REPORT
ON
THE MINERAL EXPLORATION
IN
PERAK, MALAYSIA

(PHASE I)

MARCH 1989

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

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

The JICA and MMAJ sent to Malaysia a survey team headed by Mr. H. Fuchimoto from July 22nd to November 7th, 1988. The team exchanged views with the officials concerned of the Government of Malaysia and conducted a field survey in Perak Area. After the team reterned to Japan, further studies were made and the present report has been prepared.

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

We wish to express our deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extened to the team.

February, 1989

Kensuke Yanagiya
President
Japan International Cooperation Agency

Junichiro Sato
President
Metal Mining Agency of Japan

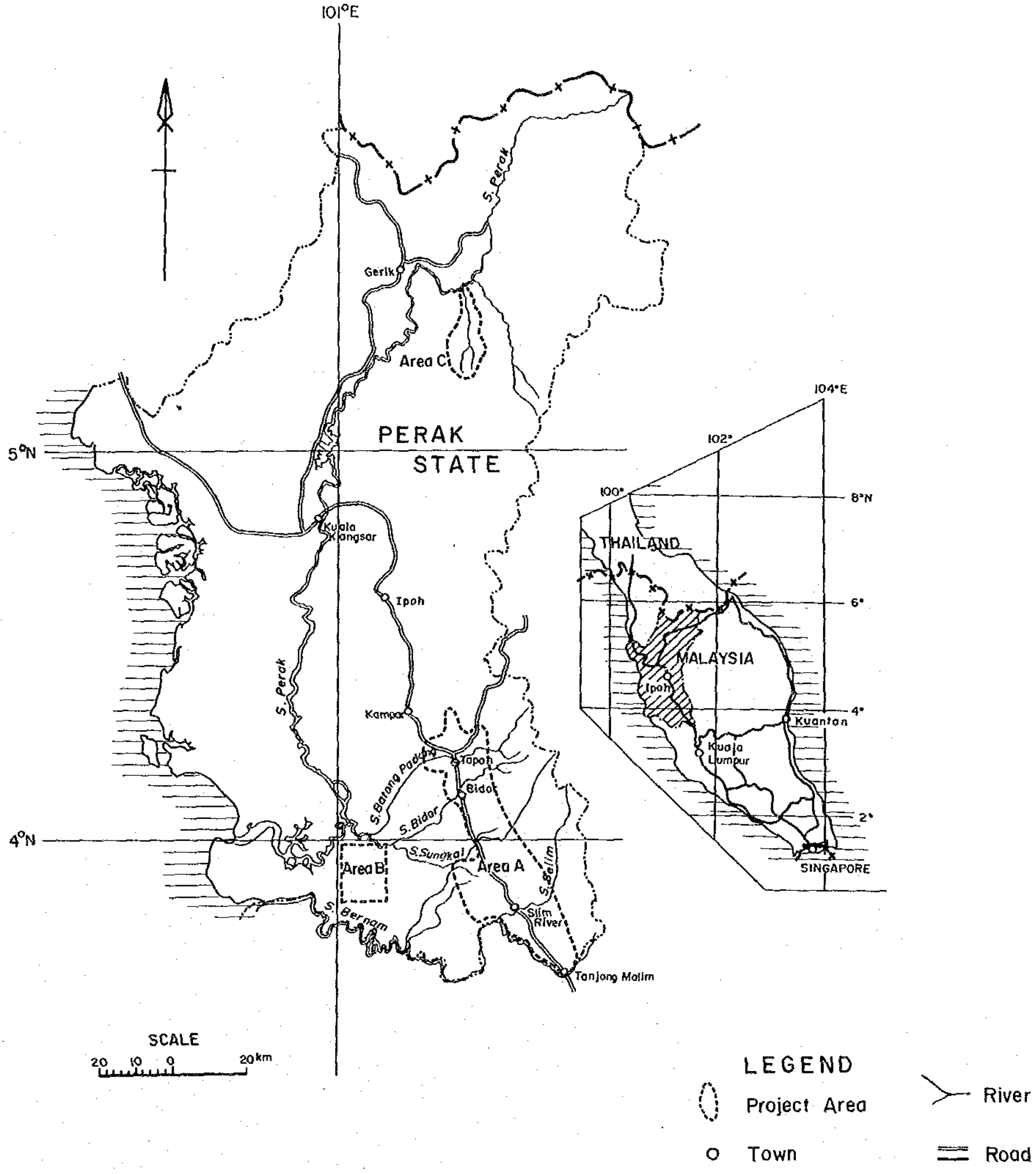

Fig. I Location Map of the Project Area (Areas A, B and C)

ABSTRACT

In Phase I of the mineral exploration in Perak, Malaysia, the following surveys were carried out in the promising areas, A, B, C (which were selected by Malaysia as having high potential for gold, tin, tungsten and rare earths) in order to determine the mineral occurrence through clarification of the geological structure. The Areas A, B, and C are located in the southeast, south and north of the Project area, respectively.

Geological and Geochemical Surveys

Area A; Area 1,060 km^2, Survey Route 374 km, Geochemical Samples 1310 pcs

Area C; Area 130 km^2, Survey Route 72 km, Geochemical Samples 360 pcs

Geophysical Survey (CSAMT Method)

Area A; Area 4 km^2 , Measuring Points 113,

Review of Existing Data

Area B ; Area 200 km^2

The following is the abstract of the surveys.

(1) Area A

1 Geological and Geochemical Surveys

The area is composed of Paleozoic phyllite and Permian–Triassic Main Range granite.

The geological survey with photo-interpretation disclosed the distribution of thick sandstone in the phyllite zone. Accordingly, the geological structures with folding axes of a NNW–SSE system became clear. The Main Range granite was lithologically classified into equigranular granite, porphyritic granite and granite porphyry, all of which were delineated.

The ore deposits consist of gold bearing quartz vein on the east of Tapah, tin quartz vein on the east of Bidor and Kaoline of a hydrothermal type on the south of Tapah. All of them occur in the Main Range granite and the Terolok Formation near the granite.

Geochemical survey that was conducted for heavy minerals and silts, disclosed a zonal arrangement of geochemical anomalies. That is, rare earths anomalies, which chiefly originate from monazite, occur in the Main Range granite and are followed towards phyllite zone, by tin · tungsten anomalies and then gold anomalies.

Among these anomaly zones, the gold zone located on the east of the Tapah–Bidor highway was proved to be of a large scale with an extension of 2–4 km ×22 km, presenting its northern part a higher potential for gold deposit than the Bukit Mas gold mine area, 2 km south of

Tapah.

2 Geophysical Survey

In the Bukit Mas area which has been considered promising from the geochemical soil survey results obtained by Geological Sruvey of Malaysia (hereinafter reffered to GSM), a geophysical survey by using the CSAMT method was carried out to obtain information on the horizontal and vertical extension of gold bearing quartz mineralization. As a result, the high resistivity zone corresponding to the ore zone could not be detected. Therefore, the mineralization are of a small scale and poor in persistence.

It has also become clear that the gold anomalies in soil occur in the metasandstone bed and has not a direct connection with the distribution of known deposit. Therefore, it is desirable to plan an exploration programme for the Bukit Mas area based on the exploration results of not only the Bukit Mas but the large-scaled gold anomaly zone.

(2) Area B

The Area B is covered by the thick Quaternary sediments. The suitable geophysical techniques of investigating the bedrock relief were reserched for the Changkat Jong or the Teluk Intan area, both of which were proposed by GSM has having high potential for tin resources.

As the results of the study on the existing data it was judged that the Changkat Jong area has few potential for tin and rare earths resources because of poor drilling results and few geochemical anomalies in the background area. While in the Teluk Intan area, high tin concentration (thickness: 1.5–6.0 m, SnO_2 content: 0.24–1.29 kg/m^3) was intersected by drill holes in an area of 3 km X 8 km and possibly extends toward north. As the thickness of tin concentration is controlled by the bedrock topography, it is concluded that gravimetric survey is the best way to investigate the bedrock profile by reasons of big specific gravity difference, easy access and low cost.

(3) Area C

The area is composed of Paleozoic mica schist and phyllite which are intruded by the Main Range granite.

Only one mineralization was found in the porphyritic granite as a few cassiterite–tourmaline –quatz veinlets.

The geochemical survey for heavy minerals and silt sediments also desclosed a zonal arrangement of gold, tungsten, tin and rare earths. That is, gold anomalies are mainly in schist zone. Tungsten and then tin・rare earth anomalies are arranged from the granite contact to the interior.

Based on the above-mentioned results, the following will be recommended for the phase II survey.

Area A: To carry out detailed geological (and/or trenching) and geochemical soil sampling over the gold anomaly zone which extends from the north of Tapah to the south of Bidor and clarify the details of mineralization.

Area B: To carry out gravimetric survey in the area centering around Labu Kubung in the Teluk Intan sheet and clarify the bedrock profile.

Area C: To carry out detailed geological and geochemical (soil and rock) surveys for the Au, Sn and rare earth anomalies located in the basins of S. Duabelas and S. Jopal., and for Au anomalies located in the lower reaches of S. Ringat and clarify their details.

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PART I GENERAL REMARKS

Chapter 1 Introduction

1–1 Background and Purpose of the Survey

The Kinta Valley, which extends southwards from Ipoh, the Capital City of Perak State, has been known as a placer-tin producing center from hundreds years ago and has supplied more than 50% of the amount of tin consumption in the free world. However, the amount of production is recently on the decrease due to drain of its resources and aggravation of the market price. Several hundred units of dregger and sand pump were operated in the best time of early 1970's, whereas only ten-odd units are moving due to suspension or stop of mining, causing tin production to reduce by half.

Under this situation, in 1987 the Government of Malaysia requested the Japanese Government a mineral exploration in Perak in order to seek new natural resources for tin. In response to the request, the Japanese Government dispatched a delegation consisting of JICA and MMAJ to Malaysia in March, 1988. The scope of work for the mineral exploration in Perak was signed between Geological Survey of Malaysia and Japanese delegation.

The mineral exploration aimes at determination of the mineral occurrence through clarification of the geologic structure.

1–2 Outline of Phase 1 Survey

1–2–1 Survey Area

As shown in Fig. I and Fig. I–1, the survey area in this phase is composed of the following three areas.

(i) Area A	Area covered	1,060 km^2
(ii) Area B	do	200 km^2
(iii) Area C	do	130 km^2
	Total	1,390 km^2

The Are A has an area of about 20 km x 50 km, covering four topographic sheets, Tapah, Gunung Batu Puteh, Changkat Jong and Tanjong Malim. Initially about 1,300 km^2 was planned to be covered but about 240 km^2 was excluded due to contamination (mining and tailing).

The Area B, which is about 12 km x 14 km in area and initially located in the Changkat Jong sheet, was studied together with an alternative area in Teluk Intan and Tapah sheets.

The Area C is located in the east of the Grik sheet and covers whole basins of the S. Grik, a branch of the S. Perak.

1–2–2 Objectives of the Survey

All of the projected areas are considered to have high potential for mineral resources of gold, tin, tungsten and rare earth elements. The objectives and activities in each area are as follows :

1) Area A

In order to investigate it's geological structure and mineralization, geological mapping and geochemical sampling were conducted. A geophysical survey (CSAMT method) was carried out in the Bukit Mas area, east of Tapah, where the geochemical soil sampling made by GSM indicated a high potential for gold mineralization.

2) Area B

All existing data available were reviewed in order to research into the most suitable geophysical technique to investigate the bedrock profile and the nature of the alluvial cover.

3) Area C

In order to investigate geology and mineralization, geological mapping and geochemical sampling were conducted.

1–2–3 Survey Method

(1) Geological Mapping & Geochemical Sampling

A geological mapping was made along most of the drainage systems in the Areas A & C. Afterwards, 1 : 50,000 geological maps were prepared based on all data obtained and results of airphoto interpretation.

Geochemical sampling was also conducted together with the geological mapping. Heavy mineral concentrates and silt samples were collected about every 1 km. Typical rock and ore samples were also taken for geochemical analysis, petrographic study and/or X-ray diffractive analysis.

No field survey was carried out in the Area B, however, a review of the existing data was made and the most suitable geophysical exploration programme was recommended to investigate the bedrock profile.

(2) Geophysical Survey

A geophysical survey (CSAMT method) was carried out in the Bukit Mas gold mineralized

Table I − 1 Amount of Survey and Analytical Item

(1) Amount of Surveys

Item	Quantity	
Geological & Geochemical Surveys		
(1) Area A	Survey Area	1,060km^2
	Survey Route Length	374km
	Number of Samples collected	
	Heavy Mineral Concentrates	605pcs
	Silts	603pcs
	Rocks	100pcs
(2) Area C	Survey Area	130km^2
	Survey Route Length	72km
	Number of Samples collected	
	Heavy Mineral Concentrates	155pcs
	Silts	155pcs
	Rocks	50pcs
Geophysical Survey (Area A)	CSAMT	
	Survey Area	4 km^2
	Measuring Points	115

(2) Analytical Item & Component

Analytical Item & Component		Quantity
(1) Thin Section		21pcs
(2) Polished Section		16pcs
(3) X-ray Diffraction Analysis		20pcs
(4) Chemical Analysis		
a) Geochemical Sample		
Heavy Mineral Concentrate	(Nb, Ta, U. Th, La, Ce, Nd, Sm, Eu, Tb, Yb,Lu)	852pcs
Rock	(Na, Ta, U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu)	150pcs
b) Whole Rock Analysis	(SiO_2, TiO_2, Al_2O_3,Fe_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, LOI, H_2O^-)	20pcs
c) Ore Analysis	(Au, Ag, Pb, Zn, Cu, As, W, Sn, Nb, Ta, U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu)	10pcs
(5) Resistivity Measurement		10pcs

area, east of Tapah in the Area A. The details are as follows.

Line spacing : 200 m   Station spacing : 150 m

Total number of lines : 10   Total number of stations : 113

The amounts of surveys and analytical items by area are shown in Table I–1.

1–2–4 Survey Period

(i) Planning and Negotiation

The work was carried out from Mar. 2, 1988 to Mar. 12, 1988 and the scope of work was signed on Mar. 9, 1988.

(ii) Field Work

The geological and geochemical field works in this phase started on Aug. 1, 1988 and ended on Sep. 30, 1988. On the other hand, the geophysical field survey started on Aug. 26, 1988 and ended on Sep. 30, 1988.

(iii) Data Analysis and Report Preparation

Data analysis and report preparation were made in Ipoh/Tokyo and completed on Feb. 28, 1989. The time schedule of Phase 1 work is shown in Table 1–2.

Table I -2 Time Schedule of Phase I Work

	Jul/1988	Aug	Sep	Oct	Nov	Dec	Jan/1989	Feb
Mobilization	26	30 22 25						
Field Work	1	26	30					
Demobilization			1	8				
Analysis & Compilation				9				8
Report Preparation								9 28

Geological Survey : ═══ } in Malaysia, ─── } in Japan
Geophysical Survey : = = = ---

1–3 Organization of the Survey Team

The members who participated in the planning and negotiation of the programme and in the field survey are as follows:

Planning and Negotiation

Japanese Delegation		Malaysian Logistic Organization	
Yoshio Matukawa	M.M.A.J.*	Yin Ee Heng	GSM****
Nobuyoshi Takabe	M.F.A**	Fateh Chand	do
Tetsuo Tsujino	M.I.T.I***	Foo Khong Yee	do
Takashi Kamiki	J I C A	Aw Peck Chin	do
Natumi Kamiya	MMAJ	Wong Yew Choong	do
		Shu Yeoh Khoon	do
		Chu Ling Heng	do

* Metal Mining Agency of Japan
** Ministry of Foreign Affairs
*** Ministry of International Trade and Industry
**** Geological Survey of Malaysia

Field Survey

	Japanese Team		Malaysian Team	
Leader, Geology & Geochemistry	Hiroshi Fuchimoto	(BEC)*	Chu Ling Heng	(GSM)
Geology & Geochemistry	Yoshiaki Shibata	(do)	Mohd. Anuar Mohd Yusaf	(GSM)
do	Masakatsu Onodera	(do)	Mohd Suhaili Ismail	(GSM)
Geophysics	Tamio Tanaka	(do)	Ho Choon Seng	(GSM)
do	Masatane Kato	(do)	Dzazali Ayub	(GSM)
do	Kazuto Matsukubo	(do)	–	
Survey	–		Liew Wee	(GSM)

* Bishimetal Exploration Co., Ltd.

Chapter 2 Geography

2–1 Location and Accessibility

The three (3) projected areas to be investigated are located in Perak State, Malaysia, being 100–250 km distant from Kuala Lumpur, a capital city of Malaysia.

The Area A extends from Tapah, 60 km south of Ipoh, to Tanjong Malim which is located near the state boundary between Perak and Selangor. Both railway and the highway which link Kuala Lumpur and Ipoh, run through the area so that it is very easy to access.

The Area B lies in a paddy field and is close to the Area A. The national roads and farm roads are well developed.

The Area C, however, is located near the national border between Malaysia and thailand, in the upper reaches of the S. Perak. There are only two routes going to the Area C. One of them crosses the Gerik River by logging company's ferryboat from Gerik, 154 km north of Ipoh and proceeds eastward about 25 km to the western ridge of the Area C by logging road. The other goes up north along the national road up to the Perak multipurpose dam, then rows upstream of the S. Perak to the northern corner of the Area C.

2–2 Topography and Drainage

In the west of Peninsular Malaysia, a mountain range of 1,500–2,000 m in height (called the Main Range) runs along a NW–SE direction. On the west of this range lies a wide lowland.

The Area A is composed of a part of the Main Range and a lowland of less than 50 m in height. The topograph is generally mild. On the west of the highway, placer tin mining was once active and many mining ponds and tailings are found scattered.

There are two drainage systems in the area, viz., S. Perak and S. Bernam. The former has S. Batang Padang, S. Bidor and S. Sungkei as its tributaries and the latter, S. Slim. All of them have big discharge and are flowing down southwestwards.

The Area B is a paddy field with 20 m above sea level. The mainstream of S. Perak flows into the Straits of Malacca, meandering on the west of the area.

The Area C is a mountainous district with 100–1,700 m above sea level and covers all the drainage basins of S. Gerik, a tributary of S. Perak. It is very rugged with many chiffs and waterfalls. In the mainstream of S. Perak some large multipurpose dams with different levels are constructed.

2–3 Climate and Vegetation

Malaysia has a typical climate of the equatorial rain forest type characterized by a uniform high temperature and humidity. Rain falls throughout the year with no pronounced rainy or dry season.

Table I–2 shows the monthly average temperature and rainfall in Teluk–Intan near the Area B. As is evident from the table, the monthly average temperatures are almost uniform. The daily temperature differences (11°C from 22°C to 33°C) are said to be much bigger than the monthly differences. Although the field surveys were conducted in August and September of relatively less rainfalls, squalls swept the teams everyday and the highway was once blocked due to flooding.

Table I -3 Monthly Average Temperature and Rainfall in Teluk Intan

	1	2	3	4	5	6	7	8	9	10	11	12	Yearly
Average Temperature	26.0	26.6	27.0	27.1	27.2	27.0	26.6	26.6	26.4	26.3	26.1	26.0	26.6
Average Rainfall	181.4	190.6	228.9	254.0	168.5	100.8	124.2	125.9	176.2	300.8	293.9	249.7	2394.9

(1951-1980)

In the Area A, as mentioned above, due to placer tin mining, a large part of the plain extending on the west of highway is barren. On the contrary, in the neiborhood or the eastern side of highway, rubber and oil palm estates are developed in various places. For diversification of agriculture and regional development, the transfer from rubber to oil palm is going on. Large–scaled oil palm estates have been constructed by Federal Land Development Agency (FELDA) in the Tanjong Malim and Changkat Jong sheets.

Most of the plains have been thus developed and accordingly, virgin forests are hardly seen except for the eastern flank of the range.

The Area B is a paddy field where some trees grow near the houses.

On the other hand, the Area C is covered with thick forests and designated as the protection area for wild animals.

CHAPTER 3 Geological Information on the Project Area

3–1 Previous Works

The following authors discussed Peninsular Malaysia from the regional point of view.

Hutchison C.S. (1977) subdivided Peninsular Malaysia into four major tectonic regions and from his studies on geochronology, petrology and geochemical data on the Main Range granites of a vast batholith and the Eastern granites, he synthetically discussed the structural development of both granites and proposed (1978) a model showing the main granites generated by structural movement of a continental collision type.

Raiah S.S. et al. (1977) discussed the granitoids and mineralization of the Eastern Belt of Peninsular Malaysia. They concluded that the mineralization is generally confined to the marginal or apical parts of the granitic intrusives and recommended to carry out a detailed geological mapping around the granite/sediments contact.

Local works in or around the project area were carried out by GSM. Some of them were published and others are kept in GSM Library as field records.

The following reports are most related to the area.

Ingham F.T. (1938) investigated geology and mineral deposits in the neighbourhood of Tapah and Telok Anson areas. He described granites and sediments in detail and outlined 20 working mines.

Gan A.S (1978) carried out geological survey in the Tanjong Malim area and clarified that the metasedimentary formations were deposited in the Middle Devonian to the Upper Paleozoic. His geochemical reconnaissance disclosed promising areas for tin, titanium, zircon and rare earths.

Loh C.H. (1987) synthetically investigated many drilling cores of Quaternary sediments in the Teluk Intan area which is adjacent to the northwest of initially proposed Area B. He clarified the sedimentary environment of each formation and indicated good prospects for finding economic concentrations of deep seated placer tin in the Labu Kubung area.

Chand F. et al (1968) conducted geological and geochemical reconnaissance in the S. Ringat in the Area C and left a detailed field record. Chemical analysis of the heavy mineral concentrates indicates that tin and gold mineralization can be expected in this area.

Lee S.L. et al (1985) carried out detailed geological and geochemcial surveys and drilling in the Bukit Mas area in the Area A and clarified a gold distribution in the soil.

3–2 General Geology

Peninsular Malaysia can be subdivided, from west to east, into four major tectonic regions (Fig. I–1) – the Western Stable Shelf, the Main Range Belt, the Central Graben and the Eastern Belt (Hutchison C.S. (1977)).

(1) The Western Stable Shelf is composed of the Lower and Upper Paleozoic miogeosynclinal sedimentary formations which are gently folded. These formations are considered as the oldest rocks of the peninsula.

(2) The Main Range Belt is characterized by the huge Main Range batholith which intrudes into isoclinally folded metasediments of th Lower and Upper Paleozoic.

(3) The Central Graben is characterized by gently folded Mesozoic sedimentary formations, which are underlain by more strongly folded basement rocks of Permian. This Graben is largely devoid of granitic rocks.

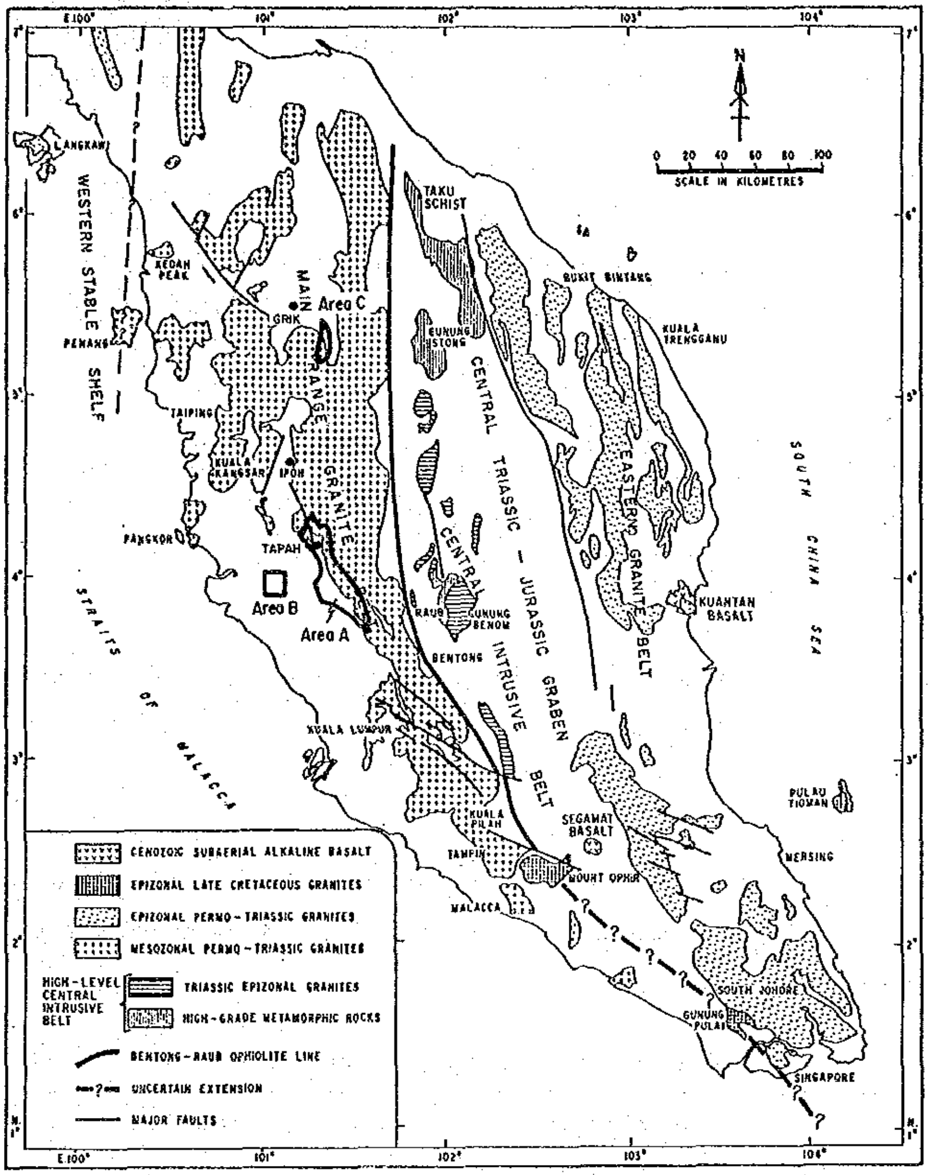
(4) The Eastern Belt is characterized by numerous elongate granitic plutons which intrude through the Upper Paleozoic sedimentary rocks.

