REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE CHIANG KHONG, DOI CHONG, RATCHABURI AREA,
THE KINGDOM OF THAILAND

PHASE Ⅱ

MARCH, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

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

The JICA and MMAJ sent to the Kingdom of Thailand a survey team headed by Dr. Hiroyuki Takahata from October 23 to December 24, 1995.

The team exchanged views with the officials concerned of the Government of the Kingdom of Thailand and conducted field surveys in the Chiang Khong, Doi Chong, Ratchaburi areas. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

March, 1996

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo Kiyotaki
President
Metal Mining Agency of Japan

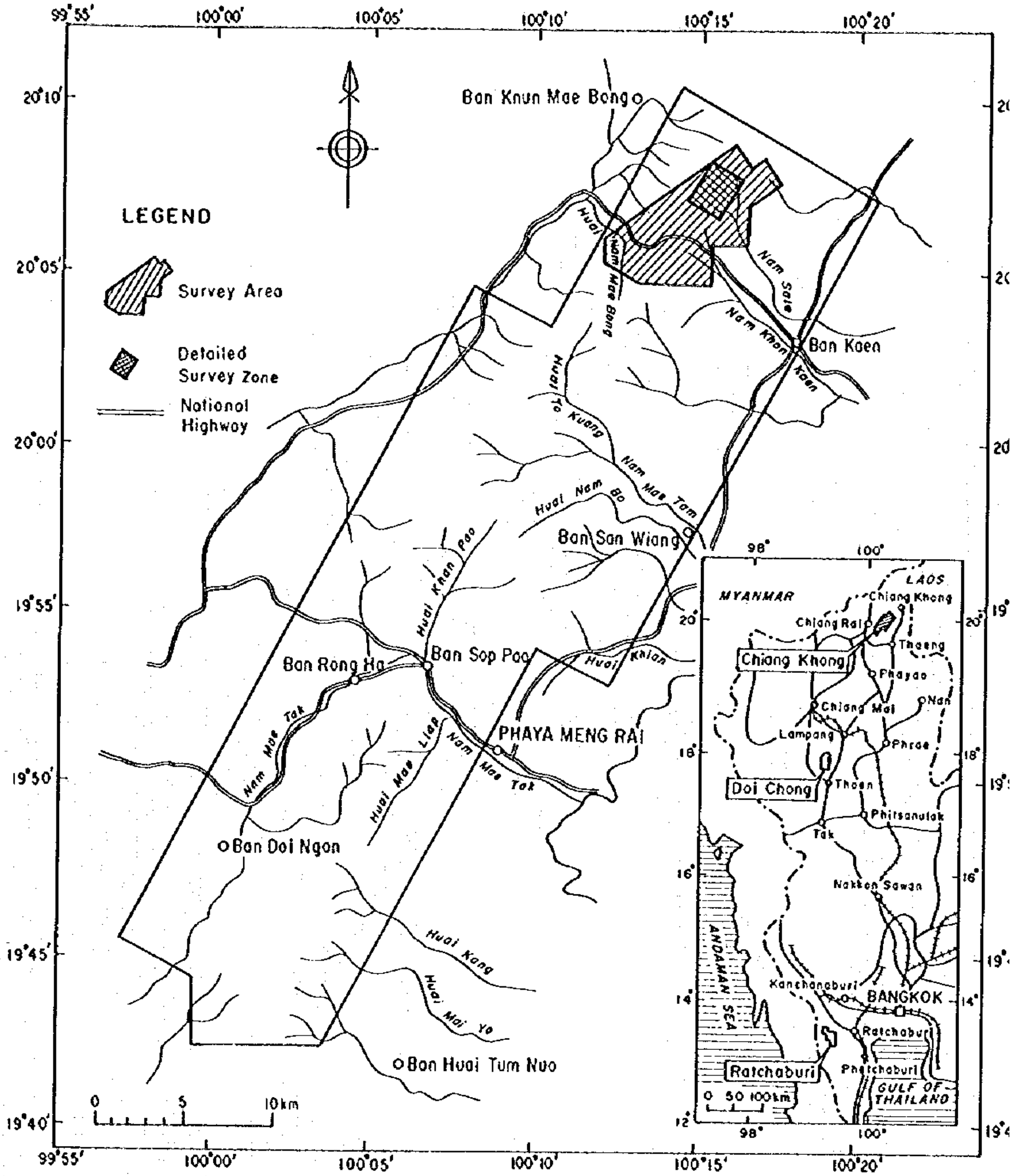

Fig. I-1-1 Location Map of the Survey Area

SUMMARY

For this year's part of survey, a prospecting area with an area of 40km² and high potential of the presence of gold and copper deposits in the Upper Huai Nam Sala area of Chiang Khong district was chosen, based on the result of the geochemical survey carried out in last year. A semi-detailed survey involving a soil geochemical survey and geological survey were carried out, and for an area of 4.8km² considered particularly prospecting a physical survey, detailed soil geochemical and geological survey were carried out.

In the eastern half of the detailed survey zone, the distribution of geochemical anomalies, suggesting the existence of gold mineralization, and corresponding to that the distribution of low resistivity zones and high resistivity zones, were clearified and it became clear that there is a strong possibility of the existence of subterranean gold deposits.

The Upper Huai Nam Sala Area is composed of Permian sedimentary rocks, the basement of this area, Permo-Triassic rhyolitic volcanic rocks, Permo-Triassic andesitic rocks, Jurassic intrusive rock and Quaternary riverbed deposit. Permian basement rocks are distributed in western part of the detailed survey zone.

Within the survey area two fault systems, running N-S and NE-SW, were observed. The alteration zones and mineral occurrences are developed in Permo-Triassic tuff which is the main hostrock, and are regulated by those fault systems.

In the eastern half of the detailed survey zone, the geochemical anomalies of Au, As, Sb, Hg which suggest gold mineralization continue in a N-S and NE-SW direction corresponding to the direction of the faults.

These geochemical anomalies are distributed from the border area between the high resistivity zones on western side of the detailed survey zone and low resisitivity zones on eastern side of the detailed survey zone(resistivity discontinuous line) to low resistivity zone which are extracted by the geophysical survey. The geochemical anomalies of the combination of Au, As, Sb is located in the eastern side of resistivity discontinuous line, and the surface part has low resistivity, but high resistivity zone thought to be a silicified zone occurs at a comparatively shallow depth underground. The geochemical anomaly zones with a combination of Hg and As, on the other hand, lie almost just above the resistivity discontinuous line, and low resistivity zones and relatively high resistivity zones continue down deep.

In the results of the ore assay analysis of guartz veins and silicified rock accompanying the alteration zones, the only values showing a high gold content were 5.6g/t and 1.0g/t, obtained from quartz veins accompanying a strong silicification zone that spreads out on the eastern side of the detailed survey zone, but in the anomaly zones of Hg and As, there is a brecciate limonite/quartz vein with a high Hg and As content the same as the quartz vein of highest Au content. Since the production temperature of quartz veins in the surface area estimated from the homogenization temperature of fluid inclusion in the quartz, is around 150℃, and it may be surmised that boiling took place, it is expected that a promising gold mineralization is present below the surface in this area.

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PART I GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 Backgound and Objective

The existence of gold in Thailand has long been known and the amount of gold produced in the past is apparent in the gold statues of Buddha found throughout the country and in individual gold ownership. Many placer gold-producing districts are known in various parts of the country and local people used to pan for gold in the classical manner during the dry season. And in western and southern Thailand gold was collected from drift sand deposits as a by-product of tin.

In recent years there has been a steady increase in the amount of gold consumed in Thailand, but the supply of gold is mostly dependent on foreign imports. For this reason, the Department of Mineral Resources of Thailand is promoting the discovery of primary deposits and the reassessment of secondary deposits in the area in the vicinity of previously known occurrences of gold.

Under these circumstances, the Government of the Thailand requested the Japanese government to conduct to a cooperative mineral exploration project for gold and base metals deposits in three areas in the north and west of Thailand.

In response to this request, the Japanese government dispatched a preliminary survey mission to Thailand and on September 1, 1994 a Scope of Works was signed between the International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ), and the Thailand representatative, the Department of Mineral Resources (DMR), the Ministry of Industry.

On the basis of this agreement, it was decided to conduct a cooperative mineral resource exploitation survey extending over three years, starting in 1994, in the Chiang Khong and Doi Chong areas in the north of Thailand and the Ratchaburi area in the west.

The purpose of the survey is to grasp the possibility and amount of useful elemental deposits, such as gold, tin, base metals and antimony, by obtaining a comprehensive grasp of the relationship between the geology and geologic structures of the survey areas, and mineralization, geochemical characteristics and geophysical prospecting.

1-2 Conclusions and Recommendations of the First Phase Survey

1-2-1 Conclusions of First Phase Survey

In the first year of the survey, geologic surveys and geochemical prospecting were carried out with the aim of selecting promising regions from 3 areas extending over 1800 km^2 in the Kingdom of Thailand: Chiang Khong and Doi Chong areas in the north and Ratchaburi area in the west. The following conclusions were reached.

(a) Chiang Khong Area

The Chiang Khong area is composed of Permian sedimentary rock including sandstone, mudstone, conglomerate and limestone, Permo-Triassic andesitic and rhyolitic lava, tuff and tuff breccia, Triassic granite, Jurassic andesite, Jurassic red siltstone and sandstone, Pliocene siltstone, Plio-Pleistocene basalt.

The overall survey area consists of a mountainous region extending NE-SW, and a tendency is seen for the distribution of the various strata to continue virtually in harmony with this direction. The lowest level Permian stratum shows a synclinal structure with its axis in the center of the mountainous region. Permo-Triassic volcanic rock accompanied by tuff covers the Permian system unconformably and is distributed in two parallel zones running NE-SW. It is likely that andesite was active along fractures running in this direction.

The faults or lineaments in the Chiang Khong area have developed in a NE-SW direction along the synclinal axis of Permian sedimentary rock, and there are noticeable faults crossing them obliquely in an ENE-WSW direction. The lineaments are more developed in the north than in the center of the Chiang Khong area. Distribution of Jurassic andesite and alteration zones in the north is controlled by these fault systems.

From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions were selected.

i) Upper reaches of Nam Sala (20 km^2)

The fault systems running NE-SW and ENE-WSW and accompanied by activity of Jurassic andesite have developed conspicuously. White alteration zones accompanied by limonite-quartz veins extend along the fault systems. Au-Hg(-Ag-Pb) geochemical anomaly zones are distributed accompanying the alteration zones and epithermal vein deposits containing gold can be expected.

ii) Nam Mae Bong region (20 km^2)

This region covers the southwest part of the upper reaches of Nam Sala and the southwest part of the fault and alteration zones extending from Nam Sala. Fe-Zn-Cu-Pb-Mn geochemical anomaly zones are distributed in the region and vein deposits of base metals can be expected. Gold anomaly zones are also distributed further to the southwest.

iii) Upper reaches of Huai Mae Liap (10 km^2)

There are few outcrops and the geological condition is not clear in many places, but most of the region is composed of Permian slate and not many alterations are seen. In addition to Au-Hg-As-Sb, there are distributions of Cu and S geochemical anomaly zones.

iv) Huai Mai Ya region (12 km^2)

This region is composed of Permian sedimentary rock and Permo-Triassic andesite and tuff. The tuff has altered intensely and Cu, Zn, Fe, Hg, S, As and Sb geochemical anomaly zones accompanied by quartz veins are seen, with Au anomaly zones in some parts. Vein deposits of base metals containing gold can be expected.

(b) Doi Chong Area

The geology of the Doi Chong area is composed, from below, of Carbono-Siluro-Devonian Mae Tha Group and Donchai Group, Kiu Lom Formation, Pha Huat Formation and Huai Thak Formation of the Permian Ratburi Group, Permo-Triassic volcanic Formation, Triassic Lampang Group Hong Hoi Formation and Triassic intrusive granite and diorite.

There are assumed to be faults running NW-SE, N-S and NW-SE in the survey area. In particular, the faults running NNW-SSE, N-S along Huai Mae Thot are assumed to be relatively large-scale reverse faults.

The Carbono-Siluro-Devonian and Permian geologic structure on the whole runs NNW-SSE and the upper strata overlie towards the NE. Also, Permo-Triassic volcanic rock and Triassic system are distributed, covering them unconformably.

However, judging by the fault along Huai Mae Thot, the east side of the fault is thought to have risen in relation to the west and the lower Permian stratums is exposed, with the fault as the boundary.

The intrusive direction of the granite also conforms to the direction of the fault.

From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions have been selected.

i) Huai Mae Pu region (14 km^2)

Geochemical anomaly zones for base metals and Au, Sb and Hg are seen over an extremely wide area extending from Huai Mae Pu to Huai Mae Haet in the west. Geologically, the Permian sandstone layer is prevalent, but according to local people, there was once an antimony mine. Polymetallic hydrothermal vein deposits can be expected.

ii) Doi Khun Mae Thot region (24 km^2)

Many seams of granite and aplite have intruded into the Permian sandstone and mudstone along the schistose structure. There are also many quartz seams and silicified zones have developed in some parts.

Geochemical anomaly zones for Au and the parent elements of Hg and Sb are distributed running E-W along the sides of Doi Khun Mae Thot and As geochemical anomaly zones are distributed continuously to the south of these anomaly zones.

Also, geochemical anomaly zones for base metals are distributed at the foot of the mountain. Hydrothermal Au vein deposits and mineralization of base metals below them can be expected.

iii) Region of upper reaches of Huai Mae Toen (18 km^2)

Geochemical anomaly zones for base metals (Cu, Zn and Fe) are distributed overlapping distribution of diorite in the upper reaches of Huai Mae Toen, silicified zones that have developed in the vicinity, and subsurface granite (diorite) to the south. An anomaly zone for the single element of gold (2,180ppm) is distributed overlapping these zones. Chalcopyrite is disseminated in the diorite, though in small quantities. Metasomatic and hydrothermal deposits of base metals can be expected.

iv) Northern region of Ban Na Ban Rai (2 km^2)

Small granite bodies have intruded into the Permian semi-schist in the area where local people excavated gold. Au and Hg geochemical anomaly zones are distributed here. It is already known for mineral occurrences at the surface, but more detailed assessment is required in deeper part.

v) Mae Haet region (9 km^2)

As there are hardly any outcrops in the flat lands between Huai Mae Haet and Huai Mae Tam, the geological condition is not clear. Anomaly zones of base metals (Fe, Cu and Zn) and Hg and Sb are distributed here and hydrothermal base metal deposits can be expected.

vi) Eastern region of Huai Mae Thot (20 km^2)

Geochemical anomaly zones for niobium and tantalum are extremely strong in the vicinity of granite zones to the east of Huai Mae Thot. In addition to niobium and tantalum, other rare earth element deposits can also be expected.

(c) Ratchaburi Area

The Ratchaburi area is composed of Ordovician Thung Song Group, Silurian-Devonian Kanchanaburi Group, Devonian-Carboniferous Kaeng Krachan Group Huai Phu Ron Formation, Kao Phra Formation and granite that has intruded into the Jurassic-Cretaceous.

On account of the intrusion of granite, the sedimentary rock structure shows fragmental distribution, but the schistosity and sedimentary structures run in a NW-SE direction and there is a tendency for new strata to overlie on both sides of the Silurian-Devonian anticlinal structure.

The granite bodies are part of a giant batholith which has intruded along the Thai-Myanmar border, and the intrusive direction of the batholith on the whole conforms to the structure of the sedimentary rock. Lineaments running NE-SW`NNE-SS W are conspicuous in the granite distribution zone.

From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions have been selected.

i) Huai Suan Phlu region (34 km^2)

ii) Huai Sa region (9 km^2)

Both region are located in the contact zone between granite and Devonian-Carboniferous sedimentary rock and narrow quartz veins have developed in the sedimentary rock. In addition to the anomaly zone just for gold, the region also shows an anomaly zone for base metals. The two anomaly zones overlap in few places and the gold anomaly zone tends to be distributed in the vicinity of the base metal anomaly zone. Judging from the fact that hardly any alteration zones are seen, mineralization of stockwork-type quartz veins that have developed near the granite bodies can be expected.

iii) Huai Takua Pit Thong region (4 km^2)

Slate, calcareous mudstone and limestone are found in the granite and have undergone thermal metamorphism. Ploymetallic contact metasomatic deposits can be expected

1-2-2 Recommendation for the Second Phase Survey

(a) Chaing Khong Area

With regard to the upper reaches of Huai Sala in i) and the Nam Mae Bong region in ii), in addition to conducting geochemical prospecting of the soil at random points using the ridges and streams (at intervals of about 50m) and detailed geologic investigation, electrical prospecting by specific resistance or the IP method should be carried out to narrow down the more promising zones.

With regard to the upper reaches of Huai Mae Liap in iii) and the Huai Mai Ya region in iv), considering that the type of mineral deposits is not clear, detailed geologic investigation and detailed geochemical prospecting of the stream sediments should be conducted to narrow down the promising zones and clarify the mineralization situation.

(b) Doi Chong Area

With regard to the Huai Mae Pu region in i) and the upper reaches of Huai Mae Toen in iii), as the whole range of mineral occurrence has not always been grasped, detailed geologic surveys and detailed geochemical investigation of stream sediments should be carried out to clarify the scale of mineral occurrence and narrow down the promising regions.

With regard to the Doi Khun Mae Thot region in ii), detailed geochemical investigation of the soil using the streams and ridges and detailed geologic surveys should be carried out to narrow down the more promising regions.

With regard to the northern part of Ban Na Ban Rai in iv), in addition to carrying out detailed geochemical prospecting of the soil by grid method to specify the location of promising quartz veins, the continuity of the quartz veins to deep parts should be grasped by electrical prospecting, etc. Where necessary, pits should be dug to confirm the grade and existence of quartz veins.

With regard to the Huai Mae Haet region in v), exposure is poor and the mineralization pattern is not clear. Considering that the topography is flat, the promising regions should be narrowed down by geochemical prospecting of the soil and detailed geologic surveys and the mineralization pattern clarified.

With regard to the region east of Huai Mae Thot in vi), as the mineral occurrences are outside the mineral types under this survey, the pathfinder elements should be changed and detailed geochemical prospecting carried out. Reassessment is necessary.

(c) Ratchaburi Area

It may be possible to clarify the origins of placer gold not previously specified. For this reason, detailed geologic surveys and detailed geochemical prospecting of stream sediments should be carried out to clarify the existence of quartz veins and mineral occurrence.

1-3 Outline of the Second Phase Survey

1-3-1 Survey Area

Among the extracted areas as promising region from the result of the first phase survey, Upper Huai Nam Sala Area, which is located in the northest part of Chaing Khong area in the northern part of the Kingdom of Thailand as shown in Fig. I-1-1, is the survey area of the second phase.

The Chiang Khong area is situated 20 km east of Chiang Rai, the northernmost city of the Kingdom of Thailand and it covers an area of 700 km^2 and is approxisimetly 50 km at its longest side and 18km at its shortest side. Administratively it belongs to the Chiang Rai province. The Upper Huai Sala Area is located in the northen part of Chaing Khong area, about 40 km northeast of Chaing Rai. This area has an extent of 40 km^2. The detailed survey zone where geophysical and detailed geochemical survey has done is situated in the northern part of the Upper Huai Nam Sala Area and it covers 4.4 km^2. National highway Route 1 runs from the capital of Bangkok to Chiang Rai and it takes about 12 hours to cover the distance of 820 km by car. There are also 4 return flights a day between Chiang Rai airport and Bangkok (flight time: 1 hour 20 minutes) and 2 return flights a day to Chiang Mai (flight time: 40 minutes). A paved road runs from Chiang Rai to the survey area and takes about one hour.

1-3-2 Objective of the Survey

The objective of the survey is to find new deposits through clarifing the setting of geology and mineralization in the Chaing Khong, Doi Chong, Ratchabri Area,the Kingdom of Thailand.

It also intends to transfer the technology to the Government of the Kingdom of Thailand through the survey.

1-3-3 Contents of the survey

To extract the prospecting area of mineralization in more detail, soil geochemical survey, geophysical survey and associated laboratory tests have been impremented in this area. The contents and quantities are shown in Table.I-1-1.

1) Geochemical survey

Soil samples for detailed geochemical survey were taken on the 13 survey lines with 2km length for geophysical survey (the interval of each line was 200m) and sampling point intervals were 50m on each line. Soil sammples for semi-detailed geochemical survey were equally taken by the Ridge-and-spur method in principle out of the detailed survey area. Rock and ore sammples were taken to clarify geological conditon, alteration pattern, mineralization condition and a period of mineralization by laboratory test such as ore assay chemical analysis of quartz vein and silicified rock, X-ray diffraction test for altered rocks, etc.

2)Geophysical survey

To clarify the relation between resistivity structure and geological structure, to extract resistivity anomaly zone related to mineralization zone and to collect data for selecting the drilling survey site, resistivity survey by Alay type CSAMT (Controlled Source Audio-frequency Magnetio-Telluric) method was carried out after setting up the 13 survey lines with 2km length (the interval of each line was 200m) at the Upper Huai Sala Area. Survey lines and points were set up by the method of open traverse measuring with transit magnetic compass and measuring tape.

Ten frequencies within 1 to 4,096 Hz were measured and two components, one telluric field and one magnetic field, were measured at each point.

The interval of electric potential electrodes was 100m and the contact resistance of an electric potential electrode was lowered to a level to be able to obtain data with enough sensitivity, and was kept under 10K Ω.

The interval of survey points was 100m and the direction of survey lines were set as same as the direction of the ground dipole line. The interval of ground dipole was 3,850m.

In addition, typical rock samples and ore sammples were collected in detailed survey zone and resistivity measurement of them was carried out to get the basic data for analysis of resistivity structure.

Table I-1-1 Contents of Survey

Contents	Item	Quantity
Geochemical surveys	Soil Sample(Total)	982 pieces
	Soil Sample(Detailed Survey Zone)	533 pieces
Geophysical Surveys	Survey Line Length	26 km
	Number of Survey Lines	13 lines
	Number of Survey Point	273 points
Laboratory Works	Rock Thin Section	14 pieces
	Ore Polished Thin Section	11 pieces
	X-ray Diffration Test	120 pieces
	K-Ar Method Age Determination	2 pieces
	Homogenized Temperature of Fluid Inclusion	17 pieces
	Resistivity Measurement	24 pieces
Chemical Analysis	Soil Samples	
	Au,Ag,Cu,Pb,Zn,Hg,Sb,S,As	982 pieces
	Ore Assay	
	Au,Ag,Cu,Pb,Zn	42 pieces
	Whole Rock Analysis	
	Al_2O_3,CaO,Cr_2O_3,Fe_2O_3,MgO,MnO,FeO,P_2O_5	
	K_2O,SiO_2,Na_2O,TiO_2,LOI,SUM	13 pieces

1-3-4 Memmbers of the Survey Team

Japan		
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Katsuhisa ONO	Metal Mining Agency of Japan	
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1-3-5 Period of the Survey

Geochemical Survey: from October 23, 1995 to December 24,1995

Geophysical Survey: from November 8, 1995 to December 24,1995

CHAPTER 2 GEOGRAPHY

2-1 Topography

The Chiang Khong area is situated in the very north of Thailand near the border with Myanmar and Laos and occupies part of the basin between the mountains which has developed in the upper reaches of the Mekong River. The basin forms flat land at an altitude of around 400 m with mountains rising 800 to 900m in the center. The form of the basin reflects the form of the surrounding mountainous area which reaches altitudes of 1,000 to1,800m, extending NNE-SSW from the Mekong River to the middle of the basin and bending in the southern half to run in a N-S direction. The principal rivers flowing northwards on the west side of the central mountainous region are the Nam Mae Lao and Nam Mae Kok, and on the east the Nam Mae Ing. Chiang Khong Area covers the central mountainous region located in the north of the sedimentary basin. The mountains extend in a NNE-SSW direction parallel to the structure of the basin.

The survey area, Upper Huai Nam Sala Area, is situated in the northern part of Chiang Khong Area. From central to northern part of this area, mountains have ridge lines extending in a NNE-SSW and a ENE-WSW direction. As the mountains are composed of sedimentary rocks, andesite and rhyolite, they have relatively steep gradients and have been deepened by the deep-cut valleys. On the other hand, from western to southern part of this area, mountains are composed of mainly tuff, and they are steadily eroded and display gentle-sloping mountains.

The river system that flows parallel to the direction of the mountains and the system that crosses it perpendicularly are well developed and show an overall grid pattern.

2-2 Climate and Vegetation

Northern Thailand, including the Chiang Khong area, is situated inland and is not greatly affected by monsoons, but it belongs to the tropical savanna climatic zone and is affected by the northeast monsoons in winter.

Winter lasts from mid-October to mid-February in the Chiang Khong area. During this time the weather is dry and the lowest temperature drops below 10℃. March to mid-May is the hottest time of the year (summer) when the monsoons abate and the highest temperature sometimes exceeds 40℃. From mid-May to the end of October is the rainy season which is influenced by the southwest monsoons, and over these six months the rainfall reaches 1,000 to 1,500mm.

In the Chiang Khong area only a few tropical evergreen rain forests remain on the tops of the mountains, and at the foot of the mountains land is increasingly being cleared and turned into farmland or deciduous forests. The plains and broad alluvial land between the mountains are being cultivated as fields.

CHAPTER 3 GENERAL GEOLOGY

3-1 Geology and Geologic Structure

3-1-1 Outline of Geology

The geology of the Chiang Khong area is composed of Permian sedimentary rock such as sandstone, mudstone, conglomerate etc. which is the basement of this area, Permo-Triassic rhyolitic lava and tuff, andesitic lava, tuff and tuff-breccia, Triassic granite, Jurassic andesite lava, red sandstone and mudstone of Jurassic, Pliocene siltstone, and Plio-Pleistocene basalt. However in the upper Huai Nam Sala area which is situated in central to north-eastern part of the survey area, no Triassic granite, Jurassic red sandstone and mudstone and Plio-Pleistocene basalt distribute.

The strike has a NE-SW direction. Faults and lineaments which have also developed in a NE-SW direction are most remarkable, and faults and lineaments which run obliequely in a N-S direction are also well developed. In northern part of the survey area faults and lineaments are well developed and distribution of Jurassic andesite, white clay altered zone and silicification altered zone are controlled by them.

