Chapter 5 I-4 Area and Southern I-4 Area

5-1 Geology

5-1-1 Outline of Geology

The northernmost of I-4 area is the southern extremity of the north trending large Ordovician limestone body.

The Southern I-4 area is chiefly underlain by Devonian-Carboniferous sedimentary rocks. The western part of the area is cut by a north striking fault belonging to the north trending tectonic line along Mae Nam Yuam. Permian limestone lies on the west side of the fault.

Fig II-5-1 show a geologic map and profiles of this area.

5-1-2 Details of Geology

1. Sedimentary rocks

(1) Ordovician sedimentary rocks

The Ordovician sedimentary rocks mainly consist of schistose limestone and interbedded black shale and sandstone. The limestone area shows a small-scale cockpit karst landform formed by leaching and erosion along the foliation.

(2) Devonian-Carboniferous sedimentary rocks

The Devonian-Carboniferous sedimentary rocks mainly consist of black shale but contain fine alternation and graded beds of shale and sandstone, thick chert beds, and some beds alternating limestone and chert. Black shale rarely contains dolomite lenses with several ten centimeters.

To the north of the Huai Pong valley, a thick chert bed interbeds in black shale. It is composed of hard and brittle stratified chert. The thickness of each layer ranges from 2 to 10 cm.

Black shale is dominant in the Huai Pu valley. It contains several units of the fine alternation of limestone and chert. The surface of the alternating rock shows a series of separated thin plates of residual chert by selective dissolution of limestone layers.

The rocks in the southwestern part of the area have been subjected to the contact metamorphism by a granite batholith intruding to the east of the area. Black shale has been metamorphosed to micaceous schistose pelitic hornfels, and the calcareous part of the alternating chert and limestone contains a large amount of calc-silicate minerals such as wollastonite. Pelitic biotite hornfels also occurs in places in the Huai Pu valley.

(3) Permian limestone

The Permian limestone in the western part of the area is in fault contact with the Devonian-Carboniferous sedimentary rock. The limestone is composed of gray to white massive limestone and contains a small amount of the laminated argillaceous limestone.

5-1-3 Geological Structure

The Ordovician and Devonian-Carboniferous rocks are cut by several northeast striking faults. There is a north striking fault between these rocks and the Permian limestone in the western part.

