area as satisfying the following condition;

1) nearby contacts of Limestone (Ls) and Granite (Gr2),

2) crossing point of continuous lineaments,

3) nearby NNE-SSW lineaments that are considered as tension fracture,

4) high density area of short or discontinuous lineaments.

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

Chapter 2 Mae Sariang Area

2-1 Geology

2-1-1 General Geology

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

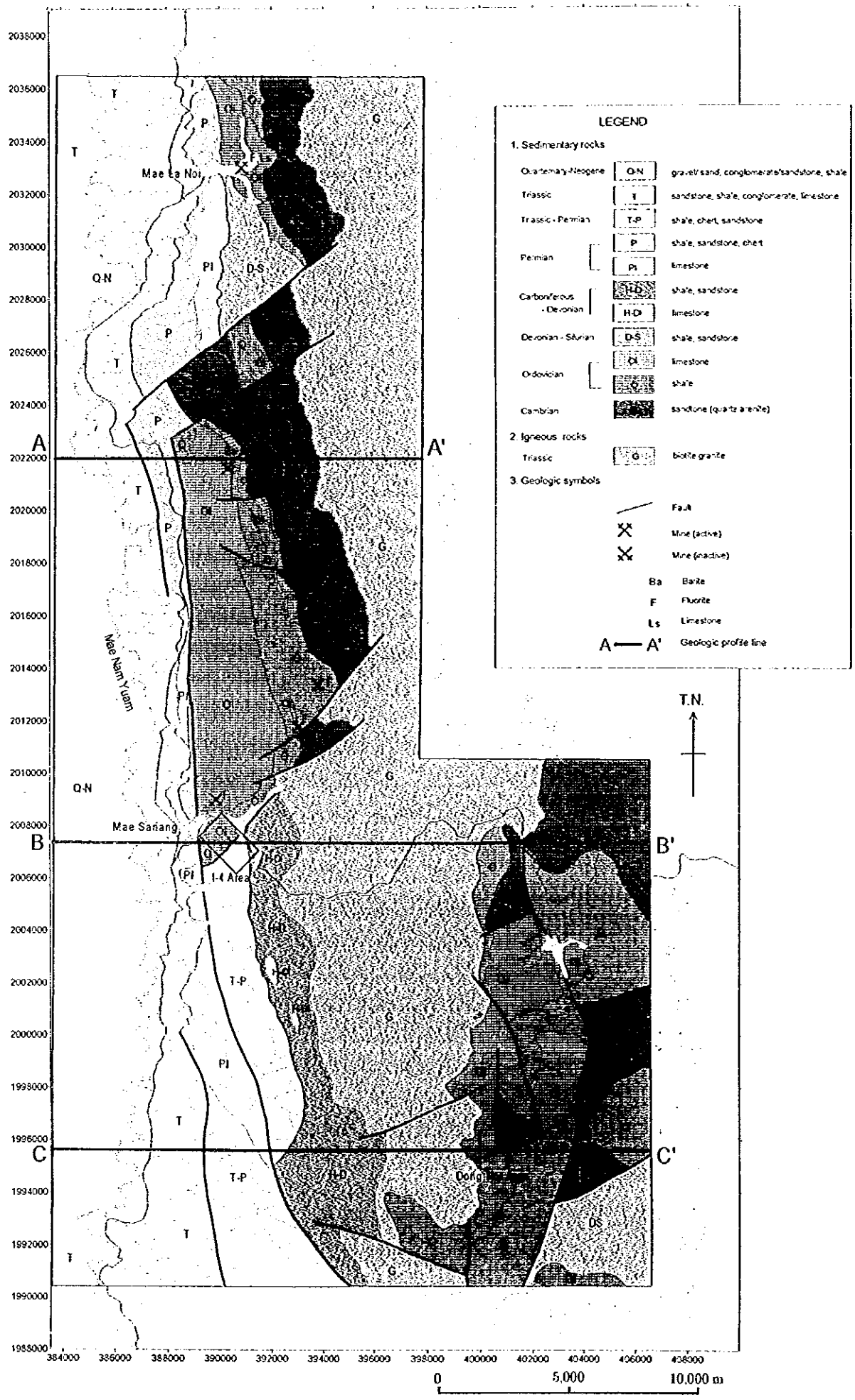
Along the Mae Nam Yuam at the western end of the survey area, there is a north-south trending tectonic line that is the border between the western tectonic province and the western major mountain tectonic province.

The region from Nam Mae Yuam to the eastern side that occupies most part of Mae Sariang area belongs to the western major mountain tectonic province and consists of sedimentary rocks and granite from the Cambrian to the Triassic in age. The total geological structure is consistent with the continuous direction of mountains of this area and extends from north to south. Batholith granite of the Triassic age intrudes from north to south in the central part of the area. By this granite, the Paleozoic formation is divided into the west and the east. The Paleozoic formation of the west as a whole has a monoclinic structure dipping west; from east to west, beds of sedimentary rocks of Cambrian in age and those of Permian (partly those of Triassic) pile up in the order of age. The Paleozoic formation on the east side mainly consists of Ordovician sedimentary rocks and partly exposes Cambrian sedimentary rocks.

In these Paleozoic formations (partly Triassic), mineral occurrences of lead, zinc and copper distribute, but there is no metallic mine that is currently under operation. There are also non-metallic deposits of barite and fluorite. At present, exploitation of some of them is continued.

The region in the west of Nam Mae Yuam belongs to the western tectonic province and the survey area of the region consists of sedimentary rocks after Triassic in age. No intrusion of igneous rocks is found within the survey area. No mineral occurrences of non-ferrous metals are found in this area either.

Fig. II-1-1 respectively shows a geological map, profiles and a schematic column of Mae Sariang Area.



a) Geologic map of the Mae Sariang area

Fig.II-2-1 Geologic in

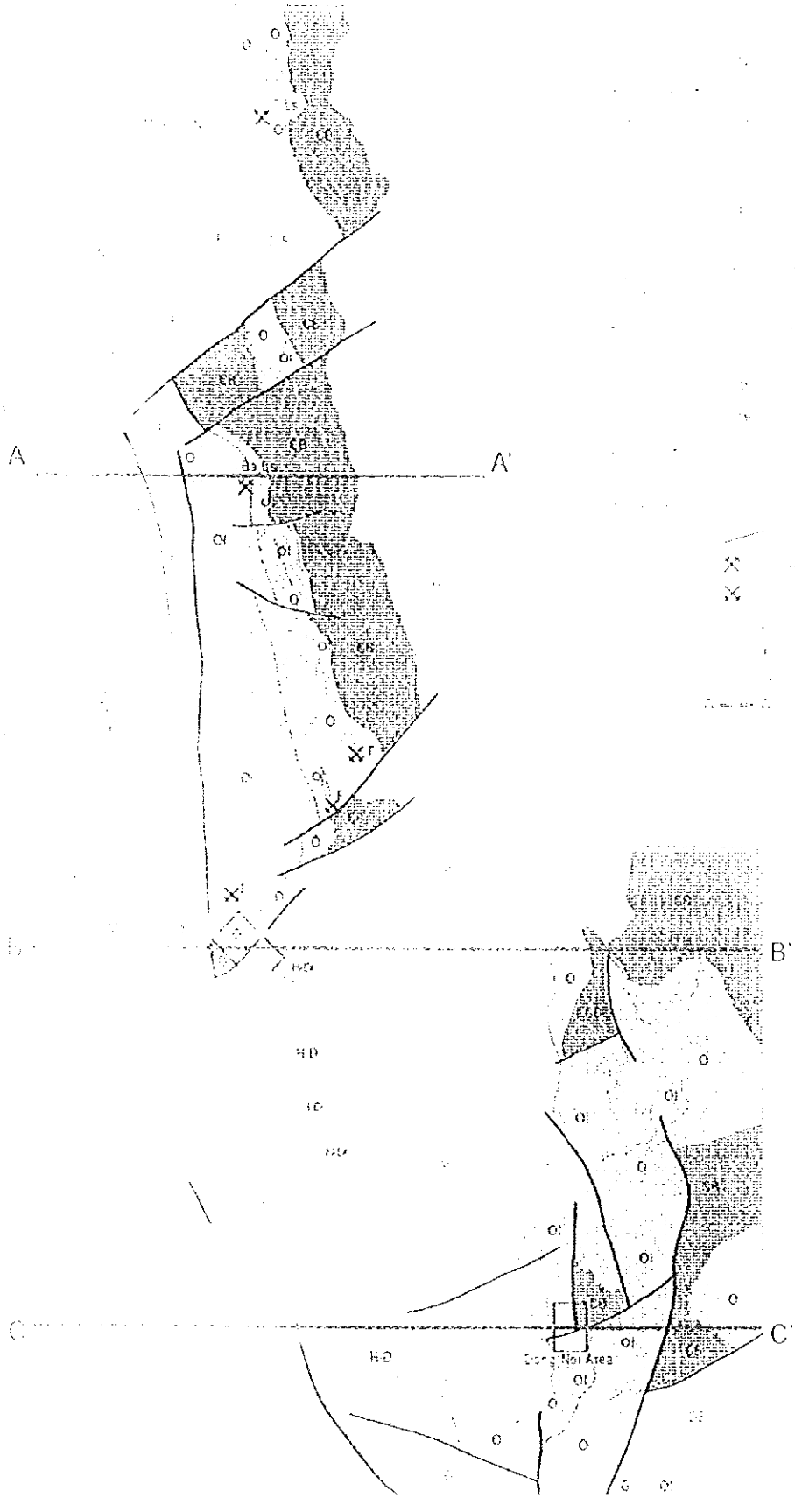
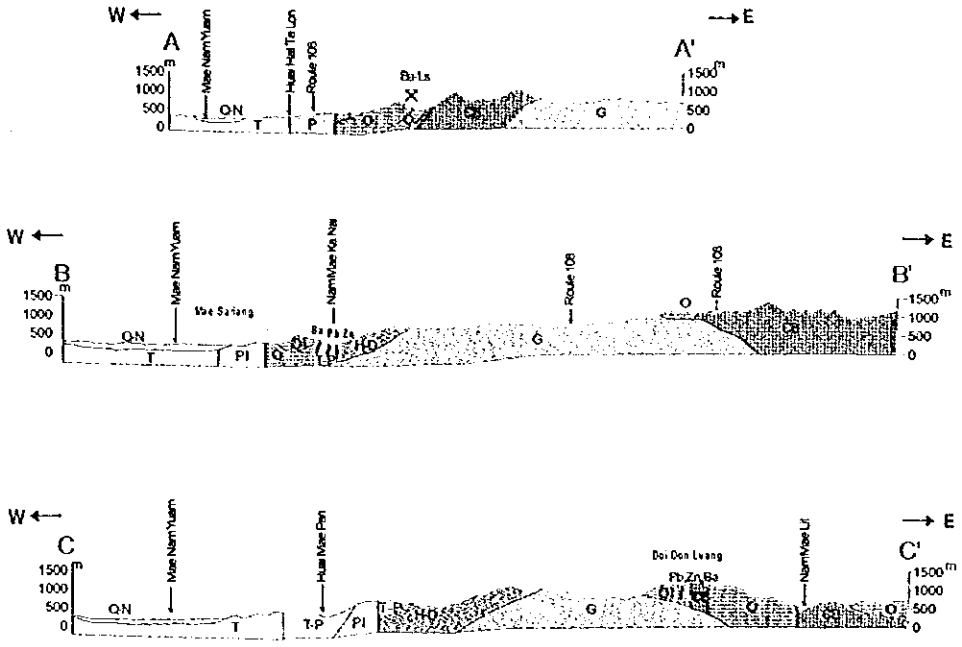


Fig.II-2-1 Geologic in



b) Geologic profile of the Mae Sariang area

period		column	lithology	igneous activity	mineralization
CENOZOIC	Quaternary	Q-N	gravel/sand, silt conglo./sandstone shale		
	Neogene				
	Paleogene				
MESOZOIC	Cretaceous				
	Jurassic				
	Triassic	T	sandstone, shale limestone conglomerate	biotite granite	Zn, Pb, Cu Ba, F
		T-P	shale, sandstone chert		
PALEOZOIC	Permian	P (Pℓ)	shale, sandstone limestone		
	Carboniferous	H-D (H-Dℓ)	shale limestone shale, sandstone		
	Devonian				
	Silurian	D-S	shale, sandstone		
	Ordovician	O (Oℓ)	limestone shale		
	Cambrian	CB	sandstone (quartz arenite)		

c) Schematic geologic column of the Mae Sariang area

ıtion of the Mae Sariang area

2-1-2 Details of Geology

1. Sedimentary Rocks

(1) Cambrian Sedimentary Rocks (CB)

In the northern part of the survey area, from the east of Ban Mae La Noi to the east of Mae Sariang urban area, these rocks, almost continuously, distribute along the western boundary of Triassic granite. In the southeast of the area, these rocks spread widely beneath the Ordovician sedimentary rocks that distribute on the east side of the granite.

They mainly consist of medium-grained massive quartz arenite (orthoquartzite) in pink or whitish brown and partly intercalated sandstone and shale and thin beds of calcareous sandstone and limestone.

In the upper stream of Nam Mae La Noi, this rock has been metamorphosed into hornfels surrounding granite body, and cordierite porphyroblasts are found in comparatively pelitic parts. Contact metamorphic rocks also occur near the lead occurrences of Dong Noi sub-area and the upper stream of Huai Mae Ho in the southeastern part of the survey area. They have turned green or dark green color due to calc-silicate minerals, and in some parts contain disseminating magnetite.

In both of the northern and the southern parts of the survey area, the Ordovician sedimentary rocks conformably overlie this rocks. There is no report of fossils in these rocks.

(2) Ordovician Sedimentary Rocks (O,Ol)

These rocks distribute from the eastern part of Ban Mae La Noi and Huai Hat Ta Lan basin to the area extending to the east of Mae Sariang in the western Paleozoic formation distribution area. In the eastern Paleozoic formation distribution area, they widely spread in the area from Ban Mae Kanai to Ban Dong Noi in the eastern part of the survey area. The rocks from Ban Mae Kanai to Ban Dong Noi have made karst landform on the top of mountains.

At the lower part of the formation, shale and alteration of shale and sandstone is dominant with thin limestone bed. The upper part is almost composed of banded limestone thinly alternating muddy seams and calcareous seams. This banded limestone generally grades upward into gray massive limestone.

The limestone formation exposed from the northwest to the west of the survey area, the east of Ban Mae Kanai area, and the area around Ban Dong Noi has contact aureole by granite and is recrystalized into coarse-grain. In addition, it is partly skarnized. Also, there are outcrops and gigantic boulders in olive color or yellowish green that are rich in calc-silicate mineral. A part of such skarnized rocks is disseminated with magnetite and galena.

The structure of this formation strikes N-S and dips westward from Ban Mae La Noi to the east of Mae Sariang, whereas it gently dips eastward in the surroundings of Ban Mae Kanai.

As above mentioned, it seems that this formation conformably overlies the Cambrian sedimentary rocks.

It has been reported that in the limestone exposing from Ban Mae La Noi to the east of Mae Sariang, conodonts from the Arenigian age to the Llanvirnian were found (Hahn et al., 1982).

(3) Silurian to Devonian Sedimentary Rocks (D-S)

These rocks mainly consist of shale and sandstone and spread in the east of Ban Mae La Noi of the north of the survey area and around Ban Huai Wak in the end of southeast of the area.

It is conformable with the Ordovician limestone. However, since Permian limestone overlies this formation near the Mae La Noi, probably, it is unconformity with the upper horizon.

(4) Devonian to Carboniferous Sedimentary Rocks (H-D, H-Dℓ)

These rocks widely crop out in the south of Mae Sariang town and the southwest of the survey area. Black shale is dominated and accompanied by lenticular limestone and alternating beds of thin bed of chert and limestone.

The lenticular limestone is generally argillaceous and often shows thin alternating beds of muddy limestone and shale. They are partly affected by silicification and skarnization and are in blue, yellowish green or green in the upper streams of Huai Pu and Huai Mae Pan.

In these rocks, many galena-barite veins are found. The black shale near the granite body, particularly at the upper stream of Huai Mae Pan, is metamorphosed into hornfels over several hundred meters from the contact. At some parts of hornfels, a great amount of mica is formed in clear schistosity.

It is inferred to be conformably covered by overlying Permian to Triassic rocks.

(5) Permian Sedimentary Rocks (P, Pℓ)

This formation consists of gray shale and massive gray to white limestone. This crops out narrowly from north to south along the east bank of Nam Mae Yuam.

Bivalvia and Fusulinidae from the middle to late Permian have been reported in the massive limestone of this formation in the south of Mae Sariang. Also in the limestone of the south of Mae La Noi, Cephalopoda from the late Carboniferous to the middle the Permian has been found.

Limestone and shale of this formation in the north side from Mae Sariang town unconformably overlie Ordovician limestone or lie in fault contact with them. In the south of the area, the relationship with this formation and Permian to Triassic sedimentary rocks is considered to be conformity.

(6) Permian to Triassic Sedimentary Rocks (T-P)

These rocks are traced from Mae Sariang town to the south along the east side of Nam Mae Yuam. The rocks mainly consist of shale, sandstone and alternating beds of shale-sandstone. In Huai Mae Pan, they conformably overlie massive Permian limestone and Conondonts from the middle to late Triassic have been found nearby.