In the upper reaches of Huai Nam Sala, Permo-Triassic volcanics, partly Permian sedimentary rocks, have widely undergone clay alteration and silicification. In those altered zone, there are with many limonite-quartz veins, and strong alteration zones are formed along the direction of faults.

3-1-2 Geological Structure

Geological structure of this area is characterized as preceding N-S fault system and following NE-SW fault system which cuts N-S fault system.

The N-S faults are shown in north-eastern part of the survey area, several of those faults run parallel and go across the detailed survey zone. Permian sedimentary rocks such as sandstone, mudstone ,conglomerate etc. those are basement of the survey area, are widely distributed in the northern part of the this area, are exposed from the bottom to the place of high altitude and form mountain bodies of the northern part. On the other hand, in the east of N-S faults, Permian sedimentary rocks, the basement, sink down and Permo-Triassic volcanics (mainly tuff) overlie the basement.

NE-SW faults are shown clearly in the central part of the survey area and cut N-S faults. Several faults run parallel and sedimentary rocks of basement are shown between those faults and it suggests the basement rose up. The form of intrusiveness of Jurassic andesite is controlled by the direction of those faults.

3-2 Alteration and Mineralization

In this survey area, white clay altered zone and silicified zones are distributed from central part to northern part of the survey area, and cover 2km wide by 6km long along the faults which run in a N-E direction in northern part of the survey area, and in a NE-SW direction in central part of the survey area. In those altered zones, Most strong silicified places are Huai Kiu Hog · Huai Kha La Zone (1km wide by 1.5km long) which situated in the reaches of Huai Nam Sala and Upper Nam Khon Kaen·Upper Huai Nam Sala Zone (400m wide by 1km long, 500m wide by 700m long) which situated widely in the southward of the detailed survey zone. Those two zones are the same places where high Au anomaly was extracted by the last year's survey. In those areas, mainly Permo-Triassic andesitic tuff is altered strongly. Comparatively wide strong silicified zone is shown in the west of Huai Nam Mae Bon which is situated in western part of the survey area. Besides those zones, comparatively small-scale clay altered zones and silicified zones lie scattered in the whole survey area and alteration of area underlain by volcanic rocks and Permian sedimentary rocks generally has a tendency to distribute more locally than alteration of the area underlain by tuff.

The characteristics of main altered zones are as follows;

1)Huai Kiu Hog・Huai Kha La Zone

The altered zone is situated along the ridge between Huai Kiu Hog and Huai Kha La, along those rivers and branches, and along the ridge in the east of Huai Kiu Hog. This altered zone is composed of white clay altered rocks, quartz veins, silicified rocks and a crowd quartz vein floats. The width of quartz veins is 5 ~ 20 cm, and general direction of those quartz veins is N10~25° E. Most of guartz veins are accompanied by limonite changing from pyrite. Those quartz veins display reddish brown color and most of them have drozes.

2)Upper Nam Khon Kaen・Upper Huai Nam Sala Zone

The altered zone is situated in hilly regions lying between the reaches of Nam Khon Kaen and Huai Nam Sala and composed of a crowd silicified rock floats and quartz vein floats, and white clay altered rocks. Silicified rock floats is 50cm ~ 1m in width and display yellowish brown ~ reddish brown color and mostl of them have drozes.

CHAPTER 4 COMPREHENSIVE DISCUSSION

The Upper Huai Nam Sala area is made up of Permian sedimentary rocks, the basement of this area, Permo-Triassic rhyolitic volcanic rocks, Permo-Triassic andesitic volcanic rocks, Jurassic intrusive rocks and Quaternary riverbed deposits. The basement rocks of Permian age are distributed in the western part of the detailed survey zone.

The west of the low resistivity anomaly zone which continues from 500m point on Line A to 300m point on Line H and the low resistivity anomaly zone which continues from Line H, changing direction to Line M, which were picked up from the results of the geophysical survey, is for the most part an area of high resistivity.

Within these area, the Permian basement rocks occur at a shallow depth, and the zone of high resistivity corresponds with the resistivity values of the shale and sandstone of the basement rocks.

On the eastern side including the above-mentioned low resistivity zones, for the most part tuffs of Permo-Triassic age are distributed; these are widely covered by argillization accompanying silicification, and the zones of low resistivity are considered to correspond to the altered tuffs.

Within this area, geochemical anomalies in Au, As, Sb and Hg, which suggest a gold mineralization effect, spread out overlapping the alteration zones. The distribution of the above-mentioned alteration zones is not accompanied by the NE-SW zones of low resistivity anomaly which continues from 500m point on Line A to 300m point on Line H; around Lines A to E anomaly zones are observed further to the southeast. Anomaly zones in Au, Sb and As are situated on the eastern side of the N-S discontinuous line of resistivity that continues from 400m point on Line H to 600m point on Line L. In contrast to this, an anomaly zone in Hg and As, which represents a higher level mineralization halo, matches the low resistivity zones on the western side of the discontinuous line; part of it straddles the NE-SW discontinuous line and the anomaly zone also stretches onto the eastern side.

As for the anomaly zones in Au, Sb and As, in vertical resistivity distribution, low resistivity occurred at the surface, but high resistivity zone is observed 100m to 250m underground. In laboratory tests this high resistivity zone had resistivity values close to those of andesite; but considering the geological conditions there is a strong possibility of the presence of silicified tuff or a silicification zone. Since the homogenization temperature of fluid inclusion for quartz at the surface is low, at 150℃, it is anticipated that the underground high resistivity zone is accompanied by gold mineralization. The anomaly area in Au, Sb and As extending southwards from the detailed survey zone which was obtained from the geochemical survey, has the same kind of geological conditions and type of alteration, and the same kind of silicified zone is anticipated in the lower part of the high anomalous values in Au occurring there.

The anomaly zone in Hg and As, on the other hand, from Line H to Line M, corresponds to the low resistivity zone alongside the high resistivity zone of the basement rock on the western side of the N-S resistivity discontinuous line. This low resistivity zone continues in slab form to depths below sea level. If we consider the fact that a anomaly zone in Hg and As indicates a mineralization halo in the upper part of hydrothermal ore deposits, the presence of gold mineralization may be anticipated deep underground. In addition, the resistivity structure of the lower part of the anomaly zones in Hg and As distributed from Line E to Line G, different from those distributed from Line H to Line M, are spread over a width of 200m to almost 200m sea level, and the geochemical anomalies occur near the border area between this low resistivity zone and the high resistivity zone in the west.

In the anomaly zones in Au, Sb and As and the mineral occurrence where high gold content were obtained, the silicified zone either occurs at a comparatively shallow depth or is already exposed on the surface; and from the results of the geophysical survey the silicified zone continues to a depth of 200 to 250m sea level below the surface. In the lower part of the anomaly zone in Hg and As, from Line H to Line M, a low resistivity zone continues to a depth of 350 to 400m sea level, with the resistivity value rising in deeper zone and towards Line M. A clear high resistivity zone that would suggest the existence of quartz veins and strongly silicifed zones is not observed, but the presence of a gold mineralization may be anticipated in the deeper part of the low resistivity zone and comparatively high resistivity zone on Lines L and M. The depth is estimated to sea level. It is clear from the results of the geophysical survey that the zone of geochemical anomalies in Hg and As from Line E to Line G is situated on the northern edge of a fusiform low resistivity zone which is 200m deep and 200m wide. The depth of gold mineralization here is estimated to be down to 300m sea level, the depth at which the resistivity value rises.

The resistivity discontinuous line from Line A to near the end of Line D which is in the zone of high resistivity of the distribution area of basement rock accompanies the distribution of geochemical anomalies in As and weak anomalies in Hg, and also matches a zone of sericite-quartz alteration. Boiling phenomenon was observed in the quartz veins near here, and there is a strong possibility of the existence of gold mineralization within the basement rock.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 Conclusion

The Upper Huai Nam Sala area is made up of Permian sedimentary rocks, the basement of this area, Permo-Triassic rhyolitic volcanic rocks, Permo-Triassic andesitic volcanic rocks, Jurassic intrusive rocks and Quaternary riverbed deposits. The basement rocks of Permian age are distributed in the western part of the detailed survey zone.

Within this area, two fault systems were observed, a N-S fault and a NE-SW fault. Both fault systems have a vertical displacement, with the western or northwestern block relatively raised. The NE-SW fault is developed on the synclinal axis of the Permian rocks, and continues to the southwestern part of the Survey Area. The N-S fault converges with the NE-SW fault, and is thought to be derived from this fault.

The alteration zones and mineral occurrences are regulated by this fault system and are developed in Permo-Triassic tuff as host rocks. The alteration zones are zones of argillization accompanied by silicification, and while there is some difference in the strength of silicification, the alteration zones are classified into weakly acidic to neutral alteration zone, that is, sericite+quartz zone; sericite+kaolinite±quartz zone; sericite+montmorillonite±kaolinite±quartz zone; montmorillonite ±kaolinite zone; weak or no alteration zone and display a zonal structure. The mineral occurrences are the area where quartz veins are accompanied by these alteration zones or strongly silicified altered rocks. The strongest alteration zone spread along the NE-SW fault on the south side of the detailed zone. It is made up mainly of sericite+quartz zone accompanied by strong silicification, and here in the assey analysis, values of Au=5.6g/t, 1.0g/t were obtained.

The alteration zone which is distributed from Line F to the starting point - 1000m point on Line M is observed to have a zonal structure, with a central zone of sericite+quartz followed by a sericite+kaolinite±quartz zone and a sericite+montmorillonite±kaolinite±quartz zone. Overlapping this alteration zone, geochemical anomalies in Au, As, Sb and Hg, suggesting the stongest gold mineralization, are observed in the whole of the Survey Area. In the geophysical survey, this corresponds to the border area between the high resistivity zone in the western part of the detailed survey zone and the low resistivity zone on the eastern side. Anomalous values in Au, As and Sb are distributed from Line J to the starting point - 500m point on Line M; in the surface area there occurs a low resistivity zone and at a depth of 100m-300m a high resistivity zone which thought to be a silicification zone; and it is anticipated the occurrence of gold. An anomaly zone of Hg and As, suggesting the mineralization halo of the upper part of hydrothermal deposits, occurs from Line E to Line M along the resistivity discontinuous line(the border area between basement rock and tuff) of the geophysical survey. From Line E to Line I and from Line J to Line M there is a difference in the structure of resistivity in the lower part, but gold mineral prospects are expected where a low resistivity zone shifts to a high resistivity zone.

Also, anomalous values in Au, As and Hg continue southwards from the starting point of Line I, and in this area also the existence of a silicified zone accompanied by gold mineralization is anticipated.

Since the boiling phenomenon is observed and the homogenization temperature of fluid inclusion near the surface seems to be low, at 150℃, there is a very strong possibiility indeed that the center of the gold mineralization effect is still further down, and that deep down there is a quartz vein and silicified zone accompanied by gold.

5-2 Recommendation for the Third Phase Survey

There is a strong possibility of the presence of gold mineral prospects in the lower part of the anomaly zone in Hg and As along the resistivity discontinuous line and the high resistivity zone accompanying the comparatively shallow zone of anomaly in Au, As and Sb extracted in the Survey this year. Next year it is desirable that a survey be made of the mineralization condition and of alteration through a drilling survey in the lower parts of each anomaly zone, and the presence or otherwise of gold mineral prospects be confirmed.

PART II DETAIL DESCRIPTION

CHAPTER 1 GEOCHEMICAL SURVEY

1-1 Method of Survey

The Survey Area is located 20km east of Chiang Rai in the upper reaches of the Huai Nam Sala, Nam Khon Kaen and Huai Nam Mae Boc rivers in the northern part of the Chiang Khong district, and covers an area of approximately 40 km^2 centered on coordinates 20° 06'6N, 100° 15'5E.(Fig.I-1-1) In the upper reaches of the Huai Nam Sala river forming the southeast foot of Mt. Doi Kha La and Mt.Doi Kiu Hok in the northeastern part of the Survey Area, 13 parallel survey lines with 2.0km length in a N60° E direction and with 200m interval were set up as a detailed survey area for physical and detailed geochemical surveys.

The survey was carried out in order to clarify the geological condition, alteration pattern, mineralization condition and period of mineralization in the Survey Area and to extract in greater detail the areas where ore deposits may be expected. A field investigation of the ground surface was carried out, and together with the collection of soil samples, rock samples and ore samples were also taken and a number of laboratory tests were carried out, including ore analysis of quartz veins and silicified rocks; whole rock chemical analysis; X-ray diffraction of altered rocks; K-Ar dating; measurement of homogenization temperature of fluid inclusions; and the observation of thin sections of rocks and polished thin sections of ores.

Soil samples were taken by the short-grid method in the detailed survey area and by the Ridge-and-Spur random method in the whole survey Area. A total of 982 soil samples were taken, 533 by the short-grid method and 449 by the random method. As shown in Fig. I-1-1, the soil samples taken by the short-grid method were collected at 50m intervals on the 2km-long geophysical survey lines set up in the upper reaches of the Huai Nam Sala river(a total of 13 lines spaced on a grid at 200m intervals); the soil samples taken by the random method were collected as evenly as possible along the main ridges, taking into account the geological conditions and alteration patterns over the whole Survey Area. As a general rule all soil samples were taken from the B horizon. The samples collected were dried and sieved, then the -80 mesh fraction was subjected to chemical analysis.

1-2 Geology

1-2-1 General Geology

1) Geology

The geology of the Survey Area is founded on Permian sedimentary rock and comprises Permo-Triassic rhyolitic volcanic rocks , Permo-Triassic andesitic rocks , Jurassic intrusive rocks and Quaternary present riverbed sediment.

The Permian sedimentary rocks are distributed near the foot of Mt. Doi Kha La and Mt. Doi Kiu Hok, which are located in the northwestern part of the Survey Area. They are mainly slate developed from slaty cleavage (PRm), accompanied by sandstone and conglomerate (PRc). The Permo-Triassic rhyolitic volcanics are welded rhyolitic tuff and lapilli tuff (PTr), and are distributed in the eastern part of the Survey Area. Covering these, Permo-Triassic andesitic volcanic rocks are distributed widely over almost all the Survey Area. These are consist of andesitic tuff, lapilli tuff, tuff brecchia (PTt) and lavas such as hornblende andesite (PRh), plagioclase-porphyritic basalt (PRp) and andesitic lava (PRa). The Jurassic intrusive rocks (I) have a basaltic-dacitic composition, and are scattered throughout the Survey Area.

2) Geological Structure

The mountainous areas and basins around the Chiang Khong district extend in a NE-SW and NNE-SSW direction. Within the Survey Area, the geological structure also follows this direction and the Permian sedimentary rocks have cleavage planes or bedding planes running generally NE-SW direction, and their distribution continues along the same direction. The Permo-Triassic andesitic volcanic rocks also have the same NE-SW directional structure in the northern part of the Survey Area.

In the northern part of the Survey Area, the Permian sedimentary rocks, the Permo-Triassic andesitic volcanic rocks and the Permo-Triassic rhyolitic volcanic rocks are on the whole distibuted in an arrangement of bands. In the southern part of the Survey Area, the Permo-Triassic andesitic volcanic rocks are widely distributed, with only a little of the Permian sedimentary rocks near the NE-SW fault.

Within the Survey Area two fault systems may be observed, one running N-S and the other NE-SW. In both fault systems the displacement is in a vertical direction, and it is assumed that the western and northern block in each case has risen. The NE-SW fault system develops on the synclinal axis of the Permian sedimentary rocks and continues to the south-western part of the Survey Area. The N-S fault system converges with the NE-SW fault, and is thought to be a derivative of this fault.

1-2-2 Details of Geology

1)The Permian Sedimentary rock series(PR)

These are exposed in the upper reaches of the Hoi Kiang creek, Huai Kha La creek and Nam Thung Lot river, and are distributed locally in strata beneath the Permo-Triassic andesitic tuff and lava. Outcrops may also be observed in the cut-earth plane by the national road near the summit.

They are mainly made up of slate, interspersed with sandstone and conglomerate. Apart from the conglomerate stratum near the ridge, the sandstone and conglomerate occur mostly in thin strata; and since the sedimentary structure has been disordered by the shearing effect after sedimentation it is difficult to specify exactly the distribution zones of the sandstone and conglomerate strata. Thus in this report, only the conglomerate continuing in a NE-SW direction near the summit has been classified as a conglomerate stratum (PRc), and other areas which are for the most part made up of slate have been lumped together as a slate stratum (PRm).

i)Slate (PRm)

This is a formation of dark grey slate, accompanied by sandstone, conglomerate and tuffceous slate. Generally the slate has developed slaty cleavage and is very fine grained. The cleavage plane runs for the most part in a NE-SW to a NNE-SSW direction, but there are some places where it runs in a NW-SE or E-W direction. The sandstone is diverse, being a hard, grey wackeceous sandstone or relatively well sorted fine to medium sandstone. The occurence is also varied; in some places it is shifting irregularly into slate or sandy slate, in others it is layered alternately with conglomerate and slate. The tuffceous slate shows a greyish-white or pale green-grey colouration, and the cleavage plane is developed.

In the cut-earth plane near the summit along the national road, there is outcrop of sandstone and slate, and folding and small faults are developed. In parts of the slate organic matter and calcic material are observed abundantly.

ii)Conglomerate (PRc)

This contains rounded to sub-rounded pebble of sandstone, chert etc. Two types of conglomerate are observed, one with a high degree of solidification and silicic matrix, and one with a low degree of solidification and tuffaceous matrix. The relationship between the two is not clear.

2)Permo-Triassic Rhyolitic welded tuff (PTr)

This is distributed in the eastern part of the Survey Area. The rock shows a greyish-white to lilac color, and sometimes has a banded structure. It is mainly vitric tuff, accompanied by lapilli tuff with a diameter of about 2cm. The rhyolitic tuff in this area is generally welded and is observed to contain pieces of flattened pumice or to show a foliation. Densely-welded, solidified tuff was also observed, and it is conjectured that this is distributed beltedly.

This rock is mainly composed of volcanic glass accompanied by crystal and volcanic fragments, etc. The volcanic glass has been almost completely replaced by secondary minerals such as silica minerals, but the welded structure still remains. The crystal are fragments consist of plagioclase, potassium felspar, opaque minerals, etc., and contain zircon, apatite, etc. as accessary minerals.

The existence of this welded tuff indicates that caldera-type volcanic activity occured around the Survey Area and there is a high possibility of deposits of epithermal metallic ore deposit in the region.

3)Permo-Triassic Andesitic volcanic rocks(PT)

These are made up of andesitic pyroclastic rocks interleaved with several layers of lava. The lava exhibits diverse rock facies, and there were observed to be at least three different types. The hornblende andesite (PTh) corresponding to the uppermost stratum, and the plagioclase-porphyritic basalt (PTp) distributed around Mt. Doi Ta Khuan, are lavas characterised by the large amounts of euhedral phenocrysts of hornblende and plagioclase, respectively. The other lavas are generally fine-grained andesitic lava containing phenocrysts of pyroxene, plagioclase, etc., and showing a variety of occurences, some strata being only a few metres thick while others reach a thickness of about 150m.

The pyroclastic rocks are mainly tuff, accompanied by tuff breccia and lapilli tuff. These rocks facies change complexly, and so in this report they have been classified together as tuff and tuff breccia (PTt).

The general stratigraphy of the pyroclastic rocks and lava is, in the northern part of the Survey Area, from the bottom to up; andesitic lava (PTa), tuff (PTt) and hornblende andesite (PTh), and in the southern part of the Survey Area; tuff (PTt), andesitic lava (PTa), tuff (PTt), plagioclase-porphyritic basalt (PTp), tuff and tuff breccia (PTt).

i)Tuff and tuff breccia **(PTt)**

These are mainly andesitic tuff, accompanied by lapilli tuff and tuff breccia. There are some differences in the facies of the rocks between the northeastern and southwestern parts of the Survey Area.

In the southwestern part of the Survey Area, the rocks are overall coarse-grained, and lapilli tuff and tuff breccia are prominent on the northwestern side of the fault in particular.

Close to the Permian sedimentary rocks, the geological structure shows a east-west direction with a gentle southerly slope, gradually shifting to a horizontal structure further away from the Permian sedimentary rocks.

On the other hand, in the northeastern part of the Survey Area, that is, near the detailed survey area, the rocks are mainly fine tuff interleaved with lapilli tuff. On the whole, the original textures of those rocks are unclear because of strong silicification and alteration. On the western side of the N-S fault running close to the detailed survey area, the tuff has a thickness of 20 to 30m and the border plane with the Permian sedimentary rocks inclines gently to the east. However, on the eastern side of the fault the tuff has a thickness of around 80m and the border plane with the Permian sedimentary rocks is almost horizontal.

ii)Andesitic lava **(PTa)**

Andesitic lavas are exposed relatively thick in places like the valley floor along survey line C in the detailed study area, and the middle reaches of the Nam Thung Lot River. The former directly covers the Permian sedimentary rocks uncomformitly, and is thought to be the bottom-most stratum of andesite lava, with a thickness of around 20m. The latter continues in a belt in a roughly east-west direction from the Nam Thung Lot River, and has a thickness of around 150m. Apart from these two strata there are lava strata over 10m thick in the basin of the Nam Khon Kaen River and elsewhere, lain between andesitic tuff (PTt).

These rocks show green-grey/blue to grey or reddish-brown color, the latter being more prominent on the ridge. In general the rocks are fine-grained, sometimes containing phenocrysts of plagioclase and/or pyroxene and displaying a glomeroporphyritic texture. These are often argillized and silicified.

iii)Plagioclase-porphyritic basalt **(PTp)**

Plagioclase-porphyritic basalt is exposed in the southern part of the Survey Area, around Mt. Doi Ta Khuan, on the mountainside on the right bank of the Huai Nam Mae Bon creek, in the basin of the Nam Thung Lot River, etc. Outcrops of this basalt expose near Mt. Doi Ta Khuan at about the same altitude, and it is assumed that it intercalates the andesitic tuff (PTt) almost horizontally. The thickness of the stratum is approximately 60m.

This rock is characterized by large amounts of euhedral platy plagioclase phenocrysts which have a diameter of about 1 cm, and occasionally 2cm. The groundmass is fine-grained and dense; the fresh rock shows a grey to dark grey color. But sometimes it is changing the color to dark green through alteration.

The plagioclase phenocryst is only, and no mafic phenocrysts are observed. The groundmass shows an intergranular texture. The rock is characterized by large amounts of apatite and zircon, and in the whole rock chemical composition the content of P_2O_5 and Zn are high in comparison with other basalts. The rock has been replaced generally by large amounts of carbonate minerals.

iv)Hornblende andesite **(PTh)**

Distribution is limited to the summits and ridges of Mt. Doi Kiu Hok and Mt. Doi Kha La, which are situated near the detailed survey zone. The rock corresponds to the upper most layer of volcanic rocks of the Permo-Triassic periods, and irregularly covers the andesitic tuff and Permian sedimentary rocks. It is estimated that the bottom border plane is either horizontal or has a gentle tilt towards the lower part of the slope. The thickness is 20 to 30 m on the western side of the N-S fault, and is slightly thicker on the east side, estimated at 40m to 50m.

The rock has a green to turquoise color, and has characteristically large amounts of idiomorphic long prisms of hornblende phenocrysts. Generally the rock is coarse and holocrystalline and shows a hypabyssal to fine-grained plutonic texture, but around the edges of the rock mass fine-grained facies were also observed.

The rock contains a lot of idiomorphic hornblende, and is made up of clinopyroxene, orthopyroxene, plagioclase, etc. It shows an equigranular or ophitic texture. The hornblende is in idiomorphic prism form and brown color, and in many cases has been replaced by opacite. The rock has undergone alteration throughout, then the clinopyroxene and orthopyroxene have been replaced by secondary minerals such as chlorite and epidote.

