REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE MAE SARIANG AREA,
THE KINGDOM OF THAILAND

CONSOLIDATED REPORT

MARCH 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

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

The survey was carried out for three years from December 1997 to March 2000 and was brought to completion with the cooperation of the Government of the Kingdom of Thailand, in particular, the Department of Mineral Resources.

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

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

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

March, 2000

Kimio Fujita
President
Japan International Cooperation Agency

Naohiro Tashiro
President
Metal Mining Agency of Japan

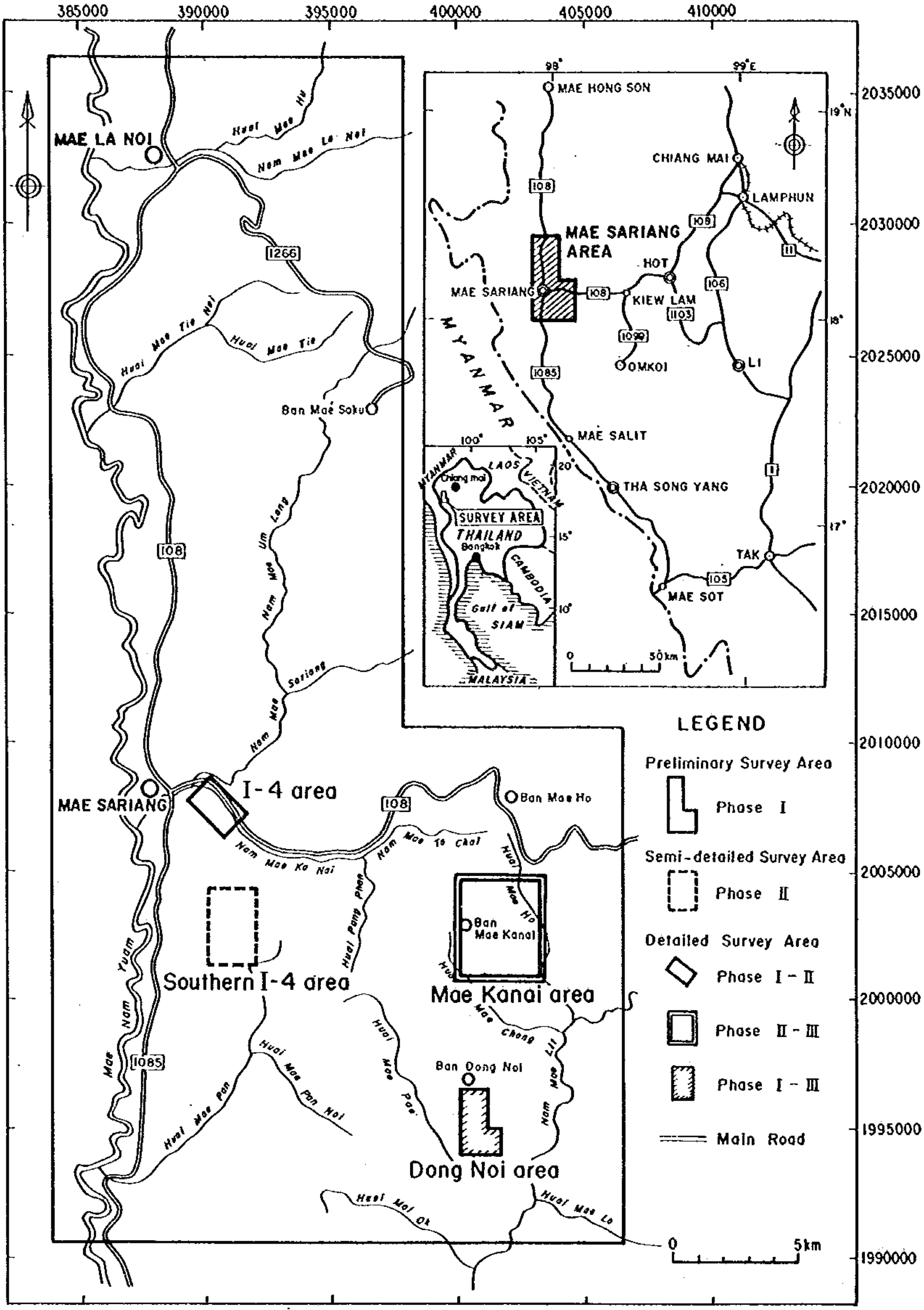

Fig.I-1 Location map of the Mae Sariang area

SUMMARY

1.Satellite Images Analysis

In this satellite image analysis, it is suggested that mineral occurrences in Mae Sariang area strongly relate with granitic rocks and limestone, and with continuous lineaments and density of short or discontinuous lineaments. Therefore, possibility of ore deposit would be high for such area as satisfying the following condition;

1) nearby contacts of Limestone (Ls) and Granite (Gr2),
2) crossing point of continuous lineaments,
3) nearby NNE-SSW lineaments that are considered as tension fracture,
4) high density area of short or discontinuous lineaments

2. Mae Sariang area

The distributions of various mineral occurrences and geochemical anomalies in Mae Sariang Area are closely related to the distribution of carbonate rocks such as limestone and limestone lenses, alternating beds of shale and limestone in the Ordovician system, the Devonian-Carboniferous systems, and the Permian-Triassic systems. It is considered that since carbonate rocks play a great role in the formation of ore mineralization.

In judging that, the areas overlapping distributions of limestone, mineral occurrences and geochemical anomalies have high potentiality for mineral deposits. Four districts of Mae Kanai, from Huai Pu to Huai Mae Pan, Um Mae Sariang West Bank and from Huai Hat Ta Lan to Huai Ng have been selected as the promising area

3 Dong Noi area

In the area with geochemical anomalies in zinc and lead values extending in the western half of Dong Noi area where limestone was distributed, hydrothermal ore solution in temperature of 140-250℃ and with high salinity rose up through joints in limestone and bedding place of fissures, formed silicificated zone on a certain horizon in relatively upper layers, caused occurrence of wide-ranged dolomitization and zinc/lead mineralization right above it, and at the same time formed quartz vein which changed joint systems and a specific horizon, precipitating galena and sphalerite. The quartz vein in dolomitized zone was in width of 80 cm and its grade values were 7.86%Zn and 2.82%Pb. The sample extracted from 20 m section including this quartz vein also showed high values of 1.60%Zn and 1.43%Pb, and existence of zinc body was expected. However, since the structure to form quartz vein changes open joints and the part along bedding of a certain specific horizon, it is necessary to explain more in detail rock faces and geological structure to estimate the position of its existence.

As a result of our investigation into MJTM-6 Hole excavated in a spare part of the district with IP anomalies, it was further clarified that the district with high IP anomalies might represent a mineralized zone of copper and lead overlapped with skarn zone. The depth of around 64 m in MJTM-6 Hole where occurrence of chalcopyrite was observed was almost in conformity with the depth of the upper limit to the anomaly zone (16 m V-sec/V or more) revealed through IP exploration. The depth of 140 m or lower where mineral showing including pyrite dissemination was intensified in general was in conformity with the district where IP anomalies (20 m V-sec/V or more) were observed. The district with IP anomalies (16 m V-sec/V or more) extended in a range of 100 m in diameter and 800 m in the total length. Based on the results of MJTM-5 Hole and MJTM-6 Hole, in view of the tendency of copper concentration to increase in a lower layer, i.e. the part where it was in contact with granite, ore body might possibly exist near the face which was in touch with granite. However, since copper showing in skarn zone is apt to be unevenly distributed, it is considered difficult to decide the exact position of such ore bodies.

4. Mae Kanai area

Resulting from our investigation on MJTM-7 Hole and past drilling survey conducted by DMR, we found that the district with high IP anomalies corresponds to the mineralized zone including the silicificated zone along the fracture continuing in the NE-SW direction and accompanied predominant pyrite dissemination and chalcopyrite showing. The chalcopyrite was the most prevailing in the depth of around 129 m, but its grade was low. We may point out that this mineralized zone might represent the passage of ore solution having formed the gossan zone where was distributed on the western side of the ridge.

The gossan zone with high zinc content in the Mae Kanai area had been considered to extend

in a vertical direction. However, through our drilling survey of this time, we confirmed that the gossan zone was distributed in thickness of a little more than 10 m and almost along the land surface and that remarkable mineral showing scarcely existed in its lower layers. The gossan zone was distributed between argillized mudstone or sandstone, and the gossan zone was originally a massive sulfide mineral abundant with pyrite and accompanying sphalerite, we presume that pyrite may have been oxidized and changed to limonite and sphalerite may have flown out through weathering.

The sedimentary rocks near the gossan zone were strongly influenced by argillization of talc-sericite-chlorite-smectite especially on the side of lower wall. Further, we observed that silicified zone in the form of hydrothermal breccia accompanying white argillization and quartz vein had been developed on the upper wall of the gossan zone.

The gossan zones occur almost on the same level, in the district surrounded by MJTM-8 Hole, MJTM-9 Hole and DMR's MK-3 Hole, it is quite possible that the horizon of the gossan may be beneath the land surface and that the gossan zone may have been hidden under it. Moreover, we presume that IP anomalies may be distributed at the east end of profile lines E and D for geophysical exploration on a slope inclined to east right under the land surface and that massive sulfide minerals may exist under the land surface.

4.I-4 area and Southern I-4 area

In the I-4 area, geological situation and mineral showings of one side remarkably differ from those of the other side of the NE-SW fault running through the center of the district.

In the northern side of the area, Ordovician limestone formation distributes and geochemical anomalies of Zn, Pb and F are recognized in the limestone. The distribution of anomalies suggests a high possibility that the distribution is controlled by the N-S fracture system. The anomaly levels are lower than those of Don Noi district by one figure. The fact that there is no anomaly of Cd is also different from Don Noi district. Judging from the fact that there are the mineralization of zinc at a certain level in this rock. This area has a difficult social condition than other areas, the development of a mine may be impossible if a ore-body will be discovered

In the southern side of the area, a mineralization zone in which several stockwork vein zones with sulfide minerals are found in the shale from the Permian to Triassic along the river. Geochemical anomalies and low specific resistivity and high chargeability zones distribute in the northwest direction that is the extension direction of the veins. Judging from this correlation, there is a high possibility of existing of vein type ore bodies under this zone which are more concentrated than the stockwork veins on the surface

There is a little possibility that an economic minable deposit exists in the Southern I-4 area.

The drill hole MJTM-4 in the I-4 area could encounter the mineralization extending from Nam Mae Kanai occurrence. The mineralized quartz veinlets at the depth ranging from 20 to 30 m is corresponded to an extension of sulfide disseminating quartz veinlets with 12 m wide in the northernmost of the Nam Mae Kanai occurrence. The estimated width of mineralized zone from MJTM-4 to the occurrence ranges from 4 to 12 m, and the distance is about 100 m. It is inferred that the mineralization extends to the southeast side and to the deeper part. The estimated grade ranges from 19.8 to 135 g/t Ag, 310 to 1,000 ppm Cu, 0.89 to 8.15 % Pb, and more than 0.1 % Zn based on the core assay.

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Part I General Remarks

Chapter 1 Introduction

1-1 Survey area and objective

1-1-1 Survey Area

The Mae Sariang area is, as shown in Figure I-1, an area of 760 km^2 covering 14 to 23 km from east to west and 20 to 46 km from north to south.

It locates at about 120 km to the southwest of Chiang Mai City in the north of The Kingdom of Thailand.

Administratively, this area belongs to Amphoe (District) Mae Sariang and Amphoe Mae La Noi of Changwat (Prefecture) Mae Hong Son. It is only 20 km from Mae Nam Sala Win that is the Thai-Myanmar border.

1-1-2 Background and objective

In Thailand, as demands for base metals such as copper, lead and zinc have increased due to the industrial development with the rapid advance of economy, the import of these metals is growing quickly; therefore, securing stable supply of domestic mineral resources is their urgent need.

Particularly as for zinc among them, Padeang Industry Company Limited. possesses mines (4.5 million ton of ore reserves: zinc grade 28.9 %; Min. Jour., 1994/4) and is operating the only zinc refinery in Southeast Asia. In recent years, however, with the exhaustion of ore reserves in mines, self-sufficiency in ores to the refinery has decreased and import from foreign countries has increased; consequently, it has been pointed out that the development of new mines is an urgent business.

The Mae Sariang area locates about 180 km in the north from Mae Sod Mine of Padeang Industry Company Limited. and is similar to geological situation of the Mae Sod Mine together with ore showings of lead and zinc. Since it locates on a geological structural extension of a skarn type massive sulfide ore body discovered in the Yang Kiang area through the Cooperative Mineral Exploration Project in 1987, this area is expected to have a high potentiality of lead and zinc deposits.

The purpose of this survey is to find out new deposits by investigating into geological conditions, mineralization, geochemical characteristics, geophysical prospecting and drilling survey in the Mae Sariang area of the Kingdom of Thailand.

1-2 Contents of the Survey

The purpose of this survey was as follows:

The survey was started with a interpretation of JERS-1/SAR and OPS image, a regional geological survey and reconnaissance geochemical prospecting over the whole survey area. Four areas had been picked out as the result of these survey. Also, in the first phase the detailed geological and geochemical survey, and IP survey was performed in the Dong Noi area and I-4area to decide some drilling site for the second Phase.

These areas were further narrowed down. Finally examinations were made for the potential of base metal mineralization by drilling survey.

The flow chart of the survey process and evaluation process are shown in Fig.I-1-1 and I-1-2.

The contents of surveys and the quantities of hese works in each phase are set forth in Table I-1-1.

1-2-1 The first phase survey in 1997

This fiscal year, reconnaissance geological surveys and geochemical survey of stream sediment to evaluate ore deposit potentiality in the whole of Mae Sariang area and the detailed geological and geochemical surveys and geophysical survey in two sub-areas, which are promising area of mineral occurrence, were conducted. These two sub-areas had been selected through the evaluation of mineral potentiality of the southern part of Changwat Mae Hong Son by Department of Mineral Resources, hereinafter referred to as DMR, of the Ministry of Industry, the Kingdom of Thailand and by the Project Finding Survey in the Kingdom of Thailand in Fiscal 1996.

For the reconnaissance geological and geochemical surveys, DMR and Project Finding reports were well studied and then, survey routes and sampling points were selected so that possibilities of existence of ore deposits in the whole area of Mae Sariang could be effectively grasped. For the survey, a topographical map drawn on a scale of 1 to 25,000 which was an enlarged existing map with a scale of 1 to 50,000 was used and the results were summarized on a topographical map drawn on a scale of 1 to 50,000.

At a detailed survey district, to grasp geological feature and alteration conditions as well as ore occurrence, geological and geochemical detailed surveys were carried out to presume the conditions of mineralization. At the same time, through an investigation of a specific resistance structure of a mineralization band and an IP abnormal area by the IP electrical prospecting method, information that would be necessary in selecting survey locations for drilling survey were obtained. For the detail survey, a topographical map with a scale of 1 to 2,500 which was an enlarged existing map drawn on a scale of 1 to 50,000 was used.

1-2-2 The second phase survey in 1998

The survey of this year is the first phase of the Cooperative Exploration in the Mae Sariang Area of the Kingdom of Thailand. The objectives of the second phase survey are to discover new promising area of ore deposit through the understanding of the metallic mineralization and the geology of the area and to evaluate the potential by detailed geological and geochemical survey, geophysical survey and drilling survey.

