PART Ⅱ DETAIL DESCRIPTION

CHAPTER 1 CHIANG KHONG AREA

1-1 Geology

1-1-1 General Geology

The Chiang Khong Area is composed of Permian sedimentary rocks such as sandstone (PRs), mudstone (PRm),conglomerate (PRc) and limestone (PRl), Permo-Triassic andesitic and rhyolitic lavas (PTa, PTr), tuff (PTt) and tuff breccia (PTb), Triassic granite (Gr), Jurassic andesite lava (ms2), red siltstone and sandstone (ms3) of the Jurassic, Pliocene siltstone (ng), and Plio-Pleistocene basalt (Ba).

The overall geologic structure conforms to the continuous direction of the mountain ridge in the Chiang Khong Area and shows extension in a NE-SW direction.

This area has not yet been surveyed for mineral deposits for DMR, and as for mining, there is only a distribution of sedimentary manganese deposits in alluvium in the southeast of the Chiang Khong Area.

The geologic map and schematic geologic column of the First Phase Survey are shown in Figs. 4 and 5, those of the Second Phase Survey are shown in Figs.6 and 7.

1-1-2 Detailed Geology

(1) The Permian sedimentary rock series (PR)

The Permian sedimentary rocks consist of sandstone, conglomerate, mudstone and limestone, and in some parts they form alternate strata. They are widely distributed along the northern boundary of the Chiang Khong Area and southwards from the central region.

Mudstone (PRm), which is the most widely distributed, is mainly made up of black slate and sandy mudstone in the north. Slate is also found in the south where granite is distributed, but in many cases it has been mica schist. Also, on the west side of the southern granite body, the mudstone contains lens-shaped limestone. Grey-colored, medium to coarse sandstone (PRs) prevails in the north, but fine or medium tuffaceous sandstone which shows a white color is prevalent in the southern half. Sandstone in the south has a high tuffaceous silt content and clastic grains are composed of quartz, feldspar, etc. Conglomerate (PRc) is mainly dark-grey color and pebbly one of relatively good roundness. In addition to the limestone (PRl) which is distributed as stacks in the plains in the southwest of the area, small-scale lens-shaped limestone bodies are also found scattered in the mudstone area in the south. Fusulinidae has been confirmed in this limestone and has been correlated from the uppermost Carboniferous to the lower Permian. (Hahn et al.,1982).

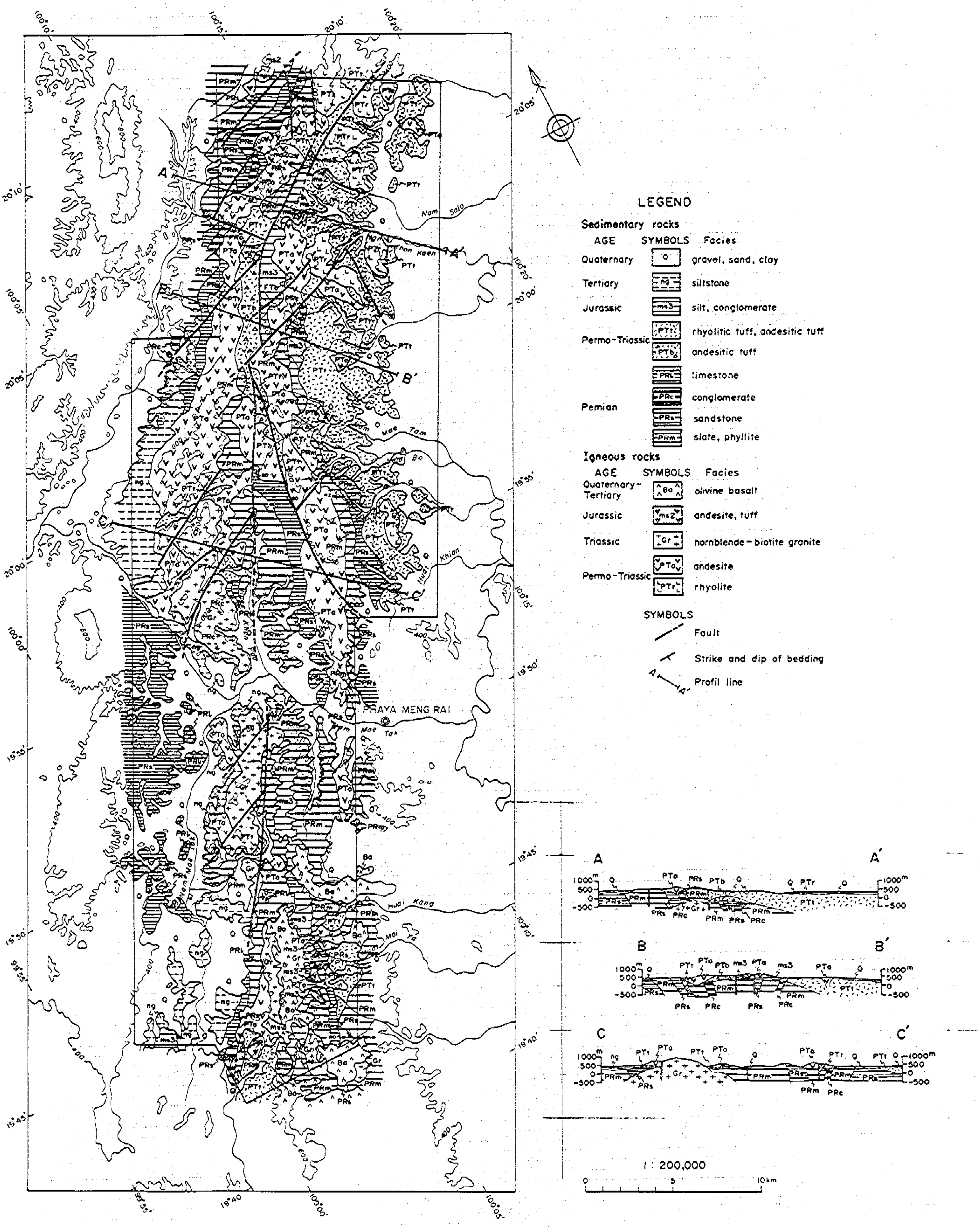


Fig. 4 Geologic Map and Profile in Chiang Khong Area

period	column	lithology	igneous activety	mineralization
Quaternary	Q	gravel,sand,clay		plocer
Quaternary Tertiary	Ba	olivine basalt	basalt	
Tertiary	ng	siltstone(partly tuffceous)	basalt	
Jurassic	ms3	dusky red coloed silt, coarse sandstone, granule to pebble conglomerate		
	ms2	andesite,tuff	andesite, granite	Au, Cu, Pb, Zn
Triassic	Gr	hornblende-biotite granite	granite	
Permo-Triassic	PTa	andesite (porphyrytic tex dominate)	andesite, rhyolite	
	PTr	rhyolite	andesite, rhyolite	
	PTt	rhyolitic tuff, andesitic tuff (partly welding)	andesite, rhyolite	
	PTb	andesitic tuff breccia	andesite, rhyolite	
Permian	PRl	limestone		
	PRc	pebble to cobble conglomerate		
	PRs	fine to medium sandstone		
	PRm	slate, phyllite		

Fig. 5 Schematic Geologic Column in Chiang Khong Area

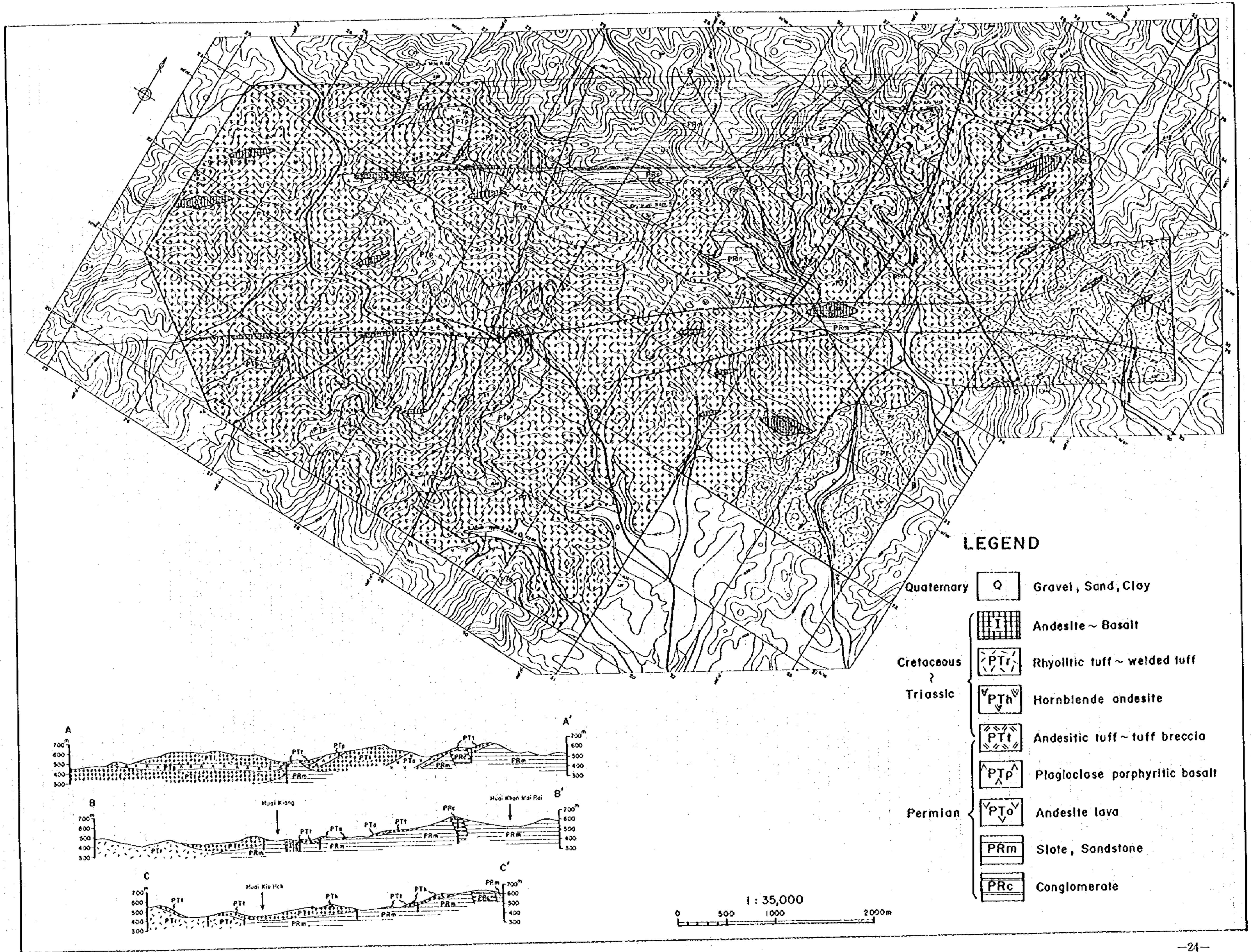


Fig. 6 Geologic Map and Profile in Upper Huai Nam Sala Area

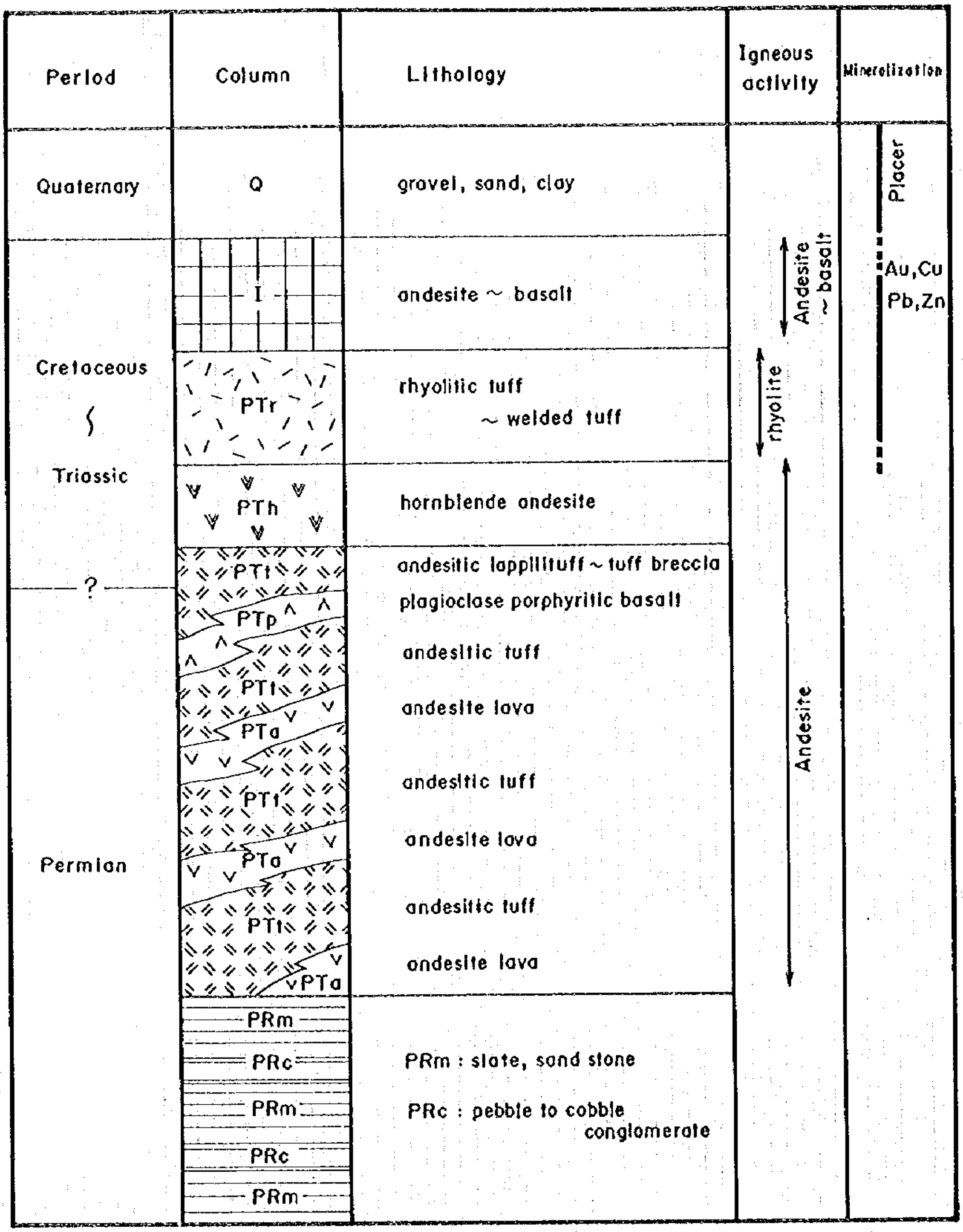


Fig. 7 Schematic Geologic Column in Upper Huai Nam Sala Area

(2) Permo-Triassic Volcanic rock series(PT)

The Permo-Triassic volcanic rocks are composed of andesite (PTa), rhyolite (PTr), andesitic and rhyolitic tuff (PTt), and andesitic tuff breccia (PTb). This volcanic rock series are part of the upper Permian-lower Triassic volcanic rock zone of Bunopas (1992). With the Chiang Khong Area and Doi Yao mountain ridge to the east marking the northern tip, it continues southwards in an S-shape, through Ngao and Phrae to the east side of the Doi Chong Area. This volcanic rock is prevalent in the northern part of the Chiang Khong Area, but with little in the south.

Andesite (PTa) is massive lava which shows a dark red or dark green color, and in some parts is characterized by a content of idiomorphic platy plagioclase phenocrysts. It is two-pyroxene andesite with intersertal texture and it has undergone intense alteration of chlorite, sericite and calcite. Overall, there are many andesites which show a dark green color and are propylitic.

Tuff (PTt) is composed of fine rhyolitic tuff, andesitic sandy tuff, lapilli tuff and welded tuff. The tuff has undergone chlorite alteration, but is weaker than andesite. Nevertheless, outcrops that have undergone intense hydrothermal alteration of kaolinite, sericite, etc. are widely distributed along the national highway on the west side of Ban Kaeng in the north of the area.

Andesitic tuff breccia (PTb) shows a grey color and is distributed in Huai Ta Khuan in the upper reaches of Nam Mae Tam. The gravel is subangular to subrounded and the amount is small.

Plagioclase-porphyritic basalt (PTp) is exposed in the southern part of the Second Phase Survey Area, around Mt. Doi Ta Khuan, on the mountain side on the right bank of the Huai Nam Mae Bon creek, in the basin of the Nam Thung Lot River, etc. 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 it is changing the color to dark green through alteration in some places.

Hornblende andesite (**PTh**) is limitedly distributed at the summits and ridges of Mt. Doi Kiu Hok and Mt. Doi Kha La, which are situated near the detailed survey zone in the Second Phase Survey. The rock corresponds to the upper most layer of volcanic rocks of the Triassic periods, and irregularly covers the andesitic tuff and Permian sedimentary rocks. 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.

Rhyolitic volcanic rocks (PTr) is a vitric rock which contains two-pyroxene. Spherulitic, perlitic textures are seen in it. Like andesite, it has undergone intense alteration of chlorite and sericite.

This is distributed in the eastern part of the Second Phase Survey Area. The rock shows a greyish-white to lilac color, and has a banded structure in some places. 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. Strongly-welded hard tuff was also observed, and they have zoned distribution. 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 fragments consist of plagioclase, potassium feldspar, opaque minerals, etc., and contain zircon, apatite, etc. as accessary minerals.

Based on the whole rock's K-Ar dating of the Second Phase Survey, these rocks is possible to have occurred in the Cretaceous ages(67.4±1.7Ma), however, the influence of some kinds of alteration is also considered.

(3) Triassic granite (Gr)

Biotite-hornblende granite of Triassic age is distributed in three rock bodies from the center to the south of the area. The granite is medium to coarse-grained granite which contains biotite and hornblende and it shows holocrystalline and equigranular texture. Chloritization of biotite and amphibole and sericitization of plagioclase are seen, but overall it is fresh.

The susceptibility of the granite by a handy susceptibility gauge shows 6.0~7.7 x 10^{-3} S.I. unit, 7.4 ~9.6 x 10^{-3} S.I. unit, and 10.0~12.5 x 10^{-3} S.I. unit, and it can be classified into magnetite series.

Granites which are observed in each place cause thermal metamorphism of the surrounding sedimentary rocks, but the width of metamorphic zone is only around 50 to 60 metres.

(4) Jurassic andesite (ms2)

In addition to andesite which shows distribution in lava cones of about 1km diameter in the north of the area, there is also andesite which shows distribution in dikes, cutting across andesite of the Permo-Triassic. Megascopically it is aphyric andesite and alteration is not very strong.

Based on the whole rock's K-Ar dating of the Second Phase Survey, these rocks is possible to have occurred in the Cretaceous ages(90.2±8.9Ma), however, the influence of some kinds of alteration is also considered.

(5) Jurassic sedimentary rocks (ms3)

There are narrowly distributed in the center of the area. It has developed by discordantly covering conglomerate, sandstone, andesite and tuff of the Permian age. The rock facies is siltstone, coarse sandstone, granule conglomerate which show such colors as dark red, brick color and reddish purple, and the dip is a gentle dip of less than 20°. Judging from these occurrences, it is assumed to be continental sediments.

(6) Pliocene sedimentary rock (ng)

This is distributed on the boundary between the mountainous region and the plains south of the center in the west of the area. It is composed of half-consolidated siltstone, tuff sandstone.

(7) Plio-Pleistocene basalt (Ba)

In the southern area basalt is distributed covering the sedimentary rock and granite. In addition to covering the mountain ridge in the form of a cap rock, there are places where distribution gently descends to the plains. It corresponds to the Chiang Rai basalt of Jungyusuk & Sirinawin (1983) and shows an overall age of 1.69±1.25 Ma by K-Ar dating. The basalt is porous rock which assumes colors from pale grey to black. It shows intergranular texture and contains microphenocrysts of olivine, pyroxene and plagioclase. Smectite and chlorite are seen in small quantities, but are extremely new.