4)Jurassic intrusive rocks **(I)**

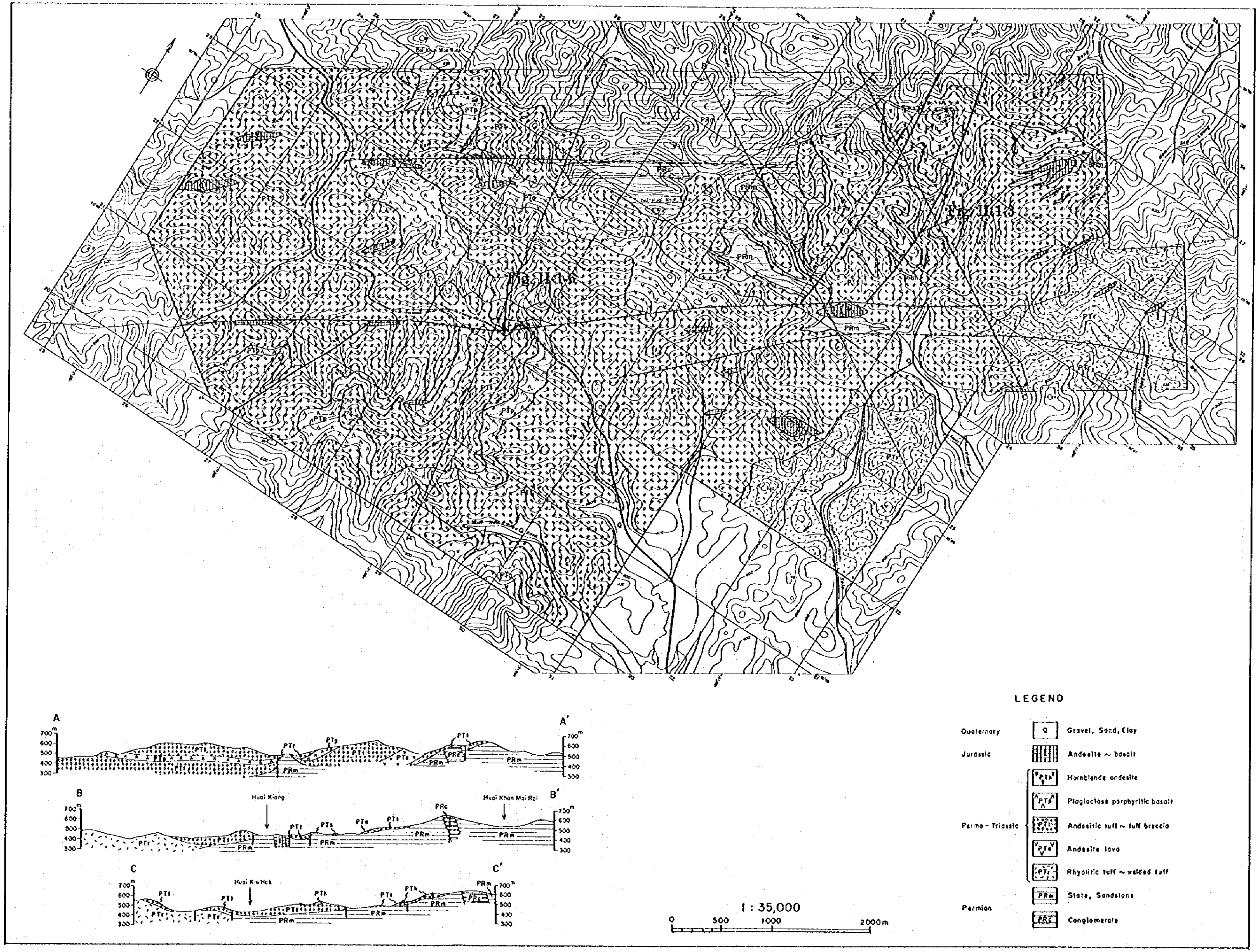


Fig. II-1-1 Geologic Map and Profile in the Upper Huai Nam Sala

Period	Column	Lithology	Igneous activity	Mineralization
Quaternary	Q	gravel, sand, clay		Placer
Jurassic	I	andesite ~ basalt	Andesite ~basalt	Au,Cu Pb,Zn
Permo ~ Triassic	PTh	hornblende andesite	Andesite	
	PTt	andesitic lappilituff ~ tuff breccia		
	PTp	plagioclase porphyritic basalt		
	PTt	andesitic tuff		
	PTa	andesite lava		
	PTt	andesitic tuff		
	PTa	andeste lava		
	PTt	andesitic tuff		
	PTa	andesite lava		
	PTr	rhyolitic tuff ~ welded tuff	rhyolite	
Permian	PRm PRc PRm PRc PRm	PRm : slate, sand stone PRc : pebble to cobble conglomerate		

Fig. II-1-2 Schematic Geologic Column in the Upper Huai Nam Sala

Jurassic Intrusive rocks are scattered throughout almost all the Survey Area. The individual rock bodies vary in size from a few metres wide to around 200m wide. Most of these rock bodies intrude in dyke form in Permian slate, Permo-Triassic andesitic volcanic rocks, rhyolitic volcanic rocks, etc.; the direction of the intrusion is mainly N-S or NE-SW, parallel to the major fault system. These caused silicification and alteration in the country rocks.

These rocks has a various compositional range from basalt to dacite, but they are mainly andesitic. They show a dark grey to grey color, and are for the most part fresh, with the exception of the reddish oxidation along the cracks.

Under the microscope they have an intergranular to intersertal texture, and can be seen to contain phenocrysts of plagioclase, clinopyroxene, orthopyroxene and hornblende. The combination of mafic minerals changes as the rock composition moves from basic to acidic, thus; clinopyroxene→ clinopyroxene + orthopyroxene → clinopyroxene+orthopyroxene+hornblende → hornblende. Together with this the maximum symmetrical extinction angle of plagioclase diminishes regularly; 37-40° (basalt)→28-32° (andesite)→22° (dacite). The clinopyroxene is commonly observed in the groundmass of basalt or basaltic andesite, showing that these rocks belong to the pigeonitic rock series. Mafic minerals and some plagioclase have been replaced by secondary minerals such as chlorite, carbonates, sericite, etc.

5)Quaternary rocks (Q)

These are distributed in the main river basins, and consists of gravel, sand and mud. In the Huai Kha La valley there are gravel bed with a relative height of around 2m, and it is thought that these are terrace or floodplain deposits.

1-2-3 Geological Structure

The topography and geological structure of the Chiang Khong area have a dominant NE-SW/NNE-SSW direction. The crest line joining up Mts. Doi Kha La, Doi Huai Nam Sala and Doi Ta Khuan continues in a NNE-SSW direction, and the topographical transition line forming the border between the mountain area and the valleys also continues in a straight NE-SW direction.

It was observed that geological strata tended to lie in harmony with this direction. The cleavage planes and bedding planes of the Permian sedimentary rocks run NE-SW, and their distribution continues in the same direction. The Permo-Triassic rhyolitic tuff is not continuous, but distribution was confirmed to be in a NE-SW/NNE-SSW direction. The Permo-Triassic andesitic volcanic rocks show in the southern part of the Survey Area an east-west strike or a horizontal structure, but in the northern part of the Survey Area they show a NE-SW strike and an eastern-dipping structure, and the NE-SW structure is thought to be predominant over a wide area.

In the northern part of the Survey Area, Permian sedimentary rocks, Permo-Triassic andesitic volcanic rocks and rhyolitic volcanic rocks are on the whole distributed beltedly. That is to say, near the crest line and to the west of the crest line Permian sedimentary rocks lie, and on the slope to the east of the crest line (near the survey lines in the detailed survey zone) Permian andesitic volcanic rocks lie. The Permo-Triassic rhyolitic volcanic rocks lie further east, on the eastern edge of the mountain range, near to the border with the valleys. However, in the southern part of the Survey Area the Permo-Triassic andesitic volcanic rocks occur widely, with only a few of the Permian rocks close to the NE-SW fault line.

Two fault systems are observed in the Survey Area, one running N-S and the other NE-SW. The N-S fault is observed in the northern part of the Survey Area; several parallel faults cut across the detailed survey zone. Outcrops directly showing the direction of fault movement were a few, but judging from the geology of the surrounding area and an outcrop in Fig. II-1-3, it is surmised that this fault has a displacement in a vertical direction and the western block has risen relatively. That is to say, on the western side of the fault the Permian sedimentary rocks that form the basement are widely distributed, and exposed to a high altitude and form the mountain body; but on the eastern side of the fault the basement is not observed, and Permo-Triassic volcanic rocks overlie on the basement thickly.

The NE-SW fault runs through almost the center of the Survey Area. This fault develops at the synclinal axis of the Permian rocks, and continues in a SW direction across the Chiang Khong area. Within the Survey Area it is estimated that the displacement direction is the same as for the N-S fault, with a relative rise in the block on the northwestern side.

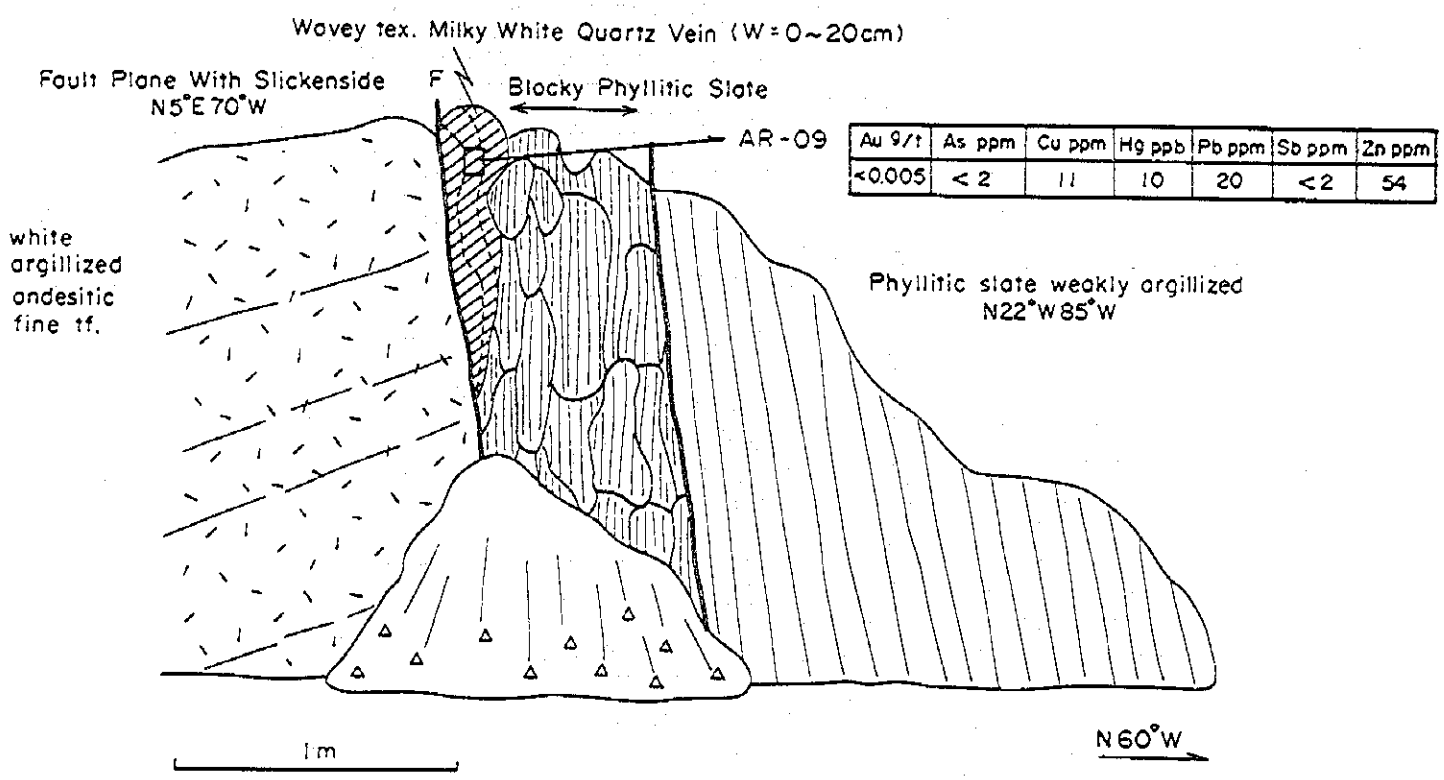
From the fact that on either side of these two fault systems the thickness of Permo-Triassic andesitic tuff is different, and from the fact that Jurassic intrusive rocks occur close to the faults and the direction of intrusion is roughly parallel to the faults, it is thought that the activity of these faults had started after the Permo-Triassic volcanic activity, continued at least until the Jurassic period, and regulated the igneous activity of that time.

1-2-4 Geochemical Characteristics of Igneous Rocks

Whole-rock chemical analysis was carried out on 13 samples of volcanic rock taken from the Survey Area. The analized chemical and norm compositions are given in the Appendix 7.

The samples analyzed were as follows: 2 samples of Permo-Triassic rhyolitic welded tuff (PTr), 1 sample of plagioclase-porphyritic basalt (PTp), 4 samples of hornblende andesite (PTh), and 6 samples of Jurassic intrusive rocks (I). The results of analysis done in the Phase I survey and in the preliminary survey on Permo-Triassic rhyolite (PTr), andesitic lava (PTa), plagioclase-porphyritic basalt (PTp), Triassic granite (Gr) and Pliocenic basalt (Ba) are also given as reference values.

Fig. II-1-4.1 shows the Harker diagram for the main portion, while Fig. II-1-4-2 shows a Varia-



Au g/t	As ppm	Cu ppm	Hg ppb	Pb ppm	Sb ppm	Zn ppm
<0.005	< 2	11	10	20	<2	54

Fig. II-1-3 Sketch of Fault in Detailed Survey Zone tion diagram for trace elements.

1)Genesis of basalt magma

In Figs. II-1-4.1and II-1-4-2, the Permo-Triassic plagioclase-porphyritic basalt (PTp) is out of line with the overall trend, being rich in TiO_2, P_2O_5, Nb, Zr and Y, and poor in MnO and MgO.

Figs. II-1-4.3, II-1-4.4 and II-1-4.5 are classification figures for basalt using respectively TiO_2 -10*MnO-10* P_2O_5, Ti/100-Zr-Y*0.3, 2*Nb-Zr/4-Y. The boundaries for each domain follow Mullen (1983), Pearce & Cann (1973) and Meschede (1986), respectively. The intrusive rocks of Jurassic age (I) and the basalt of Pliocene age (Ba) have a similar composition and are plotted near the boundaries of island arc basalt and oceanic island alkali rocks, or of within-plate alkali rocks. However plagioclase-porphyritic basalt (PTp) has a composition different to these, and is plotted in the domain of oceanic-island alkali rocks or within-plate alkali rocks.

Fig. II-1-4.6 is a spider diagram in which the trace elements of basaltic rocks are standardized by MORB. Plagioclase-porphyritic basalt shows clearly higher values than the intrusive rocks of Jurassic age for elements lefting in liquid phase, such as K, Rb, P, Zr and Y. However, the patterns for both are similar and show a configuration drained of Nb typically seen in island arc basalt.

The basalt which occurs in and around the Survey Area has the characteristics of island arc basalt to oceanic island alkali rocks or within-plate alkali rocks. It is supposed that the plagioclase-porphyritic basalt (PTp) has the same kind of formation, but when we consider that it is rich in elements lefting in liquid phase, such as K, Rb, P, Zr and Y, it may be thought that it was formed under conditions where the degree of partial melting was lower in comparison to other basalts.

2) Alkali content

Fig. II-1-4.7 is a SiO_2 -K_2O diagram, the Low-K, Mid-K and High-K boundaries following the classification of Harmon et al (1984). Basaltic to andesitic volcanic rocks are plotted in the Mid-K region, dacitic to rhyolitic volcanic rocks in the Mid-K to High-K region, and granites in the High-K region. Compared to the intrusive rocks of Jurassic age or the basalts of Pliocene age, the volcanic rocks of Permian to Triassic age show a relatively high K_2O content.

Fig. II-1-4.8 is a SiO_2-Na_2O+K_2O diagram, the boundaries for the zones of tholeiite, high-alumina basalt and alkali basalt following Kuno (1966). There is some apparent scattering of the analytic values due to the effects of alteration, but overall they are plotted close to the border with high-alumina basalt or alkali basalt.

As shown in the Harker diagram in Fig. II-1-4.1, P_2O_5 and TiO_2 generally show values close to those of high-alumina basalt and alkali basalt, and higher than those of tholeiite. Also in Fig. II-1-4.2 the Rb content has a similar trend to that of K_2O, showing that the volcanic rocks of Permian to Triassic ages have relatively high values.

The values for K_{51} (the concentration of K_2O when the SiO_2 content is 51%) in the subduction zone show 0.2-0.8 on the fore arc side, 0.8-1.8 on the back arc side. Also if we look at the correlation between the content of K_2O and Rb, we see that there is a relatively low Rb content on the fore arc side. The K_{51} value of igneous rocks within the Survey Area (see Fig. II-1-4.8) is 0.8-1.2, showing the characteristics of igneous activity on the back arc side. In comparison with the Permo-Triassic volcanic rocks (PTa,PTh), the Jurassic intrusive rocks (I) and the Pliocenic basalt (Ba) show a relatively low K_2O, Rb content, and as is shown in Fig. II-1-4.9, Rb shows a low value against K_2O. This indicates that compared to other rocks the Jurassic intrusive rocks and the Pliocenic basalt have in very small part the characteristics of the fore arc side.

3) Crystallization differentiation process.

According to Figs. II-1-4.1 and II-1-4.2, the CaO, Na_2O and Sr contents have undergone alteration which cause some scattering of values; even so the chemical components of rocks other than the plagioclase-porphyritic basalt (PTp) display valiation trends that are very similar. However, the composition of hornblende andesite (PTh) and granite (Gr) differ slightly from the composition of Basalt (Ba), intrusive rocks (I) and andesitic lava, being rich in MgO and poor in TiO_2, FeO, P_2O_5, Zr and Y. Also, while in neutral rocks phenocrysts of hornblende appear in the former, the latter contain clinopyroxene in the groundmass; and in the dacitic rocks too, phenocrysts of two types of pyroxene are predominant.

Fig. II-1-4.10 is a SiO_2 -FeO(*)/MgO diagram, the boundaries for the calk-alkali rock series and tholeiitic rock series following Miyashiro (1974). The plagioclase-porphyritic basalt (PTp) clearly shows the composition of the tholeiitic rock series. Other rocks are plotted near the borders of tholeiitic and calk-alkali rock series, although the hornblend andesite (PTh) and granite (Gr) are plotted slightly closer to the region of calk-alkali rocks, and the basalt (Ba), intrusive rocks (I) and andesitic lava (PTa) are plotted more towards the region of tholeiite.

A similar trend may be observed in the triangular MgO-FeO+Fe_2O_3 -Na_2O+$K_2$0 diagram of Fig. II-1-4.11, in which the hornblende andesite (PTh) and the granite (Gr) are plotted slightly closer to the region of the hypersthenic rock series, while basalt (Ba), intrusive rocks (I) and andesitic lava (PTa) are plotted towards the region of the pigeonitic rock series. With the exception of plagioclase-porphyritic basalt, the igneous rocks occurring within the Survey Area possess a crystal differentiation process halfway between that of the calk-alkali and tholeiitic rock series; hornblende andesite (PTh) and granite (Gr) possess the character of the calc-alkali rock series, and basalt (Ba), intrusive rocks (I) and andesitic lava (PTa) possess the character of the tholeiite series.

The characteristics of volcanic rocks in this area are summarized as the table below.