Detailed geological and geochemical survey will be performed in Dong Noi area and Mae Kanai area and I southern I-4 area. Geophysical survey by IP method will be performed in the Mae Kanai area. Drilling Survey is planed in Dong Noi and I-4 area.

1. Geological and Geochemical Prospecting

Clarify the relationship between the geological structure and mineralization, and especially

Survey area

First Phase

Satellite Image Analysis: 4,800 km²

Mae Sariang Area (regional and detailed survey)
- Survey area 760 km²
- Geological survey: Geologic map of 1/50,000
- Stream sediments: 855 samples, elements: Cu,Pb,Zn,Sb,Ag,Au,Sn,W,F,Hg,Mn,Mg

Area			
Dong Noi area (detailed survey)	1.5 km²	soil samples:	756
I-4 area (detailed survey)	2.5 km²	soil samples:	680
Mae Kanai area	Geologic map of 1/2,500	soil samples:	15

Elements: Cu,Pb,Zn,Sb,Ag,Au,Sn,W,F,Hg,Mn,Mg

Geophysical survey (IP method)

	Dong Noi area	I-4 area
Line length:	8.0 km	9.8 km
Number of line:	7 lines	10 lines
Stations:	222 points	294 points

Analysis of survey results

Selection for promising area

Recommendation for Second Phase Survey

Second Phase

Geological and geochemical survey Geologic map of 20,000

Mae Kanai area	Dong Noi area	Southern I-4 area
Survey area 8.0 km²	Survey area 2.5 km²	Survey area 3.75 km²
Geochemical survey	Geochemical survey	Geochemical survey
Soil samples 511	Soil samples 498	Soil samples 46
MMI samples 281	Trenching: 2 lines, 200.00m	

Pathfinder elements: Cu,Pb,Zn,Sb,Ag,Au,Sn,W,F,Hg,Mn,Mg

Geophysical survey (IP method)

	Mae Kanai area	Dong Noi area
Line length:	20.0 km	1.0 km
Number of line:	10 lines	1 line
Stations:	660 points	26 points

Drilling survey

Dong Noi area	I-4 area
Drill hole: 4 holes 840.00m	Drill hole: 4 holes 840.00m

Analysis of survey results

Selection for promising area

Recommendation for Third Phase survey

Third Phase

Mae Kanai area	Dong Noi area
Drilling survey: 4 holes 892.90m	Mineral occurrences survey Rock chip analysis: 61 pieces Drilling survey: 1 hole 187.50m

Analysis of survey results

Recommendation for future activity

Fig. I-1-1 Flow chart of the exploration program

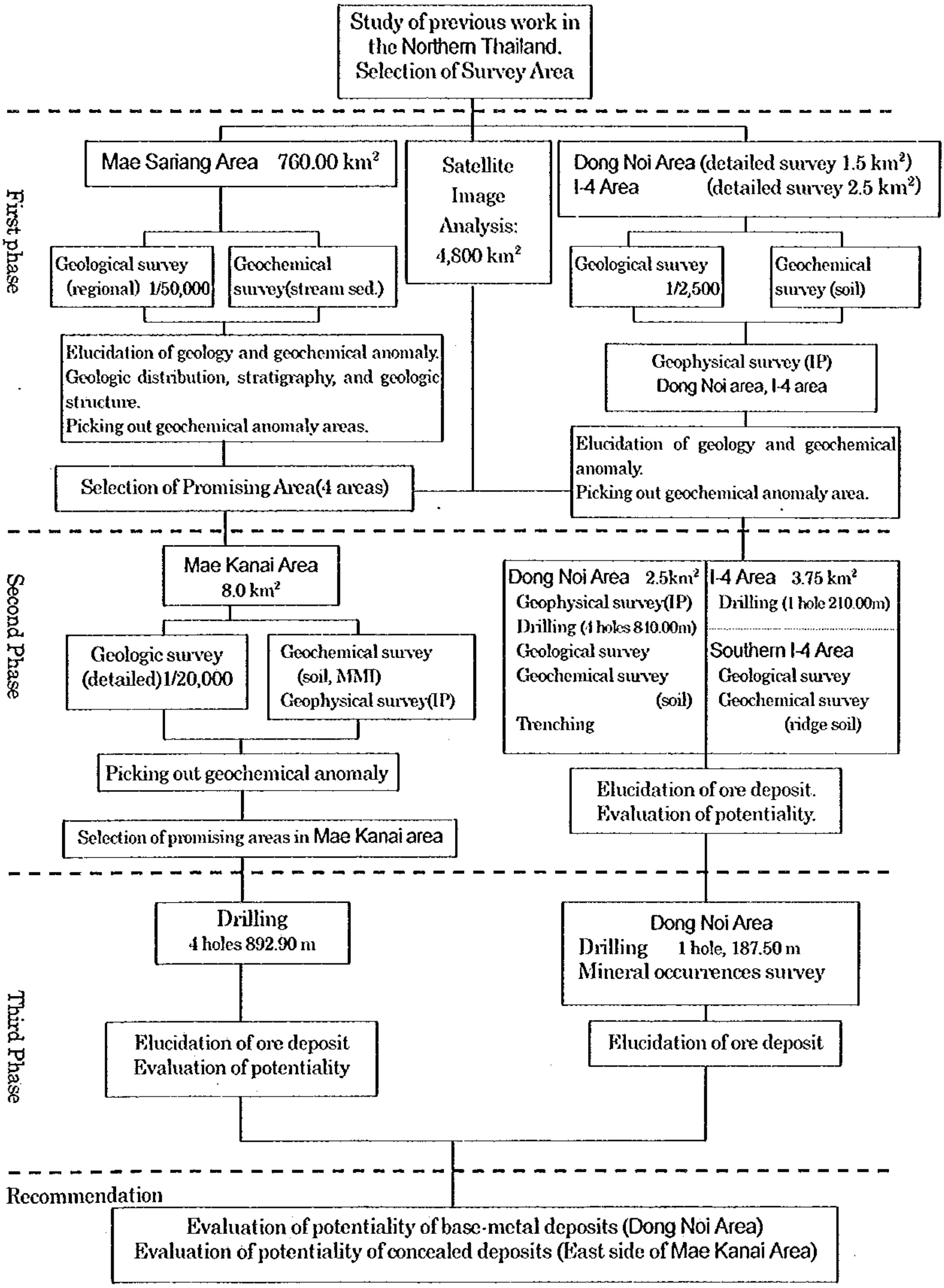

Fig. I-1-2 Flow chart of the selecting promising area

Table I-1 Contents and quantities of the survey

Items	Year	Phase I (1997)			Phase II (1998)			Phase III (1999)	
Field Work	Object	Selection of promising area by geological and geochemical work from whol Mae Sariang area			Detailed survey of promising area selected by Phase I survey			Estimation of potentiality	
Field Work	Method	Geological survey, geochemical survey, geophysical survey (IP method)			Geological survey, geochemical survey, geophysical survey (IP method), drilling, trenching			Geological survey, geochemical survey, mineral occurrences survey, drilling	
Field Work	Survey Area and Amount of Survey	Mae Sariang area (whole area) 760 km^2			Dong Noi area 2.5 km^2	I-4 area 3.8 km^2	Mae Kanai area 8.0 km^2	Dong Noi	Mae Kanai
		Dong Noi	I-4	Mae Kanai					
		Geophysical survey (IP) Area: 1.5 km^2 Length of lines: 8.0 km Number of lines: 7 Number of stations: 222	Geophysical survey (IP) Area: 2.5 km^2 Length of lines: 9.8 km Number of lines: 10 Number of stations: 294	Soil geochemical survey	Geophysical survey (IP) Line length: 1.0 km Number of line: 1 Number of stations: 26 Drilling 4 drillholes Total length: 840.00 m Trenching Number of trench: 2 Total length: 200.00 m	Drilling 1 drillhole Length: 210.00 m	Geophysical survey (IP) Line length: 20.0 km Number of lines: 10	Drilling 1 drillhole Length: 187.50 m	Drilling 4 drillholes Total length: 892.90 m
Laboratory Work	Thin Sections	12			14			5	
Laboratory Work	Polished Sections	12			42			5	
Laboratory Work	X-ray Diffraction Analysis	16			32			17	
Laboratory Work	Fluid Inclusion	12			16			9	
Laboratory Work	Stable Isotope Analysis(δ C, δ O)	9			10			-	
Laboratory Work	Measurement of Resistivity and Polarization	33			38			-	
Chemical Analysis	Stream Sediments (Element)	849 (Cu ,Pb, Zn, Sb, Ag, Au, W, F, Hg, Mn, Mg)			-			-	
Chemical Analysis	Soil	Dong Noi 756	I-4 680	Mae Kanai 15	Dong Noi 498	Southern I-4 46	Mae Kanai 511	-	
Chemical Analysis	(Element)	(Cu ,Pb, Zn, Sb, Ag, Au, W, F, Hg, Mn, Mg)			(Cu ,Pb, Zn, Sb, Ag, Au, W, F, Hg, Mn, Mg)				
Chemical Analysis	MMI (Element)	-			-	-	281 (Cu, Pb, Zn Cd)	-	
Chemical Analysis	Rock (Element)	-			-	-	-	61 (Cu, Pb, Zn, Cd, Ag, Au, Mn, Mg)	
Chemical Analysis	Ore (Element)	45 (Cu, Pb, Zn, Sb, Ag, Au, Sn, W)			86 (Cu, Pb, Zn, Sb, Ag, Au)			67 (Cu, Pb, Zn, Sb, Ag, Au)	

clarify the characteristics of each alteration.

Infer the location of the potential area for base metal deposit through geological structure and the distribution of alteration zone and geochemical anomalies.

In the Dong Noi area, soil sampling was done in the external area of the first phase area.

In the Mae Kanai area, soil and MMI sampling were performed using on Geophysical survey line.

2. IP survey

The objective of IP survey is to clarify resistivity structure and IP anomalies concerning to mineralization zone and its corresponding alteration area in Dong Noi sub-area and I-4 sub-area.

3. Drilling Survey

The objective of drilling survey is to explore and to assess the mineral potential of base metals in the Dong Noi area and I-4 area

250m, 350m and 200m holes in vertical were carried out in Dong Noi area. 250m holes with 70 degrees inclining in I-4 area.

1-2-3 The third phase survey in 1999

In third phase, mineral occurrence survey and drilling survey were performed in the Dong Noi area and Mae Kanai area where were selected for the promising areas through second phase.

1. Mineral occurrence survey

Mineral occurrence survey was done at northwestern part of Dong Noi area for checking a cause of high geochemical anomaly.

Rock tip samples and ore samples were collected along survey lines with detailed geological survey.

Infer the location of the potential area for base metal deposit through geological structure and the distribution of alteration zone and geochemical anomalies.

2. Drilling Survey

The objective of drilling survey is to explore and to assess the mineral potential of base metals in the Dong Noi area and Mae kanai area

In the Dong Noi area, one vertical drill hole with 187.50m length was operated at the north extension of MJTM-3 and MJTM-5 in IP anomaly area where was considered copper and lead mineralization zone.

In the Mae Kanai area, three vertical holes and a inclined hole with 892.90m in total length were drilled for purpose to reveal the potential of base metals mineralization.

1-3 Schedule and personnel

1-3-1 First phase survey (1997 to 1998)

1. Duration

Planning and Coordination:

November 9, 1997 to November 11, 1997

Geological and Geochemical Surveys:

December 15, 1997 to February 27, 1998 (75 days)

Geophysical Survey:

January 15, 1998 to February 27, 1998 (44 days)

2.Personnel

Planning and Coordination

Japan

Jiro Osako	Metal Mining Agency of Japan
Toru Nawata	Metal Mining Agency of Japan
Kosuke Takamoto	Metal Mining Agency of Japan
Hiroshi Shibazaki	Metal Mining Agency of Japan
Yoshiharu Kida	Metal Mining Agency of Japan, Bangkok

Thailand

Phisit Dheeradilok	Department of Mineral Resources
Suvit Sampattavenija	Department of Mineral Resources
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Werapun Jantaranipa	Department of Mineral Resources
Boonsong Yokart	Department of Mineral Resources

Field Survey Team

Geological and Geochemical Survey

Japan

Hiroyuki Takahata	Nittetsu Mining Consultants Co., Ltd.
Makoto Miyoshi	Nittetsu Mining Consultants Co., Ltd.
Yasunori Ito	Nittetsu Mining Consultants Co., Ltd.
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Thailand

Boonsong Yokart	Department of Mineral Resources
Adoon Wunapeera	Department of Mineral Resources
Phureewat Jenrungrot	Department of Mineral Resources
Wicharn Mungkhun	Department of Mineral Resources

Geophysical Survey

Japan

Hirohisa Horiuchi	Nittetsu Mining Consultants Co., Ltd.
Munemaru Kishimoto	Nittetsu Mining Consultants Co., Ltd.
Mitsuaki Kanahori	Nittetsu Mining Consultants Co., Ltd.

Thailand

Kampanart Lampoonsub	Department of Mineral Resources

1-3-2 Second phase survey (1998 to 1999)

1. Duration

Geological and Geochemical Surveys:

October 29, 1998 to December 28, 1998 (61 days)

Geophysical Survey:

November 9, 1998 to December 26, 1998 (48 days)

Drilling Survey:

October 18, 1998 to February 6, 1999 (112 days)

2. Personnel of survey mission

Planning and Coordination

Japan	
Tadashi Ito	Metal Mining Agency of Japan
Takafumi Tsujimoto	Metal Mining Agency of Japan
Noboru Fujii	Metal Mining Agency of Japan
Hiroshi Shibasaki	Metal Mining Agency of Japan
Yoshiharu Kida	Metal Mining Agency of Japan, Bangkok
Thailand	
Nopadon Mantajit	Department of Mineral Resources
Somsak Potisat	Department of Mineral Resources
Phairat Suthakorn	Department of Mineral Resources
Werapun Jantaranipa	Department of Mineral Resources
Boonsong Yokart	Department of Mineral Resources

Field Survey Team

Geological and Geochemical Survey and Drilling Survey

Japan	
Hiroyuki Takahata	Nittetsu Mining Consultants Co., Ltd.
Makoto Miyoshi	Nittetsu Mining Consultants Co., Ltd.
Yasunori Ito	Nittetsu Mining Consultants Co., Ltd.
Kosei Takayama	Nittetsu Mining Consultants Co., Ltd.
Thailand	
Boonsong Yokart	Department of Mineral Resources
Adoon Wunapeera	Department of Mineral Resources
Phureewat Jenrungrot	Department of Mineral Resources
Wicharn Mungkhun	Department of Mineral Resources

Geophysical Survey

Japan	
Toshio Kasagi	Nittetsu Mining Consultants Co., Ltd.
Munemaru Kishimoto	Nittetsu Mining Consultants Co., Ltd.
Tateyuki Negi	Nittetsu Mining Consultants Co., Ltd.
Thailand	
Suebsak Sologosoon	Department of Mineral Resources
Kampanart Lampoonsub	Department of Mineral Resources

1-3-3 Third phase survey (1999 to 2000)

1.Duration

Drilling Survey: January 20, 2000 to March 18, 2000 (69 days)

(including mineral occurrence survey in the northwestern part of the Dong Noi area)

2.Personnel of survey mission

Planning and Coordination

Japan

Tadashi Ito	Metal Mining Agency of Japan
Noboru Fujii	Metal Mining Agency of Japan
Hiroshi Shibasaki	Metal Mining Agency of Japan
Takeshi Moriya	Metal Mining Agency of Japan, Bangkok
Yoshiharu Kida	Metal Mining Agency of Japan, Bangkok

Thailand

Somsak Potisat	Department of Mineral Resources
Satien Sukontapongpow	Department of Mineral Resources
Peerapong Khuenkong	Department of Mineral Resources
Adoon Wunapeera	Department of Mineral Resources

Field Survey Team

Drilling Survey

Japan

Hiroyuki Takahata	Nittetsu Mining Consultants Co., Ltd.
Yoshihiko Ichii	Nittetsu Mining Consultants Co., Ltd.