1-1-3 Geologic Structure

The First Phase Survey Area as a whole forms a mountainous region extending NE-SW and a tendency is seen for the distribution of each stratum to continue virtually in harmony with this direction. The strikes and dips of Permian sedimentary rocks show NE-SW strike with SE dip in the central southern half of the Chiang Khong area, and NE/SW - N/S strike with W dip on the east side of the central region. It is assumed to show a large syncline structure. Permo-Triassic volcanic rocks are accompanied by tuff and covers the Permian system with unconformity. It shows distribution in two parallel zones running NE-SW. It is likely that these andesites occur along fractures running in the same direction. Permo-Triassic tuff, accompanied by dome-shaped andesite and rhyolite, is prevalent in the northeast of the Chiang Khong Area, and it shows a monoclinal structure on the east side in this region.

The faults and lineaments of the Chiang Khong area which have developed in a NE-SW direction along the synclinal axes of sedimentary rock of the Permian, it is noted that there are lineaments which run obliquely to them in an ENE-WSW direction. These faults and lineaments are more developed in the north and center than in the south of the Chiang Khong Area. Distribution of Jurassic andesite and alteration zones in the north is controlled by these fault systems.

Granites virtually intrude into the axis of the synclinal structure, and the major axis direction of the rock body conforms to the NE-SW direction of the area, but the line linking the centers of the three rock bodies runs obliquely to this direction, showing a NNE-SSW direction, and distribution is in echelon. Whereas the granite is exposed in the southern half of the area, no distribution of granite is evident at the northern tip. It is, however, known that small granite bodies have intruded to the north of the Chiang Khong Area and the existence of granite bodies is assumed below the northern tip of the area.

It is assumed from this that the N-S geologic structure of the Chiang Khong Area in the First Phase Survey shows that the southern half rose considerably and plunged to the north which was pared away.

The topography and geologic structure of the Second Phase Survey 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.

Two fault systems are observed in the Second Phase 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, 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 Second Phase 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 (to Cretaceous) 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 (to Cretaceous) period, and regulated the igneous activity of that time.

1-1-4 Geochemical Characteristics of Igneous Rocks

Geochemical analysis was carried out on 12 samples in the First Phase Survey and 13 samples in the Second Phase Survey.

(1) Results of the First Phase Survey

In Fig. 8, basalt has lower alkali and P_2O_5 than andesite and appears to have been formed at a clearly different structural site. The most basic andesite is rockfacies andesite which contains porphyritic plagioclase and it is widely different in composition from other andesites. Excluding the

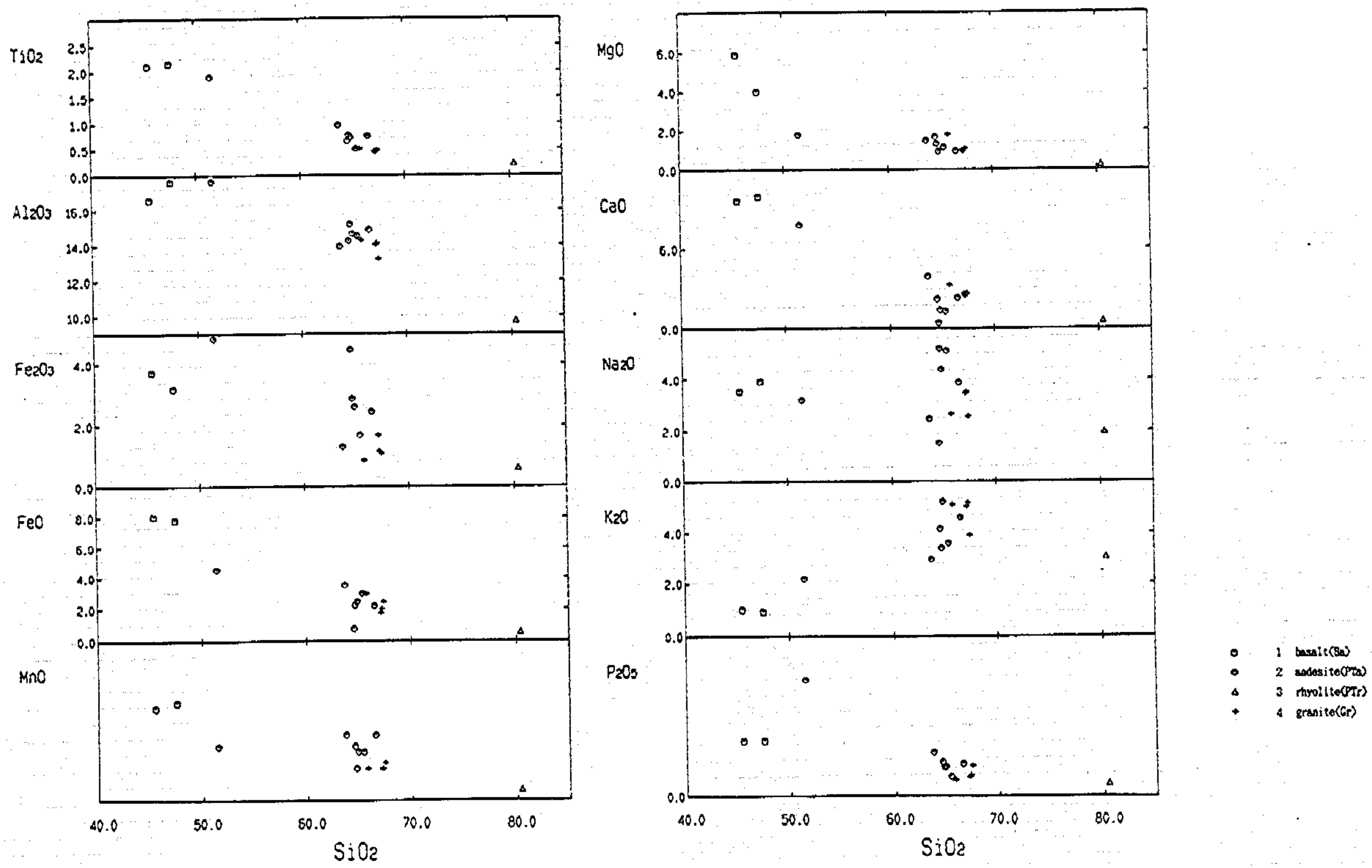


Fig. 8 Harker Diagram of Igneous Rocks in Chiang Khong Area

fact that trivalent iron, alkali, etc. have moved greatly due to the alteration of andesite, the values of andesite and granite from the Triassic period show extremely similar chemical composition values, and judging from the time of formation, it is thought possible that they derived from the same magma.

In Fig. 9 the granites are classified into "granite" in a narrow sense. And in Fig.10, judging from its susceptibility, they belong to I-type and the magnetite series.

In the MFA diagram in Fig.11, whereas granite, andesite and rhyolite conform well to the differentiation series of the island arc calc-alkali series, basalt has a tendency to be fairly rich in iron following differentiation and it shows a differentiation course similar to that of the tholeiite series. In the variation diagrams the possibility that the two were formed in different places was also pointed out, but the results in Fig. 8 suggest that the andesite and granite magma originated in response to compression zone and the basalt magma was formed under tension condition.

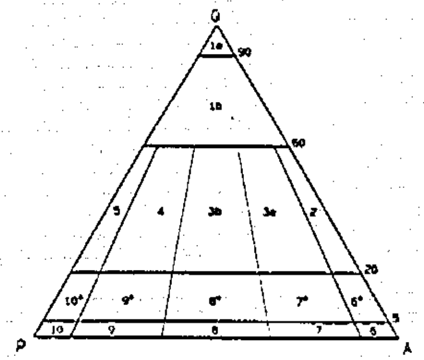
Many sapphires and other precious stones are found in the environs of Pliocene basalt in Thailand and it is thought that they originated in the excess alumina of the basalt, but no normative corundum showing excess alumina is evident in the basalt in this area.

(2) Results of the Second Phase Survey

According to Figs.12 and 13, 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 variation trends that are very similar. The composition of hornblende andesite (PTh) and granite (Gr), however, slightly differ 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. While in neutral rocks phenocrysts of hornblende also appear in the former, the latter contain clinopyroxene in the groundmass; and also in the dacitic rocks, phenocrysts of two types of pyroxene are predominant.

Fig.14 is a SiO_2 -FeO(*)/MgO diagram, the boundaries for the calc-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 calc-alkali rock series, although the hornblende andesite (PTh) and granite (Gr) are plotted slightly closer to the region of calc-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_2O diagram of Fig.15, 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 plagio-



Classification of granitic rocks (IUGS, 1973)