(7) Triassic Sedimentary Rocks (T, Mae Sariang Formation)

These rocks crop out along the Nam Mae Yuam. They mainly compose of shale and sandstone and partly intercalate thin layer of chert and small limestone lenses. *Daonella cf., Sumatriensis, Daonella aff lommeli* and *Halobia stryriaca* have been reported from them.

(8) Pliocene to Quaternary Formation (Q-N)

This formation consists of loosely consolidated siltstone and conglomerates in addition to unconsolidated gravel bed. Particularly along the Nam Mae Yuam, terraces have developed on

which this formation widely is distributed. Along the major rivers within this survey area, alluvium has developed.

2. Igneous Rocks

(1) Biotite Granite

The biotite granite is widespread from north to south in the central part of the area. The granite is characterized by a large amount of euhedral phenocrysts of potassium feldspar with a longer diameter of several centimeters, 7 cm at maximum, and is medium to coarse-grained holocrystalline granular granite that contains biotite and a small amount of hornblende. Though it is quite widely exposed in the survey area, there is little variety of lithofacies. Although fine-grained facies and aplitic parts are found partly, there is no variation of mineral composition. At both sides of the granite and the sedimentary rocks on boundary, white-agrillization by sericite, montmorillonite are frequently observed in the width of 3 to 10 m.

This granite has had thermal metamorphic effect on the surrounding sedimentary rocks with which extends often in the width to several hundred meters from the contact. Also subsurface granite bodies or some stocks may exist underneath Sedimentary rocks. Because sedimentary rocks, which are more than 1 km far from granite body, underwent thermal metamorphism; a part of Ordovician limestone on the east of Mae Sariang town is recrystallized, and Cambrian sandstone in the surroundings of Ban Dong Noi is metamorphosed into hornfels.

The activity of this granite is considered to be Triassic in age.

(2) Dike rocks

A small number of dikes are observed in the Mae Sariang area. There are only quartz porphyry dikes and dacite dikes at a part of this area.

Outcrops of the quartz porphyry dikes are observed in the northern branches near Ban Huai Ngu of northern part of the survey area, which are about 10 m wide and intruding Ordovician sedimentary rocks. Also along Nam Mae Um Long at 1 km to northeast of Ban Huai Ngu, small quartz-porphyry dike is intruding into Cambrian quartz arenite. They show pale-green color and contain round quartz crystals with a diameter of 3 to 4 mm and have been slightly proceeded argillization by kaolinite. Since a small amount of idiomorphic potash feldspar phenocrysts is also contained, they are considered to be marginal facies of Triassic granite. In the branch at 1 km to the east from Ban Huai Ngu, a great amount of the same quartz porphyry boulders is found.

A Dacite dike crops out in a small stream at 2 km in the north of Ban Mae Ho. It intrudes into biotite granite about 3 to 4 m wide. It consists of pale-green and brown fine-grained rock that contains commonly hornblende and quartz phenocrysts.

2-1-3 Geological Structure

Within the survey area, the fracture and fault system in the direction of N-S is predominant.

Nam Mae Yuam and ridge systems have also developed in this direction. In addition to this system, there is a fault system of NE-SW, which is oblique to N-S fracture. The NE-SW faults particularly develop in Huai Mae Tia Noi and along Nam Mae Sariang. From the north end to the south end of the central survey area, Triassic biotite granite also intruded in relation to lineament of the N-S system.

Each stratum also continues in consistent with N-S direction that is generally a major structural direction. Paleozoic formation of the west side of the area dips west, while Paleozoic formation on the east side dips horizontal or gently east though they have been divided into some blocks by secondary NE-SW faults.

2-2 Mineral Deposits and Occurrences

There is no metal mine in this area that has been actually operated. But there are occurrences of lead, zinc and copper covering a wide range of this area. Some of non-metallic deposits were once exploited for their barite and fluorite, but now a barite mine is only in active. Fig.II-2-2 is a map showing the locations of mineral occurrence observed by this survey in the Mae Sariang area. These occurrences have roughly gathered around the following three areas.

1. Area from the Chamrat barite mine to Ban Huai Ngu
2. Area from the eastern part of Mae Sariang town to Huai Mae Pan
3. Area from Ban Mae Kanai to Ban Dong Noi (Dong Noi Area)

2-2-1 Area from the Chamrat barite mine to Ban Huai Ngu

In this area, several limestone strata and shale of the Ordovician lie in N-S direction. They are partly intruded by quartz porphyry dikes. The Ordovician continues up to the east of Mae Sariang town.

The development of Chamrat Khongson barite mine started in 1993. A barite vein intruding limestone formation was exploited and limestone aggregate has been produced as its byproduct. The barite vein at the lower part of mining face strikes N30°E and dips 30°W with 10 m width. It appears along the limestone bedding. At the upper part of the mine, the vein is about 3 m depth and steeply dips more than over 85°. The vein cuts sedimentary plain of limestone. The extension of the vein is over 500 m. Monthly productions of barite are 1,000 to 2,000 tons. It mainly ships as a chemical raw material to Saraburi near Bangkok. Boulders of barite veins scatter from here and there on the southeast side of this mine. These barite veins scarcely contain other minerals and no sulfide minerals. However, assay results of shale boulders with fine barite veins collected from a lower stream of waste dam of Chamrat mine shows 5,200 ppm Zn.

At the area covering 5 km from Chamrat Khongson mine to Ban Huai Ngu, barite boulders and gossan floats are found in several branches that run down from the east to Huai Ngu. Assay results of the gossan show 1,500 and 3,800 ppm Zn.

2-2-2 Area from the eastern part of Mae Sariang town to Huai Mae Pan

This area is covered by the Devonian-Carboniferous formation. Many floats and outcrops of

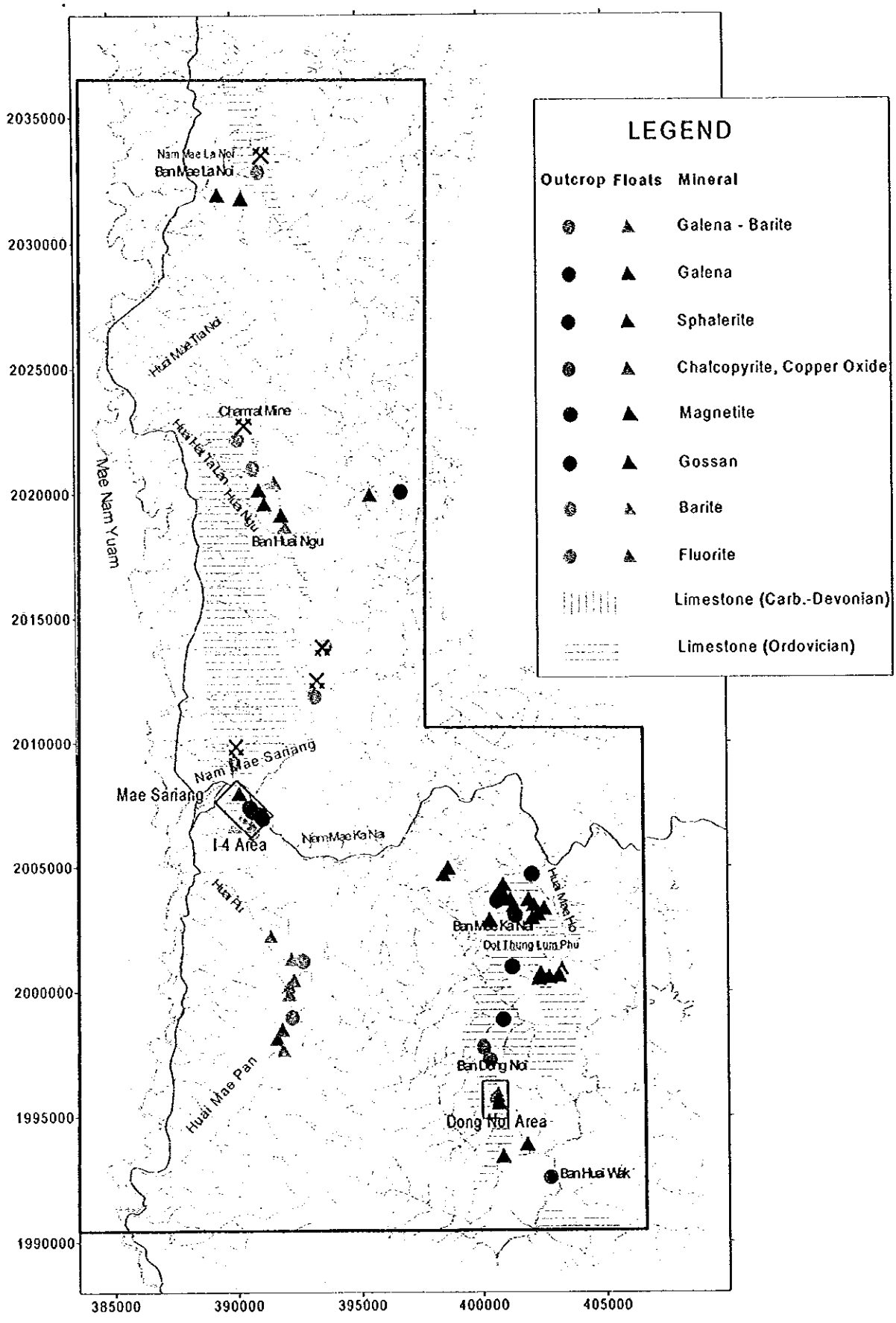


Fig.II-2-2 Mineral occurrences map in the Mae Sariang area

barite and galena veins occur in this area. As mentioned later, high anomaly values of lead and zinc in stream sediment are concentrated in this area. From the area I-4 through Huai Pu to Huai Mae Pan on the south, outcrops of mineral occurrence are found in the Devonian-Carboniferous formation and the Permian-Triassic formation. The Devonian-Carboniferous formation mainly consists of black shale and alternating beds of black shale and gray sandstone intercalating thin chert and banded limestone layers. Calc-silicate minerals occur in banded limestone looking greenish at the upper streams of Huai Pu and Huai Mae Pan. The Permian-Triassic formation consists of shale and chert with small-scale limestone lenses.

On the northern end of this area, at the riverside of Nam Mae Kanai, Nam Mae Sariang tributary, there are three or four network vein zones of galena-arsenopyrite of a few meter width on the shale outcrop that is strongly silicified about 70 m long from north to south. Many barite-galena floats are found around this mineral occurrence.

At the upper stream of Nam Mae Pan, galena-barite veins are found at several parts, and a great amount of galena-barite floats as same as those of the veins are continuously distributing from north to south. These rocks are also rich in zinc, showing 3,400 ppm and 2,020 ppm. A float of barite-quartz vein containing galena-chalcopyrite-malachyte is also found, and it shows 3.61 % Cu and 3.68 % Pb.

2-2-3 Area from Ban Mae Kanai to Ban Dong Noi

The area from Ban Mae Kanai to Ban Dong Noi of the south eastern part of the survey area is a place where Ordovician formation is dominant. Beneath limestone and shale of this Ordovician formation, blocks of Cambrian quartz arenite (orthoquartzite) are exposed here and there. Judging from the distribution of limestone of Ordovician age, the Ordovician system of this area is seems to be horizontal to gently inclining toward the east side and covering the Cambrian system. With the Ordovician limestone formation, mineral occurrences distribute here and there.

In the Ordovician limestone distributing around Ban Mae Kanai characterized by karst landform, small gossan zones below 100m width distribute over the ridge surrounding the basin landform in the karst. In addition, a large amount of gossan floats, assumedly derived from the mineralized zone in the limestone, in a tributary of Huai Mae Ho of the eastern end of karst. All of these show reddish brown or black brown; some of them have a remaining pyrite in the center.

Many magnetite(-quartz vein) boulders with a diameter of 4 m at maximum occur in the stream to the south of Doi Thung Lum Phu, where is the south end of limestone formation near Ban Mae Kanai. Ordovician shale exposes along the stream, and limestone overlies shale near the ridges. In the shale at the lower part, limonite-quartz veins in small scale are found. Since magnetite floats were large in amount and angular in shape, it was estimated that there should be some outcrops comparatively nearby, but none of them were discovered.

In the Cambrian sandstone on the north side of this limestone formation, magnetite dissemination can be seen along Huai Mae Ho. A great amount of magnetite is disseminated in the greenish sandstone. Similar magnetite dissemination is also found in the Cambrian

formation in the Dong Noi Area.

On the roadway that is about 1 km to the north from Ban Dong Noi, massive galena floats distribute across the width of about 5 m. This is a small vein intruding through probably Ordovician limestone formation was found when the roadway was improved seven years ago. By an ore, Pb 58.3 %, Ag 209 g/t and 990 ppm of Zn are detected. On the peripheral ridges, no matter which test pit is exploited, similar galena-barite veins are confirmed. Local people said that in Huai Chang that was a little to the north from here, they had once made bullets for hunting guns out of a galena-quartz vein that distributed in the width of 2 m crossing the stream. However, it was not confirmed by the survey of this time.

In the Dong Noi detailed survey area, a large-scale mineralization zone mainly consisting of galena and barite distributes.

A copper and lead mineral occurrence occurs at the west bank of Nam Mae Rit nearby Ban Huai Wak, around 5 kilometers south-southeast of the Dong Noi area (coordination: Easting 402.2 km, Northing 1990.2 km, Zone 47Q). The sketch of this occurrence shows in Fig. II-2-3. This area consists of sandstone, shale and a fine alternating shale and limestone. The northern boundary and the upper part of the ridge occur dolomitic limestone. The mineralization is dissemination and stockworks of sulfide minerals, and relates to several faults striking north-south and northwest-southeast. Ore minerals are composed mainly of chalcopyrite, galena, pyrite and pyrrhotite, with subordinate amount of secondary copper minerals. A granite body crops out at the several hundred meters lower stream of the occurrence. Three exploration adits occur in this occurrence, though no record has remained. The length of these adits ranges from 5 to 7 meters. The chalcopyrite and related secondary copper mineralization is abundant at the mouth of the adits, however only pyrite dissemination occurs in the adits.

Other mineral occurrences are described below.

Many gossan floats are observed in Huai Lum Kham of the east side and in small branch on the west side of Mae La Noi, occupied by Devonian- Carboniferous sedimentary rocks and Permian limestone. In Huai Lum Kham, plenty of gossan boulders with a diameter from 1 to 2 m can be observed at inflection points where geological structure along the stream changes suddenly. The result of analysis shows 1,100 ppm Zn.

On the west side of the contact between the granite batholith and the sedimentary rocks, many quartz veins containing galena are observed. Plenty of veins occur particularly in the valley of Nam Mae Um Long. Their width is about 0.5 m and their extension is not clear. The assay shows 530 ppm Pb and 7.9 to 13.6 g/t Ag.

Near the national highway 108, many floats of quartz veins occur and 463 ppm Cu and 2,020 ppm Zn are obtained.

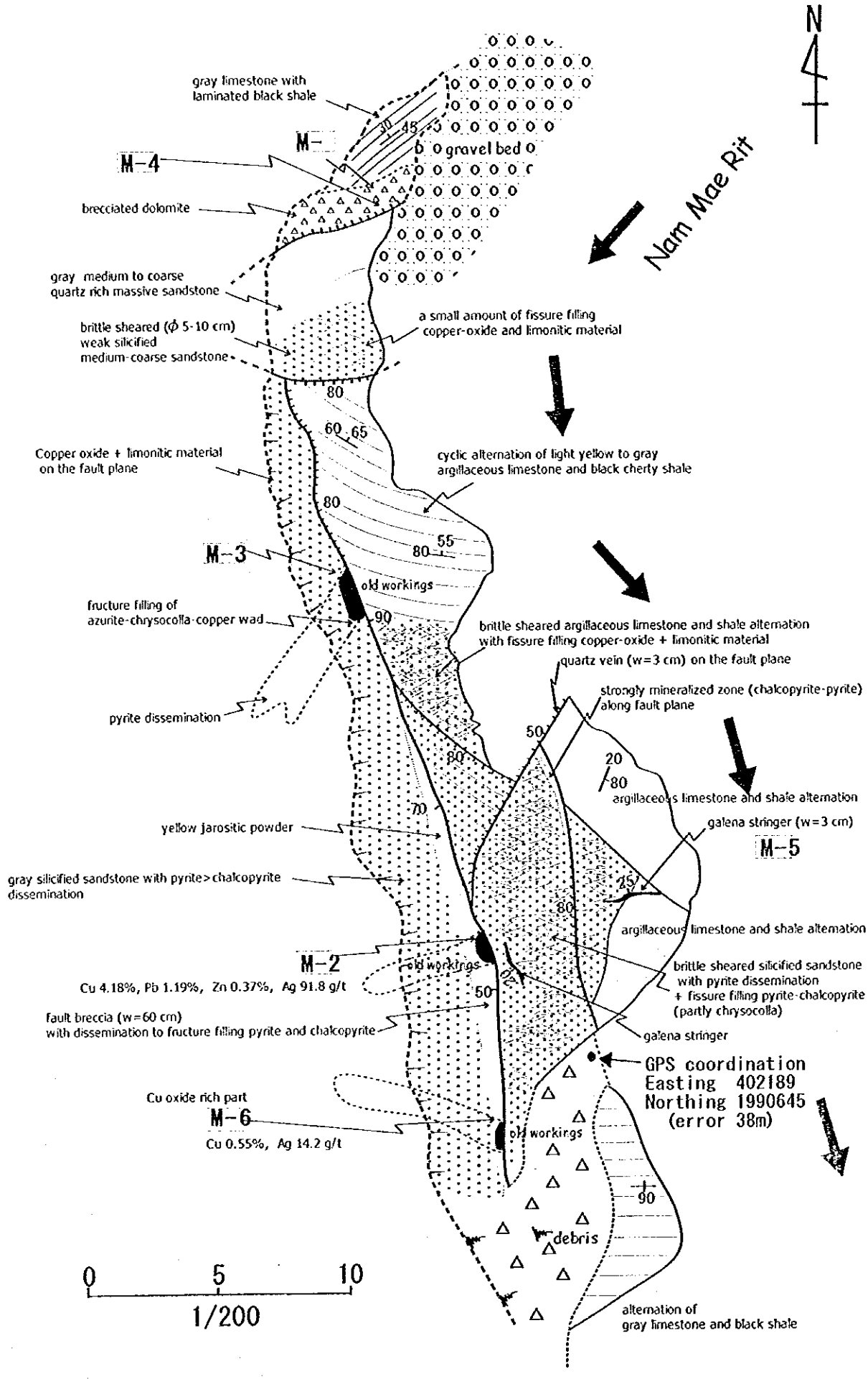


Fig. II-2-3 Sketch of the Huai Wak Cu-Pb occurrence

2-3 Geochemical Survey

2-3-1 Method

(1) Sampling and pathfinder Elements

Sampling was carried out together with geological surveys because major objective mineral types were massive ore deposits and/or stratiform deposits that were expected to be originated in limestone. Sampling density was decided with consideration of the limestone distribution shown on the existing geological map and the promising areas selected by Jamnongthai (1988). Pathfinder elements are Au, F, Sn, Ag, As, Ba, Cu, Hg, Mg, Mn, Pb, Sb, W, and Zn, judging from its mineral potential and geologic condition

In advance to sampling, orientation surveys were carried out at two places near mineral occurrences of Huai Mae Pan, and decided the most effective sieve (#80) in consideration of the sensitivity and correlation among pathfinder elements. The number of samples of stream sediment was 851 pieces.

