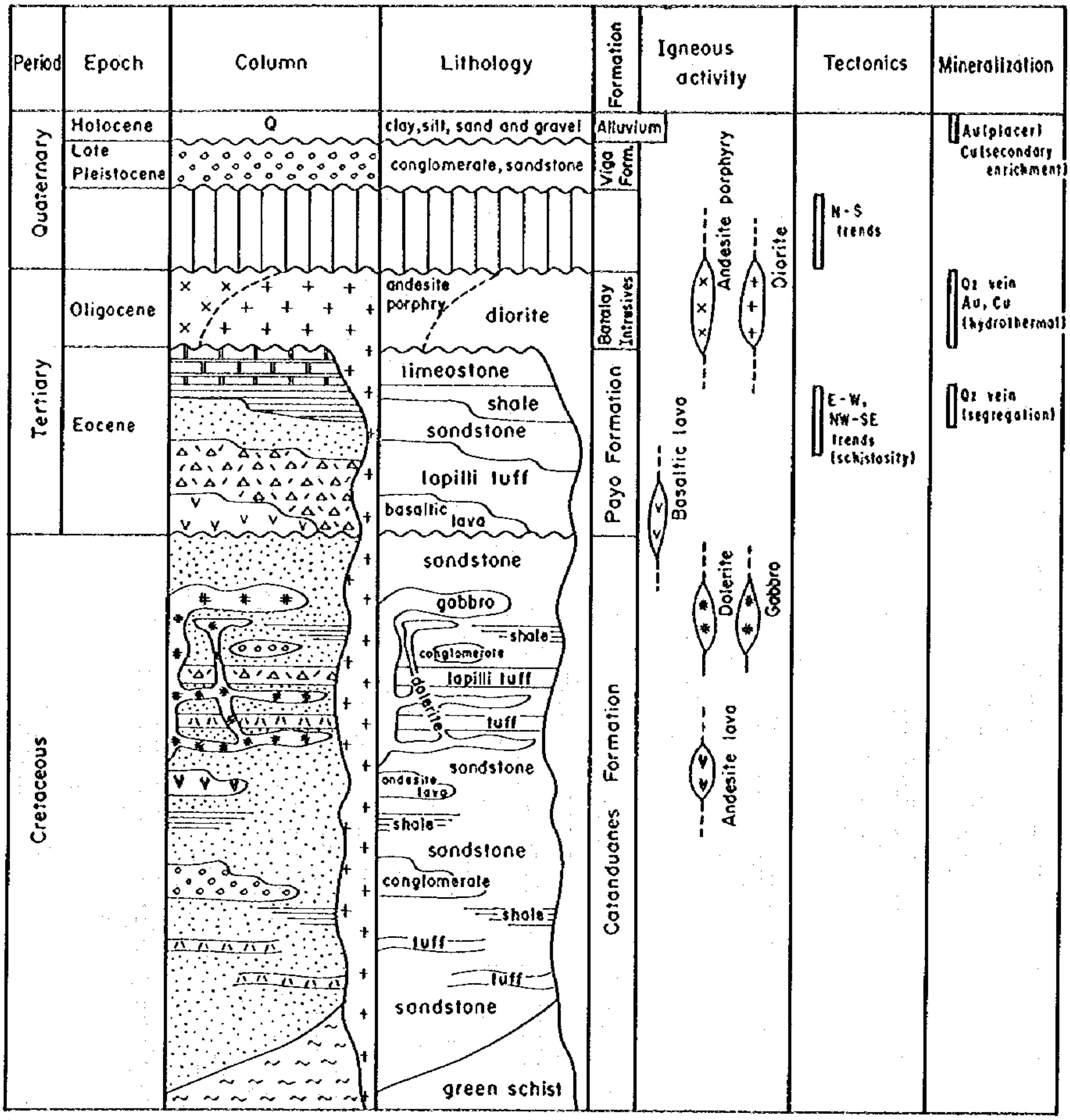


Fig. 9 Stratigraphic Classification of Catanduanes Island

The Catanduanes Formation is widely distributed in the northern 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 km east of 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 geological structure is very complex. It has been intruded by Batalay Intrusives in the southeastern part.

The Yop Formation is distributed in an area between Hitoma and San Miguel, stretching northwest to southeast (NW-SE) and unconformably overlies the Catanduanes Formation. It is also distributed in an area about 4 km east of Bato River between Kilikilihan and Siai and at Buena Vista in the northeastern part and unconformably overlies 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 NW-SE and unconformably overlies the Yop Formation. It is also distributed in the eastern mountainous area and unconformably overlies the Catanduanes Formation. It has been intruded by Batalay Intrusives in the southeastern part. The geologic structure of the block is generally controlled by a folding system which has an axis stretching northwest to southeast.

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 and unconformably overlies the Yop Formation and the Bonagbonag Limestone.

(3) Southern Block; The southern block has been thrust over the central block by the WNW-ESE trending thrust fault which has run from Maygnaway to Cabugao. The block is underlain by the Catanduanes, Yop, Payo, and Sto. Domingo Formations.

The Catanduanes Formation has in fault contact with the Yop Formation, and is distributed at the East of Dugui Too.

The Yop Formation is in fault contact with the Payo Formation in the central block through the thrust fault. The Bonagbonag Limestone conformably overlies or interfingers with the Yop Formation in this block.

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

The Cretaceous basic intrusives of dolerite to gabbro which were clarified in the Second Phase Survey may form a Ophiolitic Sequence with the basaltic volcanic rocks of the Yop Formation. Besides David Jr. (1994) asserted that the Yop Formation was in an interfinger relation with the Catanduanes Formation. Therefore, after the Second Phase Survey the Yop Formation has been included in the Catanduanes Formation.

2-1-2 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 stratigraphically possible to separate the Agban Phyllite from Cabugao Sub-greywacke.

The formation is stratigraphically situated in the bottom in the area, and comprising 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 in fault contact with the Yop Formation. The whole area of Panay Island situated to the northeast of Catanduanes Island is underlain by 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. On the other hand, David Jr. (1994) asserted that the Yop Formation was in an interfinger relation with the Catanduanes Formation. No fossil has been found from the formation, therefore some doubt exists on the age of the formation.

(2) Yop Formation; The name of Yop Volcanic Rocks was named by Capistrano (1951a) for the volcanic rocks distributed at 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 unconformably overlies the Catanduanes Formation, and is conformably overlain or interfingered 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.

This formation is mainly composed of sub-marine basaltic to andesitic lavas, tuff and tuffaceous breccia with arkose sandstone, tuffaceous sandstone and chert. The formation contains low grade manganese ores.

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. Moreover, the Cretaceous basic intrusives of dolerite to gabbro which were clarified in the Second Phase Survey may form a Ophiolitic Sequence with the basaltic volcanic rocks of the Yop Formation.

(3) Bonagbonag Limestone; Santos 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) also followed this name.

The limestone 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 widely distributed near the type locality of Bonagbonag, and in small areas in an upstream area of Comagaycay River, in an area near Hilawan and in an area near Danicop.

MGB (1982 b) reported that a fossil (Orbitolina?) which indicates early Cretaceous in age and was found from the lower part of the formation, Globotruncana which indicates late Cretaceous in age and was found from the upper part of the formation. Capistrano (1951a) estimated the thickness of the formation to 300 meters.

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

The Payo Formation is composed of three members; the Cabugao Member (Cabugao Sub-greywacke), the Hitoma-Payo Coal-bearing Member (Hitoma-Payo Coal Measure) and the Sipi Limestone Member, and distributed in large areas of the northern block and partly in the central block stretching WNW-ESE on the south of the Yop Formation area. It is also distributed in the eastern mountainous area of the central block, where it unconformably overlies 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.

(5) Buti Hill Limestone; The Buti Hill Limestone was designated by Miranda and Vargas (1967) to coral-bearing limestones cropping out at Buti Hill, the Northwest of Nagumbuaya Point.

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

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

(6) San Vicente Formation; Miranda and Vargas (1967) named the conglomerate and sandstone cropping out in the San Vicente, 3 km east of Virac, the "San Vicente Conglomerate". MGB (1983 a, b) renamed it the San Vicente Formation in the geologic map on the scale of 1 to 50,000.

Miranda and Vargas (1967) and MGB (1983b) reported an area which was underlain by the San Vicente Formation at Cabcab, the West of Calolbon.

The formation generally occurs as a discontinuous lens shape and contains pebbles of diorite, 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 estimated 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.

(7) 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.

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

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

The formation unconformably overlies the Payo and Catanduanes Formations.

Miranda and Vargas (1967), and MGB's geologic map on the scale of 1 to 50,000 defined the formation as of the late Pleistocene in age.

(9) Alluvium; The alluvial in the island is distributed along main rivers and coastal zones, comprising unconsolidated gravel, sands, silt and clay.

(10) Cretaceous Intrusives; These intrusive rocks were discovered anew in the Second Phase Survey. Based on the K-Ar Dating, these rocks were found to be in the Cretaceous age, ranging from 95.35±5.7 Ma (HR-028) to 82.85±2.6 Ma (ER-120).

These rocks are distributed on a large scale in the basins of Abobo Creek and Barinad Creek. The main lithofacies are formed of dolerite to gabbro. These rocks have not caused thermal metamorphism, hydrothermal alteration or skarnization to their surroundings. They have, however, undergone sericitization, chloritization and epidotization and appear greenish gray in color like the graywacke of the Catanduanes Formation near Barinad Creek. In addition, they can hardly be distinguished from Batalay Intrusives in the field.

The results of the chemical analysis of these rocks indicated the basic composition that the contents of SiO_2 yielded 46.40 % (ER-120) and 45.80 % (HR-028).

(11) Batalay Intrusives; Miranda and Vargas (1967) indicated that the intrusives distributed in and around Bato in the South of Catanduanes Island were diversified in the aspects of composition and texture such as diorite, andesite and dacite, then called them "Batalay Intrusives" collectively.

The lithofacies are composed of medium to coarse grained hornblende-biotite diorite, biotite granodiorite, hornblende andesite porphyry, andesite, basalt and aplite, and mainly scattered in the southern island as small intrusive bodies. Miranda and Vargas (1967) asserted that the surrounding rocks of the intrusive bodies have undergone hydrothermal alteration, i.e. pyritization, chloritization, silicification, and epidotization, and it is thought that the sulfide 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 km north to south, 1.5 km east to west. Many gold and copper mineral occurrences, e.g. Agban, Vinticayan Point, Tilod, San Pedro, Libjo, Aroyao and San Miguel, are distributed near Batalay Intrusives.

According to K-Ar Dating, Batalay Intrusives showed almost Oligocene ages ranging from 39.5 ± 0.9 Ma to 26.7 ± 0.6 Ma.

2-1-3 Chemical Composition of Igneous Rocks

The igneous rocks distributed in the survey area are basaltic to andesitic lava in the Catanduanes Formation, dolerite and gabbro of the Cretaceous ages, andesite porphyry and diorite of Batalay Intrusives. In this survey the representative samples of these rocks were subjected to the chemical analyses of major composition and ore (trace) elements. Fig. 10 shows the sampling locations of the representative rocks

ICP-AES method was applied for the assay of the principal oxide components and minor elements, however, FeO was assayed by titration method; gold by the neutron radioactivation analysis, and sulfur by the high frequency furnace combustion method.

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

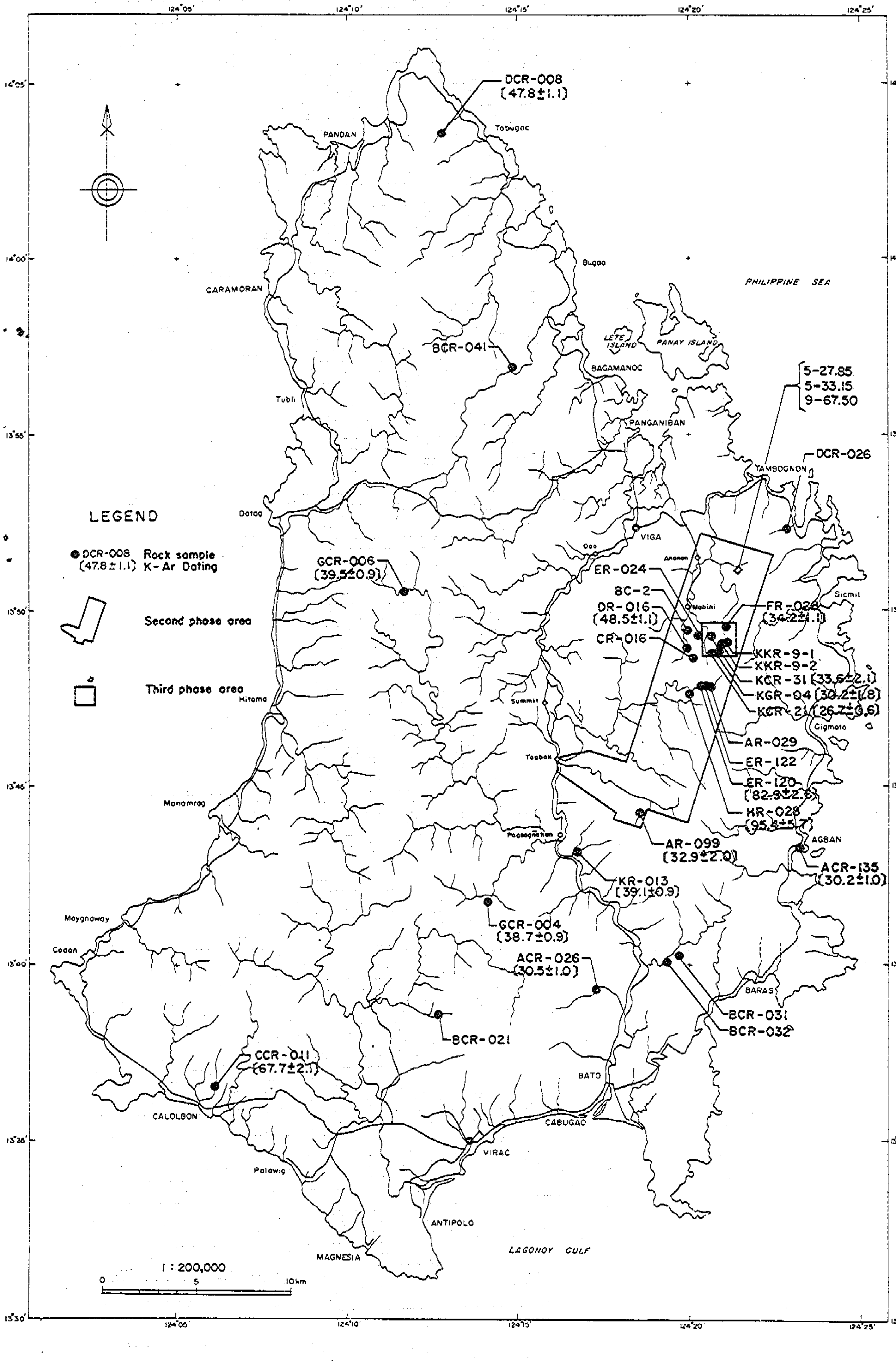


Fig. 10 Sampling Locations of Representative Rocks

(1) Major Composition; The major and trace compositions of igneous rocks were shown in Table 5. TAS (Fig. 11), ACF (Fig. 12) and MFA (Fig. 13) diagrams were used in the data analysis.

The rock type numbers 1, 2, 3, 4, 5, 6, 7 and 8 represent basalt, altered basalt or basic tuff, dolerite, gabbro, gabbro (Batalay Intrusives), metagabbro (Carorongan Area), andesite porphyry (Batalay Intrusives) and diorite (Batalay Intrusives), respectively.

The gabbro (Batalay Intrusives) of No.5 was distinguished from the gabbro of No.4 because both rocks had been differed in the field occurrences and K-Ar dating. Besides the altered basalt or basic tuff of No.2 have been excluded for petrologic discussion because the rock is clastic in nature as it was observed to contain rounded granules of basalt under the microscope.

Basalt: The content of SiO_2 in these rocks ranges from 46.20 % to 55.10 % by weight. TAS diagram indicates the category of basalt to basaltic trachyandesite. Excepting some Fe content rich ones it seems that these rocks belong to the calc-alkaline series in MFA diagram. In ACF diagram, the classification into I-type is found.

Dolerite: The content of SiO_2 in these rocks ranges from 45.80 % to 53.60 %. TAS diagram indicates the category of basalt to trachybasalt. Excepting some iron rich ones it seems that these rocks belong to the calc-alkaline series in MFA diagram. In ACF diagram, the classification into I-type is found.

Gabbro: The content of SiO_2 in these rocks ranges from 41.20 % to 54.60 %. TAS diagram indicates the category of basalt to trachybasalt like dolerite. It seems that these rocks are divided into two types; one is the calc-alkaline rock series and the other is rich in Fe content (the tholeiitic series?) in MFA diagram. In ACF diagram, the classification into I-type is found.