Thailand

Adoon Wunapeera	Department of Mineral Resources
Wicharn Mungkhun	Department of Mineral Resources

Chapter 2 Geological information

2-1 Previous works

About the geological features and the mineral deposits in the northern part of Thailand near the Laos-Myanmer border, the West Germany Geological Survey Mission investigated systematically early 1970 and drew seven pieces of geological maps on a scale of 1 to 250,000 (Hahn et al., 1986). The report of Mae Sariang area is written in Sheet 4, Chiang Mai of this report.

DMR carried out reconnaissance geochemical detailed survey of promissing area of occurrence of ore deposit in Amphoe Mae Sariang, Amphoe Mae La Noi and Amphoe Khun Yuam as follow-up surveys of the wide area geochemical survey (Jamnongthai, 1985) and geochemical semi-detailed surveys (Jamnongthai, 1986) within Chiang Mai of the geographical map on a scale of 1 to 250,000. They discovered four promising lead-zinc (barite) bearing areas, one promising copper-bearing area and two promising zinc-bearing areas in Amphoe Mae Sariang and two promising lead-zinc (barite) bearing areas in Amphoe Mae La Noi (Jamnongthai, 1988). This survey has been planned on the basis of the above reports.

Between 1984 and 1987, airborne geophysical survey (total magnetic force and radiation) was carried out across Thailand excluding the Thai Peninsula with the assistance of Canada. Result maps with a scale of 1 to 50,000, maps drawn on a scale of 1 to 250,000 and a explanation book about the survey were published. DMR is now developing the data into digital information.

2-2 Geology and Mineral Occurrences in the Survey Area

2-2-1 Geology

The northern part of Thailand is divided, from the west, into four tectonic provinces: the western tectonic province (the border between Thailand and Myanmar), the western major mountain tectonic province (between Mae Sariang and Chiang Mai), from the central plain to the central northern tectonic province and the eastern tectonic province (Khorat Plateau).

The Mae Sariang area is divided two region by N-S fualt along the Mae Nam Yuam. The east region belongs to the western major mountain tectonic province and the west region belongs to the western tectonic province. The western major mountain tectonic province consists of Late pre-Cambrian metamorphic rocks, the Paleozoic to Mesozoic Sedimentary rocks unconformably covering the Pre-Cambrian and Carboniferous and Triassic Granite. The west region is composed with the Paleozoic to Mesozoic carbonate and clastic rocks, and Mesozoic granite.

Geological structure is intensely inferred to the tectonic line dividing the two region. The tectonic line lies in the NW-SE direction in southern area and changes into N-S direction from vicinity of Mae Sariang Town to the north.

2-2-2 Mineral Occurrences

According to "Natural Resources of Changwat Mae Hong Son" (DMR, 1984), mineral resources of Amphoe Mae Sariang, King Amphoe Sop Moei and Amphoe Mae La Noi can be summarized as follows.

(1) Amphoe Mae Sariang and King Amphoe Sop Moei

Amphoe Mae Sariang has not only the largest land in Changwat Mae Hong Son (currently, the southern part is divided into King Amphoe Sop Moei) but also has the biggest income from the mining industry. Major mineral products of the district are tungsten and tin followed by fluorite. In addition, barite, lead and iron have been found in some locations.

Mae Lama Mine owned by Panashito Company Ltd. is only operating mineral deposit which has been known over forty years. This is a mine which was once famous for its largest amount of tungsten exploited in Thailand.

As for the distribution, the ore deposits in the Amphoe Mae Sariang are roughly divided into two areas (See Figure I-2-1.). The northeastern part of the Amphoe Mae Sariang (east bank area of Nam Mae Yuam) and the south end area of the Amphoe Mae Sariangwhich is near the border of Amphoe Tha Song Yang, Changwat Tak. The former excels in fluorite deposits accom-

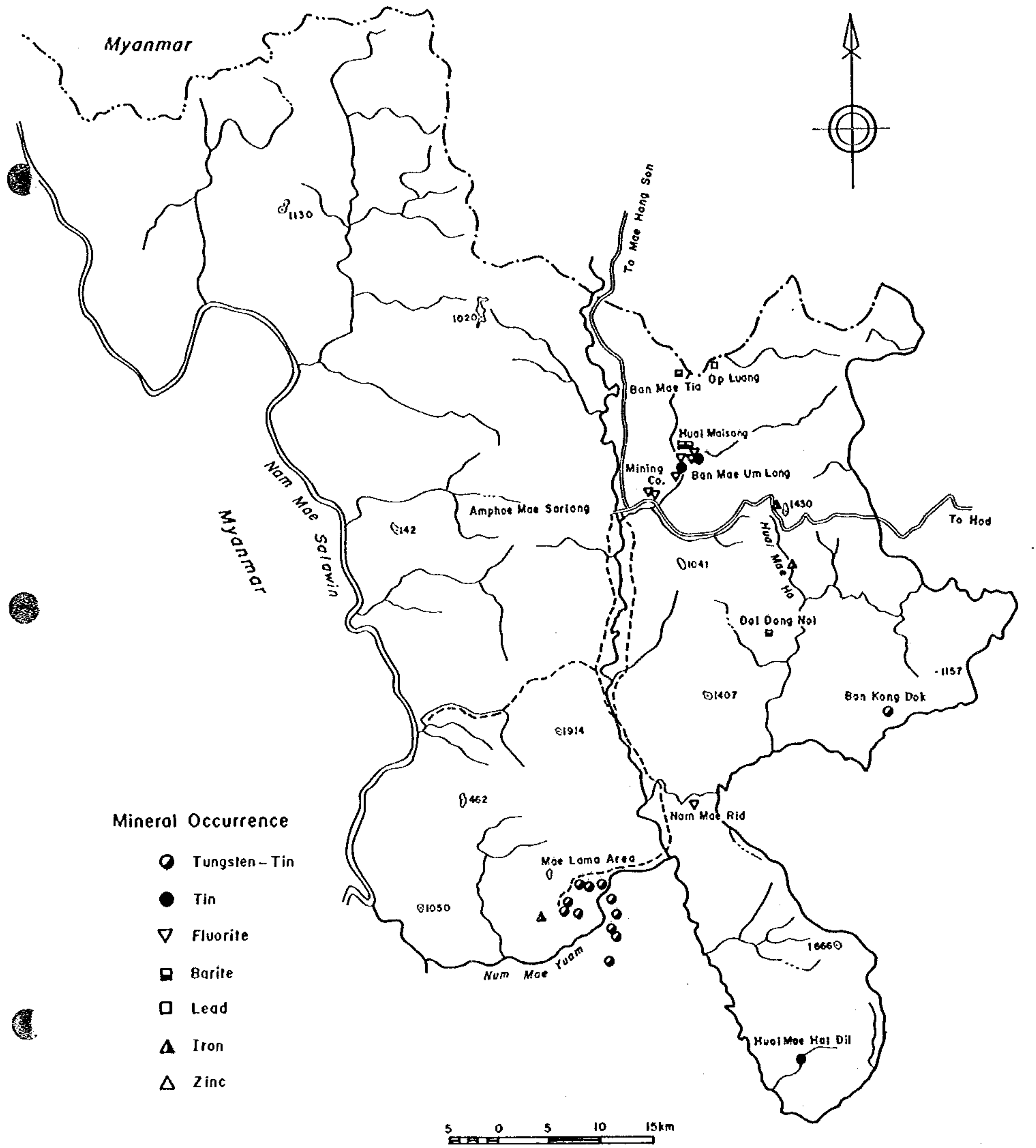


Fig.I-2-1 Mineral occurrence in the Mae Sariang District (DMR,1984) panied by ore showings of barite and lead. The latter has tungsten and tin mines. In this district, the overseas geological structure survey "Mae Sariang Area" was carried out in 1983.

From Huai Mae Sariang Noi of the Mae Sariang River to the neighborhood of an exit of a valley adjacent to Mae Sariang urban area, six fluorite ore showings are distributed. Five of them were only discovered but never have been operated yet; however, mining of the fluorite mine owned by Mining Co., Ltd. was already completed. These fluorite ore showing are occurred in the limestone that is adjacent to granite and mixed as in veins or balls. In some parts, veins of the fluorite developed in the shale formation of the lime stone foot wall are also acknowledged. As other fluorite mines owned by Yon Piphad Limited Company, there is one along Nam Mae Rid in the southern part of Amphoe Mae Sariang.

There are three barite mining area claims which are at Huai Mai San near the surroundings where many fluorite occurrences gather in the northeastern part of Amphoe Mae Sariang, at Huai Mae Tia owned by Chiang Mai Transport Company in the northern part of the Amphoe Mae Sariang and the neighborhood of Doi Dong Luang of Ban Dong Luang of the south eastern part of the Amphoe Mae Sariang. In the barite ocurrence of Huai Mai San, veins which are 1 to 5 m wide originate in fine sandstone or alternation of sandstones and shales. Barite occurrence of Doi Dong Luang is about 12 m wide and 150 m long and originate in limestone and is accompanied by lead and copper ore showings.

Lead ore showing exist in Opu Luang which is adjacent to Amphoe Mae La Noi and contain pyrite, copper and malachite. The vein width keeps irregularity varying from 5 to 20 cm and runs from east to west inclining 70° to the north.

In the Mae La Ma region of ore showing of the southern part of Amphoe Mae Sariang, there is limestone, shale, slate and quartzite of the Cambrian and the Ordovician with granite stock (Adamellite) of Triassic Period. In the quartz vein developed at these contacting parts, wolframite, cassiterite and scheelite are occurred. As for Mae La Ma mining area, five mines are distributed on each side of both banks of Nam Mae Yuam. The Mae La Ma mine group on the west bank including Mae La Ma mine mainly contains wolframite and the amounts of cassiterite and scheelite are small. On the other hand, the Huai Luang mine group on the east bank contains more cassiterite than wolframite. There are two directions for the quartz veins: an east-west system and a north-south system of which widths are irregular. Although the quartz veins contain chalcoprite, pyrrhotite, sphalerite, beryl and tourmaline, their amount is too small to commercialize.

In addition to the above mentioned, iron ore showing have been found near Ban Mae Ho. In the hill on the northern side of Route 108 and the valley of Huai Mae Ho which is 3 to 4 km from the southeast of the village, boulders of magnetite and hematite, which are partly limonitized, are dotted. There are limestone and quartzite in the Mae Ho Valley. Because the quality of discovered iron ores is good in spite of the amount to be too small for commercialization, further detailed surveys will be necessary in the future.

(2) Amphoe Mae La Noi (Fig.I-2-2)

Amphoe Mae La Noi is the newest disrict established in Changwat Mae Hong Son and its area is the smallest.

Amphoe Mae La Noi bears nine ore showings, but the deposits exploited are only two fluorite deposits.

The fluorite deposits locate in Makok Mine of Universal Mining Co., Ltd. along the Nam Mae La Luang in the middle northern part of Amphoe Mae La Noi and in Huai Mae Hu in the east of Mae La Noi urban area.

The fluorite mine in Huai Mae Hu has its origin in a vein structure along faults developed in Ordovician limestone. Operating of this mine started in 1967 and closed in 1975. By 1979, the mining continued on a contract system. The output by 1979 was from 40,000 to 50,000 tons at the lowest estimate. During the period of this year's survey, the mine was under operation as a quarry of limestones.

At a place about 500 m apart from a hot spring near the fluorite mine, boulders of magnetite and hematite are found. They are distributed in the area of 100 m x 50 m which is stretching from north to south along a branch of Huai Mae Hu. These ores are distributed up to about 2 m under the earth surface and the largest diameter is 50 cm.

Zinc occurrences have been found at three places in the basin of Nam Mae Yuam. They exist near the confluence of Huai Mae La Ngiu and the Nam Mae Yuam in the southwestern part of Mae La Noi urban district, Huai Khun Ma of Ban Mae La Luang and Wang Mu Nao of north-central part of Amphoe Mae Sariang. All of them are sphalerite in quartz veins developed in Triassic sandstones. The first mentioned two ore showings are 1 to 3 cm wide and the last one is 10 to 20 cm wide.

Lead occurrences exist in Ban Mae Khuwan and Doi Khun Kam of Southern part of Amphoe Mae La Noi. The Mae Khuwan ore showings consists of galena in an about 30 cm wide quartz vein developed in granite. The latter ore showing consists of galena with in a quartz vein and its width is about 6 cm in average, but its length is unknown.

In a small hill on the east of a national road from Mae La Noi to Mae Luang, there is ore showing of manganese. Although massive manganese dioxides are distributed on the earth surface of muddy limestone, no veins have been found.