(2) Analyses of geochemical data

To decide a threshold that sorts out an anomaly from a background level of geochemical data, mainly the combination of an average value and a standard deviation was taken as a criterion. Percentiles of frequency distribution and broken points of cumulative frequency curves were also considered for the decision.

Anomaly distribution maps were prepared for each element (univariate analysis). Geochemical data-set were also processed by principal components analysis to check groups of elements in their behavior and control factors for their grouping (multivariate analysis).

2-3-2 Result of geochemical survey

(1) Univariate analysis

Anomaly distribution map of Zn, Pb and Cu is shown in Figure II-2-4.

[Zn] The anomalies of Zn are distributed in the granite side on the contact between the granite and the Cambrian formation along Huai Mae Hu, Nam Mae La Noi and Huai Mae Sakua of the eastern part of Mae La Noi in the northern part. As for the mid-northern part, quite high anomalies distribute in the Ordovician formation from Huai Hat Ta Lan to Huai Ngu to the west of Chamrat barite mine and in the surrounding areas of Ordovician limestone between Nam Mae Um Long and a national highway. As for the southwestern part, quite high anomalies distribute over an extremely wide area from the southern side of the I-4 detailed survey area to the east side of Nam Mae Pan (I-3 promising district). Among them, along the upper stream of Huai Hu, high anomalies over 232 ppm are tightly distributed. In this district, the Devonian-Carboniferous and the Permian-Triassic sedimentary rocks distribute. Thin banded limestone, limestone lenses, calcareous shale are interbeded in shale, but no large limestone bodies are recognized. In the southeast, anomalies are found in the Ban Mae Kanai and the Dong Noi detailed survey area, surrounding Ordovician limestone.

[Pb] The distribution of Pb anomalies was quite similar to those of Zn. However, at the Zn

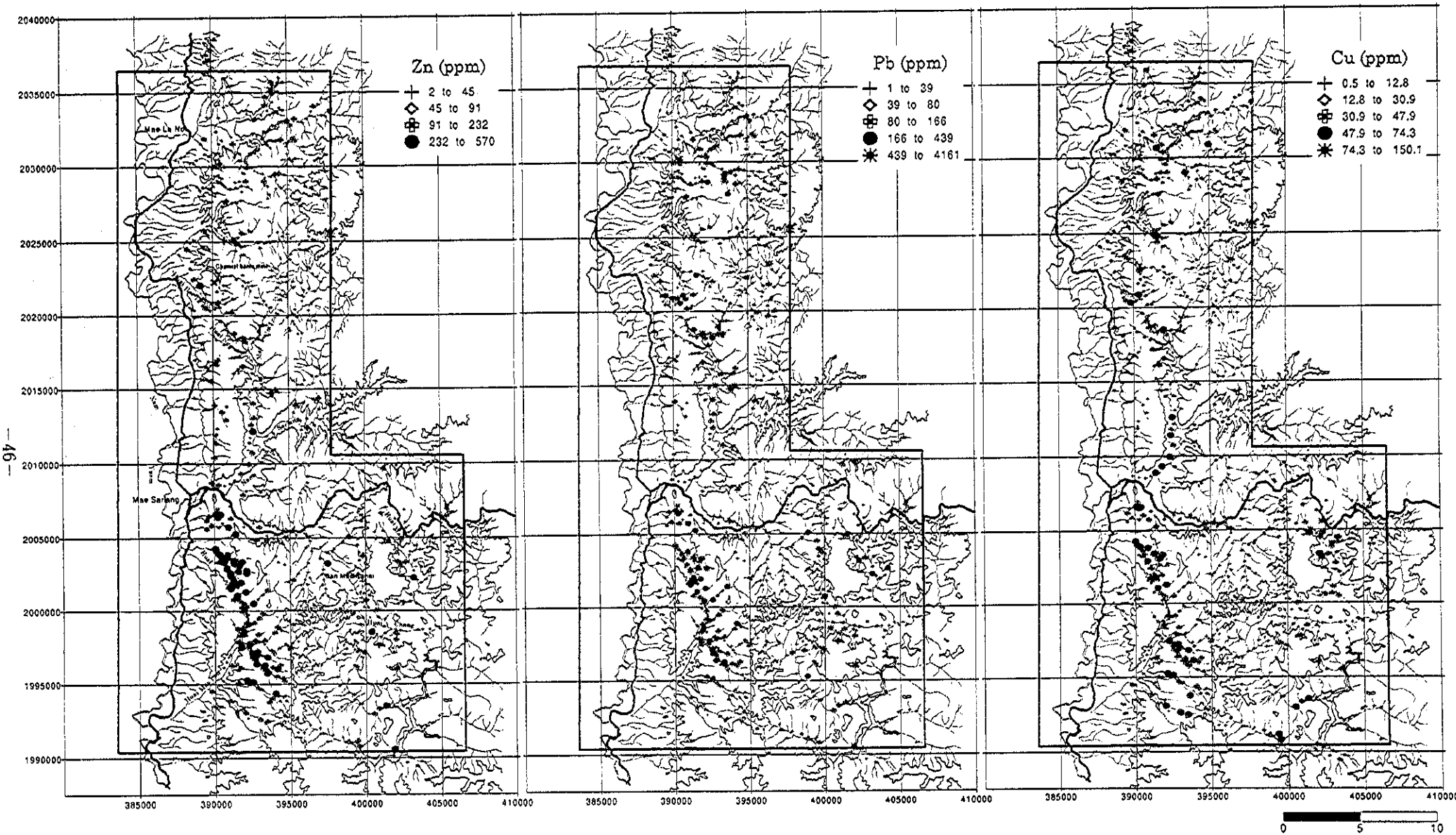


Fig.II-2-4 Geochemical map of Zn, Pb, Cu in Stream Sediment of the Mae Sariang Area

anomaly zone of Huai Mae Ho in the northern part of the Survey area, Pb anomalies are not found. At the Huai Mae Sakua, particularly high anomalies are found. These anomalies seem to correspond to the lead occurrence of Doi Lhun Kam of DMR (1984). From Huai Hat Ta Lan to Huai Ng on the west of Chamrat mine, Pb anomalies are more significant than Zn anomalies and the distribution spreads southeastward. The anomaly distribution in the southwestern part overlaps the Zn anomaly area, but it is not as significant as Zn. There is a tendency that Zn anomaly had become more significant in the south. In the southeastern part of the area, distribution of high anomalies corresponding to those from the lead occurrence on the northern side of the Dong Noi detailed survey area to the lead occurrences of Huai Mae Chang is found.

[Cu] The Cu anomaly distribution is also similar to those of Zn and Pb, it is not so significant. Most of high anomalies are found at the upper stream of Huai Mae Ho in the southeastern part of the Mae Sariang area.

[Mn] The Mn anomalies overlapped those of Zn and Pb. It was known that stratified Manganese deposit often originated in the stratiform shale of the Paleozoic age in Thailand. However, the amount of manganese was not always plenty where shale distributed in this area. The distribution of anomalies of Mn is to be effective as an indicative element of mineralization with addition of metallic elements.

[Ba] The Ba anomalies are also distributed overlapping those of Zn and Pb. Judging from the fact that many of ore showings of Mae Sariang area are a combination of sulfide minerals-balite-quartz veins, the distribution of anomalies of Ba has a high possibility of indicating the distribution of mineral occurrences in this area. It is natural that many of extremely high anomalies are found in the surroundings of the Chamrat Barite mine of the mid-northern part of the district.

(2) Principal Components Analysis

Eigen values of up to the third principal components are above 1. Cumulative contribution up to the third principal components was 72 %. Fig. II-2-5 shows the scores of Z-1.

[Z-1] Since the factor loadings of Zn, Mn, As, Cu, Pb, Ba, Sb and F are large, they are considered to correspond to mineral occurrence of these elements. The high scores of Z-1 are distributed from the east of Mae La Noi to the near to Doi Lun Kam, from Huai Hat Ta Lan to Huai Ngu, the northward of Doi Chang, the neighbor of junction of the Nam Mae Sariang Noi, the lower part of the Nam Mae Sariang, the area from Huai Hin Lek Fai through Huai Hu to Huai Mae Pan Noi, the upper stream of Nam Mae Kanai, the eastward of Mae Kanai and the district from Huai Chang through Dong Noi district up to the junction of Nam Ritto and Huai Mae Ok. All cases well matched with the limestone of the Ordovician and Permian age, and the shale intercalating limestone or limy shale of Ordovician, Devonian-Carboniferous and Permian-Triassic.

2-4 General discussion

The area in the eastern side of Nam Mae Yuam occupying the most of this survey area belongs

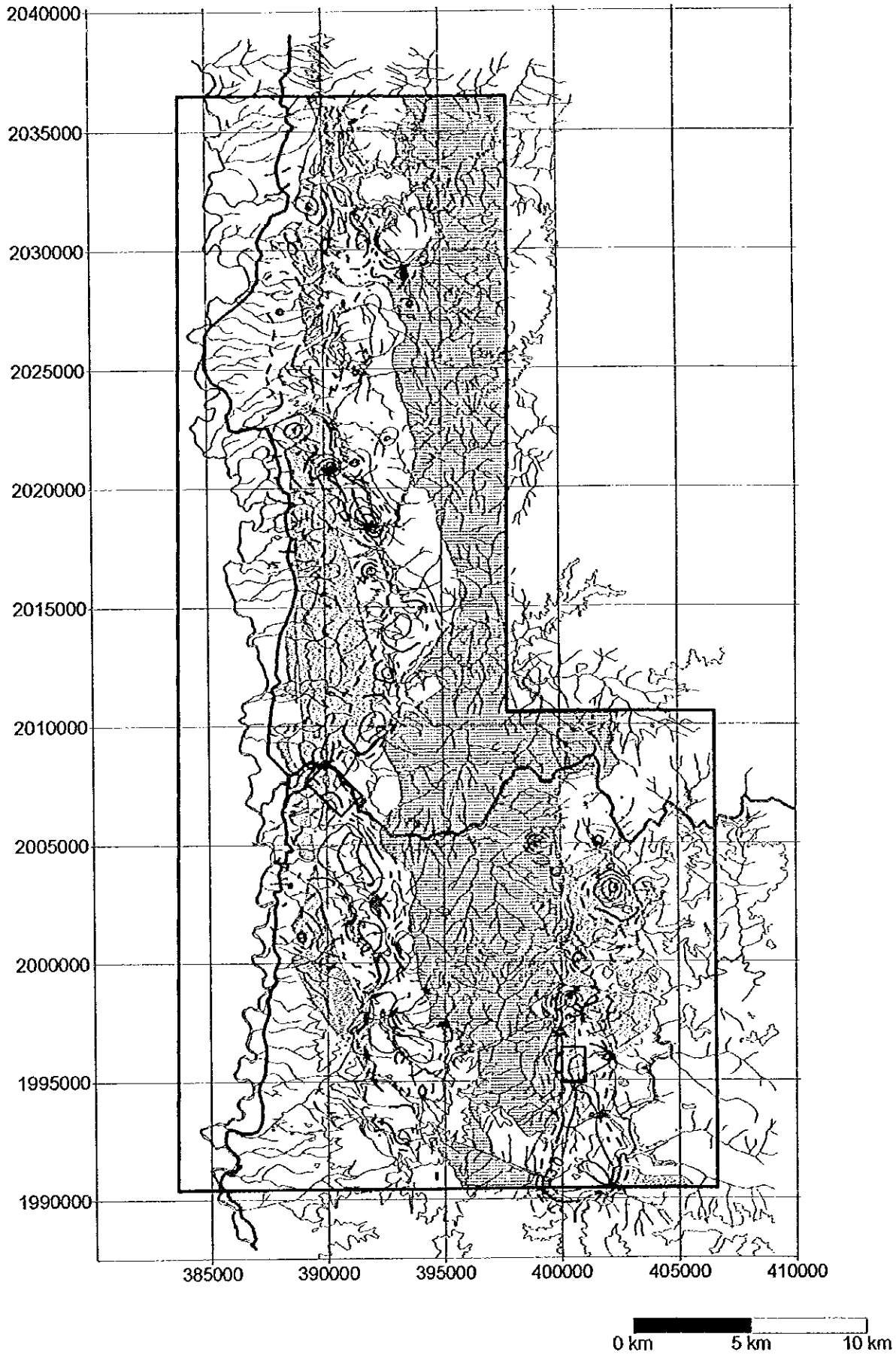


Fig.II-2-5 Result of principal analysis on stream sediment of the Mae Sariang Area(Z1

to the western major mountain tectonic province. It is composed of sedimentary rocks and granite from the Cambrian age to the Triassic age. The whole geological structure is consistent with the continuous direction of ridges in this area and extends from north to south. Since Triassic granite batholith intrudes the regional center from north to south, this granite divides the Paleozoic formation into the western and the eastern sides. The Paleozoic formation on the west side has a monoclinal structure in a western dip of strike from the north-northwest to south-southeast as a whole. Younger geologic units of sedimentary rocks from Cambrian to Triassic age overlie the unit below from the east to the west. The Paleozoic formation on the eastern side mainly consists of Ordovician sedimentary rocks and Cambrian formation exposes partly.

Thick limestone formations develop in the Ordovician and the Permian. Besides, there are thin alternating beds of shale and limestone, limestone lenses and calcareous shale in the lower Ordovician, the Devonian-Carboniferous, and the Triassic formation.

The area has been no actually operated metallic mines in this area, but many occurrences of galena-barite-quartz veins are distributed. Many of them distribute harmoniously with limestone. They are highly correlated particularly to the Ordovician limestone and limestone lenses of the Devonian-Carboniferous age. Most of these showings are indicating the existence of galena-barite-quartz veins. Many such occurrences of veins distribute in the wide area. It continues from the eastern end of I-4 sub-area of the east of Mae Sariang urban area through Huai Pu on the south side, Huai Mae Pan to the river basin of Huai Mae Pan Noi.

Judging from the geological features, gossan in the peripheral areas of Cahmrat barite mine of the northern part of Mae Sariang area and the surroundings of Ban Huai Ngu and Mae La Noi may indicate also vein-type mineralization. The mineral occurrence extending from the surroundings of Ban Mae Kanai in the eastern part of Mae Sariang area through into Dong Noi district clearly indicates vein type mineralization such as the galena-barite vein in Dong Noi district and along the road on the north of Ban Dong Noi. However, geochemical anomaly of Zn in Dong Noi district, massive gossan, skarnized limestone as well as massive magnetite floats occurring in the Ordovician limestone can be stratiform or massive type deposits through metasomatism of limestone.

On the basis of the geochemical survey of stream sediment, the geochemical anomaly of Zn and Pb are found in the surroundings of the above mentioned zones of mineral showings. According to the results of principal component analysis, it has been judged that the first component with a large factor loading of Zn, Mn, As, Cu, Pb, Ba Sb and F is a factor suggesting mineral showings in Mae Sariang area. In other words, the high score area of the first component seems to have a greater possibility of existing a mineral deposit. The areas of a high score of the first principal component are the eastern part of Mae La Noi extending to the surroundings of Doi Lum Kham, from Huai Hat Ta Lan to Huai Ngu, the northern part of Doi Chang, the surroundings of the junction of Um Mae Sariang Noi, the lower stream of Um Mae Sariang, the area from Huai Hin Lek Fai through Huai Pu into Huai Mae Pan Noi, the upper stream of Nam Mae Kanai, the eastern part of Mae Kanai and the district from Huai Chang through Dong Noi district into the

confluence of Nam Mae Rid and Huai Mae Ok. Each of them is occupied by Ordovician limestone, Devonian-Carboniferous and Permian-Triassic shale and calcareous shale with thin limestone layers.