Metagabbro: These rocks are the only igneous rock in Carorongan Area. Because the rocks have strong schistosity similar to greenschist, the rocks were ascribed to as metagabbro in the survey. These rocks yield SiO_2 content ranging from 41.96 to 50.75 %. In TAS diagram, the rocks are in the field ranging from tephrite to trachybasalt. Because these rocks possess medium to coarse grain and holocrystalline texture through microscopic observation, it is inferred to be the above-mentioned gabbro member of Cretaceous ages. These rocks, however, are different from the normal gabbro because they are poor in Mg and rich in Fe. In ACF diagram, most of the metagabbro might be affected by the surrounding

Table 5 Chemical Compositions of Rocks

SAMPLE No.	ACR-026	ACR-135	BCR-021	BCR-032	GCR-006	BCR-031	BCR-041	CCR-011	DCR-008	DCR-026	GCR-004	ER-122	CR-016	DR-016	ER-024
ROCK TYPE	7	8	8	7	5	2	2	4	1	5	1	1	3	3	3
ROCK NAME	And. Po.	Diorite	Diorite	And. Po.	Gabbro	Basaltic T	Alt. Basalt	Gabbro	Basalt	Gabbro	Basalt	Basalt	Dolerite	Dolerite	Dolerite
SiO2	63.40	69.22	65.84	62.60	47.94	48.33	47.54	49.06	50.58	49.80	49.25	49.38	48.24	48.89	48.95
TiO2	0.33	0.25	0.28	0.38	1.26	1.01	0.74	0.80	0.90	1.13	1.01	0.99	1.09	1.11	0.95
Al2O3	18.25	16.23	16.89	16.70	15.87	18.03	13.79	18.10	18.23	17.98	17.56	16.80	17.06	15.91	16.47
Fe2O3	2.27	1.53	1.48	0.73	4.98	5.81	4.92	4.31	4.12	3.28	4.67	5.56	5.25	5.19	4.29
FeO	1.55	1.22	1.38	3.00	6.84	4.77	4.17	5.59	4.55	6.32	5.42	5.42	6.58	6.86	6.44
MnO	0.05	0.04	0.08	0.10	0.23	0.21	0.21	0.19	0.29	0.20	0.21	0.23	0.21	0.24	0.20
MgO	1.60	1.29	1.11	2.39	4.94	3.75	8.11	4.94	4.53	3.52	3.82	4.13	4.67	5.12	4.11
CaO	4.89	3.23	3.49	4.64	7.76	6.32	10.27	7.28	4.82	7.71	7.35	9.05	7.38	6.78	10.23
Na2O	5.15	4.89	5.46	4.15	3.44	4.85	2.75	3.81	4.15	5.01	3.68	3.26	2.71	3.20	3.64
K2O	1.28	2.36	1.13	2.86	2.19	2.21	1.02	2.25	3.74	1.27	2.85	0.79	3.80	3.63	0.75
P2O5	0.14	0.09	0.09	0.11	0.32	0.65	0.17	0.11	0.64	0.27	0.54	0.27	0.32	0.39	0.22
LOI	1.56	0.84	3.10	2.42	2.45	3.10	3.30	2.75	3.52	3.64	2.63	4.11	2.69	2.67	3.73
TOTAL	100.47	101.19	100.33	100.08	98.22	99.04	96.99	99.19	100.07	100.13	98.99	99.99	100.00	99.99	99.98
H2O+	0.92	0.67	1.30	1.48	2.24	2.78	1.61	2.72	2.72	3.28	2.11	4.25	2.65	2.81	3.32
H2O-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.49	0.60	0.25

SAMPLE No.	ACR-026	ACR-135	BCR-021	BCR-032	GCR-006	BCR-031	BCR-041	CCR-011	DCR-008	DCR-026	GCR-004	ER-122	CR-016	DR-016	ER-024
Au(ppb)	<1	<1	<1	<1	22	30	39	3	<1	17	4	3	6	4	17
Ag(ppm)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.40	0.40	0.40	0.60
As(ppm)	<2	<2	<2	<2	<2	10	<2	<2	<2	<2	<2	<2	<2	<2	<2
Cu(ppm)	10	22	43	55	604	566	75	162	234	196	323	832	270	281	243
Mo(ppm)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.00	1.00	1.00	<1
Pb(ppm)	4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
S(%)	0.097	0.005	0.052	0.018	0.041	0.022	0.008	0.009	0.010	0.012	0.012	0.014	0.026	0.017	0.012
Zn(ppm)	20	28	44	44	78	94	64	72	92	94	92	148	90	96	96

SAMPLE No.	KR-013	AR-029	ER-120	HR-028	AR-099	FR-028	KGR-04	KCR-21	KCR-31	KKR-9-1	KKR-9-2	BC-2	5-27.85	5-33.15	9-67.50
ROCK TYPE	7	4	4	4	7	8	8	7	5	8	7	3	6	6	6
ROCK NAME	Andesite	Gabbro	Gabbro	Gabbro	And. Po.	Diorite	Diorite	And. Po.	Gabbro	Diorite	Andesite	Dolerite	Sili. Gabbro	Metagabbro	Metagabbro
SiO2	54.38	47.40	46.84	46.03	61.18	52.23	53.91	53.32	49.96	58.64	57.47	47.79	47.45	42.70	45.70
TiO2	1.08	0.95	1.12	1.12	0.42	0.88	0.74	0.79	1.15	0.79	0.90	0.94	1.15	1.32	1.09
Al2O3	17.16	17.89	17.26	17.14	18.63	19.18	17.46	17.64	17.63	18.17	18.89	19.73	10.22	17.32	17.34
Fe2O3	4.29	5.01	4.81	6.03	2.81	2.98	2.90	2.29	2.38	3.06	2.04	4.21	4.73	2.01	3.59
FeO	3.41	5.97	7.39	6.27	1.72	4.70	4.65	5.05	6.64	3.07	4.63	6.10	5.40	10.30	8.51
MnO	0.19	0.18	0.21	0.18	0.11	0.13	0.14	0.14	0.16	0.12	0.13	0.21	0.24	0.14	0.17
MgO	3.22	4.98	5.14	5.26	2.24	3.90	4.60	4.05	6.07	1.97	2.26	4.09	3.30	5.04	5.80
CaO	7.61	10.34	8.08	11.00	4.63	6.47	7.72	5.06	8.20	4.78	1.49	6.93	8.49	7.02	5.48
Na2O	3.56	2.59	3.59	2.81	5.07	3.99	3.73	3.41	4.11	4.34	3.71	3.58	4.72	3.85	4.61
K2O	3.34	1.03	2.58	1.14	0.74	2.39	1.04	4.95	0.98	1.85	3.18	2.12	0.58	0.95	0.29
P2O5	0.57	0.10	0.26	0.13	0.10	0.24	0.16	0.18	0.21	0.16	0.20	0.21	0.08	0.16	0.15
LOI	1.22	3.57	2.72	2.89	2.36	2.91	2.94	3.11	2.49	3.05	5.09	4.10	13.62	9.19	7.26
TOTAL	100.03	100.01	100.00	100.00	100.01	100.00	99.99	99.99	99.98	100.00	99.99	100.01	99.98	100.00	99.99
H2O+	0.96	3.31	2.81	2.68	2.15	3.00	2.52	2.24	2.51	2.25	3.38	3.73	0.33	4.66	4.46
H2O-	0.18	0.60	0.42	0.32	0.44	0.31	0.23	0.28	0.22	0.30	1.19	0.18	0.04	0.13	0.08

SAMPLE No.	KR-013	AR-029	ER-120	HR-028	AR-099	FR-028	KGR-04	KCR-21	KCR-31	KKR-9-1	KKR-9-2	BC-2	5-27.85	5-33.15	9-67.50
Au(ppb)	5	8	4	3	<1	<1	4	47	<1	2	6	8	1450	19	4
Ag(ppm)	<0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
As(ppm)	<2	<2	<2	<2	<2	<2	6	16	16	<2	8	<2	4	2	2
Cu(ppm)	469	316	231	205	48	135	141	133	76	25	37	210	283	303	199
Mo(ppm)	1	<1	2	1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pb(ppm)	2	<2	<2	<2	<2	<2	<2	<2	<2	6	6	4	4	4	2
S(%)	0.011	0.010	0.017	0.015	0.001	0.017	0.060	0.150	0.100	0.010	0.030	0.010	2.420	0.070	<0.01
Zn(ppm)	108	76	90	86	48	76	66	62	54	90	98	94	90	114	104

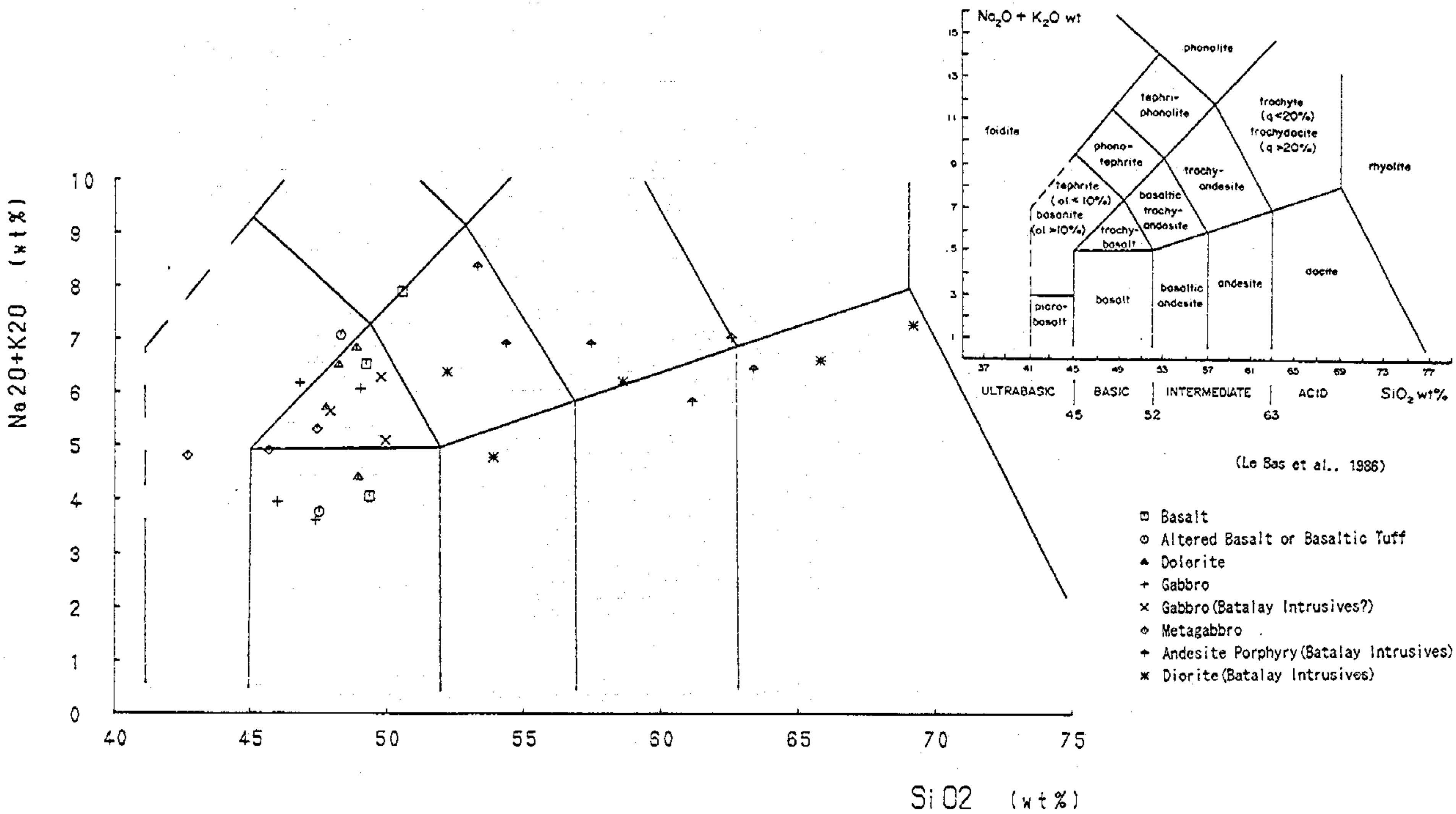


Fig. 11 TAS Diagram

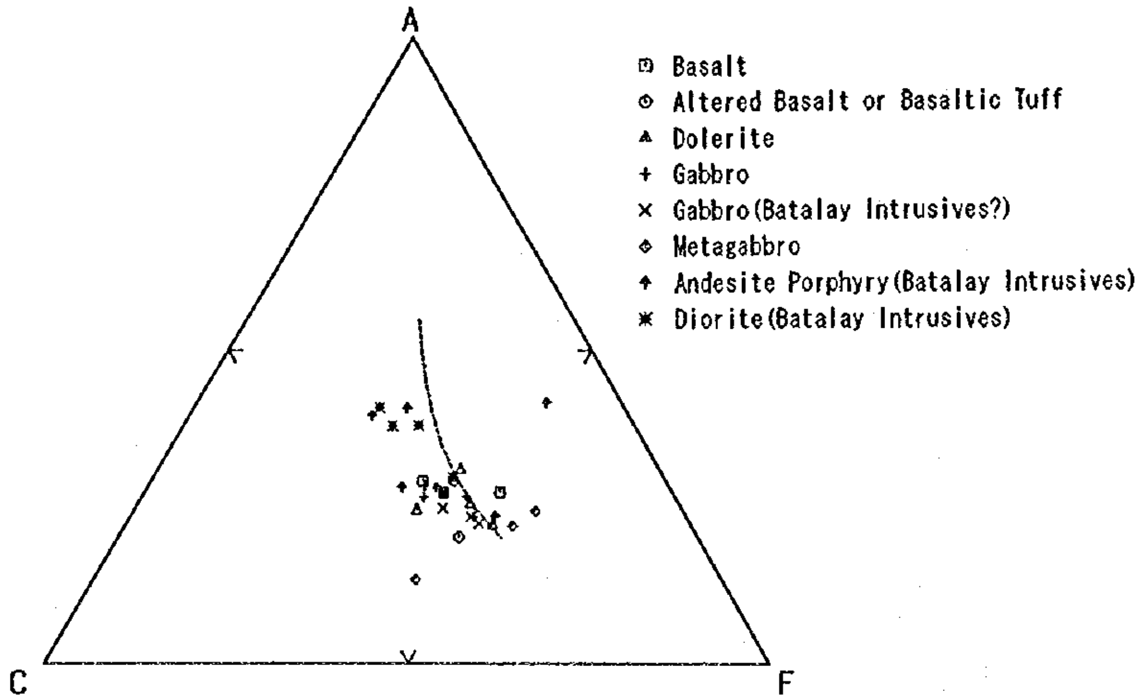


Fig. 12 ACF Diagram

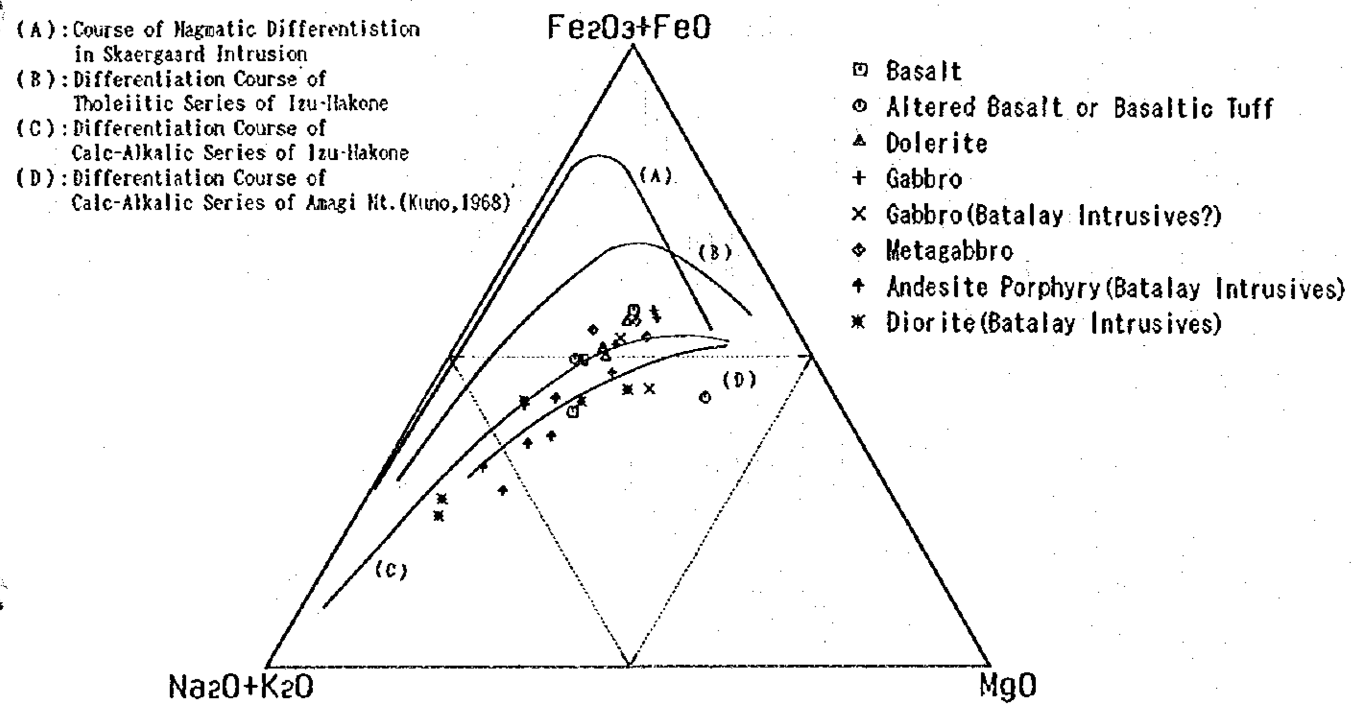


Fig. 13 MFA Diagram

sedimentary rocks because these rocks had intruded into the Catanduanes Formation.

Batalay Intrusives: Drummond and Defant (1990), Defant and Drumond (1990), Defant et al. (1990) mentioned that the island arc rocks (andesite, dacite, rhyolite) formed by subduction activity are characterized by $SiO_2 \geqq 56$ %, $Al_2O_3 > 15$ %, and $MgO < 3$ %. According to David Jr. (1994), the SiO_2 content of Batalay Intrusives ranges from 59 to 69 %.

Batalay Intrusives in the survey area are formed of andesite porphyry, diorite and aplite in the naked eye. The content of SiO_2 in these rocks ranges from 51.91 % to 73.40 %. The chemical compositions of these rocks fall within the wide field in TAS diagram. Most of the rocks belong to the calc-alkaline series in MFA diagram. In ACF diagram, the classification into I-type is found.

Most of the rocks in Kampayas Area, however, show $SiO_2 < 56$ %, $MgO > 3$ % and are different from the normal principal composition of Batalay Intrusives. In particular, the sample of KCR-21 exhibits porphyritic texture through microscopic observation and is inferred to be andesite porphyry, but the rock falls within the field of basaltic trachyandesite in TAS diagram and has the characteristics of alkaline rock series in X-ray diffraction analysis.

(2) Ore Elements; The analysis was carried out to confirm the potential contents of each ore element in the basements. Table 5 shows the results of the analysis.
According to Table 5, the contents of trace (ore) elements are different between Cretaceous Intrusives and Batalay Intrusives. In particular, as to the content of gold, the values of Cretaceous Intrusives showed clearly higher than those of Batalay Intrusives. On the other hand, the basaltic to andesitic lavas in the Catanduanes Formation and Cretaceous Intrusives indicate similar contents.

(3) K-Ar Dating; Age measurement by K-Ar method was made on igneous rock samples. The samples were very carefully selected aiming at taking the least altered materials, but microscopic observations revealed that they have alteration of chlorite, sericite and epidote to medium to strong degrees.

The ages of the Cretaceous Intrusives (ER-120 and HR-028) ranged from 95.4 ± 5.7 Ma to 82.9 ± 2.6 Ma indicating the later period of the Cretaceous.

Most of the samples corresponding to Batalay Intrusives showed almost Oligocene ages ranging from 39.5±0.9 Ma to 26.7±0.6 Ma. These ages accord well with the one Miranda and Vargas (1967) indicated from the stratigraphic relations for Batalay Intrusives.

It is possible that the samples which showed other ages were affected by the later alteration. The results were shown in Table 6.

The constants were, according to Steiger and Jaeger(1977), set as follows:

$$\lambda e = 0.581 \times 10^{-10}/Y, \quad \lambda \beta = 4.962 \times 10^{-10}/Y$$

The existence rate of ^{40}K in K was set at $^{40}K/K = 0.01167$ atom %. The estimation of measurement errors was based on Nagao et al. (1984).

2-1-4 Mineralization

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 island. MGB (1986) noted one gold, twenty-nine copper, three manganese, three phosphate, and one clay occurrences.

In the First Phase Survey, seventeen mineral occurrences (mainly gold and copper) and seven clay occurrences were surveyed and listed up.

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

In the Second Phase Survey, the detailed geological survey was carried out for the area of 66km² including Carorongan Mineral Occurrence that was reported as having the highest gold content of 21.59 g/t by Miranda and Vargas (1967).

As the result, the following mineralization and mineral occurrences were found;

① **Quartz veins** : Ananon South Area, Carorongan Mineral Occurrence and Taganopol Mineral Occurrence

② **Silicified zones** : Kampayas Area, Pinadaysan Area, Kaipa Area, Maytung Area and Kadlakogod Area

③ **Alluvial gold deposits** : Ananon North Area and Kadlakogod Area

④ **Native copper** : Barinad Area

⑤ **Others** : Kampayas Area, Tagbak Area and Pagsagnahan Area

The location map of mineral occurrences in the Second Phase Survey was shown in Fig. 14.