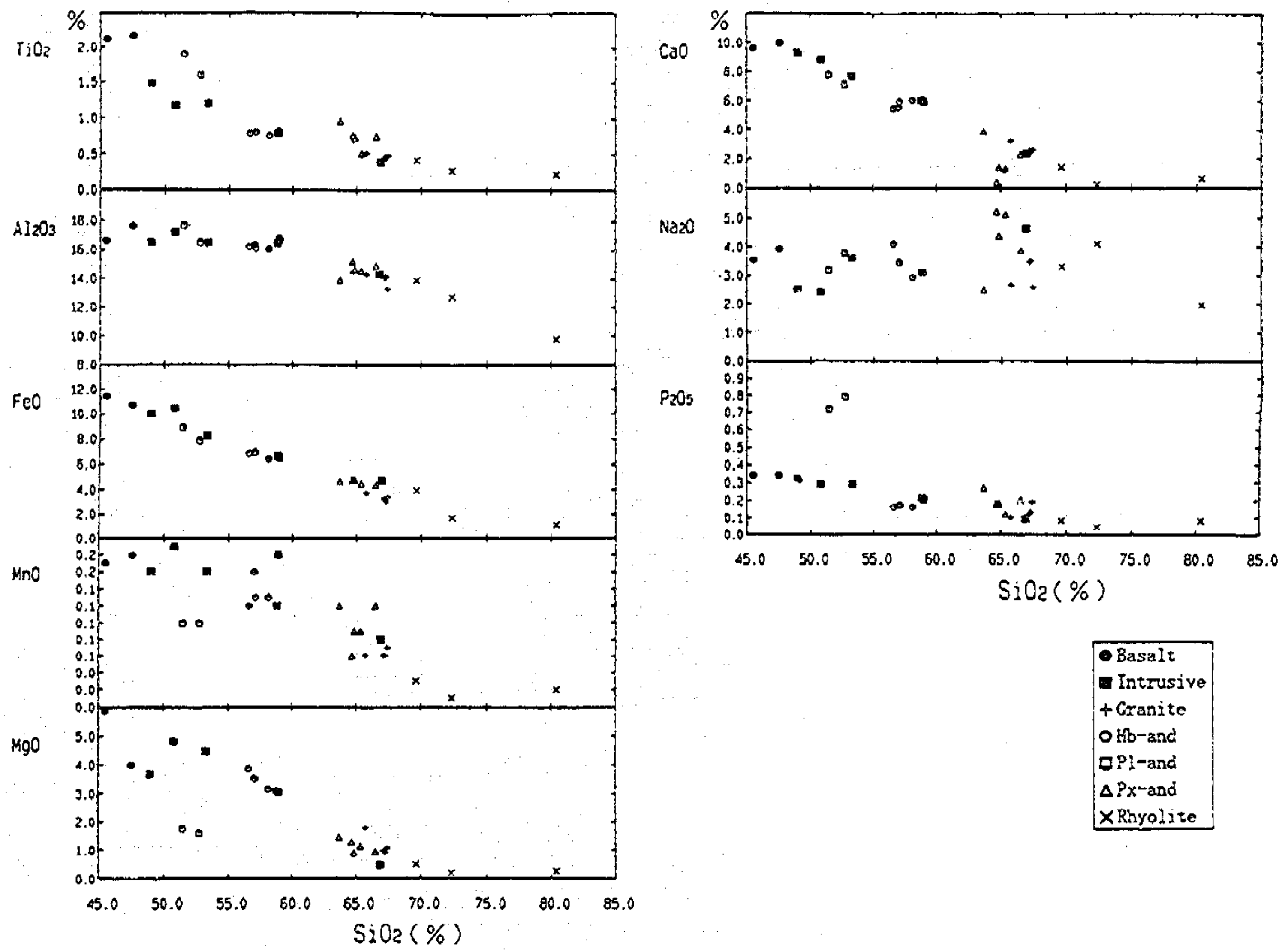


Fig. II-1-4.1 Harker Diagram of Igneous Rocks

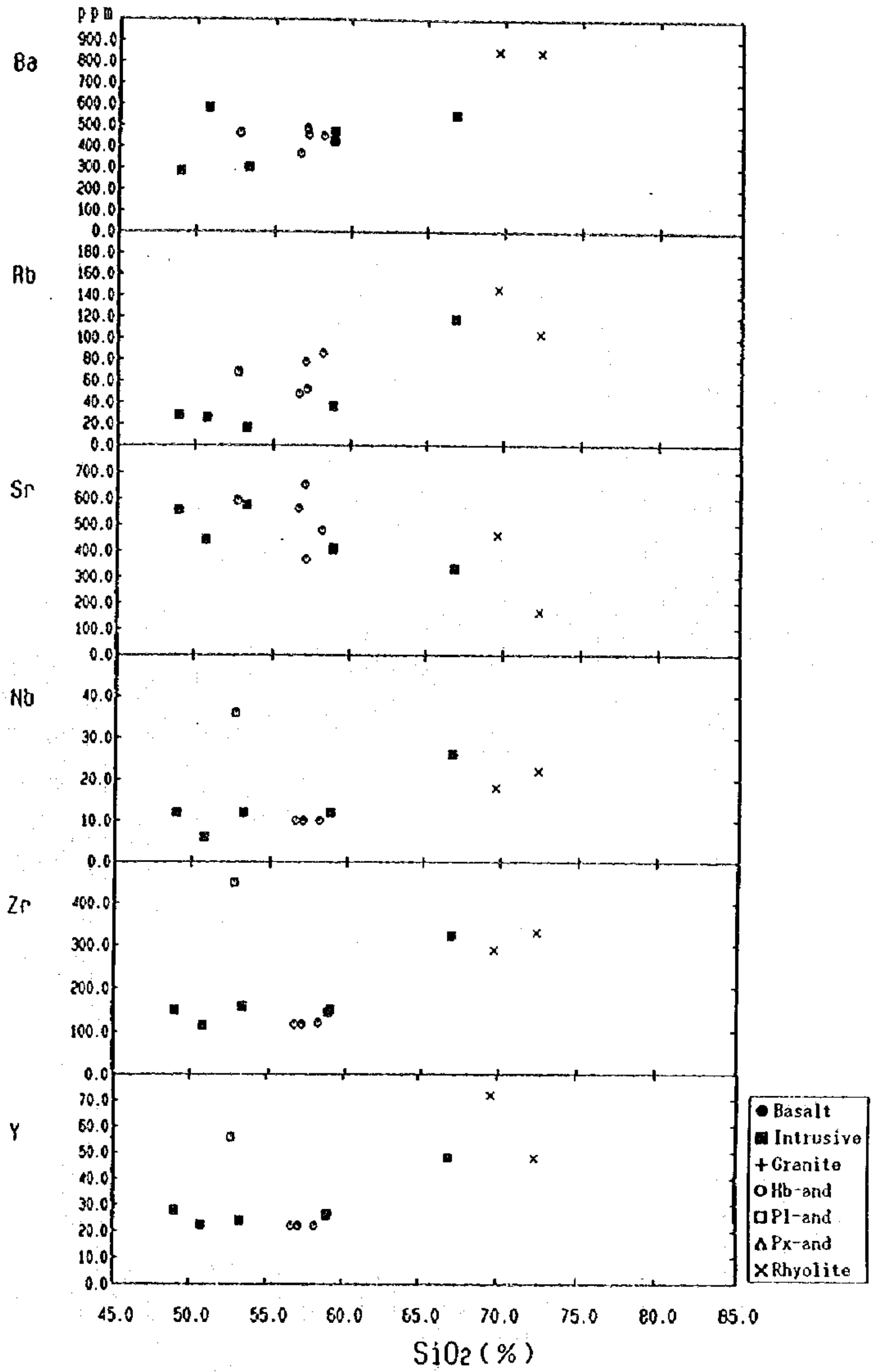


Fig. II-1-4.2 Variation Diagrams of Trace Elements in Igneous Rocks

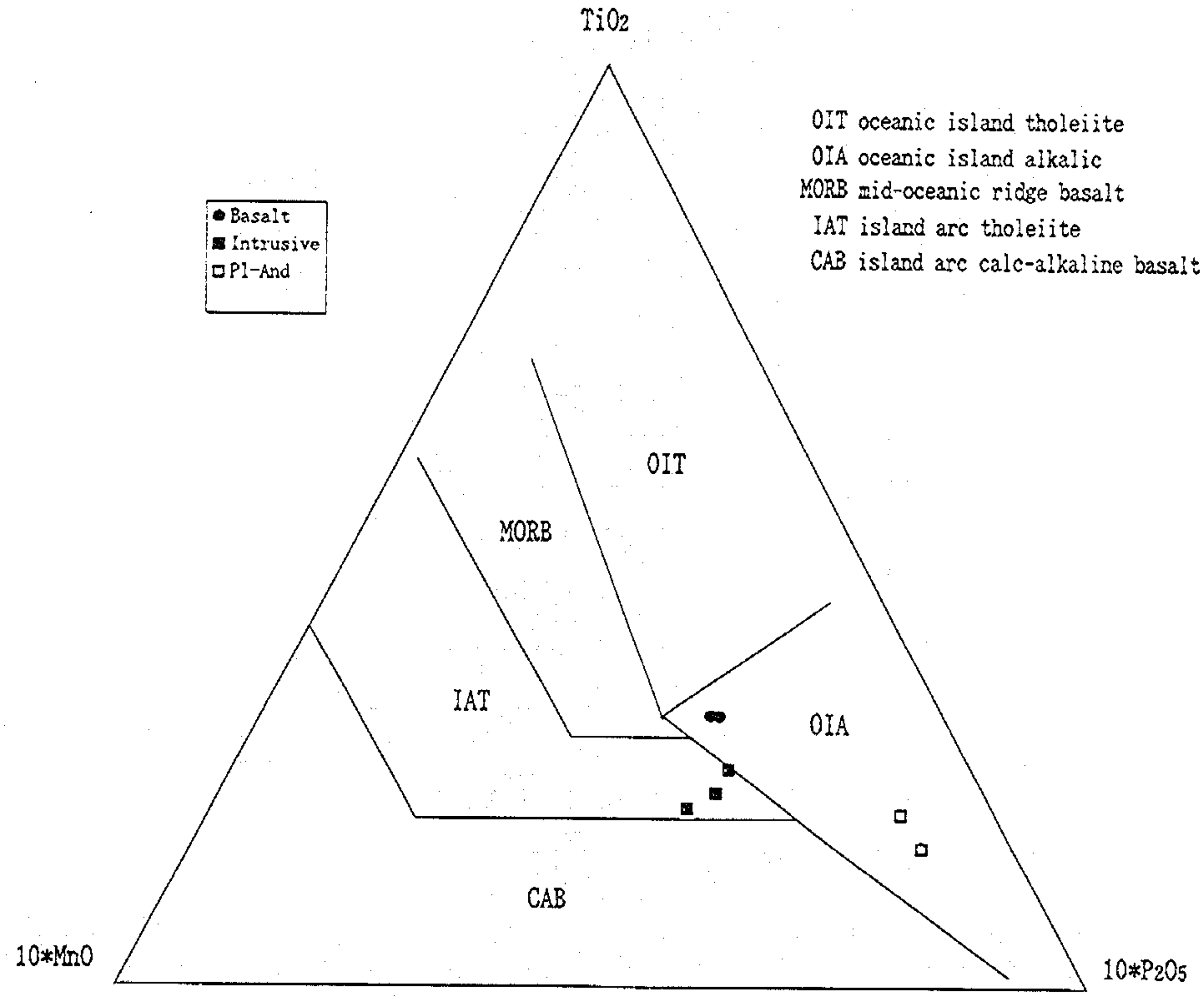


Fig. II-1-4.3 TiO_2-10*MgO-10*P_2O_5 Diagram

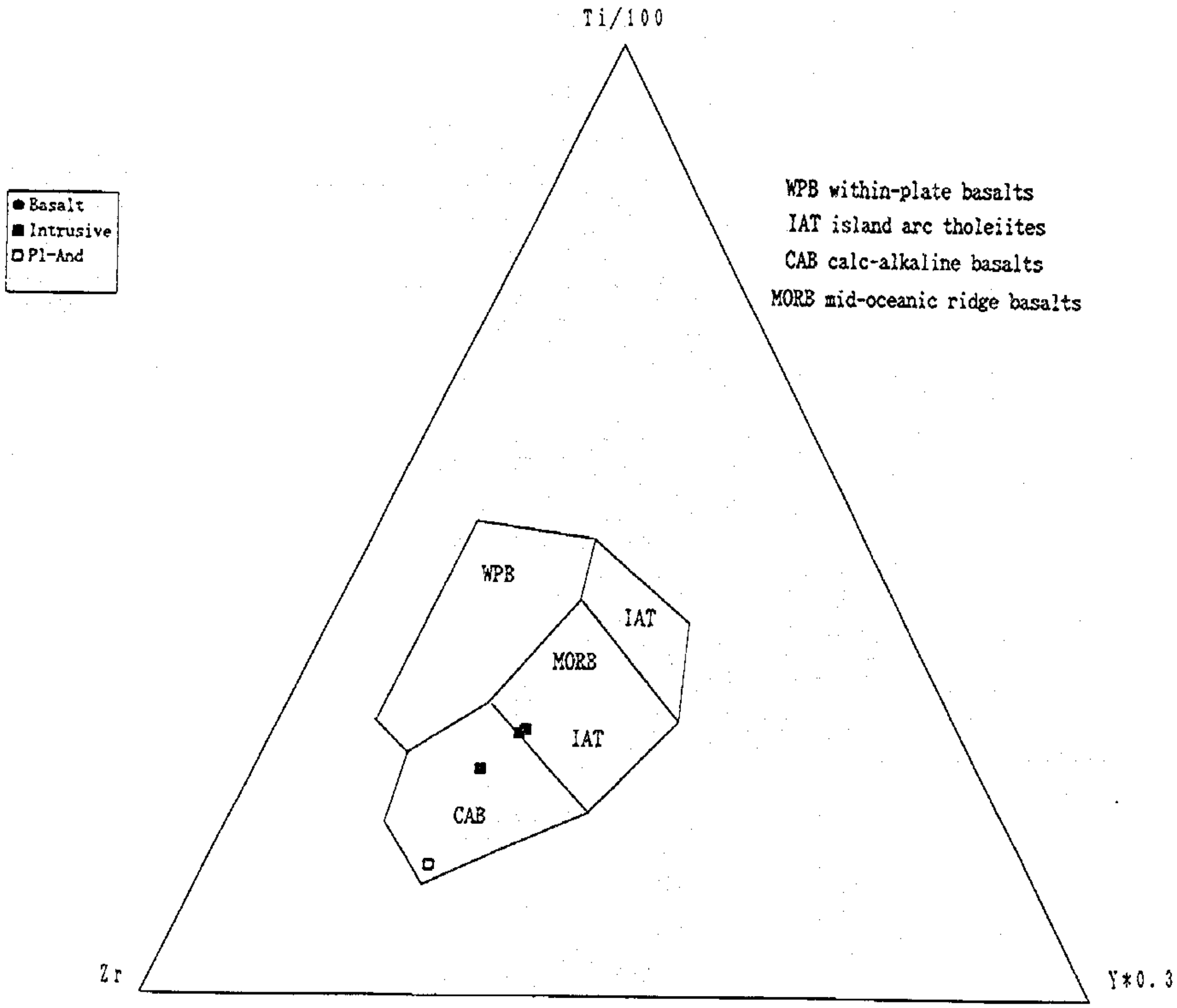


Fig. II-1-4.4 Ti/100-Zr-Y*0.3 Diagram

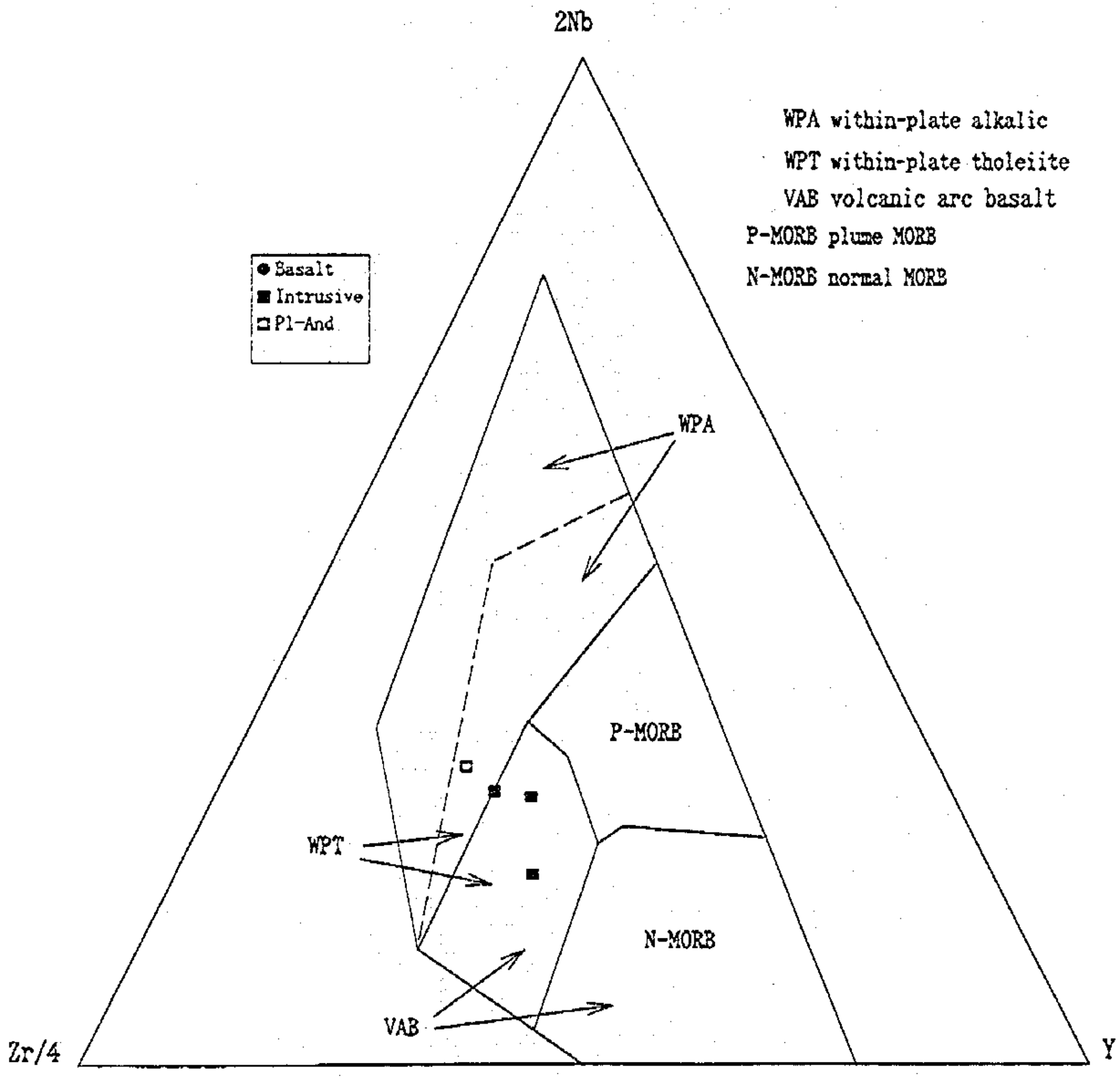


Fig. II-1-4.5 2*Nb-Zr/4-Y Diagram

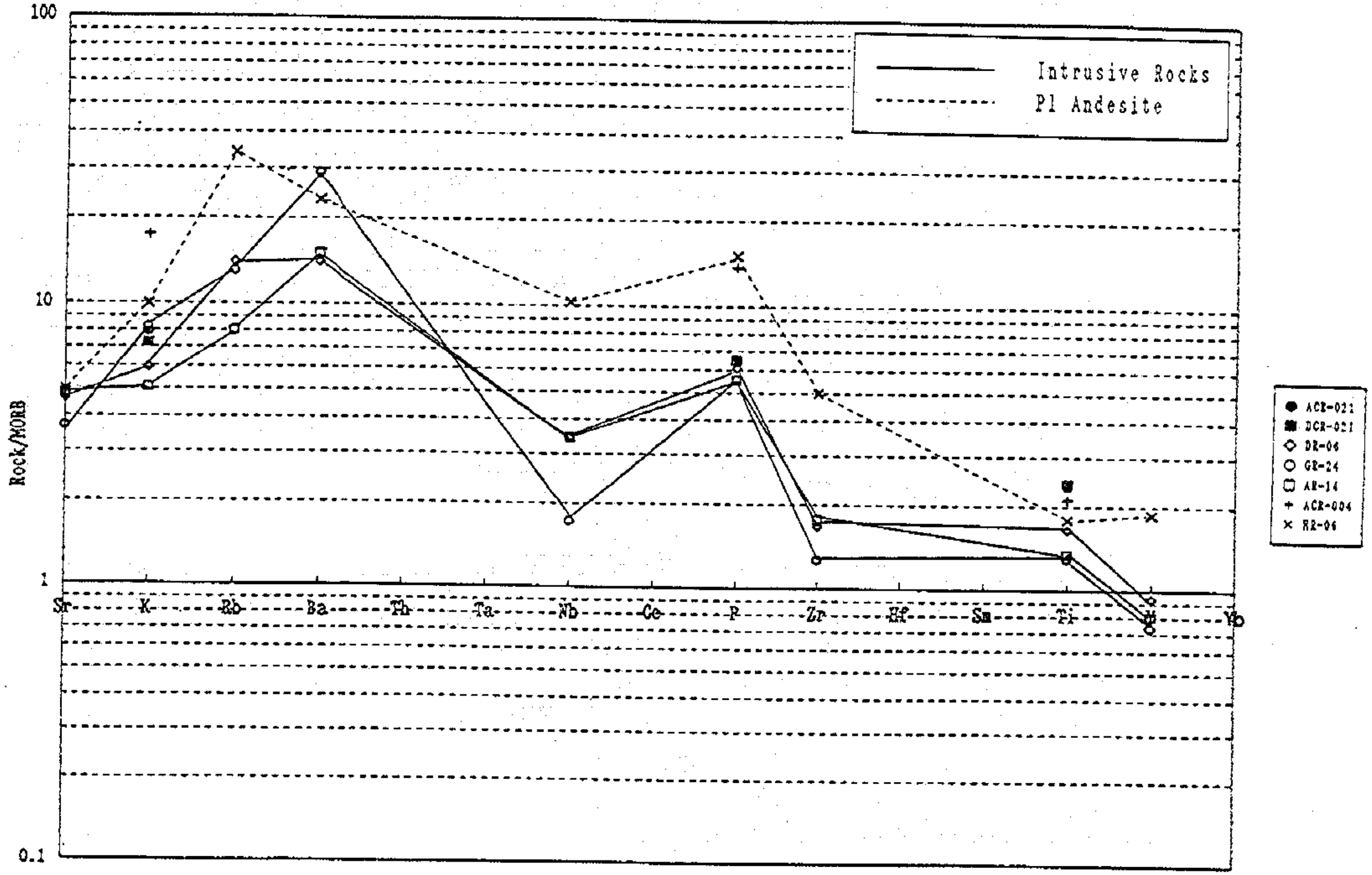


Fig. II-1-4.6 Spider Diagram (REE Pattern) of Igneous Rocks

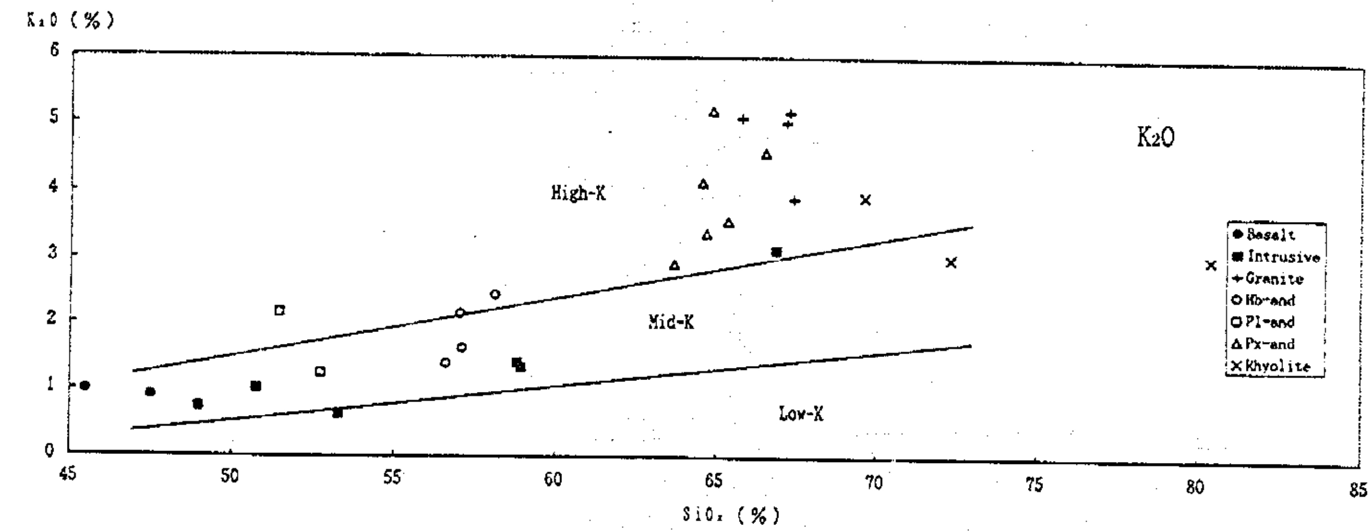


Fig. II-1-4.7 SiO_2-K_2O Diagram

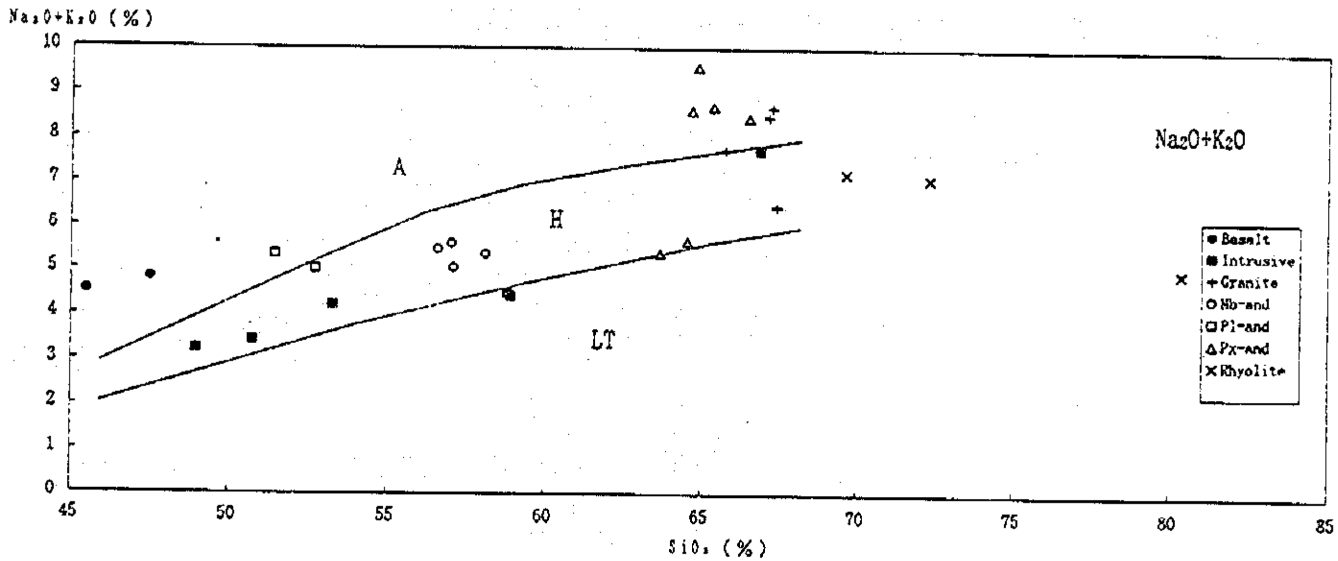


Fig. II-1-4.8 SiO_2-Na_2O+K_2O Diagram

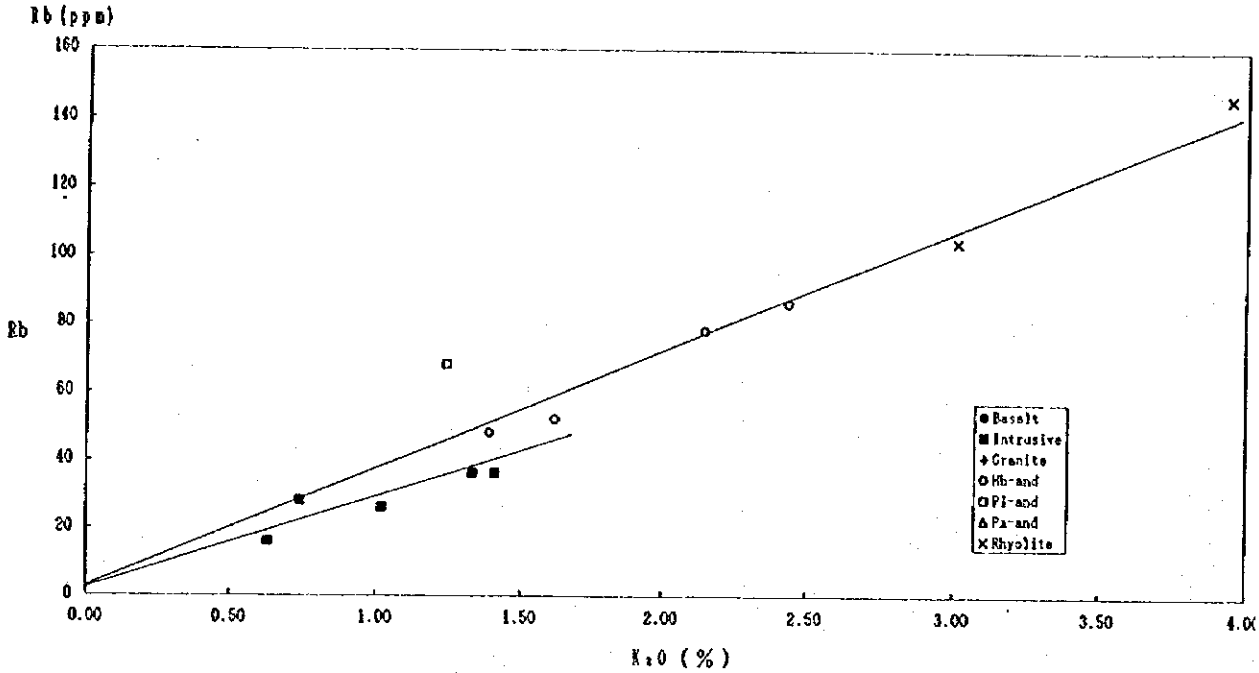


Fig. II-1-4.9 K_2O—Rb Diagram

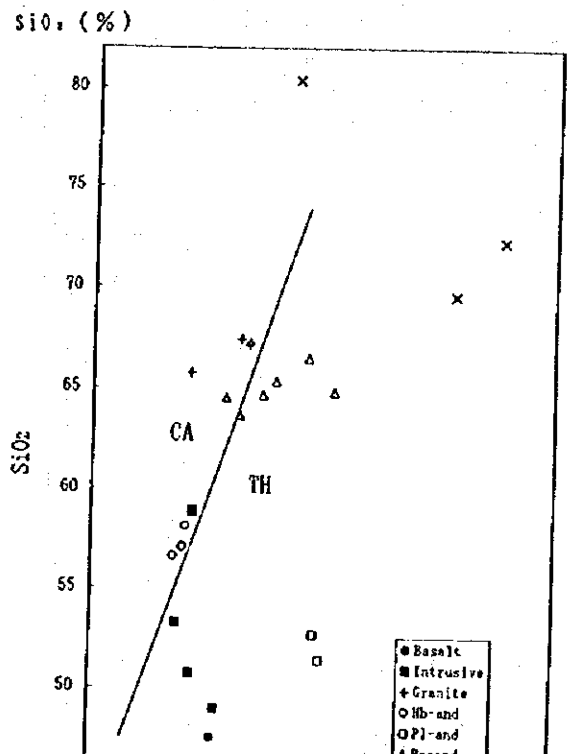


Fig. II-1-4.10 SiO_2—FeO(*)/MgO Diagram

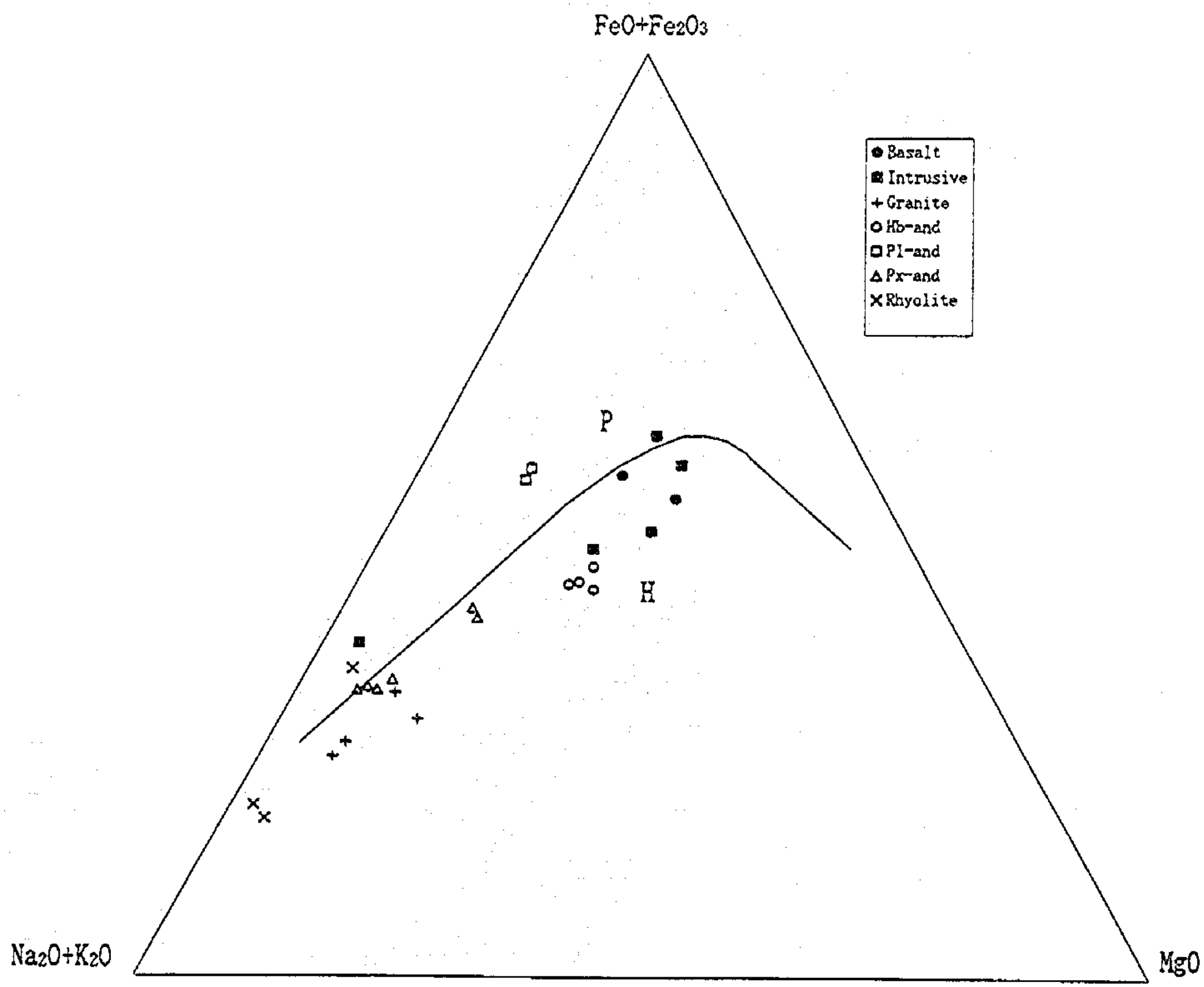


Fig. II-1-4.11 $MgO-FeO+Fe_2O_3-Na_2O+K_2O$(MFA) Diagram

Tectono-magmatic	K_2O	Differentiation series	Lithology	Period
Island arc Basalt ~ Alkali	Low~ Mid-K	Tholeiite	Olivine basalt (Ba)	Q-Ter
			Intrusive Rocks (I)	Jura
	Mid~ High-K	Calc-alkaline	Granite (Gr)	Tr
			Hb andesite (PTh)	P-Tr
		Tholeiite	Px andesite (PTa)	P-Tr
Within-plate Alkali	Mid-K	Tholeiite	Pl porphyritic basalt (PTp)	P-Tr

1-3 Alteration

An alteration distribution map of the Survey Area is shown in Fig. II-1-5.