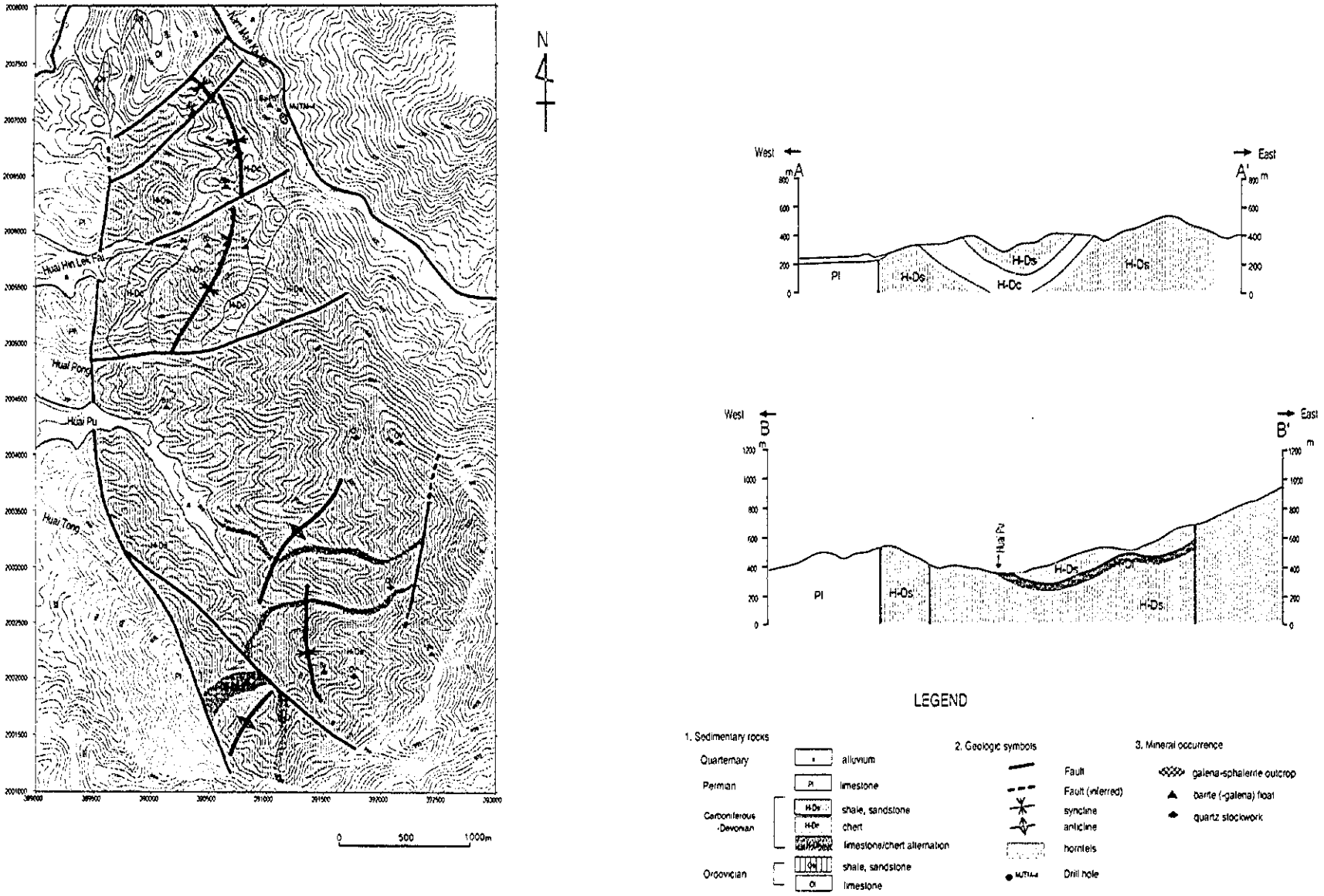

Fig. II-5-1 Geologic map and profile of the I-4 and Southern I-4 area

The Devonian-Carboniferous rocks are complexly folded on outcrops, but the fold as a whole is a north-south trending syncline in the northern part and a series of northeast-southwest trending syncline and anticline in the southern part of the area.

5-1-4 Mineral Occurences

1. Nam Mae Kanai mineral occurrence

This mineral occurrence consists of veins and dissemination of galena, sphalerite and arsenopyrite. The drill hole MJTM-4 was drilled to confirm the extension of the mineralization.

2. Barite-galena veins

Some barite-galena floats occur in the Devonian-Carboniferous black shale area. They are composed of the irregular barite-galena veins ranging from 2 to 10 cm in width. Generally the veins fill fissures of black shale. The maximum size of floats is 60 cm.

The sample in the lower stream of Huai Pu contains 615 ppm Pb and 140 ppm Zn. The barite-galena samples, collected in Nam Mae Pan valley neighboring on Huai Pu at Phase 1 survey, contain maximum 3.6 % Cu, 0.1 to 3.7 % Pb, and 1,300 to 3,400 ppm Zn.

3. Quartz stockworks

Several small quartz stockwork zones occur in the upper stream of Huai Pu valley. They are found in brecciated and silicified shale. The silicified zones are less than 10 meters wide.

The analysis result of MM-02 sample taken on the eastward ridge is 188 ppm Cu, 341 ppm Pb and 560 ppm Zn. Two samples (JR-01, MM-06) collected from other srockworks contains no anomalous values of Cu, Zn and Pb, and only pyrite is observed under microscope.

5-2 Geochemical Survey

5-2-1 I-4 Area

1. Sampling

Samples were taken at intervals of 25 m on the traverse lines in the geophysical survey in the I-4 area. Sampling points were arranged so that the entire area can be covered. The number of samples in the I-4 detailed survey area is 680.

2. Distribution of geochemical anomaly values

Cu shows a strong positive correlation with Ba and has a weak positive correlation with Fe and Mn. Pb shows a very strong positive correlation with Zn and has a positive correlation with As, Ba, and Sb. Zn has a strong correlation with Fe, Pb, and As, and shows a positive correlation with Mg, Ba, As, F, and Fe. All things considered, these elements can be divided into two groups: Pb-Zn-As-Sb-Hg and Cu-Pb-Ba-Mn group.