Chapter 3 Geography

3-1 Locations and Access

The Mae Sariang area locates within the range from 97° 54' E to 98° 07' E of Longitude and from 18° N to 18° 25' N of Latitude and about 120 km southwest from Chiang Mai which is the second largest city of Thailand. As shown in Figure I-1, the size of the survey area is 760 km^2; it extends about 14 km from east to west in the northern part and about 23 km in the southern

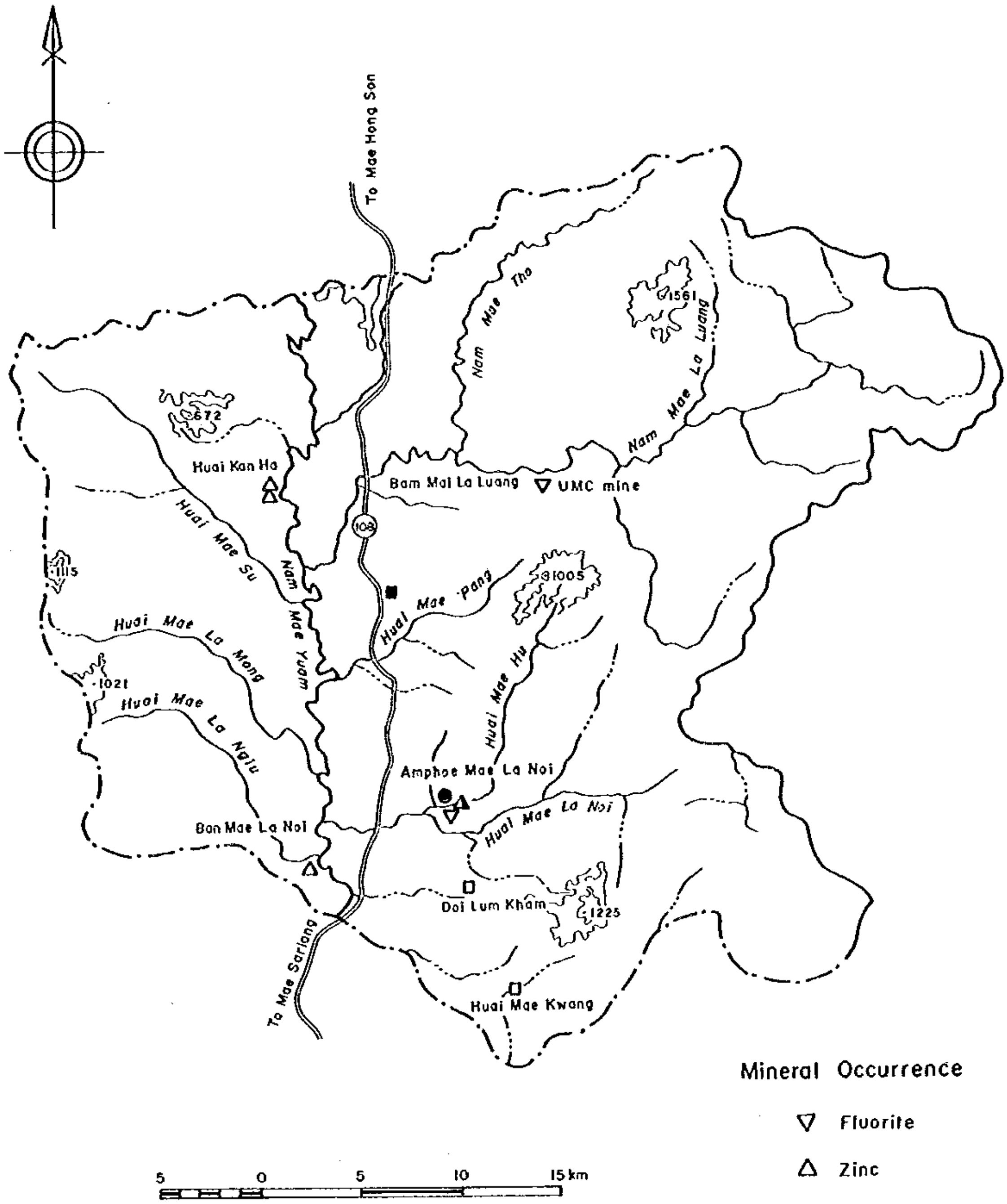


Fig.I-2-2 Mineral occurrence in the Mae La Noi District (DMR,1984) part. The length from north to south is from 20 to 46 km.

Administratively, the area belongs to Amphoe Mae La Noi, Amphoe Mae Sariang and King Amphoe Sop Moei of the southern part of Changwat Mae Hong Son which locates at the north-western border of Thailand.

Through district capital Mae Sariang of Amphoe Mae Sariang locating in southwest of the survey area, Route 108 connecting Chiang Mai with Mae Hong Son is running. Mae Sariang town is 199 km from Chiang Mai and 168 km from Mae Hong Son, almost the middle of these two cities. Transport facilities in general are private cars or buses. In addition to buses, which make eight round trips per day between these two cities, there are buses that make three round trips per midnight between Mae Sariang and Bangkok. It takes about five hours by bus from Mae Sariang to Chiang Mai and about twelve hours from Mae Sariang to Bangkok.

Between Bangkok and Chiang Mai, there are fourteen round-trip flights per day and one trip requires about one hour. From Bangkok, two express trains of the National North Railway runs per day. One trip requires fourteen hours. Moreover, there are many highway bus services.

The above mentioned Route 108 is a completely paved road crossing the southern part of the survey area. From Mae Sariang, it runs through the survey area northwardly along the Nam Mae Yuam. To the south of Mae Sariang, there is paved Route 1086 in the town of Mae Sod in which Mae Sod Mine of Padeang Industry Company Limited. exists. Since within the district, roads for cars, which had connected villages of hilltribes, had been comparatively developed, it was convenient for the survey, but, as most of those roads were not paved, they became muddy and required much attention for passing during a rainy season.

3-2 Topography

The northwestern part where Mae Sariang area locates belongs to the Thanon Tongchai-Tanasserim Mountains which starts in Yunnan Xing of China and ranges from north to south along the Thai-Myanmar border and reach Malay Peninsula. This part is a mountainous area where high mountains of Thailand including the Thailand's highest peak Doi Inthannon (its height above sea level is 2,595 m).

Mae Sariang Area locates in the West End of this mountainous area and consists of a tectonic basin along Nam Mae Yuam which runs from north to south in the western part of the survey area and a plateau platform in its eastern side. The height above sea level of the basin along Nam Mae Yuam is about 200 to 250 m and mountain streams run directly into Nam Mae Yuam which runs from north to south have developed.

The boundary between this basin and the plateau has formed a sharp cliff. The height above sea level of the plateau surface is from 800 to 1,400 m and there are many comparatively gentle undulations. However, since this plateau is deeply cut by the river system which has developed from north to south, northeast to southwest or northwest to southeast, which is the major geological structure of this area, sharp cliffs are observed from the surface of the plateau to the major rivers.

3-3 Climate and Vegetation

The northern part of Thailand including Mae Sariang area is under influence of a tropical monsoon, but since it locates inland, it has a continental tropical savannah climate which consists of a dry season due to a northeast monsoon and a rainy season due to a southwest monsoon.

The rainy season by a southwest monsoon is in May through October and about 90% of the annual rainfall fall intensively during this period. The dry season by a northeast monsoon is in November through February and there is almost no rainfall in December and January. Temperatures of this season are the lowest of the year. In the morning even in a lowland like Mae Sariang, it is not rare that the temperature becomes below 10° C, In March and April, the monsoon calms down and this period is the hottest season of the year (the hot season) and the temperature reaches as high as 38℃ at maximum.

Table I-3-1, I-3-2 and Figure I-3-1, I-3-2 show statistics of climates of the past three years.

Table I-3-1 Monthly precipitation in 1995-1997 at the Mae Sariang town

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	0.0	0.0	14.5	26.2	92.3	164.0	191.4	286.7	163.5	135.8	38.6	0.0	1113.0
1996	0.0	54.3	4.0	60.9	193.4	358.5	213.2	200.4	216.3	34.7	7.9	0.0	1343.6
1997	0.0	0.0	0.0	58.9	70.5	144.1	138.5	341.0	209.8	88.8	4.0	0.0	1055.6

More than 85 % of Mae Sariang area is a mountainous area which is designated as the National Conservation Region and the Wildlife Preservation Region.

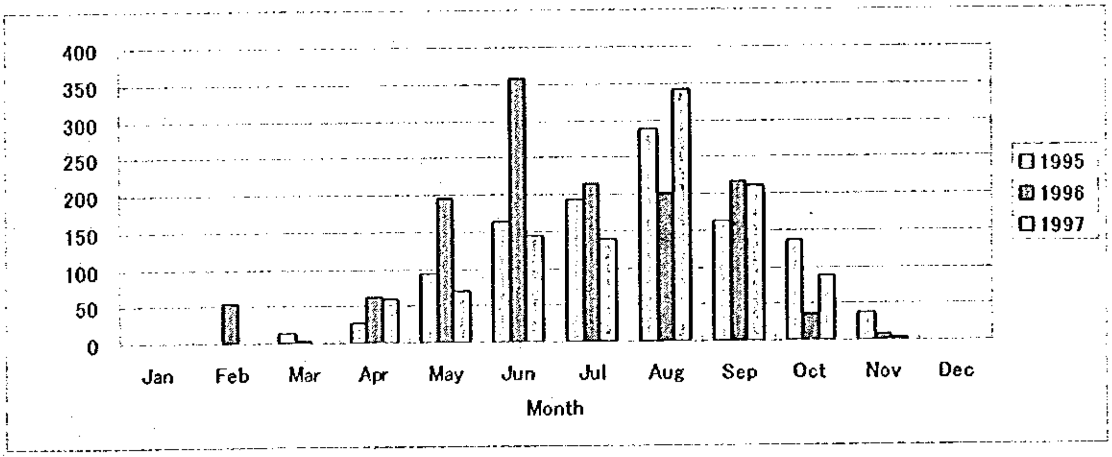


Fig.I-3-1 Monthly precipitation diagram at the Mae Sariang town

Woods are thin deciduous forests consisting of miscellaneous trees together with coniferous trees, teak, shara, red sandalwood. Since many leaves fall during the dry season, can afford an unobstructed view. On the flat part of the mountain summit, villages of hilltribes are dotted. Around this area, almost no forests have remained because a cash crop is cultivated in accordance with the permanent resident policy and traditional traveling slash-and-burn farming is being carried out.

3-4 General Information

The Mae Sariang area lies across three districts of the southern part of Changwat Mae Hong

Table I-3-2 Monthly average temperature at Mae Sariang town

Max. temp.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	32.30	33.57	37.36	39.87	35.20	32.11	30.75	31.38	32.07	32.27	31.47	30.12
1996	31.28	33.29	36.15	36.55	34.05	31.89	31.34	30.94	31.55	32.80	32.31	31.03
1997	30.78	33.18	36.40	36.15	36.39	32.69	30.45	30.23	31.92	33.76	31.86	32.50

Min. temp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	14.40	12.50	18.36	23.01	24.23	23.99	23.40	23.57	23.24	22.63	19.94	14.35
1996	11.55	14.38	17.74	22.52	23.34	23.26	23.06	22.93	23.09	22.38	20.30	15.65
1997	11.54	10.03	17.36	19.77	23.74	23.36	23.15	22.82	22.75	22.49	20.01	17.04

Son such as Mae Sariang, Mae La Noi and Sop Moei. Its major part belongs to Amphoe Mae Sariang.

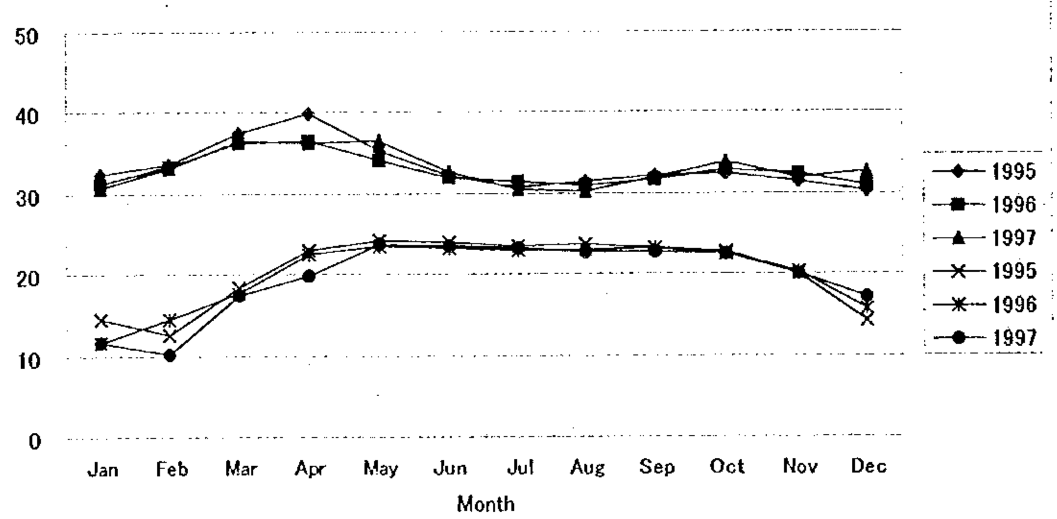


Fig.I-3-2 Monthly average temperature at the Mae Sariang town

Amphoe Mae Sariang is the center of administration and economy of this area. In addition to the administrative government, there are primary, junior high and senior high schools, a hospital, a post and telegraph office and telephone office, an district police station, a bank and others.

The population of Amphoe Mae Sariang is 52,204 people (as of the end of June 1997) and the population density is 21 people. 60 % of the people center on the lowland near the Nam Mae Yuam. Since many tribes such as the Karen tribe, the Rawa tribe, the Meo tribe, the Thaiyai tribe and the Thai Lan Na are mixed in addition to the Thai race, their religions, cultures and customs are diversified.

Their main industry is agriculture and stock raising. They cultivate rice and vegetables such as bean, peanut, garlic and cabbage as well as fruits such as longan, tamarind and mango.

Chapter 4 Conclusions and recommendations

4-1 Conclusion

4-1-1 Satellite image analysis

In this satellite image analysis, it is suggested that mineral occurrences in Mae Sariang area have strong relation with Granite and Limestone, and with continuous lineaments and density of short or discontinuous lineaments. Therefore, possibility of ore deposit would be high for such area as satisfying the following condition;

1) nearby contacts of Limestone (Ls) and Granite (Gr2),
2) crossing point of continuous lineaments,
3) nearby NNE-SSW lineaments that are considered as tension fracture,
4) high density area of short or discontinuous lineaments.

Hereafter, it is necessary to explore that gives attention to above-mentioned condition.

4-1-2 Mae Sariang area

The occurrence of various mineralization and the stretch of geochemical anomalies are closely corresponded with carbonate rocks, which are Ordovician and Devonian-Carboniferous limestone formations and thin limestone beds, lenses and alternative beds intercalated in the Permo-Triassic in the Mae Sariang area. This fact indicates that the carbonate rocks in this area had played a great role for the formation of mineralization.

Four promising areas for next phase survey are selected. There are the Mae Kanai area, the Huai Pu to Huai Mae Pan area, the Northeastern of Mae Sariang town area and Huai Hat Ta Ran to Huai Ngu area, where are overlapping the distribution among carbonate rocks, mineral occurrences and Zn-Pb geochemical anomaly.

4-1-3 Dong Noi area

In the area with geochemical anomalies in zinc and lead values extending in the western half of Dong Noi area where limestone was distributed, hydrothermal ore solution in temperature of

140-250℃ and with high salinity rose up through joints in limestone and bedding place of fissures, formed silicificated zone on a certain horizon in relatively upper layers, caused occurrence of wide-ranged dolomitization and zinc/lead mineralization right above it, and at the same time formed quartz vein which changed joint systems and a specific horizon, precipitating galena and sphalerite.The quartz vein in dolomitized zone was in width of 80 cm and its grade values were 7.86%Zn and 2.82%Pb. The sample extracted from 20 m section including this quartz vein also showed high values of 1.60%Zn and 1.43%Pb, and existence of zinc body was expected. However, since the structure to form quartz vein changes open joints and the part along bedding of a certain specific horizon, it is necessary to explain more in detail rock faces and the geological structure to estimate the position of its existence.

As a result of our investigation into MJTM-6 Hole excavated in a spare part of the district with IP anomalies, it was further clarified that the district with high IP anomalies might represent a mineralized zone of copper and lead overlapped with skarn zone. The depth of around 64 m in MJTM-6 Hole where occurrence of chalcopyrite was observed was almost in conformity with the depth of the upper limit to the anomaly zone (16 m V-sec/V or more) revealed through IP exploration. The depth of 140 m or lower where mineral showing including pyrite dissemination was intensified in general was in conformity with the district where IP anomalies (20 m V-sec/V or more) were observed. The district with IP anomalies (16 m V-sec/V or more) extended in a range of 100 m in diameter and 800 m in the total length. Based on the results of MJTM-5 Hole and MJTM-6 Hole, in view of the tendency of copper concentration to increase in a lower layer, i.e. the part where it was in contact with granite, ore bodies might possibly exist near the face which was in touch with granite. However, since copper showing in skarn zone is apt to be unevenly distributed, it is considered difficult to decide the exact position of such ore bodies.