Table 6　Results of K-Ar Dating

Sample No.	Rock Type	Sample Locality (latitude, longitude)	POTASSIUM (K wt%)	Rad. ^{40}Ar (10^{-8}cc/g)	K-Ar AGE (Ma)	AIR CONT. (%)	Average of K-Ar Age (Ma)
ACR-026	Amphibole Porphyry	Solong Prospect. (N13° 39′ 31″, E124° 17′ 32″)	1.14±0.03	135±2.0 136±2.0	30.3±1.0 30.6±1.0	13.0 12.0	30.5±1.0
ACR-135	Biotite Diorite	Agban Prospect. (N13° 43′ 32″, E124° 23′ 35″)	1.51±0.05	177±2.0 180±2.0	30.0±1.0 30.4±1.0	16.0 15.4	30.2±1.0
CCR-011	Gabbro	1.6Km north of Calolbon. (N13° 37′ 12″, E124° 06′ 15″)	1.42±0.04	382±5.0 378±5.0	68.0±2.2 67.4±2.1	8.3 9.0	67.7±2.1
DCR-008	Basalt	2.4Km northwest of Tabugoc. (N14° 04′ 07″, E124° 13′ 30″)	2.72±0.05	513±6.0 509±5.8	48.0±1.1 47.6±1.1	7.2 5.6	47.8±1.1
GCR-004	Plagioclase Porphyry	7.5Km northeast of Guiamlong. (N13° 42′ 31″, E124° 14′ 20″)	2.17±0.04	327±4.0 330±5.0	38.5±0.9 38.9±0.9	19.3 19.9	38.7±0.9
GCR-006	Diorite	Lower Stream of the Sumigin River. (N13° 50′ 45″, E124° 12′ 02″)	3.75±0.08	578±7.0 584±7.0	39.3±0.9 39.7±0.9	11.2 11.3	39.5±0.9
BLR-001	Dacite	Southern coast of Gata Prospest. (N13° 55′ 20″, E123° 50′ 38″)	0.75±0.05	197±3.0 199±3.0	66.4±4.1 67.2±4.1	30.1 34.5	66.8±4.1
BLR-028	Andesite	170m east of Matalhod Point. (N13° 56′ 28″, E123° 49′ 51″)	1.74±0.05	602±7.0 615±7.0	87.2±2.8 89.2±2.8	9.8 9.4	88.2±2.8
ALR-071	Andesite	420m southeast of Balong Point. (N13° 56′ 53″, E123° 49′ 04″)	1.55±0.05	571±7.0 577±7.0	92.5±2.9 93.4±3.0	12.6 13.0	93.0±3.0
ALR-075	Dacite	500m north of Gogon. (N13° 58′ 04″, E123° 50′ 30″)	2.38±0.05	380±5.0 384±5.0	40.7±1.0 41.2±1.0	14.5 13.9	41.0±1.0
AR-099	Andesite Porphyry	Kadlakogod creek. (N13° 44′ 19″, E124° 18′ 16″)	0.54±0.03	68.7±0.9 69.2±1.0	32.8±2.0 33.0±2.0	23.0 22.4	32.9±2.0
DR-016	Dolerite	Gibawis creek. (N13° 49′ 52″, E124° 19′ 55″)	2.89±0.06	553±6.0 550±6.0	48.6±1.1 48.4±1.1	6.3 6.2	48.5±1.1
ER-120	Gabbro	Barinad creek. (N13° 47′ 53″, E124° 20′ 17″)	1.47±0.04	481±5.0 493±5.0	82.7±2.6 83.0±2.6	8.7 7.2	82.9±2.6
FR-028	Diorite	Up stream of The Taganopol river. (N13° 49′ 30″, E124° 21′ 06″)	1.16±0.04	157±2.0 153±2.0	34.6±1.1 33.8±1.1	17.6 16.2	34.2±1.1
HR-028	Gabbro	Branch of Barinad creek. (N13° 47′ 43″, E124° 19′ 58″)	0.89±0.05	328±4.0 344±4.0	93.2±5.5 97.5±5.8	10.1 12.3	95.4±5.7
KR-013	Andesite dike	1.5Km southeast of Pagasagnahan Point. (N13° 43′ 08″, E124° 16′ 38″)	2.48±0.05	379±5.0 380±5.0	39.0±0.9 39.1±0.9	13.4 13.6	39.1±0.9
KCR-21	Porphyrite	Kampayas creek (N13° 48′ 56″, E124° 20′ 59″)	2.19±0.04	227±3.0 229±3.0	26.5±0.6 26.8±0.6	11.3 11.9	26.7±0.6
KCR-31	Gabbro	East of Kampayas creek (N13° 49′ 52″, E124° 20′ 59″)	0.68±0.04	89.5±2.0 88.4±2.0	33.8±2.1 33.4±2.1	26.5 23.3	33.6±2.1
KCR-04	Diorite	Kampayas creek (N13° 48′ 15″, E124° 21′ 00″)	0.91±0.06	109±2.0 106±2.0	30.5±1.9 29.8±1.8	19.7 19.2	30.2±1.8

* Dating was done bulk samples by Mitsubishi Material Co.,Ltd. Central Laboratory.
* Decay Constant(after Steiger and Jaeger, 1977):
  $\lambda e = 0.581 \times 10^{-10}/yr$
  $\lambda \beta = 4.962 \times 10^{-10}/yr$
* ^{40}K content in K: $^{40}K/K = 0.01167$ atom%
* Error estimation was done after Nagao et al. (1984)

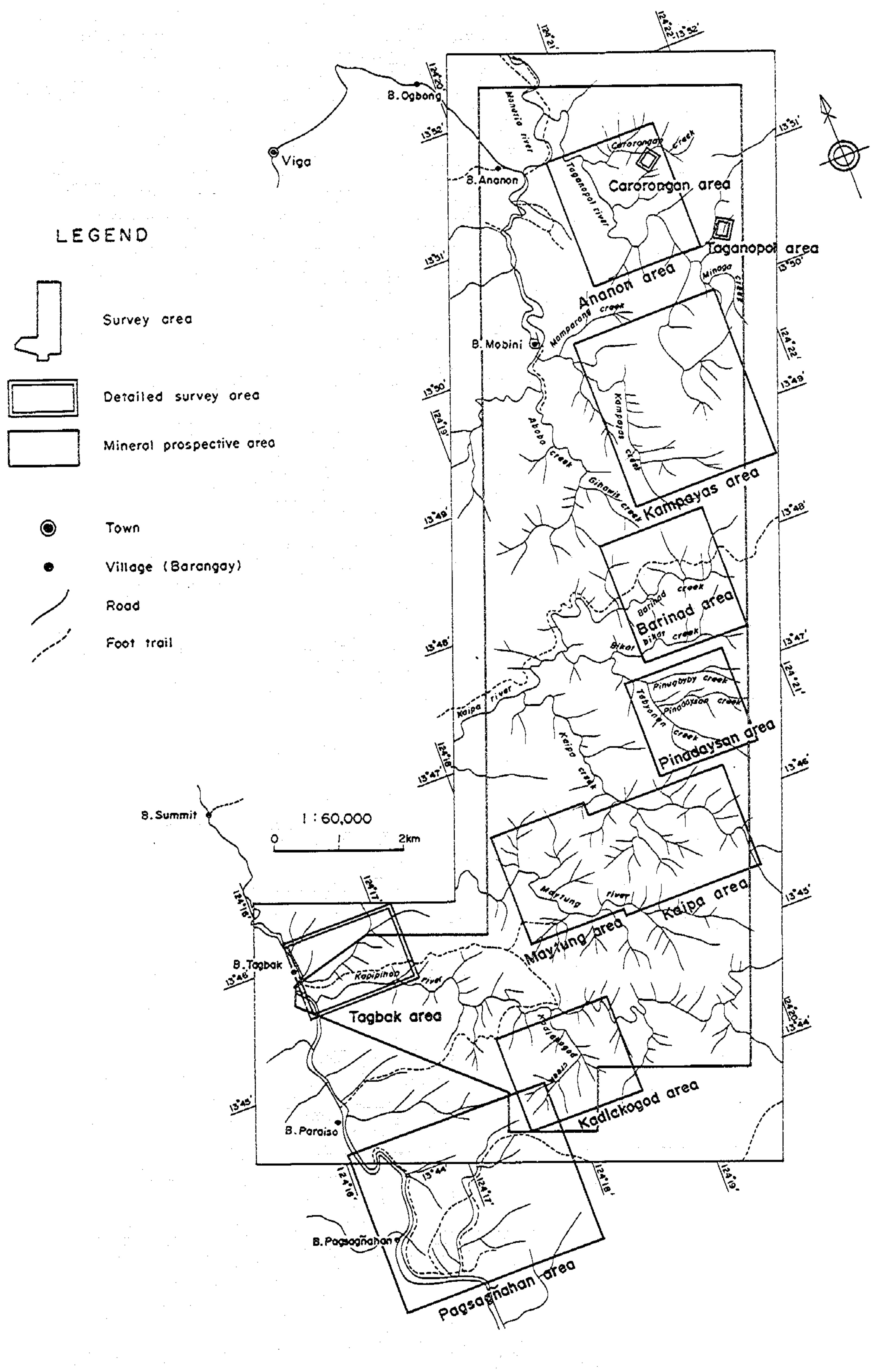


Fig. 14 Locations of Mineral Occurrences in the Second Phase Survey

(1) Quartz Vein; Quartz veins occur in the greenschist unit of the Catanduanes Formation and floats of quartz veins are mainly scattered at the area of greenschist and its periphery. These are divided into two types; segregation quartz veins and hydrothermal veins.

Segregation quartz veins: These veins are formed through dynamo-metamorphic processes. They mainly occur in the greenschist and show milky white in color and it is generally embedded parallel to the schistosity of the greenschist. The widths of veins are generally 1 to 5 cm (Occasionally 25 cm), and extensions are 0.5 to 3 m. No alterations were observed.

Hydrothermal quartz veins: Three areas were found out to produce hydrothermal quartz veins. They are recognized at Ananon South Area, Carorongan Mineral Occurrence and Taganopol Mineral Occurrence. Silicification and argillization with pyrite dissemination are observed at the areas. Widths of veins are 0.5 to 1.0 m and extension may be approximately 30 m maximum. The big quartz floats ranging 0.3 to 1.0 m (maximum: 2.5 m) are distributed along Taganopol River.

(2) Silicified Zone; The silicified zones are distributed in the central and southern part of the Second Phase Survey' s Area. The zones are generally 150 m by 200 m in dimension excepting one which is 300m by 600 m. The rocks within the zone are gray to pale greenish gray in color and they are hard because of silicification. The original rocks are mainly composed of graywacke. Small amount of pyrite and occasionally small veins of quartz and /or calcite are observed in the zones.

(3) Placer Gold Deposit; The placer gold deposits are located in the East of Ananon and along Kadlakogod Creek. The gold occurs in alluvium and is recovered through pitting and panning. Most of the pits were dug or explored before the second world war.

(4) Native Copper; The mineral occurrences of native copper are recognized at Barinad Area which is located in the upper reaches of Barinad Creek. The geology is composed of the Catanduanes Formation and Cretaceous Intrusives. The intrusives are mainly formed of gabbro, but there are not a few parts where porphyritic texture is seen. The intrusives generally gave no thermal metamorphism and alteration to the surrounding rocks.

They, however, underwent hydrothermal alteration in some parts. The gabbro seen along the main stream of Barinad Creek has developed thin veins of quartz and calcite with a width of 0.5 to 1.0 cm. In minute fissures in the gabbro and adjacent green graywacke and in thin veins of quartz and calcite, native copper is observed in the form of films and minute veins.

(5) Others; The silicified and argillized zones with pyrite dissemination were recognized near Batalay Intrusives at Kampayas Area and Pagsagnahan Area. The quartz veinlet zones were discovered within the weathered sandstone at Tagbak Area. These mineral occurrences were described as others in the Second Phase Survey.

2-2 Geochemical Survey

2-2-1 Methodology

(1) Sampling; The sampling of the geochemical survey by stream sediments has been done along main rivers and their tributaries at sampling points selected beforehand to cover the whole area. Stream sediments have been taken at the center of the stream in each sampling point and sieved to minus 80 mesh fraction.

The geochemical surveys by soils were conducted for the potential areas, Carorongan Mineral Occurrence (Area: 300 m by 250 m), Taganopol Mineral Occurrence (Area: 300 m by 240 m), Tagbak Area and Barinad Area in the Second Phase Survey, and Kampayas Area (Area: 1.6 km by 1.6 km) in the Third Phase Survey. At each sampling point, 1 kg of soil sample was taken from B horizon. After air-drying, samples were sieved. About 100 g of minus 80 mesh fraction was taken for each sample and they were split in two parts; one part for the Philippines and the other part for the Japanese survey team and were later analyzed.

(2) Pathfinder Elements and Method of Chemical Analysis; Au and Cu were expected to occur in the survey. Thus the following 11 elements were selected as pathfinder elements; Au, Ag, Cu, As, Fe, Hg, Mo, Pb, S, Sb, Zn.

Neutron activation analysis was applied for analysis of Au. Induction furnace method was applied for analysis of S. ICP-AES method was applied for the other nine elements.

The lower detection limits for each element were as follows; Au: 1 ppb, Ag: 0.2 ppm, As, Pb, Sb and Zn: 2 ppm, Cu, Hg and Mo: 1 ppm, Fe and S: 0.01 %.

(3) Analysis of Geochemical Data; Analytical values were converted into natural logarithms. Half of the value of the lower limit has been used for convergence of statistical processing.

In this survey, mean and standard deviation together with frequency and cumulative frequency curve have been used to establish the threshold value. For all elements, more than two steps of classifications are set to distinguish the high anomalies.

On the data analyses, first the distribution of anomalies each elements were drawn on the geologic maps (Monovariant Analysis). Next, principal component analysis (Multivariant Analysis) was accomplished in order to see if there are groups of elements with correlative behavior and what control their grouping. Correlation coefficients are used for the calculation of the principal component analysis.

2-2-2 Results of the Geochemical Survey by Stream Sediments

(1) The First Phase Survey in 1993; The rather large anomaly zones for gold (Au) are distributed in Dugui Too Area and Carorongan Area in the First Phase Survey. Small Au anomaly zones are dispersed around Batalay Intrusives in Tilod, San Pedro, Libjo, Aroyao and Solong Mineral Occurrences. In the mountainous area, the East of Bato River, there are sporadic distribution of Au anomalies. Small Au anomaly zones are also distributed in Gigmoto, Guiamlong and around Mabil (Fig. 15). The anomaly zone in Dugui Too is the largest and the most intense one of all. The anomaly zone in Carorongan Area is the second largest one.

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

High scores for the first principal component are distributed near Pagsagnahan in the central island and along a tributary of Bato River, which joins with the tributary at Pagsagnahan. A copper mineral occurrence is known in the upper stream of Kaglatawan River.

High scores for the third, fourth and fifth principal components are recognized at Carorongan Mineral Occurrence, the East of Bato, Dugui Too Mineral Occurrence and mountainous areas to the northeast of Pagsagnahan. The comprehensive map of the First Phase Survey was shown in Fig. 16.

(2) The Second Phase Survey in 1994; Compared with the mean values of each element and the Clarke number, the content of gold is 72 times higher than the Clarke number, Sb: 17 times, Ag: 7 times, other elements: 0.4 to 3 times, respectively. These data suggest that gold has the highest potential in the survey area.

As shown in Fig. 17, Au concentrated areas are located at Taganopol River and the northeastern side of Kampayas Creek, Barinad Creek, Tabyonan Creek, Kaipa Creek, Maytung Creek and Kadlakogod Creek.

The PCA was carried out in two areas; the greenschist area (Area A) and the greywacke area (Area B). The both areas were divided by Ogbon Fault trending NW-SE. The comprehensive map of the Second Phase Survey was shown in Fig. 18.

As the results of PCA, the first principal component in Area A, the second, fourth and fifth components in Area B were selected as the factors showing gold related mineralization. On the whole, Taganopol River area in Area A, the upper reach of Taganopol River and Kampayas Creek in Area B were selected as the most promising area for gold related mineralization. In addition, the other promising areas are located at the lower reach of Barinad Creek, middle part of Tabyonan Creek and Maytung Creek.

Besides, high scores of the first principal component having the large factor loadings of Zn, Fe, Sb, Pb and Cu are distributed in and around Barinad Creek. Moreover, outcrops and floats of gabbro are noted along Barinad Creek.

2-2-3 Results of the Geochemical Survey by Soils

(1) The Second Phase Survey in 1994; The following potential areas were selected by the results of the geological survey; Carorongan Mineral Occurrence, Taganopol Mineral Occurrence, Tagbak Area and Barinad Area. The soil geochemical surveys for their areas were carried out in the Second Phase Survey.

In the Carorongan Mineral Occurrence, the maximum Au content is 1,870 ppb, and the mean is 155.9 ppb. This figure is large as compared with the Clarke number. Other elements except Sb, Hg are less than 3 times of the Clarke number. Accordingly, gold is selected as the most important mineralization in the area.