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

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

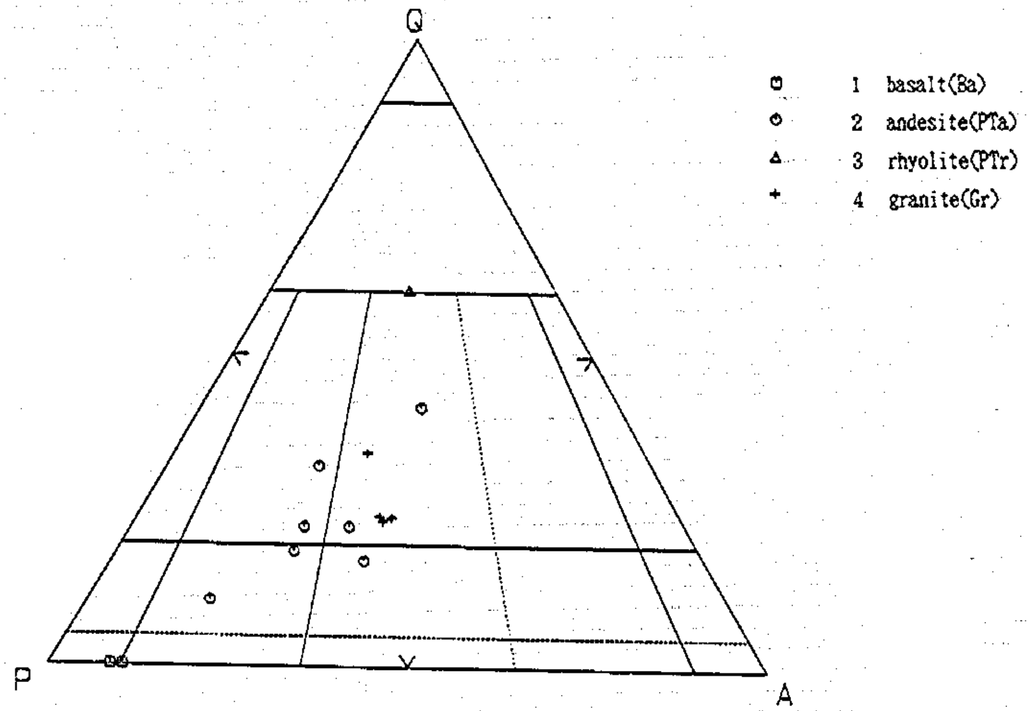


Fig. 9 Normative Q-P-A Diagram in Chiang Khong Area

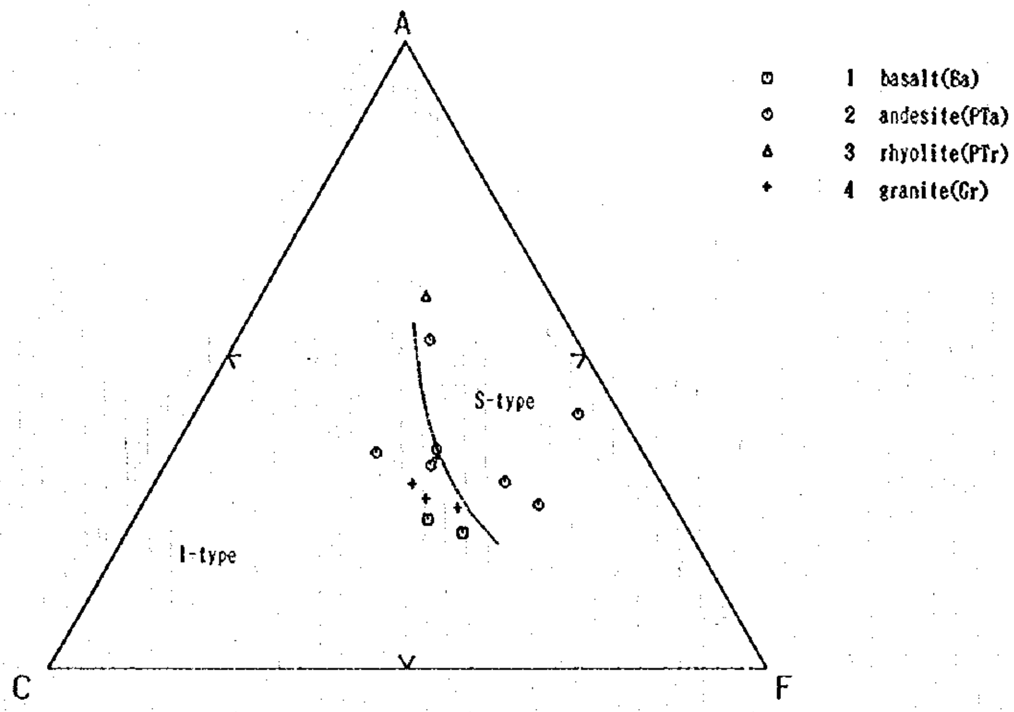


Fig.10 ACF Diagram of Igneous Rocks in Chiang Khong Area

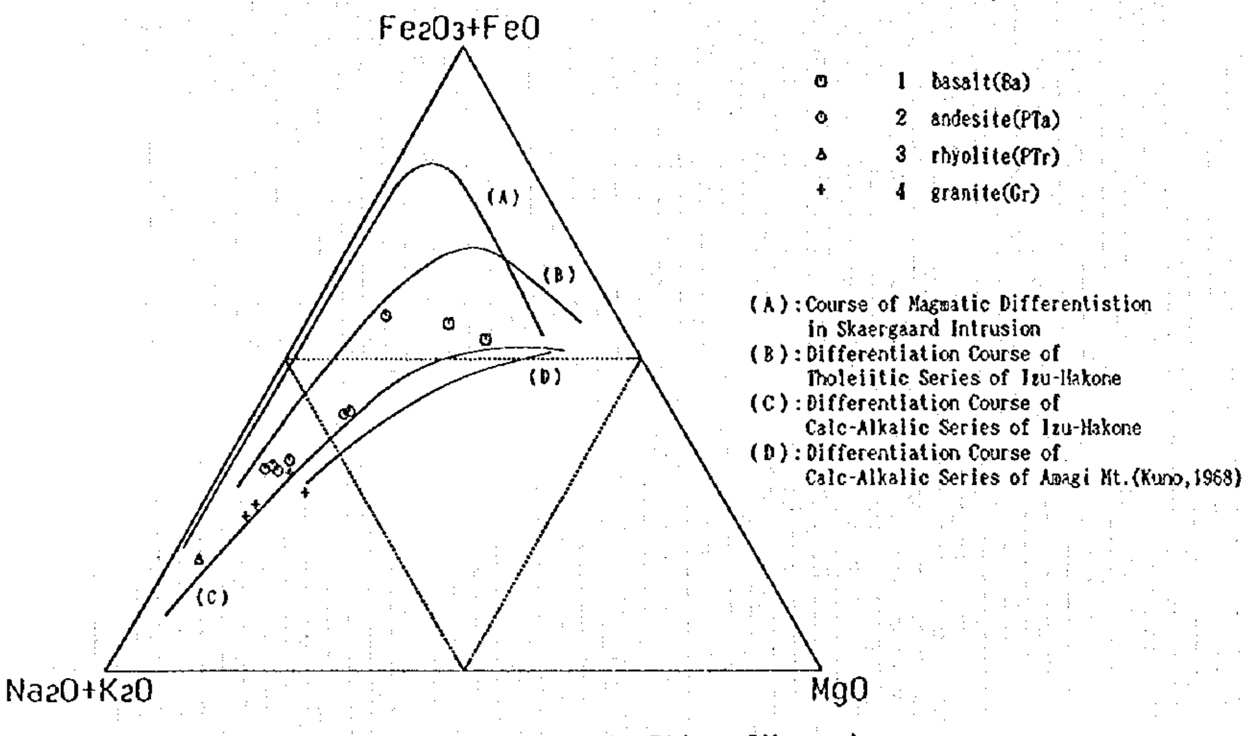


Fig.11 MFA Diagram of Igneous Rocks in Chiang Khong Area

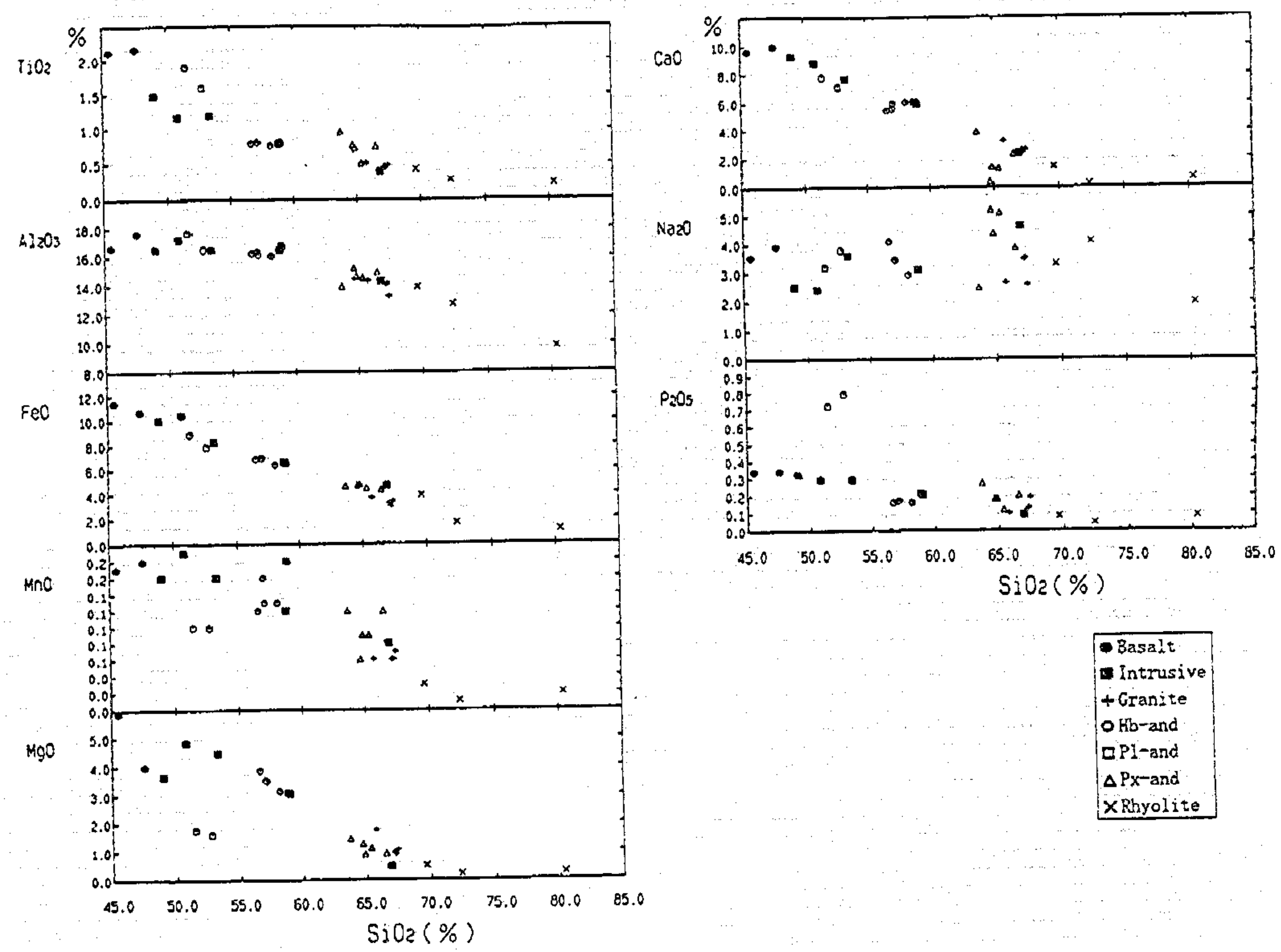


Fig.12 Harker Diagrams of Igneous Rocks in Upper Huai Nam Sala Area

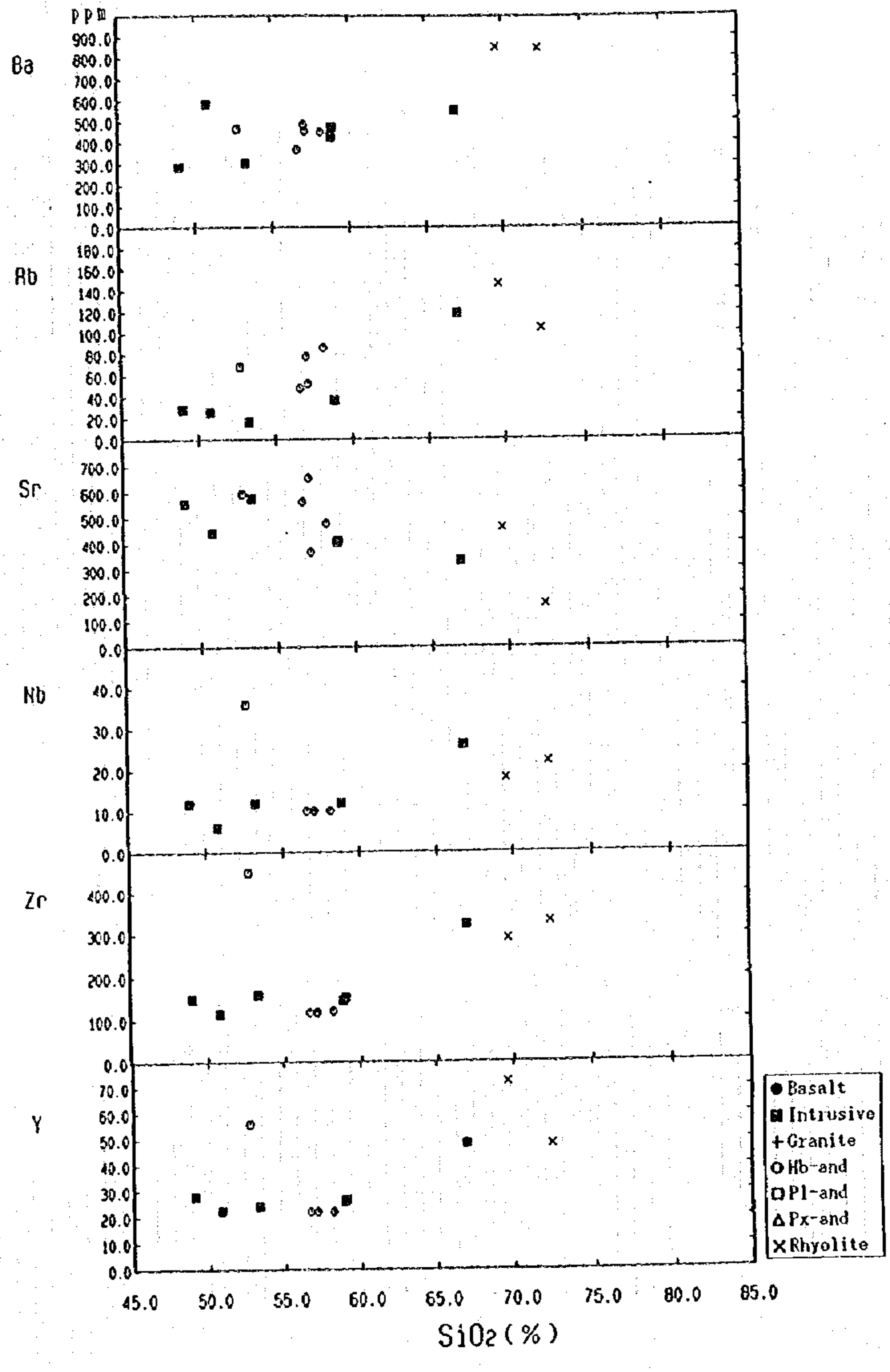


Fig.13 Variation Diagrams of Trace Elements in Upper Huai Nam Sala Area

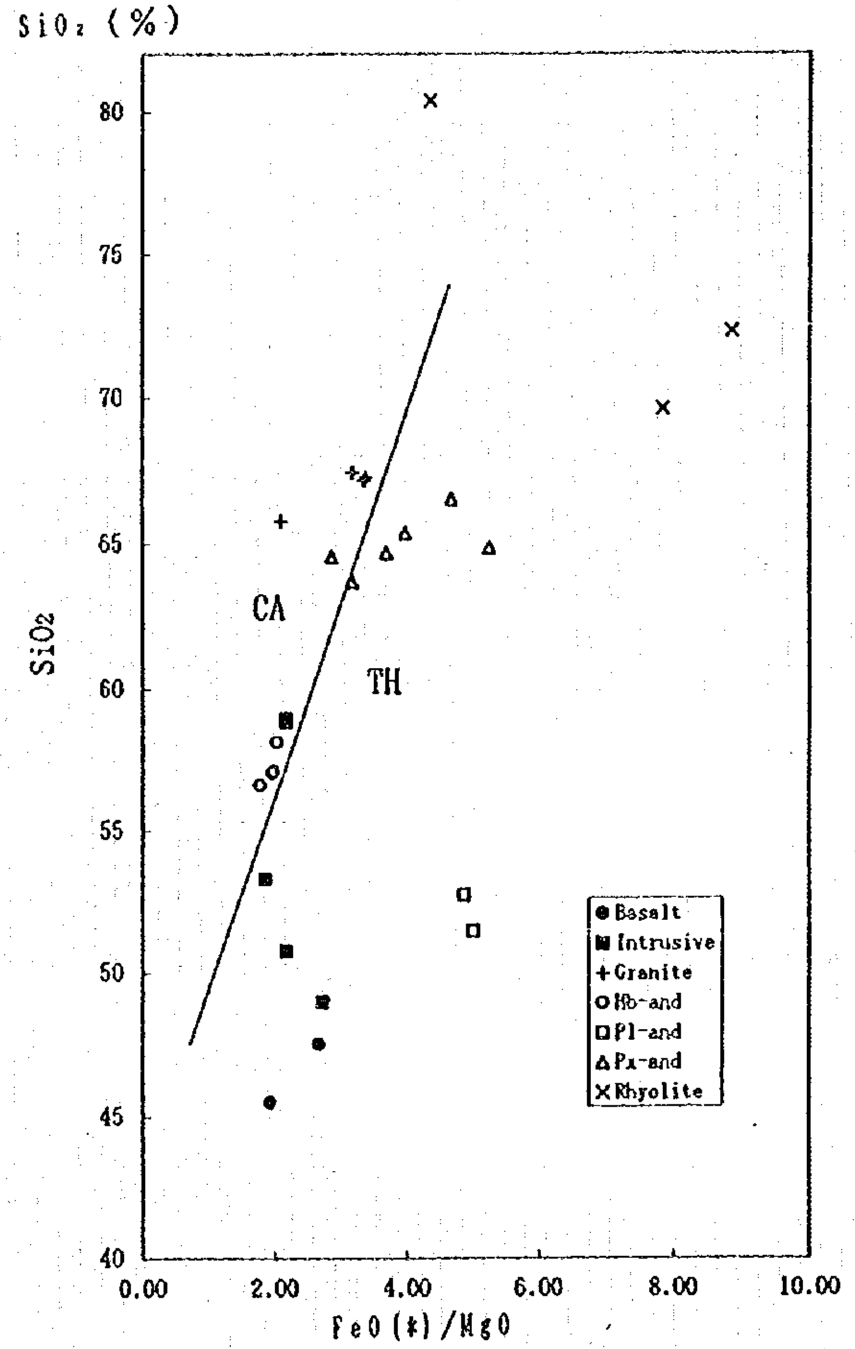


Fig.14 SiO_2-$FeO^{(*)}$/MgO Diagram of Igneous Rocks in Upper Huai Nam Sala Area

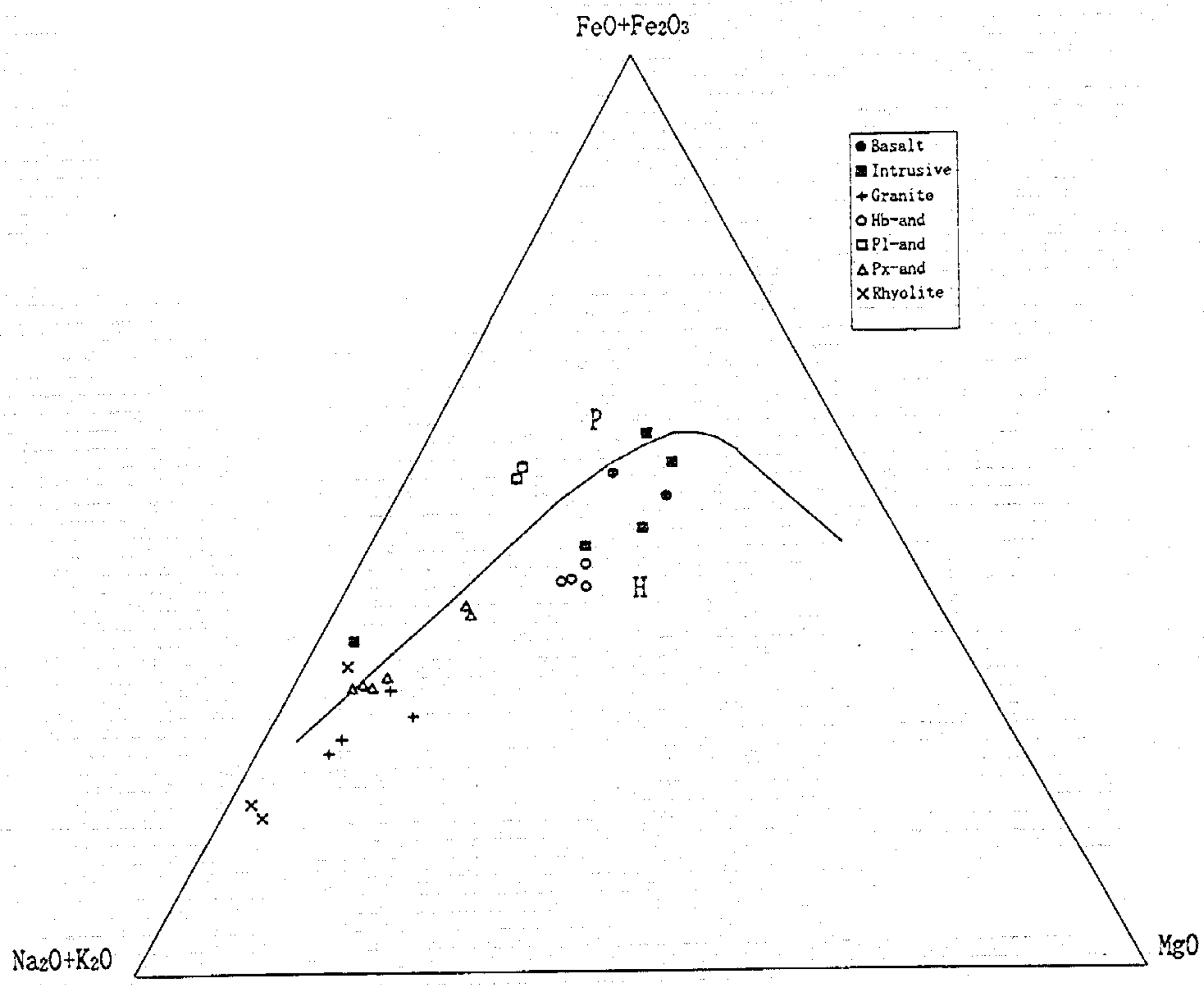


Fig.15 MFA Diagram of Igneous Rocks in Upper Huai Nam Sala Area

clase-porphyritic basalt, the igneous rocks occurring within the Survey Area possess a crystal differentiation process halfway between that of the calc-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 the Second Phase Survey Area are summarized as the table below.

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

1-1-5 Alteration and Mineral Occurrences

As stated earlier, there are no metal mines with a production record in the Chiang Khong Area. Fig.16 shows a map giving the location of prospective mineral regions in the area.

According to the only information obtained during the field survey, placer gold in riverbed deposits in the middle reaches of the Nam Mae Tam was mined by about 10 local peoples for about 5 years from around 10 years ago, but the details are not clear.

Furthermore, according to information from a local owner of mining rights, there are two prospective regions for copper and one for gold. The gold region lies on the boundary with sedimentary rock at the southernmost part of the granite body in the middle of Huai Hom Hae, and the owner of the mining rights once discovered gold flake with 5 to 6 millimeters in diameter by panning there. In addition to ascertaining contact between granite and mica schist originating in the sedimentary rock, contact with andesite is also apparent. Andesite is skarnized and pyrrhotite, chalcopyrite, magnetite, etc. are disseminated. A small-scale silicified zone and skarn zone are evident in the sedimentary rock further up the same river and minute particles of chalcopyrite and pyrite are disseminated. One of the prospective copper regions is distributed on the Doi Ngaem mountain ridge west of Ban Bo Seang. The geology is a Permian white sandstone stratum and seams of green copper can be seen in this massive sandstone. It was prospected 15 or 16 years ago. Ore assay re-

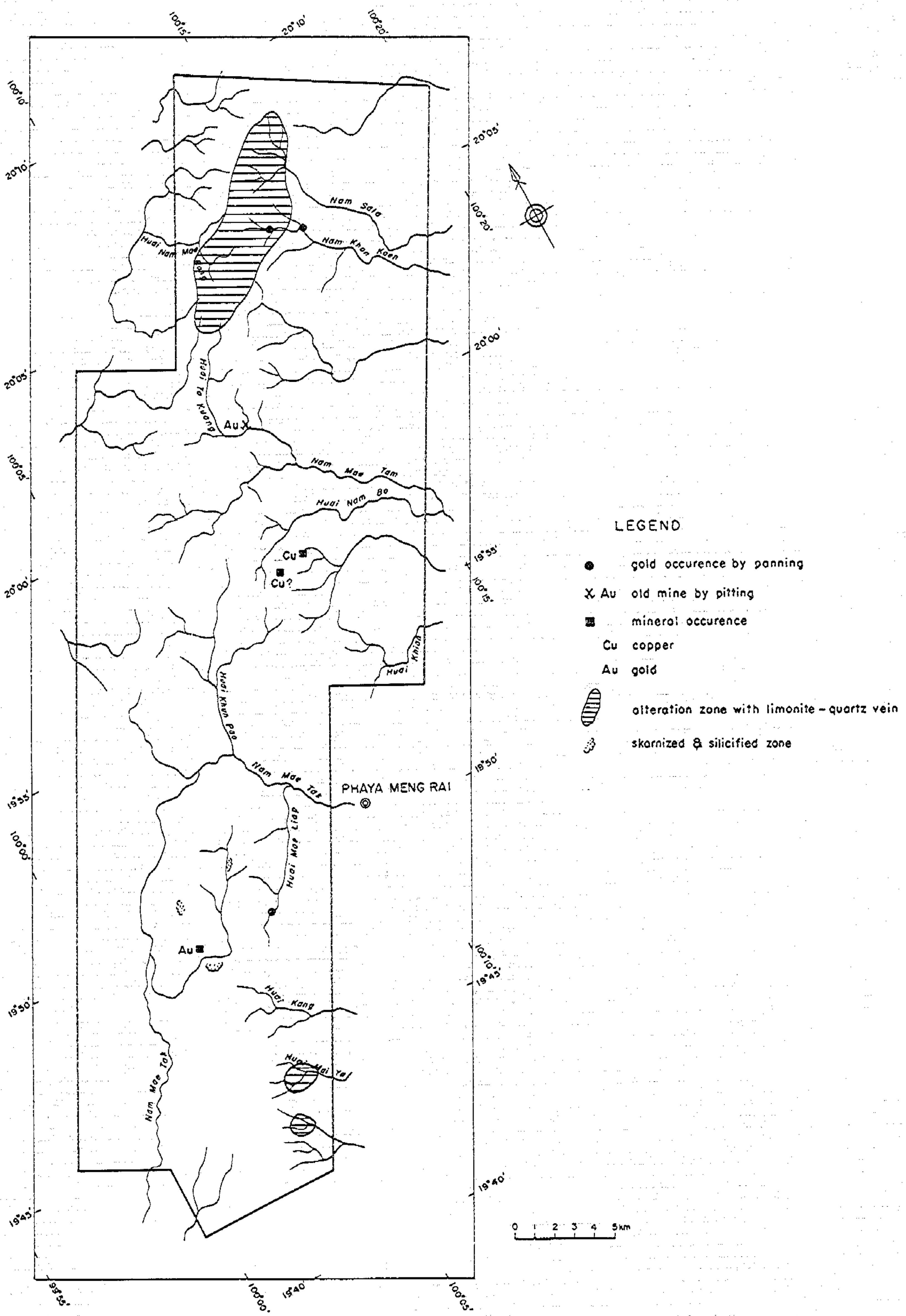


Fig.16 Location Map of Mineral Occurrence in Chiang Khong Area

sult is Cu= 1.58%. The other prospective copper region is said to be located on the Doi Nang Puk mountain ridge which is composed of andesite, west of the first prospective copper region. It consists of massive rocks about 2 meters in diameter and the surface is covered with covelline and green copper.

Tuffaceous rocks in the Chiang Khong Area have undergone marked white argillization, but it is mostly thought to have been kaolinized due to tropical weathering. Nevertheless, white argillized alteration zones accompanied by limonite-quartz veins are evident in a number of places by the side of the highway which traverses the north of the Chiang Khong Area. Gold flakes were found by panning in two places in the river along this alteration zone and there is a strong possibility that it is an alteration zone related to the mineralization of gold. The alteration zone covers an area 2 km wide by 15 km long along the fault zone that runs NE-SW.

Small-scale quartz veins and rocks with disseminations of sulfides, other than those mentioned above, are found here and there in the Chiang Khong Area.

An alteration distribution map and the location map of mineral occurrence within the Second Phase Survey Area are shown in Figs.17 and 18, respectively. The widespread distribution of a white argillized zone accompanying silicification from the central part of the Second Phase Survey Area to the northeastern part, the same kind of alteration zone occurs on both the western and eastern edges of the Second Phase Survey Area. These alteration zones are distributed in harmony with the NNE-SSW and NE-SW faults that are developed in the same areas. While there is some difference in the strength of silicification, the alteration zoning are classified from the center outwards into zones of weak acidic to neutral alteration and display a progressive structure, i.e., sericite + quartz zone; sericite + kaolinite ±quartz zone; sericite + montmorillonite ±kaolinite ±quartz zone; montmorillonite zone; zone of weak or no alteration. The Permo-Triassic tuffs is undergone by alteration, but also extends to the lavas of the same age and the Permian sedimentary rocks.