Figure II-2-6 shows the distribution of limestone in the Mae Sariang area, the distribution of mineral occurrence and the results of principal components analysis. As understood from this figure, the following four districts are with high possibilities of the existence of mineral deposits.

1. Mae Kanai Area

This area locates on the eastern side of a mountain ridge extending from Doi Khun Mae Kanai to Ban Mae Kanai. It forms a flat plateau and it is occupied by Ordovician formation. The formation, from the base upward, consists of shale-sandstone alternating beds and limestone. Cambrian quartz arenite lies in fault contact along the northern boundary of the Ordovician formation. Triassic granite is intruding on the west side. The limestone area forms a large karst landform shaped like a boat's bottom. On the ridge surrounding the caved-in area, there are several massive gossan zones and gossan float zones in a 100 meter scale. In the tributary of Huai Mae Ho of the east end of limestone, many gossan floats are observed on the boundary of limestone and sedimentary rock. The assay results of these floats show 1.5 % Zn. Gossan in this area generally contains a high level of zinc, 1,000 to 4,400 ppm. In the branch of the southern side of the limestone, many magnetite boulders of angular shapes (4 m at maximum) distribute. In the upper stream of Nam Mae Kanai on the western side, skarnized limestone containing garnet distributes on the border of granite. The geological situation is similar to those of Dong Noi district. Judging from mineral occurrence, existing of stratiform or massive sulfide (oxidized) mineral deposits in limestone and/or skarn deposits at the lower part of limestone are highly expected.

2. Huai Pu - Huai Mae Pan Area

This area consists of Devonian-Carboniferous and Permian-Triassic black shale, sandstone and chert with banded limestone and thin layers of limestone. Limestone in general contains calc-silicate minerals and often becomes greenish. Many floats with barite-quartz vein containing galena, chalcopyrite, sphalerite, pyrite and others are found along the stream as well as at the slope of mountainside. Moreover, small veins (below 30 cm wide) of the same components are also found among shale. Although big limestone bodies do not distribute, geochemical anomaly of zinc and lead are quite high. Therefore, there is a high possibility of existing vein-type mineral deposit like the above mentioned or a massive sulfide ore body that has replaced a limestone lens.

3. Northeastern Area of Mae Sariang Town

Ordovician limestone distributes from the I-4 area on the east of Mae Sariang town to northward. The ridge of mountains continues from north to south ranging from 700 to 900 m above sea level. Along the Nam Mae Sariang on the East Side, the lower Ordovician shale and sandstone distribute and Triassic granite intrudes into these rocks. On the west side it contacts with the Permian limestone by north-south faults. There are no mineral occurrences of metallic minerals, though there are fluorite deposits in the southern part of the area.

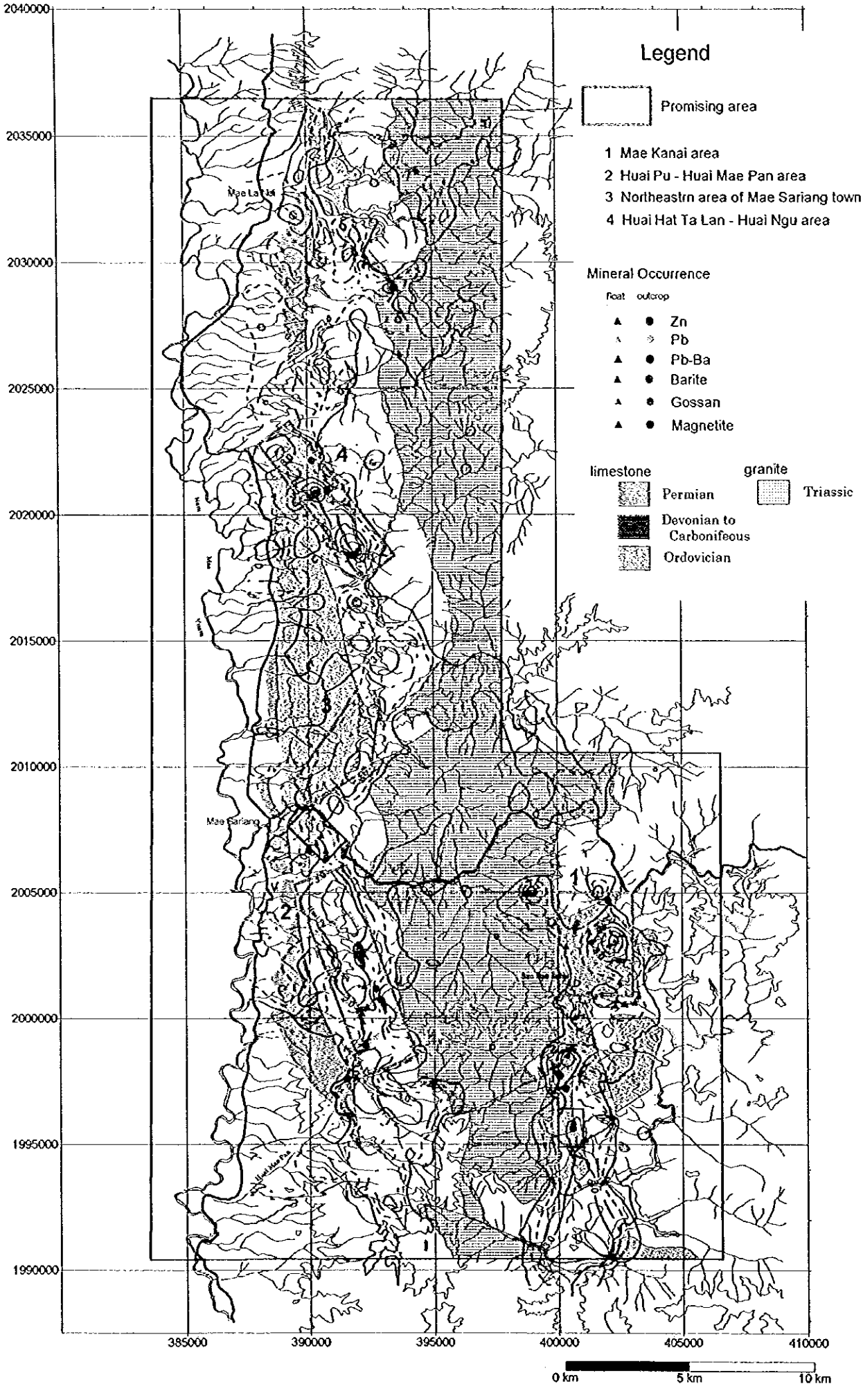


Fig.II-2-6 Interpretation map of reconnaisance geological and geochemical survey in the Mae Sariang Area

The Zn anomalies of the stream sediments geochemistry are commonly detected in this area, though their level is not so high. The geological situation is similar to those of Dong Noi area and Mae Kanai area. Therefore it is suggested that this area has a possibility of existing zinc occurrence among limestone.

4. Huai Hat Ta Lan - Huai Ngu Area

This area extends from the right bank of Huai Hat Ta Lan on the west of Chamrat Barite Mine to Ban Huai Ngu. The lineament from Huai Hat Ta Lan to Huai Ngu has a high possibility of being a fault judging from its topography. In this area, several streaks of limestone and shale of the Ordovician age that continue from north to south distribute and quartz porphyry dikes are intruding into it.

Many gossan and barite floats are observed in the tributaries that run into Huai Hat Ta Lan and Huai Ngu from the east side. In the mountains and hills, barite veins without sulfide minerals are scattered. The Zn content of gossan samples ranges from 1,500 to 5,200 ppm. The Pb level of stream sediments is higher than that of Zn. The geochemical anomalies are scattering and no continuous. Judging from the geological condition, there is a high possibility of existing mineralization in vein-type.

Chapter 3 Dong Noi Area

3-1 Geology

3-1-1 Outline of geology

The Dong Noi area is underlain by the Cambrian and the Ordovician sedimentary rocks. Triassic granite is distributed in the western part of the area as a large-scale batholith.

The Cambrian formation consists of sandstone. The Ordovician formation consists of shale and sandstone, and impure limestone. The rocks have been often metamorphosed to hornfels and calc-silicate rocks. The limestone is occasionally recrystallized and dolomitized.

The Dong Noi mineral occurrence, that consists of dissemination and stockworks of galena-barite-quartz, is situated in the central part of the area. A gossan zone is found in the southern part of the area. Fig. II-3-1 respectively show a geological map and profiles of the Dong Noi area.

3-1-2 Details of geology

1. Sedimentary rocks

(1) Cambrian sedimentary rocks (CB)

The Cambrian sedimentary rocks widely expose around Doi Dong Luang. The formation mainly consists of green or dark green, hard and compact medium- to coarse-grained siliceous sandstone. The sandstone has been extensively metamorphosed and skarnized, and is accompanied by calc-silicate minerals as garnet porphyloblasts. A dissemination of pyrite is widely observed in sandstone at a precipitous cliff on the South of the Doi Dong Luang.

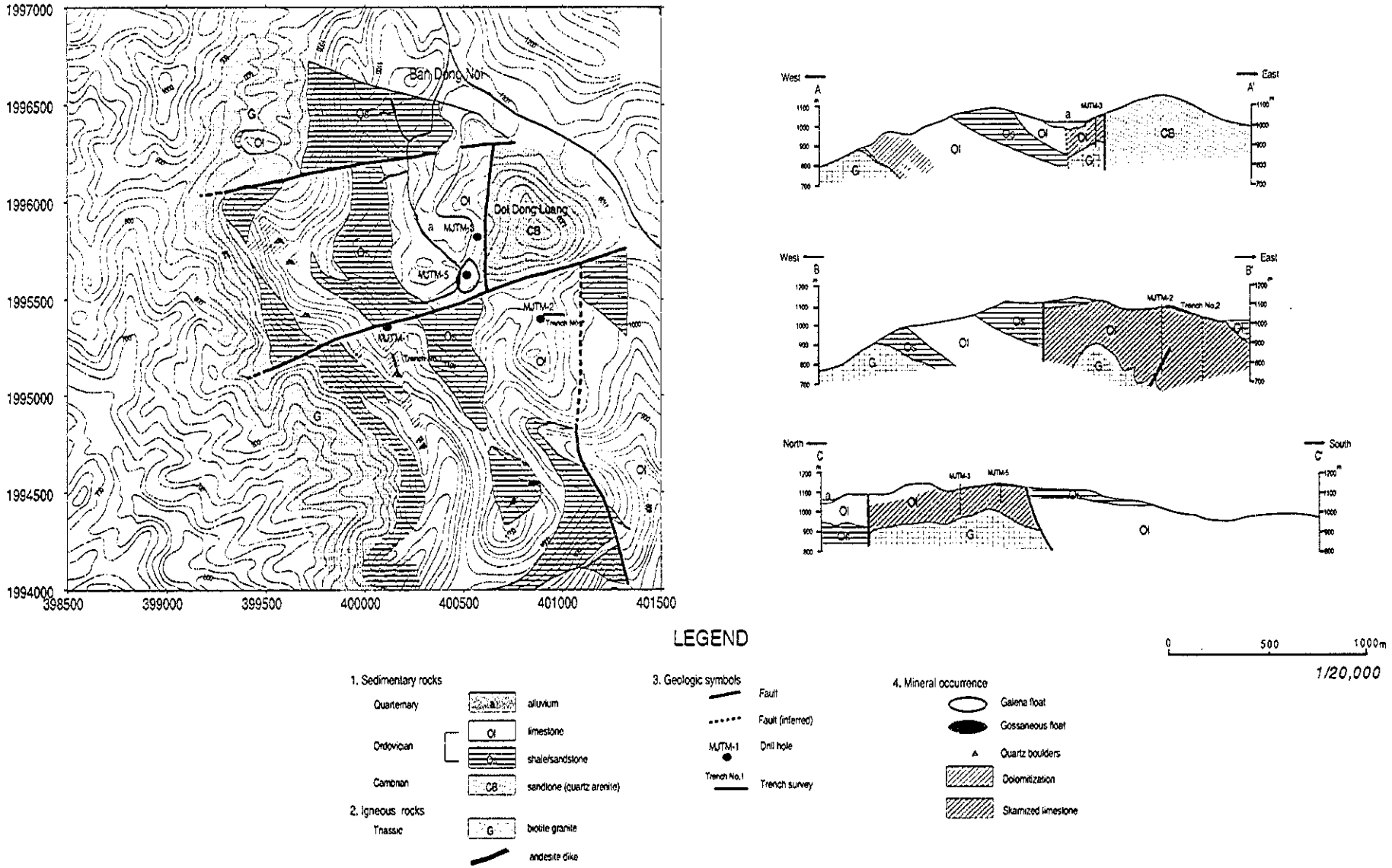


Fig. II-3-1 Geologic map and profile of the Dong Noi Area

(2) Ordovician sedimentary rocks (Oℓ, Os)

The Ordovician sedimentary rocks mainly consist of impure limestone (Oℓ) and shale (Os).

The impure limestone contains a large amount of thin argillaceous layers or schlierens. The limestone with abundant argillaceous layers is phyllitic, and locally grades into phyllitic shale. The limestone is recrystallized in the southwestern and the western parts of the area. The limestone of the western part has strongly undergone dolomitization, and is accompanied with vein-form or pool of white crystalline dolomite. The intensely dolomitized limestone also contains a large amount of veinlets of quartz and calcite, and dark brown carbonate material consisting carbonate mineral and its stained secondary iron mineral.

The shale mainly consists of phyllitic black shale, with occasional gray to dark green sandstone beds in the western part of the area. The shale has been often metamorphosed, and is accompanied with cordierite porphyloblasts in the southern part of the area.

2. Granitic rocks (G)

The Triassic biotite granite is widespread in the western part of the area. The granite is characterized by a large amount of euhedral phenocrysts of potassium feldspar. The aplitic fine-grained biotite granite is distributed near the boundary between biotite granite and sedimentary rocks. The aplitic granite contains a small amount of disseminating pyrite.

The distribution of crystalline limestone and pelitic hornfels, and the skarn-type mineralization detected by the drilling survey shows that the granite bodies or some stocks widely intrude underneath the sedimentary rocks. The drill hole MJTM-3 encountered aplitic granite and porphyritic biotite granite at 123 meters depth to the bottom. It means that the top of the granite body is rather shallow around the Dong Noi mineral occurrences.

3-1-3 Geological Structure

The Dong Noi area is divided into blocks by the east-west and north-south striking faults. Thereby the Cambrian sedimentary rocks and the Ordovician sedimentary rocks are in fault contacts. The Ordovician sedimentary rocks are observed intense folding on outcrops. However, judging from the strikes of argillaceous layers in limestone and those of shale, the formation steeply dips east at the western part, and eastward they gradually dips gently southeast.

3-1-4 Ore deposit and occurrences

Fig. II-1-3-2 shows the locations of mineral occurrences in the Dong Noi area.