4-1-4 Mae Kanai area

High IP anomalies corresponds to the mineralized zone including the silicificated zone along the fracture continuing in the NE-SW direction and accompanied predominant pyrite dissemination and chalcopyrite showing. Chalcopyrite was the most prevailing in the depth of around 129 m, but its grade was low. We may point out that this mineralized zone might represent the passage of ore solution having formed the gossan zone where was distributed on the western side of the ridge.

The gossan zone with high zinc content in the Mae Kanai area had been considered to extend in a vertical direction. However, through our drilling survey of this time, we confirmed that the gossan zone was distributed in thickness of a little more than 10 m and almost along the land surface and that remarkable mineral showing scarcely existed in its lower layers. The gossan zone was distributed between argillized mudstone or sandstone, and the gossan zone was originally a massive sulfide mineral abundant with pyrite and accompanying sphalerite, we presume that pyrite may have been oxidized and changed to limonite and sphalerite may have flown out through weathering.

The sedimentary rocks near the gossan zone were strongly influenced by argillization of talc-sericite-chlorite-smectite especially on the side of lower wall. Further, we observed that silicified zone in the form of hydrothermal breccia accompanying white argillization and quartz vein had been developed on the upper wall of the gossan zone.

The gossan zones occur almost on the same level, in the district surrounded by MJTM-8 Hole, MJTM-9 Hole and DMR's MK-3 Hole, it is quite possible that the horizon of the gossan may be beneath the land surface and that the gossan zone may have been hidden under it. Moreover, we presume that IP anomalies may be distributed at the east end of profile lines E and D for geophysical exploration on a slope inclined to east right under the land surface and that massive sulfide minerals may exist under the land surface.

4-1-5 I-4 area and southern I-4 area

In the I-4 area, geological situation and mineral showings of one side remarkably differ from those of the other side of the NE-SW fault running through the center of the district.

In the northern side of the area, Ordovician limestone formation distributes and geochemical anomalies of Zn, Pb and F are recognized in the limestone. The distribution of anomalies suggests a high possibility that the distribution is controlled by the N-S fracture system. The anomaly levels are lower than those of Don Noi district by one figure. The fact that there is no anomaly of Cd is also different from Don Noi district. Judging from the fact that there are the mineralization of zinc at a certain level in this rock. This area has a difficult social condition than other areas, the development of a mine may be impossible if a ore-body will be discovered

In the southern side of the area, a mineralization zone in which several stockwork vein zones with sulfide minerals are found in the shale from the Permian to Triassic along the river. Geochemical anomalies and low specific resistivity and high chargeability zones distribute in the northwest direction that is the extension direction of the veins. Judging from this correlation, there is a high possibility of existing of vein type ore bodies under this zone which are more concentrated than the stockwork veins on the surface

There is a little possibility that an economic minable deposit exists in the Southern I-4 area.

The drill hole MJTM-4 in the I-4 area could encounter the mineralization extending from Nam Mae Kanai occurrence. The mineralized quartz veinlets at the depth ranging from 20 to 30 m is corresponded to an extension of sulfide disseminating quartz veinlets with 12 m wide in the northernmost of the Nam Mae Kanai occurrence. The estimated width of mineralized zone from MJTM-4 to the occurrence ranges from 4 to 12 m, and the distance is about 100 m. It is inferred that the mineralization extends to the southeast side and to the deeper part. The estimated grade ranges from 19.8 to 135 g/t Ag, 310 to 1,000 ppm Cu, 0.89 to 8.15 % Pb, and more than 0.1 % Zn based on the chemical analysis of core samples, but all length of mineralized core is not analyzed.

Other two mineralized zones are observed at the 81 m depth and the depth ranging from 105 to 120m. The former zone is corresponded to the pyrite-galena disseminated silicified rock on Nam Mar Kanai occurrence by its similar characteristic of mineralization. Usually the grade is not high as a whole, but this zone frequently contains highly mineralized parts; for example

0.37 % Pb and 1.22 % Zn by 30 cm core sample

4-2 Recommendations for the future

4-2-1 Dong Noi area

It is indeed possible that zinc bodies may exist in the limestone in the northwestern part of the Mae Kanai area. However, in estimating the position of such existence, careful attention should be paid to the result of detailed surveys on the geological structures and degrees of dolomitization concerned.

We note that the area with IP anomalies - especially the part with anomalies of 16 m V-sec/V or more -- located in the central part of the Dong Noi area actually accompanies copper mineralization. Resulting from the drilling surveys conducted three times by now, although no adequate grade or reserve of the deposit has been discovered to be considered as object of an operation, we think there still remains some room for further investigations.

4-2-2 Mae Kanai area

Further investigations should be made on the eastern part of the district where existence of subsurface gossan and massive sulfide ores is quite possible.

4-2-3 I-4 area

Further drilling is necessary to confirm the lateral extension and the depth of vein-type mineralization extending from Nam Mae Kanai occurrence.

Part II Detail Description

Chapter 1 Satellite Image Analysis

1-1 Processing of satellite image data

1-1-1 Data for satellite image analysis

In this study, satellite image analysis has been applied to a rectangle area extending 60 km EW and 80km NS (white rectangle in Fig. II-1-1) using JERS-1/SAR and JERS-1/OPS image data. The Mae Sariang Area can be covered by 4 scenes of JERS-1 data (meshed part in Fig.II-1-1). Specification of each image is shown in Table II-1-1.

Table II-1-1 List of satellite image data.

JERS-1/SAR		Obs. Date	Scene Center		Sun Angle		Cloud
Path	Raw	yyyy/mm/dd	North	East	Elev.	Azim.	(%)
132	270	1993/03/21	18:15	98:16	------	------	----------
132	271	1993/03/21	17:40	98:09	------	------	----------
133	270	1996/02/11	18:15	97:45	------	------	----------
133	271	1997/01/28	17:38	97:39	------	------	----------
JERS-1/OPS		Obs. Date	Scene Center		Sun Angle		Cloud
Path	Raw	yyyy/mm/dd	North	East	Elev.	Azim.	(%)
132	270	1993/02/12	18:15	98:26	51	144	< 1
132	271	1993/02/12	17:39	98:18	51	143	< 1
133	270	1996/01/05	18:14	97:55	45	155	< 1
133	271	1996/01/05	17:38	97:47	45	155	< 1

1-2 Analysis of Image

1-2-1 Classification of Geological Units

1. Result of geological interpretation of satellite images

Geological units are classified by photo-geologic interpretation (Table II-1-2, Fig. II-1-2). At first, the units were roughly classified based on the rock resistance and drainage density, then the units were further subdivided based on the differences in other elements. As a result, 36 geological interpretation units were distinguished.

To see all the area for analysis, lowlands (geological interpretation unit: Q, showing only unit mark in follows) with less undulation distribute along the Yuam river that flows from north to south at the western margin of ground survey area, and characteristics of geological units differ between on west side and east side of the river. Geological unit with the same rock resistance and drainage density tends to distribute extending north and south along the river.

Along the Yuam river, geological units with low rock resistance (L**) extend north and south near the Mae Sariang city, and geological units with medium rock resistance (M**) extend northward of that. Geological units with high rock resistance (H**) extend continuously north and south on the West of them. It extends largely north and south on the East of the river, while it is separated into north and south parts by geological units with medium rock resistance (M**)

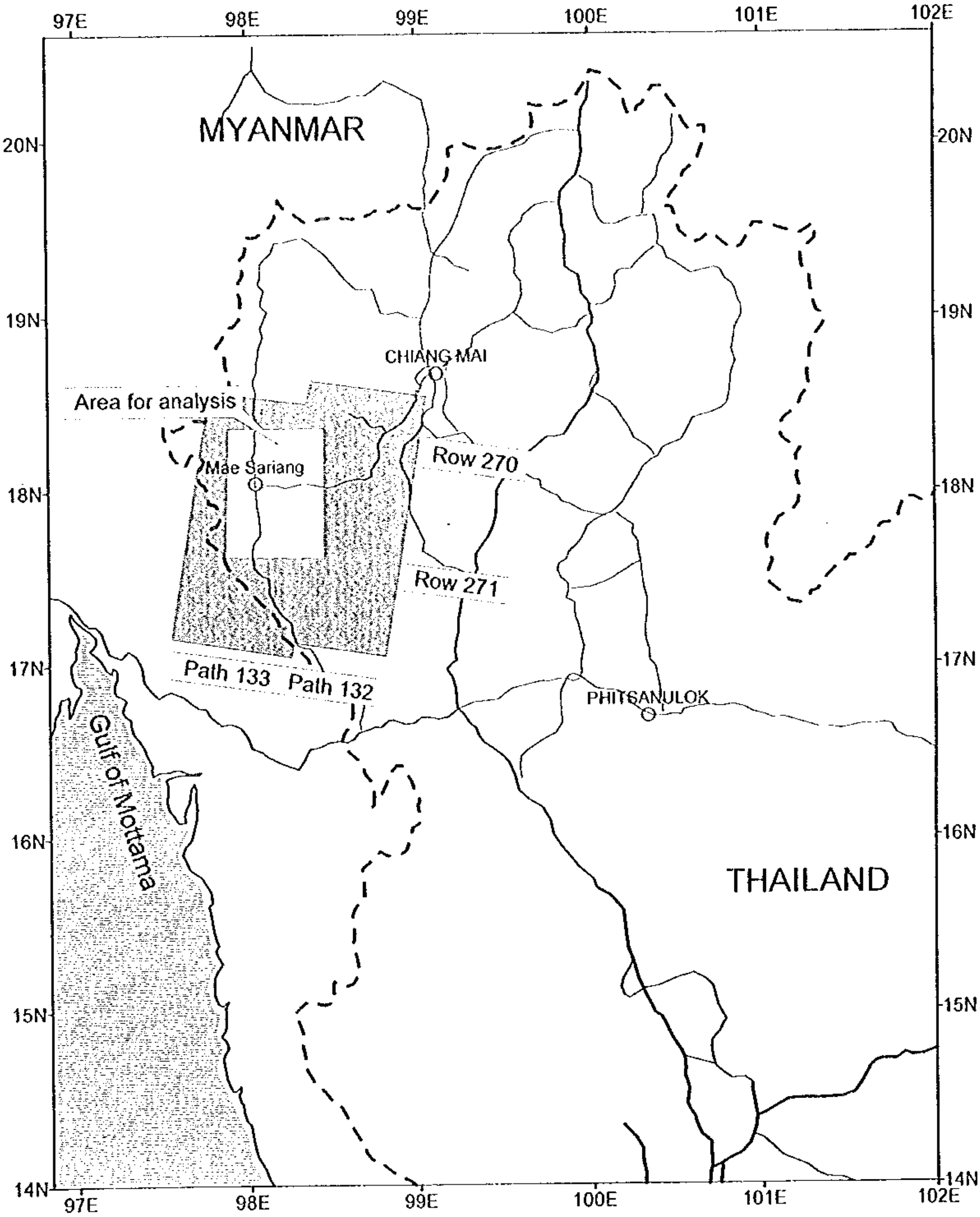


Fig. II-1-1 Coverage of JERS-1/SAR & OPS imagery and area for analysis.

Table.II-1-2 List of geologic unit on JERS-1/SAR and OPS image.

Geol. Unit		Caracteristics(SAR/OPS)		Morphological expression					Vegetation
Int.	Anal.	Tone	Texture	Drainage pattern & density		Resistance	Cross section	Bedding	density
Hh1	P1	B/M	C/M	SP	H	H		M	D
Hh2	P4	MD/M	S/F	B	H	H		M	D
Hm1	P1	MB/MB	M/M	B	M	H		M	D
Hm2	P4	M/M	M/M	B	M	H		M	D
Hm3	P4	M/M	F/F	B	M	H		M	D
Hm4	P4	M/M	F/F	B~SP	M	H		M	D
Hm5	P4	MD/MB	M/M	O	M	H		M	D
Hl1	Gr1	M/MB	M/F	R	L	H		M	D
Hl2	Gr2	MD/MD	M/M	SP	L	H		M	D
Mh1	P1	M/MD	C/C	SP	H	M		M	D
Mh2	N2	M/MD	M/M	B	H	M		M	D
Mh3	P1	M/MD	M/C	SP	H	M		M	D
Mh4	P3	MD/M	M/C	G	H	M		B	D
Mh5	Gr2	MD/B	C/C	G	H	M		M	D
Mh6	Gr2	M/M	C/C	G	H	M		M	D
Mh7	Gr2	M/MB	C/C	G	H	M		M	D
Mh8	P5	MB/MD	C/C	B	H	M		M	D
Mh9	P5	MB/M	C/M	B	H	M		M	D
Mh10	Gr4	M/MB	C/C	G	H	M		M	D
Mh11	Gr3	M/M	C/F	B	H	M		M	D
Mh12	Gr3	MD/MD	C/F	B	H	M		M	D
Mm1	P4	MD/MD	F/S	B	M	M		M	D
Mm2	P4	MD/B	C/M	G	M	M		M	D
Mm3	P4	M/B	M/M	G	M	M		M	D
Mm4	P5	MB/MD	F/F	B	M	M		M	D
Ml1	P2	MD/D	S/S	B	L	M		M	D
Ml2	P4	MD/MD	F/S	B	L	M		M	D
Ml3	Ls	MB/M	S/S	SP	L	M		M	D
Ml4	P4	MD/MD	F/F	B	L	M		M	D
Ml5	P4	MD/M	F/M	B	L	M		M	D
Ml6	Ls	MB/MD	S/S	B	L	M		M	D
Ml7	Gr3	M/MB	F/M	G	L	M		M	D
Lh1	N1	M/M	F/F	SP	H	L		M	D
Ll1	Ls	M/MD	S/S	B~P	L	L		M	D
Ll2	P4	D/M	F/M	B	L	L		M	ND
Q	Q	D/Blue	S/D	–	–	–		–	ND