In the Second Survey Area there are no ore mines in operation nor any areas with mineral prospects ready to be mined; but silicified rocks accompanying quartz veins, quartz vein floats and pyrite dissemination were observed together with the alteration zones. The alteration and mineral occurrence are mainly distributed around the Huai Kiu Hok to Huai Kha La and Nam Pong Ngao to Huai Kiang on the eastern edge of the Survey Area; Nam Khon Kaen to Huai Nam Sala in the central part; on and around Mt. Doi Huai Nam Sala, in the northern part; and on and around Mt. Doi Huai Rong Bong in the western part. The above-mentioned alteration zoning was observed in each case, although there were varying degrees of strength and weakness. The alteration around the Huai Kiu Hok to Huai Kha La develop along the NNE-SSW fault, and are developed mainly on the eastern side of the fault. On the eastern ridge of Huai Kiu Hok and the eastern ridge of Huai Kha La

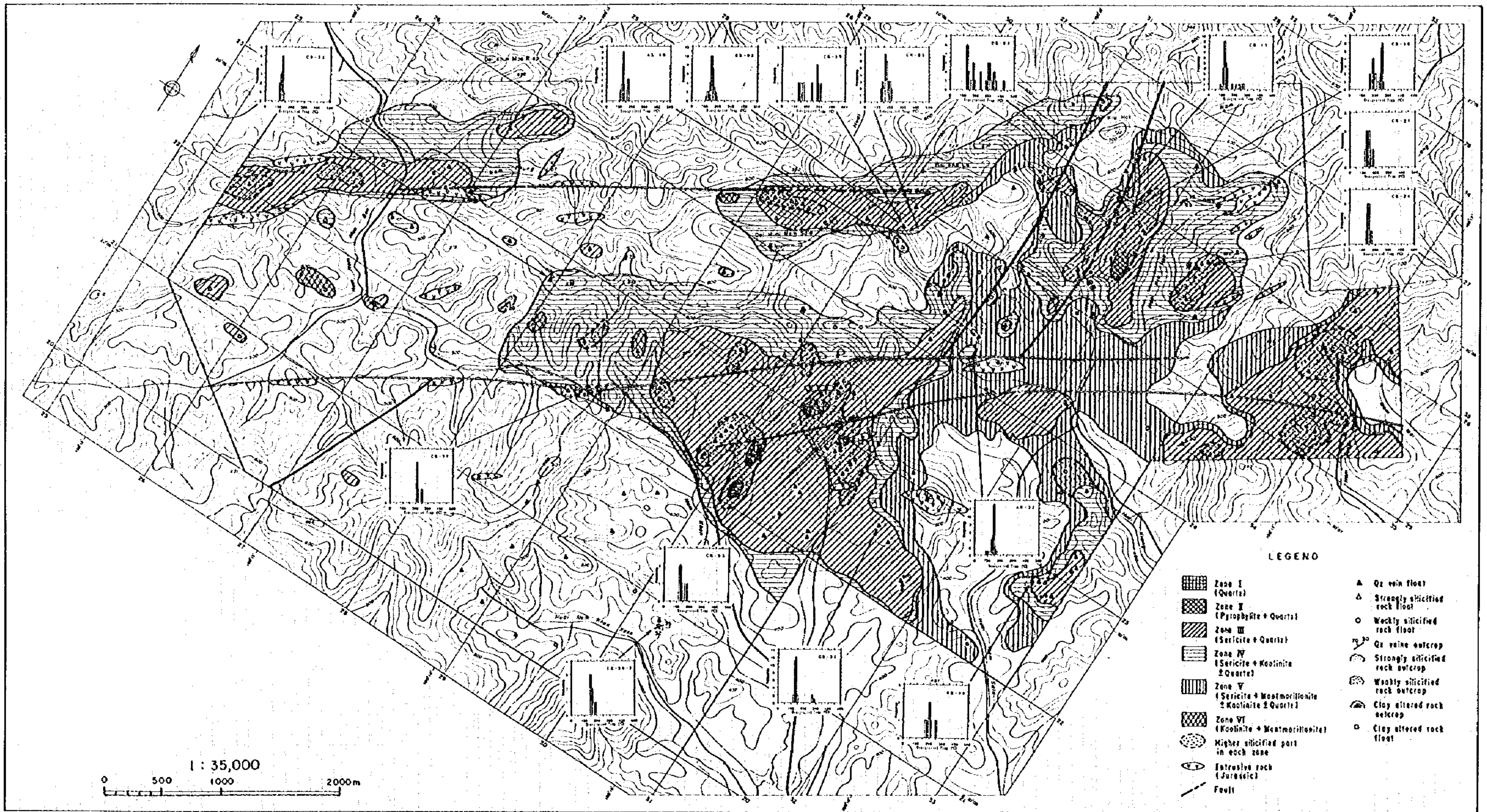


Fig.17 Alteration Map of Mineral Occurrence in Upper Huai Nam Sala Area

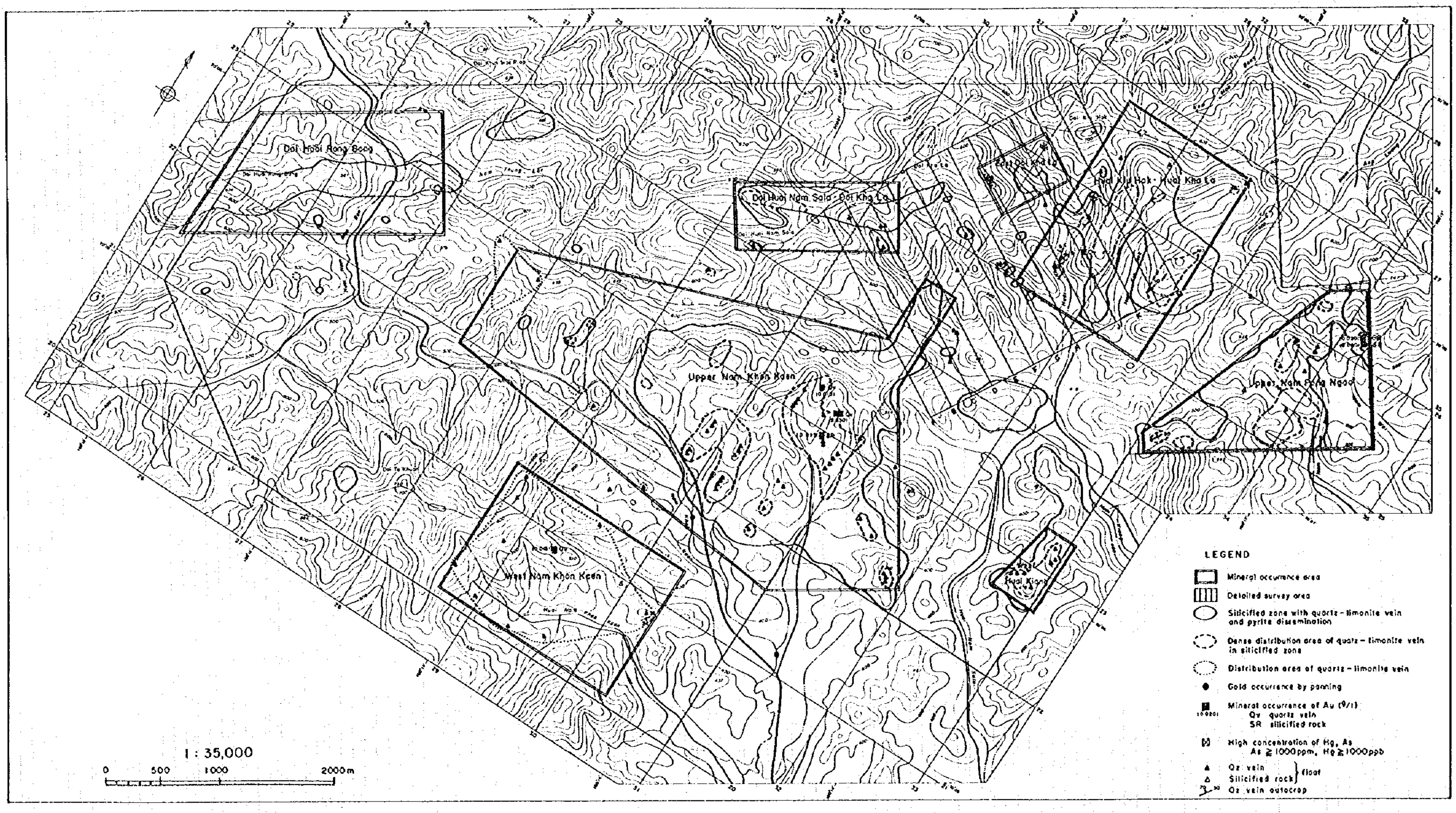


Fig.18 Location Map of Mineral Occurrence in Upper Huai Nam Sala Area

there is a sericite+quartz zone accompanied by a not very large area of strong silicification, and around that a zone of sericite+kaolinite ±quartz, and this continues through a zone of sericite+montmorillonite ±kaolinite ±quartz to the zones of alteration of the Nam Khon Kaen/Huai Nam Sala rivers. The altered country rocks are mainly tuff of Permo - Triassic age, but silicification and pyrite mineralization replacing hornblende were also observed in the hornblende andesitic lava of the top part. In this area, in a N10 to 25° E direction, a quartz vein accompanied by druse with a width of 10-30cm occurs as outcrops and floats. Ore assay produced no significant values for Au, but in the brecciated limonite-quartz vein in the small creek near Line J/700m on the east bank of the Huai Kha La values were As=2,610ppm, Hg=8,440ppb, Sb=20ppm. Values for As and Hg were high, as in the samples with high concentrations of Au from the Nam Khon Kaen area, which will be described later; and it is anticipated that there is gold in the lower part of this vein. The alteration on the Nam Khon Kaen to Huai Nam Sala are developed along the main NE-SW fault, and in the eastern part of the zone of alteration they spread N-S along the convergent NNE-SSW fault. The sericite+quartz zone occurs over a wide area, and a large strongly silicified part was observed. In the center of the strongly silicified part there is a zone of strong silicification made up almost entirely of quartz, and in and around this area pyrite dissemination was observed. On the outside of that is a sericite+kaolinite±quartz zone. There are no outcrops of quartz vein, but many quartz veins with a width of 20 to 50cm, and silicified floats reaching up to 1m, were observed. The ore assay results of the quartz veins and the floats of silicified rock in and around the strong silicification zone in the upper reaches of a tributary of the Nam Khon Kaen river, produced the following values respectively: Au=5.63g/t, Ag=3.6g/t, As=5530ppm, Hg=10630ppb, Sb=120ppm: Au=0.995g/t, Ag=1.8g/t, As=96ppm, Hg=70ppb, Sb=22ppm. In the alteration zones in the Nam Pong Ngao to Huai Kiang area, rhyolitic welded tuff has undergone alteration. In the center is a strongly silicified sericite+quartz zone, and there is a gradual shift in order towards the outside, to a sericite + kaolinite±quartz zone then a sericite + montmorillonite ±kaolinite ± quartz zone, but the two outside zones have a narrow distribution. There are lots of floats of quartz vein and silicified rock. Two samples of strongly silicified rock taken from the ridge at the eastern edge of the Survey Area produced ore assay values in both cases of Au=0.02g/t, Ag=0.4g/t, and As=80ppm, 52ppm, Hg=160ppb, 10ppb respectively. The alteration from Mt. Doi Huai Nam Sala to Mt. Doi Kha La spread in a long narrow strip along the NE-SW fault: there is a sericite+quartz zone in the northern part of Mt. Doi Huai Nam Sala, and encasing that a sericite+montmorillonite ±kaolinite ±quartz zone distributes as far as the environs of Mt. Doi Kiu Hok. Alteration has affected the Permian sedimentary rocks to the Permo-Triassic volcanic rocks. Many quartz veins with a width of 20 to 50cm and silicified floats 50 to 150 cm in diameter were observed. The alteration zone on and around Mt. Doi Huai Rong Bong lies on a southwestern extension of the fault that regulates the zone of alteration around Mt. Doi Huai Nam Sala, and extends along the fault. Andesite of the Permo-Triassic age is strongly silicified and is frequently subject to massive pyrite dissemination.

1-2 Geochemical Prospecting

1-2-1 Method

(1) Sample collecting and pathfinder elements

To ensure coverage of the whole survey area, the principal rivers and their tributaries were selected in advance and sampling was carried out in parallel with the geologic survey in the First Phase Survey. As a rule there was a distance of 350 to 450m between sampling points. Stream sediment from the middle of the stream at each sampling point was put through an 80-mesh screen and 100 to 150g of samples through 80-mesh sieves was collected. 698 samples were taken. After air-drying, the samples were divided between the Thai and Japanese teams and one part was submitted for chemical analyses. As the main purpose of the First Phase Survey was to extract base metal deposits containing gold, 12 elements were taken as pathfinder elements: Au, Ag, Cu, Pb, Zn, Hg, As, Fe, S, W, Sb and Mn.

From the results of the First Phase Survey it was ascertained that geochemical anomalies in Au, Hg and Cu occur in stream sediments in the Chiang Khong 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 the Second Phase Survey, 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 zone was 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 First Phase Survey, nine elements were treated as indicator elements, namely, Au, Ag, Cu, Pb, Zn, Hg, Sb, As and S in the Second Phase Survey. 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 to 300m intervals along the ridge, a total of 982 samples.

(2) Analysis of analytical data

Analytical values were converted into natural logarithms. Half of the value of the lower limit has been used for convergence of statistical processing.

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

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

1-2-2 Results of the Geochemical Prospecting

(1) Results of the First Phase Survey

The comprehensive map of the Chiang Khong area in the First Phase Survey is shown in Fig.19.

The high anomaly zone for gold is particularly marked in the north of the Chiang Khong Area and anomaly zones are distributed in the upper reaches of Nam Khon Kaen and Nam Sala, and in Nam Mae Bong, Nam Thung Lo, etc. With the exception of Nam Mae Bong, these anomaly zones are in harmony with the alteration zones seen in this area and are also closely connected with the faults which accompany by andesite activity. These gold anomalies are thought to have been formed in connection with the formation of the alteration zones and the activity of andesite. Similar anomaly zones, though smaller in scale, are seen on the south side of Nam Khon Kaen. Judging from the fact that the upper reaches of Nam Mae Bong are close to the anomaly zone in the upper reaches of Nam Sala, it is likely that the anomaly zone of Nam Mae Bong is a secondary anomaly zone that flowed from the same anomaly zone. Anomaly zones of gold are distributed here and there in the north of the area, but each anomaly zone only has one or two anomalies and no large anomaly zone is shown. The anomalies are distributed near faults or on the extensions of faults, suggesting that they show gold mineralization along these fractures. The anomaly values in the middle reaches of Nam Mae Tam are close to the pit where placer gold was once mined. Anomalies are scattered in the vicinity of the boundary between granite and sedimentary rock in the south of the area. Here too the anomalies show no large distribution. Large anomaly zones are seen in Huai Mae Liap southwest of Phaya Men Rai and Huai Pla on the west side of the granite body. Four anomaly values are concentrated at Huai Pla and 1,660 ppb, the highest result in the Chiang Khong Area, was obtained here.

In the principal components analysis, the first component (Z-1) has large factor loadings for Fe,

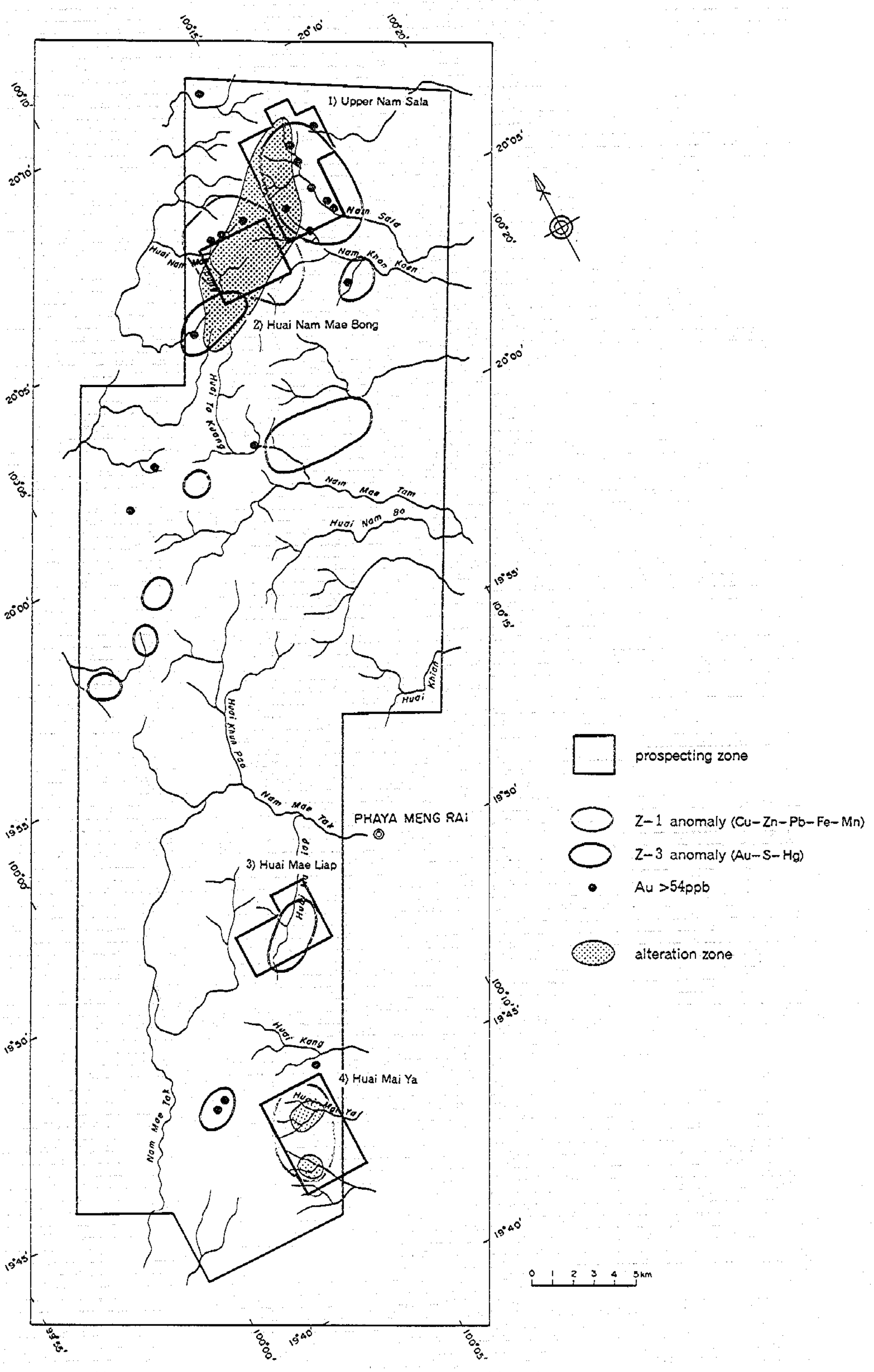


Fig.19 Interpretation Map of Chiang Khong Area

Zn, Mn, Cu, Pb, W and Hg, suggesting that they reflect the existence of base metals. High Score zones for Z-1 are seen around the alteration zone and along the fault in the north and is thought to indicate base metals mineralization. In the south high scores are distributed to the east of the south granite body. The third component (Z-3) has large factor loadings for Ag, S, Au and Hg are high. Considering that Ag has low, it is thought to indicate gold mineralization and its halos. In the north of the area, in addition to high score zone overlapping the alteration zone and faults in the upper reaches of Huai Nam Sala, there is high score in the lower tributaries of Huai Khon Kaen and along the faults which continues to the southwest of the alteration zone. High Score zone is also seen in the area from Nam Mae Tam to the middle reaches of Nam So. In central region, high scores are evident on the boundary with sedimentary rocks, the western side of North Granite Body. This high score zone is almost dependent on the S anomaly values, True high score zones of Z-3 are distributed in the upper reaches of huai Liap and Huai Pla, western side of the South Granite Body.