Within the Survey Area, an alteration zone of white argillization accompanying silicification occurs widely from the central part of the Survey Area to the northern part. In the northeastern part of the Survey Area the distribution follows the N-S fault line, and in the northern and central parts it follows the NE-SW fault line. Places where the silicification is particularly strong are the Huai Kiu Hok to Huai Kha La Zone (1km wide, 1.5km long) in the upper reaches of the Huai Nam Sala, and the Upper reaches of the Nam Khon Kaen to Upper Huai Nam Sala Zone (400m wide, 1km long and 500m wide ,700m long) in the south of the detailed survey zone. This conforms with the area in which Au high geochemical anomalies we found in phase I survey. In these areas, the andesitic tuff of Permo-Triassic age has in the main undergone strong alteration. In addition, zones of silicification are distributed in the upper reaches of the Nam Pong Ngao (1.2km wide, 2.2km long) and the western bank of the Huai Kiang (over 400m wide, over 1.2km long), both on the eastern edge of the Survey Area; a silicification zone stretches from north of Mt. Doi Huai Nam Sala to the southeast of Mt. Doi Kha La (250m wide, 1.8km long) in the northern part of the Survey Area; and on the northeastern edge of the Survey Area, a silicification zone runs by Mt. Doi Huai Rong Bong (400m wide, over 2.0km long). In each of these zones the area of silicification is formed in the central part of a clay zone, and silicification grows weaker towards the surrounding areas.

Apart from these areas, argillization and silicification zone scatter throughout the Survey Area on a relatively small scale, and in general a tendency was observed for the alteration to be local in the areas of distribution of volcanic rocks or Permian sedimentary rocks, in comparison with areas of tuff distribution.

As to the time of alteration, the Permian sedimentary rocks and the Permo-Triassic rocks have undertaken alteration, while the Jurassic intrusive rocks are for the most part fresh; thus it may be thought that alteration occured subsequent to the Permian volcanic activity, and prior to or concurrently with the Jurassic intrusive activity.

X-ray diffraction tests were carried out on 120 altered rock samples taken from the above-mentioned alteration zones. The results of the testing are shown in Appendix 3. The alteration minerals detected in the Survey Area may be classified as pyrophyllite and kaolinite, formed under acid conditions: and sericite and montmorillonite, formed under acid/neutral conditions. In addition to these, silica minerals were discovered in the form of quartz; carbonate minerals in the form of calcite, dolomite and siderite; and iron minerals in the form of pyrite, goethite, hematite and siderite. Chlorite and epidote were also detected, each in one location.

Kaolinite can be formed through tropical weathering, but in view of the fact that pyrophyllite, indicating higher temperatures under acidic condition, was also observed, it may be thought that it was formed at least partly by hydrothermal alteration effect through acidic hydrothermal activity.

From the combinations of altered minerals it is possible to divide the alteration into seven zones. These are Zone Ⅰ, strong silicification zone: Zone Ⅱ, pyrophyllite zone: Zone Ⅲ, sericite + quartz zone: Zone Ⅳ, sericite + kaolinite ±quartz zone: Zone Ⅴ, sericite + montmorillonite ±quartz ± kaolinite zone: Zone Ⅵ, montmorillonite ±kaolinite zone: Zone Ⅶ, weakly altered to unaltered zone.

Of alteration zones of Ⅳ, Ⅴ, Ⅵ, which are distributed on the outer side of the zone of alteration zoning, have neutral altered minerals such as sericite and montmorillonite together with kaolinite which is an acid-altered mineral; but no kaolinite is found in the central Zone Ⅰ (strong silicification zone) or in Zone Ⅲ (sericite-quartz zone). From this it may be thought that in the alteration effect in the Survey Area, pyrophyllite and kaolinite were first formed through acidic hydrothermal activity, after which sericite and montmorillonite were formed as the hydrothermal temperature dropped and conditions became neutral.

A description of each part of alteration follows.

1)Huai Kiu Hok to Huai Kha La

This zone of alteration occurs along the ridge to the east of Huai Kiu Hok, along by the ridge and the stream between the Huai Kiu Hok and the Huai Kha La. A zone of silicification and argillization on which the alteration center stretches in a N-S direction, and matches the direction of the N-S fault which occurs on the western side of the zone. Along by east branch from the Huai Kiu Hok quartz veins containing epidote were observed, and this shows that alteration took place at high temperatures. The silicification grows weaker from the zone of strong silicification towards the outer edge, and in the southwest part shifts to a zone of strong argillization. Towards the south of the ridge flanked by the Huai Kiu Hok and the Huai Kha La, thought to be the centre of the alteration, there occurs a thin belt of pyrophyllite; around this is a wide band of sericite-quartz zone, further out from that a band of Zone Ⅳ, and still further out a band of Zone Ⅴ, showing the zonal structure.

2)Upper reaches of the Nam Khong Kaen to Huai Nam Sala

This zone occurs in the hilly district between the upper reaches of the Nam Khong Kaen and Huai Nam Sala. The alteration spreads out from the two NE-SW faults that pass through the central part of the Survey Area, and a particularly strong argillization spreads in a NE-SW direction along the fault line. Strong silicification and argillization spreads out to a width of 400m and a length of 1km in the upper reaches of the branch out in a NNE direction from the Nam Khong Kaen, and to a width of 500m and a length of 700m on the northern bank of the Nam Khong Kaen ; in addition to which small-scale distributions were observed in several places. On the outer edge of the zone of strong silicification and argillization an area of weak silicification and strong argillization zone stretches out to a width of 2km and a length of 2.5km, on the outer edge of which is an area of strong argillization zone, continuing into the area of strong argillization in the Huai Kiu Hok to the Huai Kha La area. In the central part of this zone of alteration there is formed a zone of strongly-silicified quartz, and on the outer edge of that a zone of strongly-silicified, stongly-argillized sericite-quartz combination is widely distributed. Further out from that Zone Ⅳ spreads out westwards and northwards, forming an area of strong argillization. Further out from that Zone Ⅴ continues northwards and eastwards, but to the west there are few outcrops and distribution is unclear.

Fig. Ⅱ-1-6 shows a sketch of the outcrops of the strongly argillized zone occurring along the national road in the western part of this alteration zone. These comprise andesitic tuff, lapilli tuff, tuff brecchia etc., and the fracture system develops mainly in two directions, N45° W,60° N and N60° E,65° N. Quartz-limonite veins accompanied by the N60° E fracture and show marked variation in width, from 10 to 50 cm. The quartz-limonite vein shows a reddish-brown color. In the center of the vein a fine white vein of quartz was observed. Silicification is strong along the N60° E fault, and the silicification also spreads out into the surrounding area. On the outer edges of this alteration is an area of strong argillization alteration, accompanied in parts by pyrite dissemination. Further from the N60° E fault alteration grows weaker, becoming medium to weak argillization on the upper parts of the outcrops and on the western side. The areas along the N60° E fault where the silicification is strong contain sericite abundantly, but kaolinite is either present in minute quantities or not observed at all. In the areas of strong argillization where the silicification is weak the amount of kaolinite gradually increases. On this outcrop minute quantities of anhydrite were also observed.

3)Upper reaches of the Nam Pong Ngao

The zone of alteration occurs in the hilly land in the upper reaches of the Nam Pong Ngao on the eastern edge of the Survey Area. Welded tuff has undergone silicification and argillization. On the eastern slopes of the hills on the west bank of the upper reaches of the Nam Pong Ngao, strong silicification/strong argillization extends over an area 400m wide and 1km long, and in the surrounding areas there is weak silicification to strong argillization. On the whole silicification predominates over argillization, and the area of strong argillization on the outer edges of the area of weak silicification is small. In this zone of alteration, epidote was observed on a peak 535m above sea level on the east bank of the Nam Pong Ngao river. The zone of alteration with a strong silicification effect corresponds to Zone Ⅲ, and the area of strong argillization on the outer edges of that is Zone Ⅴ.

4)West bank of the Huai Kiang

This zone of alteration occurs in the hilly land hemmed in between the Huai Kiang marsh and the Huai Nam Sala river, on the eastern edge of the Survey Area. Here floats of quartz veins and silicified rock were observed. An area of strong silicification/strong argillization extends northwards along the ridge from the 470m peak on the eastern bank of the Huai Nam Sala, covering an area 250m wide and 500m long.On the outside of the area of strong silicification/strong argillization an area of weak silicification and strong argillization extends northwestwards along the ridge, and on the outside of that is an area of strong argillization. Of these areas of alteration, the central area of strong silicification and strong argillization corresponds to a band of Zone Ⅲ, the area of weak silicification outside that to a band of mainly sericite-kaolinite zone, and the outermost zone of strong argillization to a band of mostly Zone Ⅴ.

5)North of Mt. Doi Huai Nam Sala to southeast of Mt. Doi Kha La.

The zone of alteration occurs on top of the ridge that extends from north of Mt. Doi Huai Nam Sala, southeast of Mt. Doi Kha La, to the north of Mt. Doi Kiu Hok, and covers a long narrow area along the NE-SW fault which lies in roughly the same position. Floats of quartz vein and of silicified rock, and white argillization, were observed. An area of strong silicification/strong argillization occurs only over an area 100m wide and 500m long to the north of Mt. Doi Huai Nam Sala, but outside of that an area of weak silicification and strong argillization extends from north of Mt. Doi Huai Sala to the southeast of Mt. Doi Kha La, covering an area 300m wide and 1.8km long. In addition, an area of strong argillization covers a large area 600m wide and 3.5km long. The area of strong silicification and strong argillization and the area of weak silicification and strong argillization correspond to an area of mainly Zone Ⅲ, and the outer weakly silicified and strongly argillized area corresponds to an area of Zone Ⅳ.

6)Mt. Doi Huai Rong Bong.

The zone of alteration extends over a long narrow area northeastwards from Mt. Doi Huai Rong Bong on the western edge of the Survey Area, following the NE-SW fault which lies in roughly the same position. It is made up mainly of silicified rock, floats of silicified rock and white clay; very few veins of quartz were observed. A zone of strong silicification and strong argillization occurs in only narrow areas, near the peak of Mt. Doi Huai Rong Bong and to the ENE of the peak, but a zone of weak silicification and strong argillization extends over a long narrow area 300m wide and 2km long, northeastwards from Mt. Doi Huai Rong Bong. In addition, a zone of strong argillization covers an area 300m wide and over 3km long. The area of strong silicification and strong argillization and the area of weak silicification and strong argillization correspond to Zone Ⅲ, and the outer weakly silicified and strongly argillized part corresponds to Zone Ⅳ. The zone of alteration

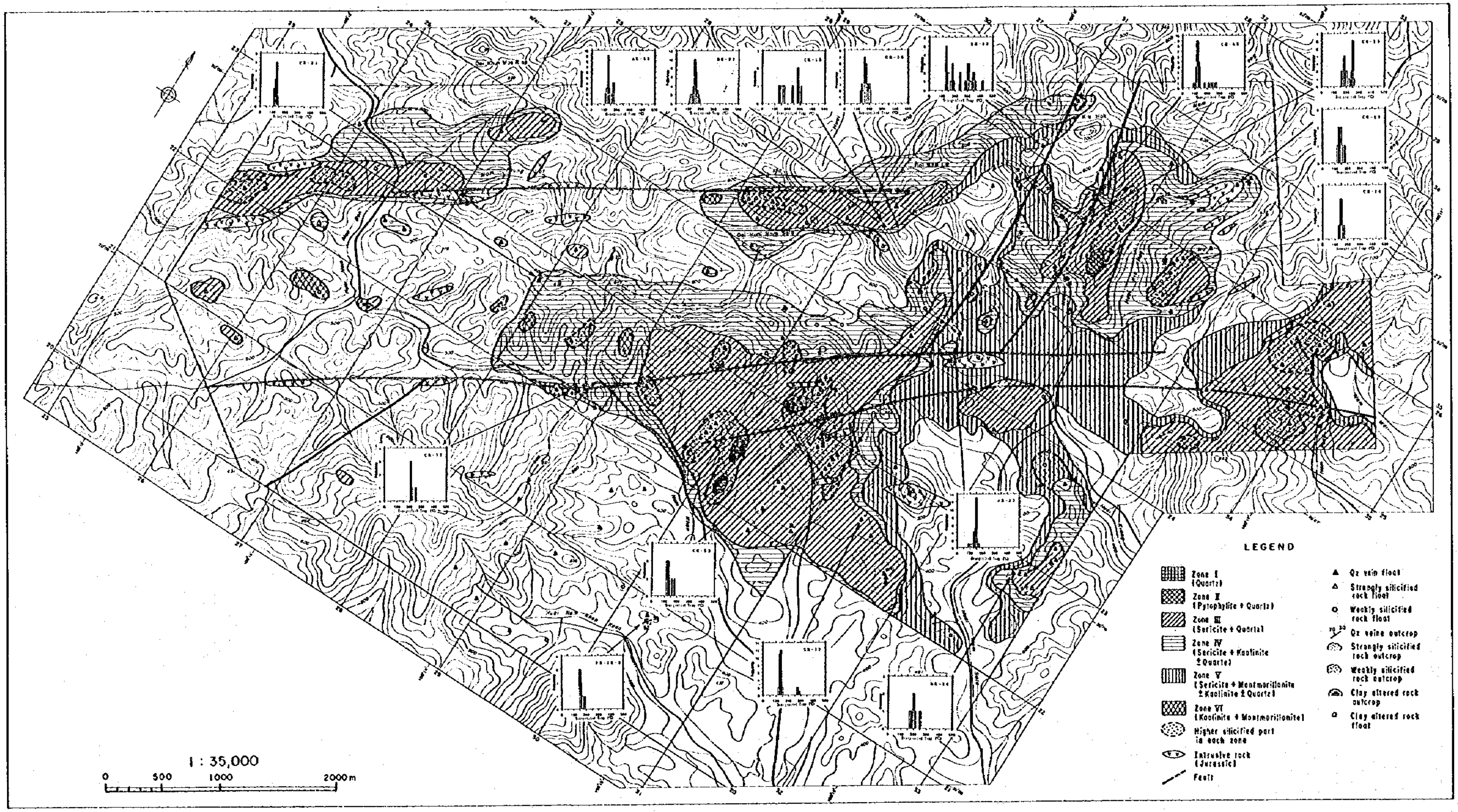


Fig. II-1-5 Alteration Map of the Survey Area

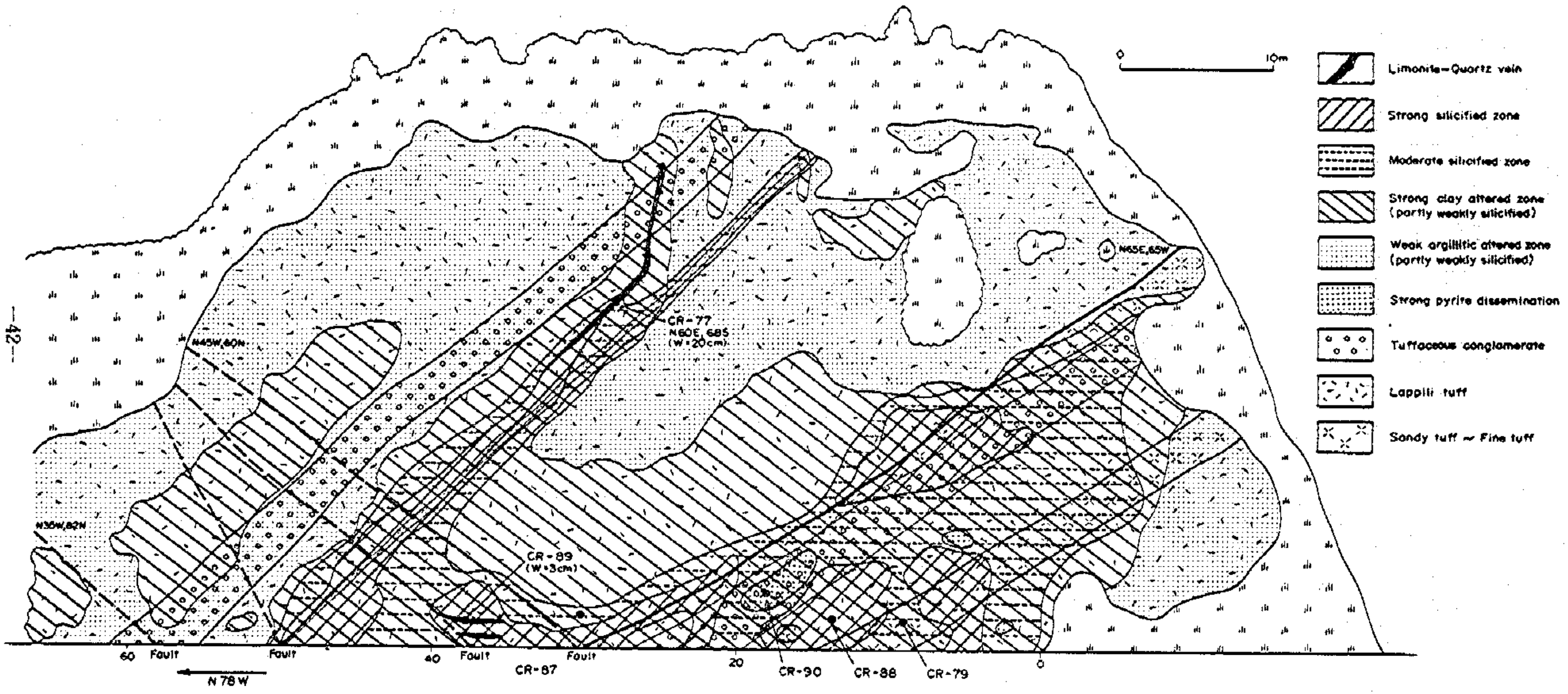


Fig. II-1-6 Sketch of Alteration Zone along the National Highway develops along the same NE-SW fault as does the zone of alteration from the north of Mt. Doi Huai Nam Sala to the southeast of Mt. Doi Kha La, and the two zones have similar patterns of alteration.

1-4 Ore Deposits and Mineral Occurrence

1-4-1 Ore Deposits and Mineral Occurrence

There are no metal mines with a history of production in the Survey Area.
Mineral occurenses found in the Survey Area were as follows:

1)Quartz veins

2)Strong silicification zone

3)Pyritization

4)Gossan

From the results of the geological survey the mineralization and mineral occurrence listed above were recognised in the alteration zones described in the preceding sections. Location map of mineral occurrence within the Survey Area are shown in Fig. II-1-7, and the results of ore analysis carried out on quartz veins, silicified rocks and their floats are shown in Appendix 6.

1)Huai Kiu Hok to Huai Kha La.

This mineral occurrence lies along the ridge and creek between Huai Kiu Hok and Huai Kha La, within the zone of alteration which extends along the ridge to the east of Huai Kiu Hok, and contains quartz veins, hard silicified rock and quartz vein floats. There is mainly underlain by andesite and andesitic tuff of Permian to Triassic ages that have undergone silicification and argillization; along by the marsh the geology is the Permian sedimentary rocks that have undergone partial alteration. The quartz vein on the ridge slope on the eastern bank of the Huai Kiu Hok has a width of 13cm with a strike and dip of N10° E, 90° ; the vein observed along the Huai Kha La, a width of 30cm and a strike and dip of N15° E, 90° ; the vein observed along the eastern tributary of the Huai Kha La, a width of 10cm and a strike and dip of N20° E, 50° W; the vein observed along the western tributary of the Huai Kiu Hok, a width of 10cm and a strike/gradient of N25° E, 65° E. The direction of strike of these quartz veins, N10° E to N25° E, is in harmony with the N-S fault that is developed in this area, and it is thought possible that these quartz veins were formed filling the tension fractures that developed in the N-S fault. Quartz veins occur frequently on the ridge sandwiched between the Huai Kiu Hok and the Huai Kha La, along the tributaries of the Huai Kha La and along the ridge to the east of the Huai Kiu Hok. Many of these quartz veins and quartz vein floats are accompanied by limonite that has changed from pyrite mineralization; they display a reddish-brown colouration overall, and are often accompanied by droze. In addition, gossan was observed in the silicified rock floats on top of the ridge 600m northeast of Doi Kiu Hok. Ore assay was carried out on these quartz veins, silicified rocks and their floats, and in the limonite-quartz vein float (AR-22) sample taken from the small creek on the eastern bank of the Huai Kha La, the results were: Au<0.005g/t, Cu=0.012%, Zn=0.04%. Thus Au was not detected, but the values for Cu and Zn were comparatively high, while the contents of As and Hg, the indicator elements for Au, were As=2,610ppm, Hg=8,440ppb, extremely high in comparison with other ore samples, indicating the possibility of the presence of Au mineralization nearby. Also a silicified rock float (HR-11) taken from the top of the ridge 600m northeast of Doi Kiu Hok showed a rather high value of Zn=0.043%. None of the other samples contained meaningful amounts of any of these elements.

2)Upper Nam Khon Kaen

This mineral occurrence lies within the alteration zone that extends over the hilly land in the upper reaches of the Nam Khon Kaen, and is made up of hard silicified rocks and a crowd of quartz vein floats. There is mainly underlain by andesite and andesitic tuff of Permian to Triassic age that has undergone silicification and argillization. In the upper reaches of the creeks that branch off in a NNE direction from the Nam Khon Kaen, many examples of hard silicified rock floats displaying a striped structure of 50cm to 1m width were observed; these display a khaki-reddish brown color, and some were observed to have droze reaching a width of 10 cm. The quartz vein floats have a vein width of 20 to 50cm. The quartz is coloured a reddish-brown and is accompanied by limonite changed from pyrite. In many of the veins droze is developed from several mm to 1cm. Quartz vein floats occur frequently over a wide area of the hilly land that extends over the upper reaches of the Nam Khon Kaen. Also, on the top of the ridge on the eastern bank of the upper reaches of the marshes that branch in a NNE direction from the Nam Khon Kaen, gossan and floats of quartz vein and silicified rocks were observed abundantly. Pyrite dissemination was observed in the strongly silicified/strongly argillized rocks distributed in the hilly land covering the upper reaches of the Nam Khon Kaen river. Ore assay was carried out on these floats of quartz vein and silicified rock, and the results for quartz vein floats from the upper reaches of the marshes branching off in a NNE direction from the Nam Khon Kaen were, in sample CR-53, Au=5.63g/t; in sample CR-54, Au=0.01g/t; for silicified rock floats the results were, in sample CR-50, Au=0.995g/t, in each case clearly indicating mineral occurense. In sample CR-53 results for the indicator elements of Au were extremely high at As=5,530ppm, Hg=10,630ppb, and in sample CR-50 the values were rather high in comparison with other samples, at As=96ppm, Hg=70ppb. As for other elements, Zn displayed comparatively high values, with 0.027% in sample CR-53 and 0.12% in sample HR-80; values for Ag were in themselves low, but significantly high in samples in which the Au content was high; in sample CR-53, Ag=3.6ppm, and in sample CR-50, Ag=1.8ppm. This may be considered to indicate a connection with Au mineralization in this area.

3)West bank of the Nam Khon Kaen

This mineral occurrence is situated on the west bank of the Nam Khon Kaen river. There is mainly underlain by Permo-Triassic andesite, and there is no wide-scale alteration, only local pockets of alteration. However, the occurrence of quartz veins, strongly silicified rocks and quartz vein floats are widespread. A quartz vein is found on the top of the hilly land sandwiched between the Khon Kaen and the Huai Nam Khon Kaen , with a width of 8 cm and a strikeand dip of N35° E,52° E. As for the quartz vein floats, those found in the upper reaches of the Huai Nam Khon Kaen are milky-white quartz and are accompanied by red to reddish-brown limonite, while in those found around the Khon Kaen river the quartz has a reddish-brown to orange colouration and is accompanied by pyrite dissemination, reddish-brown limonite and geode. Ore analysis was carried out on these quartz veins and their floats, but the results showed no elements present in meaningful amounts.

4)Upper reaches of the Nam Pong Ngao.

This mineral occurrence is situated in the zone of alteration that spreads out over the hilly land in the upper reaches of the Nam Pong Ngao , on the eastern edge of the survey area. There is mainly underlain by welded tuff, with widespread alteration. Outcrops of silicified rocks and quartz veins, quartz vein floats and silicified floats were observed, but the quartz veins were few in number, with a width of only 5cm to 10cm, and the quartz was white to pale green or pale brown. An outcrop of quartz vein was observed at a point 500m west of the 662m peak in between the upper reaches of the Nam Pong Ngao and the Huai Kiang; this had a width of 5cm and a strike and dip of N30° E, 90° , roughly the same as that of the quartz vein observed in the Huai Kiu Hok·Huai Kha La area. The strongly-silicified altered rocks showed a white to lilac colouration, and were hard. Ore assay of these silicified rock floats was carried out, and the results obtained were: samples GR-20, GR-21, silicified rocks from the upper reaches of the Nam Wai river, showed signs of Au, although small in quantity, with Au=0.02g/t; and in the indicator elements for Au, rather higher values were obtained in comparison with other samples: in GR-20, As=80ppm, Hg=160ppb; in GR-21, As=52ppm.