B:bright M:medium D:dark

C:corse M:medium F:fine S:smooth D:dappled

P:pallarel SP:subpallare B:branch G:grid O:oblong R:rudial

H:high M:medium L:low

B:bedded M:mussiv

D:dense N:not dense

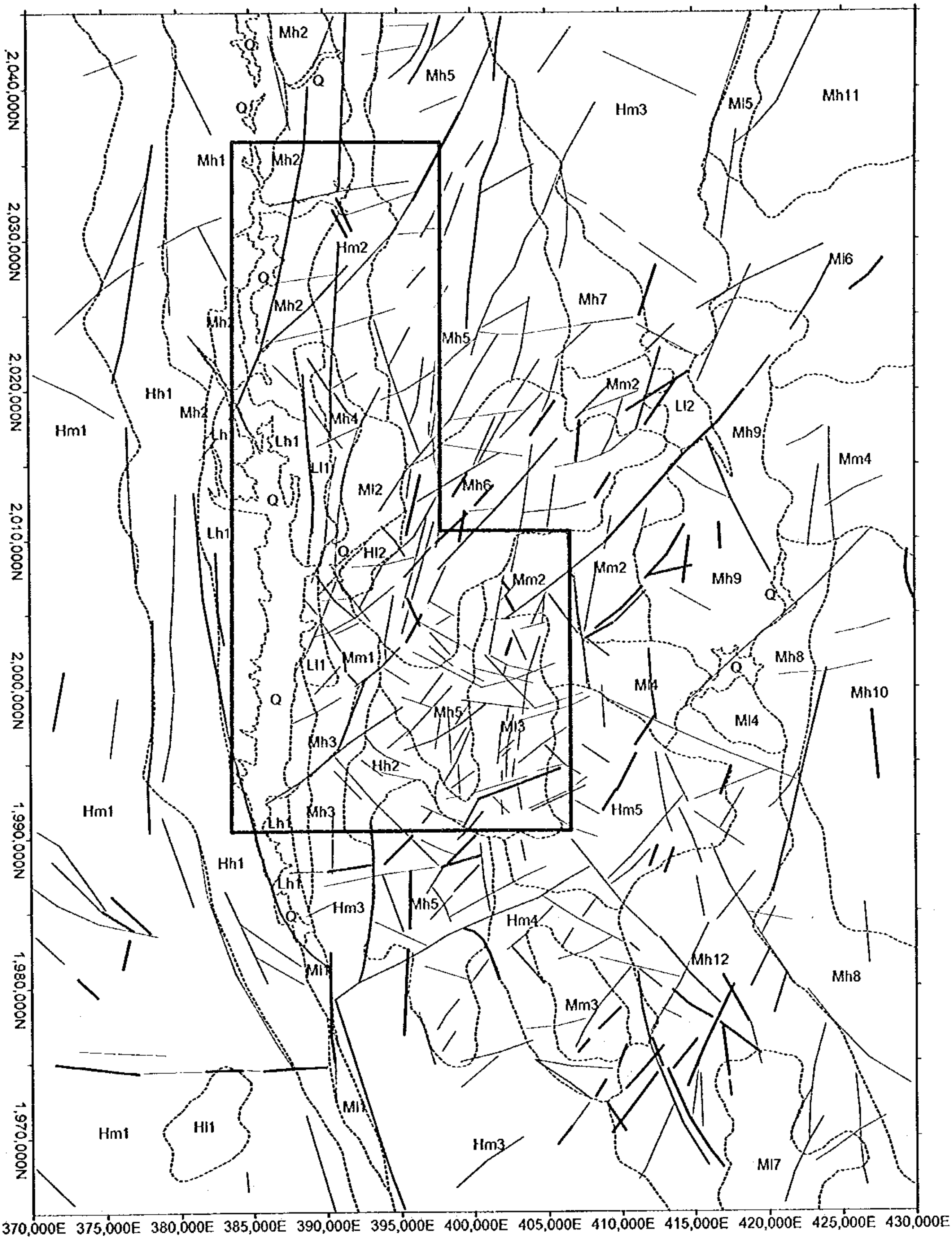


Fig.II-1-2 Photo-geologically interpreted unit and structure that distribute near the Mae Kanai river on the center of the satellite image. On the east of the image, geological units with medium rock resistance (M**) extend largely north and south that adjoin the same analysis unit near the Mae Kanai river.

Geological units with high drainage density (*h*) extend along the Yuam river and on the center of the satellite image, while they are separated into east and west by geological units with medium drainage density (*m*) that elongating north and south on the east side of the river. Also, geological units with high drainage density (*h*) extend north and south on the East of the image. Other area is of geological units with medium drainage density (*m*), while it is dotted with geological units with low drainage density (*l*) on the center of the image.

2. Result of geological analysis

Geological analysis units (Table II-1-3 and Fig. II-1-3) have been analyzed by examination of characteristics of geological unit classified through photo-geological interpretation and by comparison of them with existing materials. For sediments after Neogene age, geological analysis units correspond in one-to-one to geological interpretation unit. While for sedimentary rocks of Paleozoic age and granite, some numbers of geological analysis units have been united into one geological unit. Characteristics and distribution of geological analysis units will be shown below.

Alluvium (geological analysis unit: Q, showing only unit mark in follows) extend north and south along the Yuam river that flows southward at the western margin of ground survey area, and terrace sediments of Pliocene to Quaternary ages (N1 and N2) extend north and south on the both river side. Other geological analysis units also tend to elongate north and south.

Geological unit analyzed as Paleozoic Limestone (Ls) shows smooth texture, low drainage density and smooth landform. It elongates narrow and long (ca. 22km) north and south along its strike on the East of Mae Sariang city. It also extends, near the Rit river, Dong Noi and Mae Kanai, as a rectangle block (15km NS x 5km EW) between Central Granite (Gr2) and Central Paleozoic (P4) that will be presented bellow. On the Northeast of the image, it extends largely between Eastern Granite (Gr3) and Eastern Paleozoic (P5), while it is considered that its characteristics are different a little from two Limestone units mentioned above.

All geological interpretation units except for Alluvium, Paleozoic Limestone, and Granite interpreted as Paleozoic (partly Mesozoic). According to distribution and characteristics of them, they have been classified into five units; Western Paleozoic (P1 and P2), Central Paleozoic (P3 and P4) and Eastern Paleozoic (P5).

Western Paleozoic (partly Mesozoic) units (P1 and P2) distribute on the West of Yuam river and very rarely on the eastern side of the river. One of Western Paleozoic-Mesozoic (P1) on the West of the river is composed of three types of geological interpretation units. With considering of continuity and characteristics of them, a geological interpretation unit on the east river side south of Mae Sariang city was also classified as Western Paleozoic-Mesozoic (P1). Another Western Paleozoic (P2) extends only a little on the south margin of the image.

Central Paleozoic units (P3 and P4) extend largely north and south on the East of Yuam river

Table. II-1-3 Comparison of interpretation and analytical unit.

Geologic unit by interpretation	Geologic unit by analysis	Assumed geology and lithology by comparison with existing materials
Q	Q	Alluvium
Lh1	N1	Quaternary terrace sediments
Mh2	N2	
Ml3 Ml6 Ll1	Ls	Paleozoic limestone
Hh1 Hm1 Mh1 Mh3	P1	Paleozoic(Western)
Ml1	P2	
Mh4	P3	Paleozoic(Central)
Hh2 Hm2 Hm3 Hm4 Hm5 Mm1 Mm2 Mm3 Ml2 Ml4 Ml5 Ll2	P4	
Mh8 Mh9 Mm4	P5	Paleozoic(Eaztern)
Hl1	Gr1	Granite(Western)
Hl2 Mh5 Mh6 Mh7	Gr2	Granite(Central)
Mh11 Mh12 Ml7	Gr3	Granite(Eastern)
Mh10	Gr4	