(2) Results of the Second Phase Survey

The comprehensive map relating to the geochemical survey of the Second Phase Survey are shown in Figs. 20 and 21.

The soil geochemical survey carried out using the rectangular grid method in the detailed survey zone and the Ridge and Spur random method over the whole of the Second Phase Survey Area made it clear that geochemical anomalies in Au and its intimate elements As, Sb and Hg occur in the eastern half of the Survey Area, and that there is a strong possibility of the existence of hydrothermal vein-type deposits containing gold.

The results of the principle component analysis show that Z-1, which is a factor related to gold mineralization, occurs in the upper reaches of the Nam Pong Ngao and the Nam Wai in the north-east part of the Survey Area, and also continues N-S from the eastern edge of the detailed survey zone to the southeast edge. It branches to the southwest along the NE-SW fault from near the upper reaches of the Huai Nam Sala, and once more continues in a N-S direction from near the zone of strong silicification on the tributary of the Nam Khon Kaen river. Also principle Z-4, which is a factor indicating a halo of the upper part of hydrothermal deposits, in the detailed survey zone occurs adjacent to the fault on the western side of Z-1. Apart from the places where it overlaps Z-4, Z-1 is distributed along the streams and on ridges of a lower altitude than the ridges on which Z-4 occurs. There is a possibility that this reflects a vertical zonal structure of indicator elements suggesting gold mineralization.

If we look at the relationship of the distribution of the four elements Au, As, Sb and Hg, the relationship between altitude and the state of alteration shows that Hg is the element representing

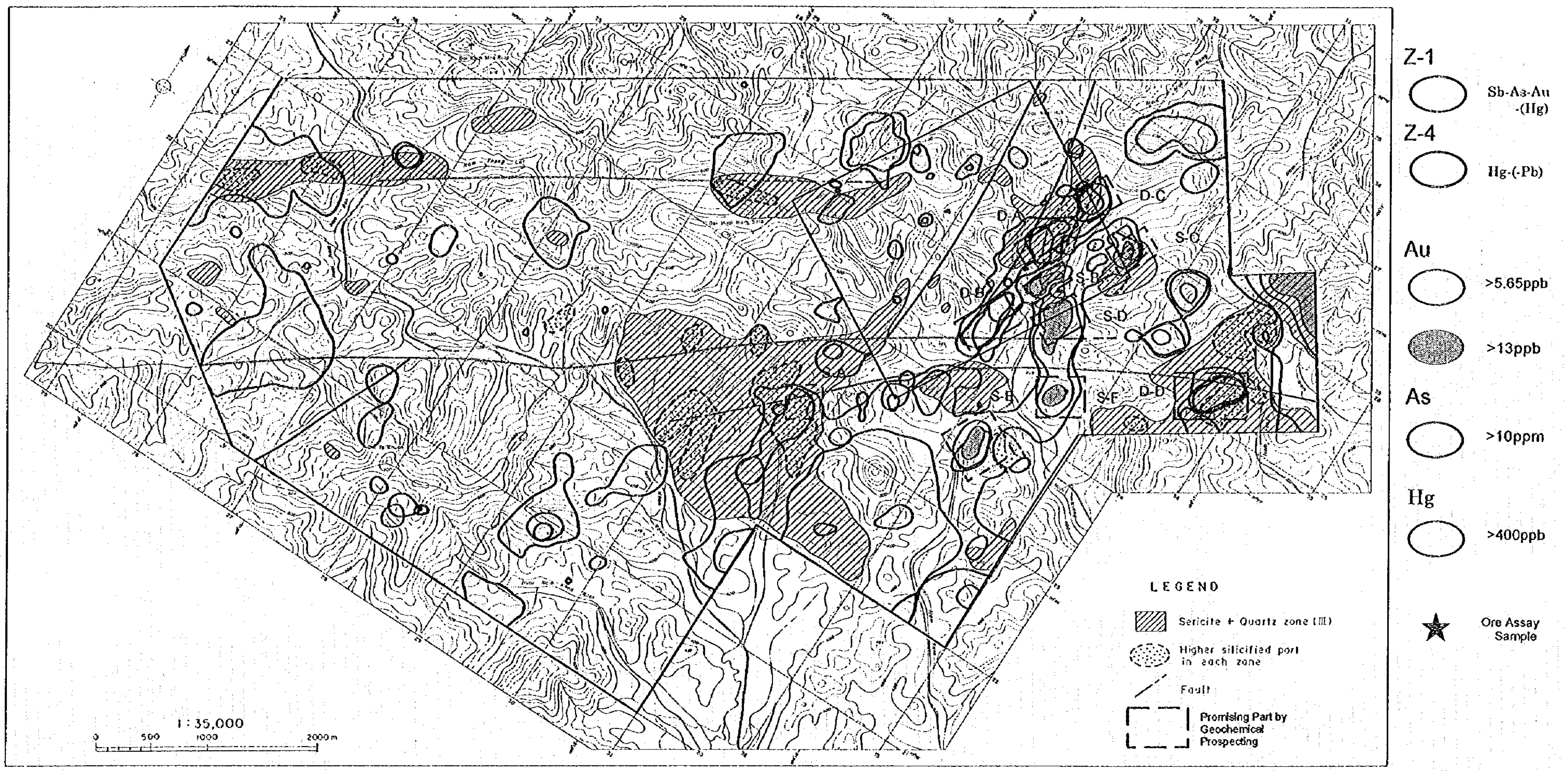


Fig.20 Geochemical Comprehensive Map of Upper Huai Nam Sala Area

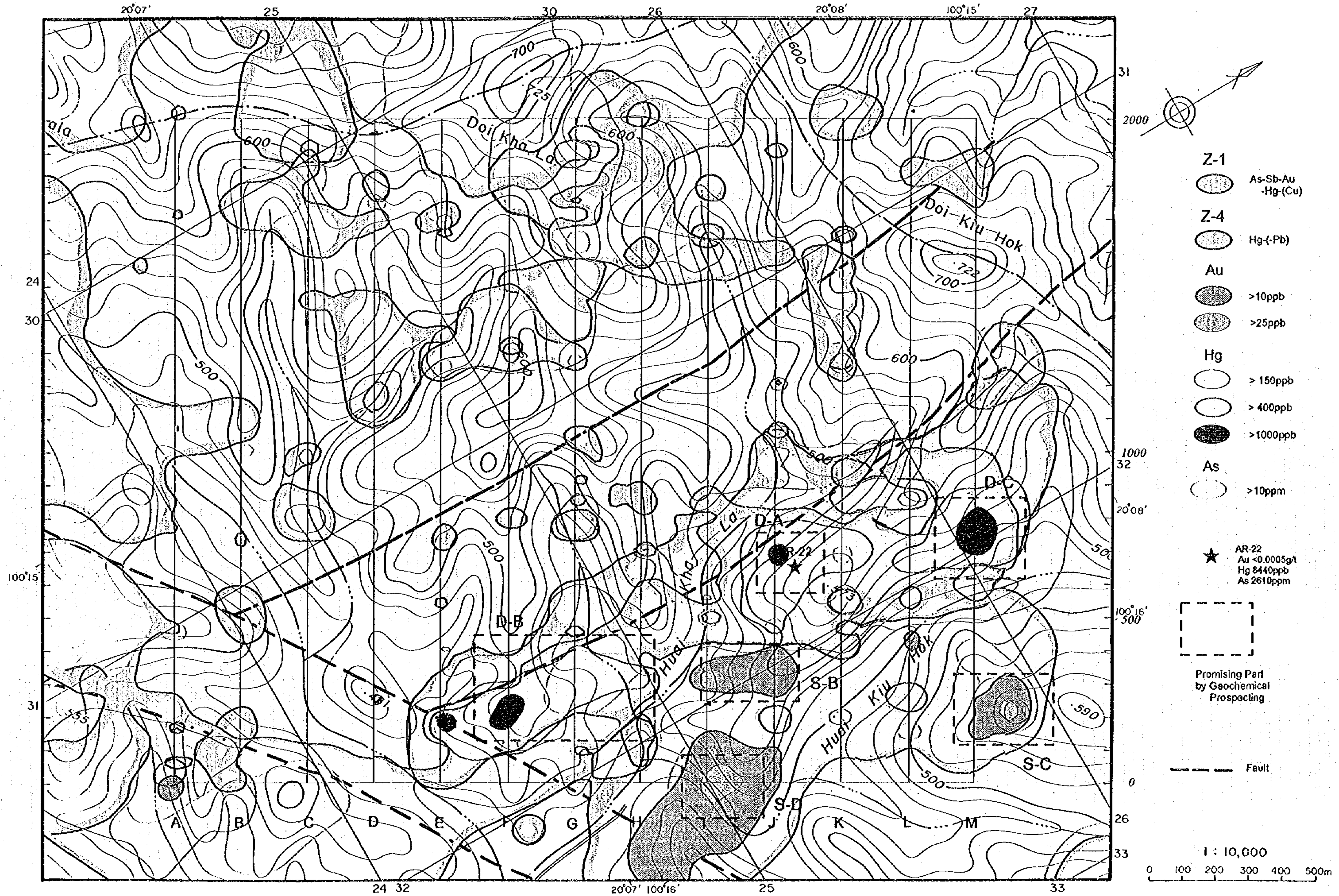


Fig.21 Geochemical Comprehensive Map of Detailed Survey Zone

the uppermost halo, As is between Hg and Au, and Au shows a high temperature halo.

1-3 Geophysical Survey

1-3-1 Method of Survey

In the detailed survey zone of the Second Phase Survey, 13 of the geophysical survey lines extending 2.0 km length and drawn at intervals of 200 m were established. As shown in the map indicating the location of survey area in Fig.22. The direction of the survey lines is N60° W. A total of 21 measurement points at intervals of 100 m was also set up on the survey line. The array CSAMT method (Controlled source audio-frequency magneto-telluric method) was carried out in the survey zone.

1-3-2 Method of Interpretation

The static effects such as the influence of topography and the local resistivity anomaly in the subterranean shallow zone are included in the CSAMT data. In the case of applied one-dimensional interpretation, these influences cannot be evaluated by conducting and the interpreted resistivity structure on the interpreted plane map and interpreted cross section does not correspond to the actual subterranean structure. Accordingly, this report is applied two-dimensional inversion interpretation to illustrate both the interpreted resistivity plane map and interpreted resistivity cross section for interpreting the resistivity structure in the survey zone.

1-3-3 Results of Interpretation

Referring to the resistivity cross section of the survey lines made by conducting two-dimensional interpretation and the resistivity plane map such as for a depth of 50 m from the surface of the earth, alt.400m, alt.300m and alt.200m, the panel diagram of interpreted resistivity plane maps(Fig.23) and the panel diagram of interpreted resistivity cross sections (Fig.24) were illustrated.

The panel diagram of interpreted resistivity plane maps indicates that in the east part of the survey area, the low resistivity zone of below 200Ωm is distributed in the area from the lines A to H, in the width of the measurement points from 0 to 500 in the direction nearly from NE-SW. The panel diagram of interpreted resistivity cross sections shows that the low resistivity anomaly zone indicates a tendency which the resistivity values gradually decrease toward the lines A to E and conversely it gradually increases toward the lines E and H, and toward the lines I and M it turns out to the high resistivity anomaly. Such low resistivity anomaly stretches out from the surface of the earth to a depth of alt.250m. The anomaly section changes the direction on the line H at the measurement point of 400, then stretches out to the line L at the measurement point 600 and connected in lineation (N-S). This

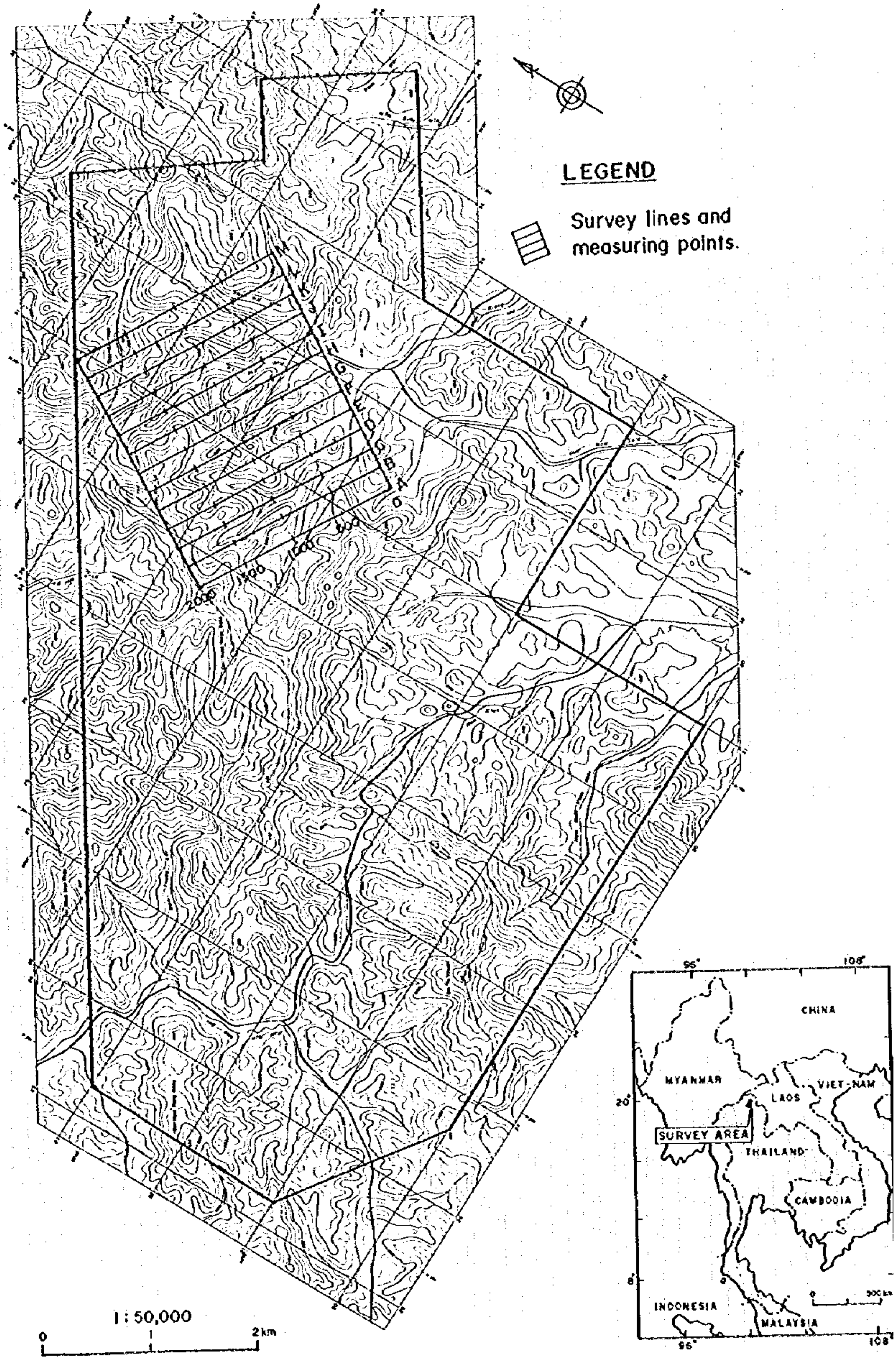


Fig.22 Location Map of the Geophysical Survey Area

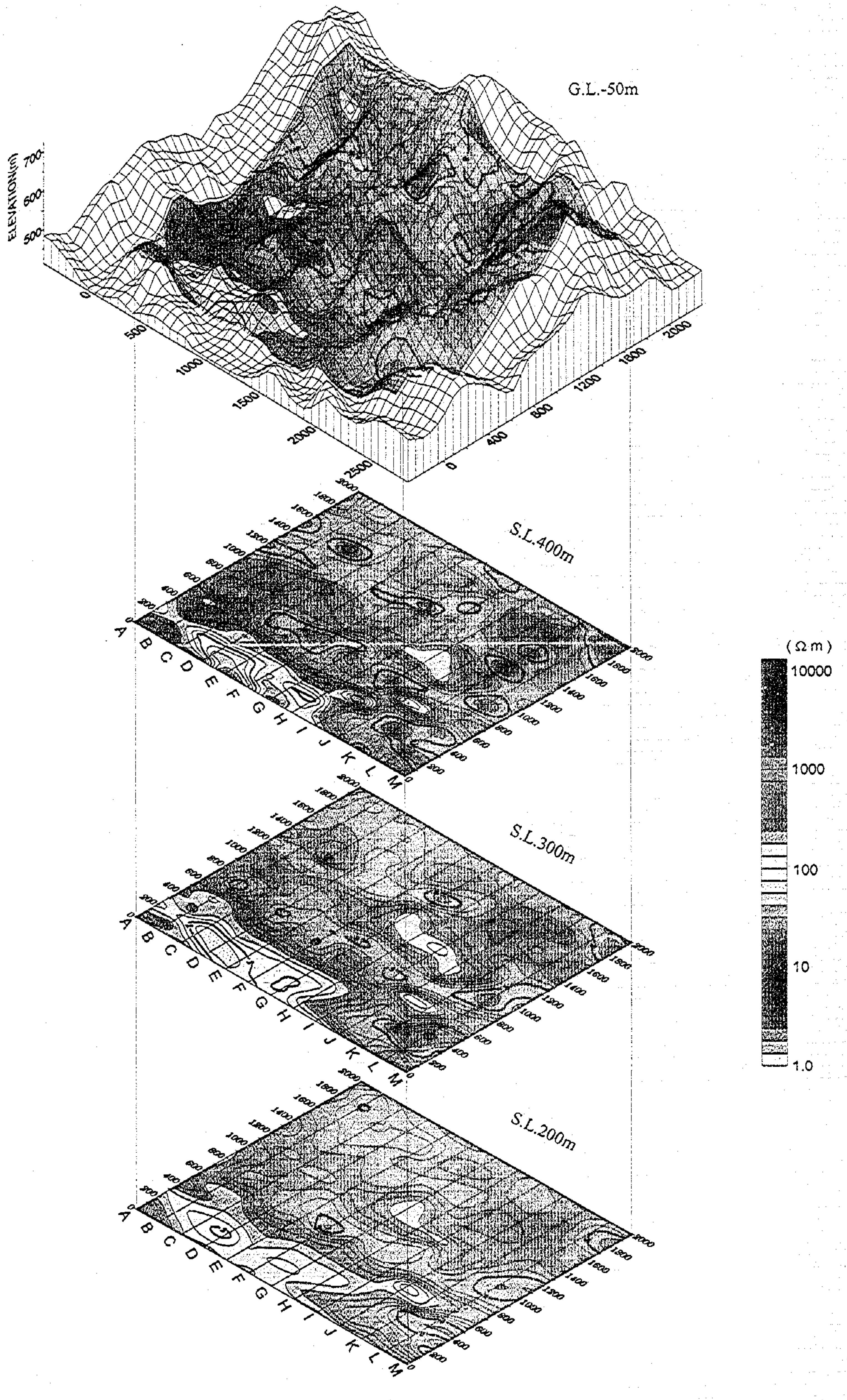


Fig.23 Panel Diagram of Interpreted Resistivity Plane Maps in Detailed Survey Zone