(1) The Dong Noi mineral occurrence

The Dong Noi mineral occurrence of lead and barite occurs at the central part of this area. This mineralization is stockwork-form or dissemination-form of galena-pyrite-barite-quartz in banded limestone and crops out in a range of 20 x 10 m at the top of a low hill. Although the mineralization range is not clear because the outcrop is poor, same floats are ovally scattered in an area of 100m east and west and 200 m north and south around this outcrop. The test pitting was conducted at two points (Test Pits No. 1 and No. 2) in this floats area. These test pits did not

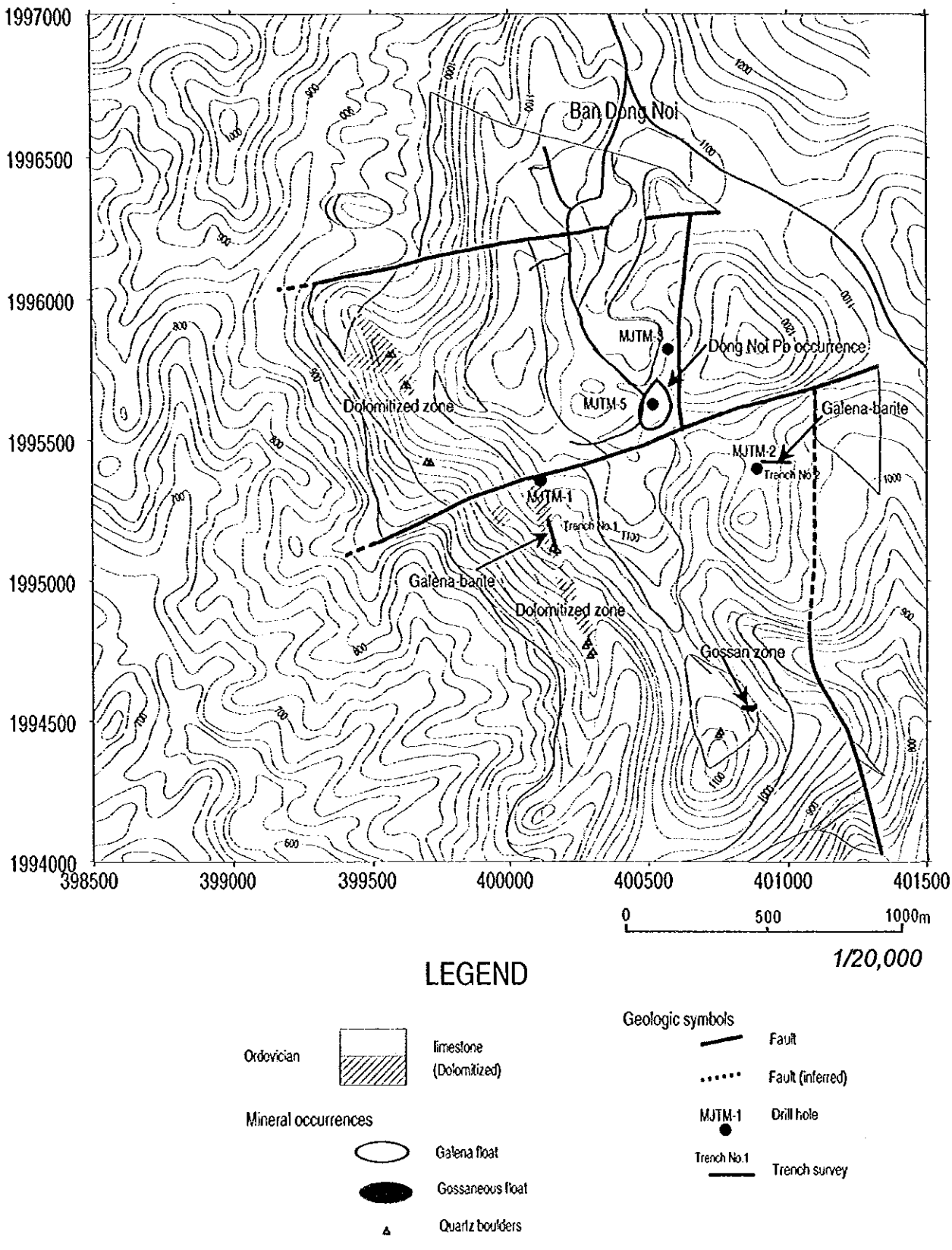


Fig.II-3-2 Mineral occurrences of the Dong Noi area

reach fresh bedrock. However, in addition to galena and barite ores, gravel of massive pyrite and magnetite are found at Pit No. 1 and there is also a large amount of floats rich in calcareous silicate that are apparently seemed as country rocks. Furthermore, we obtained a large amount of quartz vein floats at the top of Pit No. 2. Also we observed soil with the dissemination of pyrite and weathered silicified muddy sandstone with limonite stockworks which is judged as C horizon in the lower part. Assay of rocks rich in sulfide shows 970 ppm Cu and 32.4 g/t Ag.

A very high concentrations of Zinc (> 300 ppm), lead (> 3000 ppm), and copper (> 900 ppm) are detected from soil samples of both test pits.

This mineral occurrence is located on the limestone side near the intersection of two faults, in the directions of east-west and north-south. This indicates unquestionably that the mineralization in this area is strongly controlled by structure and lithofacies.

The Cambrian sandstone in the east of the area underwent a thermal metamorphism and calc-silicate minerals are partly found. Quartz veins and silicified parts are also observed on a cliff in the southeastern part. In addition, an intense magnetite dissemination was found near survey point 400 along the geophysical survey traverse line Y.

(2) Gossaneous zone

At the southern part of the Dong Noi area, many gossan floats are distributed an area of 50 meters east-west and 25 meters north-south. These floats range from 20 cm to 6 m in diameter, and generally contain 600 to 800 ppm Cu (DN-G1 to DN-G5), whereas no anomalous Zn and Pb values are detected.

In the northeastern part of the area, a large number of gossan floats with a diameter of 40 to 60 cm are distributed on the boundary between a bank karst and a hill composed by the Cambrian formation. These floats contain 210 ppm Cu, 5,700 ppm Pb, and 2,350 ppm Zn. These gossan floats scatter on east-west geochemical anomaly zone in the northern part of the area described later.

3-2 Geochemical survey

3-2-1 Method

In Phase I exploration, soil samples are taken at intervals of 25 m by using a geophysical survey traverse line. These are also taken in the middle of a geophysical survey traverse line to grasp a spread of an anomaly value in detail in the center of the area. Other sampling points are arranged using existing roads and paths in places where there is no geophysical survey traverse line can cover the entire area.

The soil geochemical survey continues for Phase II exploration. The anomaly was open to the outside of the Phase I exploration area, though the soil geochemical survey for the Phase I exploration revealed clearly the anomaly of Zn and Pb. Therefore the soil sampling is planned to delineate the anomaly around the Phase I area, and adopted the same sampling method and condition with the phase I survey.

Additional soil sampling of five sampling line (Line F to Line J) is also conducted to check the

mineralization style of the gossan zone discovered in the southern part of the area.

Other two traverse lines in 1km length are arranged in east and west direction between the Dong Noi area and a galena-quartz vein that occurs about 1 km north from the Dong Noi area. 82 samples were collected at intervals of 25 m in order to clarify the relationship about the vein and the Dong Noi occurrence.

Total number of soil samples is 1,254 in the Dong Noi area.

3-2-2 Distribution of geochemical anomaly

On the basis of the anomaly value distribution charts, pathfinder elements are classified into three categories: Cu group elements (Ag, Ba, Cu, Fe, Sb), Zn group elements (Cd, Zn), and Pb group elements (As, Mn, Pb). The anomaly of Cu group elements and the that of Zn group elements are clearly separate distributions each other. The anomaly of Pb group elements overlaps with both of the Cu group anomaly and Zn group anomaly. It means that the elements related to the Z-01 factor loading of principal component analysis are divided into further two category.

1. The distribution of Zn group elements (Zn, Cd)

The Zn anomaly values are clustered at two areas: the western limestone area and the limestone area to the south of Doi Dong Luang around the drill hole MJTM-1. The anomaly of the western limestone is coincident with the dolomitized zone. Therefore it means that the dolomitization is close relationship with the zinc mineralization at the western part of the Dong Noi area. The distribution of Cd anomalies is quite similar to those of Zn.

2. The distribution of Cu group elements (Cu, Ag, Ba, Fe, Sb)

The Cu anomaly values are concentrated at the Dong Noi mineral occurrence. The anomaly zone is an elliptic shape with the major axis trending north-northwest to south-southeast. The weak anomaly values are widely distributed at the meta sandstone area. This broad anomaly indicates the high Cu background of meta sandstone.

The Ag and Ba anomalies are almost coincident with the Cu anomaly, though the strong anomaly of Ag and Ba extends ranging from the Dong Noi to about 300 meters south-southwestward.

The anomaly values of As and Sb are clustered at the Dong Noi occurrence and the area along the north-south striking fault.

3. The distribution of Pb group elements (Pb, Mn, As)

The highest anomaly of Pb is the area around Dong Noi occurrence. It appears that this anomaly has a close association with the north-south striking fault zone on the west of Dong Noi occurrence. Other anomalies are distributed at the western limestone area and the limestone area to the south of Doi Dong Luang around the drill hole MJTM-2, that are similar to the anomaly area of Zn. The distribution of Mn and As anomalies is similar to those of Pb.

At the southern gossan zone, the geochemical anomalous values of almost pathfinder minerals

are not detected, but the copper values are relatively higher than the background. The Cu level of the gossan zone is above 100 ppm, whereas the background ranges from 40 ppm to 70 ppm. The Au values are also high at the gossan zone and ranges from 30 to 40 ppm, while the Au values of the other part of Dong Noi area are normally 5 ppm or less. The mineralization, related Au and Cu, is unique in the Dong Noi area, though the detected anomaly level is rather lower.

3-2-3 Geochemical anomaly map of the Dong Noi area

The geochemical anomaly areas of the Zn, Pb and Cu, representing the pathfinder element groups, are integrated in Fig. II-3-3.

The Zn anomaly is only confined to the carbonate rock area, and clearly overlaps with the dolomitized area in the western limestone area.

The Pb anomaly overlaps with the Zn anomaly and the Cu anomaly. An extra high Pb anomaly is limited to the area around the Dong Noi occurrence, where is also recognized the very high Cu anomaly.

3-3 Mineral occurrence survey

3-3-1 Survey method

The survey line of 1.64 km is set on the geochemical anomaly detected by Phase II work, and the continuous sampling and the observation are conducted along and around the line. The mineralized rock such as quartz veins with sulfide minerals were collected as different samples from the continuous samples. The number of rock chip samples is 61 (Fig. II-3-4).

3-3-2 Survey result

1. Situation of geology and mineralization

The northwestern part of Dong Noi area is underlain by massive limestone and banded limestone intercalated with thin argillaceous layers. The limestone generally strikes NNE-SSW and dips 10 to 20° SE. Complex intraformational-foldings are observed in the big outcrop. There is no significant sheared zone or fault, but open joints are common in the northwestern part of the Dong Noi area. The joints have north-south strikes and vertical dips.

Numerous veins are present in the northwestern part of the Dong Noi area, but most of the veins are barren. Only some veins are accompanied by galena, sphalerite and chalcopyrite. No calc-silicate minerals are observed in this area.

In the southern portion, shear cliffs are composed of the limestone with obvious stratiform structure. There, north-south striking small quartz veins are abundant, and limestone has been silicified. Also the horizontal quartz veins in the range of 0.3 to 3.0 m in width partly replace along bedding plains of limestone, and the limestone around this-type quartz veins is dolomitized. Most of the quartz veins are barren except a quartz vein near the sample of D20-55. The druze of the center part of this vein is filled by brown carbonate mineral that was also observed in Trench No.1 and MJTM-1 hole at Phase II work. The vertical vein of brown carbonate mineral with 7 m

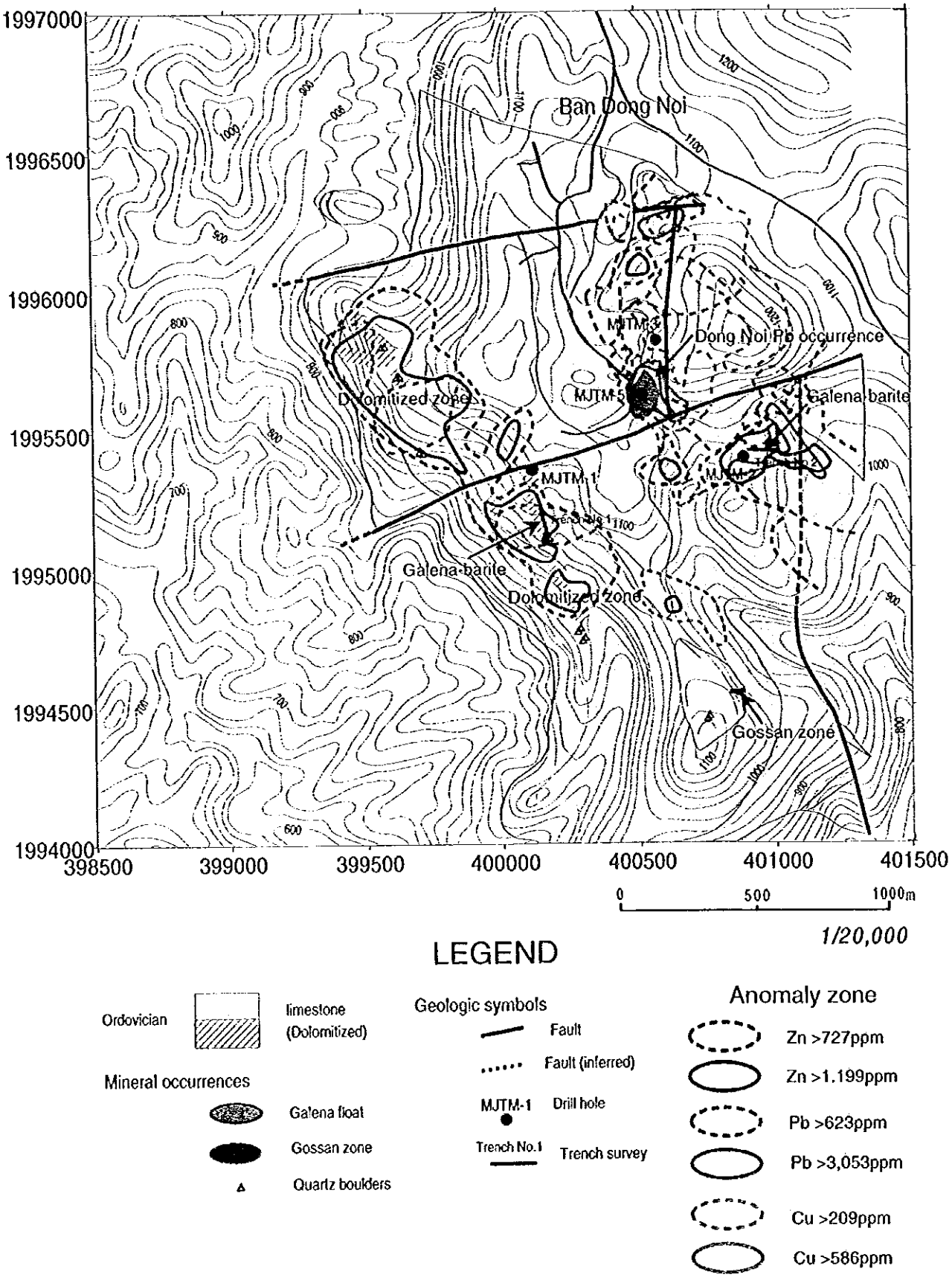


Fig.II-3-3 Geochemical interpretation map of the Dong Noi Area

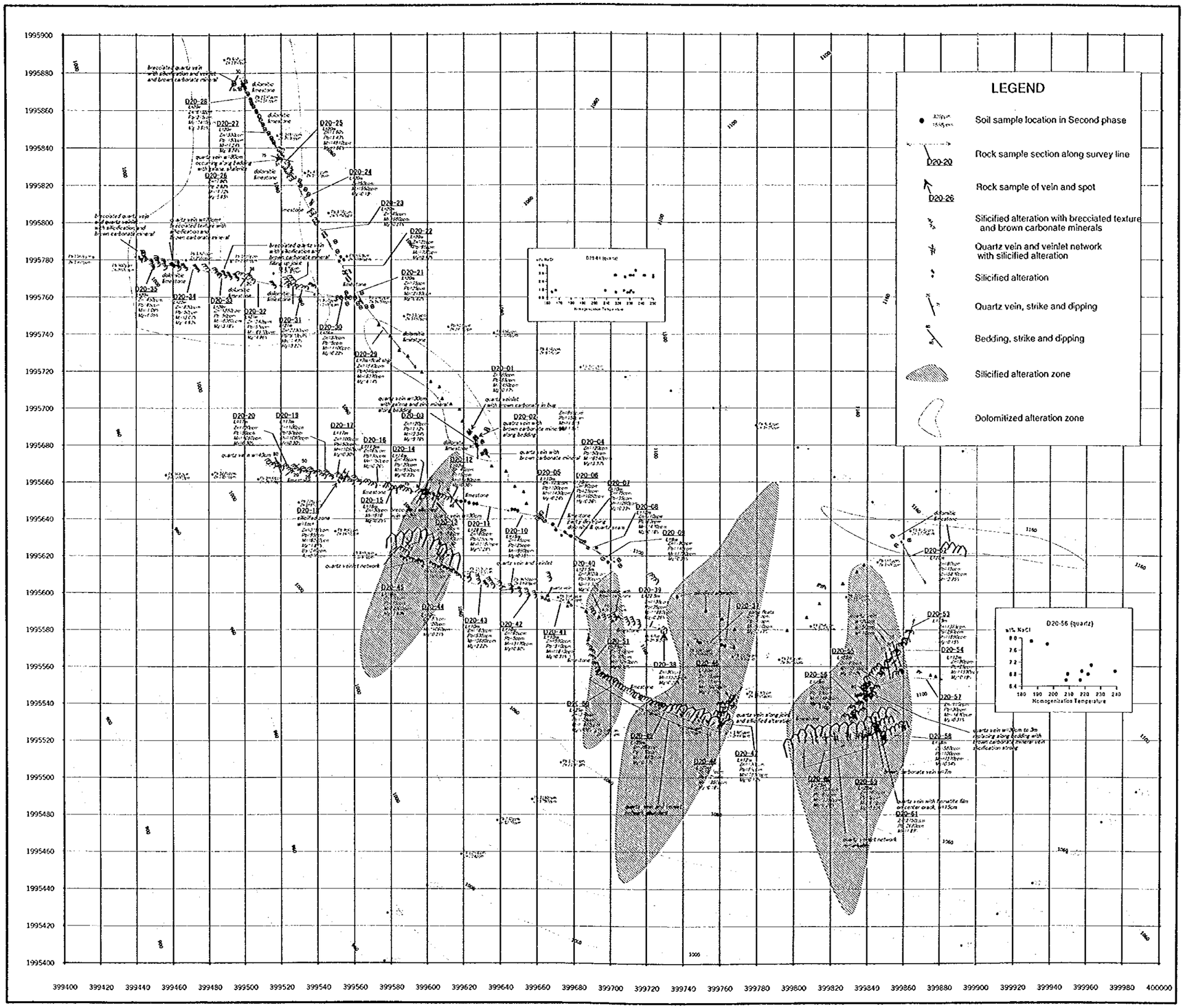


Fig.II-3-4 Result of mineral occurrence survey at northwest part of the Dong Noi area

wide was found around the sample down below the above-mentioned vein, and a quartz vein with hematite films (D20-61 with 15 cm wide) occurs at the boundary between this vein and hosted limestone. The limestone around 1,100 m above sea level in the northeast side is often horizontally dolomitized, but no significant mineralization is found.