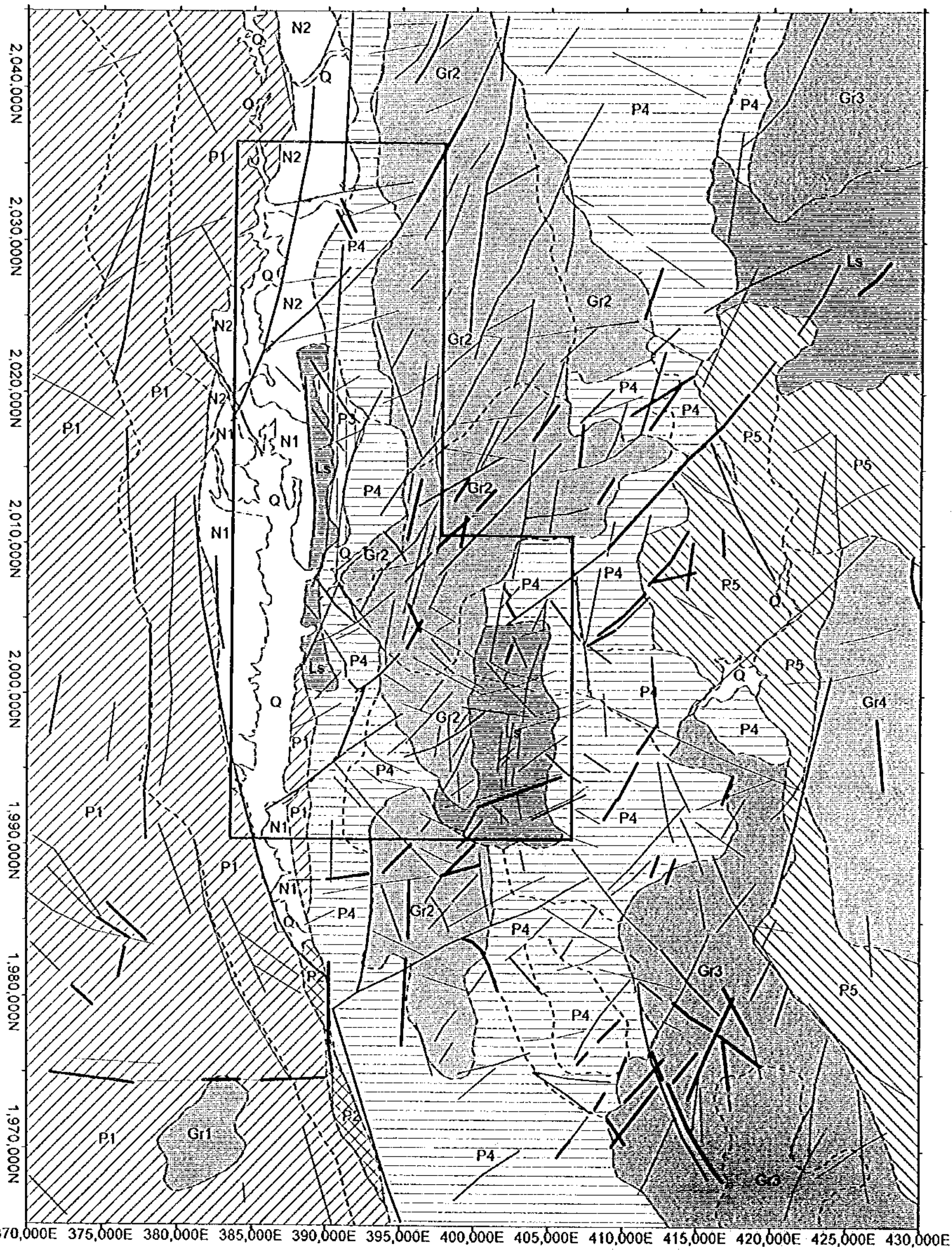


Fig. II-1-3 Distribution of geological unit analysed

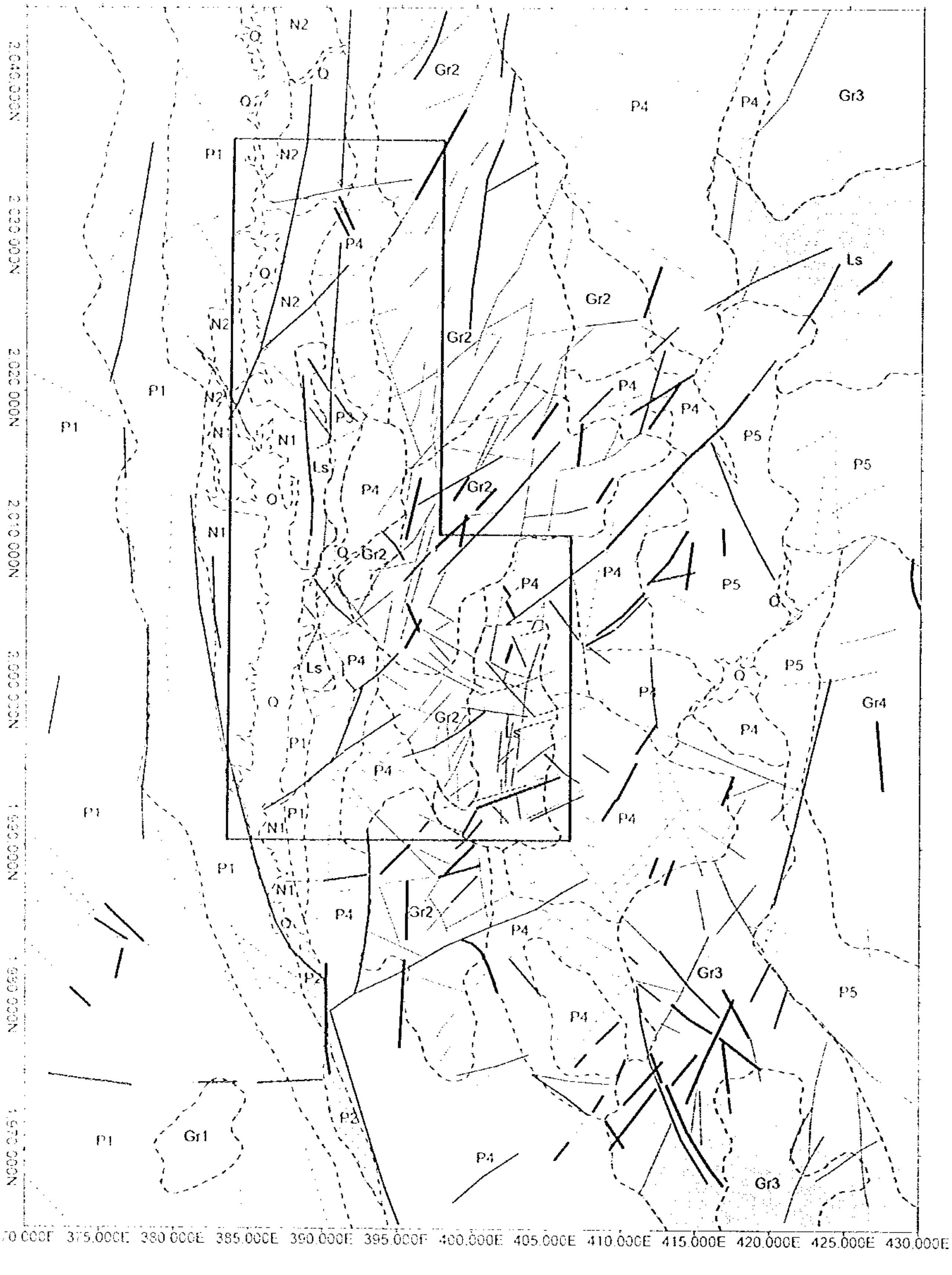


Fig. II-1-3 Distribution of geological unit analysed

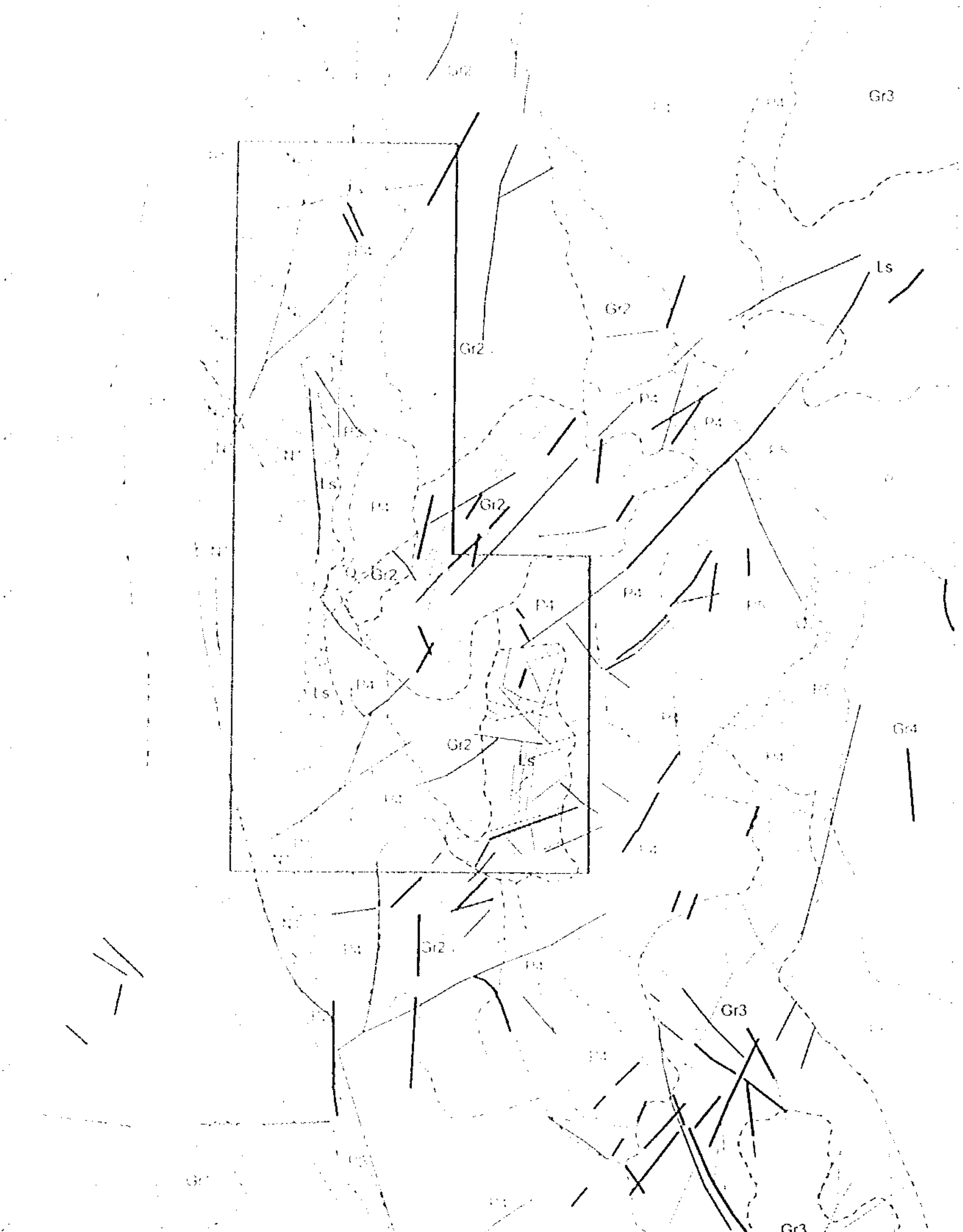


Fig. II-1-3 Distribution of geological unit analysed

Fig.II-1-4 JERS-1/OPS digital mosaic imagery of the Mae Sariang area

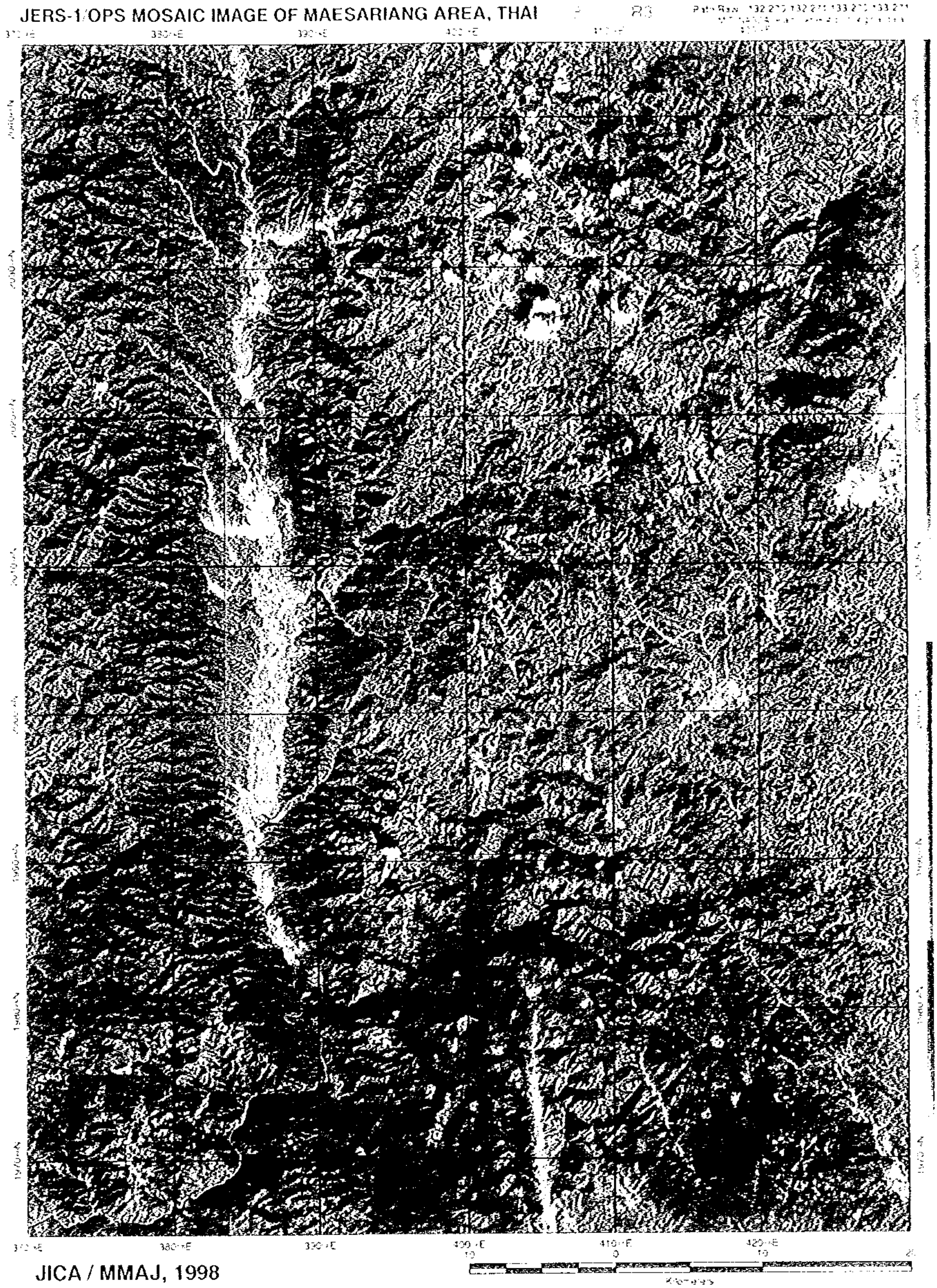
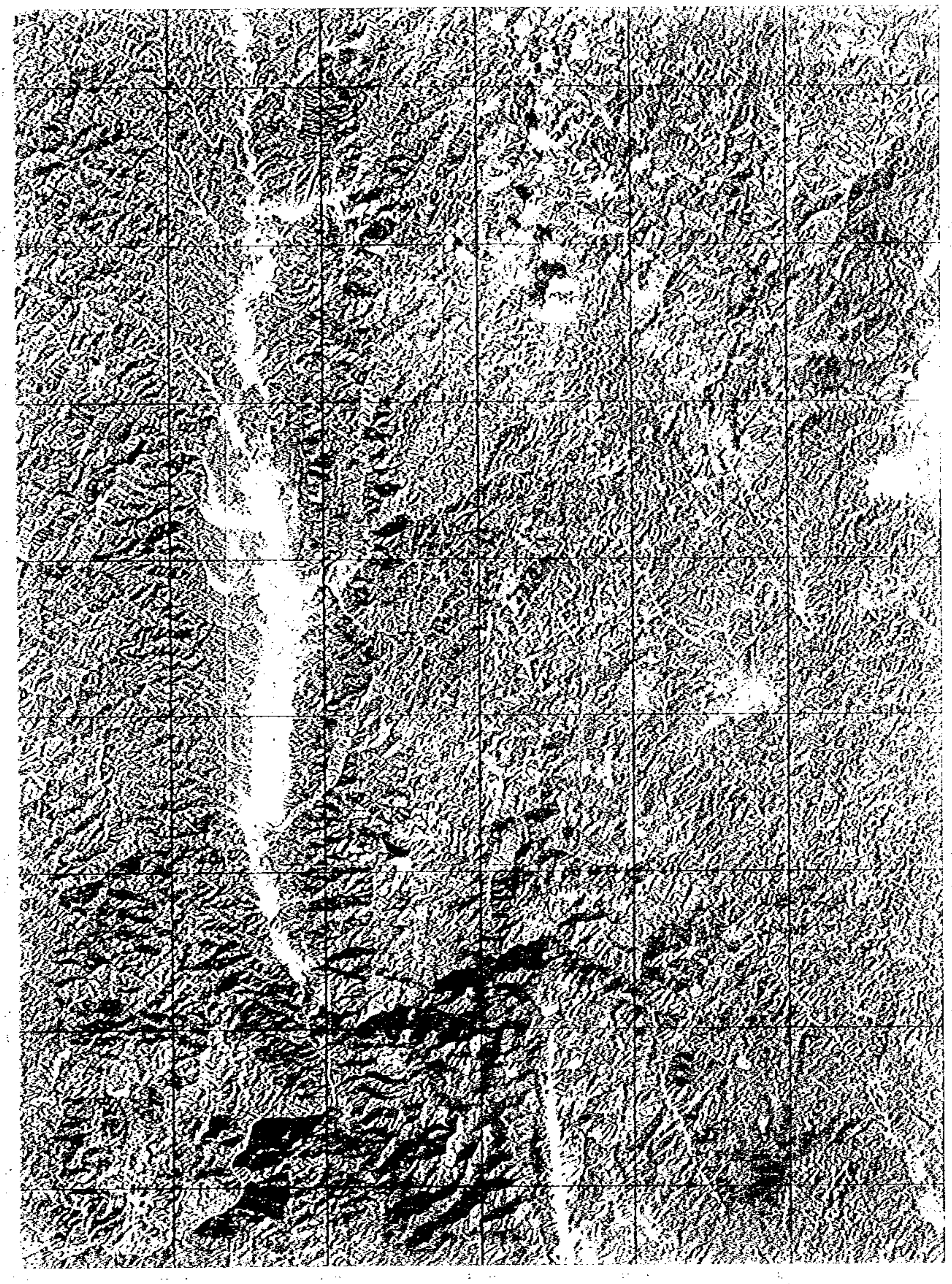


Fig.II-1-4 JERS-1/OPS digital mosaic imagery of the Mae Sariang area

JERS-1 OPS MOSAIC IMAGE OF MAESARIANG AREA, THAI



JICA / MMAJ, 1998

Fig.II-1-4 JERS-1 OPS digital mosaic imagery of the Mae Sariang area and on the center of the image. A unit with bedded structure was classified to a Paleozoic unit (P3) and other massive units were classified to another Paleozoic unit (P4). The bedded Paleozoic (P3) is considered to be alternation of limestone, limy sediments or normal sediments, since it lies adjoining Paleozoic Limestone (Ls) on the West. The massive Paleozoic units (P4) extend largely surrounding Central Granite (Gr2) on the center of the image.

Eastern Paleozoic units (P5) extend largely surrounding Eastern Granite (Gr4) on the East of the image, and they are medium rock resistance and with less undulation.

Granite shows commonly medium rock resistance and fine drainage pattern. According to distribution and characteristics of geological interpretation units, four Granite units have been classified; Western Granite (Gr1), Central Granite (Gr2) and Eastern Granite (Gr3 and Gr4). Western Granite (Gr1) is an oval-shaped body (ca. 5km x 8km) lying in the Western Paleo-Mesozoic (P1) on the West of the image, and so it is considered as an intrusive body of Mesozoic or later age. Central Granite (Gr2) extends largely north and south in Central Paleozoic (P4) on the center of the image. With attention to drainage pattern of geological interpretation units, it is estimated that Granite along the Mae Sariang river and north east of the river is different from Granite extending north or south of these area, and that Central Granite (Gr2) might be of composite intrusive or of two or more intrusions of different time. Eastern Granite units (Gr3 and Gr4) extend on the northeast and south east of the image, and they are divided into two; Granite (Gr3) adjoining Central Paleozoic and Granite (Gr4) lying in Eastern Paleozoic.

1-2-2 Result of interpretation of geological structure

Through interpretations of geological structure using satellite image, only a few bedded structures have been found while we have made attentions to stratum tracing, folding structure, fault structure and ring structure.

On the West of the Yuam river, boundaries between Western Paleozoic units (Hm1/Hh1 or Hh1/Mh1) seem to reflect a bedded structure of them. Strike of the boundaries is ca. N5° W on the North, and it turns to ca. N25° W on the South. Westward dip may be assumed, while it is difficult to judge direction of dip since direction of radar probe crosses near a right angle with strike of geological unit. Paleozoic Limestone (Ls) and Paleozoic rocks (P3) on the north of Mae Sariang along the Yuam river trend north-south and seem to dip westward.

1-2-3 Result of interpretation of lineament

Lineaments, interpreted using JERS-1/SAR and JERS-1/OPS images, are classified into three grades; clear, medium and obscure. Distribution of them is show in figures (Figs.II-1-2 and 3). Concentration area of lineament is on the center-north, center and southeast, and is corresponding to distribution of Central Granite and Central Paleozoic. Lineament tends to be rare in the area of the Western Paleo-Mesozoic, northeast to eastern margin of the image.

Direction of lineament is different between grades of lineament or between east side and west side of the Yuam river. To see all grades of lineament, NS direction is dominant for both sides of the river, NNW-SSE and NW-SE to E-W directions for west side, and NE-SW and NW-SE for east side. On the other hand, to see lineament of individual grade, NE-SW direction is dominant for grade "clear"; N-S, NNW-SSE and ENE-WSW directions for grade "medium"; and ENE-SWS direction for grade "obscure". Further, to see continuity of lineament, lineaments are very continuous in N-S direction along or west of the river. For east side of the river, lineaments with N-S to NE-SW direction are continuous on the center to north of the image, while direction of continuous lineament is not concentrated in a certain direction on the South of the image.

According to the distribution of continuous lineament, the area might be divided into four blocks; NE block, NW block, SE block and SW block (left of Fig. II-1-5). Lineament pattern of these blocks is assumed to represent fracture system accompanied by a regional stress field. For the lineament pattern of the NE and NW blocks, lineaments with N-S or NE-SW direction are considered as a set of conjugate shear planes or faults that would be caused by a stress field with maximum compression axis in NNE-SSW direction. In this case, N-S lineament would correspond to right-lateral fault, NE-SW lineament to left-lateral fault, and NNE-SSW lineament to tension fracture.

In this way, lineament pattern on the center to north part of the image can be explain by a model; an assumption of a stress field with maximum compression axis in NNE-SSW direction, but lineaments on the south part of the image do not show typical fracture pattern accompanied with a regional stress field. According to the continuity of lineaments, the SW block might be explained by the same model, but lineaments in the SE block might be difficult to be explained by the same model. Thus, it is possible to assume that the central to north part is different to the south part in term of regional stress field or geological structure unit, and that the boundary of them is a tectonic line that is represented by NE-SW lineaments crossing the image at the center.