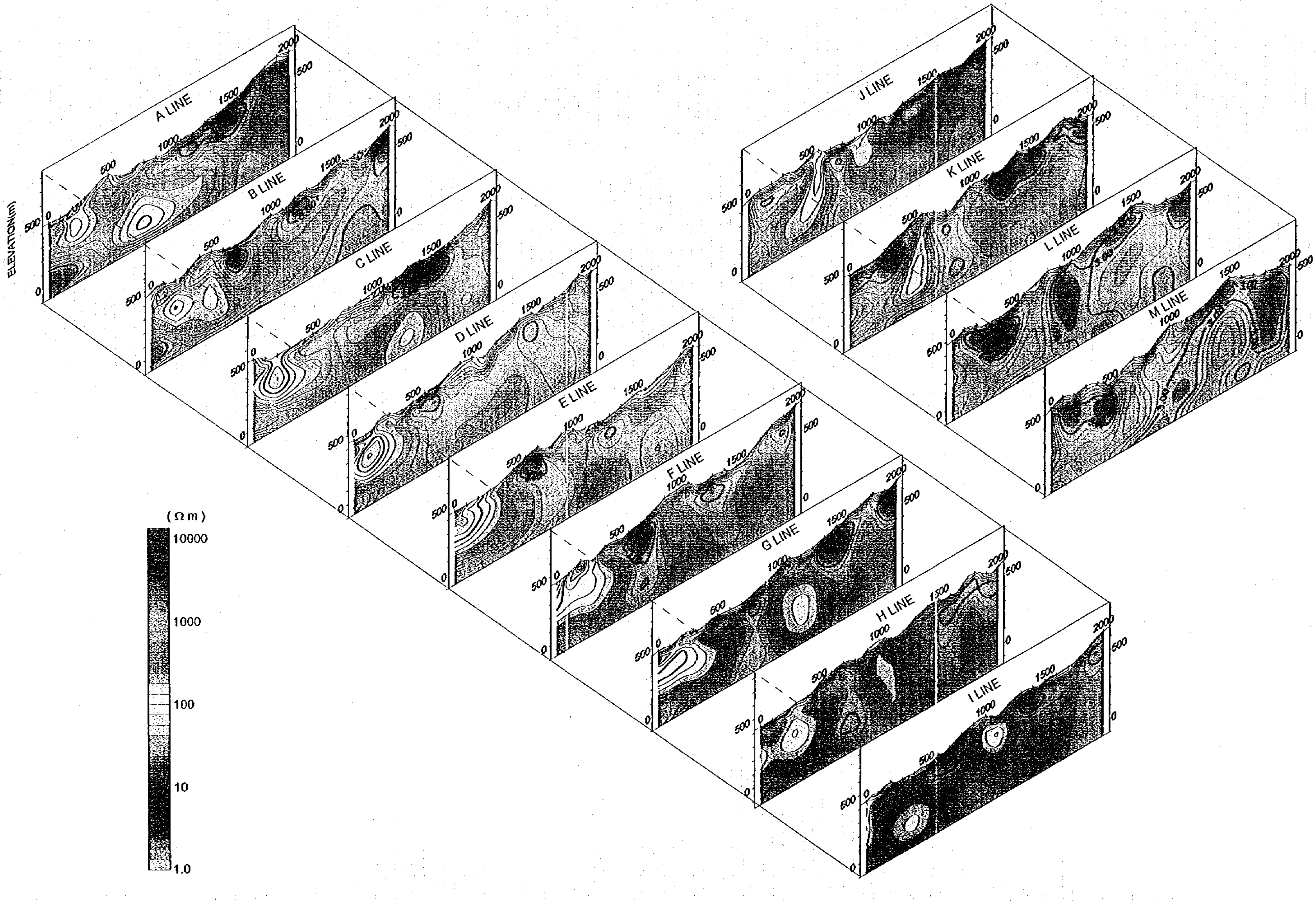


Fig.24 Panel Diagram of Interpreted Resistivity Cross Sections in Detailed Survey Zone

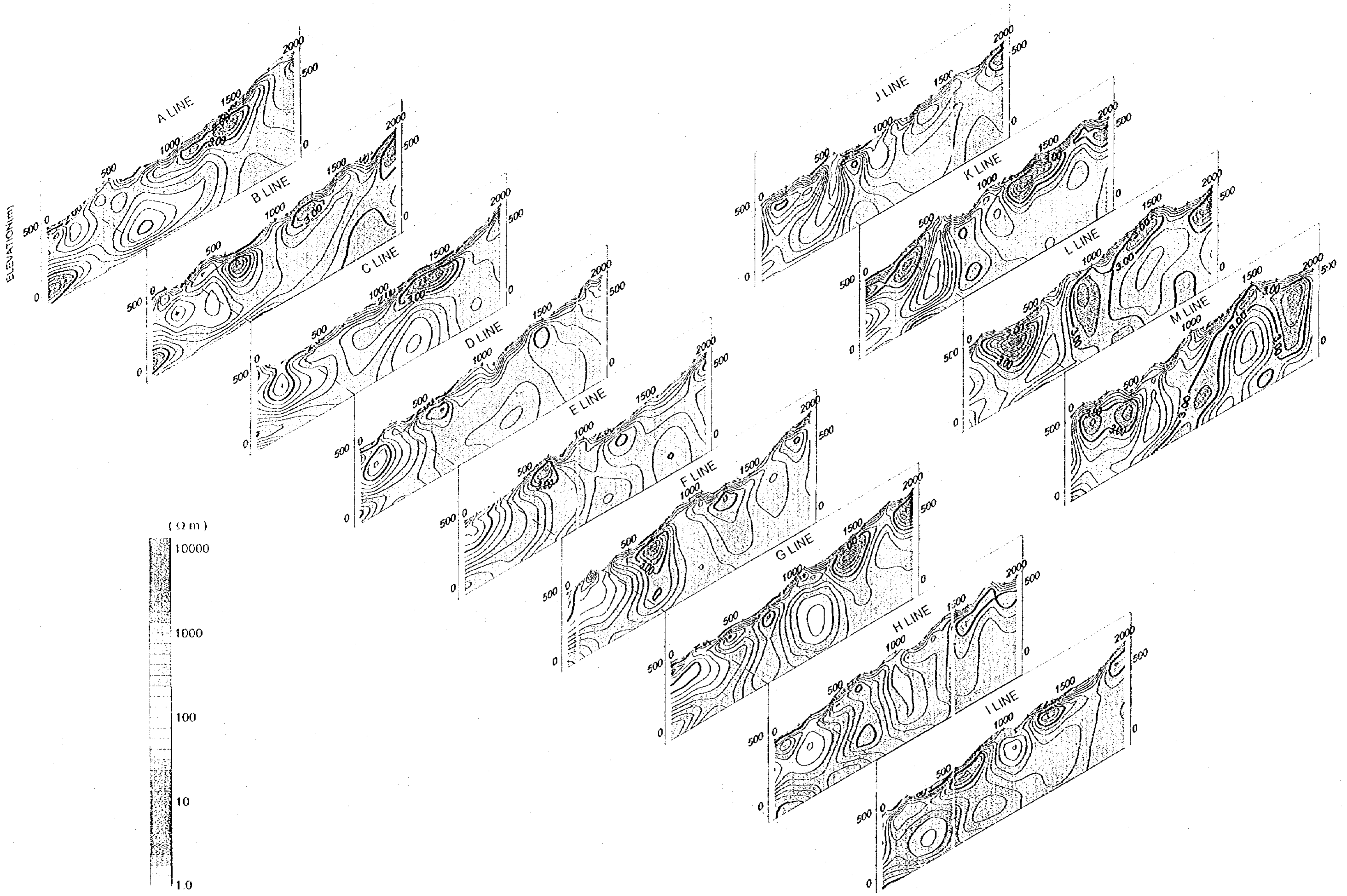


Fig.24 Panel Diagram of Interpreted Resistivity Cross Sections in Detailed Survey Zone

anomaly resistivity structure is distributed along the lateral discontinuous resistivity structure which runs toward NE-SW, and NNE-SSW from the line A around the measurement point 500 to the line H around the measurement point 300 that have been assumed by the apparent resistivity plane map and cross section. This structure is considered to be a fault and altered zone run along a fault. The high resistivity anomaly from the lines I to M between the measurement points 0 and 500 which is described above shows the tendency of the resistivity increasing in the direction from the lines I to H and the area too is extending.

Nevertheless, the central and western part of the survey area is mainly the high resistivity zone, the low linear resistivity anomaly of approx.200 Ω m is recognized in the area from the line G between the measurement points 1100 and 1200, alt.0m to alt.300m and to the lines I between the measurement points 1000 and 1100, alt.250m to alt.400m. This low resistivity anomaly corresponds with the structure that are assumed by the apparent resistivity plane maps and cross sections that stretch out continuously from the line B around the measurement point 900 to the line K around the measurement point 1000 in the direction from NE-SW to NNE-SSW. It is considered to be the lateral resistivity fault structure. Such as the interpretation conducted in the structure, a strip of the high resistivity zone is distributed from the line B between the measurement points 600 and 900 to the line I between the measurement points 600 to 900. This high resistivity zone, same as the low resistivity zone described earlier, changes the direction from the line I to N-S, and then stretches out to the line M between the measurement points 1000 and 1200.

Apart from these structures, the apparent resistivity plane maps and cross sections shows that in the south west of the survey area, the structure in the direction of NE-SW to NNE-SSW from the line A at the measurement points 1800 to the line E at the measurement point 1800, and the structure which stretches out to the line C at the measurement point 0 from the line A at the measurement point 200, and also from the line M at the measurement point 100 to the line L at the measurement point 0 are all assumed.

1-4 Drilling Survey

1-4-1 Content of Survey

In the drilling survey, two holes, MJTC-1 and MJTC-2, were bored at two drilling sites shown in Fig.25 and Fig.26. The drilling length of each hole was 300.10m for MJTC-1 and 454.60m for MJTC-2, making a total of 754.70m. About 120 test samples were collected from the two survey holes for use in ore analysis, X-ray diffraction tests, grinding of fragments and measuring the homogenization temperature of fluid inclusions.

The holes were drilled with diameters of PQ, HQ and NQ as shown in the drilling performance

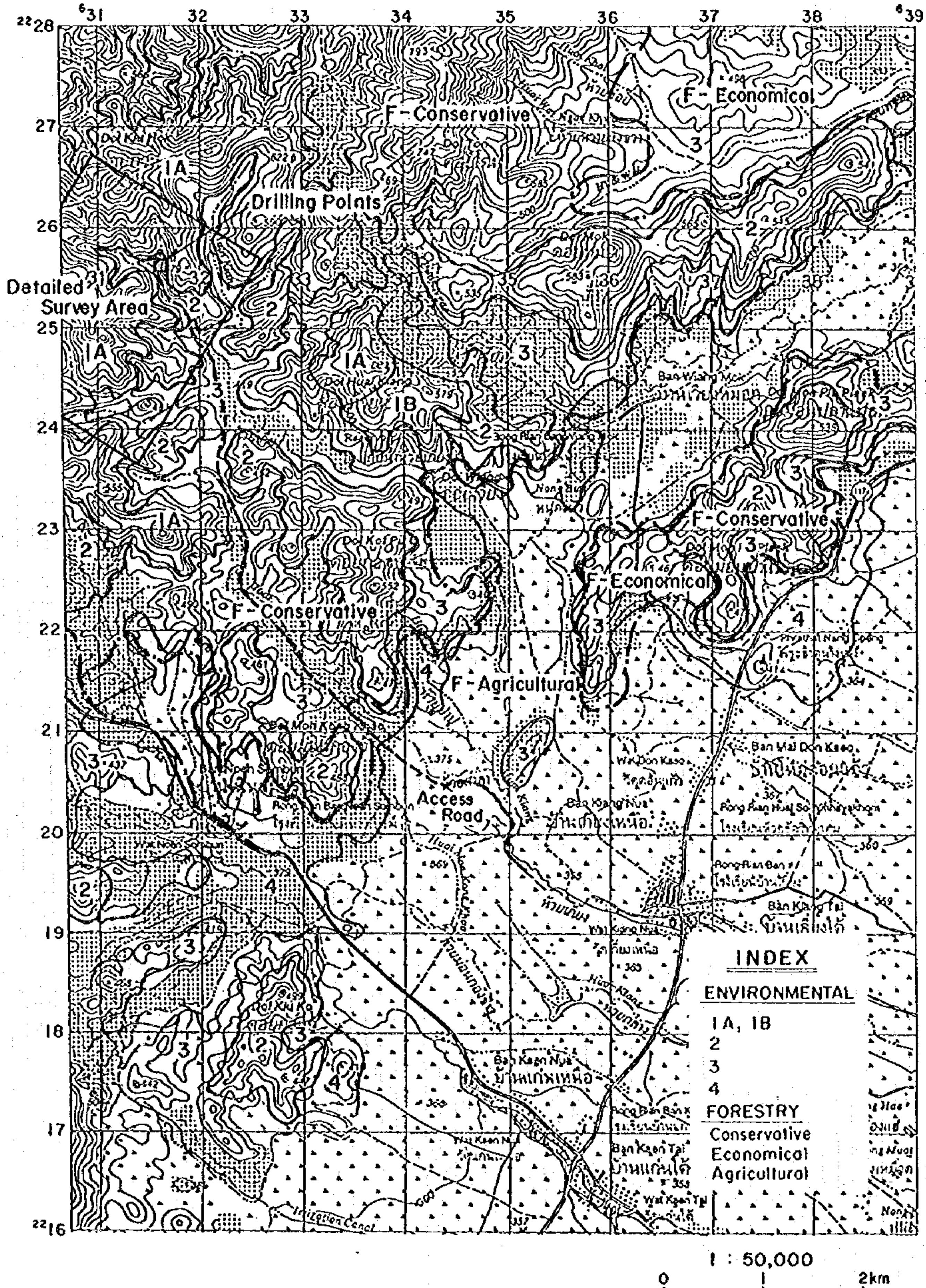
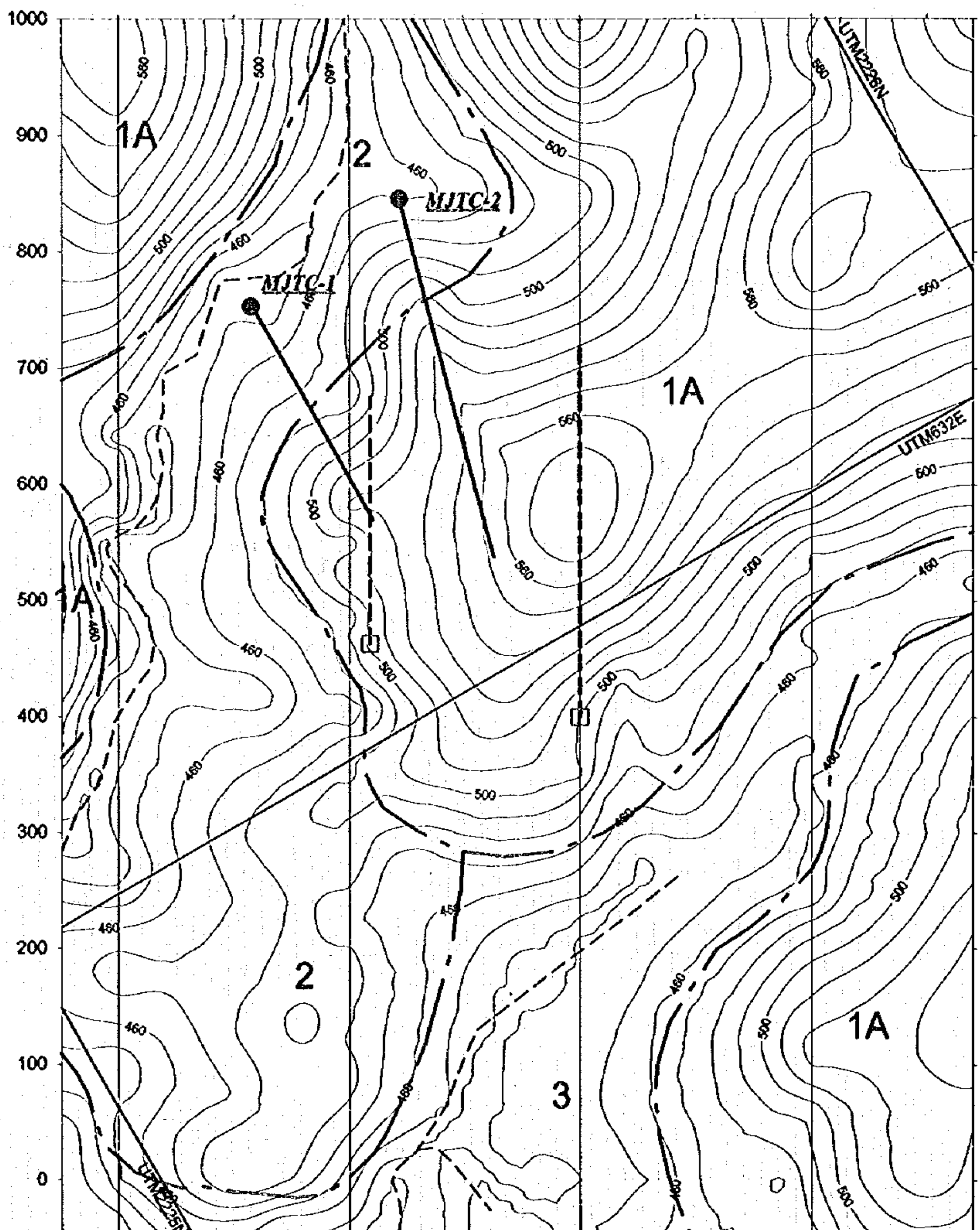


Fig.25 Relation between Drilling Locations and Restricted Area



□ Original Planning Point

● Actual Drilling Point

Boundary of Restricted Area

Cart Road

0m 100m 200m 300m 400m

Fig.26 Location Map of Drilling Site

table, and a core recovery rate of over 95% was achieved. Drilling efficiency fluctuated according to the geological conditions during drilling and was extremely low in the argillized and brecciared zones which were particularly fragmented, but the drilling efficiency for each hole was 10.72m/total number of working days for MJTC-1 and 16.84m/total number of working days for MJTC-2. The cores that were collected were stored in the core warehouse of the Chiang Mai Branch of the Department of Mineral Resources.

1-4-2 Survey Results

The geology, detection of mineralization and ore grades are described below. The columnar section is drawn to a scale of 1:200 and is appended at the end. The geologic cross-section is shown in Fig.27 and Fig.28. As for the apparent dip in the bedding (schistosity), intrusion plane, veins, etc. shown on the columnar section, the dip that is parallel to the drilling direction is taken as 0° and the perpendicular dip as 90°.

(1) Hole MJTC-1

This hole has a drilling direction of N90° E, a dip angle of -45° and a length of 300.10m.

The soil from the surface to a depth of 3.30m is orange laterite and contains small rounded pebble to cobble of shale and altered tuff breccia from a lower level.

Permian sedimentary rock is distributed between a depth of 3.30 and 77.20m, and shale, sandstone, and alternate shale and sandstone layers are repeatedly seen. The shale has a well developed slate cleavage. Compared with the bedding where it alternates with sandstone, the cleavage has developed virtually parallel to the bedding. The bedding and/or schistosity in this sector is 40°-65°.

Dikes of intensely altered plagioclase porphyritic basalt intrude at depths of 53.20-54.50m and 60.70-62.05m, and the intrusion plane is parallel to the bedding plane.

With the exception of an extremely small section, the sedimentary rock in this sector is unaltered. At depths of 25.70-26.85m, 39.50m and 50.80m, the shale in the vicinity of the quartz-carbonate veins has been silicified, argillized (chlorite, mica) and carbonatized (mainly ankerite). Alteration in basalt is the same as in sedimentary rocks.