The geochemical anomaly zones are described as below:

[Zn] Anomalies of Zn are observed on both sides of the Ordovician limestone area and the Permian to Triassic sedimentary rock area. Anomalies in limestone are distributed at the northern end of traverse lines W, X, and Z and near the intersection point of these lines and line C. Although it is not certain, the distribution of these seems to continue in the north to north-

northeast direction. This direction seems to be predominated by a foliated fracture system developed in limestone. Anomalies observed in the Permian to Triassic sedimentary rocks are distributed on the west side from the intersection point of lines A and B, and line W, on the south side from the intersection point of line Y and line A, at the point of 600 m to 700 m of lines A and B and on its northwest side. Among these anomalies, it is thought that the latter corresponds to floats of galena - quartz vein in a mineralized zone at 800 m point of line B and on its northwest extension and the former corresponds to floats of barite with galena dissemination. Anomalies are also observed in shale along the marsh in the center of the area. It is thought that this anomaly is distributed along a fault.

[Pb] The distribution of Pb anomalies is similar to that of Zn anomalies. The values in the limestone area are low but are high in the sedimentary rock area, particularly, near the ore occurrence along line B. Like Zn, the anomalies are also observed in the central part of the area.

[Cu] Cu shows the same distribution as Pb and Zn near lines A and B and in a marsh in the central part of the area. In other parts, Cu anomalies overlap on shale. It is thought that a part of it represents an existence of shale having an initially high Cu value.

[F] The F anomalies are distributed in the Ordovician limestone area. This distribution is harmonious with that of Zn and Cd anomalies. In many cases, samples having an average Zn values are classified as anomaly values. Judging from an existence of a fluorite deposit in limestone on the north side of this area, it may be an extension of this ore showing. The anomalies reach out in the same direction as Zn from almost north and south to slightly east.

[Mn] The Mn anomalies concentrate in the eastern part of the area. Although in some parts they overlap the Zn and Pb anomalies, the Mn anomalies are found at a higher place in altitude than the Zn and Pb anomalies.

The result of the principal component analysis is described as below:

[Z-1] The factor loading amount of Zn, Pb, Sb, As, Fe, W, and Mg is large, and F and Ba show the factor loading amount to some extent. Z-1 is considered to be a factor that reflects an existence of mineral showings of these elements(Fig.II-5-2). A high-score zone is roughly distributed in four places. One is distributed beneath an intercalation of shale and sandstone at the north end of the area. Particularly, it is continuously observed in the north and south direction at the foot of the mountain on the west side and on the east side of the mountaintop. The high score zones show a wide range. On the east half of the area, the high score zone is divided into three parts showing a narrow range. A high-score zone around the 700 m point along traverse line B continues in the north and west direction through the 700 m point along line A. On the easternmost side along lines A and B, an anomaly area having a center on the side of traverse line A is formed. Another high score zone is observed along a marsh in the center of the area. This anomaly area is accompanied by a NE-SW fault. However, an anomaly of neither this principal component nor other principal components is observed in other part of this fault.

[Z-2] As for the second principal component, the factor loading amount of Cu, Ba and Mn is large and Z-2 is considered to be a factor that represents the mineralization of these elements. A high-