The Main Range granites are of a mesozonal type, emplacing throughout the Permian and Triassic. They have very large phenocrysts (more than 5 cm in length), showing a porphyritic texture. Based on the studies on chemical composition and radiometry, the Main Range granites are considered to have been resulted from continental collision. Grouping of K/Ar data suggests that the Main Range Belt was uplifted in the lower Jurassic to upper Cretaceous.

The Eastern Belt granites intruded in the same period as the Main Range granites but the former is of an epizonal type, showing an equigranular texture.

The mineralization is different in different belts, i.e. the Western Main Range Belt is characterized by tin, the Central Graben, by gold and base metals and the Eastern Belt, by tin, tungsten and iron.

Hosking K.F.G (1977) described the following differences in tin mineralization between the Main Range Belt and the Easternn Belt.



after Hutchison C.S.(1977)

Fig. I-1 Geological Map of Peninsular Malaysia

Table I–4 A Comparison of the Tin Mineralization of the Main Range Belt with that of the Eastern Belt

	MAIN RANGE BELT	EASTERN BELT
1 Sn pegmatite	present	absent
2 Skarn	Sn skarn	Sn/Fe skarn
3 Malayaite ($CaSnOSiO_4$)	present	absent
4 Pleochroism of cassiterite	dark to pale red	dark to pale brown
5 Wood tin	absent	present
6 Stannite	common	rare
7 Accessories		
Sb species	present	absent
Be species	present	rare

3–3 Mining History

The gold and tin mining in the Area A has been active during last several centuries but only production records after 1880 are available.

(1) Tin

The plain on the west of the Kuala Lumpur–Ipoh railway had vigorously produced placer tin. Most of the tin mines were operated by Europeans and Chinese companies with gravel pumping, hydraulicing or dredging methods.

Table I-5 Yearly Tin (SnO_2) Production from the Whole Batang Padang Area

Year	Production in ton	Year	Production in ton
1880-1884	160.0	1918-1922	871.8
1885-1889	236.5	1923-1927	540.0
1890-1894	411.6	1928-1932	4,453.6
1895-1898	709.9	1933-1937	3,694.2
1899-1902	1,829.1		
1903-1907	3,735.2	1969-1973	13,048.6
1908-1912	1,668.8	1973-1979	7,856.3
1913-1917	1,498.9	1980-1985	6,711.0

Source : Ingham F.T. (1983) & GSM record

In the best season about 260 companies were in operation with a yearly production of 1.3 ton of SnO_2. However, only ten-odd companies are mining now.

(2) Gold

Gold has been collected as by-product of placer tin. Many gold occurrences were knwon on the west of the Tapah-Bidor highway. Gold production from the Batang Padang area is shown in Table I–6.

Table I -6 Yearly Gold Production from the Whole Batang Padang Area

Year	Production in g	Year	Prduction in g
1895- 1899	41,032	1920-1924	52,837
1900- 1904	34,266	1925-1929	77,906
1905- 1909	43,273	1930-1934	118,783
1910- 1914	51,967	1935-1937	269,123
1915-1919	44,982		

Source : Ingham F.T. (1938)

The Bukit Mas gold mine, where the CSAMT survey was conducted, is the only one hard rock mine of a vein type in Perak State.

It was operated for a few years from 1897 and shut down due to lack of funds.

Chapter 4 General Discussion on the Survey Results

4–1 Area A

4–1–1 Geological Structures, Geochemical Anomalies and Mineralization

The Area A is composed of the Terolak and Belta Formations of Paleozoic, which are intruded by the Main Range granite and the Changkat Rembian granite.

Both formations are chiefly composed of phyllite. However, the Belta formation is weakly metamorphosed and rich in metasandstone compared with the Terolak Formation. They generally strike NNW and dip 40–60°W and possibly show isoclinal foldings at some places from distribution of thick sandstone beds.

The Changkat Rembian granite (a small stock) intruding into the Terolak Formation near Tapah, seems to be contemporary with the Main Range granite from the viewpont of constituent minerals and chemical components, though their direct contact cannot be observed in the field.

The ore deposits except for placer deposit are of a vein type of gold, tin and tungsten and hydrothermal Kaolin, all of which are accompanied by granite intrusion, occurring in or near the granites.

On the north of the Changkat Rembian granite, many lineaments are developed and many mineral showings are known, suggesting close relations between them.

The geochemical survey for heavy minerals and silts disclosed a zonal arrangement of Au, Sn, W and rare earths anomalies (Fig. I–2).

The Au anomalies are distributed on the east of the Tapah – Bidor – Sungkai highway, covering an area of (2–4) km x 22 km, which includes the bukit Mas gold mine area (Fig. II–2–17).

The Au anomaly zone can be divided into three areas, namely, Northern Area, Bukit Mas Area and Southern Area, gold content for each area is shown in Table I–7.

Table I -7 Gold Contents in Anomalous Zone (Heavy Mineral Concentrate)

	Northern Area	Bukit Mas Area	Southern Area
Anomalous Area	2 km×8 km	3 km×4 km	3 km×10 km
Average Content	0.192×10^{-3} g/m³	0.026×10^{-3} g/m³	0.046×10^{-3} g/m³
Maximum Value	1.833×10^{-3} g/m³	0.099×10^{-3} g/m³	4.001×10^{-3} g/m³

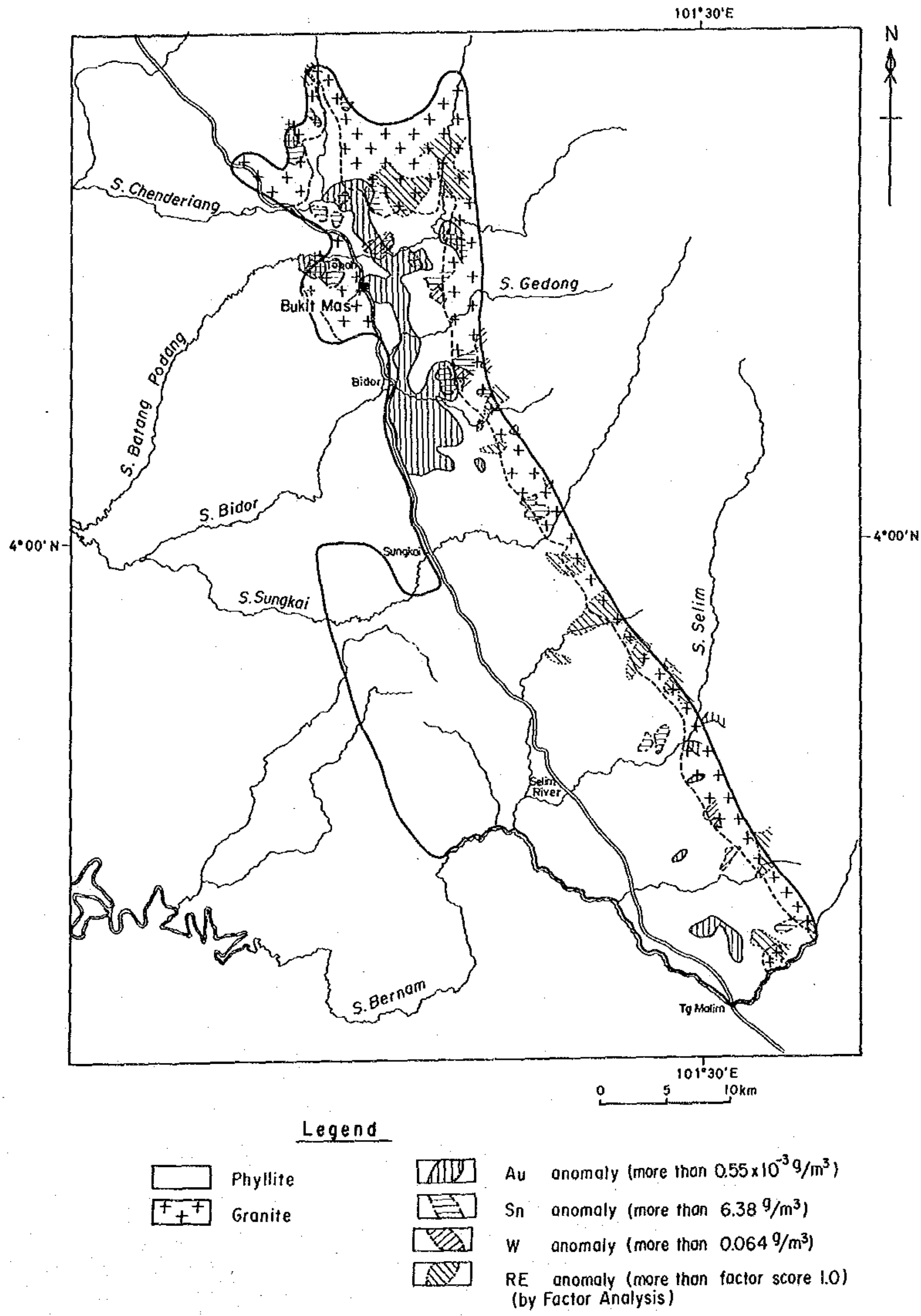


Fig. I -2 Geochemical Anomalies in the Area A (Heavy Mineral Concentrate)

As is evident from Table I–7, the Northern Area is most promising for gold deposits from the viewpoints of size of anomalous zone and gold contents. This is also supported by analytical results of silts.

Tin and tungsten anomalies often overlap each other. They tend to occur on the east of gold anomalies, in other words, in a zone closer to the Main Range granite.

Each element of rare earths is distributed lognormally. High values of rare earths are concentrated in the granite, suggesting that rare earths anomalies are caused by monazite, zircon, xenotime etc. which occur in the granite.

4–1–2 Geophysical Survey Results and Mineralization

The area is composed of phyllite of the Terolak Formation which is intruded by the Changkat Rembian granite. The boundary between phyllite and granite lies near the highway which runs at the western end of the survey area. The phyllite is generally graphytic, striking NNW and dipping 40–60°W. It apparently shows a monoclinic structure but possibly has an isoclinal folding structure. In the phyllite zone a few quartzose metasandstone beds and many segregation quartz veins are intercalated.

The Bukit Mas gold deposit is reportedly of a gold-bearing quartz vein type occurring parallel to the fissility of phyllite. No ore lodes and no silicification connot be observed around the old workings.

As a result of geophysical survey, a tabular high resistivity zone with a NNW-SSW direction was detected in the west of the survey area. Other high resistivities are found locally distributed at the southwest end and in the east of the area.

The tabular resistivity zone extends horizontally about 1600m with a 100–200 m width and continues 1,000 m towards depth. The other zones tend to extend outside (Fig. II–2–16). The tabular high resistivity zone is considered to be caused by quartzose metasandstone which occupies the west of the area. However the other high resistivity zone in the southern end of the area seems to be due to the granite left unkaolinized.

Many resistivity discontinuity lines were also detected. Among these NNW–SSE, NNE–SSW, NE–SW and N–S systems are predominant. The NNE–SSW system passing near the highway is regarded as the fault line between the granite and the metasandstone. The other lines are probably caused by fault or fractured zone.

From the results mentioned above the following can be considered.

(1). High resistivity zones were obtained in the east and west of the area. They correspond to metasandstone beds.

(2) As no resistivity structure indicating a mineralization could be detected, gold deposit probably consisting of a swarm of quartz veins would be of a small scale.

4–1–3 Potential for Ore Deposits

As shown in Fig. I–2, the contact of the Main Range granite extends from Tanjong Malim in the south to Chenderiang, north of Tapah, in a straight line of a NW–SE direction and then switchs westwards. The Changkat Rembian granite is located on the south of the bending. The lineaments interpreted on the airphotos are developed in the area sandwiched between tow granites. It is easily imagined that many structure lines pass this area, though they could not be recognized in the field due to poor exposures.

The geochemical survey results support this conception. That is, anomalies of gold and tin are concentrated in the above area and no anomalies of other components than rare earths (probably originated from the granite) are concentrated near the granite contact extending in a straight line.

Based on QME results, the area north of Sunkai is characterized by tourmaline, and the area south of Sunkai, by ilmenite. As an abundance of tourmaline and a relatively low content of ilmenite might be useful guides to proximity of the primary source (Fletcher W.K. 1984), the south of Sunkai possibly has low potential for tin resources.

As mentioned above, from the geological and geochemical point of view it can be concluded that the area north of Bidor, especially north of Tapah has high potential for gold and tin resources.

In the Bukit Mas gold area where a geophysical survey (CSAMT method) was conducted, a high resistivity zone corresponding to the quartzose sandstone bed (which is located 50–100m west of the deposit) was detected but no resistivity structure proper to the deposit could be obtained. The gold anomalies found by GSM are possibly located in the quartzose sandstone and still need drilling. However, the area north of the Bukit Mas seems to have much high potential and so the exploration in the Bukit Mas area should be carried out according to its priority in the large-scaled gold anomaly zone.

4–2 Area B

A general study on the drilling data which were obtained by GSM has drawn the following conclusions (see Fig.II–3–1, 2)

(1) Changkat Jong Area

This area (200 km^2) was initially proposed as Area B by GSM. The thickness of the Quaternary deposits from the surface to the bedrock varies from 15 m to 70 m.

The average content of theavy minerals is 300 g/m^3, which is mainly composed of ilmenite (65–80%) and rare earths oxides (13%). Few tin minerals can be observed. It is, therefore, not necessary to carry out further survey in this area.

(2) Teluk Intan Area

In the Labu Kubung area, some bore holes intersected tin concentration (240–1290 g/m^3 SnO_2) with 1.5~6.0 m widths in the Quaternary sediments. The depth of the concentration varies from 50 m to 80 m below the surface. The concentration was confirmed within an area of 3 km x 8 km and possibly extend towards northeast. As the Labu Kubung area has much higher potential for tin deposit than the Changkat Jong area, it is prefereable to designate the area as new Area B and conduct further survey in the new area.

Tin concentrations are located on or near the bedrock, so that if the bedrock relief becomes clear in advance, it is very easy to make a drilling programme.

GSM once conducted a seismic survey to clarify the bedrock relief. However, good results could not be obtained due to the following reasons ;

1 The dwellers of the area did not allow GSM's team to use a big amount of explosive as a seismic source.

2 The soft layers intercalated in the Quaternary sediments absorbed the seismic waves to the noise level.

Therefore, to meet the above purpose a gravimetric survey is recommended due to the following reasons.

1 The difference of specific gravity between the Quaternary sediments and the bedrock is more than 1.0.

2 The measurement is easy because of a flat topagraphy.

3 The measuring cost is lower

4–3 Area C

4–3–1 Geological structures, Geochemical Anomalies and Mineralization

The survey conducted in this phase was the first systematic one in the Area C, providing new geological information.

The area is composed of Paleozoic schist and the Main Range granite which has intruded into the schist. The granite is generally porphyritic except for equigranular in the contact zone of a 2–4 Km width.

A similar pattern of geochemical anomalies as that of the Area A, is observed, that is, Au anomalies in the schist zone on the east bank of S. Ringat, W anomalies in the granite zone on the east bank of S. Ringat and Au, Sn and rare earths anomalies in the basins of S. Jopal and S. Duabelas (see Fig. I–3).

These anomalies except for rare earths are considered to indicate relevant mineralizations. To complement the above results it is, therefore, recommendable to carry out detailed geological and geochemical surveys in order to check a potential for mineral resources.

4–3–2 Potential for Ore Deposits

It is well known that the drainage basin of S. Ringat produces placer gold but no information on the other metalic deposits could obtain.

The geological survey found many veins of aplite, pegmatite and quartz. All of them are barren except a few veins of cassiterite–tourmaline–quartz (width 10 cm), occurring near the granite contact.

On the other hand, geochemical analysis for heavy mineral concentrates indicated, as shown in Tables II–2–4, II–4–2 that the amounts of gold in the area are generally a little lower than those in the Area A but the amounts of tin and tungsten are higher. Especially, the amounts of rare earths are much higher (several to more than 200 times). The same trend can be seen in the QME or silt data.

As mentioned in the preceding clause, geochemical anomalies of gold, tin, tungsten and rare earths are zonally distributed in the area, which suggests a regional wide mineralization, accordingly considerably high potential for the mineralization.

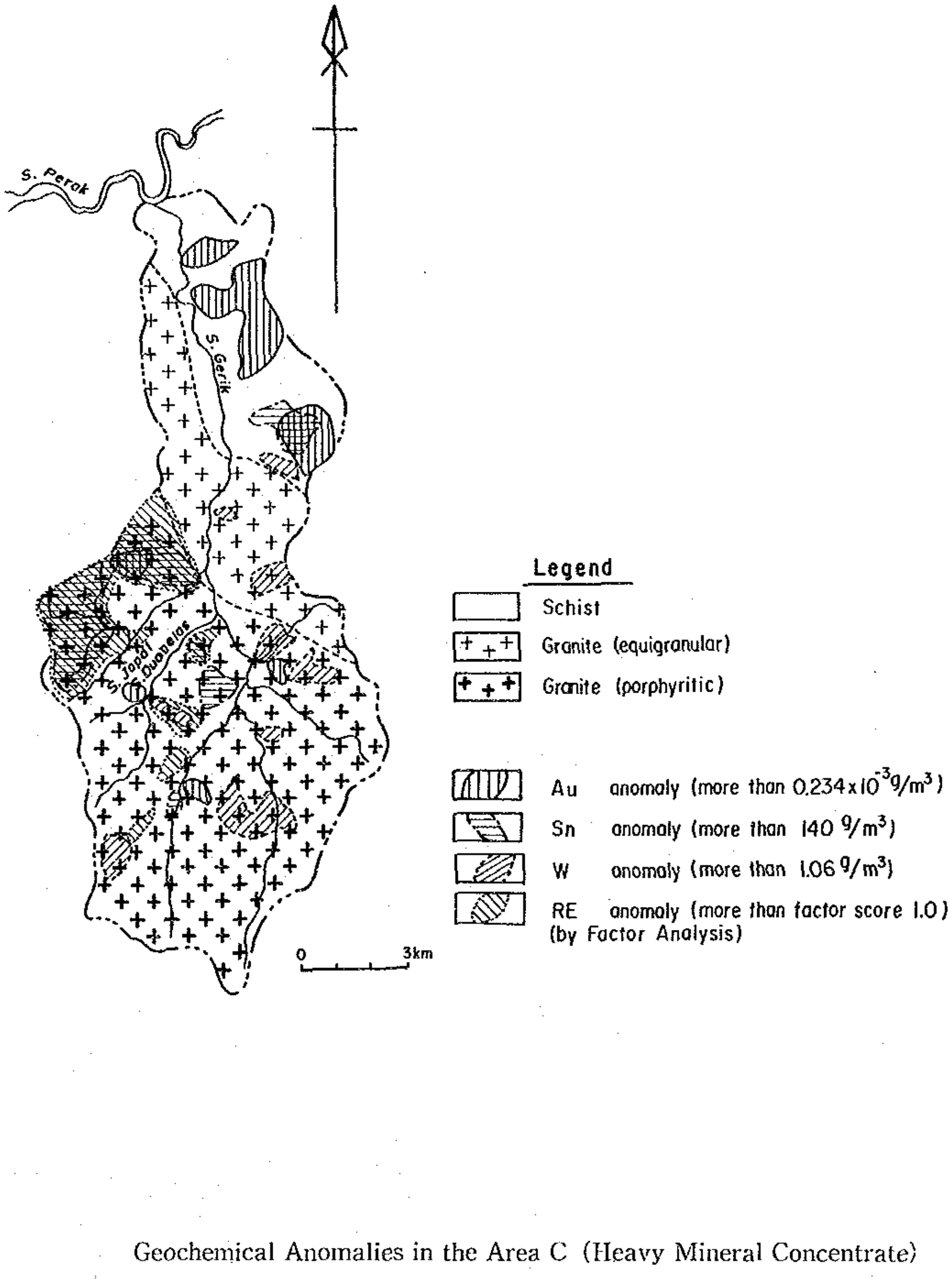


Fig. I-3 Geochemical Anomalies in the Area C (Heavy Mineral Concentrate)

Chapter 5 Conclusions and Recommendation

5–1 Conclusions

Based on the results of geological, geochemical and geophysical (CSAMT method) surveys, the following conclusions were drawn.

Area A

The Area A is composed of the Paleozoic phyllite and the Permian–Triassic Main Range granite, the latter of which has intruded into the former. The mineralization in the area is of a vein type of gold and tin.

The geochemical survey disclosed a zonal arrangement of geochemcial anomalies as rare earths → Sn · W → Au from the Main Range granite to the phyllite zone.

Among these anomalies, Au anomalies distributed on the east of the Tapah–Bidor highway are outstanding. They cover an area of (2–4) km x 22 km, including the Bukit Mas gold mine area. The anomallies lain on the north of Bukit Mas are better than those of Bukit Mas, suggesting higher potential for gold deposits than the Bukit Mas.

The Bukit Mas deposit is of a gold bearing quartz vein type in the phyllite zone. Judging from the resistivity structure obtained by CSAMT survey, the mineralization of Bukit Mas is considered to be of a small scale.

It became clear that the gold anomalies in soil found by GSM before occur in the metasandstone bed and has no direct connection with the distribution of known deposit. Therefore, it is desirable to carry out an exploration for these anomalies based on the exploration resutls of not only the Bukit Mas area but the large-scaled anomaly zone.

Area B

In the Quaternary deposits, the Teluk Intan area has much higher potential for SnO_2 concentration than the Changkat Jong area. The SnO_2 concentrations (thickness: 1.5–6.0m, SnO_2 content 0.24–1.29 kg/m^3) are controlled by the bedrock relief, therefore, it is necessary to investigate the bedrock structure prior to drilling.

By reasons of big specific gravity difference, easy access and low cost, a gravimetric survey is considered to be the best way for this purpose.

Area C

The Area C is composed of Paleozoic schist and the Main Range granite, the latter of which has intruded into the former.

The geochemical survey found a zonal arrangment of geochemical anomalies as rare earths · Sn → W → Au from the Main Range granite to the schist zone, which suggests potential for gold and tin mineralization.

5–2 Recommendations for Phase II Survey

Based on the above–mentioned conclusions, the following works are recommended for the phase II survey.

Area A: To carry out detailed geological (and/or trenching) and geochemical soil sampling over the gold anomaly zone which extends from the north of Tapah to the south of Bidor and clarify the details of mineralization.

Area B: To carry out gravimetric survey in the area centering around Labu Kubung in the Teluk Intan sheet and clarify the bedrock profile.

Area C: To carry out detailed geological and geochemical (soil and rock) surveys for the Au, Sn and rare earth anomalies located in the basins of S. Duabelas and S. Jopal., and for Au anomalies located in the lower reaches of S. Ringat and clarify their details.

PART II PARTICULARS

Chapter 1 Outline of Survey

1–1 Field Procedure

1–1–1 Geological Mapping

Using 1:20,000 drainage maps which were prepared from 1:63,360 map sheets. Detailed survey and sketch were also made at important outcrops. All the data obtained were campiled to 1:50,000 geological map, taking airphoto interpretation results into consideration.

1–1–2 Geochemical Sampling

Geochemical sampling was done in parallel with the mapping. Sample of heavy mineral concentrate, silt and rock were collected in such way that uniform sample densities were obtained.

Before the start of Phase I survey, all the Tanjang Malim area in the Area A was geochemically covered by GSM (sampling density : 0.5 pcs/km^2) so that only supplemental samples were collected from this area.

The western side of the highway (about 240 km^2) was excluded from the project area because this area seems to be much polluted by placer tin mining and has less meaning for the survey.

Thus, the surveyed Area A was finally 1,060 km^2 with an average sample density of 0.8 pcs/km^2.

Some sampling standard technique used by GSM was applied for three geochemical media. Namely, more than 35 g of heavy mineral concentrates were collected using a standard dulang (about 4.7 ℓ in volume) repeatedly, dried them in the sun and sent them to the laboratories. Number of dulang and total weight of concentrates are in Table A–6–1 & 2.

Large and small volumed silt samples (very fine-grained particle usually absorbs more metal ions) were collected at the same points as heavy mineral samples'. After drying large volumed samples in an oven for common metallic elements analysis and small volumed samples in the sun for Hg, they were split into two by 150 mesh shieve. The samples under this size were sent to the laboratories.

Representative rock samples were also collected for petrographic studies and chemical analysis.

Heavy minearl samples, silt samples and rock samples were analyzed in the GSM Kuantan Laboratory and Chemex Labs for the following elements.