5)West bank of the Huai Kiang .

This mineral occurrence is situated in the zone of alteration in the hilly land sandwiched between the Huai Kiang and the Huai Nam Sala , on the eastern edge of the Survey Area, and here floats of silicified rocks and quartz veins were observed. There is underlain by rhyolitic welded tuff which has undergone strong silicification and strong argillization. Many floats of quartz vein were observed on the peaks of the hilly land between the Huai Kiang and the Huai Nam Sala river, but these had a width of only 5cm to 10cm and displayed a white to pale brown colouration. Some were accompanied by limonite turned from pyrite. Ore assay was carried out on these quartz vein floats, but the results show no elements present in meaningful amounts.

6) Doi Huai Nam Sala to Doi Kha La.

This area is situated in the zone of alteration that stretches from north of Mt. Doi Huai Nam Sala, southeast of Mt. Doi Kha La to north of Mt. Kiu Hok, in particular the area from north of Mt. Doi Huai Nam Sala to southeast of Mt. Doi Kha La, where the silicification is strong. There is mainly underlain by andesite of Permian to Triassic age and sedimentary rocks of Permian age. No outcrops of quartz vein or silicified rock were observed, but floats of quartz vein and hard silicified rock occur frequently in bands in the area from north of Mt. Doi Huai Nam Sala to southeast of Mt. Doi Kha La. Along the creek, the north of Doi Huai Nam Sala many quartz veins with a width of 20cm to 50 cm, and floats of strongly silicified rocks with a width of 50cm to 1.5m, were observed. The silicified rocks are extremely hard, reddish-brown to khaki in colour, and accompanied by limonite. In the quartz vein float ores the quartz is white in colour, with reddish-brown limonite in grain boundaries. In the southest of Mt. Doi Kha La mainly floats of quartz vein occur, with a maximum vein width of 16cm and accompanied by droze with a width of 5mm. The quartz is reddish-brown in colour, and in addition to accompaniment by limonite turned from pyrite, pyrite dissemination was also observed. Ore assay was carried out on these floats of silicified rock and quartz vein, but the results show no elements present in meaningful amounts.

7) Doi Kiu Hok.

This area is situated in the zone of alteration east of Mt. Doi Kha La, and is made up of floats of quartz vein and silicified rock, and white clay. There is mainly underlain by Permo-Triassic andesitic rocks, with some occurence of Permian sedimentary rocks. The quartz vein floats observed on the southwest slopes of Mt. Doi Kiu Hok have a width of 6cm; the quartz is white in colour, with sericite and reddish-brown limonite from pyrite mineralization occurring between the grains. Also, the quartz vein float observed on the ridge 700m east of Mt. Doi Kha La has a width of 20cm; the quartz is reddish-brown in colour and is accompanied by limonite from pyrite mineralization. Ore assay was carried out on these quartz veins, but the results show no elements present in meaningful amounts.

8)Doi Huai Rong Bong.

This area is situated in the zone of alteration that covers a long narrow strip northeastwards from Doi Huai Rong Bong, on the western edge of the Survey Area, and is made up mainly of silicified rocks, silicified rock floats, quartz vein floats and white clay. The geology is andesite of Permian to Triassic age and Jurassic intrusive rocks ; the andesite of Permo-Triassic ages has undergone strong silicification and strong argillization, but the Jurassic intrusive rocks have undergone no alteration. Silicified rocks occur around the peak of Doi Huai Rong Bong and ENE of the peak; these are extremely hard and are pale brown to reddish-brown in colour. Large amounts of pyrite dissemination are frequently observed. In the quartz veins the quartz has a white to pale brown color, and is accompanied by limonite. Ore assay was carried out on these silicified rocks, but the results show no elements present in meaningful amounts.

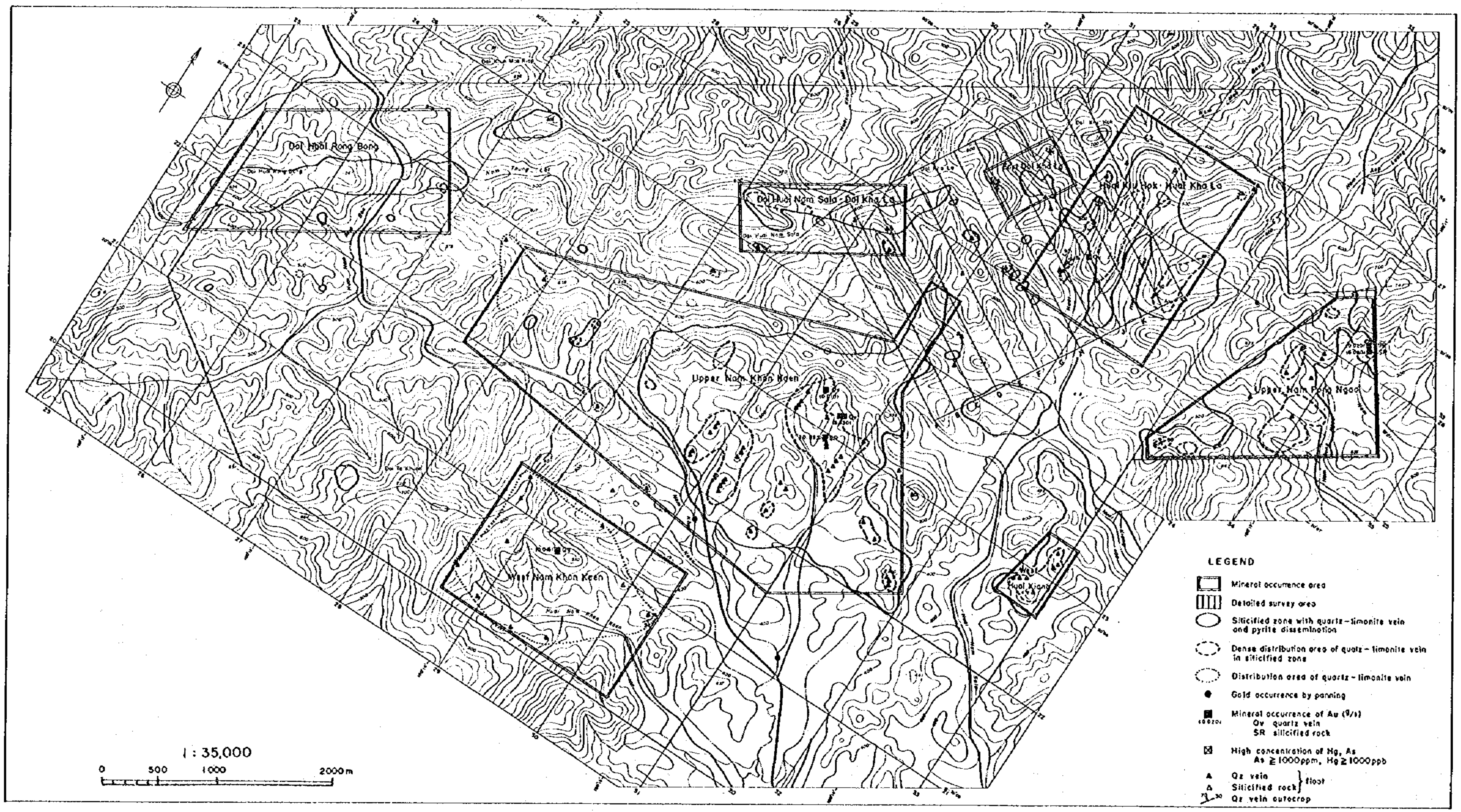


Fig. II-1-7 Mineral Occurrence in the Survey Area

1-4-2 Filling Temperature of Fluid Inclusion

To clarify the charactaristics of mineral occurance of survey area, it is important for us to know the crystallization temperatures of their quartz vein.

Because of this reason, We measured the filling temperatures of fluid inclusions in the quartz veins (17 samples) from which we have made ore assay analysis.

We use the microscopic with heating-cooling stage (TH600RH) and controller which were made by Linkam Co.Ltd in England. The ascending rates of temperature were 40°C/min. and 4°C/min.. We have measured homogenization temperatures seeing not to inclease volume because of over-heating and occur partial decrepitations.

Most of fluid inclusions were smaller than 10 μm in diameter and some of them had Brown movement in normal temperature. The fluid inclusions which were measured existed in quartz grains at ramdom.

Most of fluid inclusions had two phase, liquid phase and gas phase which was much smaller than liquid phase, but we also observed another type of fluid inclusions which had only liquid phase or had solid phase (daughter minerals) in liquid phase. We measured homogenization temperatures in one sample (DR-03) that had fluid inclusions mainly composed of gas phase, and its homogenization temperature was 450°C.

The fliud inclusions which were measured almost showed white color or colorless, but some of them showed black color or shadow.

For the sample FR-08, fluid inclusions are so small that we can not measure its homogenization temperatures.

Histograms of homogenization temperatures are shown in Fig. II-1-8 and values of measurement are shown in Table II-1-1. The distribution of homogenization temperatures in survey area is shown in Fig. II-1-5.

Among 16 samples which are measured, 8 samples have the peaks of homogenization temprERATures in the range from 140℃ to180℃, then it showed that those quartz veins were formed relatively at low temperatures. It is not inconsistent with the observation which druses are developed in the quartz veins and growing idiomorphic quartz grains. As concerning on the other 4 samples (CR-15,CR-43,DR-03,GR-32), they have bimodal distributions with two peaks of homogenization temperatures which are at around 150℃ and in the range from 200℃ or 300 to 350℃. These samples are quartz vein which occured around the boundaries of Permian basements and Permo-Triassic volcanic rocks. Under the microscope, it can be observed that the fluid inclusions are primary and the differences of occurrence were not observed. Considering the fact that DR-03 has some fluid inclusions composed of gas phase, it may show the possibility of that hydrothermal fluid was boiling when it moved from the hard basements to more vesicular tuffs. The temperature of hydrothermal fluid in boiling was estimated at 150℃, which is almost the same as the peaks of the homogenization tempratures. The homogenization temperatures of sample CR-53 ,which shows highest Au content in ore assay, is disributed in the range from 120℃ to 180℃ (peak is at around 120-130℃). The temperatures are lower than those of common Au ore deposits.

Since among 16 samples, 12 samples have low homogenization temperarure which is lower than 150℃, it is suggested that the temperatures of hydrothermal fluid near surface in the survey area was at around 150℃. The homogenization temperatures of another 4 samples show a little higher than those of formers. The homogenization temperature of GR-05 is 160-210℃, HR-38 is 170-250℃, CR-18 is 160-260℃, CR-77 is 210-250℃. As GR-05 and CR-18 are located near the samples of low homogenization temperatures and which have evidences of boiling occured, it may be possible to have existed hydrothermal fluid of high temperature which has been at around 200℃ there. The sample of HR-38 is derived from the alternation zone of the welded tuff in the eastern part of the survey area, and it has higher homogenization temperatures than those of the other alternation zones. As it takes under consideration that the alternation zone is accompanied with the anomalies of Pb and Zn (mentioned after), It is suggested that this alternation zone was formed by higher hydrothermal fluid than those which the other alternation zones were formed. CR-77 was taken from the altered outcrop(Fig II-1-6), which is located on the crest of the national road, the sample is the white quartz at the central part of limonite-quartz vein.The outcrop closely near the quartz vein is altered strongly, around the outside of strongly altered zone, however, alternation become weak radically. This outcrop is located on the extension of the fault which passes across the widespread and strongly silicified sericite-quartz zone in the survey area, it is considered that a little higher hydrothermal fluid went up along the fissures and formed the quartz vein.

Table II-1-1　Homogenization Temperature of Fluid Inclusions

Sample No.		Tested Num	Result	Count No	Avg. (℃)	D iviation (℃)	Mode (℃)
1	AR-33	quartz	success	28	139.6	92 - 165	150
2	AR-40	quartz	success	23	137.2	108 - 171	130
3	BR-02	quartz	success	32	150.3	109 - 186	150
4	CR-15	quartz	success	10	213.4	126 - 292	
5	CR-18	quartz	success	21	212.0	157 - 263	250
6	CR-21	quartz	success	11	124.7	111 - 140	150
7	CR-24	quartz	success	8	146.3	127 - 170	140-150
8	CR-27	quartz	success	8	142.9	122 - 175	
9	CR-43	quartz	success	28	141.0	94 - 268	140
10	CR-53	quartz	success	7	138.1	117 - 176	
11	CR-77	quartz	success	5	219.8	207 - 249	210
12	DR-03	quartz	success	31	237.2	126 - 418	150
13	DR293	quartz	success	7	162.4	148 - 193	150
14	FR-08	quartz	failure				
15	GR-05	quartz	success	31	169.0	130 - 207	160
16	GR-32	quartz	success	31	153.8	123 - 294	140
17	HR-38	quartz	success	6	200.2	173 - 246	200

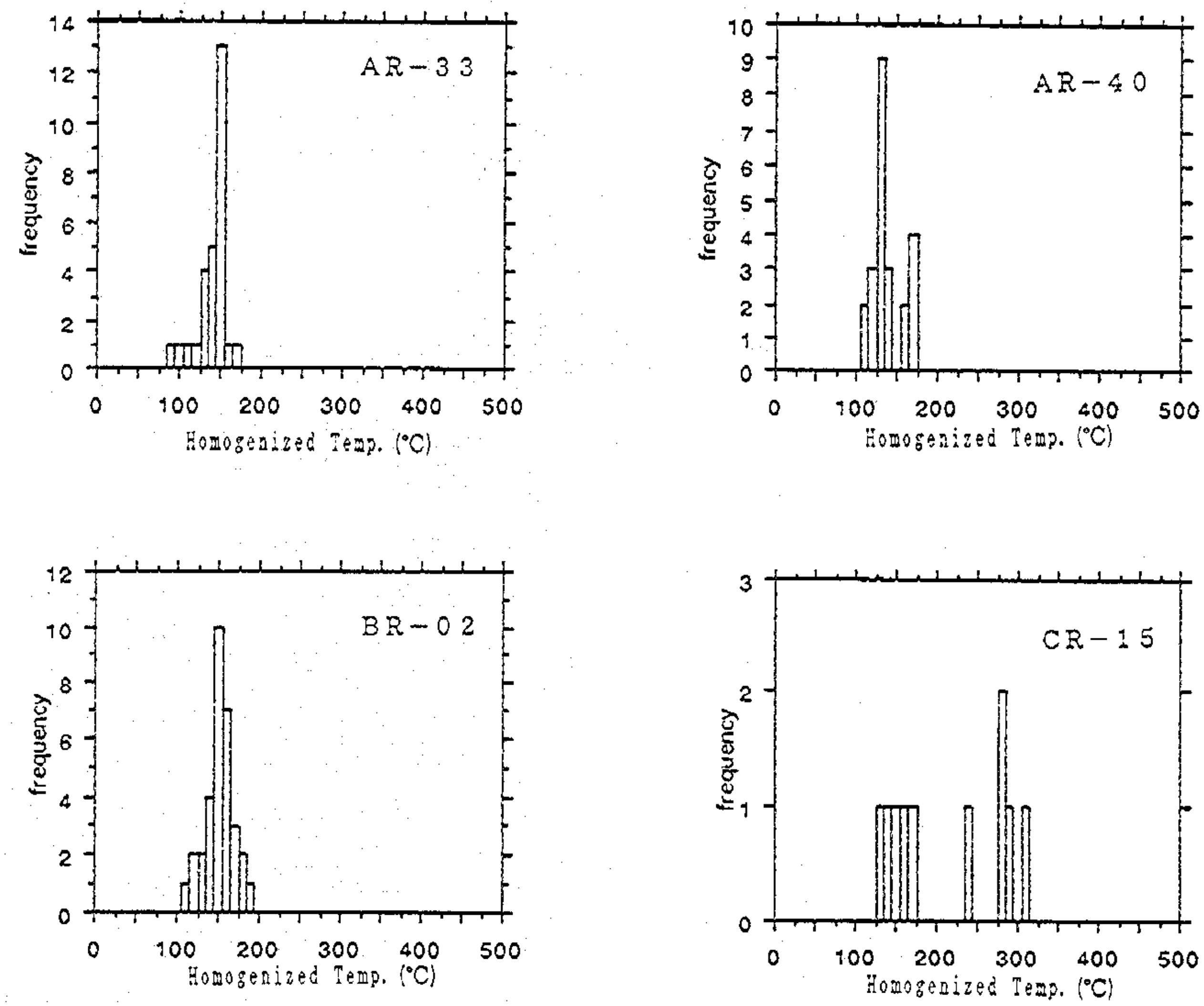


Fig. II-1-8 Frequency Distribution of Homogenization Temperature(1)

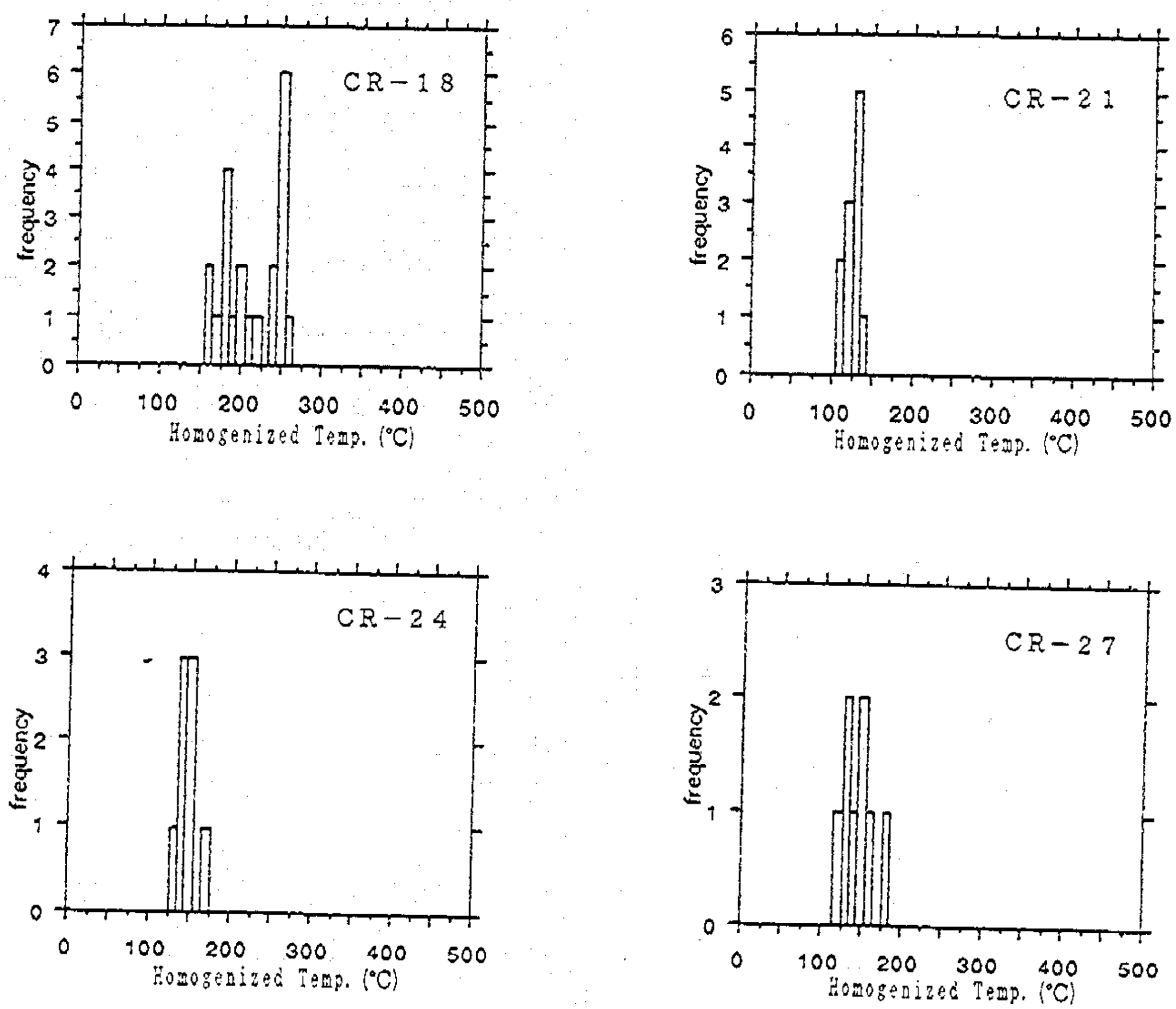


Fig. II-1-8　Frequency Distribution of Homogenization Temperature(2)

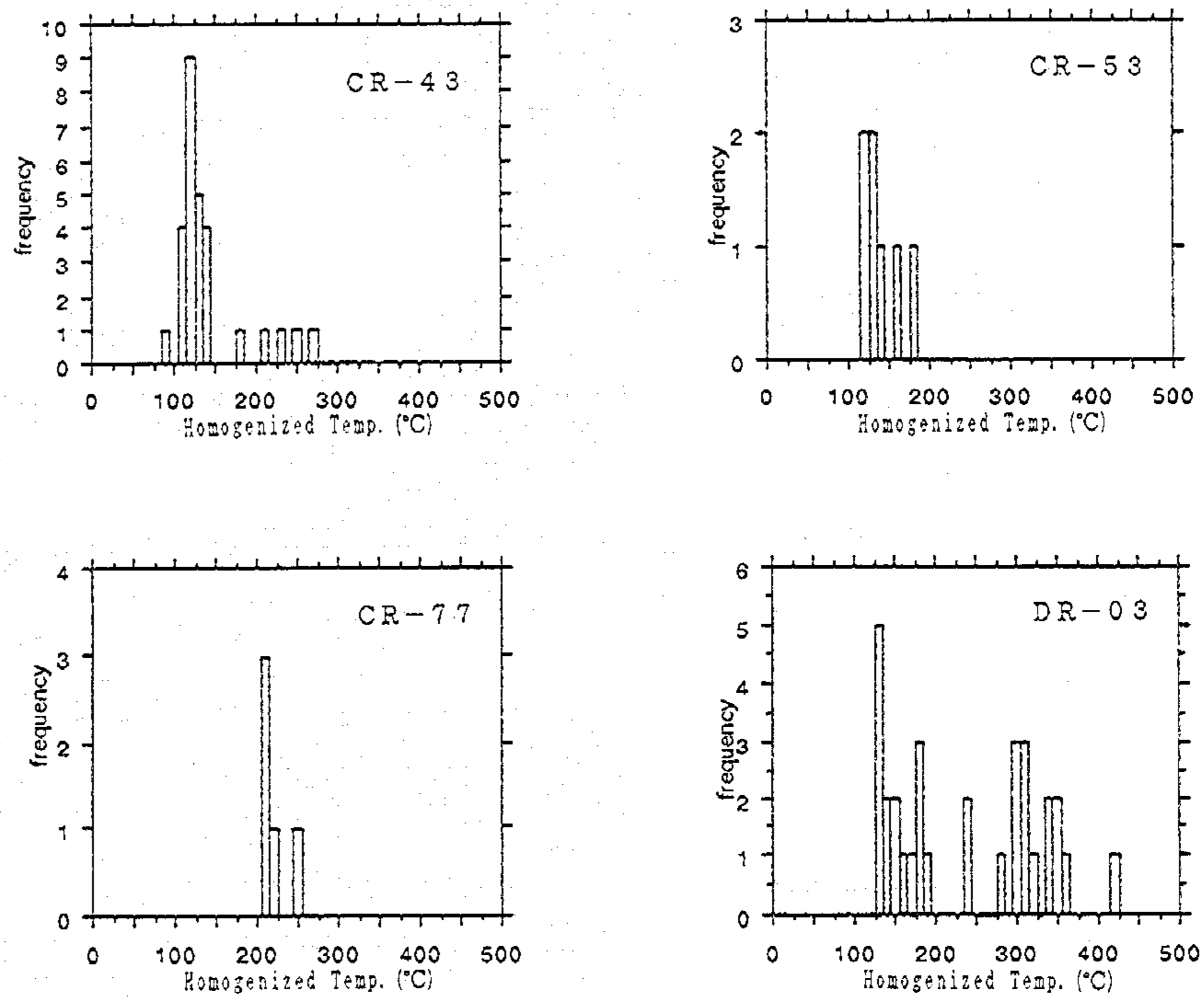


Fig. II-1-8 Frequency Distribution of Homogenization Temperature(3)

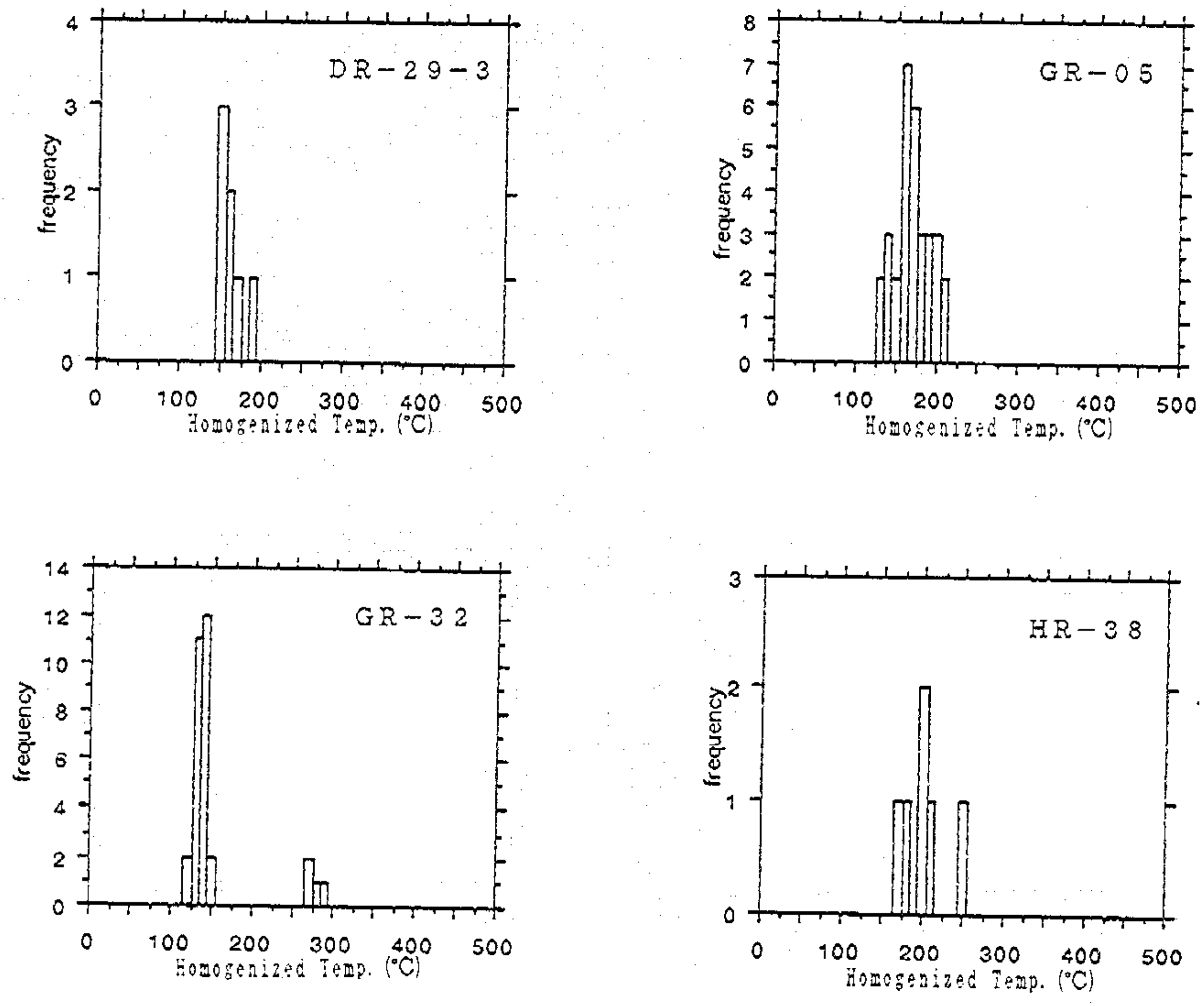


Fig. II-1-8　Frequency Distribution of Homogenization Temperature(4)

1-5 Results of Geochemical Investigation

From the results of the survey carried out last year it was ascertained that geochemical anomalies in Au, Hg and Cu occur in stream sediments in the survey area, and also that gold flake was discovered in several areas by panning.