In the northwestern portion, strongly dolomitized limestone occurs on the ridge. Two occurrences with quartz veins accompanied by galena and sphalerite, which replace along interlayer of dolomitized limestone, are discovered on the ridge. The quartz veins are small-scale with maximum 80 cm wide and maximum 40 cm wide respectively, and contain silicified limestone, galena, and small breccia of brown carbonate mineral. The limestone around these occurrences shows strong intra-formational folding, and the quartz veins replacing bedding plains have poor continuity.

At the west slope of the ridge, quartz veins occur in places. They fill vertical joints of dolomitized limestone and include silicified breccia and brown carbonate breccia. The veins of brown carbonate mineral are also scattered in the ridge. The widths of these veins range from 20 to 30 cm, and are accompanied by a small-scale silicified zone. The extensions of veins are limited, and most of the veins pinch out approximately 10 m.

2. Result of the chemical analysis

The rock chip sampling sites were arranged at the collected unit of 20 to 25 m along the survey line. The amount of each rock chip sample was about 2 kilograms. Each vein sample was collected from its whole width as different samples from the continuous rock chip samples.

In the silicified zone of the southern portion, most of the samples show low grade ranging from 35 to 590 ppm Zn, from 5 to 535 ppm Pb, and lower than 2,000 ppm Mn, except for two samples rich in brown carbonate veins (D20-40, D20-53). D20-40 and D20-53 show high manganese and zinc contents, 7,270 ppm and 1.32% Mn, 580ppm and 3,020 ppm Zn respectively. The samples rich in quartz veins also show high manganese content.

The quartz veins in this silicified zone contain high zinc and lead: D20-18 is 3,180ppm Zn and 95 ppm Pb, and D20-61 is 2,750 ppm Zn and 2,680 ppm Pb. These content levels are almost equivalent to the values of the soil samples analyzed in Phase II work. Magnesium content of the rock chip sample, which indicates the degree of dolomitization of limestone, is commonly less than 0.3%. Therefore dolomitization is not so strong in this area.

The samples collected from weak dolomitized portion (Mg$\leqq$1.0%) show several tens ppm Zn and Pb, whereas those from strong dolomitized portion show 330 ppm to 1.6% Zn, and 50 to 970 ppm Pb.

Two occurrences with quartz veins containing galena and sphalerite are detected in the strongly dolomitized ridge. The analysis value of D20-2 quartz vein with 30 cm wide is 995 ppm Zn and 150 ppm Pb, D20-3 with 30 cm wide is 120 ppm Zn and 1.12 % Pb, a small vein of D20-4 is 120 ppm Zn and 50ppm Pb, and D20-26 with 80 cm wide is 7.86 % Zn and 2.82 % Pb. All samples contain highly manganese and magnesium in the range of 6,540 ppm to 1.72 % Mn, and 1.81 % to

9.78 % Mg.

The D20-25 rock chip sample with 20 m interval, including D20-26 vein, presents 1.60 % Zn and 1.43 % Pb, but ore mineral has not been determined in the outcrop.

3-3-3 consideration

In the relevant northwestern part of the Dong Noi area, geochemical anomaly in lead, zinc, manganese and cadmium was observed along the district where limestone was distributed just as in the central to southern part of the Dong Noi area. Anomalies in lead (500-3,600 ppm) and zinc (500-3,400 ppm) were widely spread. Similar geochemical anomalies had been observed also around Trench No. 1 and MJTM-1 Hole during our survey of last year. However, no mineralized part was found in our boring and trench surveys.

On the other hand, out of rock samples gathered this time, although sectional samples extracted from strongly dolomitized part in the northwestern end and from quartz vein indicated high anomalies of over 1,000 ppm, most of their values were 200 ppm or less. As a result of our outcrop observation, in brown carbonate mineral vein, thread-lace quartz vein, quartz veins including quartz veinlets and granule of silicified breccia were assumed to have been formed through rise of ore solution along fissures and joint systems in limestone vertically, and later through their replacement and spread along joints in intra-layer directions and partly along specific horizon (lithofacies).

Also, from the result of outdoor observation, a well-developed silicificated zone consisting of quartz vein and brown carbonate mineral vein was found developed under a lower part of the dolomitized zone, and above it dolomitized zone was widely formed. In a dolomitized zone, with increase of zinc and lead concentrations also in host rocks, a quartz vein containing galena and sphalerite was considered to have been formed to be replaced with a specific horizon of the dolomite folded intraformationally, showing an accordion-like structure. These relationships are consistent with the result of our observation at Trench No.1. Few samples were seemingly included in the rock samples extracted from these sections that might show high geochemical anomalies.

Our measurement of homogenization temperatures and Salinity of fluid inclusion revealed no remarkable difference in homogenization temperatures between the sample from lower silicificated zone and quartz vein replaced with upper dolomite layer. However, a large difference in Salinity was observed. Homogenization temperatures of the former and the latter were 180-240℃ and 160-250℃ respectively. Salinity as equivalent with NaCl of the former showed high values of 6.5-8.0wt%, while the latter showed lower values of around 1.0 wt% and 3wt%.

It is difficult to explain only from the results of rock sample analyses possible reasons for the wide-ranged and intensified geochemical anomalies in soil samples. However, it may be possible that lead and zinc contained in quartz vein and dolomitized zone formed widely along the joint fissures in limestone were absorbed into manganese oxide during the time when manganese similarly contained in them was changed to oxide in the weathering process and stayed on the

land surface.

In the northwestern ridge carefully investigated this time, a certain amount of lead and zinc ore body might have occurred. A detailed investigation into geological structures will be necessary to decide the points of their occurrence.

3-4 Geophysical Survey

3-4-1 Survey location and amount

This survey has a purpose to define the resistivity structure and the IP anomaly area of the mineralized zone and the related alteration zone in the Dong Noi area. Seven IP lines were measured in Phase I exploration, and one TDIP line in Phase II exploration. Survey amounts is shown in Table II-3-1.

Table II-3-1 Survey amounts of IP survey in the Dong Noi Area

Phase	Length	Number of lines	Number of points
First Phase	8.0km	1.0kmx 5 lines 1.5kmx 2 lines	222
Second Phase	1.0km	1.0kmx 1 lines	26
Total	9.0km	7 lines	248 points

3-4-2 Survey method

1. Measurement method

It made electrode arrangement dipole-dipole array with pole interval 100 m and pole separation coefficient from n=1 to 4. It measured IP method in the time domain, it floated down the pause corrugation of 1/8 Hz as the principle and it measured decay voltage after electric current cutting.

2. Analysis method

(1) Topographical correction

When calculating apparent resistivity, it supposes a pole arrangement coefficient as the one to have arranged a pole in the infinite plan. However the apparent resistivity is influenced by the topography, that the earth was calculated even if it was electrically homogeneous. The apparent resistivity is observed small in the place such as a valley, while it becomes high in the ridge in the dipole-dipole type array by the IP method. On the other hand, chargeability is hardly influenced in the topography, because it is calculated from the transition phenomenon with potential after electric current cutting.

The Dong Noi area consists of mountains and hills. Therefore topographic corrections, using the finite element method of two dimensional, were carried out in the all measurement Line, then the values of apparent resistivity were revised and pseudo sections and plan maps were made by using these corrected values.

(2) Two Dimensional model analysis

In this investigation, it analyzed in simulation by the finite element method of Two

Dimensional (2-D) about all lines. It used model computation (Forward Modeling) by the finite element method and the 2-D inversion analysis method (Sasaki, 1988) which composes an automatic analysis method by the non-linear least square method each other for the computation.

In the model analysis of 2-D, it gives all the blocks identical resistivity as the first basic model and calculates a theoretical value with apparent resistivity and chargeability to this model. Next, for residuals with this theoretical value and measurement value to become small, it corrects a model by the automatic iteration analysis by the least square approximation method and it calculates replying to the correction model. This work carries out repeatedly, and it makes a theoretical value approximate a measurement value. Then it estimates optimal underground structure.

In this investigation, it provided a resistivity block boundary for the middle of basically marching station and moreover, it made the all sides -shaped block that divided a block under each station to become thick at the depth thin at the shallowness to the direction of the depth. Then, it transforms this according to the topography of the surface of the ground, in the level direction, it made and it used the resistivity block that becomes parallel to the topography for the analysis.

3-4-3 Result of the survey

The Survey line layout is shown in Fig.II-3-5.

The result of TDIP measurement and the 2-D analysis are shown in Fig.II-3-6 and II-3-7.

Apparent resistivity in this area ranges from 67Ω·m to 1608 Ω·m and the chargeability shows a maximum of 28 mV·sec/V.

The zones of the apparent resistivity of less than 200 Ω·m and those of the high chargeability above 20mV·sec/s are shown in Fig.II-3-8, picked out from the result of N=1 of the IP method measurement. Faults and mineral occurrences in the geologic map are also shown in the same chart.

The Dong Noi occurrence is located in station 500 of line C. The apparent resistivity in this station is about 100 Ω·m and the chargeability is 18 mV·sec/V, rather high value. The rock specimen collected around this station is measured the chargeability 18mV·sec/V, and it contains galena. The floats containing galena are found around the Dong Noi occurrence, and the fault trending E-W runs to the south of line-D and another fault trending N-S to the east of the occurrence.

The low apparent resistivity of less than 200 Ω·m is distributed around the northernmost, the southernmost, the easternmost, and the Dong Noi occurrence (the area center part). The high chargeability zone is detected along the fault trending north to south, and comes in contact with the low apparent resistivity part of the center part of the area. A lot of geophysical anomalies are observed at the neighborhood of the Dong Noi occurrence at station 500 of line-C. Therefore it is situated near the discontinuous plane of the underground structure.

The contour line of 15 mV·sec/V of the chargeability plan map of N=1 is displayed by a dotted