Permian sedimentary rock prevails at a depth of 77.20-131.70m, and intrusion of basalt and andesite is seen. Compared with the upper sector, the intrusive basalt and andesite dikes are wider and pyrite dissemination is seen throughout the sector. The bedding and/or schistosity of the sedimentary rock is virtually uniform at 40°-45°, but intruded boundary of dikes that are

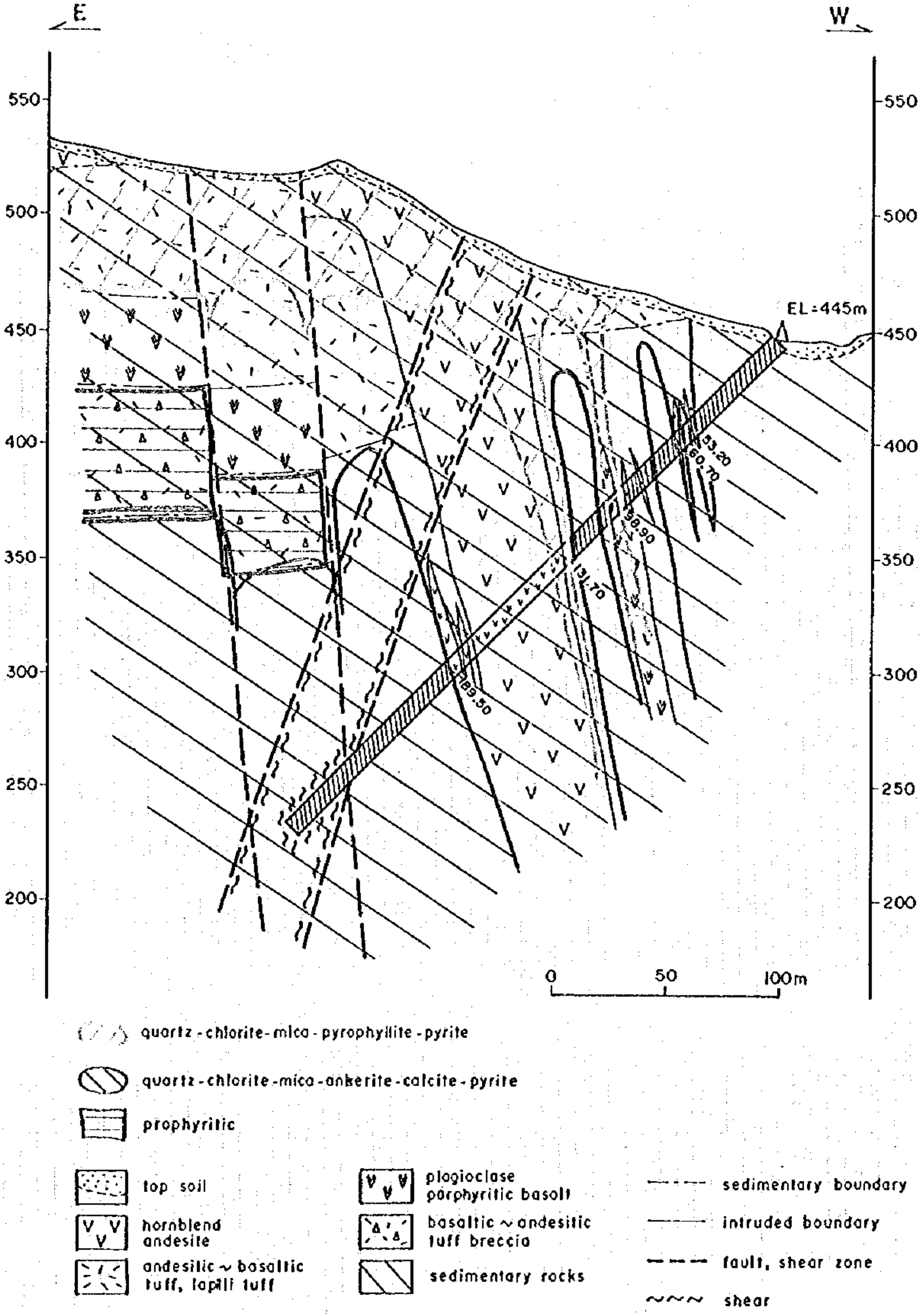


Fig.27 Geologic Profile of MJTC-1

both parallel and slightly inclined to 60° are seen. The sedimentary rock is generally not altered to the naked eye, but silicification and carbonatization are seen on the hanging wall side of the altered andesite and in sandstone-bearing foliated shale. The andesite shows clear silicification, argillization (mainly chlorite), and carbonatization (calcite, ankerite). Pyrite is disseminated along the slate cleavage in the mudstone and at scattered points in the sandstone and andesite, but it forms a marbled vein-type dissemination zone at 45° at 100-103m.

Altered andesite is distributed at a depth of 130.70-200.30m. There are interbeded of shale, 0.5-3.5m wide. As the andesite has autobrecciared in parts, it is likely to be lava. As the boundary area has frequently been brecciared or crushed by new fault activity, the relation between the andesite and the slate in between is not clear, but judging from the fact that the slate is unaltered although there is clay in between and the andesite has been altered, it is likely that it is related to the fault. The andesite has undergone intense alteration overall, and silicification, argillization (chlorite, mica) and carbonatization (ankerite> calcite) are seen. Silicification is the strongest at 155-178m, gradually weakening in the lower part. Argillization and carbonatization grow stronger in the lower layers as silicification becomes weaker. The pyrite dissemination zone forms a marbled vein-type dissemination zone and has frequently developed at 45°. The dissemination zones are clearly developed immediately in both side of the intensely silicified zone.

Shale that has a slate cleavage, massive sandstone and shale containing a lot of sandstone fragments that extends in the direction of the schistosity (slumping sediment?) are repeatedly distributed between a depth of 200.30m and 300.10m. From around a depth of 268m to the bottom of the hole, the soil has undergone conspicuous fragmentation and there has been brecciation and argillization, and the outer shape of the core can no longer be seen. Mineralization and alteration are not seen apart from extremely small pyrite dissemination in the sandstone breccia at a depth of 229.65-229.75m.

Quartz-carbonate minerals (-chlorite) veins between 5mm and 20cm wide are seen throughout the entire hole. They appear at a frequency of 4 or 5 veins over 10m, and the prevailing direction of the veins is 0-10°, 40-60° and 80-90°. Apart from the veins that lie in the altered adesite at a depth of 130-140m, there is no accompanying pyrite.

18 samples were collected for ore assay. When they were analyzed, all the samples showed Au<0.07g/ton and Ag<1ppm or 1ppm. Values of 15-105ppm, 40-315ppm and 75-305ppm were obtained for Cu, Pb and Zn respectively in the pyrite disseminated part of the altered andesite

at depths between 95m and 155m.

5 samples were analyzed for the homogenization temperature of fluid inclusion. Expecting F-3, almost of Temperature is distributed from 140 to 150℃. Inclusions of F-3 and a part of F-2 show around 200℃.

(2) Hole MJTC-2

This hole has a drilling direction of S75° E, a dip angle of -45° and a length of 454.60m.

From the surface to a depth of 3.25m, it is orange-colored laterite silt and it contains round green andesite boulders of a maximum 1m in size.

Between depths of 3.25m and 128.25m, there is repeated distribution of shale that has developed a slate cleavage, massive sandstone, massive calcareous shale containing fossils, schistose shale containing a lot of lens-shaped sandstone fragments, and alternationg of shale and sandstone. Intensely altered andesite dikes intrude at depths of 13.50-15.25m and 94.20-95.10m. Between depths of 3m and 11m, 25m and 43m, and 77m and 99m, it has been intensely crushed, and pulverization, argillization and brecciation are conspicuous. The schistosity or bedding of the sedimentary rock is 10-30° up to a depth of about 50m, but 40-60° over 50m. The intruded boundary of the andesite is parallel to the schistosity.

In the parts that have not been crushed, 5 or 6 veins of quartz-carbonate minerals vein have developed over 10m. Most of these veins have developed in the direction of 60-75° and 80-90°.

Hardly any signs of alteration are seen in the sedimentary rock, but the andesite dikes have undergone alteration to the extent that the groundmass texture of the original rocks can no longer be distinguished. The altered minerals that were detected are quartz, chlorite, mica minerals, calcite and ankerite.

In addition to distributions of sandstone, alternate layers of sandstone and shale, shale, and shale containing lens-shaped sandstone fragments in the sector between depths of 128.25m and 187.40m where sandstone prevails, andesite dikes intrude into the upper levels at 128.25-129.10m and 131.80-132.80m. The bedding or schistosity is 50-60° up to a depth of 150m, and 40-50° over 150m. The intruded surface of the andesite is parallel to the bedding.

The andesite dikes have been altered, and in addition the sandstone and part of the shale have undergone alteration and pyrite dissemination. The altered minerals are mainly quartz, chlorite, mica minerals and ankerite, and the ankerite disappears in the parts where there is strong silicification. Silicification cuts across the alterations. The quartz-carbonate mineral veins are mainly calcite and no ankerite appears.

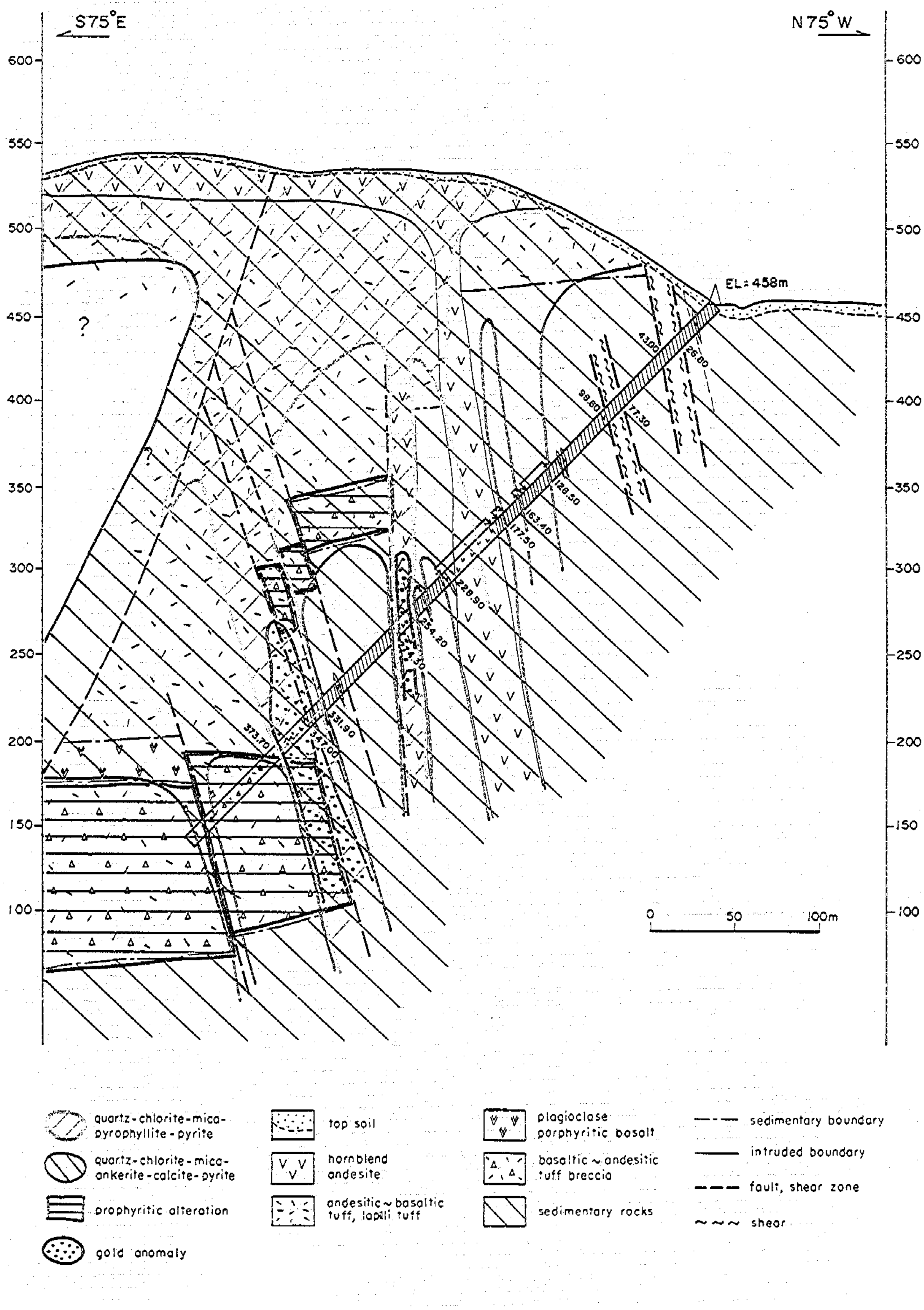


Fig.28 Geologic Profile of MJTC-2

Apart from the quartz-carbonate mineral veins, quartz veins and carbonate mineral veins have also developed, and most of the veins are 30-40° in the upper levels to a depth of about 140m, and 50-70° or 90° in the lower levels.

Hornblende andesite that has undergone strong silicification accompanied by pyrite dissemination and chloritization is distributed at a depth of 187.40-226.90m. Silicification is strong overall, but calcite and ankerite also appear universally. As for clay minerals, mica minerals are seen in addition to chlorite. Pyrite is uniformly distributed at scattered in a range of 2-5%, but it accompanies narrow quartz veins that have developed in parallel at a depth of 203.60-206.50m, and it is disseminated in extremely large quantities in network or vein-like form at 209.30-209.80m.

Banded quartz-carbonate mineral veins can be seen extending in virtually the drilling direction at 215.60-217.35m. The width of the veins is 3-6cm+, and there are enriched bands of relatively fine-grained pyrite between the 3-5mm veins of quartz and carbonate minerals that run parallel, and at a glance these are observed to be "gin-guro".

Shale is interposed at 216.90-227.90m, and no alteration is seen in the shale itself, but narrow chlorite veins have developed in network form.

Between 228.90m and 254.20m it is composed of shale and alternation of shale and sandstone, and andesite dikes intrude at 246.50-247.60m. No alteration or mineralization are seen in the sedimentary rock. The andesite dikes have undergone silicification, argillization and carbonatization, and there is dissemination of pyrite.

Altered andesite is distributed between depths of 254.20m and 274.30m. Silicification is rather weak, and argillization and carbonatization are conspicuous. There are few cracks overall, and narrow black veins 1-2mm wide composed of carbonate minerals, graphite and pyrite have developed in network form. Concentrations of carbonate minerals-quartz veins are distributed at 269.402-270.50m and from 273 to 274m.

There is a clay fault zone 35cm wide bordering the alternating layers of shale and sandstone in the lowest part, and the two breccias have been mixed together, but only the andesite pebbles have undergone alteration.

As a result of ore assay in the pyrite dissemination zone at 269.402-270.50m, values of Au=0.08 and 0.16g/t were obtained.

Between 274.65 and 331.90m there is composed of alternating layers of shale and sandstone, shale, and sandstone, and andesite dikes intrude at 318.20-319.60m. In the uppermost part of this sector about 30m there are relatively few cracks and bedding has developed at 70-85°, and calcite-quartz veins seen at 280-290m have also developed along this structure. Below 305m there is brecciation and many cracks, and in many parts the core has no shape. Virtually no alteration or mineralization are seen in the sedimentary rock. Chlorite veins have developed, filling the cracks at 312-313m, and the surrounding part has undergone silicification.

The andesite dikes have undergone intense silicification, argillization and carbonatization, and pyrite is extensively disseminated. Values of Au=0.10g/t and Zn=120ppm were obtained by ore assay of the samples.

Alteration and pyrite dissemination are seen overall in parts where sandstone dominates at a depth of 331.90-347.00m. It is interbeded by lapilli tuff at 338.00-340.40m. Alteration tends to be strong in the lapilli tuff parts and weak in the sandstone parts, but pyrite dissemination shows the opposite tendency, becoming strong in the sandstone areas. With regard to the altered minerals, in addition to quartz, chlorite, mica minerals, calcite and ankerite, pyrophyllite is detected in the X-ray diffraction tests.

The results of ore assay in areas where pyrite is disseminated show Au:<0.07, 0.22 and 0.08g/t, and Ag: 1.0, 1.8 and 1.4ppm, and at the same time the following high values were obtained for As, Sb and Hg: As:96-390ppm, Sb:19-49ppm, and Hg:1,020-9,460ppm.

Between depths of 347.00 and 373.70m, the ground is composed of tuff and autobrecciared andesitic lava. Fine-grained tuff distributed at 347.00-350.00m has undergone intense silicification and carbonatization, but no pyrite dissemination is seen. The autobrecciared andesite areas have been intensely silicified, argillized and carbonatized, and pyrite has been disseminated overall in marbled veins at 45°. Alteration of coarse-grained tuff at the lowest level is also extremely intense, as with andesite. There is no overall pyrite dissemination, but pyrite veins have developed in parallel at 372.50-372.70m.

With regard to the altered minerals, quartz, chlorite, mica clay minerals, calcite, ankerite and pyrophyllite are seen.

The highest gold-bearing values in the present analysis were obtained in the ore assay, with Au at 0.34, 0.26g/t and Ag at 0.4 and 0.2ppm. At the same time, the following high values were also seen, As:444 and 492ppm, Sb:84 and 84ppm, and Hg:5,420 and 6,150ppm.

Between 373.70m and 454.60m (the bottom of the hole), it is composed of repetitive dark green or reddish-brown lava, and tuff breccia, and in parts it is interbeded with lapilli tuff and coarse-grained tuff that are characteristic of this area. This layer has also undergone silicification and carbonatization (calcite>>ankerite), but it has undergone propylitization which is characterized by chloritization, albitization and pyrite dissemination. It correlates to the tuff breccia layer that makes up the lowest strata of Permian-Triassic volcanic rock in the rock facies. At 443-453m this layer shows quite intense silicification and there is fairly intense pyrite dissemination in parts, but here too albitization is marked and it differs to the alteration of other layers.

The results of ore assay in the areas of intense silicification show Au<0.07g/t and Ag<0.2ppm.

The homogenization Temperature is concentrated from 170 to 220℃ excluding 2F-6. There is higher than in MJTC-1. 2F-6 in propylitic alteration has three peaks of homogenization temperature which are 150, 220, 300℃.

1-5 Summary of the Survey Results

(1) Geology

The survey area is a region where Permian sedimentary rock and Permian-Triassic volcanic rock are adjoined by a fault on a N-S trend. Permian sedimentary rocks are distributed on the west side of the fault, and Permian-Triassic volcanic rock tuff is distributed on the east side, and the east side is presumed to have subsided in relation to the west side.

Drilling survey was carried out in the area where sedimentary rock is distributed on the west side of the fault into the boundary area between the sedimentary rock and volcanic rock.

The Permian sedimentary rock is composed of shale that has developed a slate cleavage, massive sandstone from fine to coarse-grained, alternating layers of shale and sandstone, schistose shale (slumping sediment) containing sandstone fragmwnts that extends in the schistosity or bedding direction, calcareous shale and tuff. The strike and dip of bedding and/or schistosity at the ground surface is N5-15° W/70-90° W. Looking at the area surrounding the shear zone and fault, in many cases the bedding or schistose plane of the drilling hole is 30-70° taking the extension direction of the core as 0°, and by comparison with structure at the surface, it is presumed to be N0-15° W/65-90° W.

As for the Permian volcanic rock, there is distribution of andesitic-basaltic tuff breccia, plagioclase porphyritic basalt, basaltic-andesitic tuff and lapilli tuff, and hornblende andesite. Basalt and andesite dikes intrude parallel to the schistosity of the sedimentary rock in the core, often at 40-60 . Plagioclase porphyritic basalt is distributed in relatively shallow places in the drilling hole (above 100m), and the veins are not very wide. Hornblende andesite between 10 and 60m wide is distributed, though there are places where it is several meters wide, and it spreads out as lava at the ridge of the survey area. Tuff breccia is distributed from a depth of around 373m to the bottom of hole MJTC-2, and it is mixed with motley dark green and reddish-brown tuff breccia, autobrecciared lava and massive lava. Similar rock facies are exposed along the main fault for about 10km in a southwestern direction from the present survey area.

The faults that have developed in this region mainly run at an inclination or parallel to the bedding and/or schistosity of the sedimentary rock, and most dipping to the west strike in a direction of N0-15° W. Development of shear zones composed mainly of fracturing action (brecciation or fault argillization) and totally unaccompanied by alteration or mineralization is seen as final fault activity.