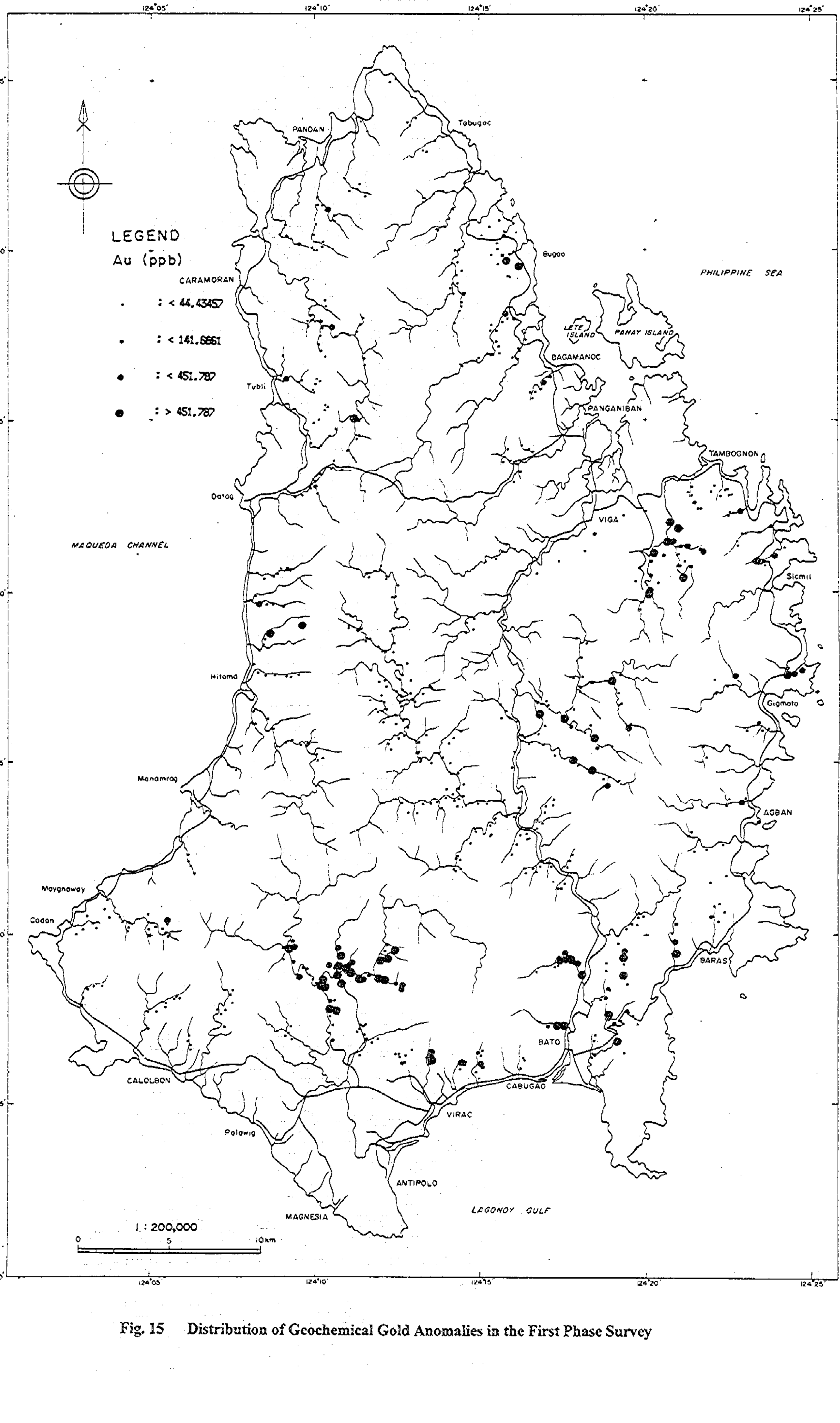


Fig. 15 Distribution of Geochemical Gold Anomalies in the First Phase Survey

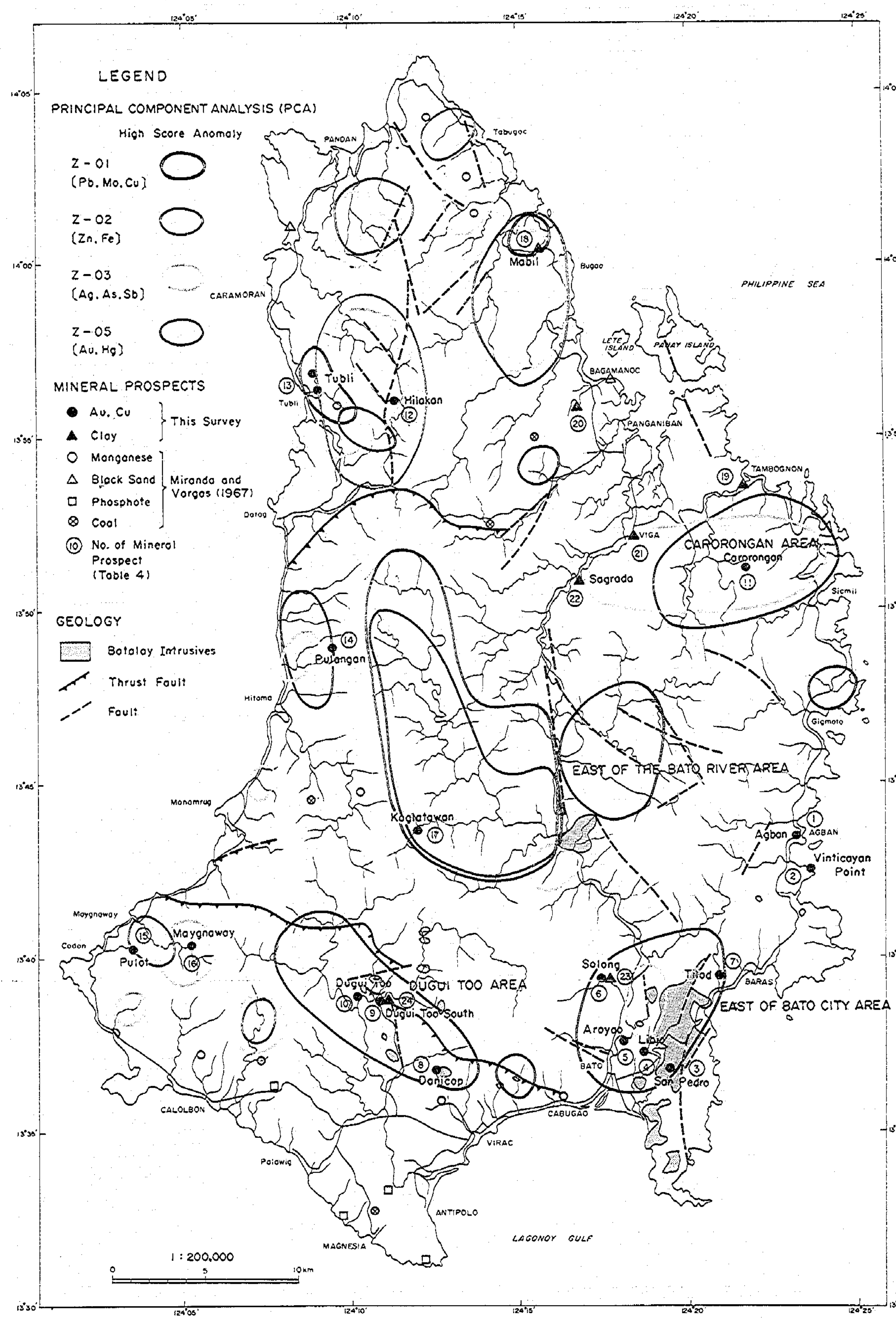


Fig. 16 Comprehensive Map of the First Phase Survey

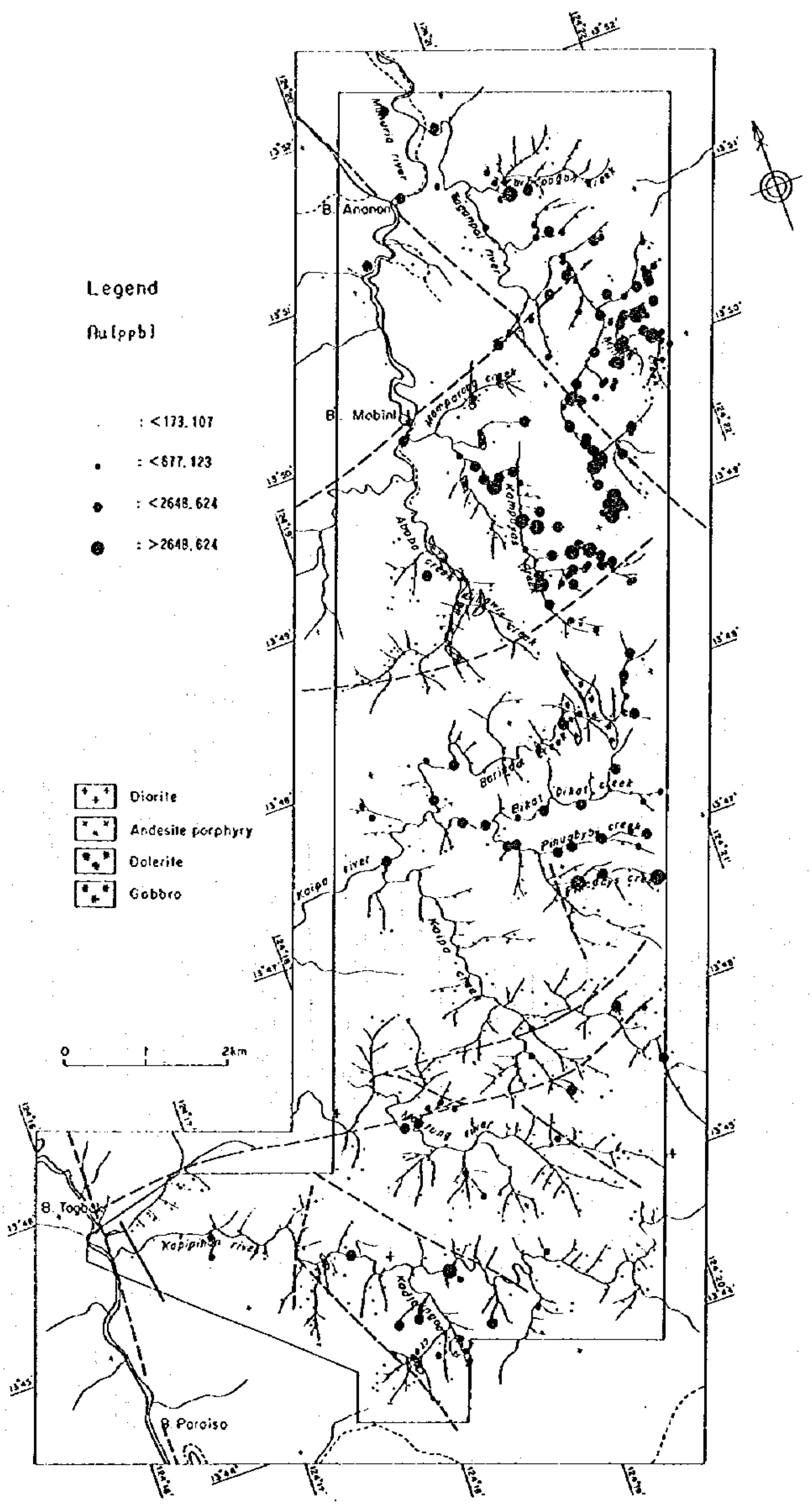


Fig. 17 Distribution of Geochemical Gold Anomalies in the Second Phase Survey

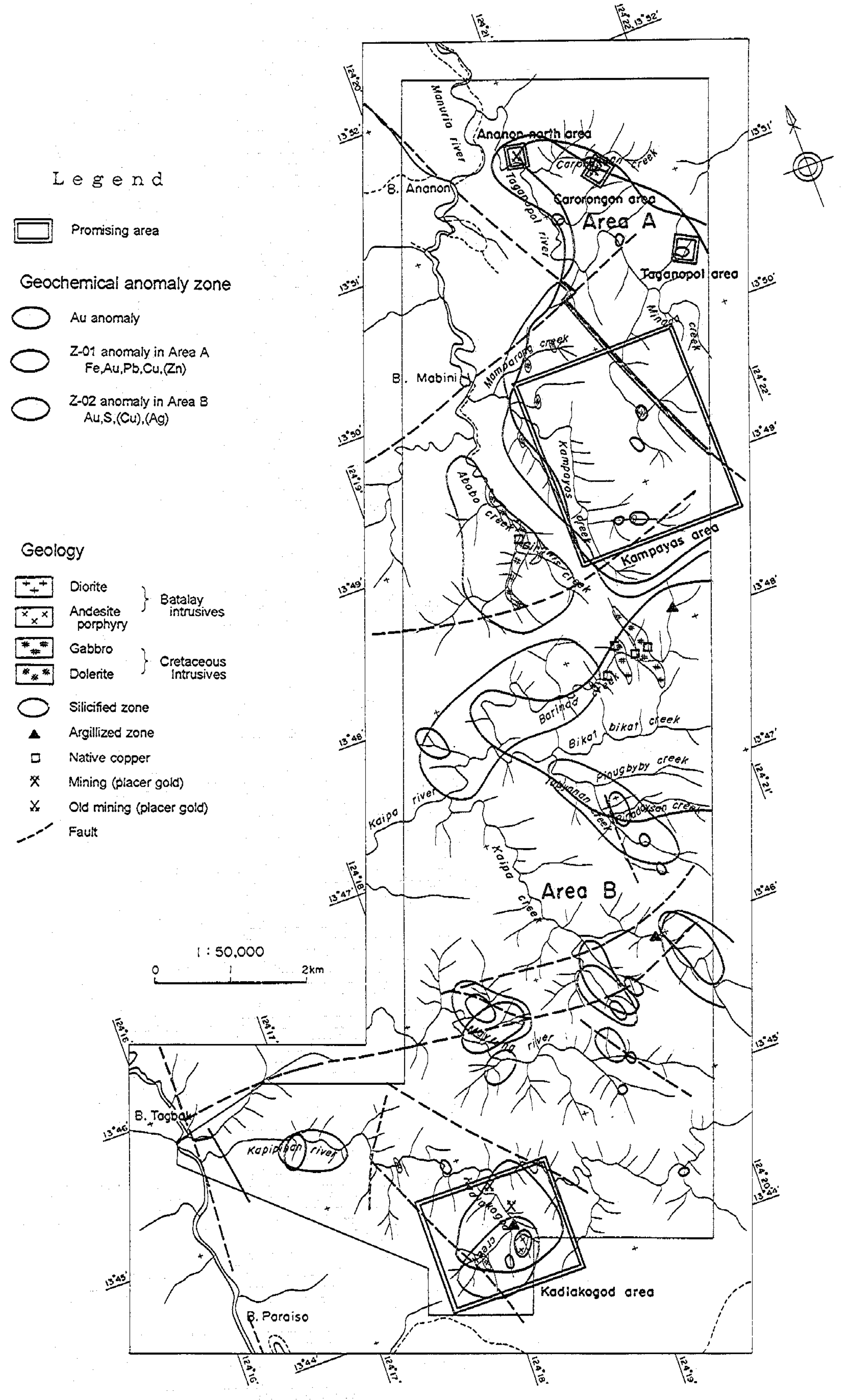


Fig. 18 Comprehensive Map of the Second Phase Survey

Monovariant and Multivariant analytical data show that gold mineralization is concentrated near the boundary between the greenschist of the Catanduanes Formation and the Payo Formation.

In Taganopol Mineral Occurrence, the maximum gold content is 504 ppb and the average is 50.9 ppb. They showed high values compared with the Clarke number. Other elements except Sb, the mean values are less than 3 times of the Clarke number. Accordingly, gold is selected as the most important mineralization in this occurrence. In this occurrence, geochemical anomaly cannot be extracted clearly due to mixing two geological units; the Catanduanes Formation and the Payo Formation.

In the Tagbak Area, Au content is very low compared with the former two occurrences. Each content of Cu, Pb and Zn is at most 3 times compared with the Clarke number.

In the Barinad Area, high scores of the first principal component which shows the factor of mineralization of Fe, Cu, Sb, (Zn), (S) are distributed near gabbro intrusives. High scores of the third and fifth principal components related to Au mineralization are also distributed in and around the area.

(2) The Third Phase Survey in 1995; The survey was executed in Kampayas Area in order to pick out the geochemical anomalies from the analyses of soil samples and to know the potential of the area and consequently select the prospective areas.

Kampayas Area is located at the southern part of Carorongan Area. Both areas were divided by Ogbon Fault trending NW-SE.

The geology is mainly composed of dark green colored, medium to coarse sandstones with obscure bedding and originated from the pyroclastic rocks of the Catanduanes Formation. These volcano-sedimentary rocks are cut by dolerite and gabbro of Cretaceous ages and by andesite porphyry and diorite of Batalay Intrusives.

The geological structure of the area was transacted by two NNE-SSW oriented faults passing by Kampayas Creek and the ridge around peak 379 m. Therefore, the strike of the area between both faults showed NE-SW orientation which was different from the general strike (NW-SE trend) of the region. At the ridge around peak 379 m, numerous floats of andesite porphyry and microdiorite were recognized indicating that the ridge might be underlain by Batalay Intrusives which could be responsible for the mineralization of the area.

Geological mapping indicates that the whole survey area is silicified in which very strong silicification with large amount of pyrite crystals was identified on the west-central part of the survey area. In other parts of the area, some traces of pyrite could be observed on slightly silicified portions. Generally, the area was affected by numerous NW-SE and NE-SW trending quartz veins/veinlets which are probably conjugate. A 1 m thick quartz vein was identified at the southeastern part of the area and trends N30° E dipping around 65 degrees NW.

As to gold anomaly in the area, the high anomalies are distributed near the diorite body or along the NNE-SSW oriented fault passing by the ridge of peak 379 m. The high Au concentration area is also recognized at the silicified zone which is distributed along the eastern side of Kampayas Creek and at the upper stream of Kampayas Creek corresponding to the southern part of the survey area.

As the results of the PCA, following each principal component has such characters mentioned below;

First principal component: This component has large positive factor loadings of Fe and S. These elements may relate to propylitic alteration with large amount of pyrite. High scores are distributed near the ridge of peak 379 m and its northeastern part, and near the silicified zone at the eastern part of Kampayas Creek.

Second principal component: This component has large positive factor loadings of Cu, Pb and Zn, and suggests multiple base metal mineralization. High scores are distributed near the diorite body at the ridge around peak 379 m. Most of high scores exist at the western side of NNE-SSW oriented fault passing by the ridge around peak 379 m, while most of low scores are recognized at the eastern side of the fault.

Third principal component: This component has notably negative factor loading of Sb. It ,however, bears no meaning in the geology because most of Sb show very low values.

Fourth principal component: This component has large positive factor loading of Au and negative factor loading of As related to gold mineralization. High scores are distributed from the ridge around peak 379 m to the southern part. These high scores correspond to the Au high concentration areas and the areas are where numerous floats and outcrops of andesite porphyry and diorite are recognized.

The comprehensive map of the survey area was shown in Fig. 19.

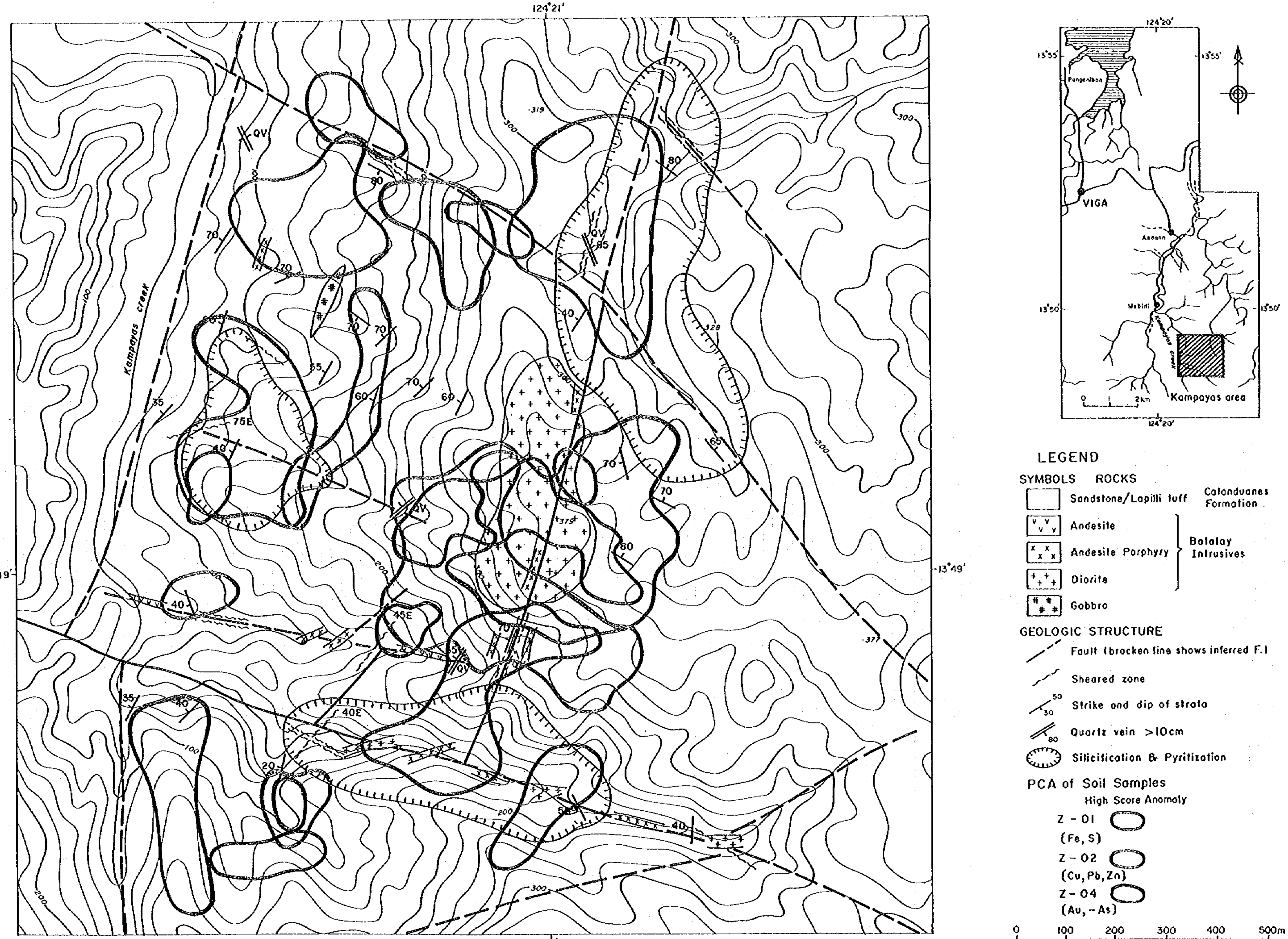


Fig. 19 Comprehensive Map of the Third Phase Survey (Kampayas Area)

2-3 Trenching Survey

2-3-1 Methodology

The survey was carried out to clarify the extension and grade of the mineralization for the geochemical anomalies and the original place of quartz floats with 0.5 to 1.0 m in size on surface which were recognized at Carorongan Mineral Occurrence in the Second Phase Survey. The methodology was as follows;

(1) Total length of the trenches was 204m and the trenches were dug at 9 places.