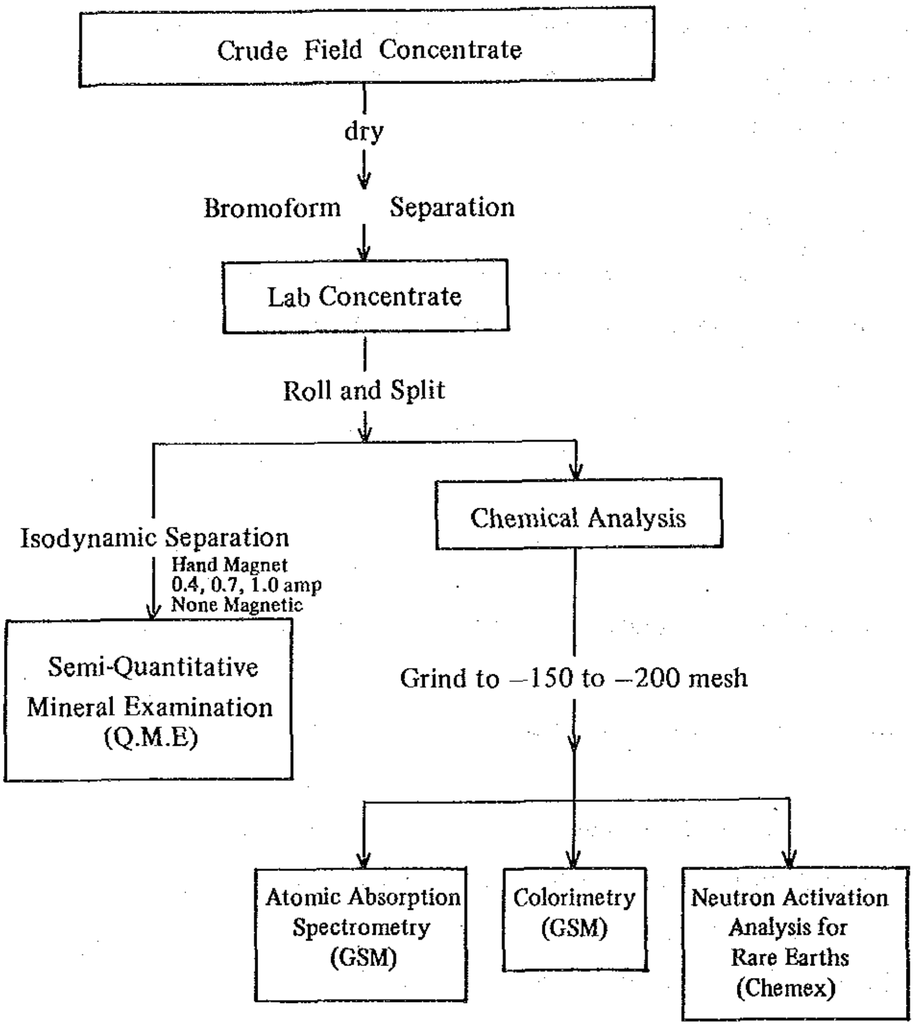


Fig. II-1-1 Flow Chart for Heavy Mineral Concentrate Analysis

Table II–1–1 List of Elements Analyzed

Sample \ Labo	GSM	Chemex Labs
Heavy mineral	Area A: Au, Ag, Hg, Sn, As, W	Nb, Ta, U Th, La, Nd, Ce, Sm, Eu, Tb, Yb, Lu
	Area C: Au, Ag, Hg, Sn As, W, Ni, Co	do
Stream sediment	Area A: Au, Ag, Hg, Sn, As, W	–
	Area C: Au, Ag, Hg, Sn, As, W, Ni, Co	–
Rock	Area A & C: Au, Ag, Pb, Sn, Cu, Sn, As, W, U, Mo, Fe, Mn, Co, Ni, Ba, Hg	Nb, Ta, U, Th, La, Nd, Ce, Sm, Eu, Tb, Yb, Lu

1–1–3 Geophysical Survey

The CSAMT (Controlled-Source Audio-frequency Magneto-Telluric) method was conducted in the survey area. This method is a semi-detailed geophysical method to delineate the promising zones of the ore bodies and/or mineralized zones by means of clarifying the underground resistivity structure.

The purpose of the CSAMT survey is to delineate the distribution of gold bearing quartz veins.

Location of the CSAMT survey area is shown in Fig. II–1–2.

(1) Principle of CSAMT Survey

The CSAMT (Controlled-Source Audio-frequency Magneto-Tellurics) is an electro-magnetic method developed as a deeper-penetrating exploration tool. The MT (Magneto-Telluric) method, using the low natural signal source, is a deeper exploration tool than the CSAMT, but this method is restricted by the field conditions such as topography, climates, seasons, etc. On the other hand, the CSAMT which uses an artificial signal source permits faster and more economical data acquisition, and has a better resolution to detect a lateral distribution of resistivity. At present, this method is widely adopted for the mineral, geothermal and groundwater explorations.

In the CSAMT method, each of the electric field parallel to the source (Ex) and the magnetic field normal to the source (Hy) is observed at the field. An apparent resistivity (ρ_a) at the frequency (f) is given by the following equation, presented by Cagniard (1953):

$$\rho_a = (1/5f) \cdot | Ex / Hy |^2 \quad \ldots\ldots (1)$$

This equation means that the resistivity of the earth could be obtained by measuring the ratio of the electric field and the magnetic field perpendicular to the electric field. The ratio of the

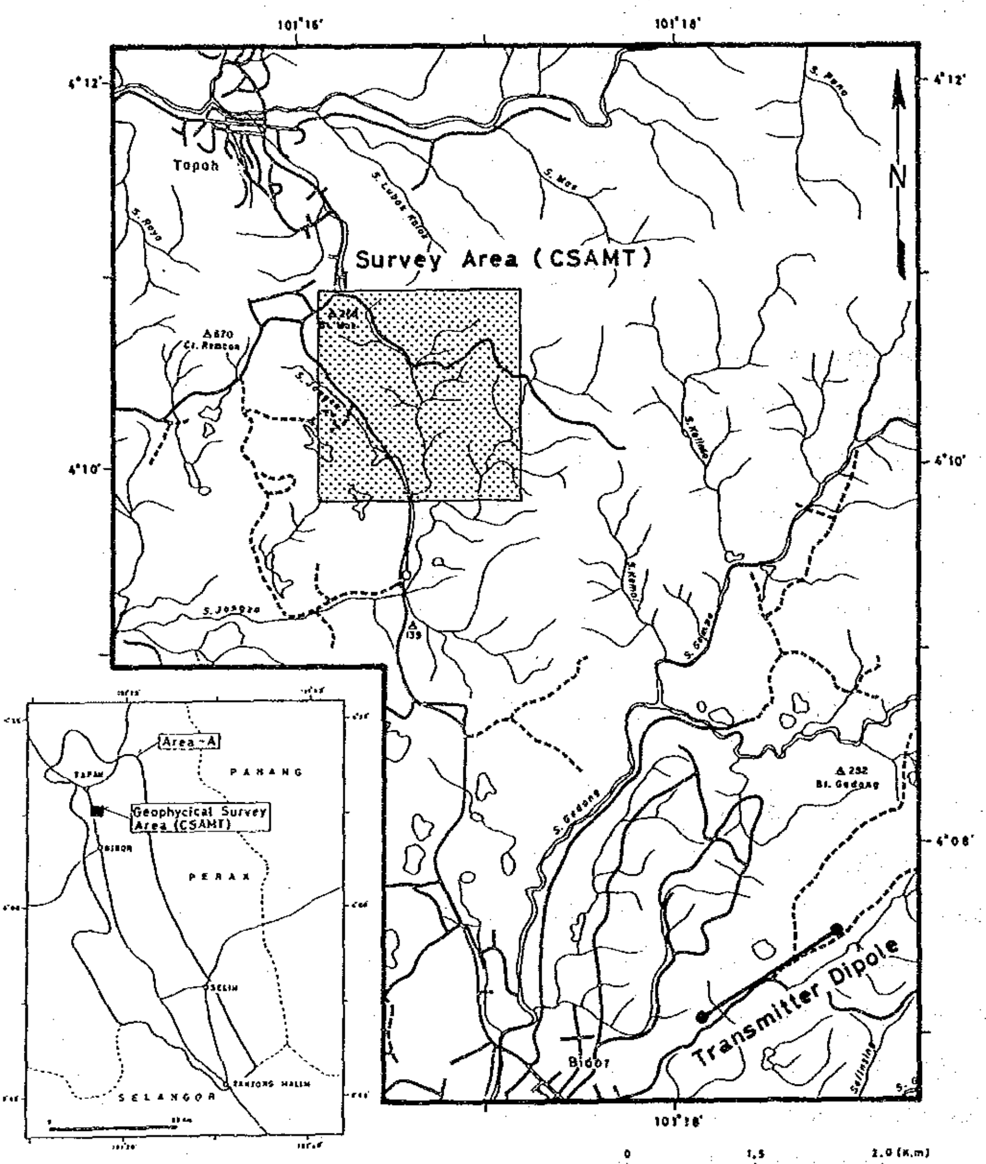


Fig. II-1-2 Location Map of the Surveyed Area (CSAMT) both field is called the wave impedance Z (= Ex/Hy).

Penetration depth (skin depth) of the electro-magnetic wave is a function of the resistivity of the earth and the frequency, and the apparent resistivities of the lower frequency range reflect the resistivity information in the depth.

However, in the unhomogeneous earth, apparent resistivity at some frequency is treated as average resistivity between the ground surface and the skin depth corresponding to the frequency.

Several presentations were made for skin depth. In general, skin depth, presented by Cagniard (1953), is adopted. Assuming the homogeneous earth of the resistivity of ρ $\Omega \cdot$m, when the electro-magnetic sine wave with frequency of f Hz is transmitted parallelly to the ground surface, the current density in the earth decreases with the depth, that is, it is proportional to $\exp[-(\pi f \mu / \rho) \cdot Z]$, where, μ is magnetic permeability in H/m. The behaviour of the current density is shown in Fig. II–1–3 schematically.

Skin depth is a depth at which the amplitude of the electro-magnetic wave becomes about 37% (1/e) of that at ground surface, and, when $\mu = 4\pi \times 10^{-7}$ H/m, skin depth δ in metres, presented by Cagniard (1953), is given by the following equation:

$$\delta = (\rho / \pi \mu f)^{1/2} = 503 \cdot (\rho / f)^{1/2} \quad \text{(2)}$$

While, bostick (1977) presented the following equation for skin depth, derived experimentally:

$$\delta = (\rho / 2\pi \mu f)^{1/2} = 356 \cdot (\rho / f)^{1/2} \quad \text{(3)}$$

Since skin depth derived from equation (2) is commonly utilized, this skin depth is used as the guideline of the penetration depth in this survey.

The basic assumption of the MT and CSAMT methods is that the plane electro-magnetic wave incidents perpendicularly to the ground surface. The CSAMT source is generally placed at the distance of three times of skin depth from the CSAMT measuring point, as shown in Fig. II–1–6. This means that the electro-magnetic energy, travelling from the source to CSAMT station in the earth, attenuate enough to eliminate the effect of the spheric electro-magnetic wave. This sonze is called "Far Field" zone.

On the other hand, in the "Near Field" zone, both of the electric and magnetic fields are affected by the current flowing directly from the source, so that wave impedance shows no variation when the frequency varies half. Then, apparent resistivity becomes twice, and ρ_a-f curve, suggesting a high resistivity layer in the depth, is obtained as shown in Fig. II–1–4. When two stations are located at the different distance from the source and the similar resistivity

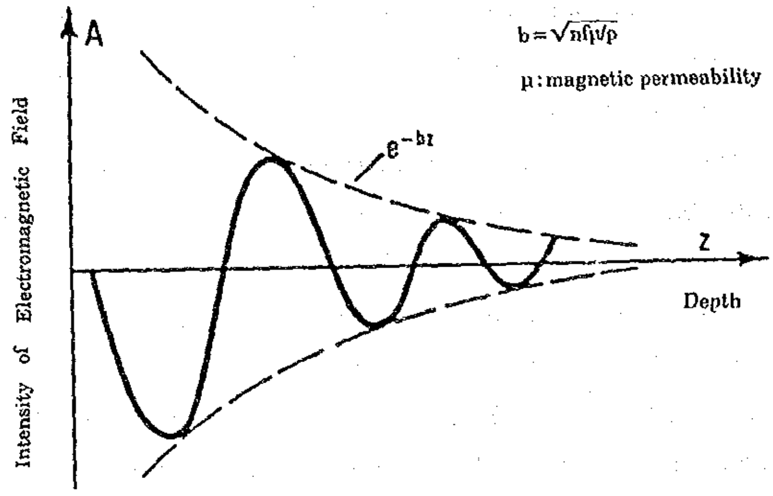


Fig. II-1-3 Current Density vs Depth

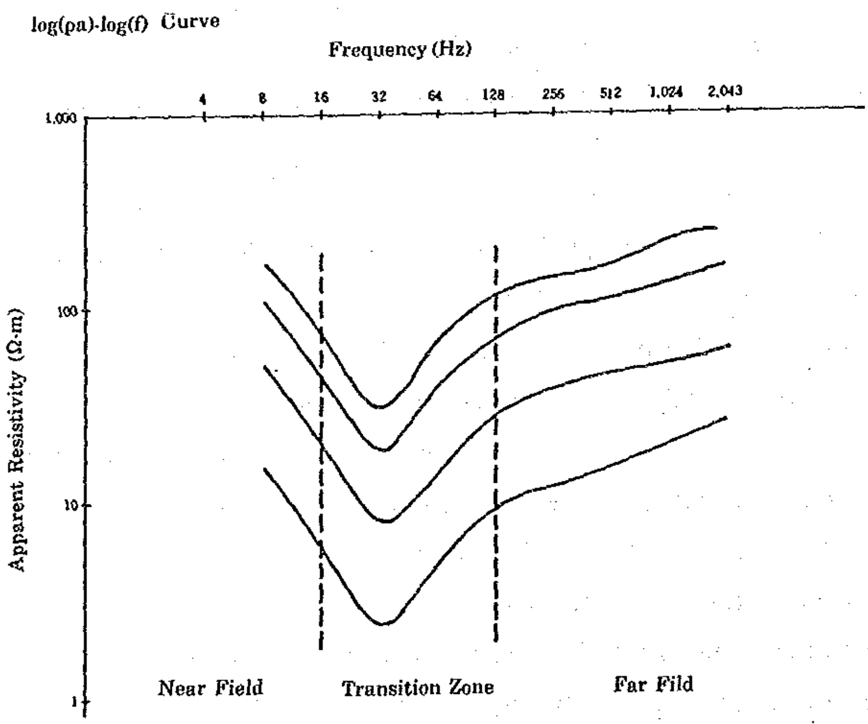


Fig. II-1-4 Cagniard ρa-f Curves

structure is existed at each of both station, the "Near Field" effect could be observed only at one station. And when several stations are located at the same distance and the resistivity structure at each station is different together, this effect could be also observed at some station. In particular, this effect could be observed in the low resistivity zone. Therefore, the "Near Field" effect should be interpreted carefully.

The zone between the "Near Field" and "Far Field" zones is called "Transition" zone.

The MT method utilizes two measurement modes; TE (Transverse Electric) mode and TM (Transverse Magnetic) mode. In the TE and TM modes, the potential dipole is placed parallelly and perpendicularly to the strike of the geological structure, respectively. And the MT method measures two components of the electric field and three component of the magnetic field, so that after obtaining these data, the discrimination of both modes and the analysis is made.

The TE mode is effective to delineate the lateral resistivity distribution but is affected by a low resistivity layer at the shallower depth. While, the TM mode is effective to detect the horizontal resistivity distribution.

Since the CSAMT method uses two components of each of one component of the electric and magnetic fields, the CSAMT should be done by the TE mode which is effective to detect a lateral resistivity distribution. Therefore, the bipole of the CSAMT source should be placed parallelly to the strike of the geological structure in the area.

(2) Arrangement of CSAMT Stations and Current Electrode

CSAMT stations were arranged on the survey lines in order to make a two-dimensional (2–D) analysis ease, and were surveyed by open traverse surveying method. Base station of the surveying was positioned at the station 82 located near the root 1.

Specifications and amounts of the CSAMT survey are given in Table II–1–2, and the location of CSAMT stations is shown in Fig. II–1–5.

(3) Measurements

In this survey, electric field, magnetic field and those phase differences at each station were obtained using the CSAMT instrument system, made by Zonge Engineering & Research Organization Inc. (U.S.A.), and the schematic illustration of CSAMT measurement in the field is shown in Fig. II–1–6.

Electric field was observed using one pair of potential electrodes, which was placed parallelly to the direction of the CSAMT source. And the resistance between electrode and the ground was lowered to less than 20 kΩ. While, magnetic field was measured by means of a magnetic sensor (antenna coil), which was placed perpendicularly to the direction of the CSAMT source.

In this survey, ten audio-frequencies of 4 Hz, 8 Hz, 16 Hz, 32 Hz, 64 Hz, 128 Hz, 256 Hz, 512 Hz, 1,024 Hz, 2,048 Hz, were utilized.

Three times of measurements at least for one frequency at each station were done according to the time table shown in Table II–1–3, and average values were utilized in analysis.

Using these observed data at each station, apparent resistivity, phase difference, etc., were calculated on real-time by the geophysical data processor (GDP–12/2GB), and these observed and calculated data were stored into a data recorder (DR–1). Apparent resistivity vs. frequency (ρ_a-f) curve, as shown in Fig. II–1–9, was made at each station. The data stored into DR–1 are shown in Appendix.

The instruments utilized in this survey are shown in Table II–1–4.

Table II-1-2 Specification and Amount of CSAMT Survey

Area	Spacing	Survey Line	Line Length	Number of Measuring Points
4 km^2	Point Spacing:	Line-A	1,800 m	13points
(2 km × 2 km)	150 m	Line-B	1,950 m	14points
	Line Spacing:	Line-C	1,800 m	15points
	200 m	Line-D	1,800 m	13points
		Line-E	1,500 m	11points
		Line-F	1,350 m	10points
		Line-G	1,500 m	10points
		Line-H	1,200 m	9points
		Line-I	1,350 m	10points
		Line-J	1,350 m	10points
	TOTAL	10 Lines	15,600 m	113points

Table II-1-3 Time Schedule of CSAMT Method for the Tapah Area

1st			**2nd**			**3rd**		
15	8:00	2,048Hz	15	9:00	2,048Hz	15	10:00	2,048Hz
14	8:03	1,024Hz	14	9:03	1,024Hz	14	10:03	1,024Hz
13	8:06	512Hz	13	9:06	512Hz	13	10:06	512Hz
12	8:09	256Hz	12	9:09	256Hz	12	10:09	256Hz
11	8:13	128Hz	11	9:13	128Hz	11	10:13	128Hz
10	8:17	64Hz	10	9:17	64Hz	10	10:17	64Hz
9	8:21	32Hz	9	9:21	32Hz	9	10:21	32Hz
8	8:25	16Hz	8	9:25	16Hz	8	10:25	16Hz
7	8:30	8Hz	7	9:30	8Hz	7	10:30	8Hz
6	8:35	4Hz	6	9:35	4Hz	6	10:35	4Hz
	8:40	END		9:40	END		10:40	END
4th			**5th**			**6th**		
15	11:00	2,048Hz	15	12:00	2,048Hz	15	13:00	2,048Hz
14	11:03	1,024Hz	14	12:03	1,024Hz	14	13:03	1,024Hz
13	11:06	512Hz	13	12:06	512Hz	13	13:06	512Hz
12	11:09	256Hz	12	12:09	256Hz	12	13:09	256Hz
11	11:13	128Hz	11	12:13	128Hz	11	13:13	128Hz
10	11:17	64Hz	10	12:17	64Hz	10	13:17	64Hz
9	11:21	32Hz	9	12:21	32Hz	9	13:21	32Hz
8	11:25	16Hz	8	12:25	16Hz	8	13:25	16Hz
7	11:30	8Hz	7	12:30	8Hz	7	13:30	8Hz
6	11:35	4Hz	6	12:35	4Hz	6	13:35	4Hz
	11:40	END		12:40	END		13:40	END
7th			**8th**			**9th**		
15	14:00	2,048Hz	15	15:00	2,048Hz	15	16:00	2,048Hz
14	14:03	1,024Hz	14	15:03	1,024Hz	14	16:03	1,024Hz
13	14:06	512Hz	13	15:06	512Hz	13	16:06	512Hz
12	14:09	256Hz	12	15:09	256Hz	12	16:09	256Hz
11	14:13	128Hz	11	15:13	128Hz	11	16:13	128Hz
10	14:17	64Hz	10	15:17	64Hz	10	16:17	64Hz
9	14:21	32Hz	9	15:21	32Hz	9	16:21	32Hz
8	14:25	16Hz	8	15:25	16Hz	8	16:25	16Hz
7	14:30	8Hz	7	15:30	8Hz	7	16:30	8Hz
6	14:35	4Hz	6	15:35	4Hz	6	16:35	4Hz
	14:40	END		15:40	END		16:40	END

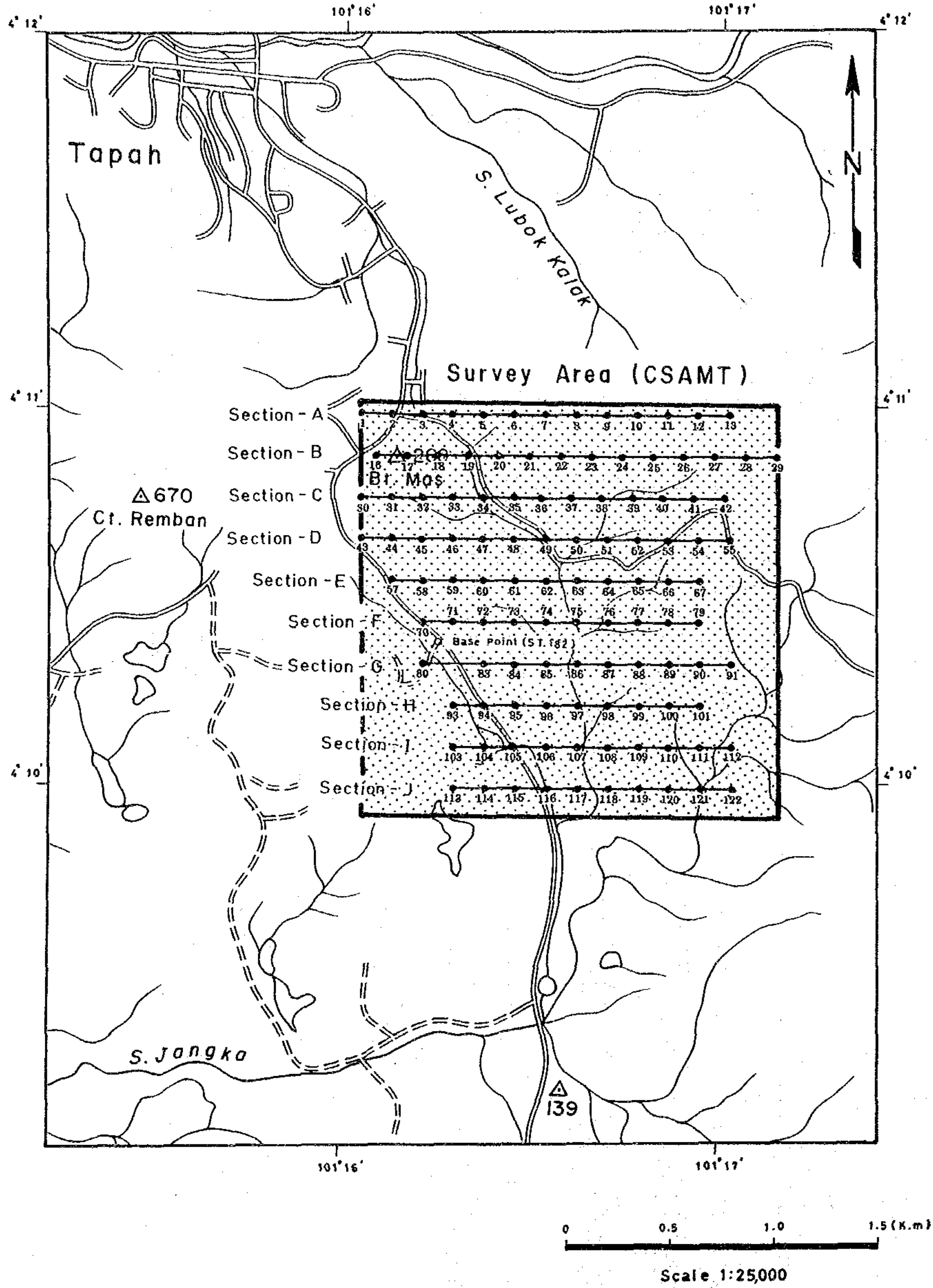


Fig. II-1-5 Location Map of the Survey Stations

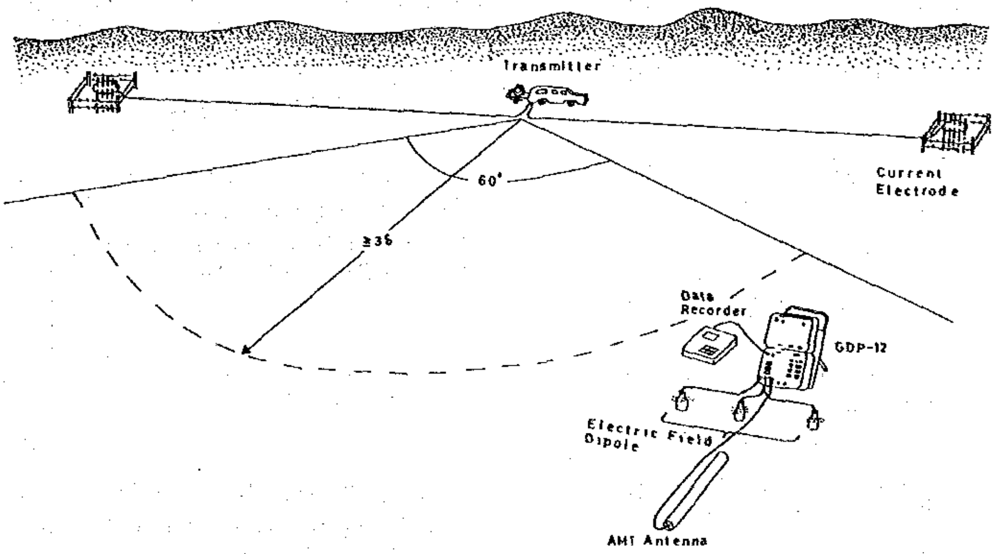


Fig. II-1-6 A General Concept Map of CSAMT Surveyed System

Table II-1-4 CSAMT Equipment Used

System	Equipment	Model	Specification	Amount
Transmitting System	Engine Generator	ZMG–10	Output Power ; 10 kVA/400Hz/3–phase	1 set
	Transmitter	GGT–6	Output Power ; 25 kVA, Current ; 0.2 A to 20 A, Output Voltage ; maximum 1 kV, Output Frequency ; DC to 12 kHZ	1 set
	Transmitter Controller	XMT–12	Frequency Controllable ; 1/16 Hz to 2,048 Hz	1 set
Receiving System	Data Processor	GDP–12/2GB	Frequency ; 1/16 Hz to 2,048 Hz, Detection Signal ; minimum 0.2 μ V/1,024 stacking, Filter ; 50/60 Hz notch-filter, A/D Converter ; 12-bit, Digital Processor ; 16-bit built-in microprocessor with boot ROM and 16 kB RAM, I/O Port ; one RS–232C serial port, Output ; electric/magnetic fields, apparent resistivity, phase difference, etc.	1 set
	Antenna Coil	ANT/1B	Coil ; single-axis, ferrite core coil, Windings ; 7,000 turns, Sensitivity; 0.5 mV/γ/Hz	1 set
Recording System	Data Recorder	DR–1	Memory ; 442 kB RAM, I/O Port ; two RS–232C serial ports	1 set

1–2 Data Processing

1–2–1 Geological Survey

Typical rock and core samples collected by the survey were observed under the microscope and chemically analyzed whole rocks and ores to study the variation in mineral or chemical composition. Some samples were taken from the central and marginal parts of the Tapah kaolinized zone in order to identify the constituent minerals and each mineral ratio through X-ray diffraction analysis. All kaoline samples were also analyzed for gold to check the relation between kaolinization and gold mineralization.