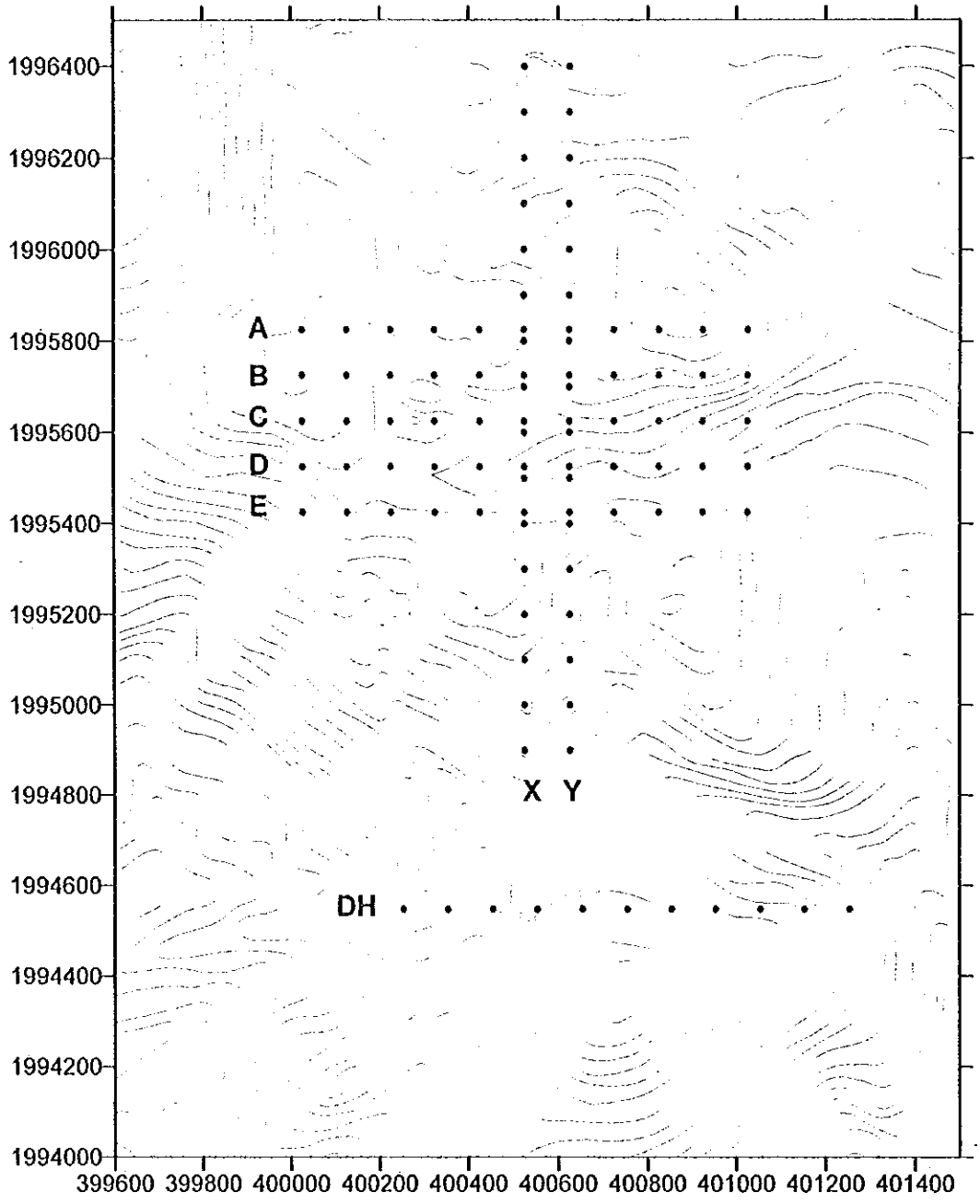


Fig.II-3-5 Location of survey line in the Dong Noi area

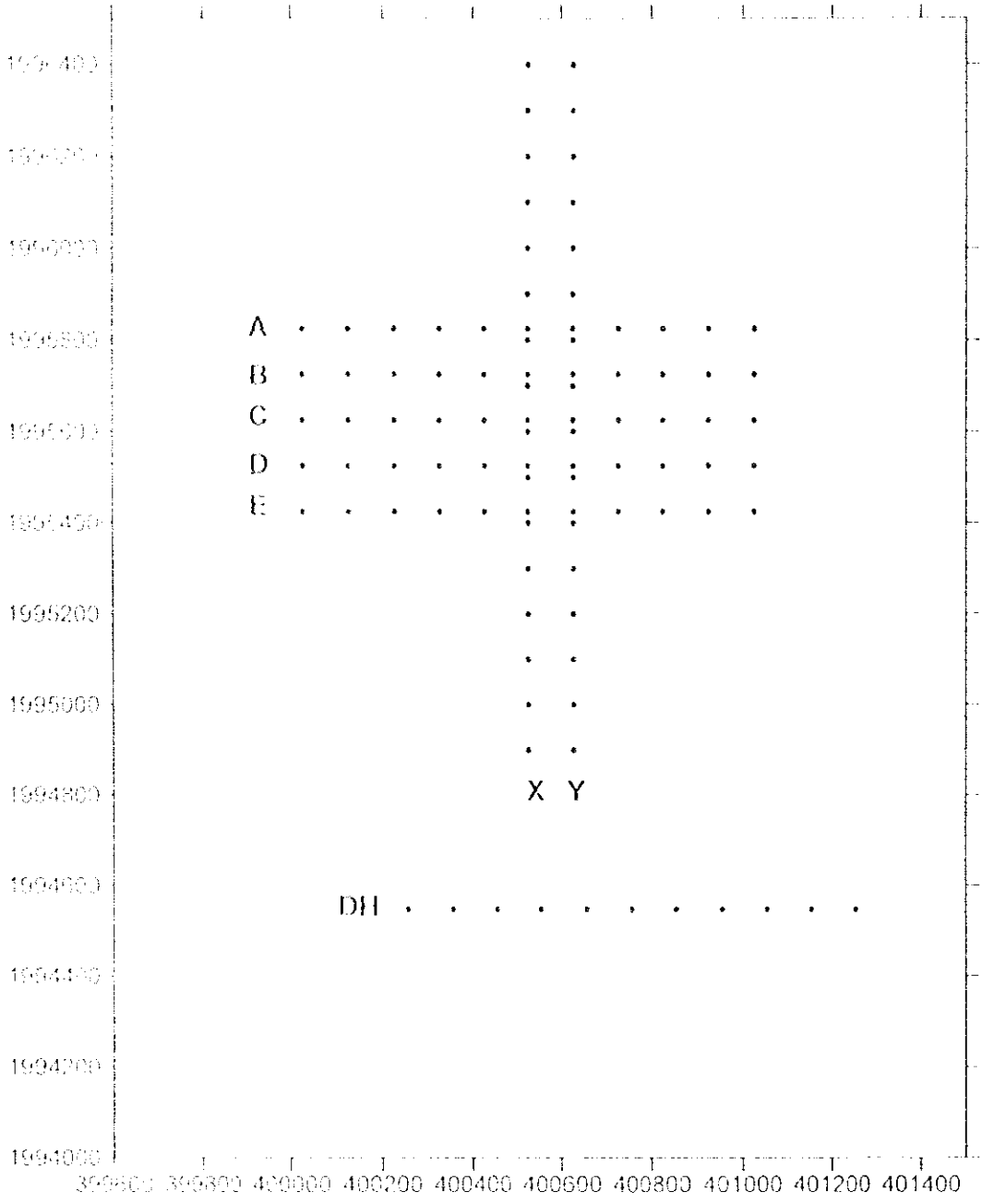


Fig.II-3-5 Location of survey line in the Dong Noi area

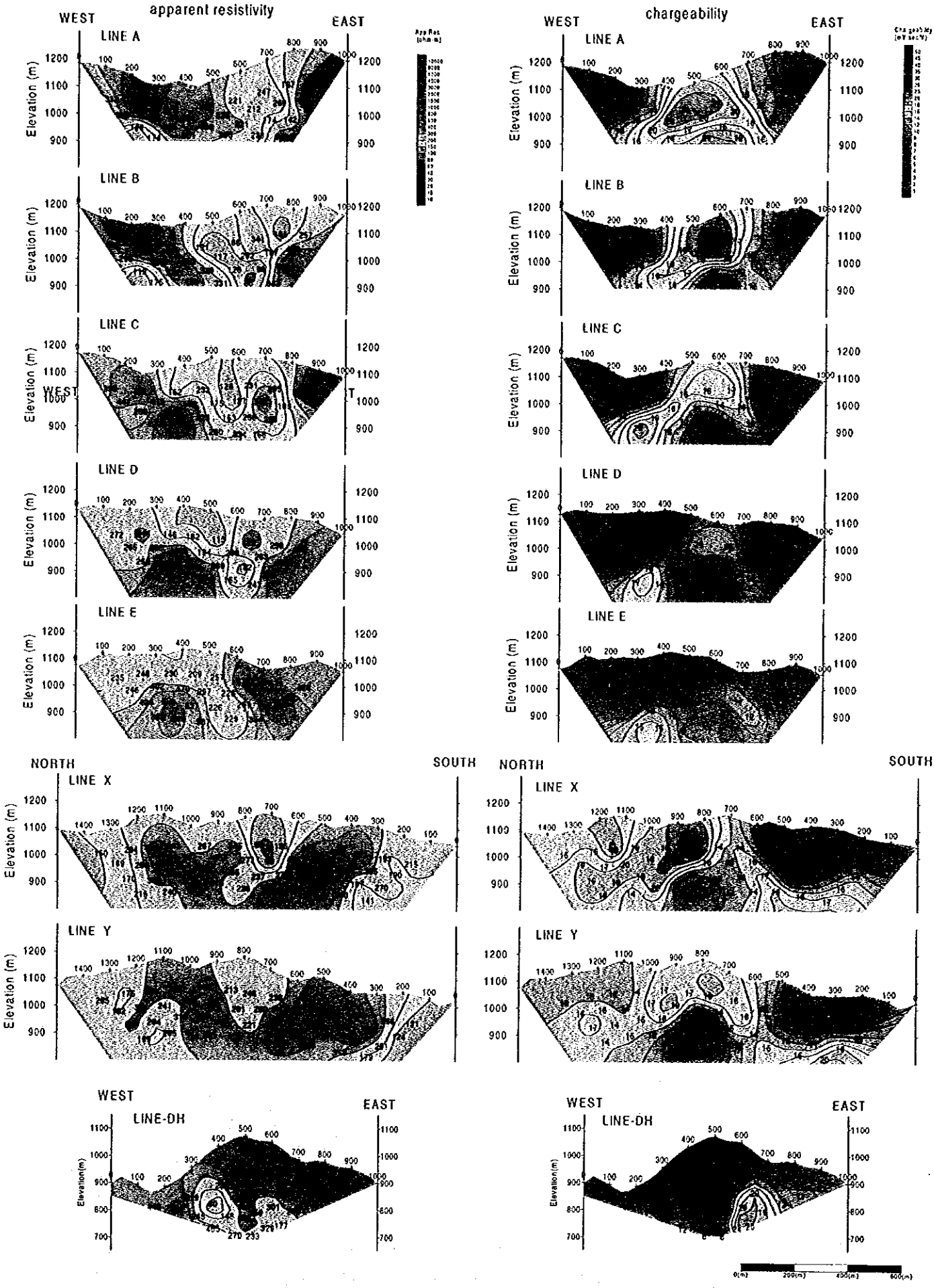


Fig. II-3-6 Pseudosection of apparent resistivity and chargeability of the Dong Noi area

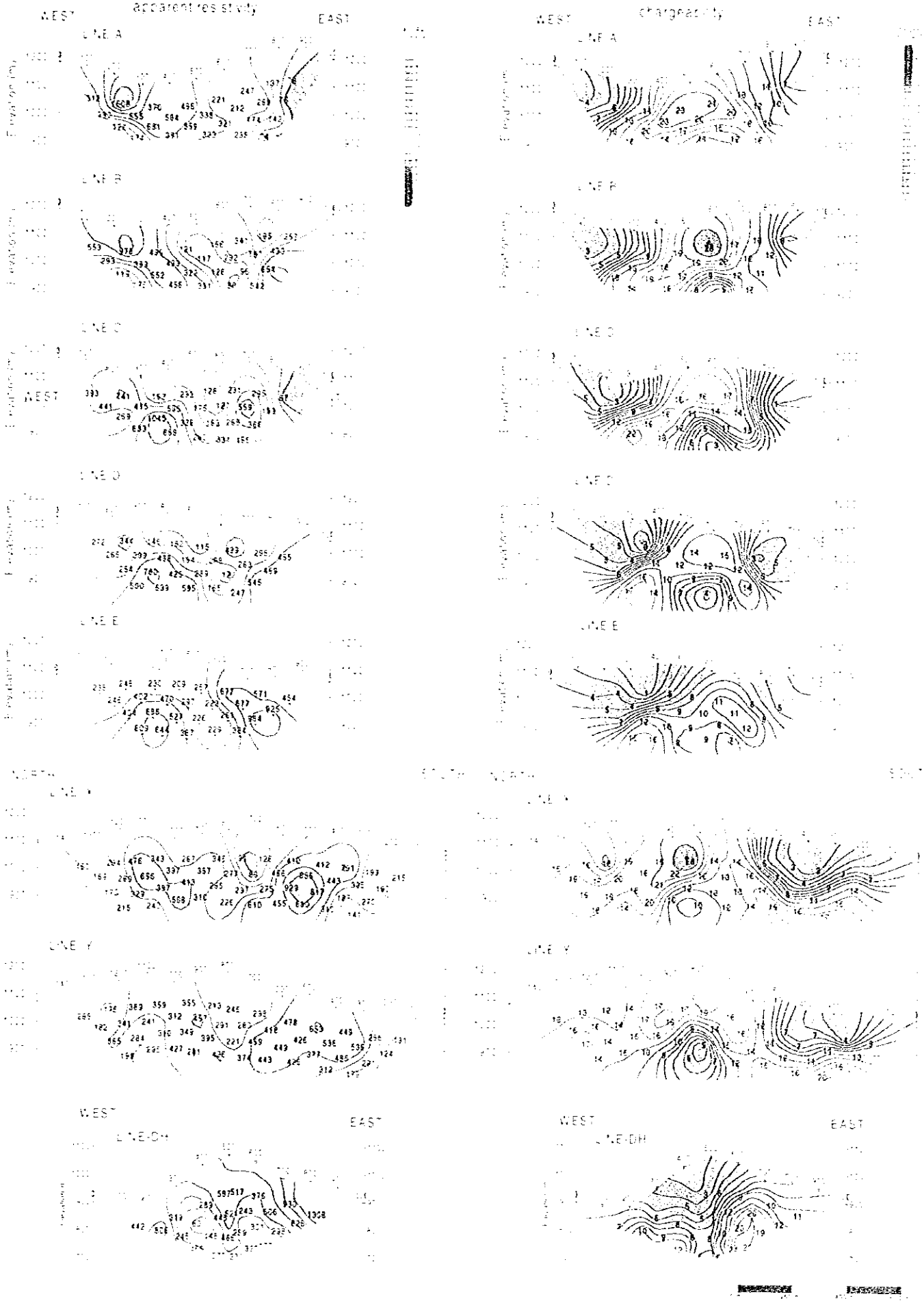


Fig. II-3-6 Pseudosection of apparent resistivity and chargeability of the Dong Noi area

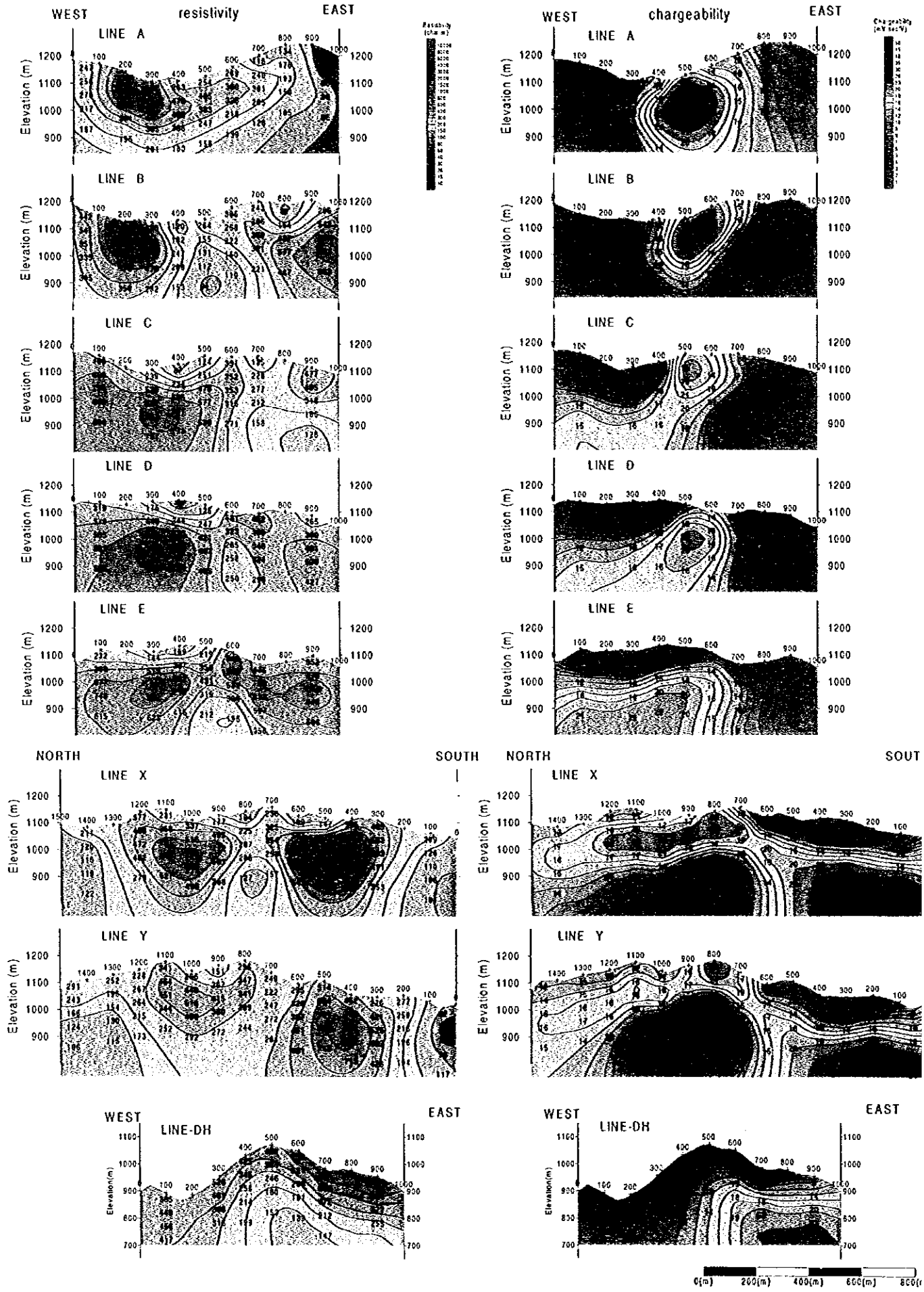


Fig. II-3-7 Results of model simulation of the Dong Noi area

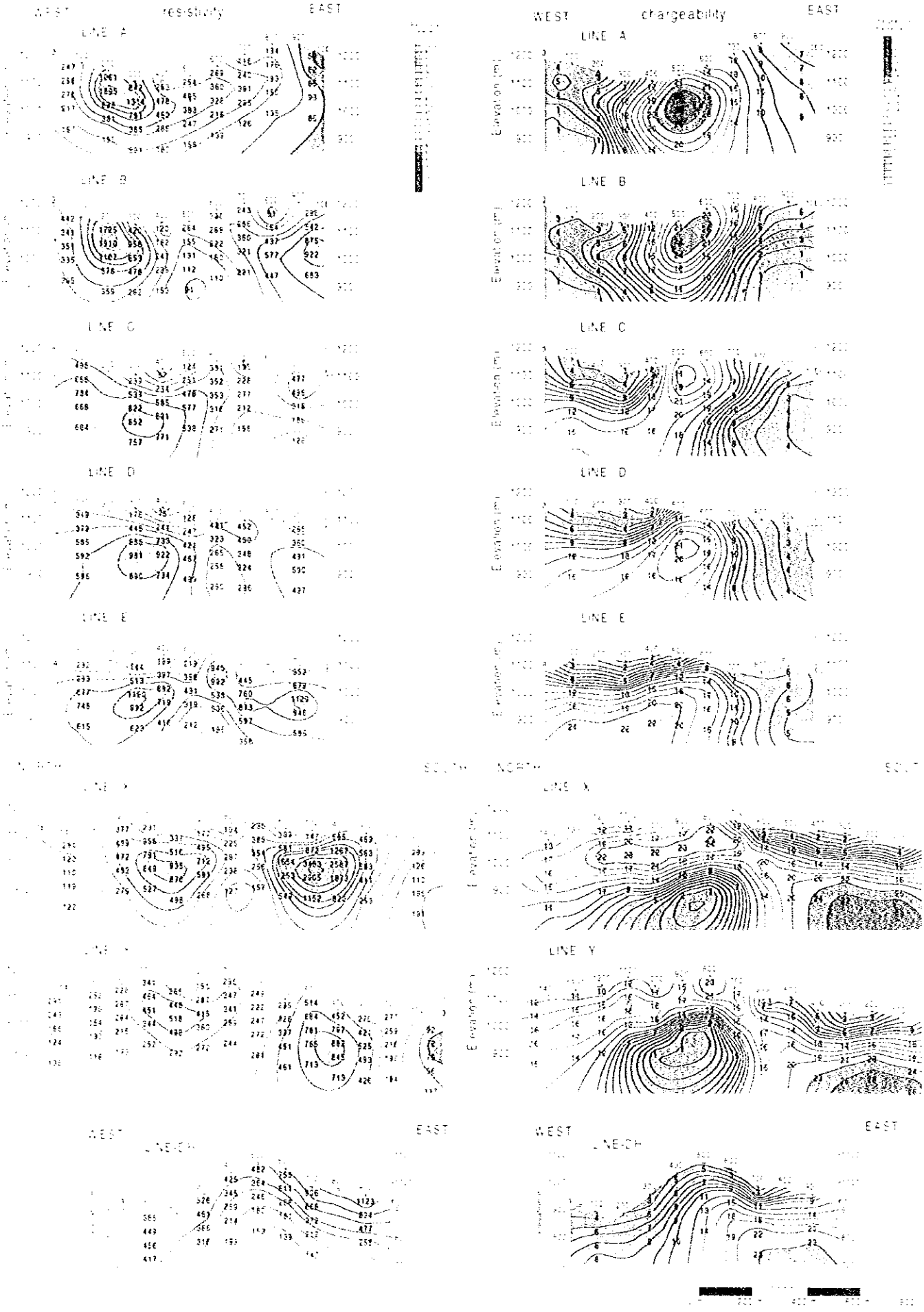


Fig. II-3-7 Results of model simulation of the Dong Noi area

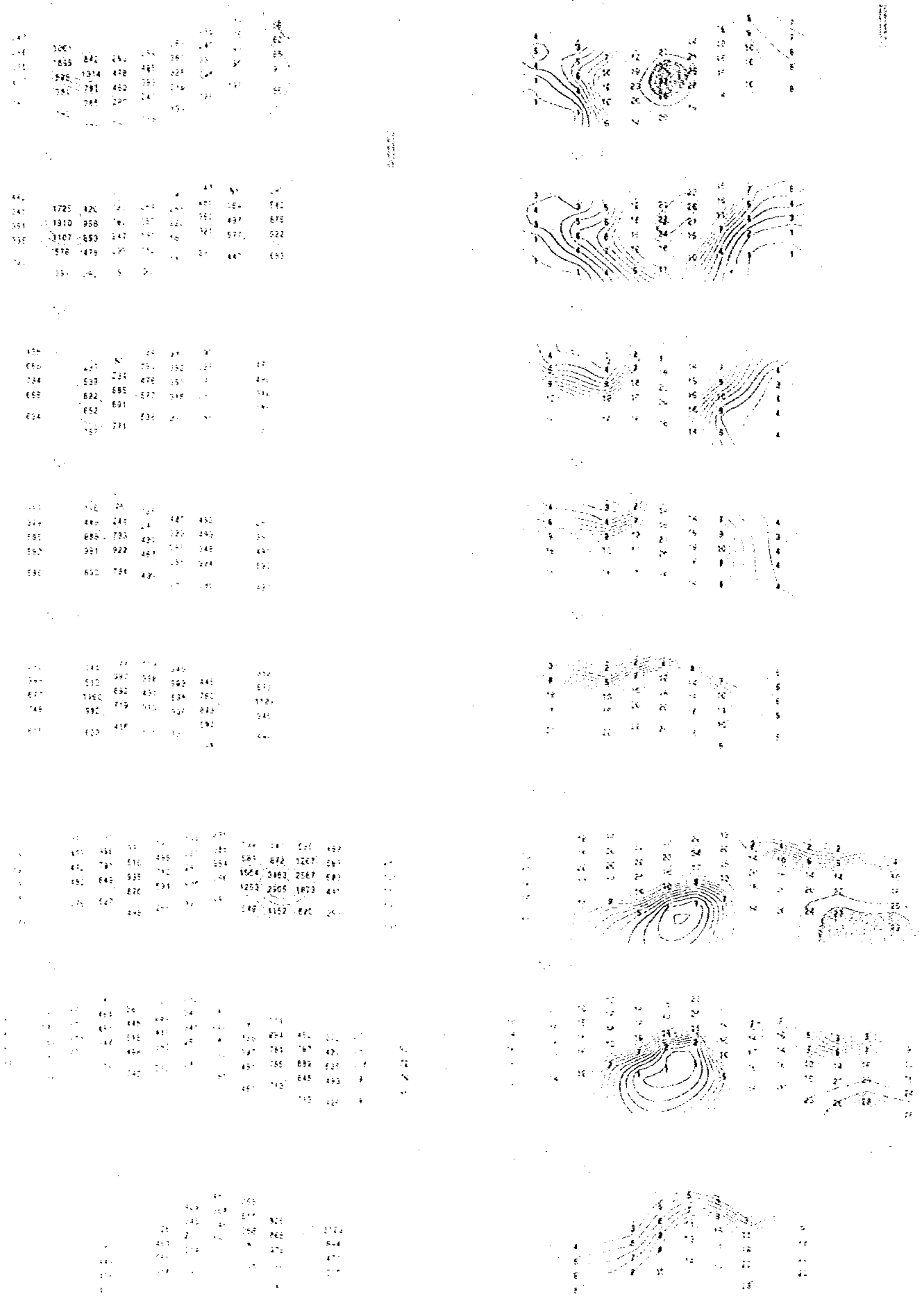


Fig. II-[illegible] Results of model simulation of the Dong Nai area

line in Fig. II-3-8. It tends that the high chargeability area shown by this line extends NNW–SSE direction. This direction should be related to the distribution of the underground structure, and concordant with the result of the geochemical survey.