(2) The width of each trench was 1.5 m, and the trenches were dug up to expose the rocks.

(3) We observed the geology and mineralization in detail, and made the trench map on the scale of one to one hundred (1:100).

(4) The laboratory test samples for ore analysis, X-ray diffraction analysis, polished thin section, homogenization temperature measurement of fluid inclusion, etc. were collected to clarify the geology and mineralization.

(5) After the trenching survey, the trenches were recovered with soil just like the original condition.

2-3-2 Results of the Survey

The geology observed through the trenches is characterized by highly oxidized and schistosed volcano-sedimentary rocks cut by metagabbroic intrusives. These rocks generally have the schistosities showing NW-SE direction and are silicified and argillized around the mineralization zone. The metagabbro is relatively strongly altered with high frequency of quartz veinlets than the greenschist, although the host rocks are difficult to distinguish due to the influence of tropical weathering.

The geological structure is characterized by NW-SE trending faults and folds which are cut by E-W and NE-SW (northeast-southeast) trending faults (JICA and MMAJ,1995). This trend is also recognizable within the trenches. The extended directions of sheared zone and silicified zone mainly follow the NW-SE trend, but some quartz veins containing high gold grade have the E-W direction.

As to mineralization, there are gold anomalies related to hydrothermal alteration and quartz veins throughout the whole series of trenches from Trench-1 (T-1) to Trench-9 (T-9). The dominant trend of quartz veins is NW-SE and in decreasing frequency of N-S, E-W and

NE-SW direction. The quartz veins with high Au grade generally trend NW-SE and in E-W directions. Of particular interest is Trench-3 wherein the silicified zone contains 4.2 g/t Au and about 4 m in width. It seems that the silicified zone continues to N50° W direction. Therefore, the silicified zone with values of 1.3 to 4.7 g/t Au and about 3.5 m in width also exists within Trench-1. The quartz vein which contains 58.8 g/t Au and about 15 cm in width at the above-mentioned silicified zone in Trench-3, however, shows N75° E/85° NW in the dip-strike, and gold anomalies also continue to E-W direction considering the high gold anomaly zones of Trench-5 and Trench-6. Other notable gold occurrences are the argillized zone having Au values of 1.5 g/t with about 2 m width within Trench-4 and the quartz veinlets zone yielding values of 30.3 g/t Au and about 1 m in width within Trench-6.

The quartz veins are mainly divided into transparent and opaque varieties in the field. The latter are white to white with brown tinge. The white with brown tinge quartz veins which contains oxidized pyrite forming limonite and hematite mainly exhibit the high Au grade. Based on X-ray diffraction analysis, the quartz veins are generally composed of quartz, kaolinite, sericite, albite, chlorite, gibbsite, limonite, hematite and mix layered clays.

The homogenization temperatures of quartz fluid inclusions have the peak at around 200° C. In some places the clay parts close to the quartz veins yield higher Au grade than the quartz vein itself.

Based on the results of ore analysis, only Au has the high potential, though there are some samples yielding slightly high concentrations of Cu and Zn.

The locations of trenching and drilling surveys in Carorongan Area, the geologic sketch of representative trench, the schematic geologic map and mineral occurrences in Carorongan Area were shown in Fig.20, Fig. 21 and Fig. 22, respectively.

2-4 Drilling Survey

2-4-1 Methodology

The survey was carried out at Carorongan Mineral Occurrence which was selected as potential area during the Second Phase Survey to explore and assess the mineralization zone of the area.

The survey was undertaken by conducting the exploratory drilling in 12 holes on five sites totaling 1,104 m. The length of each drill core ranges from 50 to 132 m. The depths

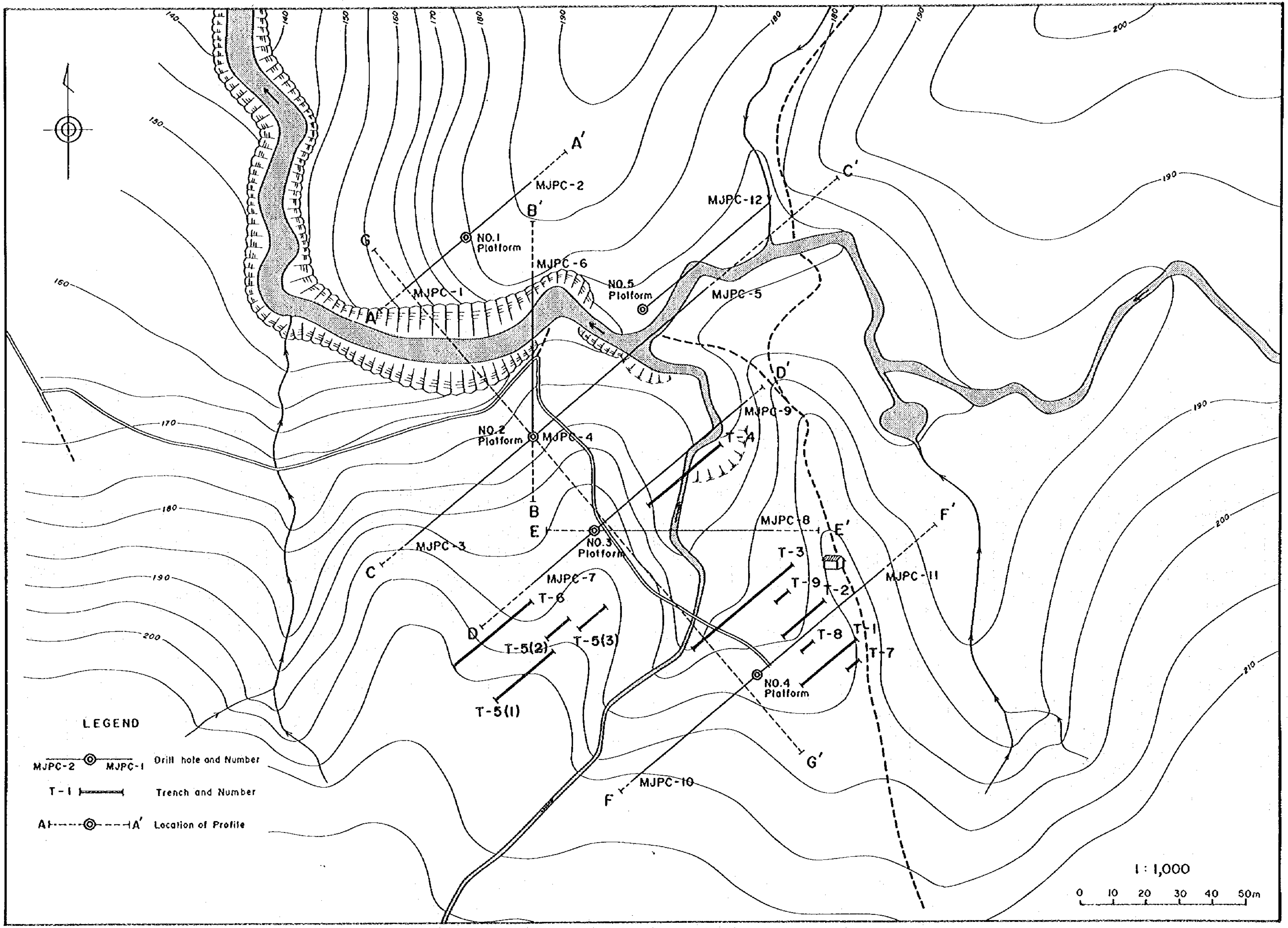
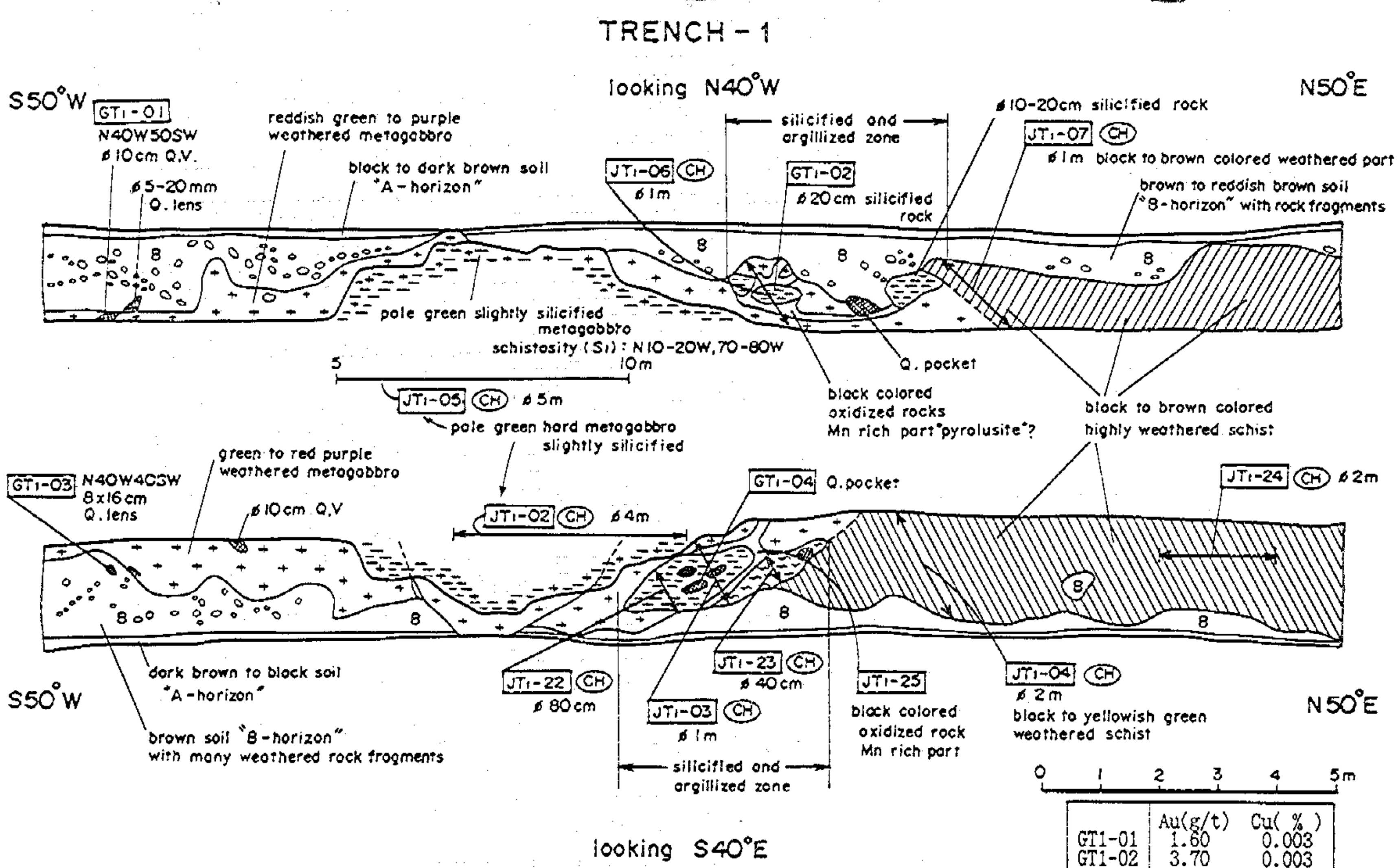


Fig. 20 Locations of Trenching and Drilling Surveys in Carorongan Area



	Au(g/t)	Cu(%)
GT1-01	1.60	0.003
GT1-02	3.70	0.003
GT1-03	0.37	0.002
GT1-04	0.40	0.002
JT1-02	0.10	0.028
JT1-03	2.10	0.020
JT1-04	0.08	0.034
JT1-05	0.13	0.026
JT1-06	1.30	0.020
JT1-07	0.05	0.039
JT1-22	3.80	0.024
JT1-23	4.70	0.007
JT1-24	0.02	0.017
JT1-25	2.20	0.020

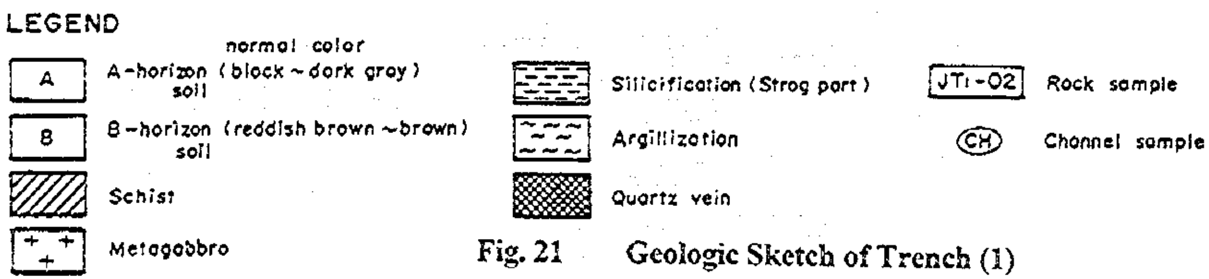
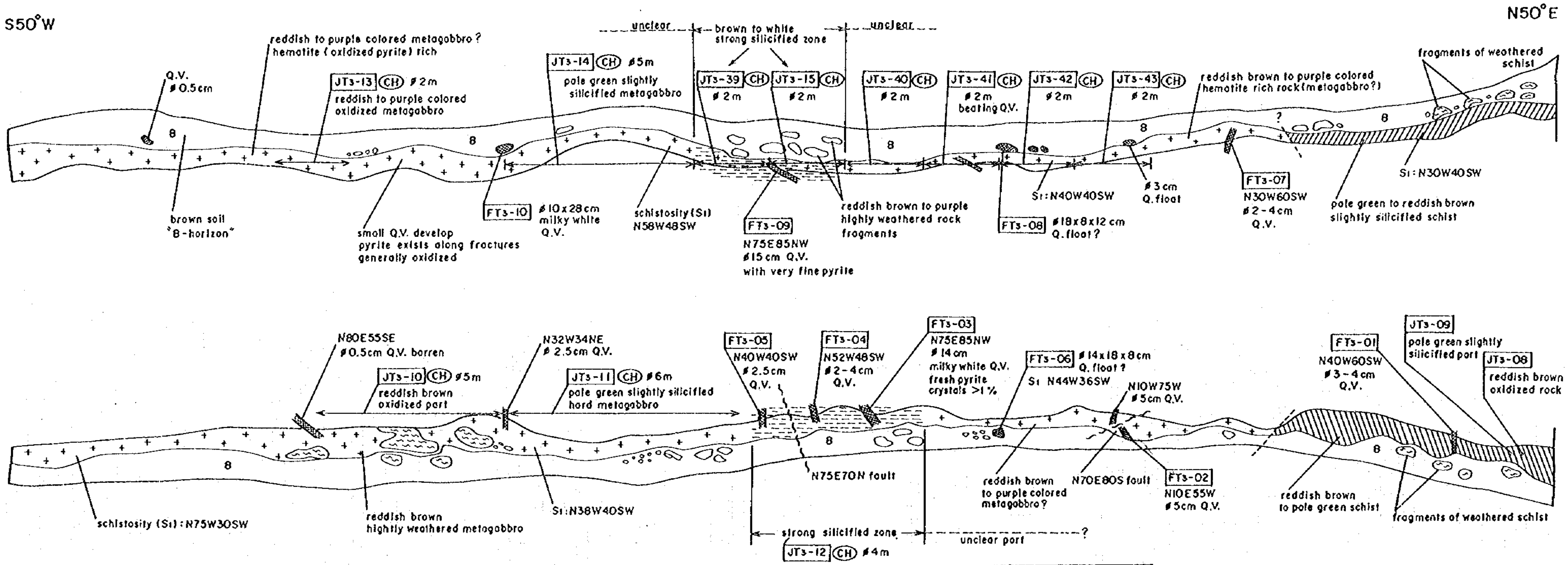


Fig. 21 Geologic Sketch of Trench (1)

TRENCH - 3

looking N40°W

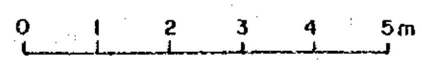
S50°W N50°E



S50°W N50°E

looking S40°E

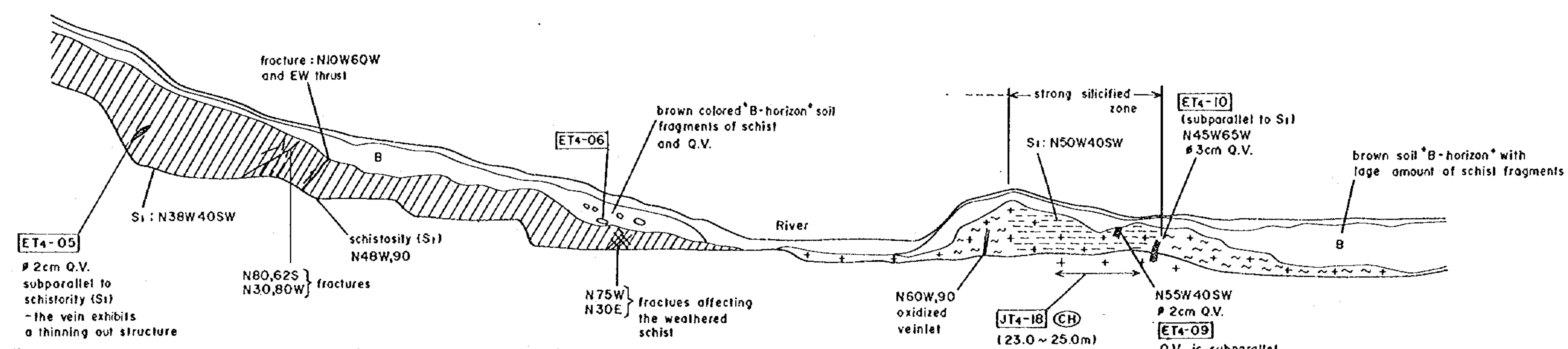
	Au(g/t)	Cu(%)
FT3-01	0.02	0.004
FT3-02	0.06	0.003
FT3-03	23.90	0.004
FT3-04	1.90	0.013
FT3-05	0.45	0.004
FT3-06	56.60	0.008
FT3-07	6.50	0.022
FT3-08	1.80	0.005
FT3-09	58.80	0.009
FT3-10	44.60	0.006
JT3-08	0.02	0.049
JT3-09	<0.01	0.024
JT3-10	0.10	0.027
JT3-11	0.38	0.036
JT3-12	4.20	0.023
JT3-13	0.11	0.020
JT3-14	0.45	0.024
JT3-15	2.25	0.018
JT3-39	2.30	0.017
JT3-40	0.09	0.023
JT3-41	0.50	0.017
JT3-42	0.15	0.013
JT3-43	0.08	0.019