1–2–2 Geochemical Survey

The rocks distributed in the Areas A and C are composed of granite and sedimentary rocks. One hundred fifty pieces of typical rocks (100 pcs from A, 50 pcs from C) were analyzed to check the differences for every elements between granite and sedimentary rocks. As a result, significant differences could not be obtained, therefore, all analytical data were statistically processed.

(A) Heavy Minerals

1. Semiquantitative Mineral Examination (QME)

In order to identify heavy minerals and to study their distribution, 203 pcs of heavy mineral concentrates (167 pcs from the Area A, 46 pcs from the Area C) were chosen for microscopic study. All the QME works were done by GSM. The techniques are as follows.

The crude field concentrate is dried and then bromoform* (SG : 2.9) is used to separate the heavy mineral fraction (Lab-concentrate) from the light minerals. 1–3 grams of Lab-concentrate is separated into 5 fractions using hand magnet and isodynamic separator. These are:

(1) magnetic fraction – picked by hand magnet
(2) 0.4-ampere fraction
(3) 0.7-ampere fraction
(4) 1.0-ampere fraction
(5) nonmagnetic fraction

The heavy minerals in each fraction are identified under the binocular microscope and each mineral percentage is evaluated.

An example of the microscopic observation card is shown below.

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* Bromoform separation was applied for the Tanjong Malim samples but not used for other areas, because heavy minerals were well separated.

To minimize sampling errors, the concentrate with visible gold flakes is analyzed for gold in the following way.

gold content = weight of gold flakes picked by hand under the microscope

+ analytical gold value of the host sample

As chemical or mineralogical analyses of heavy mineral concentrates are notoriously erratic, it would be less meaningful to process the data quantitatively (Zantop and Nespereira (1979) and others).

However, this time the survey team repeated panning from 1 to 80 times to collect more than a certain amount (35 g) of heavy mineral concentrate. This variation is too large to be disregarded, the amount of each mineral was, therefore, standardized (viz weight per standard dulang) and divided into 3 classes, m (mean value) – 2 m, 2 m – 4 m and 4 m+. Distribution of each mineral is shown in Plates 5–1 & 5–2.

(B) Quantitative Analysis

Analytical data of Area A samples (852 pcs x 18 components) and Area C samples (155 pcs x 20 components) were standardized and statistically processed by computer.

Histograms and cumulative frequency distribution diagrams were constructed in order to decide the threshold value of each component. And then geochemical anomalies were extracted by means of single component analysis and multivariate analysis.

1) Single Component Analysis

Based on the histogram and cumulative frequency distribution of each component (Fig. II–1–7 (1), (2) the threshold value was determined by Sinclair method (1974). Based on the inflection points in each cumulative frequency distribution diagram, the whole population was divided into two or three populations, viz, background population and anomalous population. The top 2.5 % value of the background population was used for the threshold value of the whole population.

Components of Au, Sn and W were interpreted but analytical values of Ag, As and Hg were so small that their interpretations were omitted.

Regarding Ni•Co and rare earths, interpretation was made collectively for the following reasons,

1 The correlation ratio between Ni and Co is very high.

2 The rare earths analyzed for Nb, Ta, U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu give very high correlation ratios among them (0.70–0.97).

Table II-1-5 Semiquantitative Mineral Examination

ARUS	%	BIL	JENIS MINERAL	%	1	2	3	4	5	6	7	8	9	10	11	12	13	
HM	trace	1	MAGNETITE	100	trace													
0.4 amp	97.2	2	ILMENITE	100		97.2												
		3	GARNET	.01			trace											
0.7 amp	1.9	2	ILMENITE	80		1.52												
		3	GARNET	.01			trace											
		4	EPIDOTE	10				.19										
		5	ALLANITE	10					.19									
		6	FEOXIDE	.01						trace								
1.0 amp	.3	7	HYD.ILMENITE	70							.21							
		8	MONAZITE	20								.06						
		9	RUTILE	10									.03					
		10	TOURMALINE	.01										trace				
Non mag	.6	9	RUTILE	10									.06					
		11	ZIRCON	65											.39			
		12	LEUCOXENE	20												.12		
		13	TOPAZ	5													.03	
J U M L A H %					0	98.71	0	.19	.19	0	.21	.06	.09	0	.39	.12	.03	99.99

ii/rb

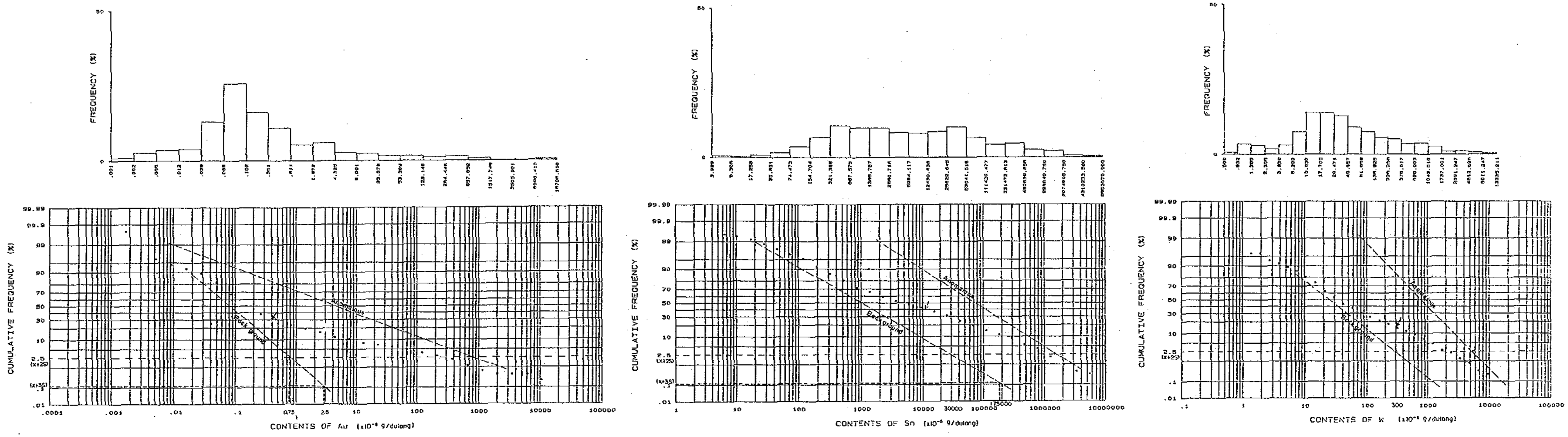


Fig. II-1-7 (1) Histogram and Cumulative Frequency Distribution of Heavy Mineral Concentrate (Area A)

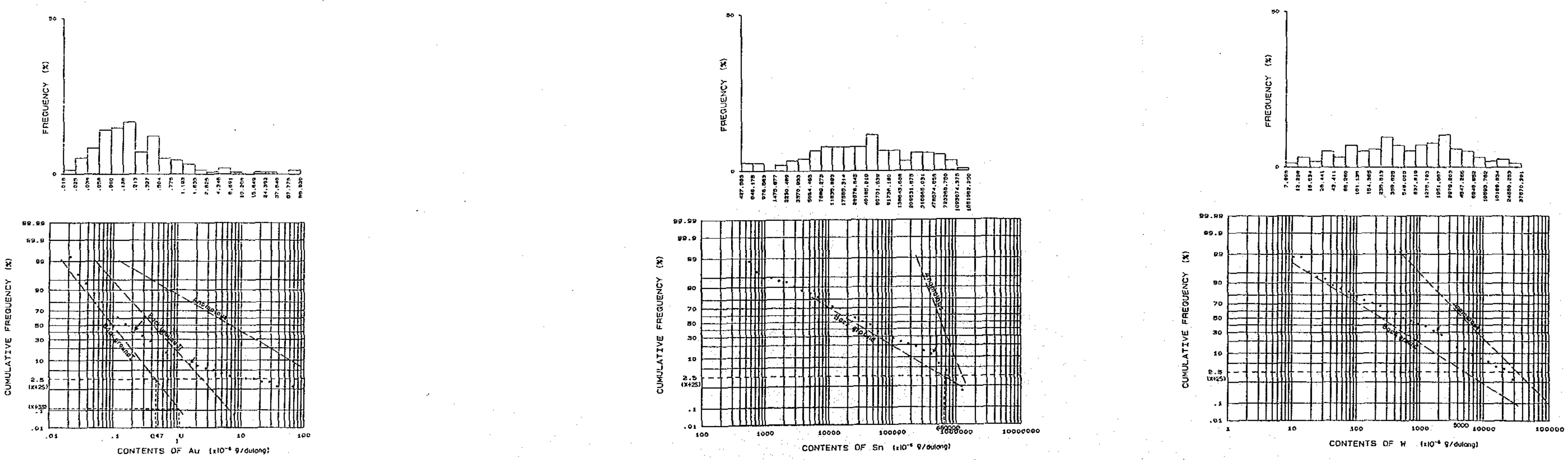


Fig. II-1-7 (2) Histogram and Cumulative Frequency Distribution of Heavy Mineral Concentrate (Area C)

3 Rare earths contents are usually shown by the total amount of rare earths oxides per unit volume.

2) **Maltivariate Analysis**

The fractor analysis with a varimax rotation method was applied for extraction of a fewer representative and hypothetical factors to explain the variations among many analytical data. This method has the purpose to clarify the relationships of each sample with mineralization or characteristics of host rock, by assigning a factor score to each sample.

(B) **Silt**

The analytical results of 1,005 samples (850 samples x 6 components from the Area A and 155 samples x 8 components from the Area C) were processed in the same way as those of heavy mineral concentrates (Fig. II–1–8 (1), (2)).

1) **Single Component Analysis**

The threshold value was determined for each element, but the following components were not interpretated owing to the reasons indicated below.

(1) Ag: There are many low values under the detection limit. Both mean and maximum values are rather low in both areas normaly, Area A: 0.066 ppm and 0.800 ppm, Area C: 0.119 ppm and 0.400 ppm. The correlation ratios with other components are also very low.

(2) As: The correlation ratios with other components are very low and the factor loading values are small.

(3) W: Although the correlation ratio with Sn and the factor loading value are not so low in the Area A, both values are very low in the Area C.

(4) Hg: Most of samples (63–77 %) show very low values under the detection limit in both areas, giving 0.180 ppm and 0.269 ppm for maximum values of Area A and C.

After all, the analytical values of Au and Sn in both areas were interpreted through single component analysis.

2) **Multivariate Analysis**

The Multivariate Analysis of a varimax method was also applied for the analytical data by area.

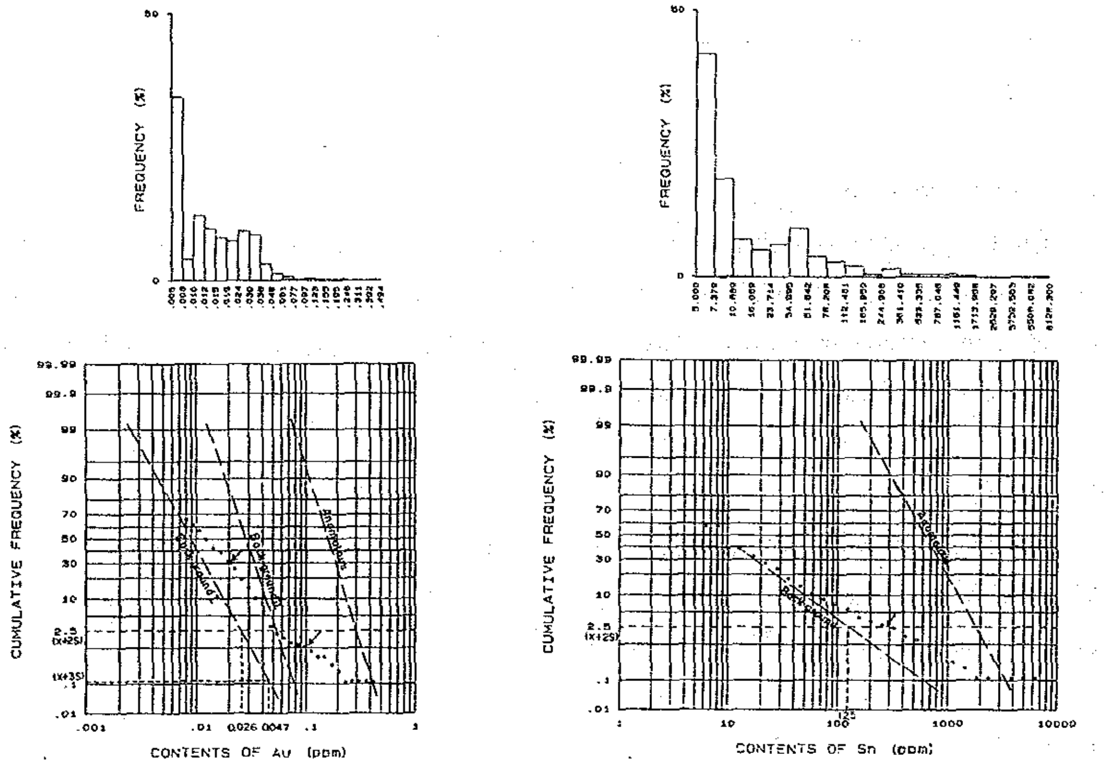


Fig. II-1-8 (1) Histogram and Cumulative Frequency Distribution of Silt (Area A)

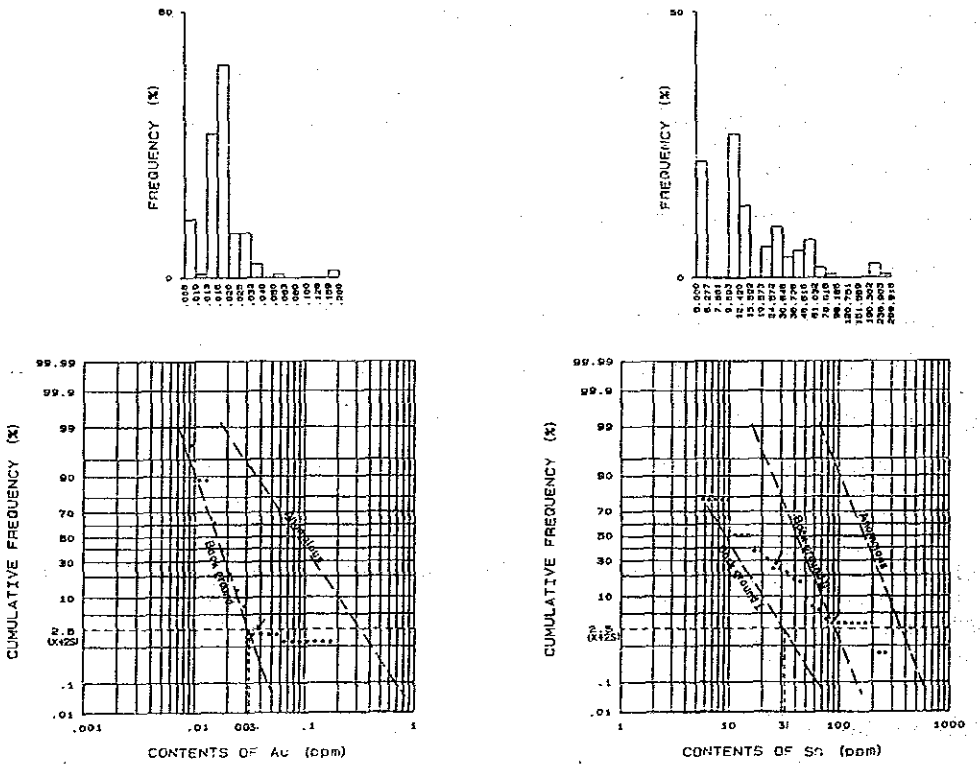


Fig. II-1-8 (2) Histogram and Cumulative Frequency Distribution of Silt (Area C)

1–2–3 Geophysical Survey

After average values of electric and magnetic fields were obtained, apparent resistivity value for each frequency was calculated and ρa-f curve at each station as shown in Fig. II–1–9 was made, using such apparent resistivities.

Apparent resistivity value for some frequency does not coincide to the true resistivity at the depth corresponding to some frequency, and contains the whole information of true resistivities distributed from the ground surface to this depth. However, it is possible to understand the outline of the resistivity structure in the survey area from the apparent resistivity distribution. Using apparent resistivities of all frequencies at all stations, apparent resistivity pseudosections and apparent resistivity plan maps were made.

In order to delineate the resistivity structure in the survey area, one-dimensional (1–D) multi-layer analysis and two-dimensional (2–D) model analysis were applied.

A flow sheet of data processing and analysis of CSAMT data is shown in Fig. II–1–10.

(1) 1–D Model Analysis

The 1–D model analysis is constructed of the forward analysis and the inverse analysis. Each of both analysis methods assumes a multi-layer horizontal earth. In the forward analysis, the suitable model is obtained by the trial-and-error method, in which the number of resistivity layers, and thickness and resistivity of each layer are modified repeatedly until the calculated ρa-f curve fit to the observed. Using this forward model as an initia model, the inverse analysis is made to obtain the best fit model by means of non-linear least square method.

When resistivity and thickness of i-th layer of n-layer structure are ρi and hi, apparent resistivity ρa is given in the equation (2).

$$\rho a = \rho_1 \mid Rn \mid^2 \quad \cdots\cdots (4)$$

where

$$Rn = \coth \{-i\gamma_1 h_1 + \coth^{-1}[\sqrt{\rho_2/\rho_1}\coth(\gamma_2 h_2 + \coth^{-1}\{\sqrt{\rho_3/\rho_2}\coth [-i\gamma_3 h_3 + \cdots + (\sqrt{\rho_{n-1}/\rho_{n-2}}\coth\{-i\gamma h_{n-1} + \coth^{-1}\sqrt{\rho_n/\rho_{n-1}}\})\cdots]\})]\} \quad \cdots\cdots (5)$$

$$\gamma_n = (i2\pi f\mu/\rho_n)^{\frac{1}{2}} \quad \cdots\cdots (6)$$

i : imaginary unit

ρj : resistivity of j-th layer (j = 1, 2, ……., n) in Ω·m

hj : thickness of j-th layer (j = 1, 2, ……., n-1) in metres

f : frequency in Hz

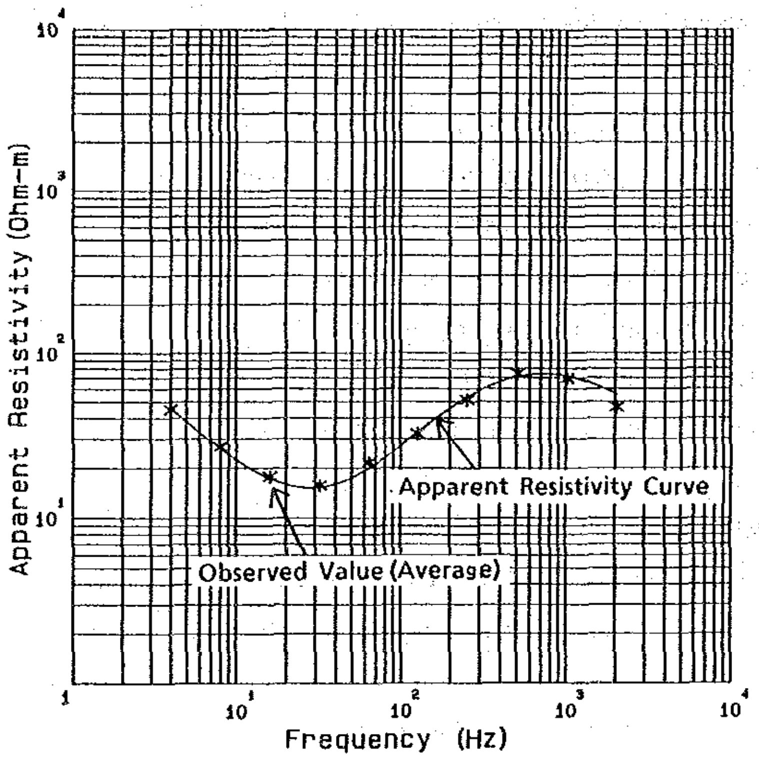


Fig. II-1-9 ρa-f Curve

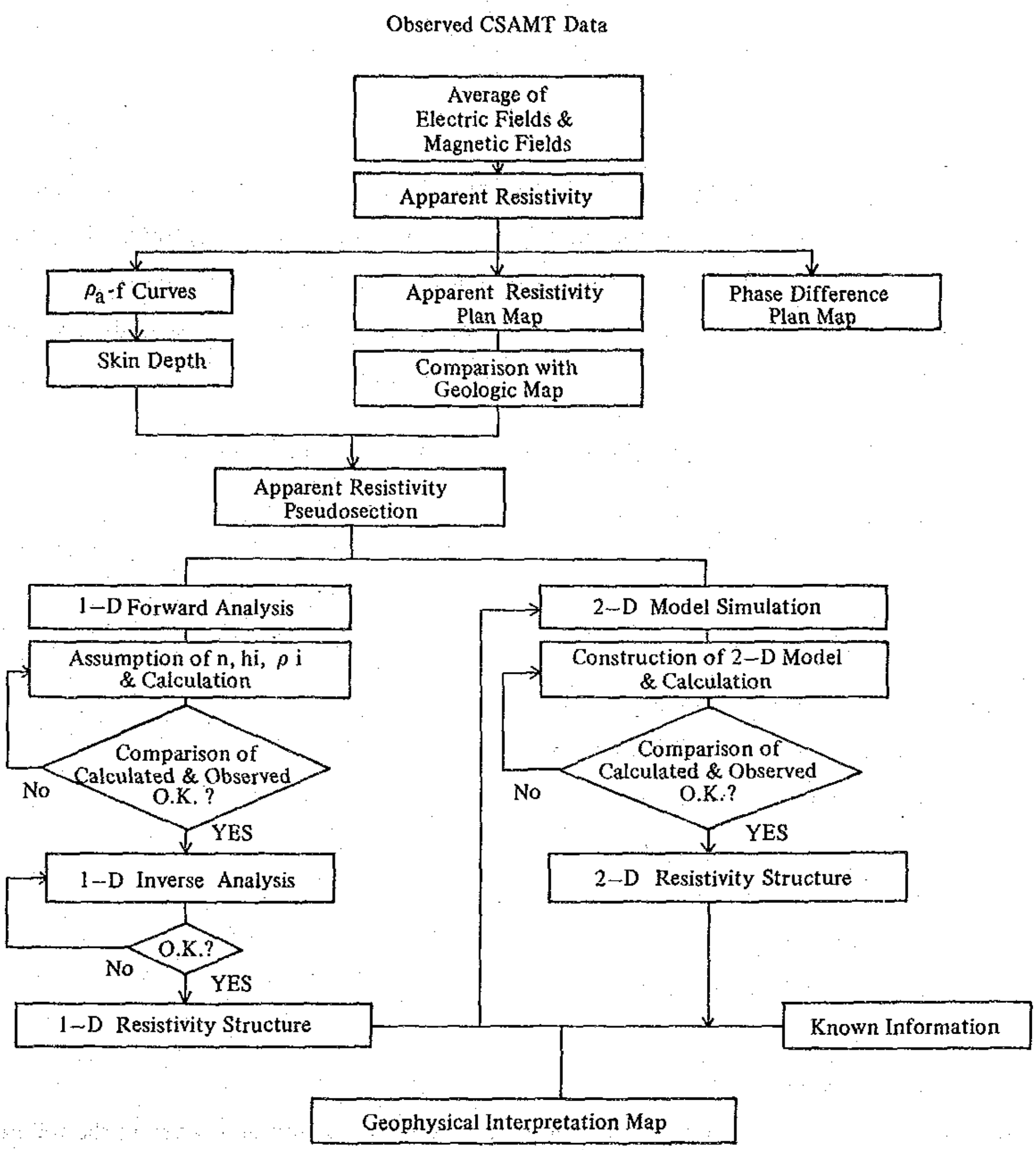


Fig. II-1-10 Flow Chart of Analysis

μ : magnetic permeability ($= 4\pi \times 10^{-7}$ H/m)

Standard ρ_a-f curves for two-layer model is shown in Fig. II-1-11.