Since the above-mentioned geochemical anomalies are anomalous values obtained from stream sediments and this does not necessarily suggest anomalies in the spot where the samples were actually taken. For this reason, in this year, soil geochemical survey was carried out using the ridge and Spur method, the aim being to extract the original anomalous zone and to assess their potential.

In particular, in the upper reaches of the Huai Nam Sala, where gold flake by panning was observed and where geochemical anomalies in Au and Hg occur, a detailed zonewas set up, with 13 profile lines 2 km long and spaced 200m apart, and an investigation was carried out aimed at extracting places with gold mineralization, in combination with a resistivity investigation using the CSAMT method.

From the results of last year's survey, nine elements were treated as indicator elements, namely, Au, Ag, Cu, Pb, Zn, Hg, Sb, As and S. The number of soil samples taken was 533 at 50m intervals on the physical investigation profile lines in the detailed zone, plus 449 at roughly 250m-300m intervals along the ridge, a total of 982 samples. The locations from which the soil samples were taken are shown in the Appendix 11.

1-5-1 Statistical Analysis

The analysis was carried out separately, for the whole Survey Area and for the detailed zone; for the whole Survey Area data from all 982 samples were used, including those taken from the detailed zone, while for the detailed zone 604 samples were used, including those taken around the detailed zone.

In this analysis, analytic values below the detection limit were taken to be half the detection limit value, and analyzed as a common logarithm.

The maximum, minimum and average values for each element and standard deviation are shown separately, for the whole Survey Area and for the detailed zone, in Table Ⅱ-1-2.

With regard to the maximun values for each element, except the values for Au and Pb which are higher in the detailed zone, other elements show higher values outside the detailed zone. However, there is little difference in the average values, and some elements, such as Hg, were observed to be higher in the detailed zone.

Table Ⅱ-1-3 and Table Ⅱ-1-4 show the correlation coefficients for each indicator element in the whole of the Survey Area and in the detailed zone. In each result there are no elements showing a strong correlation coefficient, either positive or negative, but throughout the whole of the Survey Area Au-Ag-As-Sb, As-Hg-Pb-Sb show a positive correlation. The correlativity of the latter becomes stronger in the detailed zone, and to these four elements is added Cu. A weak negative correlativity was observed for Sb-Zn. In many samples Ag and S had less than detectable values, and their correlativity with the other elements is extremely low.

Table II-1-2 Basic Static Value of Soil Samples

	Au(ppb)	Ag(ppm)	As(ppm)	Cu(ppm)	Hg(ppb)	Pb(ppm)	Sb(ppm)	Zn(ppm)	S (%)
Whole Area (N=982)									
Maximum	140	0.6	420	144	7630	80	36	125	0.11
Max. Log	2.1461	-0.2218	2.6232	2.1584	3.8825	1.9031	1.5563	2.0969	-0.9586
Minimum	<1	<0.02	<0.2	0.2	<10	0.5	<0.2	<1	<0.01
Min. Log	-0.3010	-2.0000	-1.0000	-0.6990	0.6990	-0.3010	-1.0000	-0.3010	-2.3010
Average	1.9353	0.0219	6.2521	15.3838	132.1792	17.2010	1.5486	36.9262	0.0109
Ave. Log	-0.0225	-1.7385	0.5198	1.0105	1.9025	1.2054	-0.2650	1.5013	-1.9871
Std. Div Log	0.3874	0.2262	0.5159	0.3741	0.3755	0.1673	0.6274	0.2587	0.1404
Detailed Survey Zone (N=604)									
Maximum	140	0.1	106	52.6	1790	80	22.2	111	0.11
Max. Log	2.1461	-1.0000	2.0253	1.7210	3.2529	1.9031	1.3464	2.0453	-0.9586
Minimum	<1	<0.02	<0.2	0.2	<10	6.5	<0.2	2	<0.01
Min. Log	-0.3010	-2.0000	-1.0000	-0.6990	0.6990	0.8129	-1.0000	0.3010	-2.3010
Average	2.0174	0.0202	5.7601	10.7717	146.3328	16.9958	1.1788	37.4685	0.1176
Ave. Log	-0.0194	-1.7446	0.5179	0.9726	1.9803	1.2110	-0.3728	1.5174	-1.9610
Std. Div Log	0.3935	0.2007	0.5293	0.2382	0.3688	0.1250	0.6131	0.2375	0.1349
Out of DetailedSurvey Zone									
Maximum	49	0.6	420	144	7630	74	36	125	0.02
Max. Log	1.6902	-0.2218	2.6232	2.1584	3.8825	1.8692	1.5563	2.0969	-1.6990
Minimum	<1	<0.02	<0.1	0.2	<10	<1	<0.2	<1	<0.01
Min. Log	-0.3010	-2.0000	-1.0000	-0.6990	0.6990	-0.30103	-1.0000	-0.3010	-2.3010
Average	2.0174	0.0202	5.7601	10.7717	146.3328	16.9958	1.1788	37.4685	0.1176
Ave. Log	-0.0049	-1.7331	0.4907	1.0121	1.7896	1.1886	-0.0818	1.4719	-2.0261
Std. Div Log	0.3981	0.2549	0.5310	0.4980	0.3496	0.2110	0.6301	0.2834	0.1391

Table II-1-3 Geochemical Correlation Coefficients of Whole Area

	Au	Ag	As	Cu	Hg	Pb	Sb	Zn	S
Au	1.0000								
Ag	0.2263	1.0000							
As	0.2881	0.1605	1.0000						
Cu	0.0748	0.0444	0.1525	1.0000					
Hg	0.0106	0.0375	0.2618	0.0637	1.0000				
Pb	-0.0248	0.2226	0.2614	-0.1173	0.0396	1.0000			
Sb	0.4128	0.0118	0.3452	0.0289	0.0926	-0.0521	1.0000		
Zn	-0.0749	0.1266	-0.0905	0.2491	-0.0867	0.0570	-0.2749	1.0000	
S	0.0419	0.0978	0.0082	0.0547	0.2796	-0.0334	-0.0562	0.0812	1.0000

Table II-1-4 Geochemical Correlation Coefficients of Detailed Survey Zone

	Au	Ag	As	Cu	Hg	Pb	Sb	Zn	S
Au	1.0000								
Ag	0.2860	1.0000							
As	0.2850	0.1696	1.0000						
Cu	0.1460	0.0359	0.3531	1.0000					
Hg	0.0211	0.0259	0.3525	0.1198	1.0000				
Pb	-0.0633	0.1686	0.3099	-0.0470	0.0507	1.0000			
Sb	0.4806	0.1082	0.4302	0.0981	0.2726	-0.0086	1.0000		
Zn	-0.0809	0.1582	-0.1995	0.1509	-0.1761	0.0667	-0.3004	1.0000	
S	0.0394	0.0946	0.0578	-0.0420	0.2218	-0.0314	-0.0598	0.0587	1.0000

1-5-2 Determination of Threshold Values

A variety of methods for determining anomalous values of geochemical data and threshold values to divide the background may be considered, as shown by Lepeltier (1969), Sinclair (1976) and Govett et al. (1983); eg., using the natural breaks in cumulative frequency distribution, using the break point in the cumulative frequency distribution curve, using average values and standard deviation, using the percentage order of the cumulative contribution rate, etc.

For the resent analysis, the threshold values were determined mainly on the basis of average values and standard deviation, with additional consideration of the cumulative frequency distribution curve and percentage order. Fig. II-1-9.1 shows the frequency distribution/cumulation frequency curve for the whole Survey Area, and Fig. II-1-9.2 shows those for the detailed area. Table II-1-5 shows the threshold values for each indicator element. With regards to S, since very many of the samples (over 90%) had values below the detection limit, with even maximum values close to the limit and high values distributed in scattered patterns, no threshold values in particular were set up, nor was a distribution chart drawn up.

For each threshold value, hardly any significant disparity was observed between the whole Survey Area and the detailed zone.

Table Ⅱ-1-5 Division into Geochemical Anomaly

	Whole Area		Detailed Survey Zone	
Au (ppb)	M+ 2 σ	5.65	M+ 2 σ	5.86
Ag (ppm)	M+ 2 σ	0.052	M+ 2 σ	0.045
As (ppm)	M+1.5 σ	19.66	M+1.25 σ	15.12
Cu (ppm)	M+1.5 σ	37.29	M+1.5 σ	21.38
Hg (ppm)	M+1.5 σ	292.23	M+1.5 σ	341.54
Pb (ppm)	M+1.5 σ	28.60	M+1.5 σ	24.63
Sb (ppm)	M+1.5 σ	4.74	M+1.5 σ	4.81
Zn (ppm)	M+1.5 σ	77.51	M+1.5 σ	65.21

1-5-3 Distribution of Zones of Anomaly

Anomalous value distribution charts for each indicator element were drawn up on the basis of Table Ⅱ-1-5 (Fig. Ⅱ-1-10.1 to Fig. Ⅱ-1-10.16). The distribution of anomalous values for each element are described below.

[Au]

In terms of the whole Survey Area, almost all of the high anomalouszones of Au are distributed in the eastern half of the Survey Area, which includes the detailed zone, and occur in the ridge areas which surround the zones of geochemical anomaly of stream sediment extracted in Phase I of the Survey. In addition to this a small anomalous zone was observed on Mt. Doi Ta Khuan in the southern part of the Survey Area.

These high anomalous zones overlap the distribution area of welded tuff and andesitic tuff of Permo-Triassic age. As for the relation between these high anomalous zones and alteration zones, those distributions match that of alteration zones Ⅳ to Ⅵ; it does not necessarily match strong silicified area, but does match the edges of the strongly silicified areas.

There is little regulation by the NE-SW fault deduced from the geological survey; the anomalous zone stretches out in a N-S direction, and it is thought to be regulated by the N-S fault.

In the detailed zone, anomalous zones continue on the NE side from point 0m on Line A, points 0m to 150m, 250m to 400m on Line I, point 350m on Line K, points 150m and 400m to 450m on Line

L, points 100m to 450m on Line M. The anomalous zone near the starting points of Line H and Line I continues southwards along the Huai Kiang creek. Except for the anomalous values on points 250m to 400m on Line I and on Line L, the anomalous values occur on the ridge and it can be judged that they show the geochemical anomalies of the locations where the samples were actually taken. The anomalous values on points 250m to 400m on Line I are anomalous values from the bottom of the slope to the marshy low ground, and may possibly be anomalous values diffused from the direction of Line J. The anomalous values on Line L are anomalous values on creek, and show the possibility of diffused anomalous values from the terrace deposits or from the direction of Line M.

[Ag]

The maximum value for Ag is no more than 0.6ppm, which is not a value that can be called anomalous; but with regard to the scope of values above the threshold value, especially high values are distributed in the upper reaches of the Nam Wai and Nam Pong Ngao in the northeast part of the Survey Area, and on the presumed fault in the upper reaches of the Huai Nam Mae Bon in the southwest part of the Survey Area, in addition to which anomalous values of 0.03 to 0.04ppm occur in a scattered pattern.

In the detailed zone, a value of 0.1ppm was obtained only on point 0m on Line A; elsewhere anomalous values of 0.04 to 0.06ppm occur in a scattered pattern. There are some samples on point 0m on Line A and Line I in which there is overlapping with the anomalous values for Au.

[As]

A high anomalous zone in As occurs overlapping a sericite-quartz alteration zone in the area of welded tuff distribution in the eastern part of the Survey Area. Also, in the western part of the Survey Area an anomalous zone occurs overlapping a sericite-quartz alteration zone accompanied by pyrite dissemination. The distribution of concentrations above the average value shows continuity in a N-S direction, and anomalous values occur not only in the Permo-Triassic andesitic rocks but also in the Permian sedimentary rocks. It is observed that the high anomalous zones tend to occur accompanying alteration Zone Ⅳ.

In the detailed zone, high anomalous zones occur at point 0m on Line A and Line B, around the starting point and points 1700m to 1800m on Line C, at ending point on Line E and Line F, at points 250m to 400m on Line G, around the starting point and point 1600m on Line I, at points 200m to 400m and 1300m on Line M. As for the distribution area of concentrations above the average value, four bands running in a N-S direction are observed, namely, from the west, a band from point 1700m on Line B to the end points on Line E and Line F, a band from point 450m on Line A through point 1000m on Line C to point 1600m on Line I, a band stretching the starting point of Line B and Line C through point 300m on Line G to point 1300m on Line M; and a band from the starting point of Line I to point 200m on Line M. The easternmost band matches the anomalous zone for Au, and the two bandsin the center match an anomalous zone for Hg which is described later. The second band from the east more or less matches the presumed N-S fault. This suggests the possibility of the existence of a fault in the same location as the second band from the west.

[Cu]

The maximum concentration of Cu is 140ppm, not much different from the 100ppm which is the average content of Cu in basalt or soil. Anomalous Zones of Cu occur widely in the western part of the Survey Area, the distribution more or less matching the range of distribution of basalt to basaltic andesite displaying a porphyritic texture. In the eastern part of the Survey Area, anomal zones occur in relatively weak alteration area in the distribution area of welded tuff.

In the detailed zone, the maximum value is no more than 53ppm, and along the starting points of the profile lines anomalous zone occurs in the weakly-altered to unaltered zone around the anomalous values for Au. At the end of the profile lines, values higher than average were observed in a range similar to the distribution of andesite which occurs in the ridge areas.

[Hg]

Anomalous values for Hg are distributed in the eastern part of the Survey Area as same distribution area as the values for Au. There are also high anomalous values spotted around the upper reaches of the Huai Nam Khon Kaen in the southern part of the Survey Area, as well as scattered occurences of anomalous values of 300-400ppb. The highest anomalous value within the Survey Area (7630ppb and 2150ppb) occurs on the right bank of the Nam Pong Ngao river in the eastern part of the Survey Area. These anomalous values are distributed along the edge of the strongly-silicified alteration Zone Ⅳ.

In the detailed zone, at point 0m on Line A, there are anomalous values which overlap anomalous values for Au, As, Ag, etc.

From around point 200m on Line E to point 800m on Line M, high anomalous zone continues in a N-S direction and overlaps an anomalous zone for As. This anomalous zone spreads out along the eastern side of the N-S fault, and more or less matches the alteration zone that occurs along this fault. In the area from point 450m on Line A through point 1000m on Line C to point 600m on Line I, concentrations of higher than average value occur continuously in the same way as for As. On Line F and around the end of Line G in this area, high anomalous zone was observed. These anomalous zones are accompanied by alteration zone that spread in a NE-SW direction around the end of the profile lines.

[Pb]

Anomalous values for Pb occur frequently in the eastern half of the Survey Area, and on the western side there are scattered occurrences of anomalous values of around 30ppm. On the southeastern edge of the Survey Area there are concentrations of anomalous values of 30-40ppm, and these are similar to the occurrences of unaltered andesitic lava. On the eastern edge of the Survey Area, anomalous zones were observed corresponding to the strong silicification areas of welded tuff that has undergone sericite-quartz alteration.

In the detailed zone, high anomalous values of over 60ppm occur at the end of Line F; this area is situated in the boundary between Permian sedimentary rocks and Permo-Triassic volcanic rocks, and argillization alteration accompanied by weak silicification was observed. As for anomalous values in other locations, anomalous values of 30-40ppm around the starting point of Lines B and C overlap the anomalous zone for As; in the area from point 450m on Line A through point 1000m on Line C to point 1600m on Line I there is a scattering of anomalous values that matches the areas with high concentrations of As and Hg. In the area on Lines G to M, however, where high anomalous zone in Au, Hg and As occur, concentrations of Pb are conversely low.

[Sb]

Areas with high concentrations of Sb occur in accompaniment to the occurence of the alteration zone that continues from the central to the eastern part of the Survey Area. Anomalous zones occur in and around the strongly silicified part of this zone of alteration. These anomalous zone display a greater expansion than that of other elements, but they spread from the strongly silicified part of the ridge area towards the bottom of the marsh, and it is judged that the anomalous zones have spread through secondary diffusion.

In the detailed zone, anomalous zones occur more or less overlapping the anomalous zones for Au at point 0m on Line A and on the side of starting point of Lines G to M.

[Zn]

The maximum values for Zn, like those for Cu, do not differ greatly from the average content within the Survey Area. Areas with concentrations of Zn higher than the average value occur in harmony with the distribution of andesite and basalt lavas and dikes; they derive from the weathered products of these rocks, and are thought to show the extent of their distribution. On the eastern edge of the Survey Area, an anomalou zone was also observed in the distribution area of altered welded tuff. These anomalou values have a distribution similar to that of the anomalous values for Cu in this area.

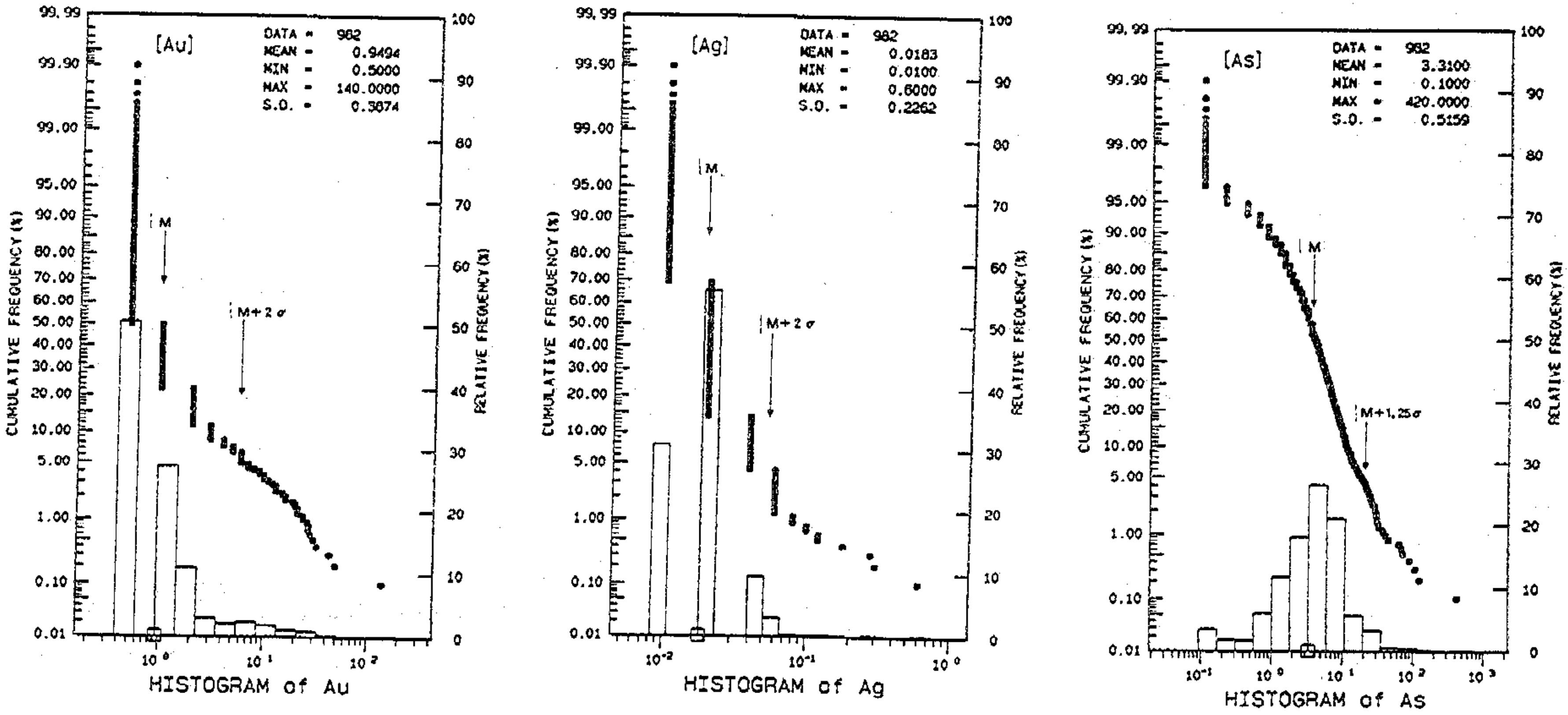


Fig. II-1-9.1(1) Relative Frequency and Cumulative Frequency Histogram (Whole Area)

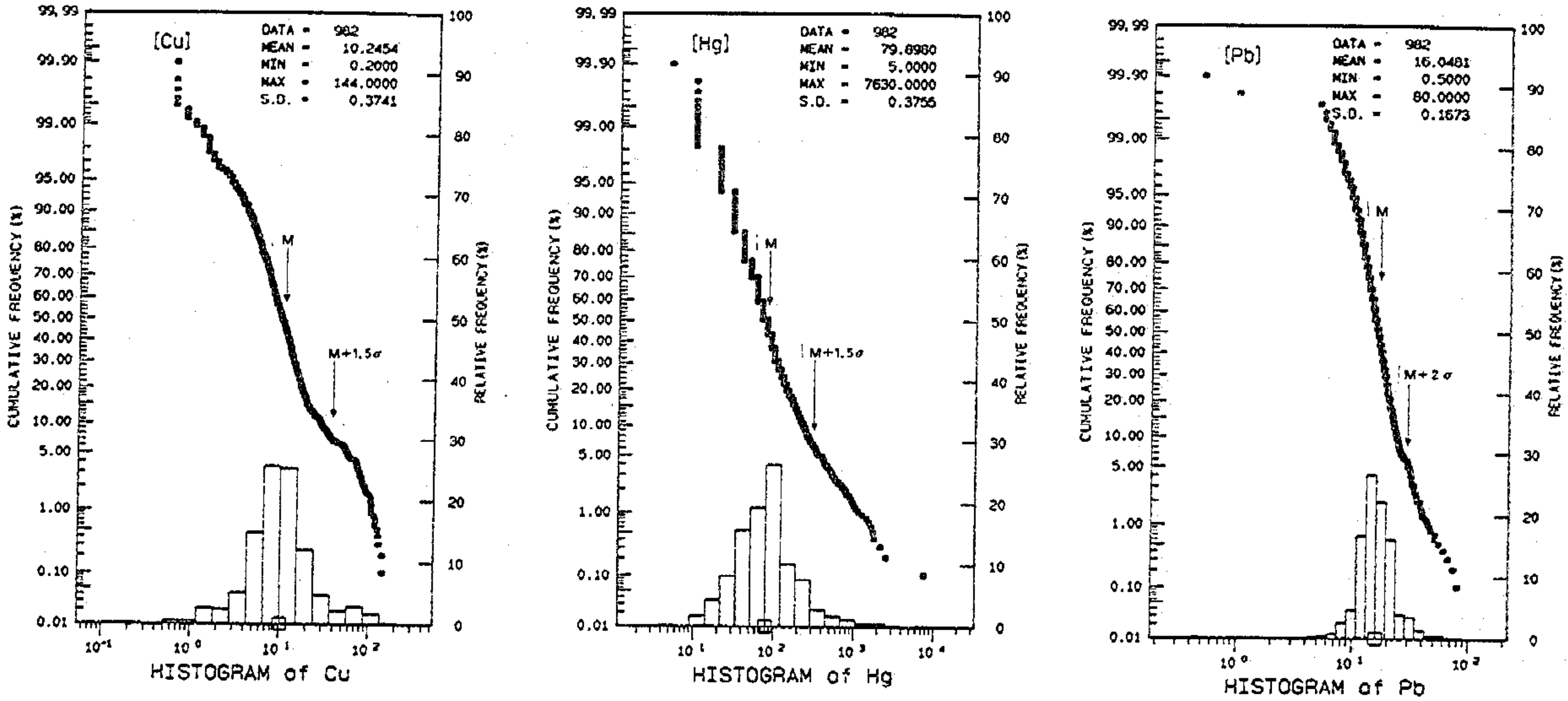


Fig. II-1-9.1 (2) Relative Frequency and Cumulative Frequency Histogram (Whole Area)