LEGEND

Fig. 21 Geologic Sketch of Trench (2)

TRENCH – 4



	Au(g/t)	Cu(%)		Au(g/t)	Cu(%)		Au(g/t)	Cu(%)		Au(g/t)	Cu(%)		Au(g/t)	Cu(%)
ET4-05	0.04	0.003	ET4-10	0.04	0.002	JT4-16	2.80	0.011	JT4-47	0.09	0.022	JT4-52	0.06	0.005
ET4-06	0.41	0.006	ET4-11	0.07	0.001	JT4-17	0.70	0.024	JT4-48	1.50	0.016	JT4-53	0.32	0.019
ET4-07	0.75	0.012	ET4-12	0.15	0.002	JT4-18	0.62	0.022	JT4-49	0.95	0.023	JT4-54	0.34	0.023
ET4-08	1.00	0.004	ET4-13	0.34	0.004	JT4-44	0.14	0.019	JT4-50	0.04	0.002	JT4-55	0.41	0.024
ET4-09	0.08	0.005	ET4-14	0.15	0.002	JT4-45	0.21	0.019	JT4-51	1.70	0.012	JT4-56	0.15	0.023

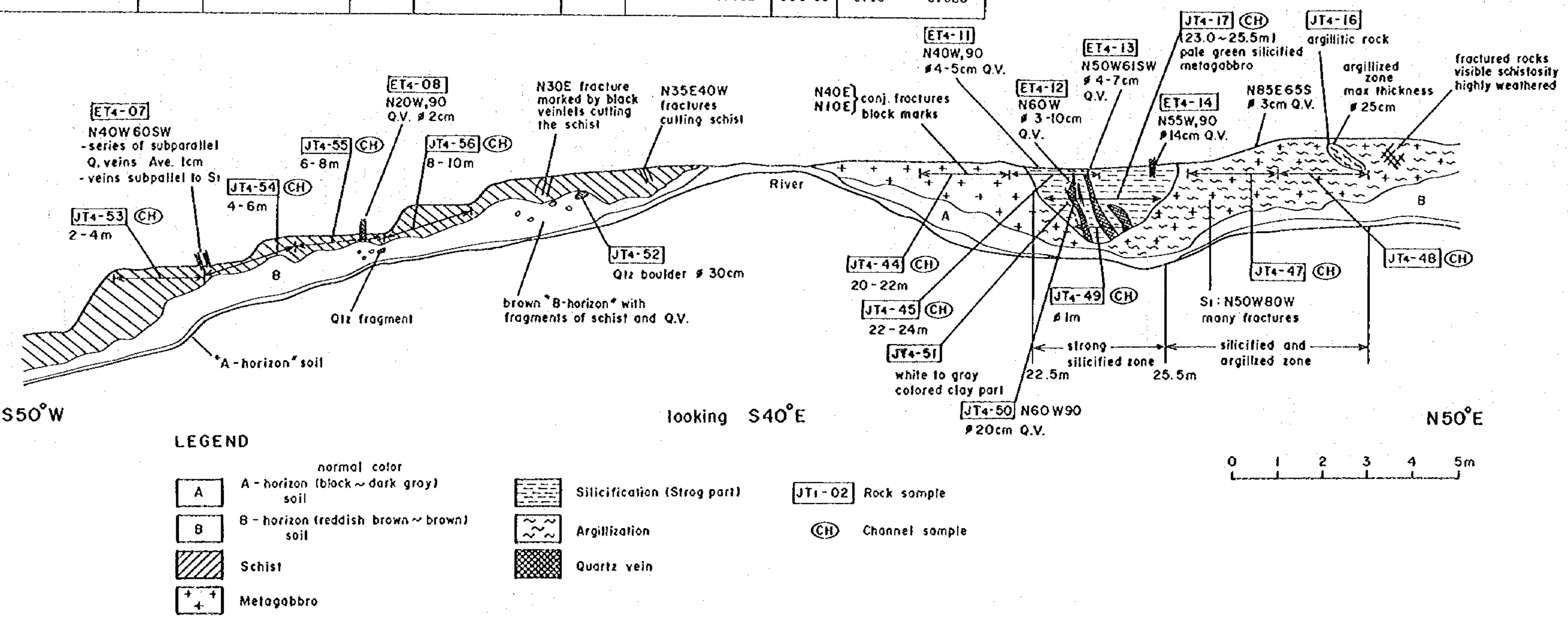
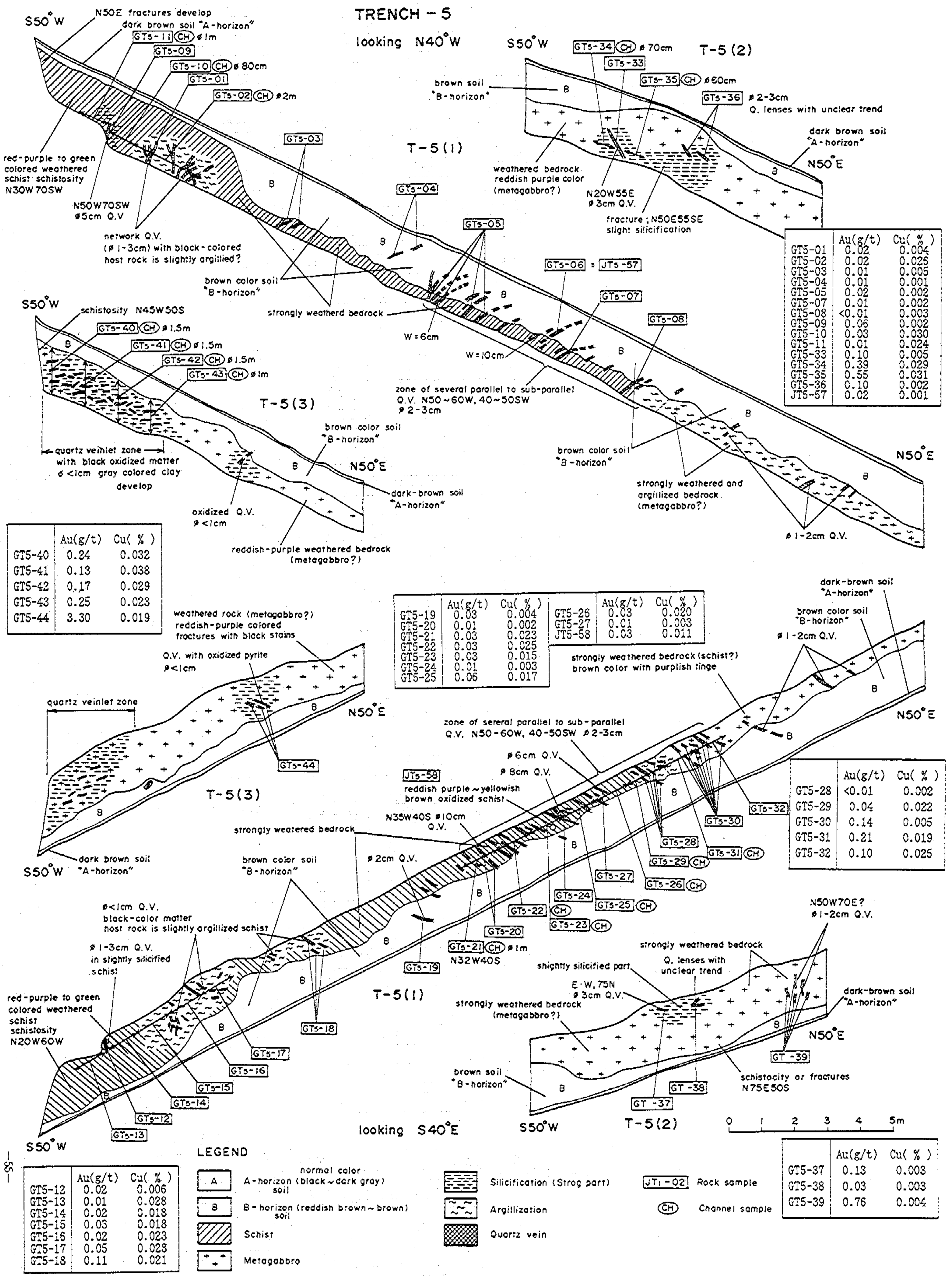


Fig. 21 Geologic Sketch of Trench (3)



	Au(g/t)	Cu(%)
GT5-01	0.02	0.004
GT5-02	0.02	0.026
GT5-03	0.01	0.005
GT5-04	0.01	0.001
GT5-05	0.02	0.002
GT5-07	0.01	0.002
GT5-08	<0.01	0.003
GT5-09	0.06	0.002
GT5-10	0.03	0.030
GT5-11	0.01	0.024
GT5-33	0.10	0.005
GT5-34	0.39	0.029
GT5-35	0.55	0.031
GT5-36	0.10	0.002
JT5-57	0.02	0.001

	Au(g/t)	Cu(%)
GT5-40	0.24	0.032
GT5-41	0.13	0.038
GT5-42	0.17	0.029
GT5-43	0.25	0.023
GT5-44	3.30	0.019

	Au(g/t)	Cu(%)
GT5-19	0.03	0.004
GT5-20	0.01	0.002
GT5-21	0.03	0.023
GT5-22	0.03	0.025
GT5-23	0.03	0.015
GT5-24	0.01	0.003
GT5-25	0.06	0.017

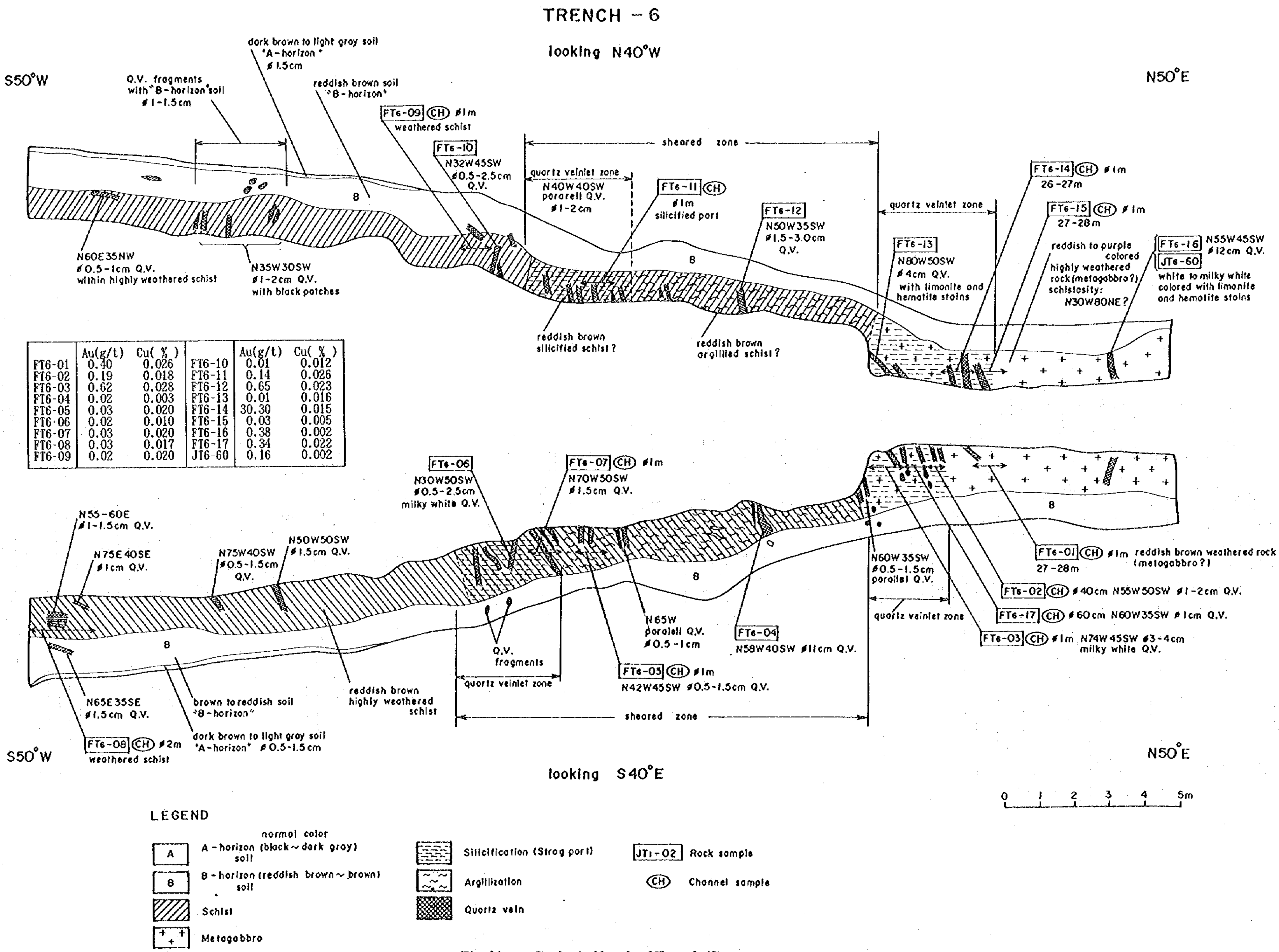
	Au(g/t)	Cu(%)
GT5-26	0.03	0.020
GT5-27	0.01	0.003
JT5-58	0.03	0.011

	Au(g/t)	Cu(%)
GT5-28	<0.01	0.002
GT5-29	0.04	0.022
GT5-30	0.14	0.005
GT5-31	0.21	0.019
GT5-32	0.10	0.025

	Au(g/t)	Cu(%)
GT5-12	0.02	0.006
GT5-13	0.01	0.028
GT5-14	0.02	0.018
GT5-15	0.03	0.018
GT5-16	0.02	0.023
GT5-17	0.05	0.028
GT5-18	0.11	0.021

	Au(g/t)	Cu(%)
GT5-37	0.13	0.003
GT5-38	0.03	0.003
GT5-39	0.76	0.004

Fig. 21 Geologic Sketch of Trench (4)



	Au(g/t)	Cu(%)		Au(g/t)	Cu(%)
FT6-01	0.40	0.026	FT6-10	0.01	0.012
FT6-02	0.19	0.018	FT6-11	0.14	0.026
FT6-03	0.62	0.028	FT6-12	0.65	0.023
FT6-04	0.02	0.003	FT6-13	0.01	0.016
FT6-05	0.03	0.020	FT6-14	30.30	0.015
FT6-06	0.02	0.010	FT6-15	0.03	0.005
FT6-07	0.03	0.020	FT6-16	0.38	0.002
FT6-08	0.03	0.017	FT6-17	0.34	0.022
FT6-09	0.02	0.020	JT6-60	0.16	0.002

Fig. 21 Geologic Sketch of Trench (5)

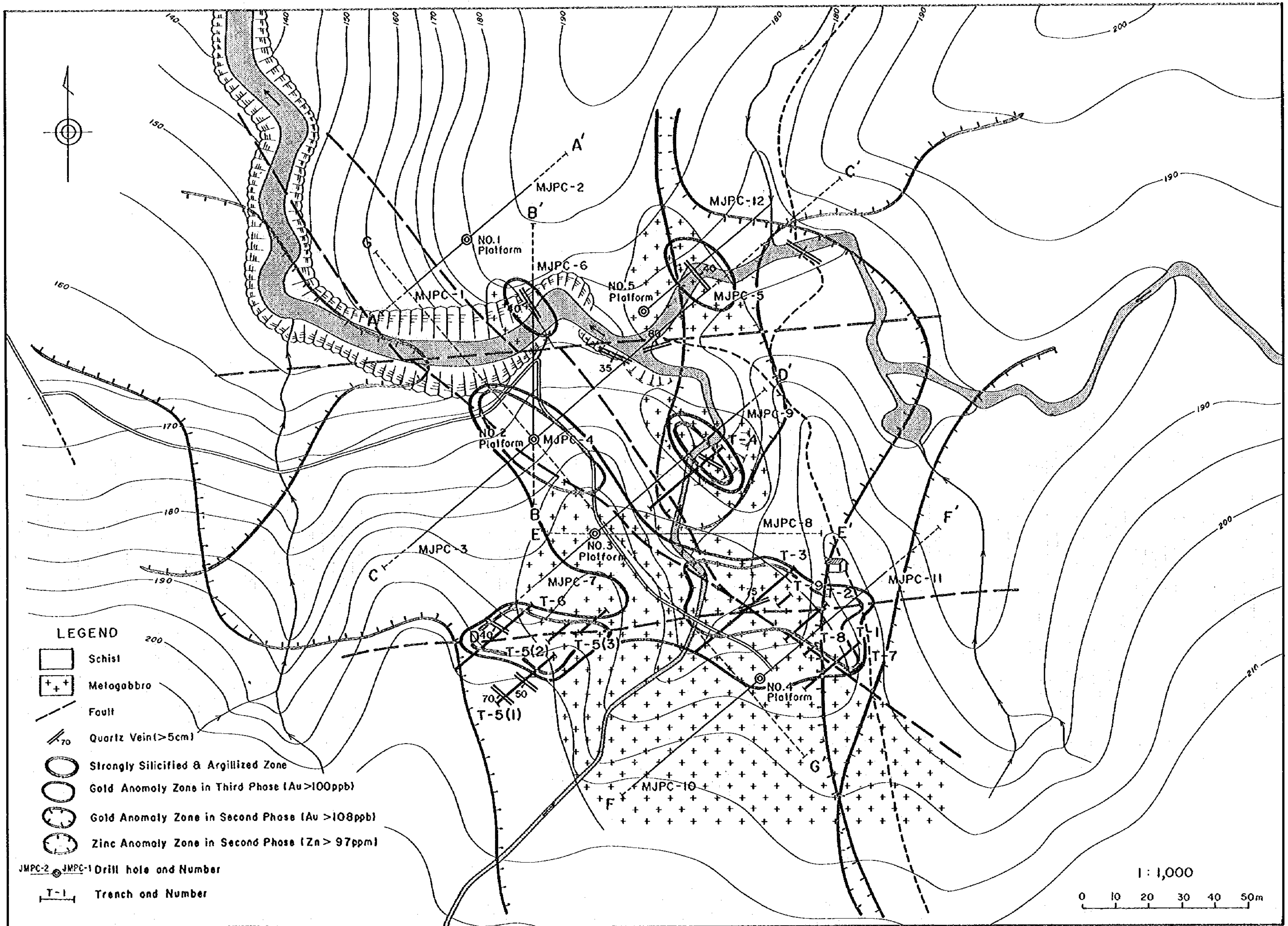


Fig. 22 Schematic Geologic Map and Mineral Occurrences in Carorongan Area

of the drill holes depend largely on the geology observed in each core during the drilling operation. Chip and channel samplings of the drill cores were undertaken for ore analysis, X-ray diffraction analysis and polished thin sections with a total of around 400 samples.