The relation between the result of 2-D analysis and the faults is as follows.

In line-X and Y, the continuity of the high resistivity breaks off the underneath of the station 600 and 700. The E-W striking fault intersects with line-X and Y at these positions on the geologic map, so this resistivity discontinuation of line-X and Y suggests this fault.

The chargeability of the shallow part to the north of stations-700 of line-X and Y is around 20 mV·sec/V. It is supposed that a mineralized zone is distributed along the north striking fault. Another high chargeability zone around 20 mV·sec/V is detected at the deeper part to the south of stations-600, but details are not clear because of the area situated almost near from the end of line.

The 2-D result of line-B and C shows that the tendency of the resistivity changes between the eastern part of stations-500 or 600 and the western part. It seems that this different tendency corresponds to the north striking fault. The low resistivity of less than 200 Ω·m is widely distributed underneath stations-500 or 600 of line-B, therefore it is inferred that the fault intersects with line-B at this zone. The discontinuation of the resistivity is not observed at the line-D and E, because the north striking fault does not intersect.

On the basis of the above results, the area around stations-500 and 600 of line-B, C and D is extracted for the promising area, where includes Dong Noi mineral occurrence. The most interesting part of this area is around line-B, because a large low resistivity zone is found on the pseudo section and the 2-D section. Another high chargeability zone is extracted underneath the southern part of line-X and Y, but it is difficult to grasp the detailed distribution because of its depth.

At the southern gossan zone, the apparent resistivity ranges from 80 to 1,308 Ω·m, and the chargeability shows a maximum of 24mV·sec/V.

As for the result of 2-D analysis, the resistivity shows high value in the shallow part and low value in the deep part. As for the geologic map, limestone, shale and sandstone (station-400 ~ 600, station-700~800) are distributed in this survey line, but the resistivity difference of lithologic character is not clear near the surface. The center of the low resistivity is seen at the station 600 about 800 m above sea level.

The chargeability shows low value near the surface, but it shows higher value in the deep part of the east side. The part of more than 20mV·sec/V is seen from station-700 to station-1000 in the deep part. The measurement data shows low value in the shallow part of station-400 and shows high value in the deep part of station-600. In result, the chargeability showed high value in the deep part of the east side after 2-D analysis. This part is the end of the survey line and out of measurement part, and it is supposed that the chargeability showed higher value at the interpolation of 2-D analysis.

In Fig.II-3-9, it extracted the low resistivity part less than 150Ω·m and the high chargeability

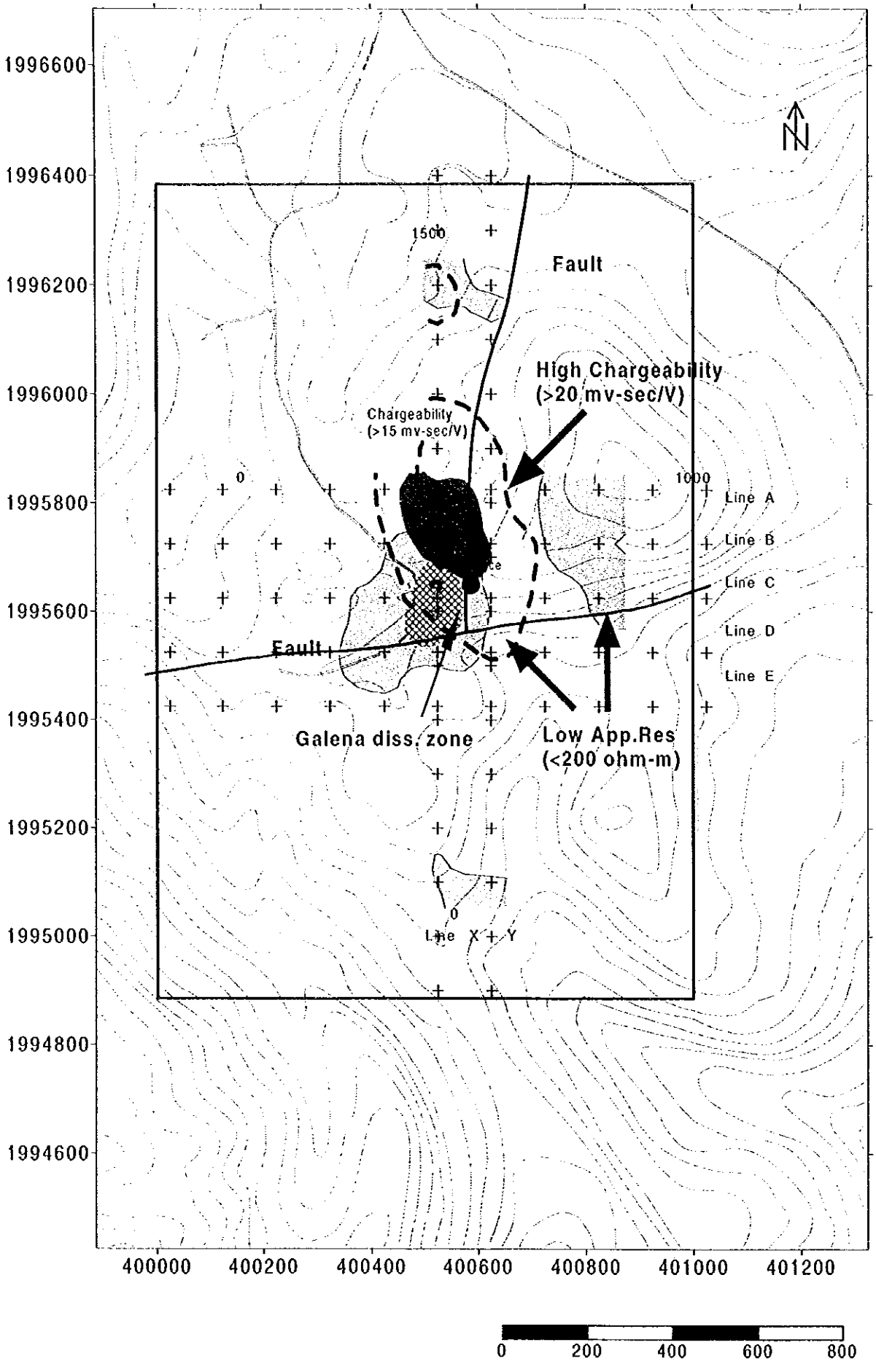


Fig.II-3-8 Integrated plan map of the Dong Noi area

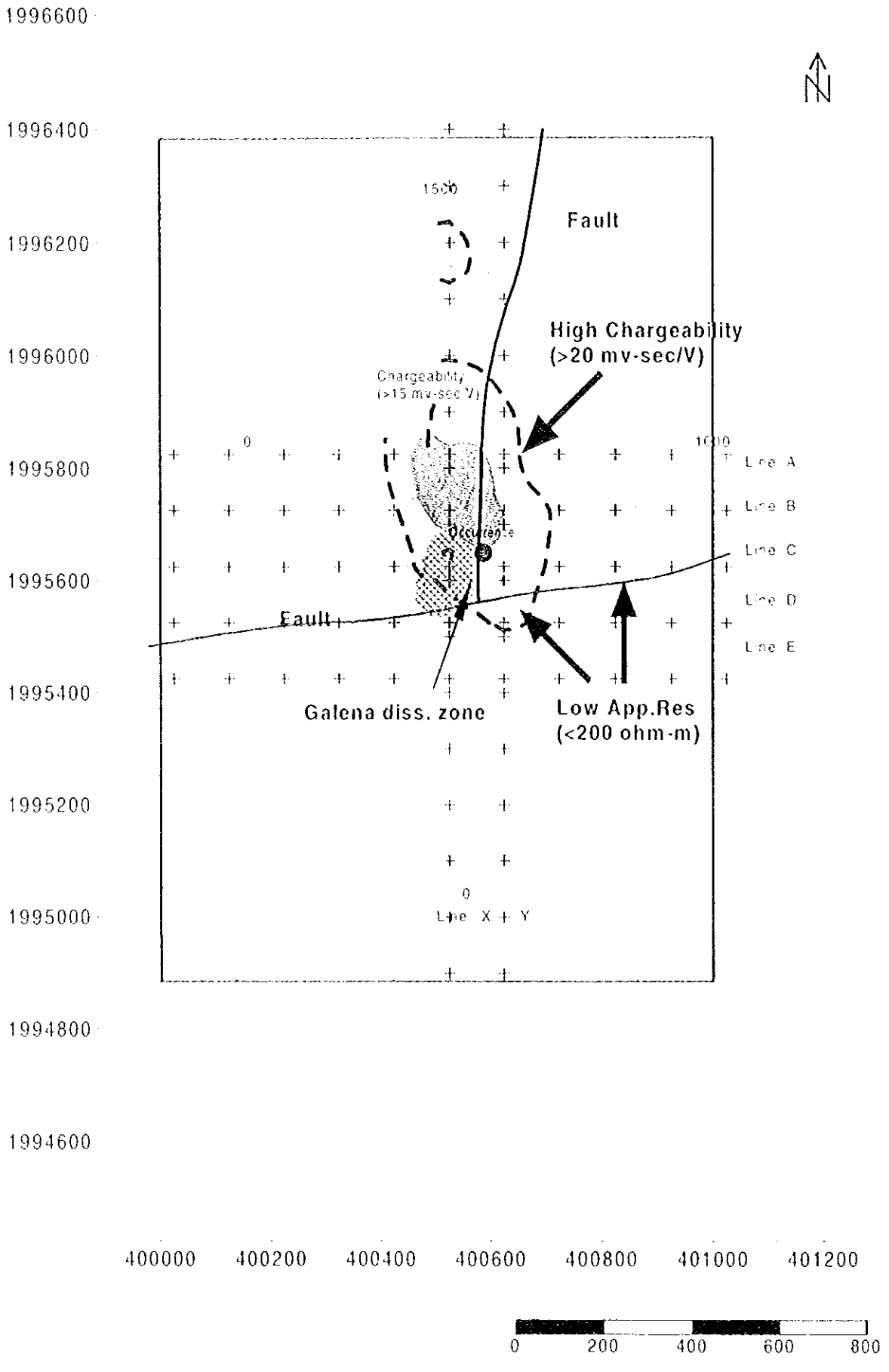


Fig.II-3-8 Integrated plan map of the Dong Noi area

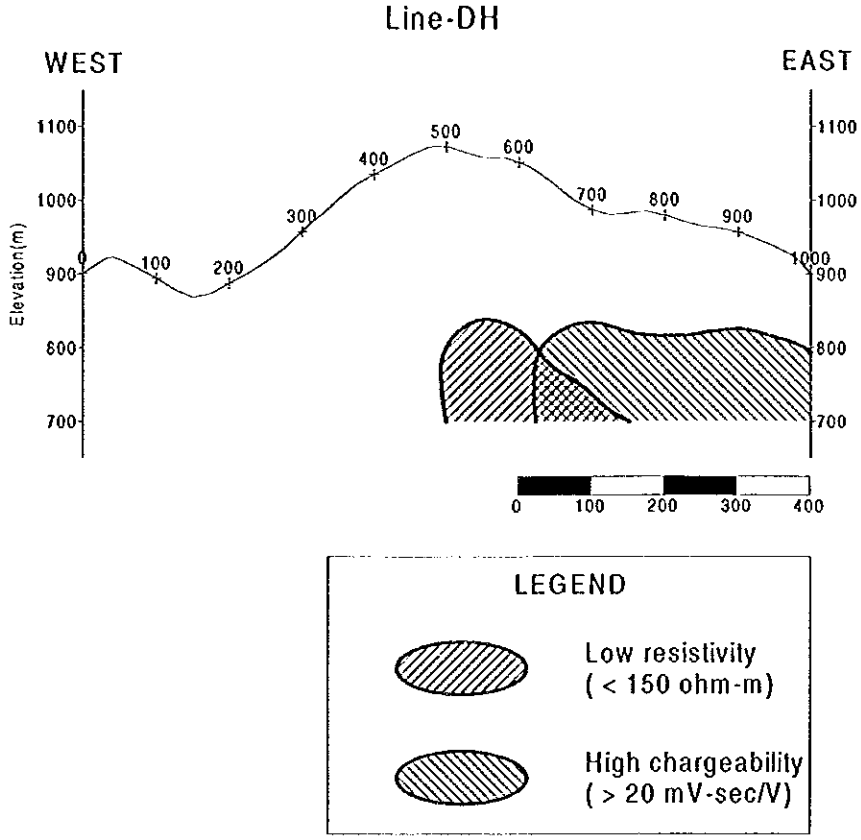


Fig.II-3-9 Integrated cross section on Line DH of the Dong Noi area

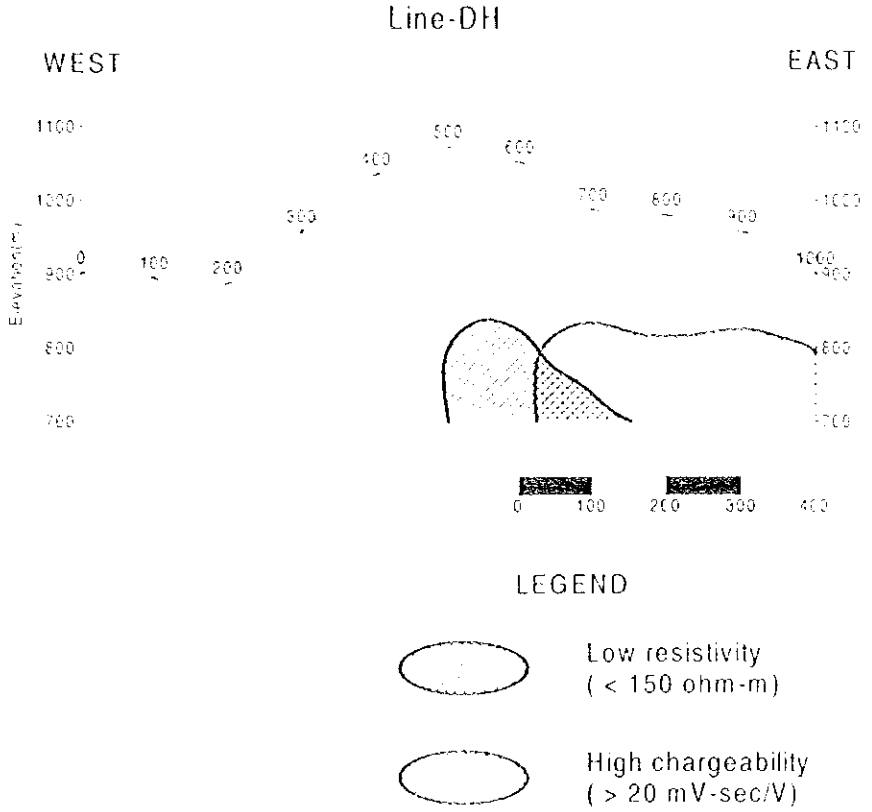


Fig.II-3-9 Integrated cross section on Line DH of the Dong Noi area