(2) **2–D Model Analysis**

The 2–D model analysis is carried out either in the TE mode or in the TM mode. The TE and TM modes assume constant electric-field and constant magnetic-field in the direction of strike, respectively. In this survey, the TE mode was adopted. When x-axis is set to the direction of the strike, y-axis is set perpendicular to the strike, and z-axis is set vertically downward, the basic electro-magnetic equations for the TE mode are given below.

$$\frac{\partial Ez}{\partial y} - \frac{\partial Ey}{\partial z} = -\gamma Hx \quad \cdots\cdots (7)$$

$$\frac{\partial Hx}{\partial z} = \eta Ey \quad \cdots\cdots (8)$$

$$\frac{\partial Hx}{\partial y} = -\eta Ez \quad \cdots\cdots (9)$$

where Ey : y component of electric-field,

Ez : z component of electric-field

Hx : x component of magnetic-field

$\eta = \sigma - i\omega\epsilon$, $\gamma = -i\omega\mu$,

σ : electrical conductivity

ϵ : permitivity

μ : magnetic permeability

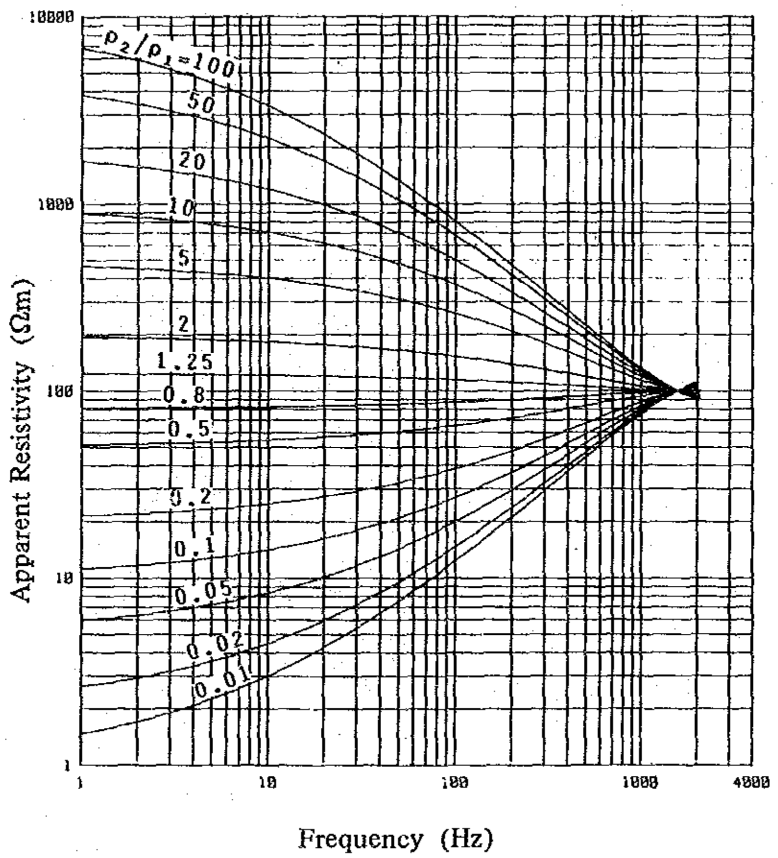
ω : angular frequency

i : imaginary unit

And when n is the outward unit normal vecter, the boundary condition is given in the following equation:

$$\frac{1}{\eta}\frac{\partial Hx}{\partial n} + \alpha Hx = \beta \quad \cdots\cdots (10)$$

The 2–D model calculation was made by solving equations (7) to (9) under the condition of equation (10) by means of the finite difference method.



	Resistivity	Thickness
First layer	ρ_1=100Ωm	100 m
Second layer	ρ_2	∞

Fig. II-1-11 Standard ρa-f Curves for two-layer Model

Chapter 2 Area A

2–1 Geology

The geology of the area is mainly composed of the Terolak and Belata Formations of Paleozoic, the Central Range granite and the Chankagt Rembian granite (both of which have intruded into the Paleozoic formations), and the Quaternary deposits. The geological map and geological columnar section are shown in Fig. II–2–1 and Fig. II–2–2 respectively.

This area is known as a tin-producing zone and is characteristically associated with gold unlike the Kinta Valley, a world-famous tin-producing zone.

2–1–1 Stratigraphy

The stratigraphic units in an ascending order are the Terolak Formation, the Belata Formation and the Quaternary deposits.

(1) Terolak Formation

The Torolak Formation was tentatively named by Gan A.S. (1978) for the formation composed of the rock facies mentioned below. In this report, this name will be adopted.

Distribution: It is distributed from the north of Tapah to the east of Tanjong Malim on the south.

Rock Facies: It is mainly composed of phyllite with meta-sandstone and meta-schist. Thin seams of green schist and iron ore are locally intercalated.

Phyllite is black to dark grey on the fresh surface and pale grey or cream-colored on the weathered surface. It is well-schistose and fissile. Graphytic parts are often recognized, especially around the Tapah area. The phyllite is commonly associated with segregation quartz veins ranging from a few to 10 cm in thickness with some tens to 200 cm in length.

Metasandstone and psamitic schist are contained in the phyllite. They are scattered in the area, forming a small-scaled, narrowly stretching and isolated mountain. They are pale grey to pale yellow in colour and commonly massive. Weak schistosity is recognizable in the psamitic schist. Clear bedding is obvious in alternation beds of phyllite and psamitic rocks. The grain is relatively coarse, ranging from medium to coarse in size, and rich in quartz, corresponding to quartzose sandstone in the classification of sandstone. The psamitic schist is developed along the granite body which crops out in the eastern area.

Green schist is exposed only in a tributary of the S. Bidor on the east of Bidor, intercalated

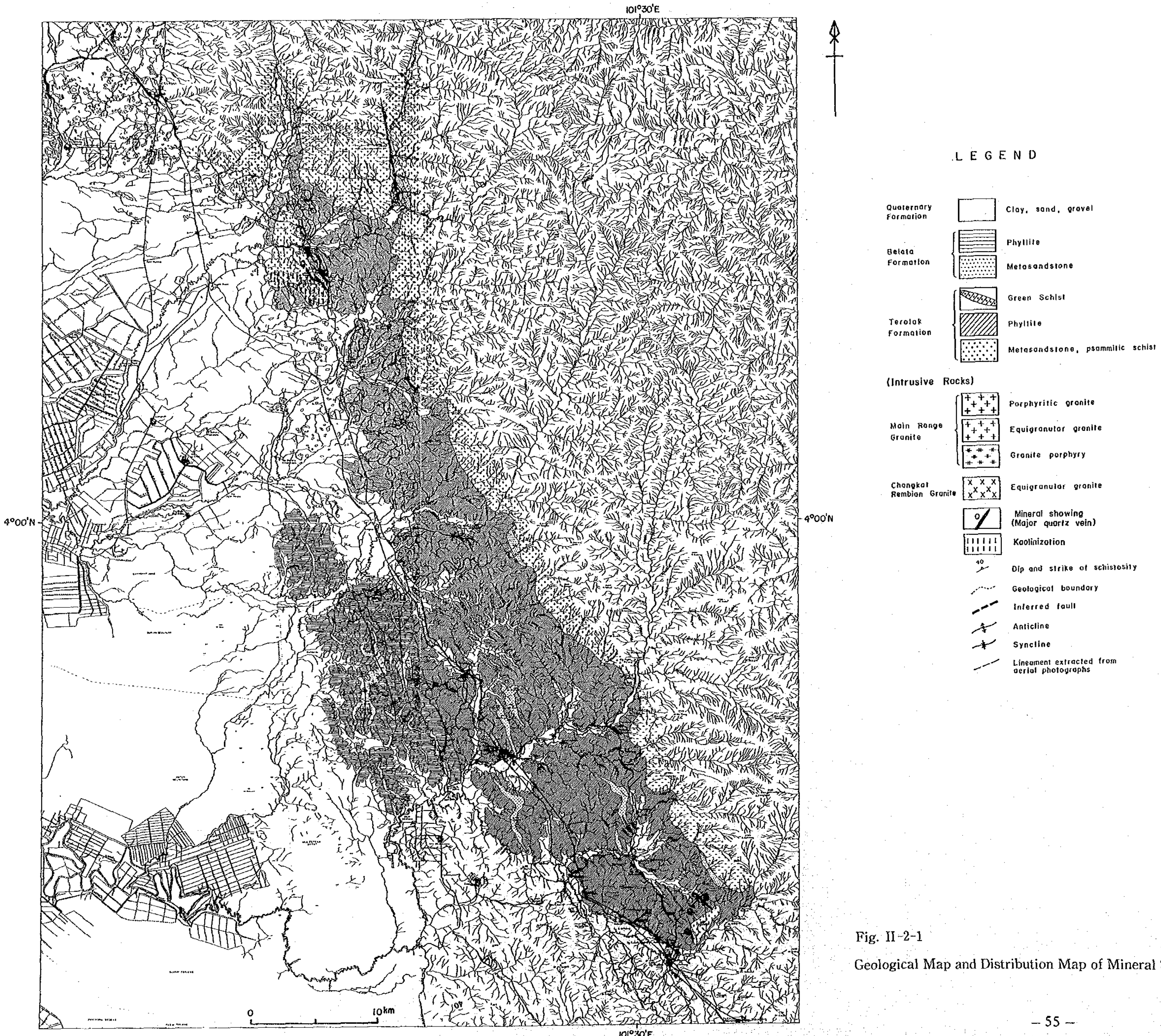


Fig. II-2-1

Geological Map and Distribution Map of Mineral Showings of the Area A

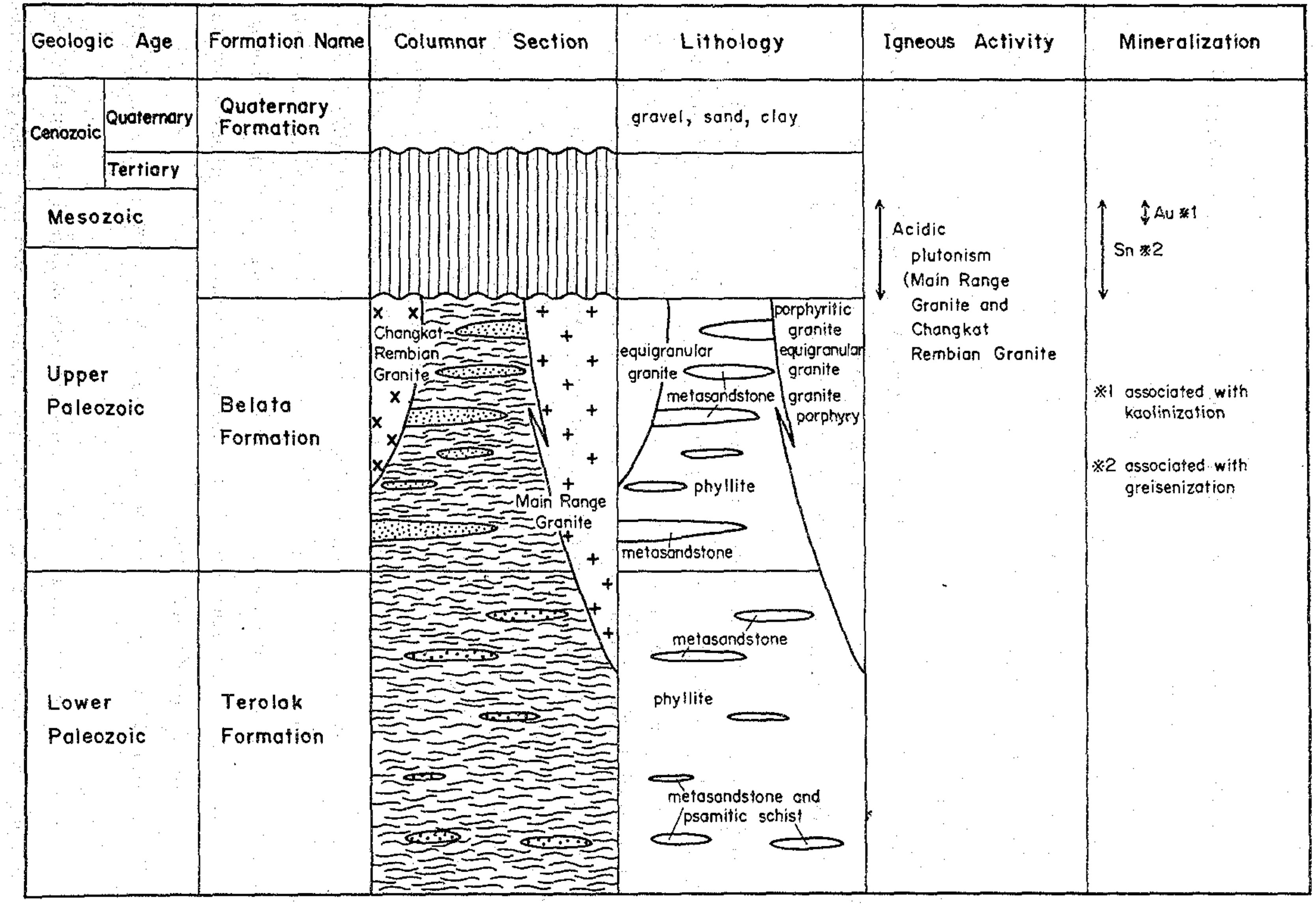


Fig. II-2-2 Stratigraphic Section of the Area A by phyllite. The thickness is 2 m^+.

An iron ore bed crops out only at Kg. S. Dara, north of Tanjong Malim. It is composed of brown limonite and hematite. It seems to be intercalated by phyllite but the detail is not clear due to a limited exposure.

Stratigraphy: This formation composes the bedrock of the area.

Age of deposition: The formation does not yield any fossils in the area. However, cephalopodas occurring in the limestone on the south of the area indicate the age of deposition as early Paleozoic (Kobayashi T. Gan, A.S. et al 1979).

(2) Belata Formation

The Belata Formation was informally named by Gan, A.S. (1978) for the formation composed of the rock facies mentioned below. The same name will be applied in this report.

Distribution: The formation is distributed in the southwest of the area.

Rock Facies: The rock facies of the formation resemble those of the Terolak Formation, mainly consisting of phyllite with a few metasandstone intercalation. They are characterized by slight lower grade of metamorphism and higher content of metasandstone than those of the Terolak Formation. Thin seams of iron ore are locally associated. In general, the sandsone areas are strongly weathered, consequently, sandstone exposes limitedly on the ridge or at the cuttings.

The phyllite is slaty. It is grey – dark grey when fresh and creamy – pale brown, when it has undergone weathering.

Thick beds of metasandstone usually form narrowly strectching, small-scaled and isolated mountain. On the contrary, its thin beds are intercalated with phyllite, forming lowlands. In either case, metasandstone is white – pale yellow in colour and massive. Like the metasandstone in the Terolak Formation, it is medium to coarse-grained and rich in quartz grain, corresponding to quartzose sandstone in the classification of sandstone. When metasandstone beds alternate with phyllite beds, the units range from 0.1 to a few meters in thickness, which is characterized by frequent intercalation of iron ore beds.

Stratigraphic Relationship: The formation is regarded to lie conformably on the Terolok Formation.

Age of Deposition: No fossils are found in the formation. However, its age can be correlated to Upper Paleozoic due to its stratigraphic correspondence with the Terolak Formation and others in the neighbouring area (Gan, A.S., 1978).

(3) **Quaternary**

The Quaternary deposits distributed in the area is Alluvium.

Distribution: Alluvium is distributed in the main river basins, especially in the west of Tapah to Bidor.

Thickness: The thickness of the Alluvium increases towards west. It was reported from some boreholes drilled near Tapah Road village (located at the western end of the area) averaged 41 m (137 feet) in thickness (Ingham F.T.).

Rock Facies: Clay is accompanied with sands and gravels. The heavy minerals included in the formation are generally ilmenite, tourmaline, zircon and topaz. Cassiterite and placer gold are locally concentrated and mining activities have been carried out for these concentrates.

2–1–2 Intrusive Rocks

The intrusive rocks in the area are granitic rocks which are composed of the Main Range granite and the Changkat Rembian granite.

(1) **Main Range granite**

Distribution: It is distributed from the north to each border of the area.

Rock Facies: From the megascopic features, the Main Range granite can be classified into porphyritic and equigranular. Both of them belong to biotite granite.

The porphyritic granit is exposed on the east of Tapah and on the west of Chenderiang. It is greyish white in colour, coarse grained and macroscopically porphyritic. It is characterized by megaphenacrysts (mostly K-feldspar) with a 2–5 cm length.

Main constituent minerals under microscope are generally quartz > K-feldspar > plagioclase > biotite > muscovite in volume. Same granites, however, contain more plagioclase than K-feldspar or more muscovite than biotite. K-feldspar consists of orthoclase and microcline, the former of which has a clear perthite texture and Carlsbad twin. K-felspar and plagioclase are partly altered into sericite and biotite, into chlorite. Apatite, tourmaline, sphene and opaque minerals are accessory minerals.

The equigranular granite is distributed on the northeast of Tapah and in the east to southeast of this area. It is coarse-grained with 0.5–1 cm long crystals of quartz and plagioclase. Microscopic features of the granite are quite same as those of porphyritic granite.

The granite porphyry is distributed on the north of Tanjong Malin being in contact with the Terolak Formation, and shows phenocrysts of idiomorphic plagiaelase in a greyish blue matrix. Under microscope, phenocrysts consist of quartz, K-feldspar, plogioclase and biotite in a holocrystalline matrix with a microgranular texture composed of minute quartz, K-feldspar and plagioclase (< 0.1 mm).

In previous reports, the granite porphyry has been described as a dyke in the granite. However, its occurrence along the Terolak Formation may suggest a marginal phase of the granite.

Age of Intrusion: Some chronological ages of the Main Range granite have been previously reported, indicating Permian to Triassic intrusion. Geological Map of Peninsular Malaysia (1973) reported two figures of 199 ± 2 m.y. (upper Triassic) and 230 ± 6 m.y. (upper Permian).

(2) Changkat Rembian Granite

Distribution: It is distributed in Tapah.

Rock Facies: Due to strong weathering and especially intense kaolinization in the southern part, the fresh Changkat Rembian granite can be seen in limited areas. It is generally equigranular and fine to medium-grained. The constituent minerals are same as those of the Main Range granite. But it has local changes in rock facies as granite porphyry (microgranular matrix) or greisen (phenocrysts are replaced by quartz and muscovite).

Age of Intrusion: Same age as the Main Range granite.

(3) Chemical Compositions of Granites

Twelve (12) granite samples collected in the area were analyzed. The analytical data and CIPW norms are shown in Table II–2–1.

When the normative composition of each sample are plotted onto the Q–An–(Or + Ab) diagram (Fig. II–2–3), all samples fall in the An–poor and Alkali feldspar–rich field except for F–30 sample, which show a very homogenous composition.

Regarding F–30 sample, it might fall in a different field for the reason that a large crystal of K-felspar was intermixed on sample preparation, causing accordingly a high Al_2O_3 content.

The Fe_2O_3/FeO diagram (Fig. II–2–4) shows that all granite samples clearly belong to the ilmenite series except for the Changkat Rembian sample. This is supported by the existence of much ilmenite in the heavy mineral concentrates collected in the field.

2–1–3 Geological Structures

The geologic structure of a NNW–SSE system which is dominant in Peninsular Malaysia is prevailing in the area. It can be recognized by a trend of granite extension and general strike of schistosity of the Terolak and the Belata Formations, whose strike and dip are generally N 20°–40°W and 40°–70°E or W. The granite seems to have not disturbed the formations when

Table II-2-1 Chemical Compositions and CIPW Norm

Area	A												C							A
Rock Body	Main Range Granite											Ct. Rembian Granite	Main Range Granite							Terolak Formation
Sample No.	AR04	AR06	FR21	FR30	FR51	SR04	SR13	SR14	SR21	SR25	TR08	FR06	JR09	HR08	HR11	HR27	HR28	HR41	HR44	FR24
Rock Name (texture)	bt granite (eq)	bt granite (eq)	bt granite (por)	bt granite (eq)	bt granite (eq)	bt granite (eq)	bt granite (por)	bt granite (por)	granite porphyry	granite porphyry	bt granite (eq)	granite porphyry	bt granite (por)	leucocratic granite	bt granite (por)	bt granite (eq)	bt granite (eq)	bt granite (eq)	bt granite (por)	green schist
SiO_2	70.25	77.75	76.55	60.75	73.00	74.29	77.55	72.33	70.73	74.17	74.95	75.35	69.15	74.40	74.69	72.92	74.52	75.00	73.99	48.55
TiO_2	0.53	0.16	0.11	0.31	0.35	0.22	0.14	0.47	0.32	0.36	0.17	0.30	0.62	0.11	0.29	0.32	0.30	0.22	0.39	2.70
Al_2O_3	14.44	12.14	13.14	21.18	14.27	14.49	12.49	14.01	15.52	13.72	14.20	13.21	14.70	14.48	13.78	13.50	13.80	13.58	13.78	12.86
Fe_2O_3	0.42	0.32	0.33	0.34	0.26	0.15	0.36	0.52	0.19	0.86	0.23	1.47	0.28	0.35	0.47	0.14	0.63	0.36	1.00	3.53
FeO	2.42	1.27	0.92	1.69	1.81	1.32	0.86	2.25	1.42	1.21	0.96	0.75	2.74	0.23	1.25	1.56	1.10	0.94	1.54	7.50
MnO	0.04	0.03	0.04	0.04	0.04	0.03	0.02	0.04	0.03	0.03	0.05	0.02	0.05	0.01	0.03	0.06	0.03	0.03	0.02	0.36
MgO	1.24	0.22	0.14	0.55	0.72	0.69	0.15	0.60	0.38	0.38	0.36	0.28	1.69	0.15	0.46	0.79	0.60	0.57	0.78	6.19
CaO	1.82	0.38	0.57	1.38	1.09	0.87	0.57	1.35	1.16	0.81	0.55	0.51	2.46	0.37	0.53	0.92	0.82	0.66	0.48	10.42
Na_2O	2.70	2.35	2.93	4.71	2.76	3.22	3.32	2.96	3.00	2.12	2.91	7.04	2.46	3.09	3.20	2.69	2.88	2.61	5.02	2.92
K_2O	5.07	5.25	5.14	7.81	5.38	4.72	4.25	5.21	6.31	5.43	2.91	0.47	4.25	7.07	5.03	4.52	4.83	6.32	2.56	0.88
P_2O_5	0.22	0.15	0.16	0.36	0.22	0.25	0.10	0.15	0.09	0.09	0.22	0.20	0.21	0.18	0.14	0.15	0.16	0.19	0.14	0.55
BaO	0.08	0.02	0.02	0.05	0.05	0.05	0.01	0.06	0.11	0.06	0.03	0.11	0.10	0.06	0.04	0.05	0.05	0.04	0.03	0.03
H_2O+	0.74	0.71	0.66	1.21	0.69	0.79	0.57	0.57	0.96	1.09	0.95	0.45	1.47	0.40	0.93	1.21	0.77	0.59	0.95	2.00
H_2O-	0.10	0.07	0.08	0.09	0.17	0.15	0.10	0.10	0.21	0.36	0.14	0.21	0.19	0.07	0.17	0.12	0.15	0.14	0.14	0.25
TOTAL	100.07	100.84	100.79	100.47	100.81	101.24	100.49	100.62	100.43	100.69	98.63	100.37	100.37	101.27	101.01	98.95	100.64	101.25	100.82	98.54
q	28.45	42.41	38.24	0.00	32.34	34.36	40.31	30.40	25.34	38.52	45.14	31.57	29.54	29.11	34.69	36.15	36.56	33.36	32.54	0.88
c	1.67	2.25	2.09	3.30	2.42	3.07	1.62	1.37	1.79	3.06	5.77	0.60	2.02	1.46	2.42	2.84	2.69	1.67	2.19	0.00
or	29.96	31.03	30.38	46.15	31.79	27.89	25.12	30.79	37.29	32.09	17.20	2.78	25.12	41.78	29.73	26.71	28.54	37.35	15.13	5.20
ab	22.85	19.89	24.79	39.85	23.35	27.25	28.09	25.05	25.39	17.94	24.62	59.57	20.82	26.15	27.08	22.76	24.37	22.09	42.48	24.71
an	7.74	0.94	1.82	4.58	4.06	2.77	2.19	5.83	5.37	3.54	1.35	1.42	11.01	0.77	1.79	3.67	3.11	2.11	1.52	19.38
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56
dien	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.05
difs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.69
hyen	3.09	0.55	0.35	0.76	1.79	1.72	0.37	1.49	0.95	0.95	0.90	0.70	4.21	0.37	1.15	1.97	1.49	1.42	1.94	7.37
hyfs	3.30	1.84	1.31	1.32	2.61	1.99	1.09	3.00	1.98	0.97	1.39	0.00	3.87	0.00	1.48	2.33	1.06	1.12	1.39	3.38
olfo	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
olfa	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
mt	0.61	0.49	0.48	0.49	0.38	0.22	0.52	0.75	0.28	1.25	0.33	1.61	0.41	0.46	0.68	0.20	0.91	0.52	1.45	5.12
hm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
il	1.01	0.30	0.21	0.59	0.66	0.42	0.27	0.89	0.61	0.68	0.32	0.57	1.18	0.21	0.55	0.61	0.57	0.42	0.74	5.13
ap	0.51	0.35	0.37	0.83	0.51	0.58	0.23	0.35	0.21	0.21	0.51	0.46	0.49	0.42	0.32	0.35	0.37	0.44	0.32	0.18
TOTAL	99.18	100.05	100.04	99.14	99.92	100.27	99.81	99.91	99.19	99.20	97.52	99.64	98.65	100.76	99.89	97.59	99.69	100.50	99.71	96.28