Drilling was carried out with hole diameters of NQ and BQ; and the average core recovery rate was more than 90 %. Drilling efficiency varied greatly depending on the geological conditions; due in particular to the crumbling of holes in clay areas, and inundation in and around the fracture zone. Average drilling efficiency for individual holes ranged 3.88 - 12.53 m/working day, the overall average being 7.72 m/working day.

After the survey, the drilling cores were kept in the MGB regional branch at Legazpi City.

2-4-2 Results of the Survey

(1) Geology; Based on the data from the surface geology, trenches and log of the drill cores, we could recognized at least two major lithofacies. One is the host metamorphosed sedimentary rocks which are generally characterized by interbeds of lapilli tuff, sandstone of varying grain sizes and laminated yellow green to brownish black shale/siltstone. These volcano-sedimentary sequences are generally folded with and in some cases suggesting tight folding. The other rock formation is the greenish gray metagabbro intrusive with notable presence of siderite and magnetite. It is notable that some parts of the metagabbro also show some schistosed structures suggesting that during metamorphism of the volcano-sedimentary sequence, the metagabbro was already intruded. Since the metagabbro was also affected by mineralization and usually cut by numerous quartz veins/veinlets, a younger intrusive would have been present in the area (probably the equivalent of Batalay Intrusives). This younger intrusive was the one responsible for the mineralization in the area.

The greenschist originates from shale, siltstone, sandstone and lapilli tuff which have basic composition. The schistosities generally trend NW-SE subparalleling the fault sheared zone. From microscopic observations, though it is highly altered and the ratio of the rock forming minerals was different from the original rock, the greenschist is mainly composed of albite, quartz, chlorite, epidote, sericite and carbonates with small amount of amphiboles, pyrite, magnetite and chalcopyrite. From the results of X-ray diffraction analysis, smectite is often recognized in the rock

Frequently the metagabbro has the schistosities subparalleling the sheared zone as well as the greenschist. Most of the metagabbro, occurring in the form of sheets in the Catanduanes Formation, are like strata. When it is observed with the naked eye, the metagabbro is hard to distinguish from the coarse sandstone and lapilli tuff of the Catanduanes Formation because it is strongly altered in the area. From microscopic observations, the metagabbro is mainly composed of albite, chlorite, epidote, carbonates and quartz with generally small amount of sericite, orthopyroxene, clinopyroxene, siderite, pyrite, magnetite, hematite and chalcopyrite. From the results of chemical analysis, the content of SiO_2 in the slightly altered metagabbro ranges from 41.96 % (MJPC-5, 33.15 m) to 46.89 % (MJPC-3, 18.85 m) corresponding to the ultrabasic to basic compositions. Some gabbroic rocks which are similar to the metagabbro yield ages of 82.85±2.6 Ma (ER-120), 95.35±5.7 Ma (HR-028) corresponding to the Cretaceous ages.

(2) Mineralization; From the results of drilling survey, the silicified zones delineated on the surface were found to continue to deeper levels. The strongly silicified zone continues from the surface to about 30 m below as observed in 4 holes (MJPC-3, 4, 5, 6) which were carried out on platform 2. The other silicified zone occurs at deeper levels (44 - 86 m below the surface) than the above-mentioned silicified zone and was recognized in the holes MJPC-8 and 9 that were carried out on platform 3. The major portion of the mineralization usually occurs within the metagabbro intrusives and near the contacts between the metagabbro and the host schistosed volcano-sedimentary sequences (Fig. 23).

Based on the results of ore analysis, only Au has the high potential, though there are some samples containing slightly high concentrations of Cu and Zn. As to the Au grade, the samples yield values of 1.5 g/t (MJPC-5, 26.80 - 30.85 m) in the silicified zone at shallower levels and values of 1.2 g/t (MJPC-8, 83.20 - 84.20 m) in the silicified zone at deeper levels.

The gold mineralization in Carorongan Area is characterized by silicification with strong carbonatization, sericitization and pyritization. Epidotization was generally recognized around the silicified zone, especially at deeper levels. The following characteristics are very notable regarding the occurrences of iron-bearing minerals and carbonates; the iron-bearing minerals are generally composed of pyrite while the carbonates are mainly composed of dolomite - ankerite series minerals in the high Au zone; whereas in the low Au zone the iron-bearing minerals are generally composed of magnetite or hematite, while the carbonates are mainly composed of calcite. Based on the results of bulk analysis, the weight percentages of SiO_2 of the strongly silicified zone increase only by about 10 %. It seems that the other elements were also transported or moved in small amount. Therefore, it is assumed that the carbon dioxide and sulfur originating from H_2S were mainly added to the mineralization zone by hydrothermal fluids.

The homogenization temperatures of quartz fluid inclusions have the peak at around 250 - 300° C and tend to be higher by about 50° C than the trench samples.

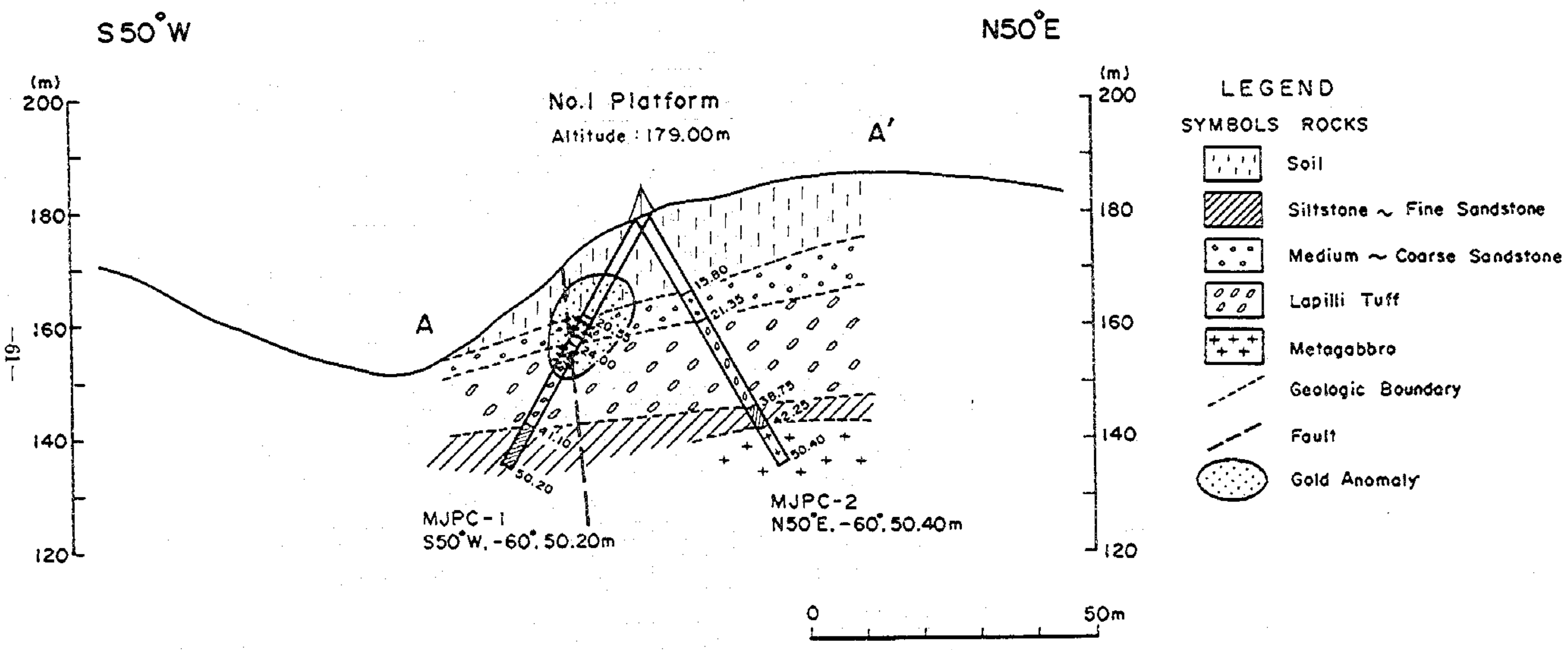


Fig. 23 Geologic Profile of Drilling (1)

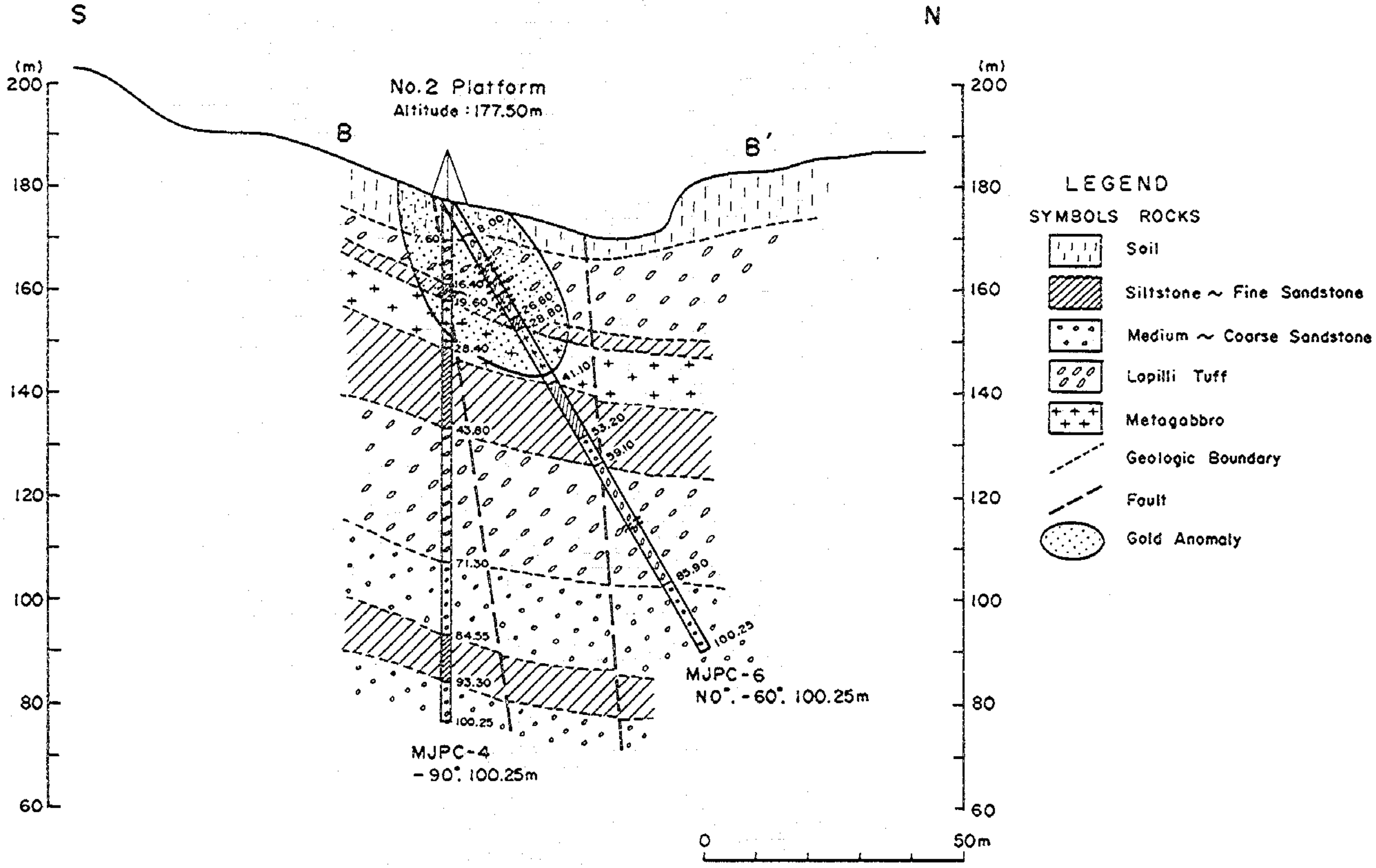


Fig. 23 Geologic Profile of Drilling (2)

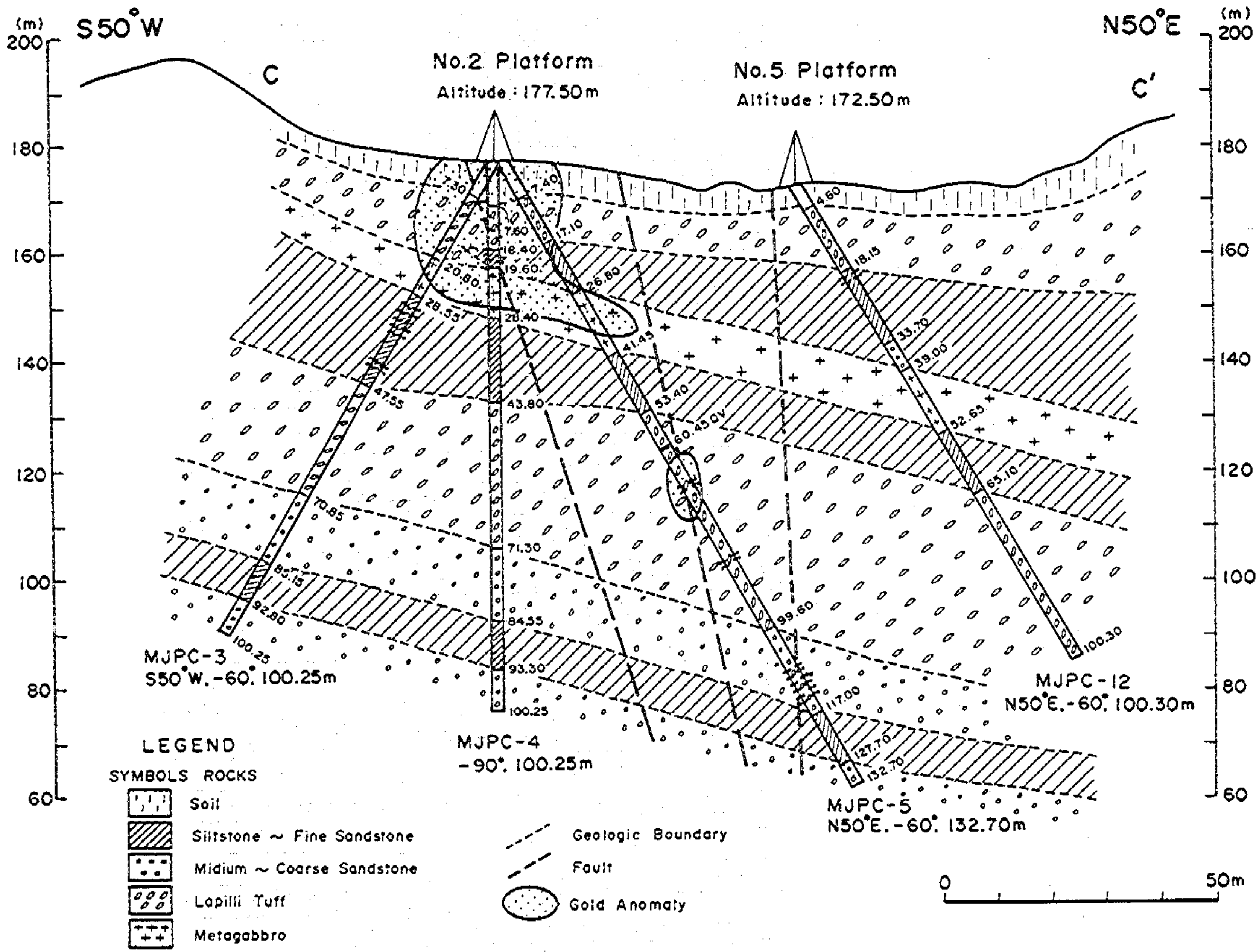


Fig. 23 Geologic Profile of Drilling (3)

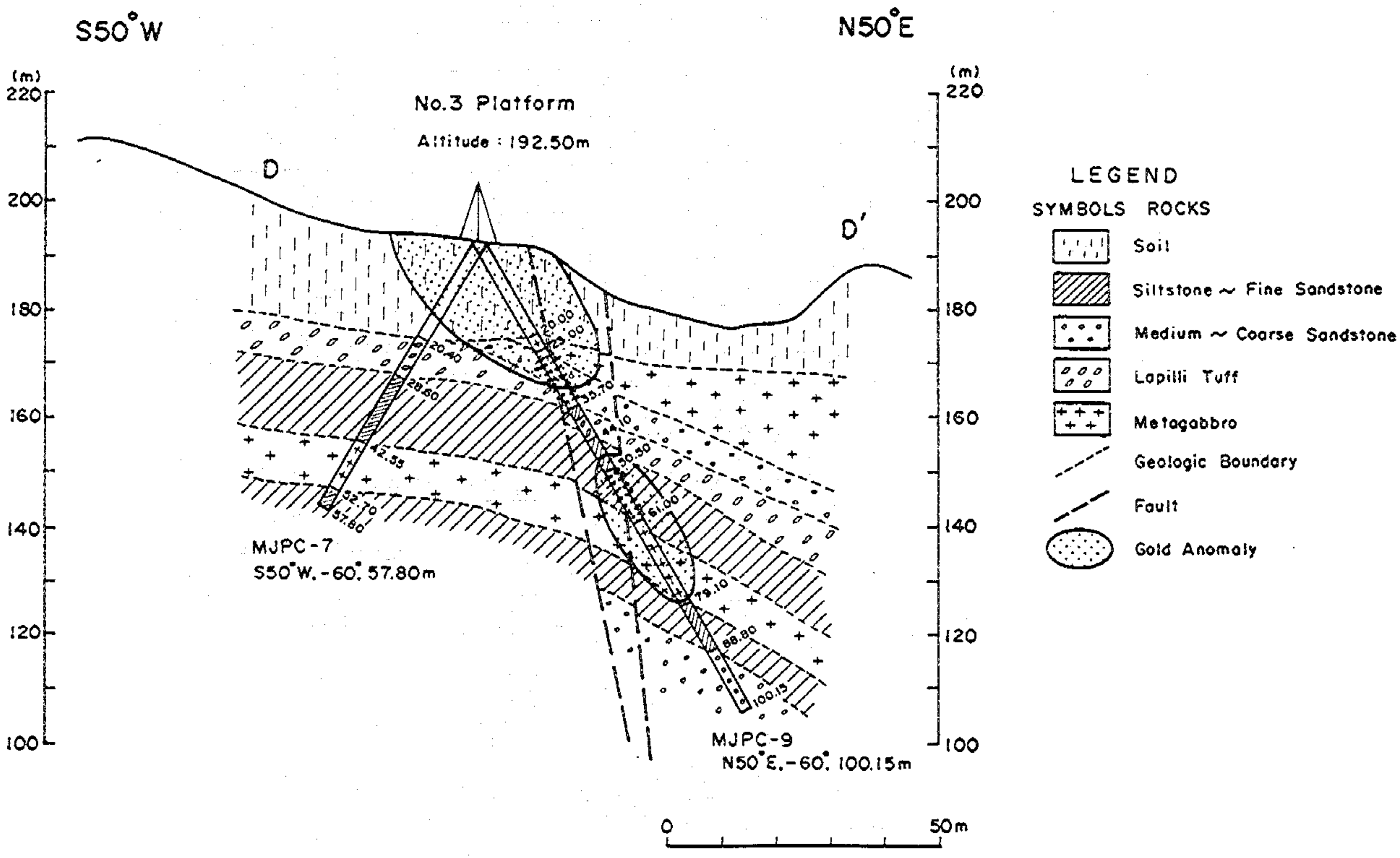


Fig. 23 Geologic Profile of Drilling (4)