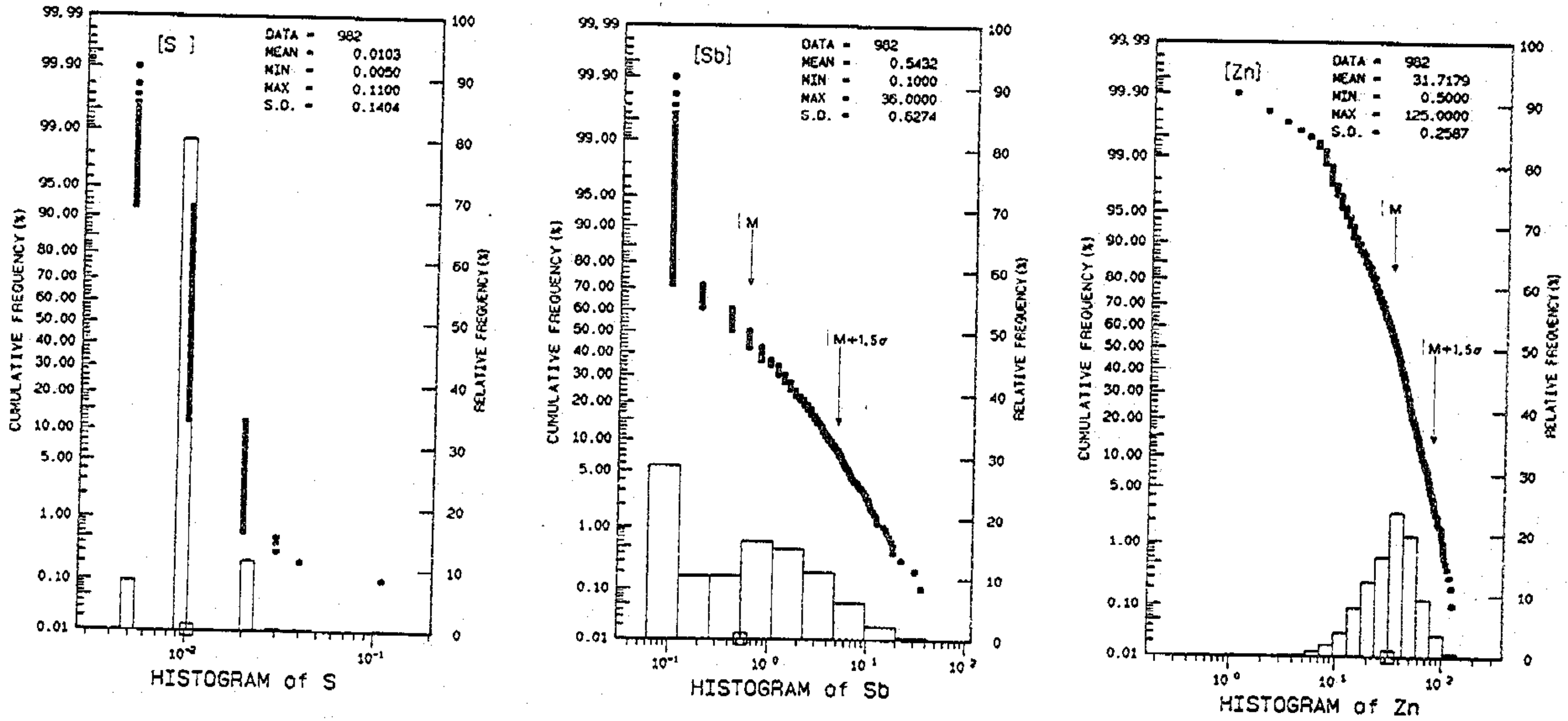


Fig. II-1-9.1 (3) Relative Frequency and Cumulative Frequency Histogram (Whole Area)

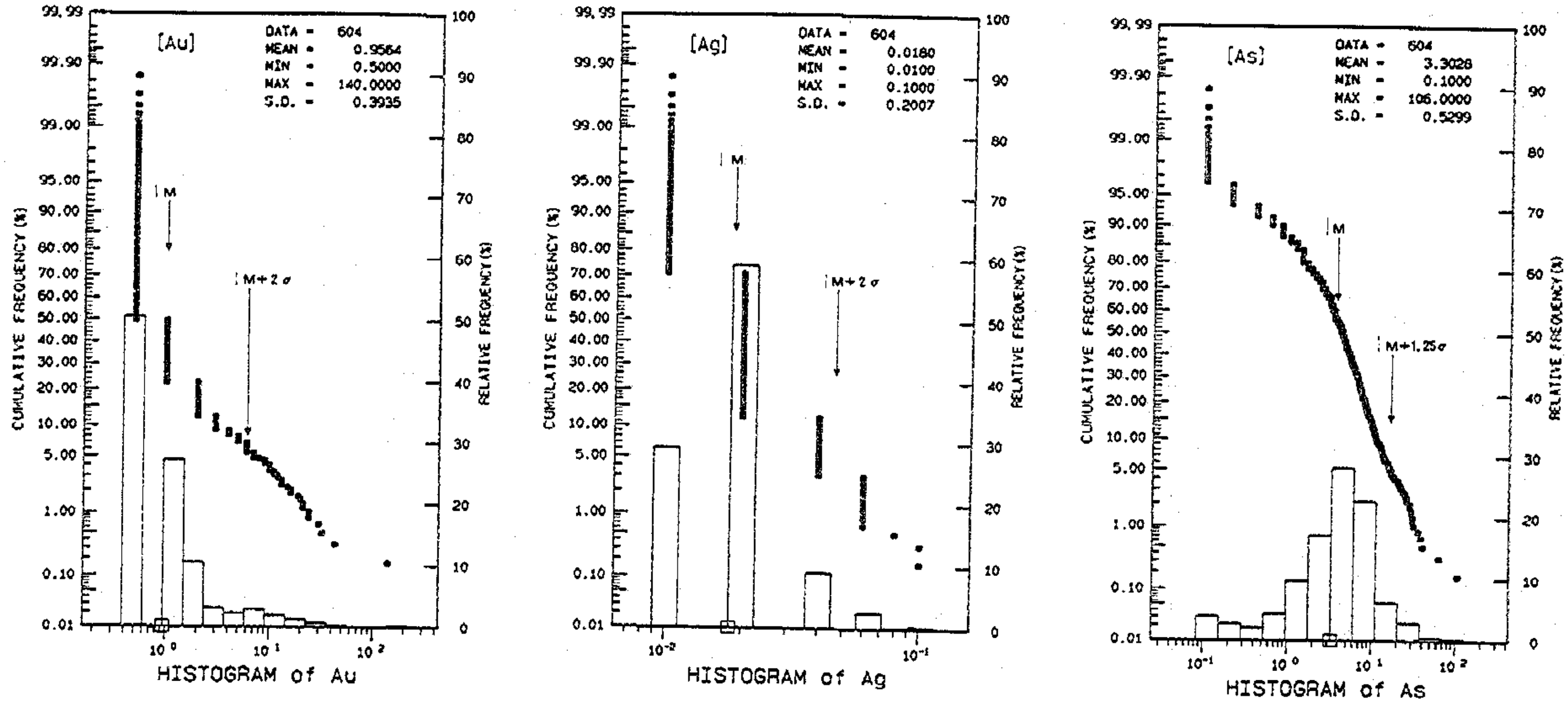


Fig. II-1-9.2 (1) Relative Frequency and Cumulative Frequency Histogram (Detailed Survey Zone)

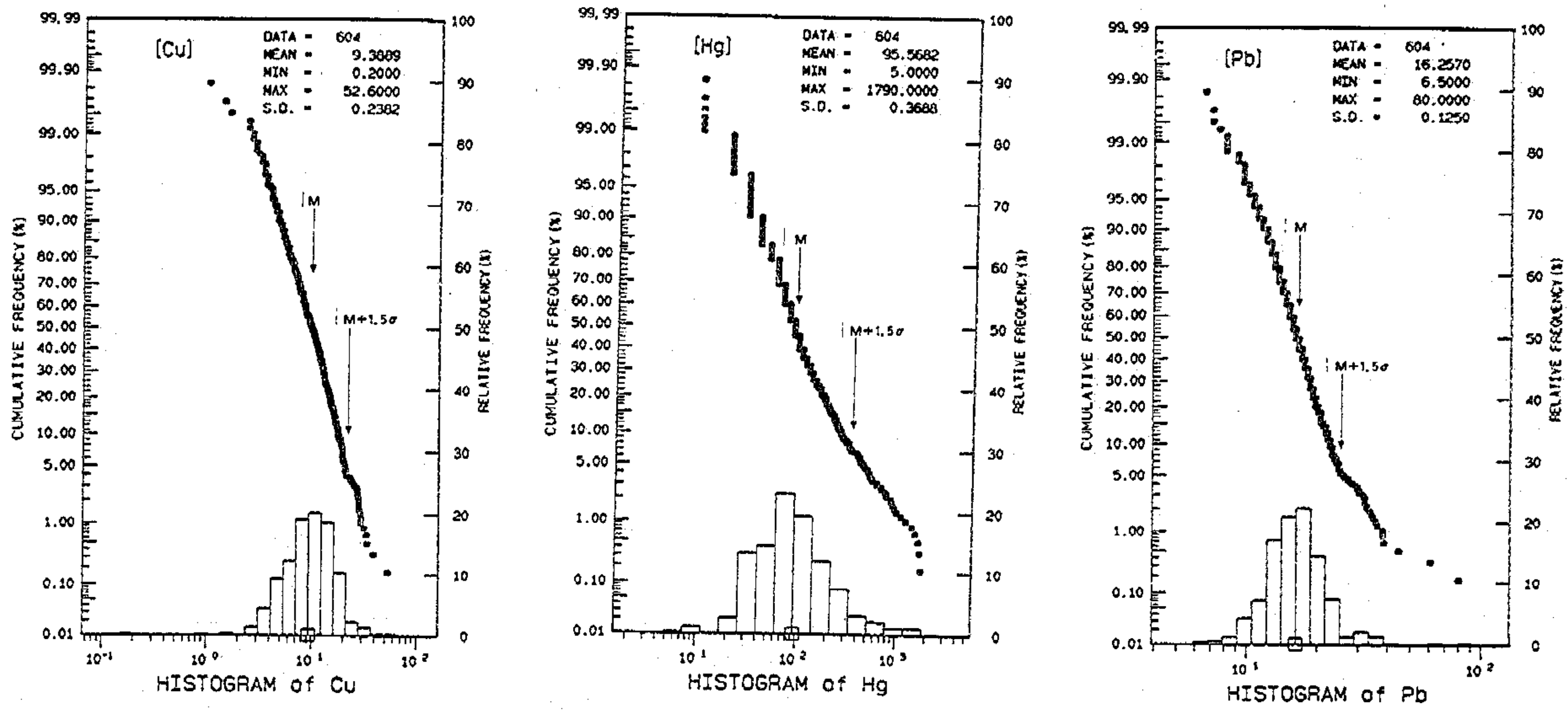


Fig. II-1-9.2 (2) Relative Frequency and Cumulative Frequency Histogram (Detailed Survey Zone)

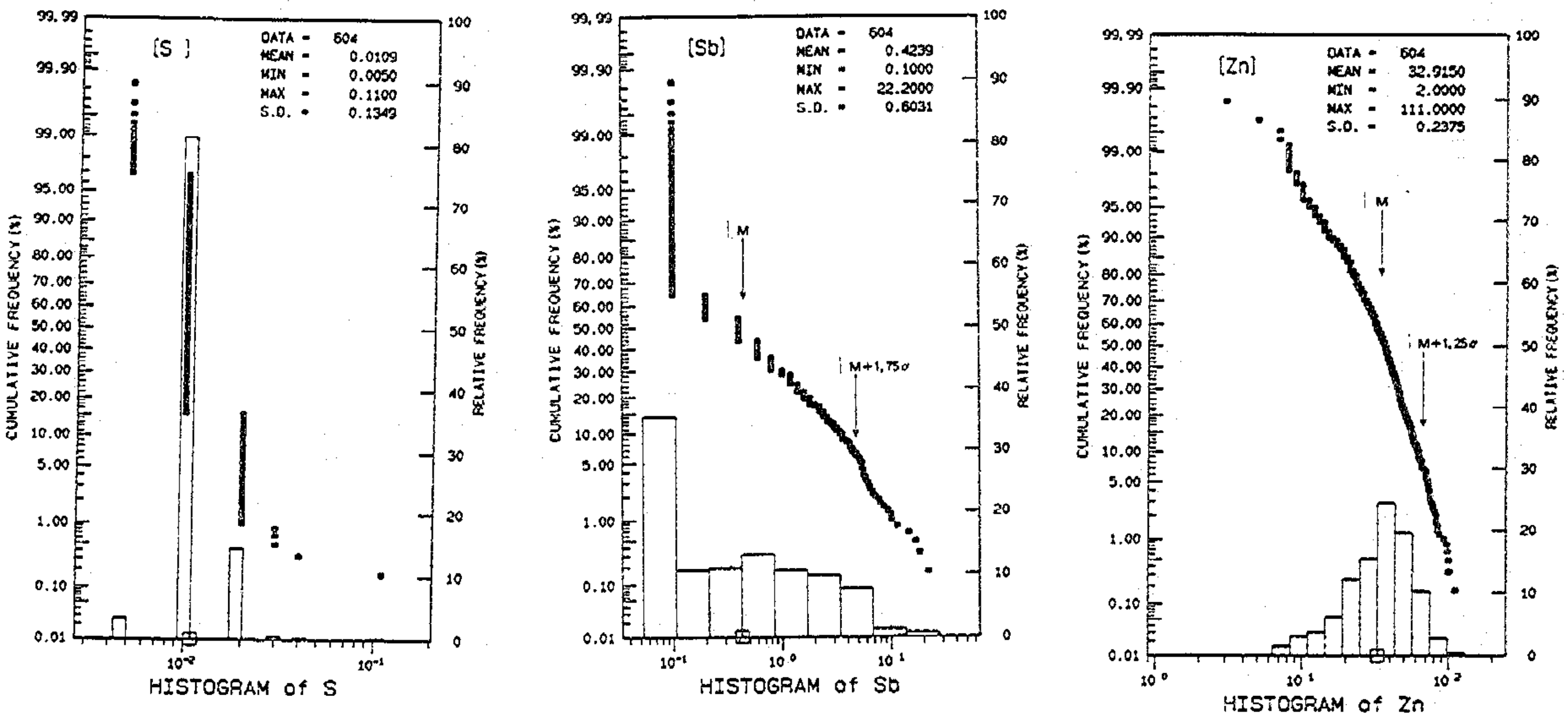


Fig. II-1-9.2 (3) Relative Frequency and Cumulative Frequency Histogram (Detailed Survey Zone)

1-5-4 Principle Components Analysis

The principle components analysis was carried out with regard to the correlational matrix obtained from the logarithmic values of the geochemical data, for both the detailed zone and the whole Survey Area. Ag and S, for which correlativity was extremely low, were excluded from the analysis, and calculations were done on the remaining seven elements. The results of the analysis are shown in Table II-1-6.

The eigen values were above or close to 1 as far as the fourth principle component, and the cumulative contribution rate was 76% for the whole of the Survey Area, 79% for the detailed zone. Since the factor loading for each element is slightly different in the detailed zone and in the whole Survey Area, and the import of each principle component differs, score distribution charts up to principle component 4 are shown in Fig. II-1-11.1～11.4 and Fig. II-1-12.1,12.2, with individual descriptions given.

Table II-1-6 Results of Principal Components Analysis

[Whole Area]

Principal Component	Eigen Value	Contribution Rate%	Contribution Cumulative%	Factor Loading	Z-01	Z-02	Z-03	Z-04
Z-01	1.8614	26.5910	26.5910	Sb	0.7638	-0.1900	-0.2587	-0.0866
Z-02	1.2835	18.3356	44.9266	As	0.7371	0.2985	0.2958	-0.0342
Z-03	1.1899	16.9982	61.9248	Au	0.6556	0.0276	-0.3376	-0.3727
Z-04	0.9922	14.1750	76.0997	Cu	0.1138	0.7567	-0.3869	0.1493
Z-05	0.6702	9.5747	85.6744	Zn	-0.3733	0.7229	-0.0433	-0.2529
Z-06	0.5246	7.4937	93.1681	Pb	0.1352	0.1662	0.8158	-0.4152
Z-07	0.4782	6.8319	100.0000	Hg	0.3664	0.1866	0.3232	0.7656

[Detailed Survey Zone]

Principal Component	Eigen Value	Contribution Rate%	Contribution Cumulative%	Factor Loading	Z-01	Z-02	Z-03	Z-04
Z-01	2.2057	31.5104	31.5104	As	0.8055	0.2917	0.1207	-0.0554
Z-02	1.2211	17.4438	48.9542	Sb	0.7680	-0.3346	-0.1713	-0.0592
Z-03	1.1668	16.6681	65.6223	Au	0.5695	-0.2301	-0.5675	-0.3350
Z-04	0.9191	13.1293	78.7516	Cu	0.3796	0.6732	-0.3597	0.1698
Z-05	0.6567	9.3814	88.1330	Zn	-0.4054	0.5865	-0.4507	0.0294
Z-06	0.4329	6.1836	94.3166	Pb	0.2398	0.4391	0.6047	-0.5494
Z-07	0.3978	5.6834	100.0000	Hg	0.5260	0.0431	0.3114	0.6846

[Whole Survey Area]

Principle Component 1 (Z-1):

There are large positive factor loadings for Au and its intimate elements Sb, As and Hg, and these are judged to be factors reflecting gold mineralization. There is a concentration of areas with high scores in the eastern part of the Survey Area, and on the whole a continuity in a N-S direction crossing the start of the detailed zone was observed. Sb and As have large factor loadings, and when compared with the zones of alteration this does not necessarily match the distribution of strongly altered zones, but there is a tendency for the areas with high scores to be distributed in and around the zones of alteration.

Principle Component 2 (Z-2):

The factor loadings for Cu and Zn are extremely high, and this is judged to be a factor related to the presence of base metal; but the factor loading for Pb is small. High-scoring areas distribute around Doi Ta Khuan in the western part of the Survey Area and on the ridge between the Nam Thung Lot and the Huai Nam Mae Bon, matching the distribution of plagioclase-porphyritic basalt and andesitic lava; this is thought to be a factor reflecting not so much the mineralization of base metal as the geological suite for a large Cu and Zn content.

Principle Component 3 (Z-3):

The factor loading for Pb is extrmely large, and is thought to be a factor showing the presence of Pb. High-scoring areas occur in the east and southeast of the Survey Area.

The three spots of low anomaly that occur in the western part of the Survey Area derive from extremely low concentrations of Pb, and from the geological conditions and state of alteration are not thought to be important factors relating to mineralization.on Parts with high scores for principle component 4, such as the high-scoring area in the eastern part of the area, correspond, with the exception of the high-scoring area in the southwest, with parts where silicification is strong. Conversely the distribution of parts with negative scores matches places with relatively low levels of alteration, such as the Zone IV (sericite + kaolinite±quartz zone) or the Zone V (sericite + montmorillonite±kaolinite ±quartz zone), and some parts were observed that suggested Pb leaching through the alteration effect.

Principle Component 4 (Z-4):

The positive factor loading for Hg and the negative factor loading for Pb and Au are large. If we consider the fact that Hg, as an intimate element of Au, is a volatile component indicative of gold mineralization effect, this principle component may be considered a factor showing sub-surface mineral occurense with gold mineralization effect in deeper parts. The high scores in the western part of the Survey area are thought to reflect, like Z-3, extremely low concentrations of Pb, and not to indicate the factors given above. The high-scoring areas for Z-4 cut through the detailed zone N-S and continue to the northern edge of the Survey Area, and also occur in accompaniment with strongly silicified parts of the upper reaches of the Huai Nam Khon Kaen in the southern part of the Survey Area, and on the left bank of the Nam Pong Ngao in the eastern part.

[Detailed Zone]

Principle Component 1 (Z-1):

Principle component 1 in the detailed zone has a high positive factor loading in As, Sb, Au and Hg, and also shows a positive factor loading in Cu. Zn displays a negative factor loading. This principle component is thought to be a factor suggesting a hydrothermal mineralization effect in the detailed area. The high scoring areas for principle component 1 are distributed around the starting points of Lines A to C, from Line F/100m through Line K/700m in a N-S direction, and around Line I/0m to Line M/200m. The high scoring area near line M accompanies an area of high silicification, but otherwise the high scoring areas overlap areas of relatively weak alteration. High scoring areas for Z-1 are developed on the eastern side of the NNE-SSW fault at the Huai Kha La and on the southern side of the NE-SW fault that skims past the starting point of Lines A, B and C.

Principle Component 2 (Z-2):

Principle component 2 has a high factor loading in Cu, Zn and Pb. Its main feature is that it shows few extremely high or high negative scores. On the eastern edge of the detailed zone where there are extensive zones of alteration, there are negative scoring areas, and on the western side in and around the ridge area where there are andesitic lavas, there is a tendency for positive scoring areas to be widespread. These are thought to be factors representing, on the western side of the detailed zone, the occurence of andesite, and on the eastern side of the detailed zone, the leaching of these elements due to the alteration zones.

Principle Component 3 (Z-3):

Principle component 3 has a high positive factor loading in Pb and a high negative factor loading in Au, and the only concentrations of Pb in the detailed zone are the high ones at the end of Line F. For these reasons the high negative scores for this principle component are assumed to be a factor indicative of a zone of gold mineralization. The high negative scores for Z-3 spread from Line I/0 to 300m straight across the profile lines to Line M/50 to 400m, and also continue on the southeastern side of Lines F to J.

Principle Component 4 (Z-4):

Principle component 4 has a large positive factor loading in Hg and a large negative factor loading in Pb. Like this principle component in the whole Survey Area, it is thought to be a factor indicating the presence at depth of hydrothermal veins. Although there is a break at the ridge line along Line H, a high scoring zone continues from the starting point of Line E to Line M/700 to 1000m. This high-scoring zone occurs along the eastern side of the NNE-SSW fault that passes close to Line I/700m, showing that ore solution has ascended along the fault line. On Lines K and L the degree of alteration is the highest in this vicinity, enclosing a strongly silicified sericite+quartz zone.

High-scoring areas were also observed close to the ends of Lines C and G, and a positive scoring area extends from Line A/1000m to the ends of Lines G and H parallel to the fault; and in consideration of the fact that there are many floats of quartz in this area, there is a possibility of the

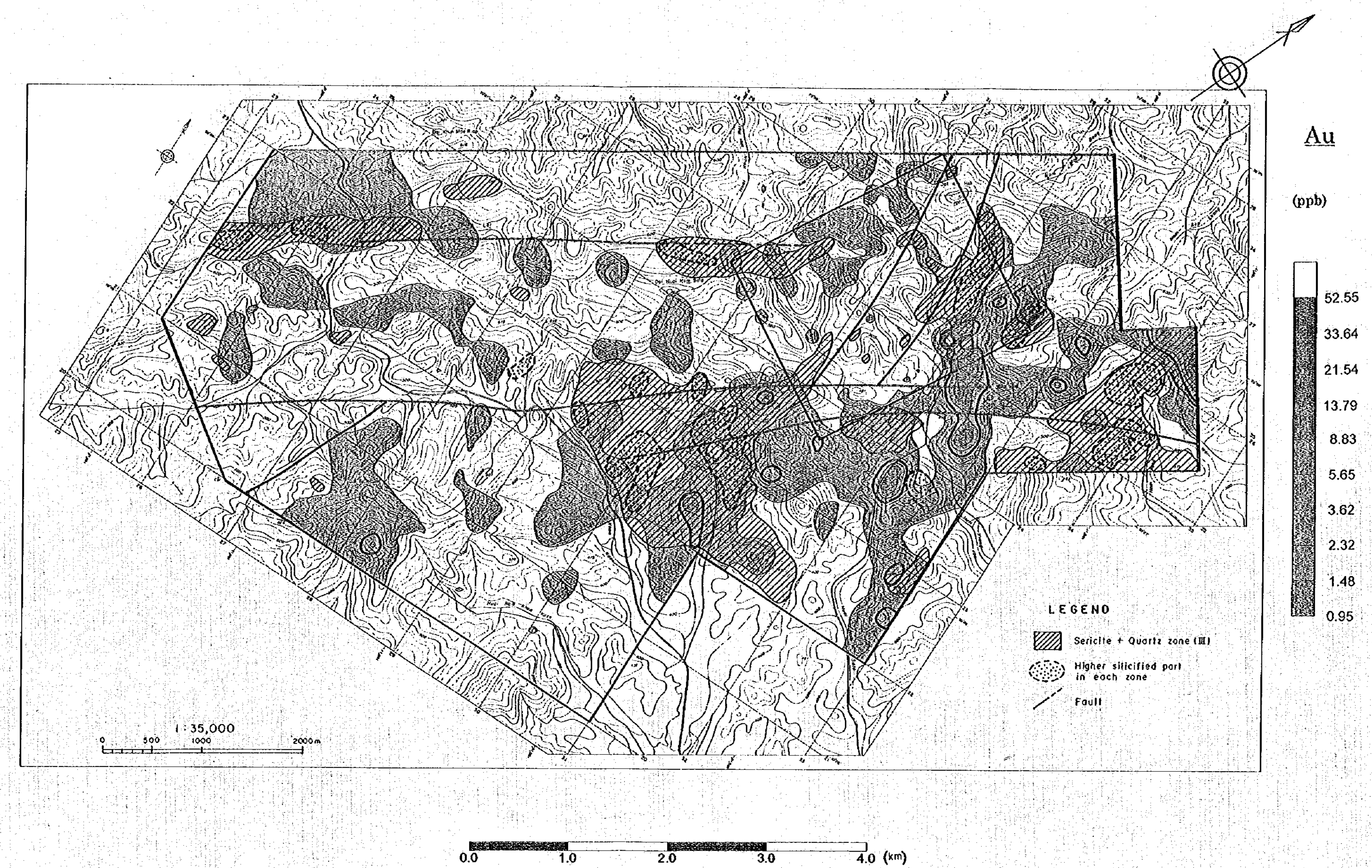


Fig. II-1-10.1 Geochemical Anomaly Map in Whole Area (Au)