bt : biotite, eq : equigranular, por : porphyritic

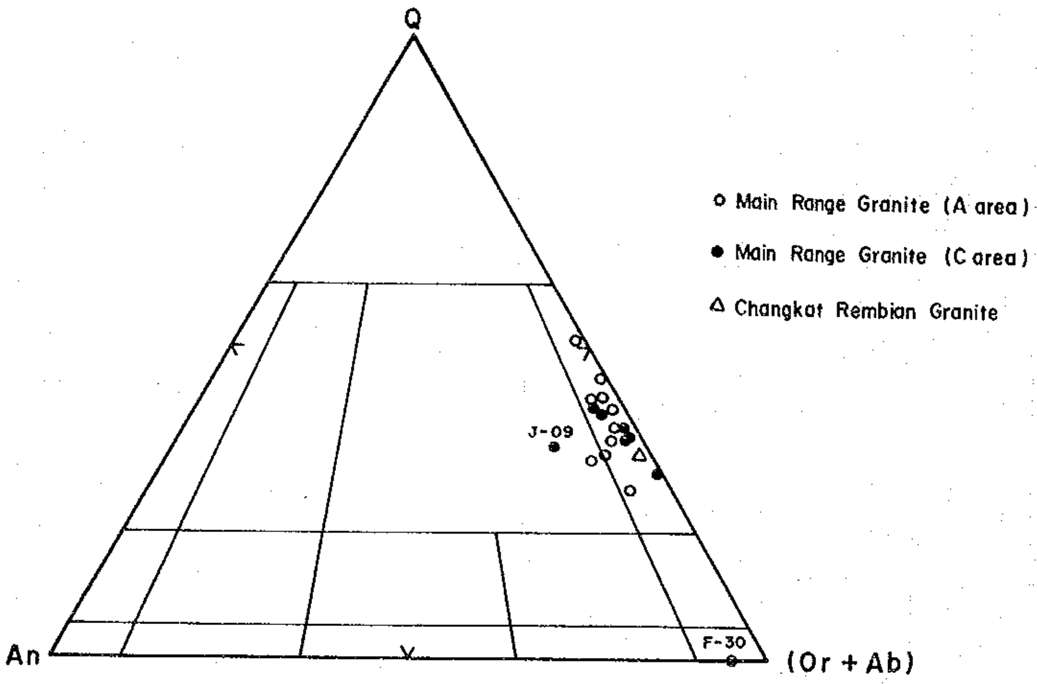


Fig. II-2-3 Q-An-(Or+Ab) Diagram

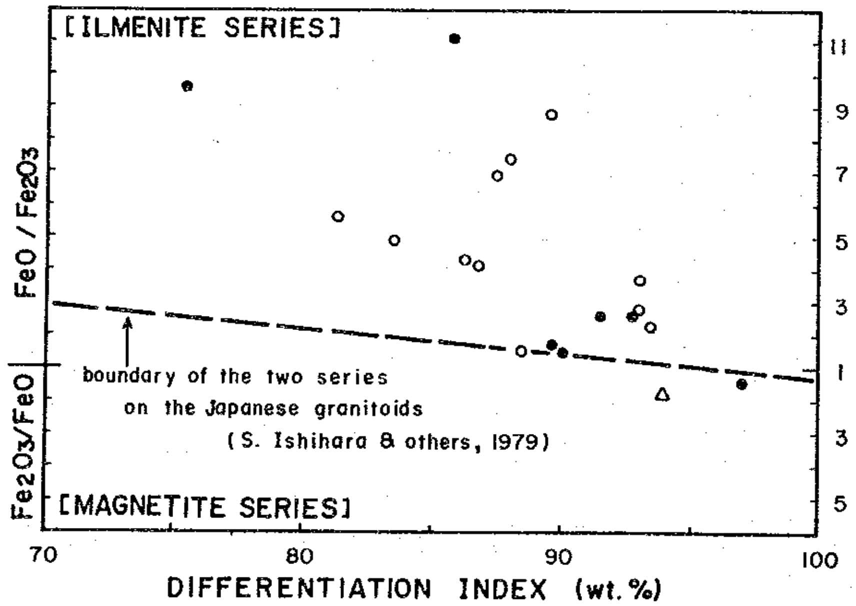


Fig. II-2-4 Ferric/Ferrous Ratio Diagram intruding.

In the southwestern area, where the Belata Formation is distributed, a folding structure can be recognized through variation in strike and dip angles and distribution of metasandstone. The folding structure has a folding axis of a N–S to NNW–SSE system, with a wave length of 3 km. A small-scaled folding structure with a wave length of 2–5 m are observable at road cuttings. Any folding structure could not be found in the Terolak Formation.

Only one fault with a N–S system has been inferred on the northeast of Tapah. Some lineaments were interpreted on the airphoto, however, no field evidences of fault were obtained because most of them occur in the Main Range granite. Lineaments are found developed on the north of Tapah.

2–1–4 Mineralization

Except for 'placer deposits', the following deposits are known in the Area A, all of which are located in or near the granite.

(1) Changkat Rembian Sn Deposit

This deposit is situated 2 km south of Tapah, the east of the Changkat Rembian (201 m above sea-level). It is well known as an important tin and tungusten (wolframite) mine. Due to poor records the detailed mining history is not clear but, it is presumed that mining activities had been carried out for tin and tungsten in weathered granite, eluvium and alluvium by hydraulic or gravel pump method and stopped the operation a short while after mining out(?). At present only old workings with high cliffs and a mining pond can be seen.

The mineralization is of a cassiterite–tourmaline–quartz vein type, occurring in altered granite (greisen). Wolframite could not be recognized in the ore samples collected from the workings.

Fig. II–2–5 outlines the old workings, where some tens parallel tourmaline–quartz veins with 5–20 cm in width run in a direction of NNW–SSE. The veins contain few metalic minerals.

At the Sketch (A) point a few cassiterite and tourmaline occur in a milky quartz vein. Under the microscope, cassiterite has many irregular fissures which are filled by quartz.

The survey team interpreted airphotographically the sheared zone on the north of the workings. This deposit seems to have formed under this structural environment.

The tourmaline–quartz veins traverse the kaolinite veinlets of an ENE–WSW direction, suggesting succeeding tin mineralization after kaolinization.

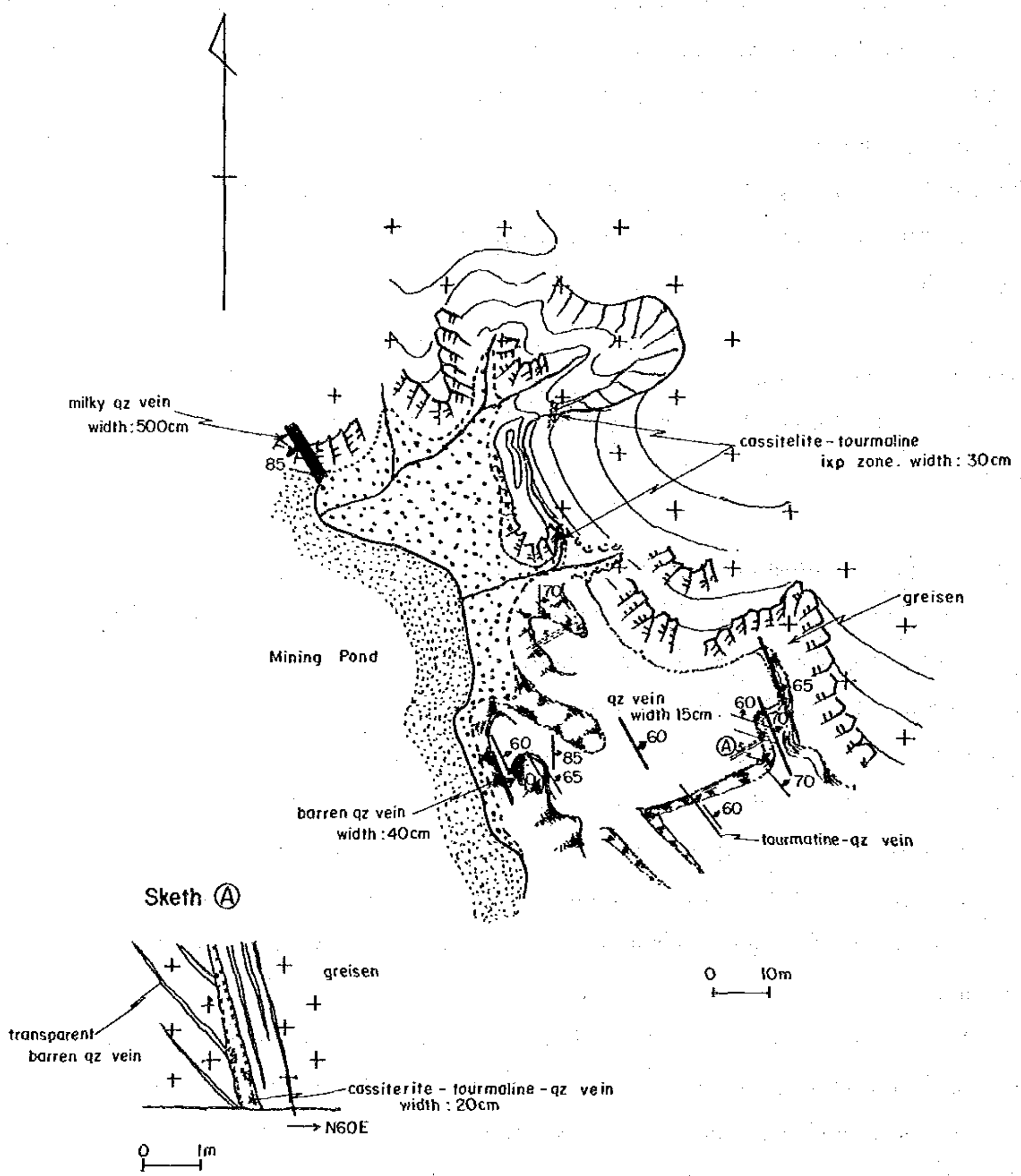


Fig. II-2-5 Geological Map of the Old Changkat Rembian Workings

(2) **Batu Lombong (Sn) Deposit**

The deposit is located 5 km east of Bidor. At present 4 companies including Lee Sen Pin & Sons Sdn. Bhd. and PPL Galian Sdn. Bhd. are under taking operations on the tin–quartz vein in the weathered phyllite or alluvium tin. Their total production is supposed to be 25–30 ton/month with 20% SnO_2.

The ore deposit is of a cassiterite–quartz vein type, occurring parallel to the schistosity of phyllite. It is lenticular in form with 1–2 cm in thickness and 10 cm in length. It contains partial limonite but does not contain sulphide minerals (Fig. II–2–6, sketch (A)). At the site of Sketch (B), some tourmaline–quartz veinlets with 2–5 cm in width traverse the shistosity of phyllite at right angles, bearing a very small amount of cassiterite. Under the microscope cassiterite crystals with less than 0.3 mm in size are columnar or irregularly granular in form.

The heavy minerals obtained from the Aluvium is composed of cassiterite > pyrite > quartz > goethite > covellite > magnetite in volume. The size of cassiterite ranges frame 0.2 mm to 1.0 mm.

(3) **Bukid Mas (Au) Deposit**

The deposit is located 2 km southeast of Tapah. An exploration reportedly started in 1894 for gold-bearing quartz vein in phyllite and continued until the end of 1898. The annual gold production for 1897 was recorded as 41.8 kg in weight, which suggests the monthly production is 600 tons of crude ore with 6 g/t in grade.

At present, after 90 years from those days, only land collapse (maybe hydraulic mining site) and a few troughs stretching in a SSE direction can be seen in the rubber estate. Any mining relic of quartz vein could not be found.

Due to thick weathered soil and consequently limited exposures along rivers, it is very difficult to estimate the geology and geological structures in the area. However, it can be said that the area is, as a whole, composed of graphitic phyllite with siliceous sandstone intercalations and that the contact between the granite and the phyllite passes along the highway.

The phyllite near the contact and the granite are strongly kaolinized. Numerous segregation quartz veins occur along the schistosity of phyllite.

G.S.M. conducted a detailed geological and geochemical surveys over the area in May 1985 and a follow-up soil sampling by means of drilling in August of same year.

As a result, the following was disclosed.

1) Most of the quartz veins distributed in the area are almost barren showing the maximum value of 0.77 g/t Au.

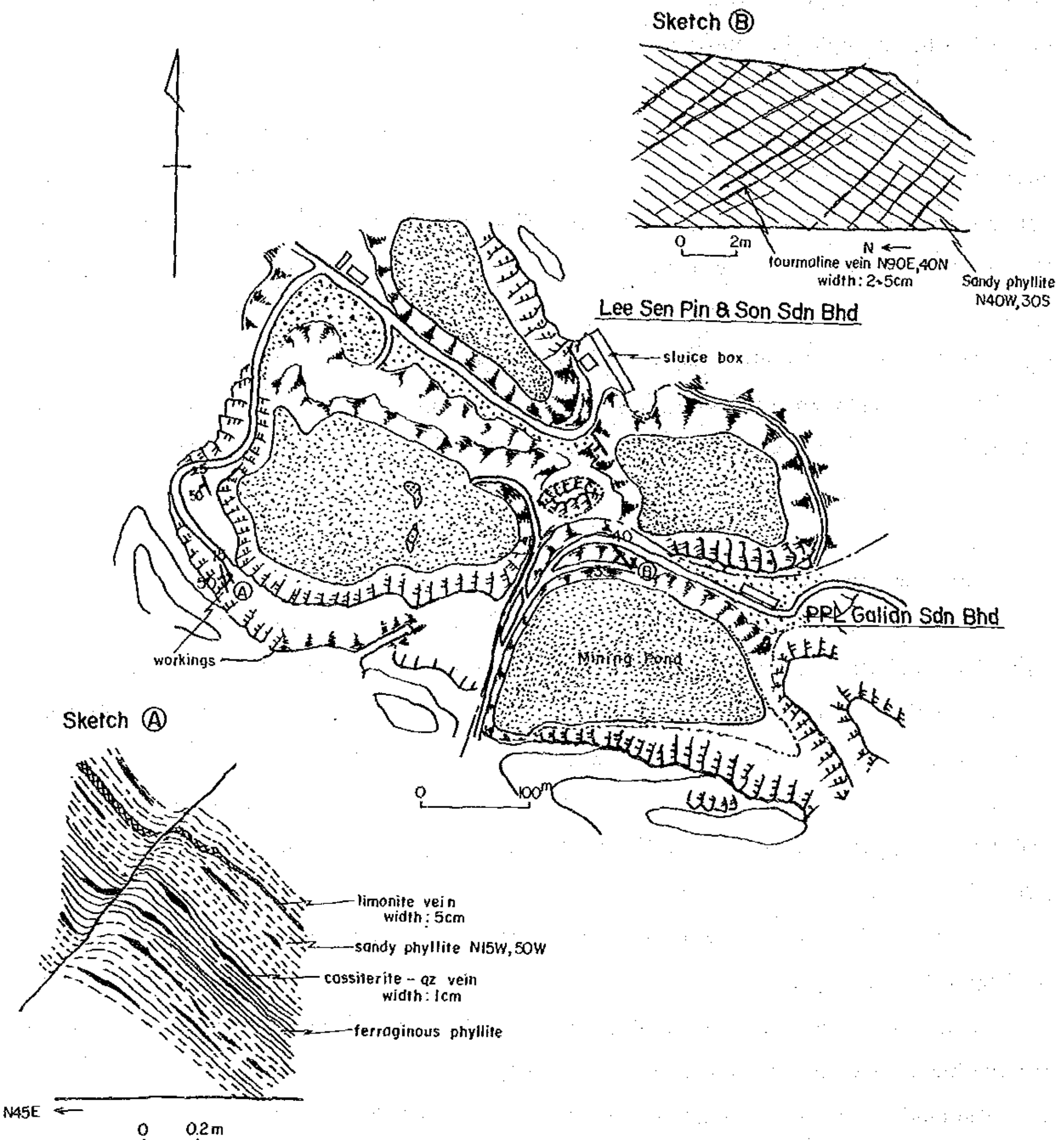


Fig. II-2-6 Geological Map of the Batu Lombong Deposit

2) On the eastern slope of hillock running parallel to the highway, there is a gold anomalous zone (more than 0.1 g/t Au in soil), extending for 200 m x 1,500 m in area. In the soil samples from the anomalous zone, gold flakes could be found under microscope.

The G.S.M.'s survey results and the supplementary survey results are compiled in Fig. II–2–16.

(4) Tapah Kaolin Deposit

The deposit is located on the south of the Changkat Rembian, occupying an area of 1.5 km x 4 km bordered by the highway on the east.

The deposit is produced by hydrothermal alteration of the Changkat Rembian granites and mainly consists of kaolinite with a little amount of illite, quartz and feldspar etc.

Mining operation started in 1932 using kaolin as a filler in rubber factory. Some mines including Associated Kaolin Industry are now under operation on a large scale.

As is evident from Results of X-ray Diffraction Analysis (Appendix Table A–4), there are few differences in mineral assemblage by sampling site in the kaolinized zone, however the intensity of kaolinization tends to increase toward the centre of the zone (Fig. II–2–7).

As stated in the preceding paragraph of Changkat Rembian Deposit, frequent existence of quartz vains of a N–S system which traverse kaolin veins of a E–W system indicates that the kaolinization occurred prior to the Au–Sn mineralization.

Eighteen kaolin samples taken in the kaolinized zone contain 0.003–0.653 g/t Au which are slightly higher than those of the Chankat Rembian granite (average content: 0.008 g/t), suggesting that kaolinization is associated with the gold mineralization.

(5) Others

3 km and 5 km east of Tanjong Malim, large-scaled quartz reefs are exposed. Both of them are located in the margin of the granitic stock of Chamgkat Lembian (931 m ASL).

The quartz reef extends more than 100 m with a 10 m width, striking NW–SE ~ NNW–SSE direction and dipping vertically. It is generally transparent, massive and barren.

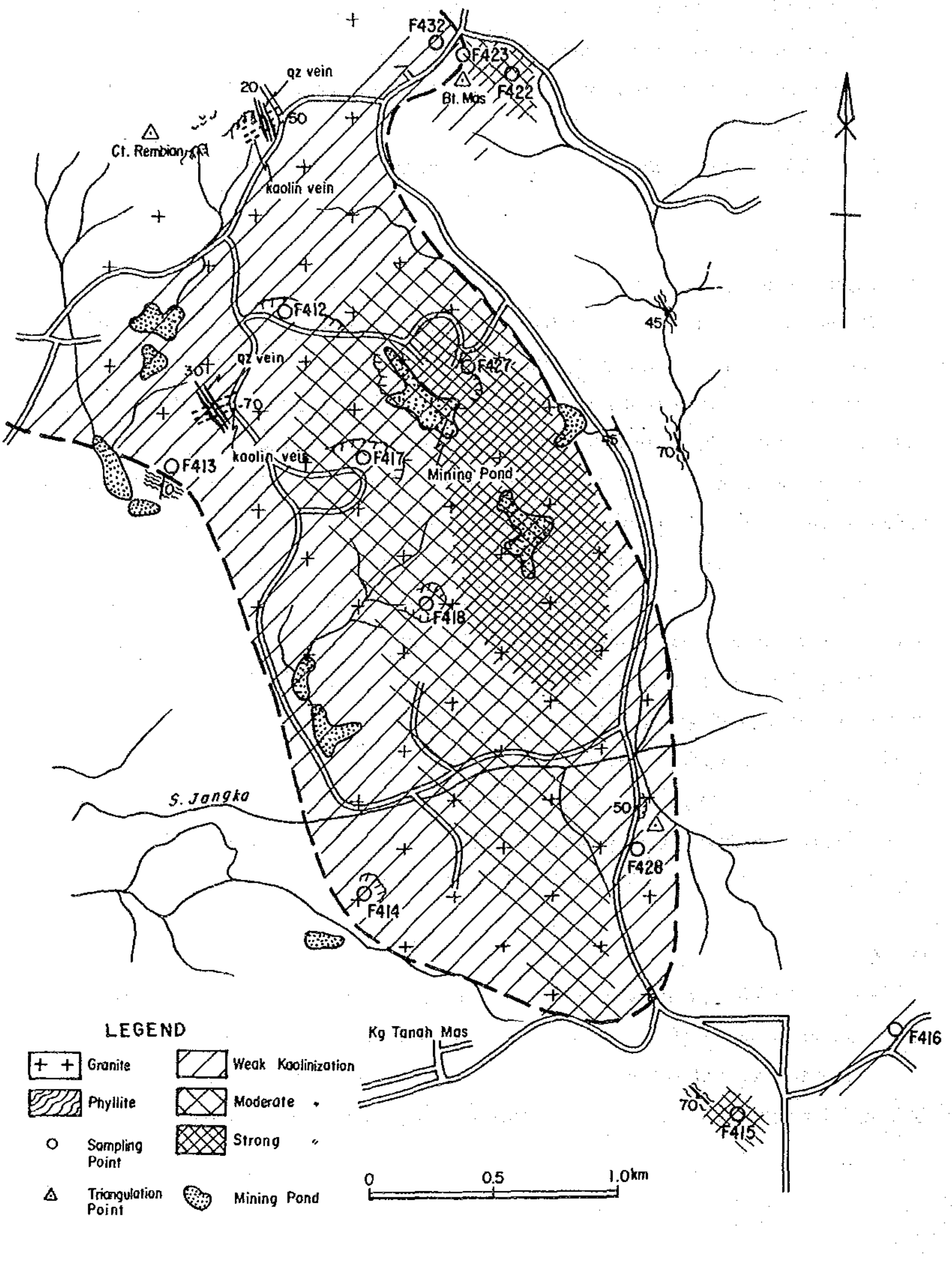


Fig. II-2-7 Geological Map of the Tapah Kaolin Deposit

2–2 Results of Geochemical Survey

2–2–1 Interpretation Results of Geochemical Survey

(A) Rock

Analytical results of 100 rock samples are shown in Appendixes Table A–9, and mean value and standard deviation of each element are illustrated in Table II–2–2.

Table II –2–2 Statistical Values of Each Element (Rock)

(ppm)

	Area A			
	Granite		Phyllite	
	Mean	S.D.	Mean	S.D.
Pb	11.740	2.080	10.713	2.588
Ni	3.076	2.449	6.794	3.141
Co	2.983	2.104	4.007	2.460
Ag	.144	2.512	.148	2.535
Mo	1.666	1.923	2.057	2.213
Cu	6.556	2.825	13.137	3.926
Zn	15.070	2.748	17.068	3.597
Fe	.549	2.748	.872	3.954
Mn	154.583	4.074	128.564	2.858
Au	.009	1.306	.009	1.227
As	9.381	2.897	12.706	2.793
Sn	13.480	2.296	10.409	2.168
W	4.562	1.552	4.000	–
U	1.452	7.709	.332	3.784
Hg	.086	1.355	.082	1.455
Sb	1.450	1.790	2.051	3.365
Bi	1.861	2.270	2.044	2.032
Ba	157.166	3.342	236.987	2.825
Ce	40.651	2.716	44.243	2.259
Eu	.483	2.449	.513	2.838
La	23.862	2.773	20.365	2.350
Lu	.350	2.193	.275	1.995
Nd	14.872	2.158	13.001	2.228
Sm	2.625	3.148	3.067	2.323
Tb	.525	2.500	.361	2.582
Th	13.912	2.606	7.750	2.296
Yb	1.718	2.773	1.145	2.547
Ta	2.560	1.675	2.091	1.189
Nb	15.148	1.479	13.699	1.710

S.D.=Standard Deviation

As it is evident from the table, few differences for every elements can be observed between granite and phyllite, all analytical data were statistically processed.