(2) Mineralization and Alteration

From the results of the drilling survey, mineralization and alteration are observed in this region, centering on the andesite dikes intruding into the sedimentary rock. When the dikes are wide, alteration and pyrite dissemination zones extend to the sedimentary rock on the hanging wall side of the dikes. Even when no dikes are seen, as at depths of 128.50m-163.40m and 331.90m-373.40m in MJTC-2, intense alteration and pyrite dissemination sometimes occur, but it is thought that in such parts some faults developed or dikes existed close by that provided a passage for hydrothermal mineralizing solution.

With the exception of the lowest breccia tuff facies, hydrothermal alteration caused intense alteration universally in the Permian-Triassic volcanic rock, albeit varying in strength. Hydrothermal alteration and pyritization of the sandstone are marked in the vicinity of the dikes that provided a passage for hydrothermal mineralizing solution, but pyrite dissemination in the shale is only seen along the schistosity.

From the results of microscopic observations and X-ray diffraction tests, alteration by hydrothermal mineralizing solution is characterized by silicification, argillization (chloritization, sericitization) and carbonatization (calcitization, ankeritization), and most of the rocks that have undergone alteration have been alternated so much that their structure is no longer distinguishable. The alteration is accompanied by pyrite dissemination, and in addition to dissemination of fine pyrite that is seen overall, marbled pyrite dissemination zones are formed around fairly intensely silicified areas, with a maximum of 40% pyrite visible in some places.

In the above alteration and mineralization, pyrite dissemination occurs after silicification and argillization have advanced, and later ankerite crystallizes across it in veins followed by calcite, to replace the matrix between the quartz interstitially. In quartz-calcite (-chlorite) veins from the final period that cut across the altered rock and are seen in the sedimentary rock, there is rarely any accompanying pyrite, nor is any ankerite seen.

From the results of ore assay, both Au and Ag are below the detection limit (Au<0.07g/t and Ag<0.2ppm) in zones where there is extensive pyrite dissemination accompanying quartz-chlorite-sericite-ankerite-calcite alteration such as described above or in quartz-calcite (-chlorite) veins from the final period, and high values are not obtained for Cu, Pb and Zn either. On the other hand, when pyrophyllite is involved in the combination of altered minerals mentioned above, anomaly values of gold and silver and anomaly values of lead and zinc are seen. High values for Pb and Zn, Pb=55-315ppm and Zn=75-305ppm, are obtained in the vicinity of 93-103m and 131-150m in MJTC-1, while MJTC-2 shows high values of Au=0.08-0.34g/t and Ag=0.2-1.8ppm at depths of 255-275m and 340-374m. At the same time As, Sb and Hg also show high values at each point.

Alteration zones containing pyrophyllite are seen in the surveys conducted last year and this year, accompanying quartz-sericite-chlorite alteration zones that cover the top of the low resistivity zone along the fault that is the subject of this survey (Fig. II-1-5), and pyrophyllite alteration tends to be stronger in the surface than at lower levels. According to the results of the survey last year, geochemical anomalies of Hg and As are confirmed to be strong in the alteration zones, and alteration involving pyrophyllite (-sericite) is thought to have caused mineralization. Pyrophyllite is formed under conditions of extreme acidity, while sericite, calcite and ankerite are formed under neutral conditions. On the other hand, whereas alteration involving ankerite occurs accompanying volcanic activity of basic rock, alteration involving pyrophyllite accompanies neutral or acid activity. From this, there is thought to be more than one hydrothermal activity in this region and that they overlap to form the present alteration zone. No data has been obtained in this survey to clarify the sequence by which the alteration zone was formed, but a close relation between extensive pyrite disseminations and quartz-chlorite-sericite-ankerite-calcite alteration is seen in the results of microscopic observation.

1-5 Considerations

1-5-1 The First Phase Survey

Four periods of igneous activity are known: andesite in the Permo-Triassic, rhyolite and granite in the Triassic, andesite in the Jurassic (to Cretaceous) and basalt in Plio-Pleistocene age.

The geologic structure shows the formation of a mountainous region extending NE-SW overall, and there is an evident tendency for the distribution of stratum to continue virtually in harmony with this direction. The strikes and dips of Permian sedimentary rocks show steep dip and a large syncline structure, with the center of mountainous range as its axis. Permo-Triassic volcanic rock is accompanied by tuffs and covers the Permian system with unconformity. It shows distribution in two parallel zones running NE-SW. Permo-Triassic tuff, accompanied by dome-shaped andesite and rhyolite, is prevalent in the northeast of the Chiang Khong Area, and it shows a monoclinal structure on the east side in this region.

The faults and lineaments of the Chiang Khong Area which have developed in a NE-SW direction along the synclinal axis of sedimentary rock of the Permian, there is marked faults which run obliquely in an ENE-WSW direction. These faults and lineaments are well developed in the north than in the center of the Chiang Khong Area. Distribution of Jurassic (to Cretaceous) andesite and alteration zones in the north is controlled by these fault systems.

Granites intrude virtually into the axis of the synclinal structure, and the major axis direction of the rock body conforms to the NE-SW direction of the area, but the line linking the centers of the three rock bodies runs obliquely to this direction, showing a NNE-SSW direction, and it is in echelon. Whereas the granite is exposed in the southern half of the area, no distribution of granite is evident at the northern tip. It is known that small granite bodies have intruded to the north of the Chiang Khong Area and the existence of granite bodies is assumed below the northern tip of the area. It is assumed from this that the N-S geologic structure of the Chiang Khong Area shows that the southern half rose considerably and plunged to the north which was pared away.

Tuffaceous rocks in the Chiang Khong area have undergone marked white argillization, but it is mostly thought to have been kaolinized due to tropical weathering. Nevertheless, a white argillized alteration zone accompanying limonite-quartz vein is seen on the mountain pass of the highway which traverses the northern part of the Chiang Khong area. Gold flake was discovered by panning in two places in rivers along the alteration zone. It is likely that this alteration zone is connected with gold mineralization. The alteration zone covers 3 km wide by 12 km long along the fault zone which runs in a NE-SW direction.

There are no very clear mineral occurrence in the south of the area, but intense argillized alteration and quartz vein are seen in a part of Permo-Triassic tuff in southeast of the area, and quartz veins have developed in the Permian slate. Hornfels and small-scale skarn is evident around the granite bodies, but it is accompanied by dissemination of only a small amount of pyrite, pyrrhotite and chalcopyrite.

From the results of geochemical prospecting, the high score zone of the third component (Z-3) which shows Au-Hg-S mineralization and its halo, extends over a wide area, overlapping with the argillized zone along the faults around the upper reaches of Nam Sala in the north. The Au anomaly in Nam Sala ranges from 30 to 770ppb. In addition, the high score zone is also found along the south extension of the fault zone and from Nam Mae Tam to Nam So. In the south, high score zones for Z-3 are also widely distributed in Huai Mae Liap, southwest of Phaya Men Rai. Other high score zones are not very large with exception of Huai Pla in the southwest of the area. Almost of these reflect the S anomaly without being accompanied by Au, Hg anomaly of single element.

The high score zone of first component (Z-1) which indicates base metals mineralization is distributed in harmony with the alteration zone and faults in the north. It surrounds the high score zone for Z-3 in the upper reaches of Huai Nam Sala. With the exception of high score zones involving Fe anomaly, the potential area of Cu and Zn mineralization is limited to the area from Huai Thung Lo to Huai Kong Kean tributary in the southwest of alteration zone. In the southeast of the area, A high score zone is observed on the east side of the granite body.

Thus, in the Chiang Khong Area, the indications of gold and base metal mineralization obtained by

geochemical prospecting show a different distribution although they overlap in some places.

These mineralizations occur with Permo-Triassic volcanic rocks and in parts, Permian sedimentary rocks. It is likely that in the north, mineralization occurred due to the activity of Jurassic to Cretaceous andesite, in the south in connection with Triassic granite.

Judging from the above, the promising regions of mineral deposits in the Chiang Khong area are the upper reaches of Huai Nam Sala and Huai Mae Liap regions for gold deposits, and Nam Mae Bong and Huai Mai ya regions for base metal deposits.

1-5-2 The Second Phase Survey

From the geochemical prospecting, geochemical anomaly zones showing the possibility of the existence of gold ore deposits were educed in the eastern half of the Second Survey Area. The first principle component (Z-1), which is thought to directly represent the presence or otherwise of a gold mineralization effect, and Z-4, which is thought to represent the upper halo of the hydrothermal effect, distribute regulated by the fault and fractures of the NE-SW system and the NNE-SSW fault deriving from it.

Z-1, which is a factor related to the gold mineralization effect, occurs in the upper reaches of the Nam Pong Ngao and the Nam Wai in the northeast part of the Survey Area, and also continues N-S from the eastern edge of the Survey Area to the southeast edge. It branches to the southwest along the NE-SW fault from near the Upper Huai Nam Sala, and once more continues in a N-S direction from near the strong silicification zone on the tributary of the Nam Khon Kaen. This distribution does not match along the fault in the geologic survey but is shifted to the eastern side-matching basic directionality. As for its relationship with the alteration zone, in and around the detailed survey zone there is wider distribution corresponding to weaker alteration zone than the sericite+quartz zone where the alteration is stronger than in any other part of the Survey Area. If we look at the distribution of anomalous values for the single element Au, they develop in and around the strongly silicified sericite + quartz zone. In the Khon Kaen alteration zone where the highest values in ore assay were obtained and a strong silicified sericite+quartz zone develops, the distribution of Z-1 is narrow, and the geochemical concentration of gold is also low. The geochemical anomalous values that spread out corresponding to this alteration zone are those of Sb; and it is thought that the geochemical anomalies of Sb alone indicate the distribution of silicified zone rather than the gold mineralization effect itself. Near to the highest grade of quartz vein, geochemical anomalies in As are found, and it is deduced that the zones of anomaly in As and Au show areas of gold mineralization originating in comparatively shallow parts.

Hg is a volatile component and easily sublimated, and is an indicator element representing the upper halo of subsurface hydrothermal deposits. Z-4, which has a large factor loading in Hg, is distributed adjacent to the fault on the western side of the distribution area for Z-1 in the detailed zone. Topographically it occurs at higher altitudes than the distribution area for Z-1, and while there are no anomalous values for Au, geochemical anomalies in As belong here. The limonite-quartz vein showing the brecciated structure of the creek near Line J/700m has a low Au content, but same as the highest grade quartz vein the values of As and Hg are high. There is a strong possibility that gold is concentrated under the ground. From these observations it is anticipated that in the lower parts of the areas of distribution of Z-4 lie subsurface hydrothermal veins containing gold.

The homogenization temperature of fluid inclusion in the quartz veins has a mode value of 125 to 150℃, showing that there was boiling around these temperatures. The above-mentioned temperatures are lower than the average deposition temperatures for gold, and there is also a strong possibility of gold deposition at lower part under the ground. The quartz veins that are thought to have boiled have deposits of the Permian sedimentary rocks in the area bordering the upper layer of volcanic rocks.

Taken together, these results narrow down the promising prospecting sites from this phase of the geochemical survey to six sites thought to have mineral prospects in gold in comparatively shallow locations, and four sites where it is expected mineral prospects in gold lie subsurface.

Prospective Site	Reasons for Selection	Unfavorable Conditions
S-A	Presence of maximum grade quartz veins, state of alteration good. The homogenization temperature is low. Anomalies in As, distribution of Z-4.	The closeness of the base rock means there is a strong possibility that the underground quartz veins are narrow.
S-B	Distribution of maximum values in soil samples, located in the border area with parts of strong silicification.	
S-C	Overlapping of anomalous values for Au, As; border area with strongly silicified sericite-quartz; extension of quartz veins	
S-D	Overlapping of anomalous values for Au, As; extended area of zone of strongly silicified sericite-quartz	State of alteration, geology obscure Prospective Site
S-E	Overlapping of anomalous values for Au, As, Sb; many fine quartz vein floats	State of alteration, geology obscure Prospective Site
S-F	Overlapping of anomalous values for Au, As, Sb; extended area of S-B, S-C	
D-A	Zone of strongly silicified sericite-quartz; distribution of quartz veins, breccia-type limonite quartz veins; anomalous values in Hg; veins with high Hg, As; homogenization temperature in surrounding area is low.	
D-B	Distribution of anomalous values in Hg, As	State of alteration, geology obscure Prospective Site
D-C	Anomalous values in Hg; border area with zone of strongly silicified sericite-quartz	
D-D	Strong anomalous values for Hg in border area with zone of strongly silicified sericite-quartz; anomalous values in As in surrounding area	Distribution of high concentrations of base metal; possibility of high homogenization temperatures

Apart from these prospective sites, there are high anomalous values for Au and As on the right bank of the Nam Wai river on the eastern edge of the Survey Area, and with regard to the state of alteration too, there is widespread distribution of zones of sericite-quartz. The greater part of the zone of mineralization appears to be eastwards outside the Survey Area, and there is a need for a further survey to be carried out here.

As can be seen in Fig.21, in the detailed zone Z-1, Z-4 and anomalous values in Hg and As occur in the area from Line A/1000m to the end of Line H and at the ends of Lines B and C. This is an area of Permian basement rocks, and it is thought that the anomalous values here represent the existence of fractures within the basement. Since it was shown by the measurement of the homogenization temperature of fluid inclusion that ore solution boiling has taken place in the border area between the basement and the overlying volcanic rocks, there is a strong possibility that gold deposition has occurred in quartz veins within the basement.

The area west of the anomalous zone of low resistivity which continues from point 500m on Line A to point 300m on Line H, and the anomalous zone of low resistivity changing direction from Line H and continuing to Line M is for the most part a zone of high resistivity. In these areas Permian basement rock occurs at a shallow depth, and the area of high resistivity corresponds to the resistivity values for shale or sandstone. In the eastern part including the above-mentioned zones of low resistivity, tuffaceous rocks of Permo-Triassic age are distributed; these have undergone wide-ranging argillization accompanied by silicification, and the low resistivity is considered to correspond to the altered tuff. In this area geochemical anomalies in Au, As, Sb and Hg, suggesting gold mineralization, are spread out overlapping the alteration zone. The distribution of the above-mentioned geochemical anomalies does not accompany the anomalous zone of low resistivity which continues from point 500m on Line A to point 300m on Line H, but from Line A to near Line E an anomaly zone was observed further to the southeast. An anomaly zone in Au, Sb and As is located on the eastern side of the resistivity discontinuous line in a N-S direction which continues from point 400m on Line H to point 600m on Line L. In contrast to this, an anomaly zone in Hg and As showing a higher halo of mineralization matches the low resistivity zone on the west side of this discontinuous line and an anomaly zone also spreads out on the eastern side, partially straddling the discontinuous line of the NE-SW direction.

In the anomaly zone in Au, Sb and As, low resistivity occurs in the surface area, and a high resistivity zone was observed at a depth of 100m to 250m underground in the vertical distribution of resistivity. This high resistivity zone has a resistivity value close to that of andesite in laboratory tests, but in view of the geologic conditions there is a strong possibility of the existence of silicified tuff or a silicification zone.

In consideration of the fact that the homogenization temperature of fluid inclusion of quartz at the surface is low, at 150℃, it is anticipated that there is gold mineralization accompanying this underground high resistivity zone. The anomaly zone in Au, Sb and As, obtained from the geochemical survey, stretching to the south from the detailed survey zone, has the same kind of geologic condition and alteration type, and in the lower part of the high anomalies in Au which occur there it is anticipated that the same kind of silicified zone is present. On the other hand, the anomaly zone in Hg and As matches the zone of low resistivity along the high resistivity zone of basement rocks on the western side of the resistivity discontinuous line in a N-S direction, between Line H and Line M. This low resistivity zone continues in slab form to a depth below sea level. If the anomaly area in Hg and As is considered to represent a mineralization halo in the upper part of hydrothermal deposits, the presence of gold mineralization may be anticipated deep underground. Also, the resistivity structure in the lower part of the anomaly zone in Hg and As occurring from Line E to Line G, differing from that between Line H and Line M, is spread over a width of 200m and a depth of close to 200m in depth, and geochemical anomalies occur close to the border area between this low resistivity zone and the high resistivity zone located in the west of the low resistivity zone.

Of the prospective area inferred from the geochemical survey, in the shallow prospects the silicification zone either occurs at a comparatively shallow depth or is already exposed. In the deeper prospects, from Line H to Line M a low resistivity zone continues to a depth of 350m to 400m, and at the deeper part and towards Line M the resistivity gradually rises. No high resistivity zone clearly indicating quartz veins/silicified zones was observed, but the presence of gold mineralization is anticipated in the deeper part of the low resistivity zone and in the zone of comparatively high resistivity on Lines L and M. This depth is estimated to be close to sea level. The results of the geochemical survey made the geochemical anomaly zone in Hg and As from Line E to Line G a deep prospective site (D-B). However, according to the results of the geophysical survey, the resistivity structure of this lower part was the northern edge of a fusiform zone of low resistivity 200m deep and 200m wide, and was different to the low resistivity zone from Line H to Line M. The depth of gold mineralization here is thought to be close to 300m, the depth at which the resistivity value rises.

The resistivity discontinuous line from Line A to close to the end of Line D which is in high resistivity zone in the distribution area of basement rocks accompanies the distribution of geochemical anomalies in As and weak anomalies in Hg, and also matches a zone of sericite + quartz alteration zone. 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 rocks.

Close to the detailed survey zone, alteration, geochemical anomalies and resistivity structure are regulated by the N-S and NE-SW faults, and from the results of the survey it was observed that there was a tendency for the faults and fractures in the N-S direction in particular to have a strong involvement.

1-5-3 The Third Phase Survey

The occurrence of hydrothermal alteration and extensive pyrite dissemination along the reverse fault on a N-S axis bordered by Permian sedimentary rock and Permian-Triassic volcanic rock has been verified in the results of this survey. In these alterations, the dikes and surrounding sandstone, and sandstone breccia in the slumping sediment, etc., undergo argillization and pyrite dissemination due to hydrothermal solution rising along the fault or the basalt-andesite dikes intruding into the sedimentary rock. In contrast, only clots or narrow veins of pyrite have developed along the slate cleavage in the mudstone.

Alteration and pyrite dissemination occur virtually uniformly though in varying strengths, and cracks sometimes develop in the altered part. Pyrite dissemination occurs after silicification and chloritization by quartz and argillization by sericite, with ankerite and calcite finally alternating in a network form. The mineralizing solution that is left finally develops across them as quartz-calcite (-chlorite)veins.

Judging from the fact that no extensive additional silicification or clear quartz vein development such as is seen in hydrothermal deposits is observed in this area, and alteration-mineralization alternate uniformly throughout without being regulated by cracks, unlike the center of mineralization where hydrothermal circulates along the cracks to form mineral veins, it is likely that porous volcanic rocks and sandstone alternated under conditions where steam prevailed in the surrounding area.

The Au, Ag, Pb and Zn anomaly zones that were detected in this survey are seen in pyrite dissemination zones accompanying quartz-chlorite-sericite-ankerite-calcite alteration in places where pyrophyllite is involved. In neither zone is there any special characteristic to distinguish mineralization and alteration to the naked eye. As the conditions under which pyrophyllite, ankerite and calcite are formed are extremely different, it is surmised that there were at least two mineralizations, or the mineralizing solution changed from acid to neutral in the first mineralization, but no data proving this was obtained. However, whereas ankerite alteration occurs in connection with basic rock activity, pyrophyllite alteration often accompanies neutral to acidic rock activity. When this is taken into consideration, it is likely that the center of mineralization in this area is in the high resistivity zone at shallow level accompanied by Au geochemical anomaly zones distributed in the vicinity of the base line of the alteration zone and detailed survey area where rhyolite is distributed, located on the southeastern side of the present survey position.