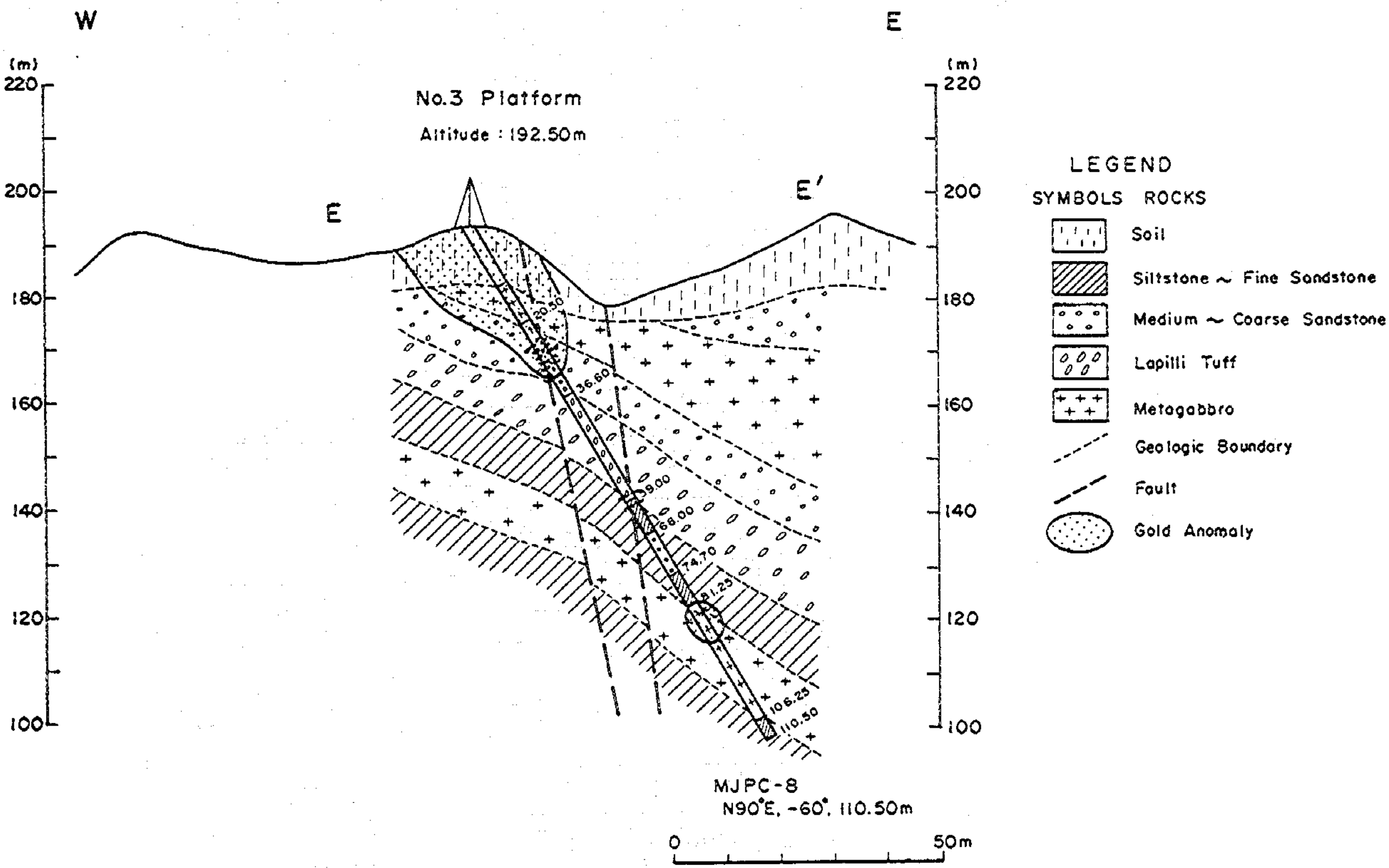


Fig. 23 Geologic Profile of Drilling (5)

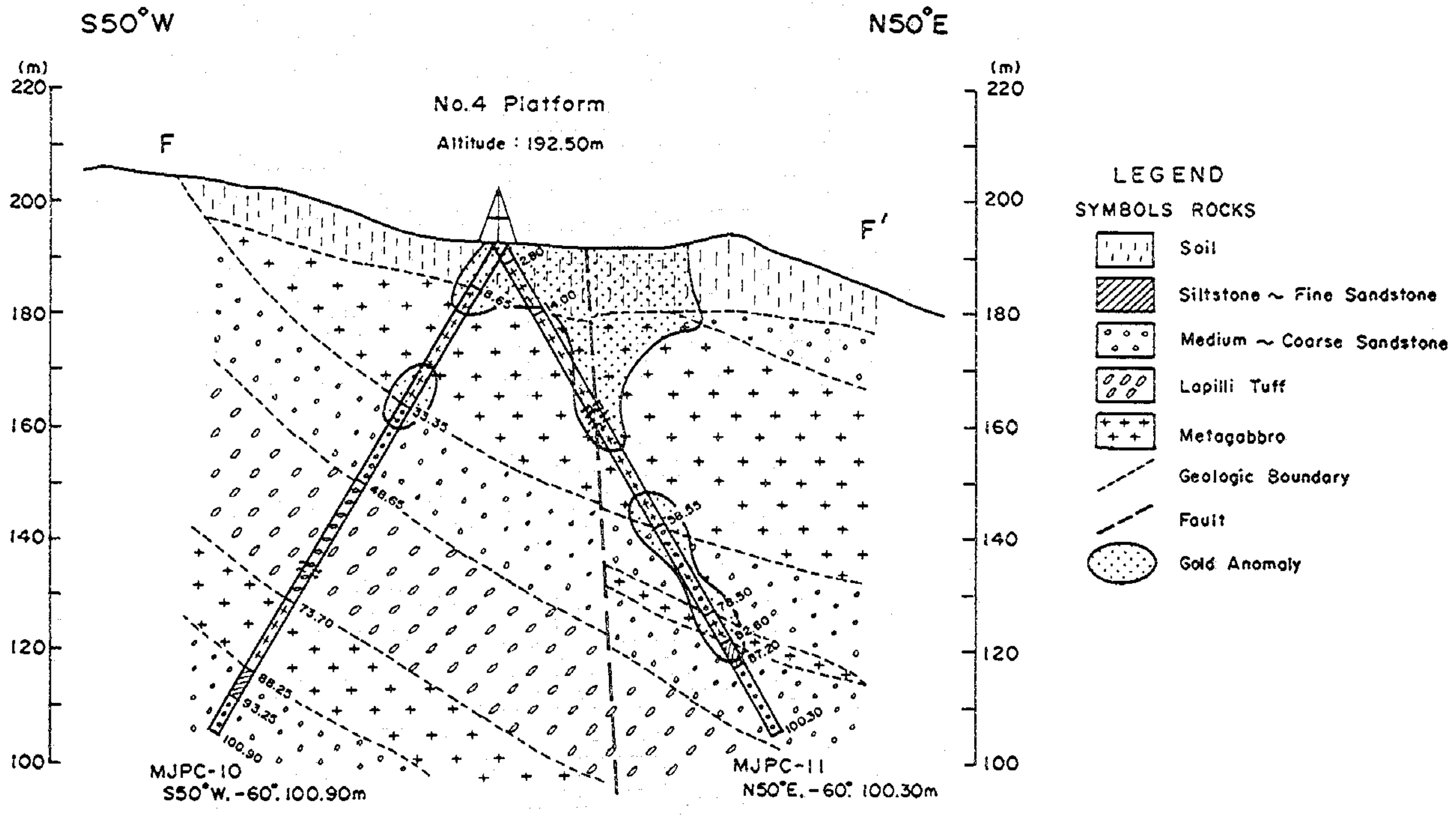


Fig. 23 Geologic Profile of Drilling (6)

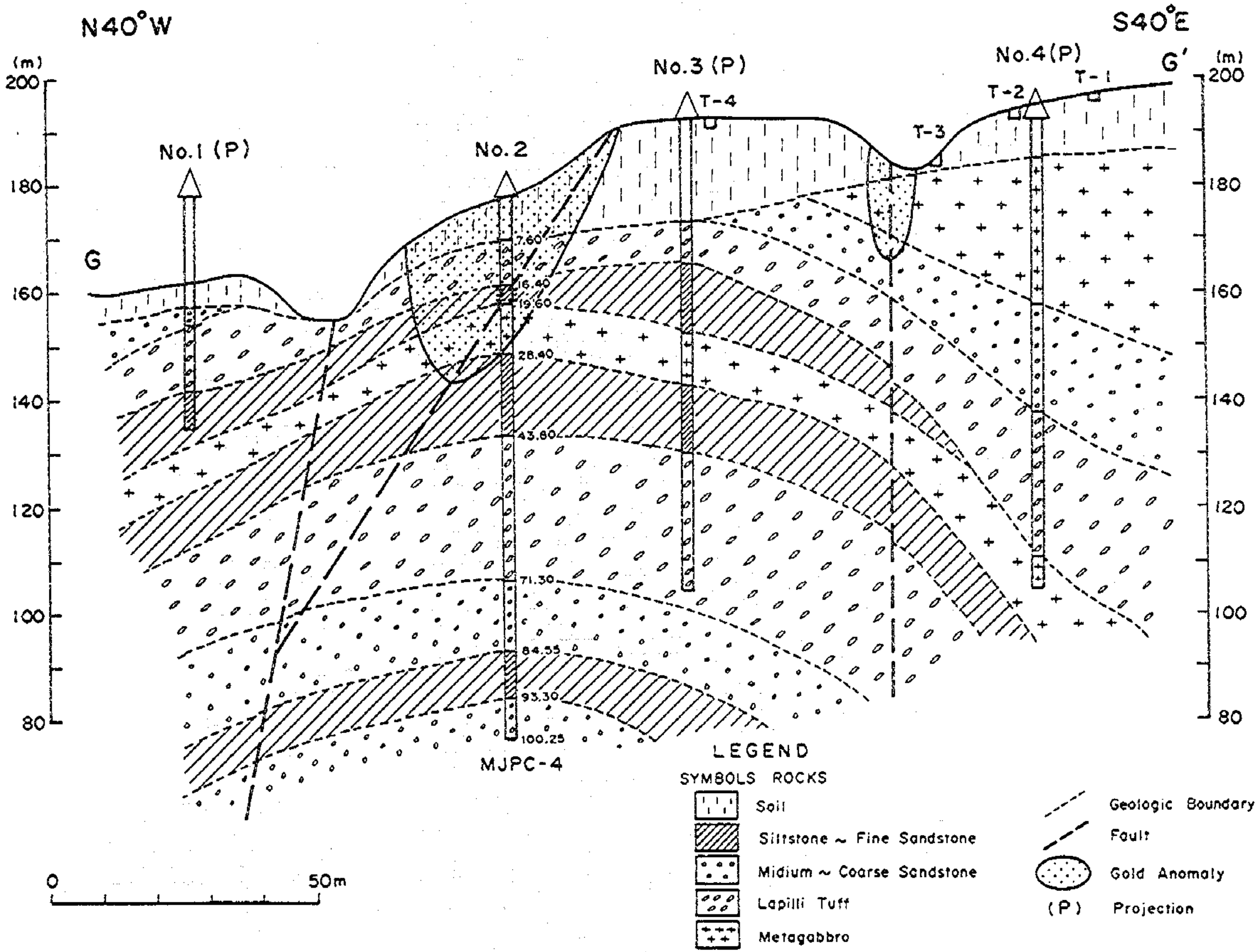


Fig. 23 Geologic Profile of Drilling (7)

2-5 Discussion

2-5-1 The First Phase Survey in 1993

The most conspicuous geochemical anomaly of Au is distributed around Dugui Too Mineral Occurrence. In the area, S and Ag anomalies overlap the Au anomaly. High scores of the fifth principal component in the PCA are also distributed in the area. Therefore, this area is considered to have high potential of Au mineralization on account of geochemical survey. From the geological survey, many intrusive bodies of Batalay Intrusives are found to generate hydrothermal alteration in the area.

The second largest geochemical anomalies of Au are distributed in Carorongan Area. Mo, Sb, Cu and Ag anomalies also overlap in the area. According to the PCA, high scores of the third and fifth principal components are distributed in the area. Geochemically speaking this area is the most promising area for Au mineralization. Many floats of quartz were observed in the area in geological survey indicating that many quartz veins are distributed here. Au, As and Cu anomalies also overlap in the East of the area. It is highly probable that Au bearing predominant quartz veins are found in the area including Tinaga by further investigation of the area.

The area around Batalay Intrusives in type locality includes many Au and Cu prospects such as San Pedro, Libjo, Aroyao and Tilod. Au, Ag, As, Cu, Mo and Sb geochemical anomalies are scattered over the area. According to the PCA, high scores of the third and fifth principal components overlap in the area and high potential for Au mineralization is indicated.

The geochemical Au anomalies are scattered at the Northeast of Pagsagnahan. As, Mo, Pb and Sb geochemical anomalies also overlap in the area, however, no mineralization has been reported from this area yet. Mineralization may be found by detailed geological survey here.

2-5-2 The Second Phase Survey in 1994

Compared with the mean values of each element obtained from the geochemical survey by stream sediments and the Clarke number, the content of gold is 72 times higher than the Clarke number, Sb: 17 times, Ag: 7 times, other elements: 0.4 to 3 times, respectively. These data suggest that gold has the highest potential in the survey area.

As the results of the PCA, the first principal component in Area A, the second, fourth and fifth components in Area B were selected as the factors showing gold related mineralization. On the whole, Taganopol River area in Area A, the upper reach of Taganopol River and Kampayas Creek in Area B were selected as the most promising areas for gold related mineralization.

In addition, the other promising areas are located at the lower reach of Barinad Creek, middle part of Tabyonan Creek and Maytung Creek. The gold related mineralization in silicified zones and near fracture zones suggests that igneous intrusives exist at deep levels and some parts of the fractures have accomplished the role as the mineralization fluid'ns paths.

The results of soil geochemical survey have revealed the following areas in their order of importance (1) Carorongan Mineral Occurrence, (2) Taganopol Mineral Occurrence, (3) Barinad Area and (4) Tagbak Area.

In the Carorongan Mineral Occurrence, Monovariant and Multivariant analytical data show that gold mineralization is concentrated near the boundary between the greenschist of the Catanduanes Formation and the Payo Formation. The results are concordant with that of the geological survey. Mineralization of Au in the greenschist unit of the Catanduanes Formation can be extended eastward where the Payo Formation covers the greenschist unit.

In Taganopol Mineral Occurrence, geochemical anomalies cannot be extracted clearly due to mixing two geological units; the Catanduanes Formation and the Payo Formation.

In Tagbak Area, Au content is very low compared with the former two occurrences. Each content of Cu, Pb and Zn content is at most 3 times compared with the Clarke number. Although there are networks of quartz veinlets on the surface, a existing possibility of promising copper deposit at shallow depth is not likely. Even if there is the deposit below the networks, it would be located at deeper portions.

In Barinad Area, high scores of the first principal component which shows the factor of mineralization of Fe, Cu, Sb, (Zn), (S) are distributed near gabbro intrusives. High scores of third and fifth principal components related to Au mineralization are also distributed in and around the area. Of particular interest is that Au mineralization relates to the gabbro intrusives like Carorongan Occurrences in the Third Phase Survey.

2-5-3 The Third Phase Survey in 1995

(1) Carorongan Area; The metagabbro is relatively strongly altered with associated gold mineralization than the greenschist, the main two lithofacies of Carorongan Area. The brittle lithologic character (usually brecciated) of the metagabbro during an earlier deformational phase due to faulting and folding might have serve as good sites for mineralization. It seems that some parts of the faults have accomplished the role as the mineralization fluids' paths. These suggest that tectonism (faulting and folding) in Carorongan Area has contributed to the mineralization that occurred.

As it has been mentioned in the above survey results, the quartz veins with high Au grade strike in NW-SE and E-W directions. Of particular interest is Trench-3 wherein the silicified zone contains 4.2 g/t Au and about 4 m in width. It seems that the silicified zone continues to N50° W direction. Therefore, the silicified zone with values of 1.3 to 4.7 g/t Au and about 3.5 m in width also exists within Trench-1. The quartz vein which contains 58.8 g/t Au and about 15 cm in width at the above-mentioned silicified zone in Trench-3, however, shows N75° E/85° NW in the dip-strike, and gold anomalies also continue to E-W direction considering the high gold anomaly zones of Trench-5 and Trench-6. These facts may be suggestive that there is a complicated event where the NW-SE and E-W oriented faults intersected near Trench-3.

We have to consider the influence of the supergene enrichment in the value of the samples collected in the trenches because the gossan in which limonite and hematite occur are recognized in all the trenches.

As to the origin of the gold, although the data were not enough to discuss it at the present, if we consider the available information, the gold might have originated from the Catanduanes Formation which was mainly composed of mafic materials or from the metagabbro which represented igneous activity during Cretaceous ages. The later volcanic activity related to Batalay Intrusives, however, may have contributed to the final stage of gold mineralization because the metagabbro had been affected by a strong hydrothermal alteration.

It seems that the ore deposits recognized in Carorongan Area is sub-economical to develop at present because the deposits are slightly low gold grade as a whole and of limited size particularly concerning the high gold portions. It is, however, notable that the gold contents of metagabbro tend to be more than 0.1 g/t where the metagabbro was altered. Therefore, Carorongan Area and its vicinity must have a huge gold potential. At present, it is difficult to conclude whether the area was the centers of hydrothermal activity which brought about the gold mineralization or not.

(2) Kampayas Area; The variation of each element in Kampayas Area was controlled by the NNE-SSW oriented fault, by the diorite body at the ridge around peak 379 m and by the strongly silicified zone at the eastern part of Kampayas Creek. The NNE-SSW oriented fault passing by the ridge of peak 379 m is believed to have served as channelways for the andesite porphyry and hydrothermal solutions.

Based on the results of geochemical survey, the highest gold potential areas are believed to be near the ridge of peak 379 m and at the intersections of NNE-SSW and E-W oriented faults in the southern part of the detailed survey area. In particular, the site for forming a gold deposit is preferable at the above-mentioned intersections of the faults because the big quartz veins of about 20 cm (0.3 g/t Au) to 1 m in width and geochemical high gold anomalies are observed near the intersections.

It is highly possible that a promising gold mineralization exists at the relatively higher part (above the 200 m in altitude) in the following reasons; There are many soil samples yielding high values of 0.1 to 2.6 g/t Au at the ridge around peak 379 m and in the southern part. High gold anomalies (more than 10 g/t Au) were recognized by the stream sediments geochemical survey of the Second Phase Survey at the eastern creek of the ridge. The quartz vein (KCR-08) of about 1 m in width at 200 m in altitude includes fluid inclusions showing the temperature ranging from 203 to 285° C (Ave. 248° C) and has low value of 0.02 g/t Au. On the other hand, the quartz vein (KCR-09) of about 20 cm in width at 270 m in altitude shows fluid inclusions homogenizing at ranging from 189 to 262° C (Ave. 217° C) and has relatively high value of 0.3 g/t Au.

Moreover, it is proposed that the geological and geochemical detailed surveys be conducted in the eastern extension of Carorongan Area and Kampayas Area because the geochemical high gold anomalies extend to the area.