(B) Heavy Mineral

(a) Semiquantitative Mineral Examination (QME)

Among the heavy minerals identified under the microscope, significant distributions of gold, ilmenite, tourmaline, monazite, cassiterite, zircon and topaz are shown in Plates 5–1.

Magnetite, garnet, allanite, epidote, xenotime and pyrite seldom appear in low level, so that study on these minerals was omitted.

Average weights of panned heavy minerals per standard dulang collected are shown in Table II–2–3.

Table II-2-3 Average Weights of Heavy Minerals per Stendard Dulang (Heavy Mineral Concentrate)

Heavy Mineral	Weight	Heavy Mineral	Weight
Gold Flakes	1,352 ppm	Cassiterite	0.67 g
Ilmenite	12.45 g	Rutile	0.47 g
Tourmaline	1.24 g	Zircon	0.43 g
Monazite	0.28 g	Topaz	0.86 g
Xenotime	0.075 g		

1 dulang : 4.7 litre

The following aspects were clarified.

1. In the rubber estate on the east of the Tapah–Chenderiang road, gold flakes are visible within a 2 km x 7 km area. Geologically, the area is composed of phyllite, lying between the Main Range and the Changkat Rembian granites. Cassiterite is also concentrated.

It the Bukit Mas area adjacent to the above area, gold flakes are also recognizable within a 1 km x 2 km area, where cassiterite, rutile and zircon are moderately concentrated.

Going further to the south, gold flakes are observed in many creeks in the oil palm and the rubber estates on the east of the Bidor–Sungkai highway. The area where gold flakes are found is 2 km x 7 km, where cassiterite, rutile, zirzon and topaz are also concentrated.

2. The heavy minerals distributed near the Main Range granite contact between the S. Batang Padang and the S. Sungkai are characterized by tourmaline and topaz. On the contrary, the heavy minerals south of the S. Selim are characterized by ilmenite.

3. In the Tapah sheet, cassiterite grains are considerably concentrated in the branches north of the S. Bidor. However, few or a very few cassiterite granis can be found in the Gunung Batu Puteh, Changkat Jong and Tanjong Malim sheets.

(b) Quantitative Analysis

(1) Single Component Analysis

The mean, minimum, and maximum values of each element are shown in Table II–2–4 (1) and correlation ratios among elements, in Table II–2–4 (2).

Au

mean value: 0.275×10^{-6} g/dulang, threshold value: 0.75×10^{-6} g/dulang, max value: $18{,}720 \times 10^{-6}$ g/dulang

If the values above this threshold are taken as anomalous values, then according to Fig. II–1–7 (1), 24 % of the total samples are to be selected, leaving scattered many anomales. In order to give more attention to the higher anomalous values, the values above the X + 3S value (mean value + 3 x standard deviation = 2.8×10^{-6} g/dulang) of population are illustrated in Fig. II–2–8 (1). In this case the number of anomalies corresponds to 16 % of whole samples.

As is obvious from the figure, anomalies mainly concentrate on the east of highway from

Table II-2-4 Statistical Values of Each Element (Heavy Mineral Concentrate)

(1) Mean, Minimum and Maximum Values ($\times 10^{-6}$g/dulang)

	Area A		
	MEAN	MIN	MAX
Au	.275	.001	18720.344
Ag	.510	.00	1064.33
As	27.862	0	23250
Sn	5821.329	4	1830000
W	40.705	0	13320
Hg	.211	.00	158.08
Ni	-	-	-
Co	-	-	-
Ce	2282.460	13	391495
Eu	6.776	.0	1856.8
La	1321.565	8	166725
Lu	19.834	.1	4890.6
Nd	890.738	6	123500
Sm	124.372	.2	23909.6
Tb	18.849	.0	4594.2
Th	609.108	3	160056
U	144.052	1	20501
Yb	95.912	.8	26305.5
Ta	222.014	1	46189
Nb	1405.116	3	377400

(2) Correlation Matrix

(Area C)

	Au	Ag	As	Sn	W	Hg	Ni	Co	Ce	Eu	La	Lu	Nd	Sm	Tb	Th	U	Yb	Ta	Nb
Au	1.000																			
Ag	.447	1.000																		
As	.276	.442	1.000																	
Sn	.219	.361	.342	1.000																
W	.241	.409	.484	.471	1.000															
Hg	.282	.531	.421	.220	.575	1.000														
Ni	.420	.608	.553	.137	.353	.642	1.000													
Co	.382	.570	.466	.099	.281	.665	.871	1.000												
Ce	.064	.412	.150	.523	.371	.496	.235	.307	1.000											
Eu	.266	.529	.266	.518	.291	.451	.442	.495	.814	1.000										
La	.068	.423	.171	.542	.356	.482	.236	.304	.992	.821	1.000									
Lu	.101	.490	.246	.328	.446	.648	.339	.455	.819	.670	.804	1.000								
Nd	.082	.388	.173	.529	.350	.489	.231	.300	.981	.807	.985	.807	1.000							
Sm	.122	.437	.222	.536	.404	.524	.290	.327	.958	.794	.962	.802	.951	1.000						
Tb	.123	.481	.227	.473	.405	.581	.322	.396	.952	.811	.955	.895	.944	.956	1.000					
Th	.002	.368	.137	.501	.364	.503	.188	.266	.971	.705	.970	.837	.964	.944	.939	1.000				
U	-.012	.290	.111	.422	.328	.466	.127	.223	.890	.604	.887	.819	.888	.832	.857	.926	1.000			
Yb	.136	.467	.209	.304	.391	.636	.346	.454	.781	.662	.764	.967	.773	.771	.873	.799	.782	1.000		
Ta	-.003	.372	.170	.545	.473	.546	.192	.307	.879	.625	.866	.804	.848	.838	.836	.908	.859	.750	1.000	
Nb	.090	.479	.275	.466	.552	.681	.327	.447	.834	.635	.815	.872	.798	.801	.832	.953	.819	.816	.952	1.000

(3) Factor Loading (Varimax Rotation)

	Area A			
	Factor 1	Factor 2	Factor 3	Comunality
Au	.256	-.766	.134	.7099
Ag	.227	-.618	.345	.7615
As	.264	-.474	.290	.7846
Sn	.273	-.533	.331	.7459
W	.158	-.337	.439	.7489
Hg	.298	-.268	.238	.7325
Ni	-	-	-	-
Co	-	-	-	-
Ce	.829	-.226	.417	.9853
Eu	.838	-.238	.109	.8070
La	.803	-.235	.458	.9767
Lu	.413	-.236	.840	.9833
Nd	.768	-.180	.452	.9009
Sm	.813	-.171	.350	.9154
Tb	.685	-.207	.615	.9517
Th	.591	-.220	.675	.9693
U	.369	-.162	.834	.9489
Yb	.435	-.244	.829	.9785
Ta	.295	-.289	.675	.9845
Nb	.288	-.241	.705	.9850
Factor Contribution	% 79.810	% 8.972	% 6.462	

the S. Chenderiang to the S. Bikam. This pattern resembles that of QME. One of differences between them is as follows;

QME: isolated gold anomaly zones, viz. north Tapah and south Bidor zones

Quantitative Analysis: continuous gold anomaly zone covering north Tapah and south Bidor zones with a larg-scaled area of (2–4) km x 22 km.

Both in the Tanjong Malim and the Changkat Jong sheets, a few gold anomalies tend to be scattered, showing a low potential for gold resources.

Sn

mean value: 5.82×10^{-3} g/dulang, threshold value: 30×10^{-3} g/dulang, max value: 1.83 g/dulang

Values higher than the threshold value are found in all river systems between the S. Chenderiang and the S. Bidor. The anomalies located in the upper reaches of the S. Sawa, west branch of the S. Chenderiang, are caused by the old tin mine. Concentrated anomalies are observed in the upper reaches of S. Jong (gold anomaly zone too), the middle reaches of S. Cerok and S. Batang Padang. Other anomalies are found within an area of 4 km x 2 km near the operating mine of Batu Lambong in the upper reaches of S. Bidor (Fig. II–2–8 (2)).

In the Changkat Rembian area (south to the old tin deposit), tin anomalies were obtained in the branch on the north side, indicating that tin mineralization extends towards north over the Changkat Rembian.

In the Tanjong Malim sheet, a few anomalies were found in the main stream of the S. Selim, the upper reaches of S. Tampan, a branch of the S. Selim, and branches near the southern boundary of the survey area. All of them are in the phyllite zone near the Main Range granite.

W

mean value: 40.7×10^{-6} g/dulang, threshold value: 300×10^{-6} g/dulang, max value: $13{,}320 \times 10^{-6}$ g/dulang

The anomalies occur in the 4 brocks in the chankat Rembian area, covering an area of 2 km x 2 km. As stated before, the tin mine on the southern side once reportedly produced wolframite, and so W–mineralization was proved to extend in a somewhat large scale. The W anomalies in the brook of the middle reaches of the S. Batang Padang and in the upper reaches of the S. Bidor almost overlap the anomalies of Sn, which indicates a close correlation between Sn and W. On the other hand, the W anomalies in the S. Sekiah (in the south) and in the upper stream of the S. Bilkechil occur independently (Fig. II–2–8 (3)).