On the other hand, short or discontinuous lineaments tend to concentrate Dong Noi Mae Kanai area and Mae Sariang river area (right of Fig. II-1-5). Lineament density in both areas elongates parallel to the NE-SW lineaments crossing the image at the center. Further, center of the high lineament density area crosses in right angle and continues from Dong Noi area to Mae Sariang area with NW-SE direction.

1-3 Result of satellite image analysis

1-3-1 Result of Image Analysis

As a result of photo-geological analysis using satellite image, it was revealed that geology of the study area consists of Paleozoic (partly Mesozoic) and Granite intruding into them, and that there are three limestone bodies in the Paleozoic. According to the arrangement and bedded structure of the interpreted units, it was assumed that the Paleozoic-Mesozoic has NS strike and dips to west. Granite extending in the ground survey area is Central Granite (Gr2) that might be of composite intrusive or of two or more intrusions of different time.

According to the distribution of continuous lineament, the area might be divided into four blocks. Lineament pattern on the center to north part of the image can be explain by a model; an

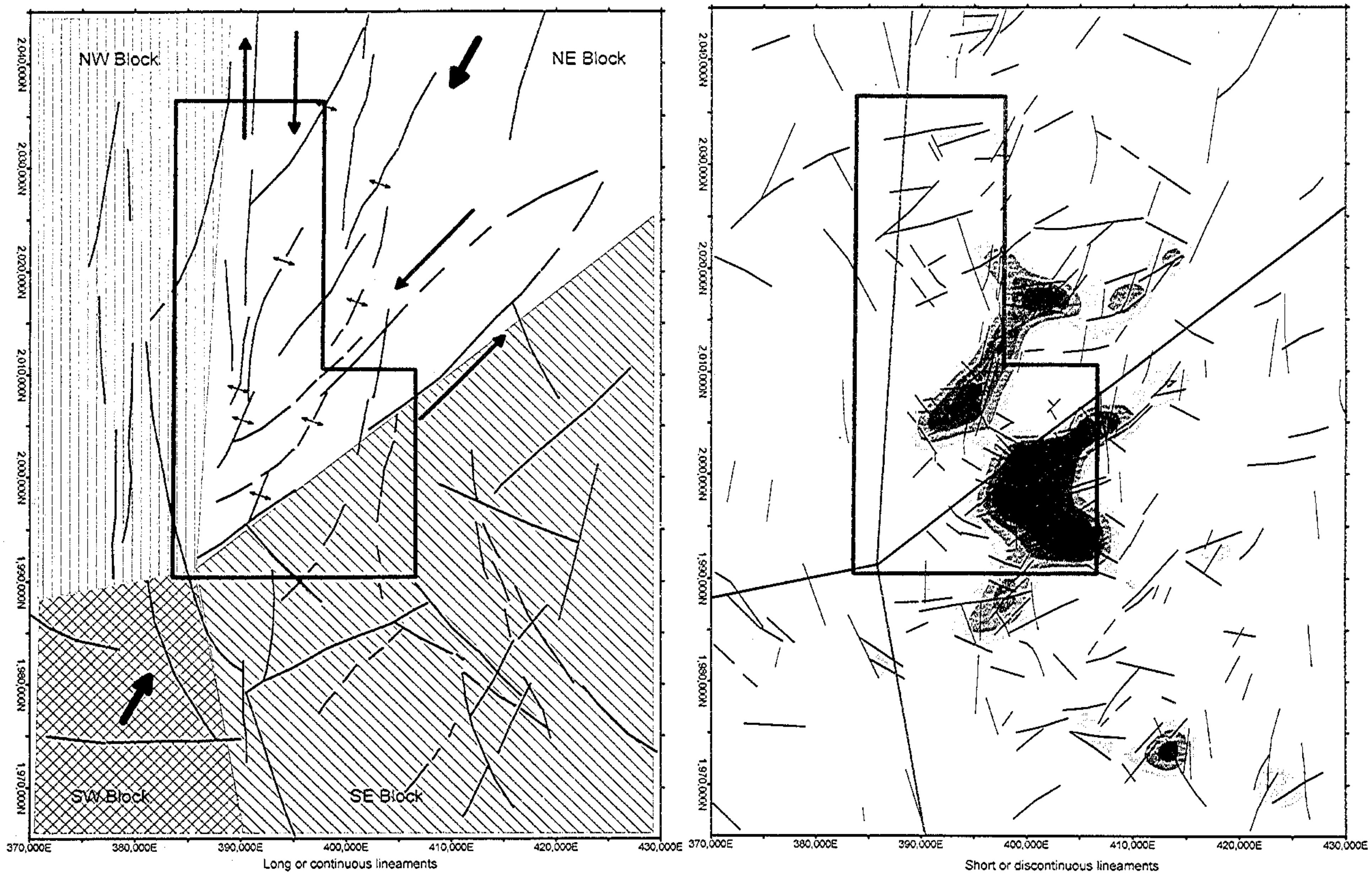


Fig. II-1-5 Structural analysis using lineament assumption of a stress field with maximum compression axis in NNE-SSW direction. In this case, N-S lineament would correspond to right-lateral fault, NE-SW lineament to left-lateral fault, and NNE-SSW lineament to tension fracture. It is possible to assume that the central to north part is different to the south part in term of regional stress field or geological structure unit, and that the boundary of them is a tectonic line that is represented by NE-SW lineaments crossing the image at the center.

Short or discontinuous lineaments tend to concentrate Dong Noi - Mae Kanai area and Mae Sariang river area, and lineament density of them elongates parallel to the NE-SW lineaments crossing the image at the center, while the center of the high lineament density area continues from Dong Noi area to Mae Sariang area with NW-SE direction.

1-3-2 Relation between Image Analysis and Ore Deposit / Mineral Occurrence

Result of satellite image analysis is shown with distribution of mineral occurrence (Fig. II-1-6). Dong Noi and Mae Kanai mineral occurrences are on the south of the NE-SW lineaments (or tectonic line) crossing the image at the center, while other mineral occurrences are on the north of the lineaments.

Dong Noi and Mae Kanai mineral occurrences are located at the west margin of a Paleozoic Limestone (Ls), on the West of that Granite (Gr2) is extending. Also, these mineral occurrences correspond to high density area of short or discontinuous lineaments. Dong Noi mineral occurrence extends southward from a crossing point of this high density area and NNE-SSW continuous lineament. Mae Kanai mineral occurrence is located at a crossing point of the NE-SW lineaments (or tectonic line) and NNE-SSW continuous lineament on the North of this high density area.

Mae Pan river mineral occurrence is lined up on a NNE-SSW lineament in Paleozoic (P4). Since being held between two NE-SW lineaments, this NNE-SSW lineament is interpreted as a tension fracture based on a regional stress field model mentioned above, and existence of vein type deposits agrees with this interpretation. Also, this mineral occurrence corresponds to low density area of short or discontinuous lineaments.

I-4 mineral occurrence is located near NNE-SSW lineaments among the boundary of Paleozoic (P4), Paleozoic Limestone (Ls) and Granite (Gr2), and corresponds to the west wing of high density area of short or discontinuous lineaments.

Hat Ta Lan river mineral occurrence is located in Paleozoic (P3 and P4) and is held between two N-S to NNW-SSW lineaments. It is lined up in NNW-SSE direction and corresponds to medium density area of short or discontinuous lineaments.

1-3-3 Promising areas of ore deposit

In this satellite image analysis, it is suggested that mineral occurrences in Mae Sariang area have strong relation with Granite and Limestone, and with continuous lineaments and density of short or discontinuous lineaments. Therefore, possibility of ore deposit would be high for such

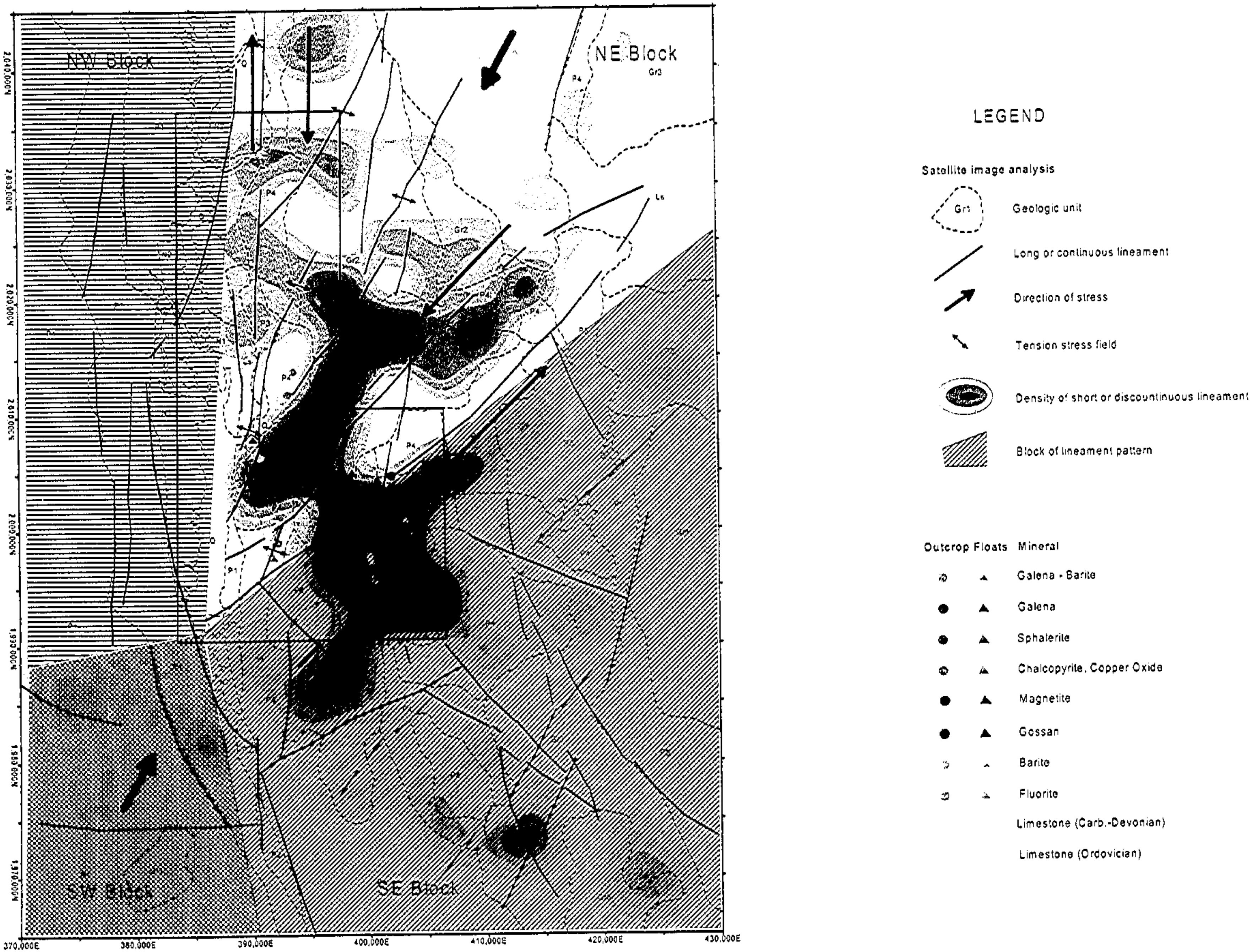


Fig. II-1-6 Result of analysis using JERS-1/SAR and OPS imagery

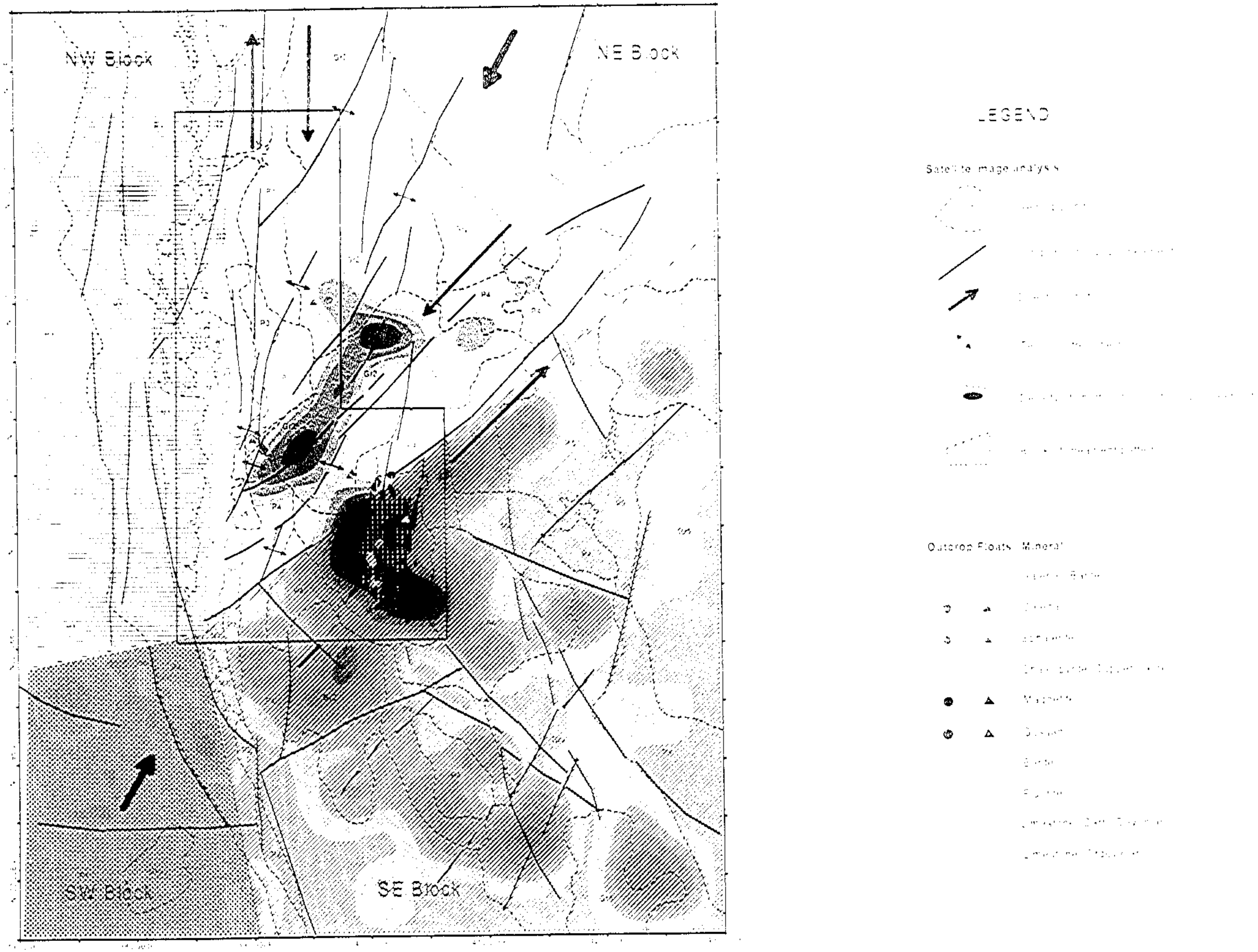


Fig. II.1.6 Result of analysis using JERS-1/SAR and OPS imagery