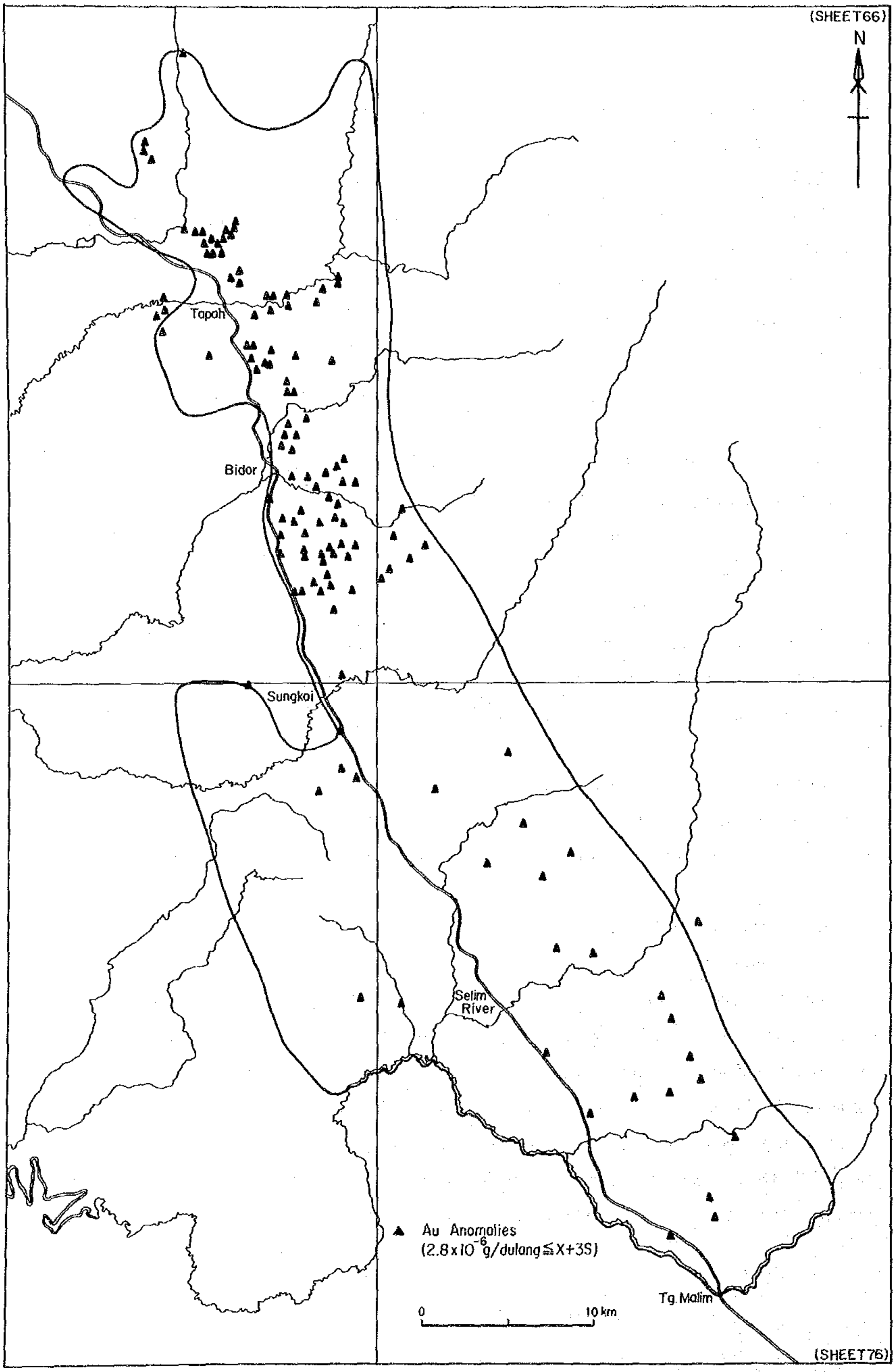


Fig. II-2-8(1) Geochemical Anomaly Map of Au in Heavy Mineral Concentrate

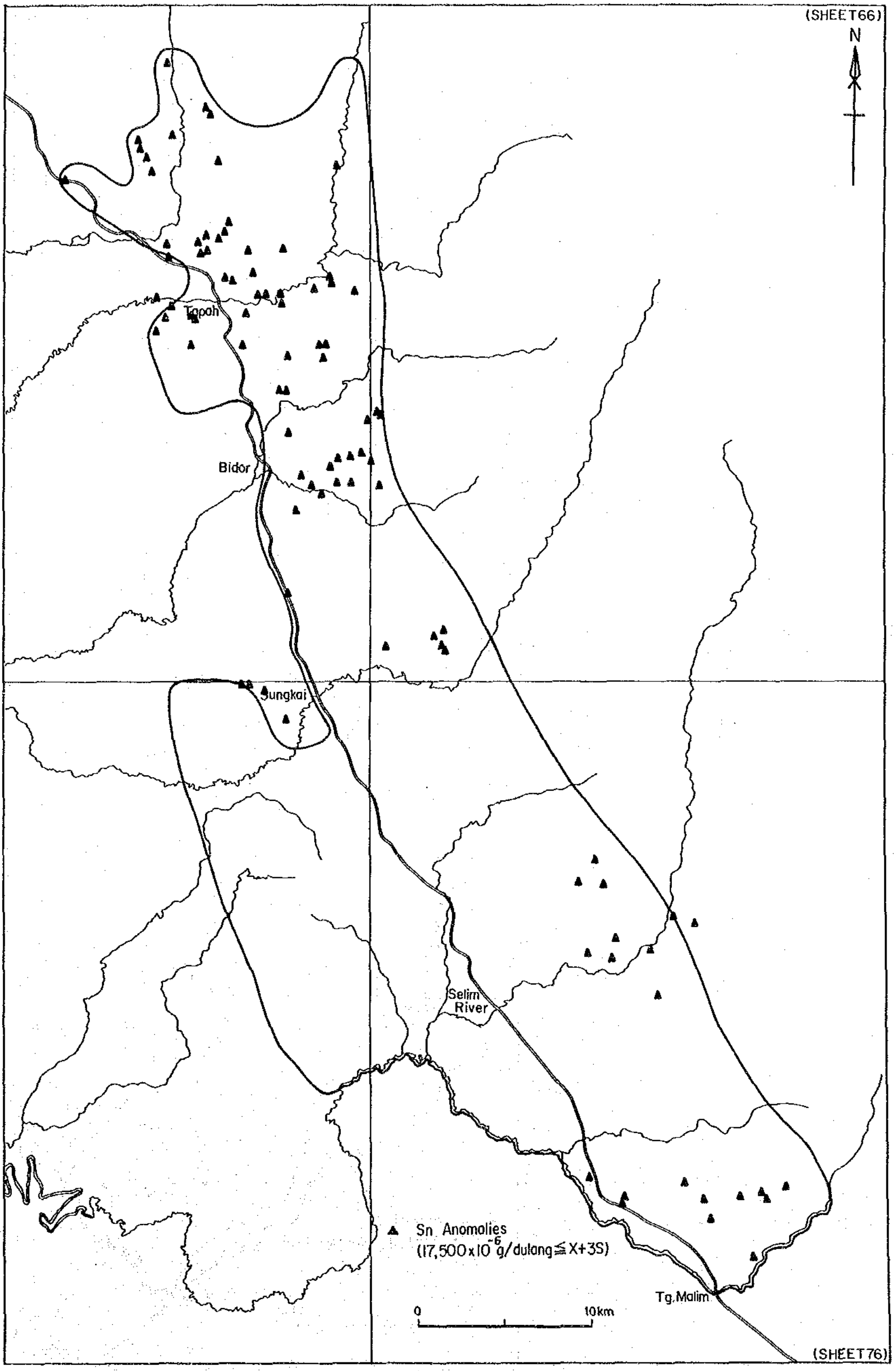


Fig. II-2-8(2) Geochemical Anomaly Map of Sn in Heavy Mineral Concentrate

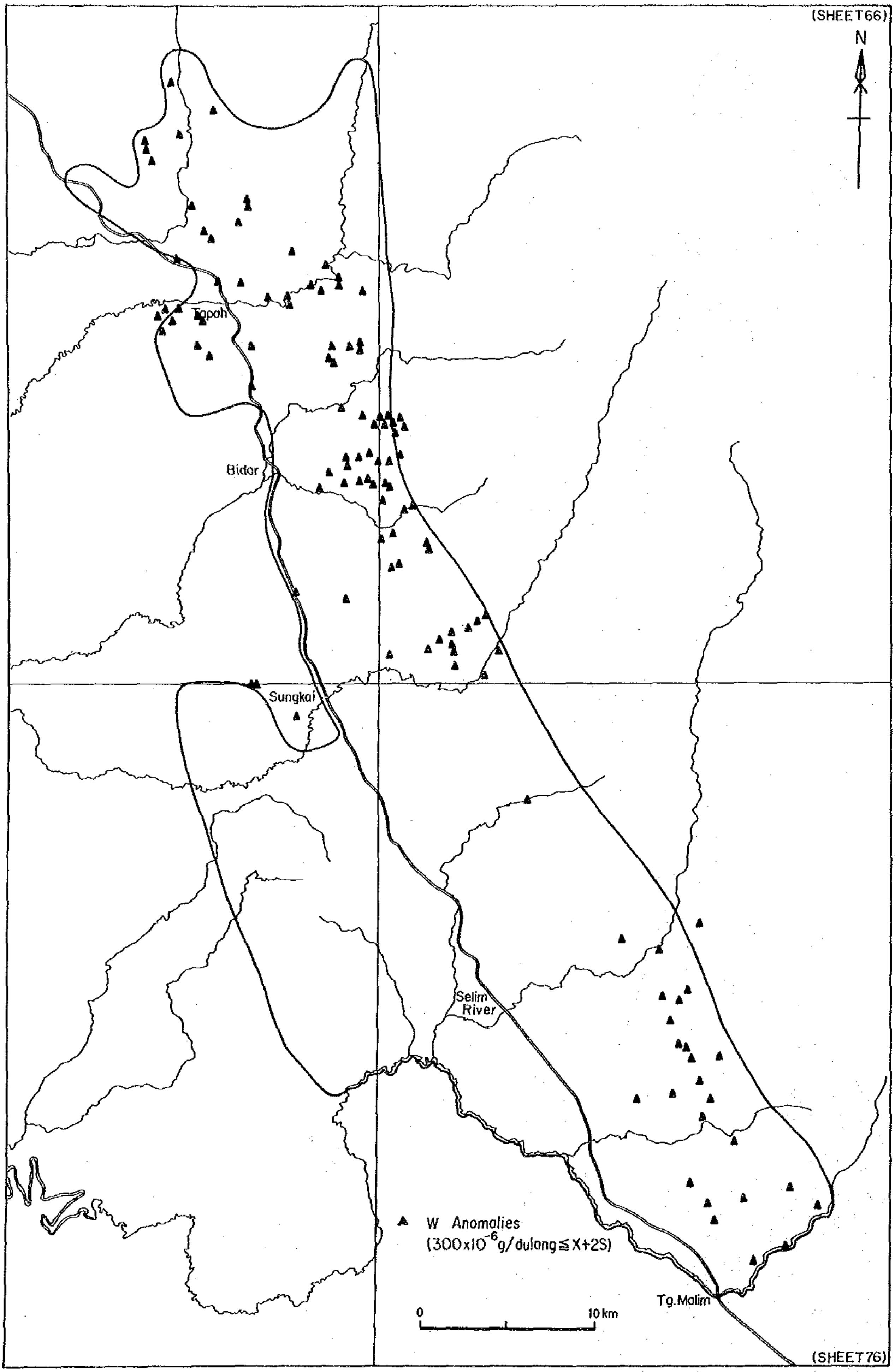


Fig. II-2-8(3) Geochemical Anomaly Map of W in Heavy Mineral Concentrate

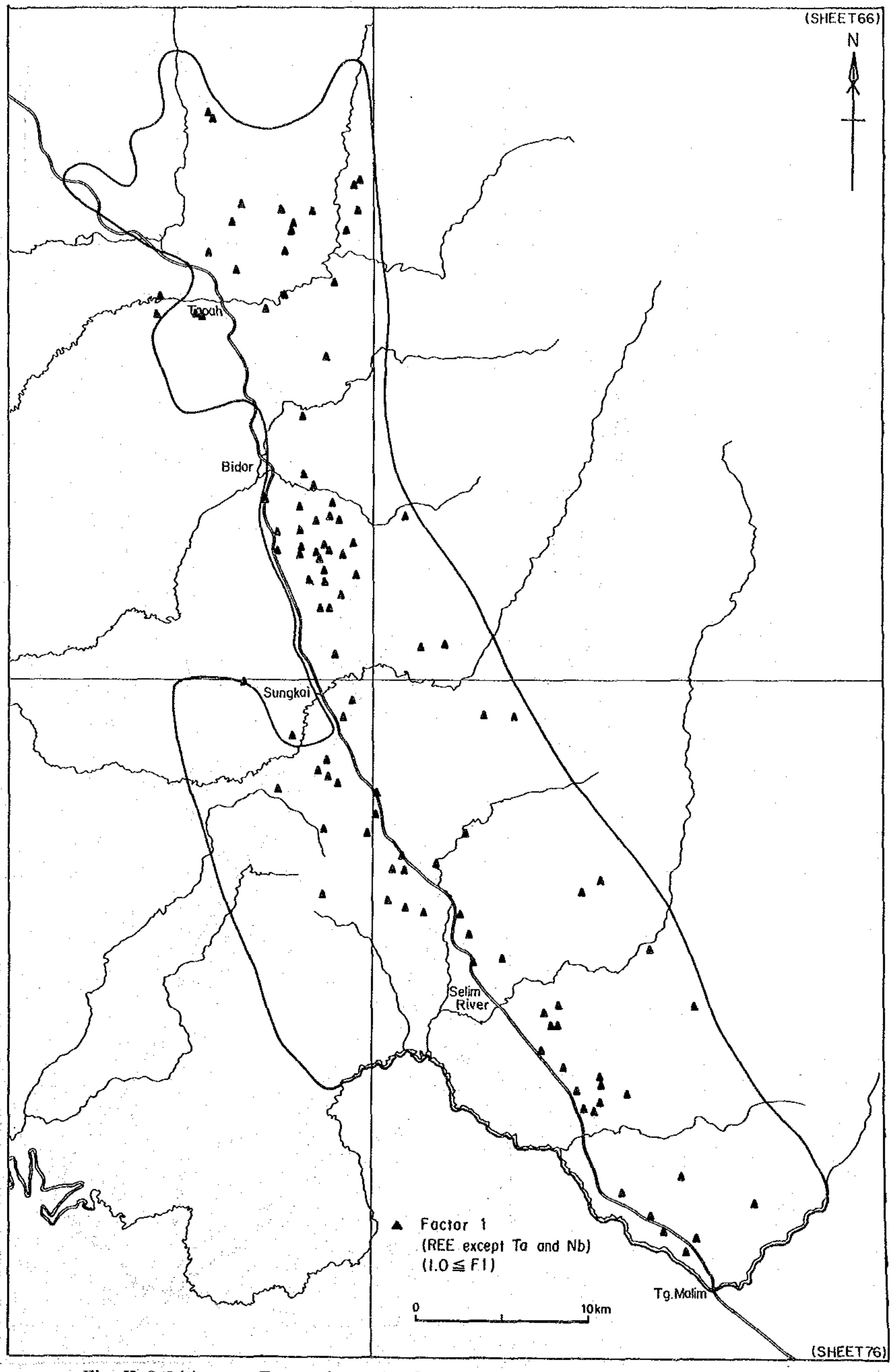


Fig. II-2-9 (1) Factor Analysis Map of Factor 1 in Heavy Mineral Concentrate

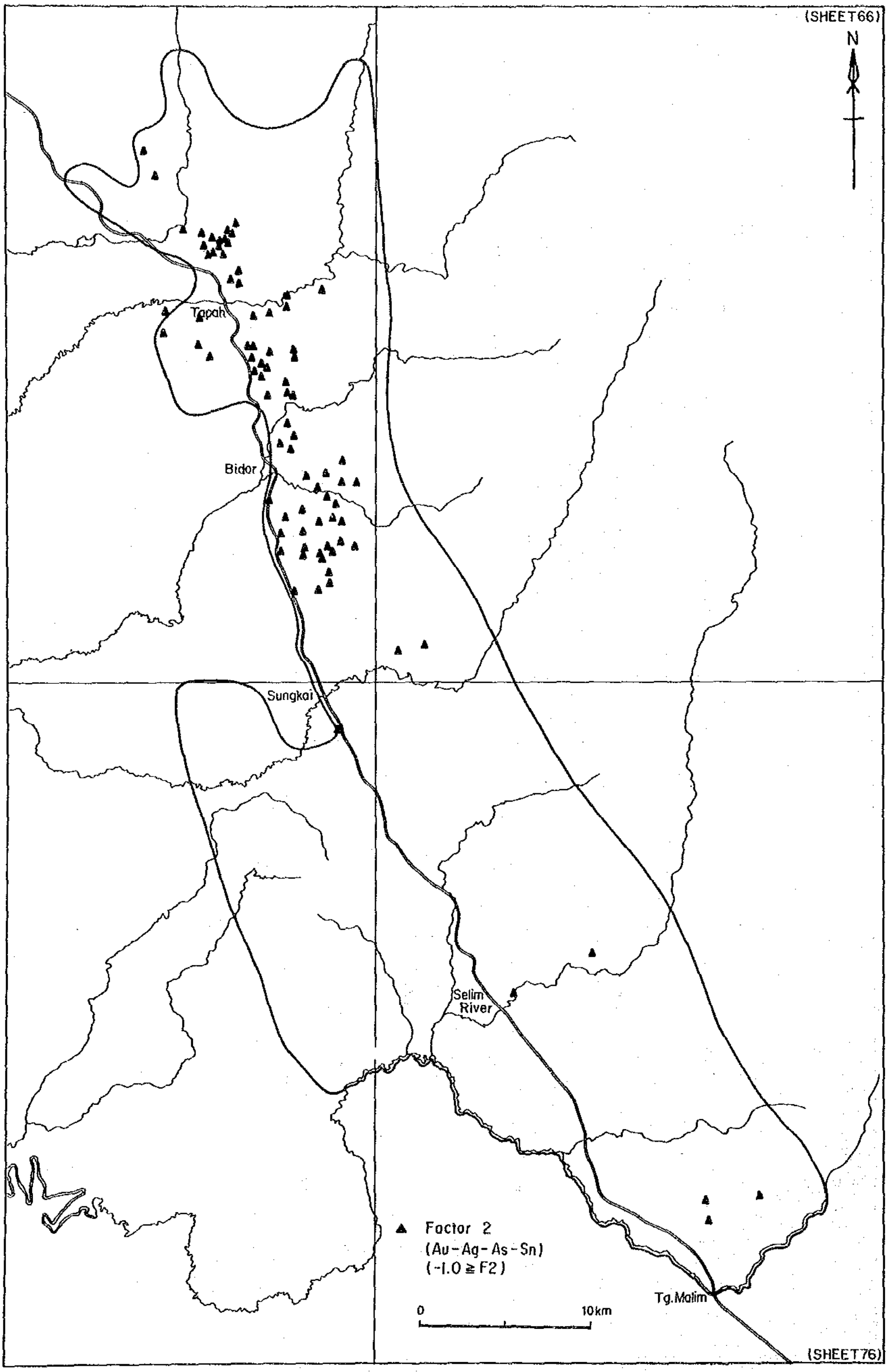


Fig. II-2-9(2) Factor Analysis Map of Factor 2 in Heavy Mineral Concentrate

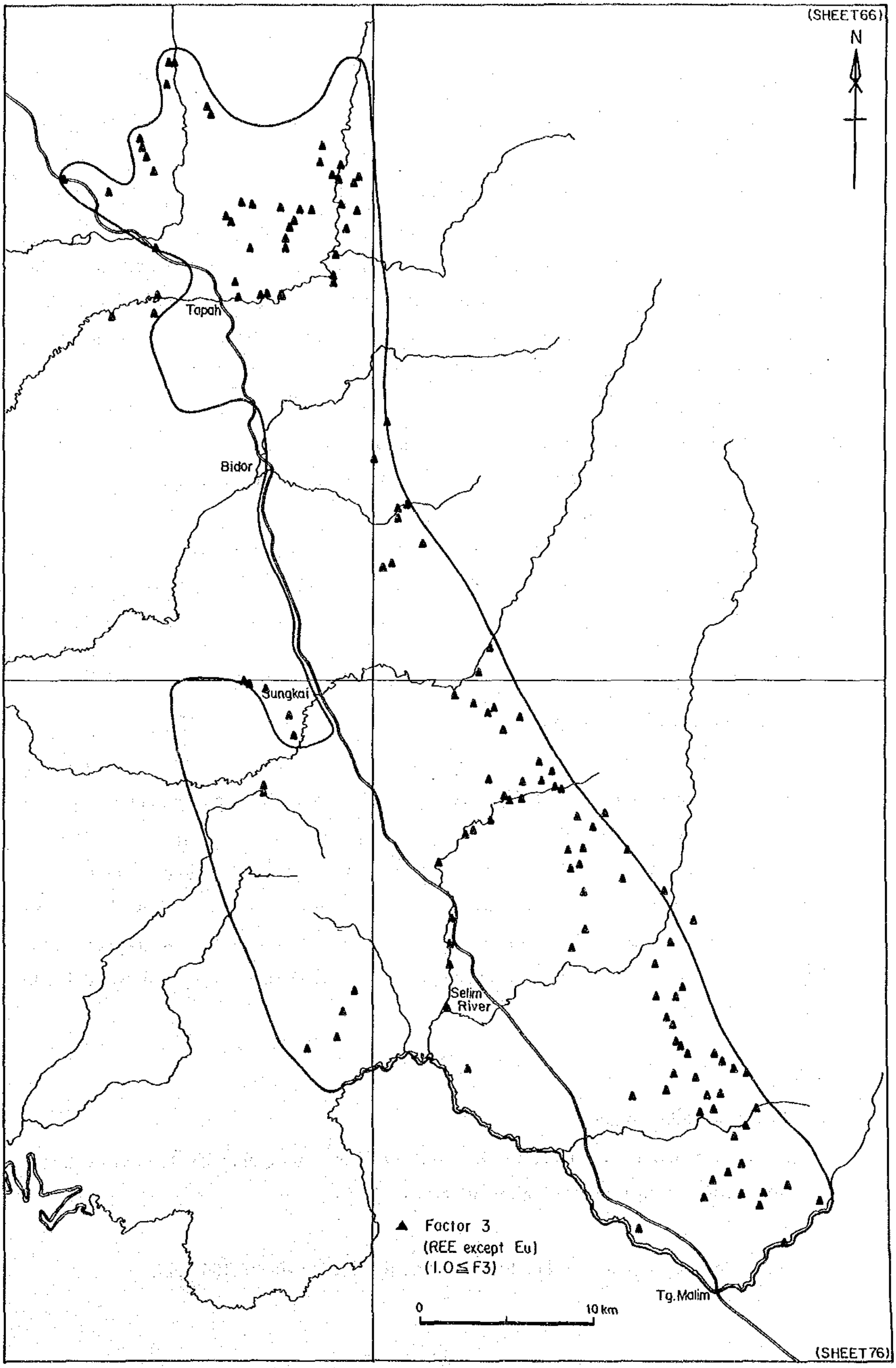


Fig. II-2-9(3) Factor Analysis Map of Factor 3 in Heavy Mineral Concentrate

(2) Multivariate Analysis

The high factor scores over 1.0 of Factors 1, 2 and 3 are shown in Fig. II–2–9 (1), (2) and (3) respectively.

Factor 1 (Rare Earths except for Nb and Ta)

The high scores are distributed in the upper reaches of the S. Batang Padang, east of Tapah, in the S. Crok, one of its branches, and also in the Changkat Rembian area. The most remarkable anomaly zone is located on the east of the Bidor–Sungkai, with an area of 4 km x 8 km, which almost coincides with the Au anomaly area. Other anomalies are well concentrated on the west of the highway between Sungkai and Selim River and on the east of the highway between Selim River and Tanjong Malim. The former anomalies near Tapah seem to be related to the granite but the latter anomalies near the highway are located in the phyllite zone and are distant 10–15 km from the Main Range granite. The reason is not clear because of lack of QME data.

Factor 2 (Au–Ag–As–Sn)

High scores of Factor 2 are distributed in the same pattern as Au anomalies in the single component analysis. A large-scaled anomaly zone with an area of 22 km x (2 ~ 3) km on the east of the Tapah–Bidar–Bikam highway occurs in the phyllite zone, being closed to the Main Range granite (about 5 km away).

Few anomalies are distributed on the south of Bikam.

Factor 3 (Rare Earths except for Eu)

As contrasted with Factor 1, high scores of Factor 3 are found in or near the Main Range granite. The anomalies northeast of Tapah cover the whole basins of the S. Batang Padang and the S. Cerok, suggesting a granite origin. The anomalies distributing in the Gunung Batu Pateh and Tanjong Malim sheets is considered to have relations with the Main Range granite which occupies the eastern end of the Area A. The rare earths seem to have moved above 5 km along the river in this flat topography. However, the heavy minerals appear to have travelled about 20 km in the S. Terolak. Northern anomalies in the Changkat Jong sheet are possibly due to mining contamination.

(C) Silt

(1) Single Component Analysis

The mean, minimum and maximum values of each element are shown in Table II–2–5 (1), correlation matrix among elements is given in Table II–2–5 (2).

Au

mean value: 0.014 ppm, threshold value: 0.047 ppm, max value: 0.494 ppm

Table II-2-5 Statisical Values of Each Element (Silt)

(1) Mean, Minimam and Maximam Values (ppm)

	Area A		
	MEAN	MIN	MAX
Au	.014	.006	.494
Ag	.066	.05	.80
As	8.593	3	400
Sn	13.351	5	8120
W	5.012	4	100
Hg	.031	.02	4.82
Ni	-	-	-
Co	-	-	-

(2) Correlation Matrix

(Area A)

	Au	Ag	As	Sn	W	Hg
Au	1.000					
Ag	-0.075	1.000				
As	0.060	0.001	1.000			
Sn	0.142	0.010	0.192	1.000		
W	0.092	0.035	0.178	0.398	1.000	
Hg	0.018	0.044	0.073	-0.054	-0.005	1.000

(3) Factor Loading

(Area A)

	Factor 1	Factor 2	Factor 3	Comunality
Au	0.158	-0.332	-0.053	0.1380
Ag	0.047	0.262	-0.059	0.0745
As	0.293	-0.052	-0.307	0.1824
Sn	0.632	-0.106	0.033	0.4113
W	0.629	0.025	-0.017	0.3965
Hg	-0.036	0.037	-0.282	0.0824
Factor Contribution	73.018%	14.465%	13.082%	

Au anomalies (over $\overline{X}$ + 3S = 0.047 ppm) are found 3 km north of Tapah and in the branch of S. Bidor, north of Bidor. The former Tapah anomaly zone well coincides with the area where Au flakes were found (Fig. II–2–10 (1)).

Sn

mean: 13.351 ppm, threshold value: 125 ppm, max value: 8,120 ppm

Anomalies of Sn are distributed in the Changkat Rembian area, the basin of the S. Batang Padang, the branch of the S. Gedong and the upper reaches of S. Paku. The anomalies obtained on the west of Sungkai in the Changkat Jong sheet are possibly caused by the suspended tin mine (Fig. II–2–10 (2)).

(2) Multivariate Analysis

The Factor 1 was extracted by Factor analysis. Factor loading, comunality and factor contribution are shown in Table II–2–5 (3).

Factor 1 (Sn–W)

High factor scores over 1.0 are shown in Fig. II–2–11. They are located in the Changkat Rembian granite and in the wide area covering the S. Gemuroh, S. Gepat and S. Bikan, east of Bidor. The anomalies are also found in the mountain on the west of Chanderiang village.

The pattern of the Factor 1 high scores is similar to that of Sn anomalies.

2–2–2 Discussion on the Results of Geochemical Survey

The results of QME and quantitative analysis of heavy minerals and silts are slightly different each other. But they have almost the same trend in the distribution of anomalies.

Geochemical anomalies of Au, Sn, W and rare earths are remarkable in the area. Especially, Au anomaly zone on the east of the Tapah–Bidor–Sungkai highway is of a large scale, stretching from the S. Jong, 7 km north of Tapah, to the S. Bikam, with an area of (2–4) km x 22 km. This zone includes the Bukit Mas gold mine area. It is located in the phyllite zone which is set between the Main Range and the Changkat Rembian granites, being associated with local Sn anomalies.

As contrasted with this zone, the Changkat Rembian Au anomalies occur in the granite and are associated with Sn anomalies.

Anomalies of W and rare earths are in or near the Main Range granite, suggesting their close relation with the granite.

As few non-remarkable geochemical anomalies except for rare earths are found scattered in the phyllite zone in the Changkat Jong and the Tanjong Malim sheets, it is considered to have low potential for heavy metal resources.

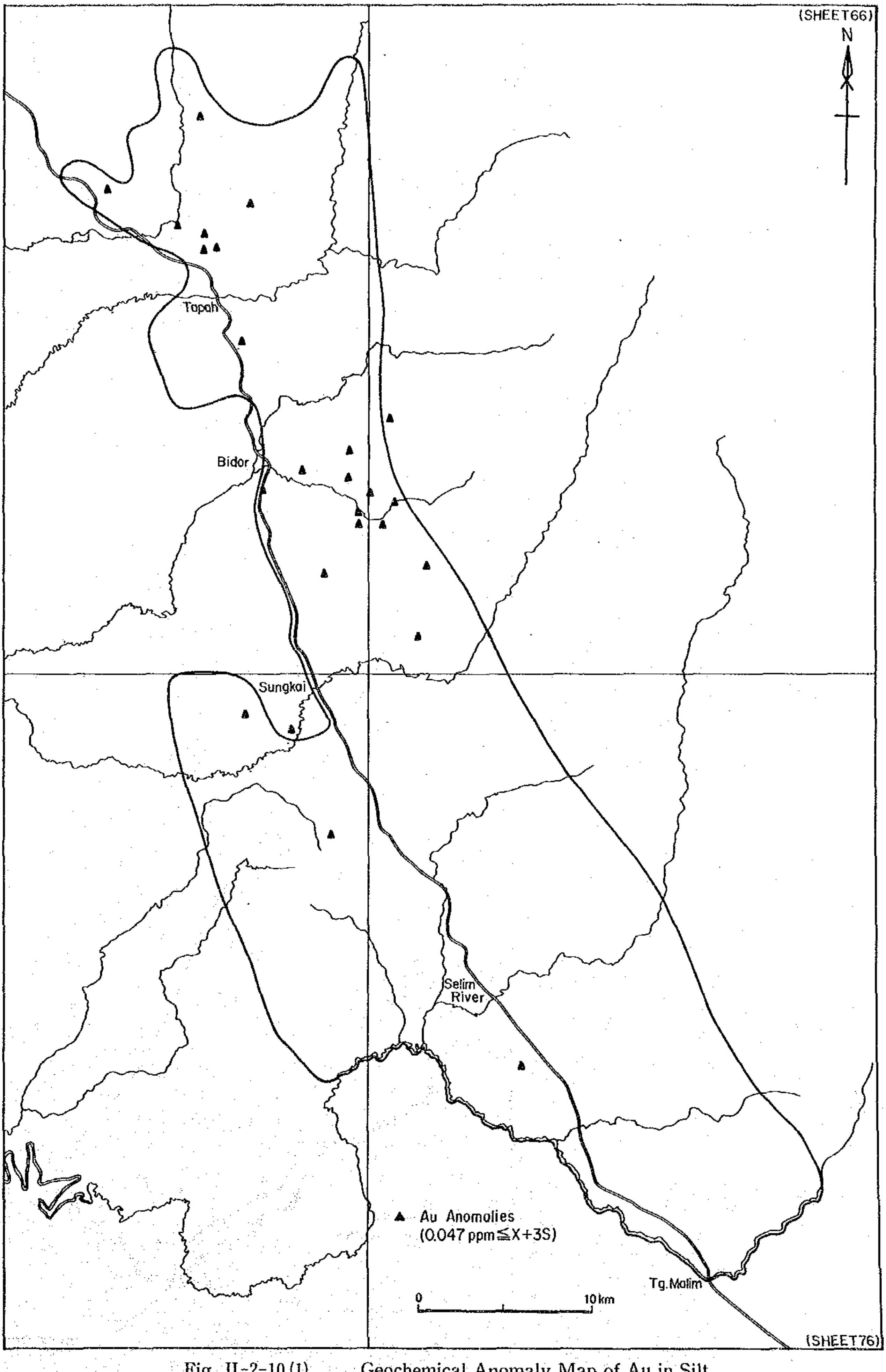


Fig. II-2-10 (1) Geochemical Anomaly Map of Au in Silt

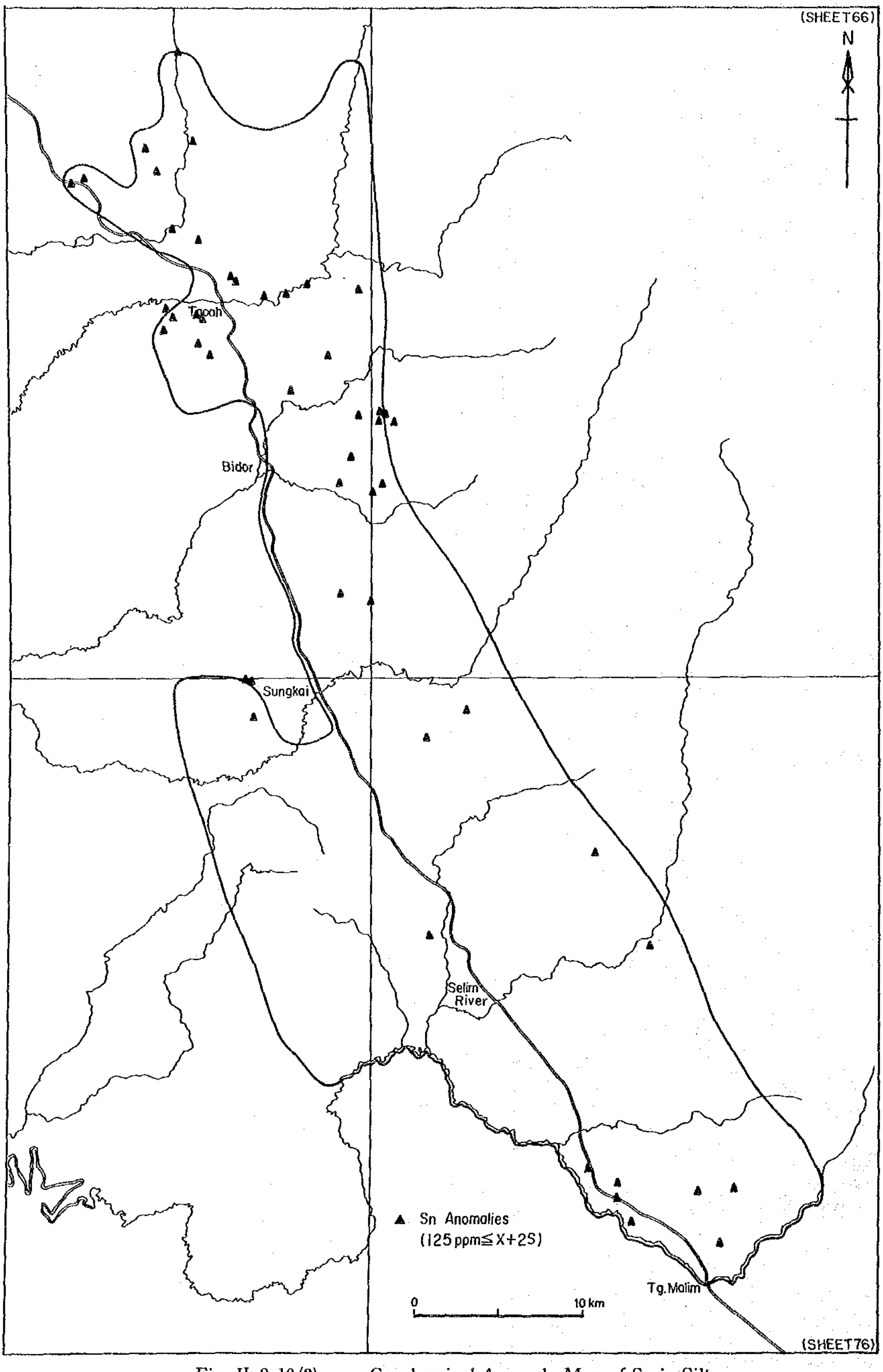


Fig. II-2-10 (2) Geochemical Anomaly Map of Sn in Silt

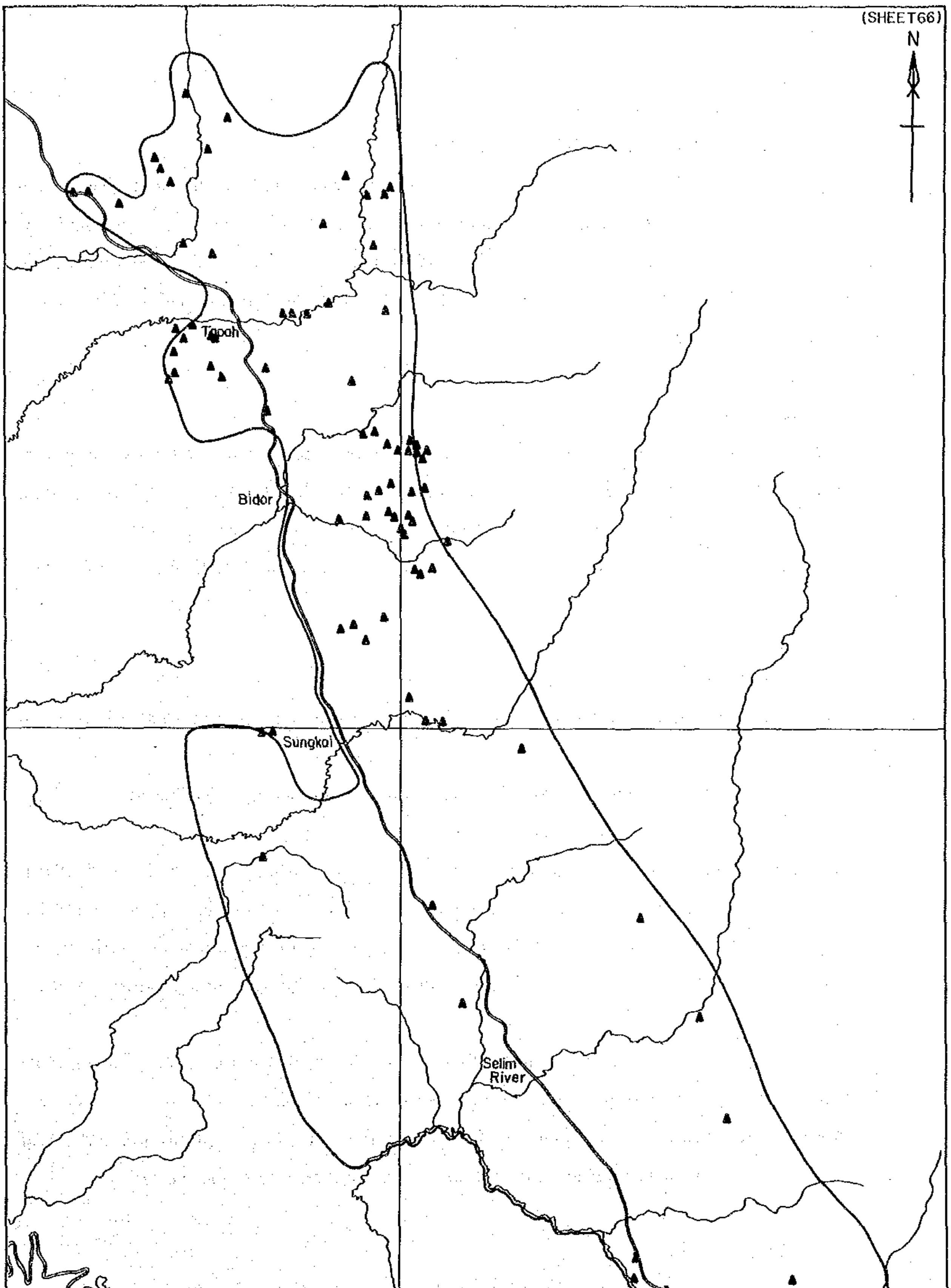


Fig. II-2-11 Factor Analysis Map of Factor 1 in Silt