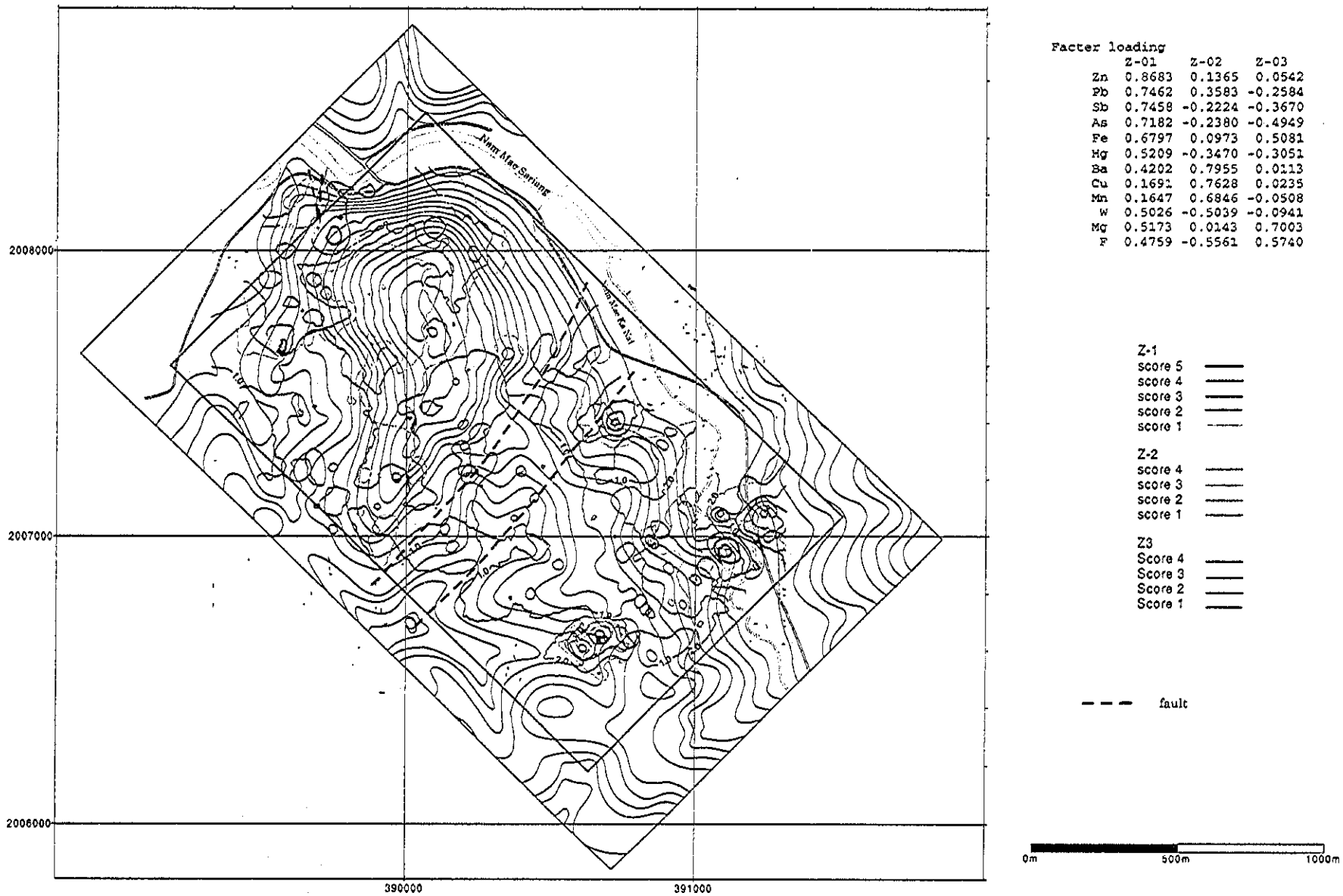

Fig. II-5-2 Principal analysis score map of the I-4 area

score zone having three points or more overlaps a high-score zone of the first principal component near the 100 m point along traverse line A and shows a narrow distribution range. It is also distributed near the 700 m point along traverse line B, at the bending point of Nam Mae Kanai on the northwest side of that point, etc. The distribution of scores having three points or less roughly matches that of shale so that there is probably suggested that this indicate the initial content of Cu and Mn in shale.

[Z-3] This is the principal component that has a large factor loading amount of Fe, Mg, and F. It seems to be distributed on the periphery of a high-score area of the first principal component. This is presumably indicating a halo of mineralization shown by the first principal component.

5-2-2 Southern I-4 Area

1. Sampling

Two sampling lines, SMS and SPS, are arranged on two ridges in the Huai Pu valley, and sample points are at a spacing of about 50 m.

Most samples are collected from black shale area, but the samples from SMS02 to SMS03 and from SMS09 to SMS11 are in the area of alternating chert and limestone and those from SMS27 to SMS28 are in the area around the silicified shale with quartz stockworks.

The number of soil samples is 46.

2. Distribution of contents

The Cu, Pb, Zn and Ba values of each soil sample are shown in Fig. II-5-3.

The Cu values are invariable, whereas the Zn, Pb and Ba values are varied and there is a strong correlation each other shown as the stacked chart in Fig. II-5-3.

The samples on alternating rocks and a silicified zone with quartz stockworks do not show anomaly values of Pb, Zn and Ba, while those on black shale contain rather high anomalous values. Those high values of Pb, Zn and Ba in soil are almost the same levels as those in stream sediments samples.

The correlation of elements and the mineral occurrences show that the Pb-Zn mineralization of the Southern I-4 area has a close association with a distribution of barite-galena veinlets. Therefore it is also inferred that some amount of barite-galena veinlets contained in the area from SMS19 to SMS21 and from SPS15 to SPS17.

It appears from the above that the anomaly detected by regional stream sediments geochemical survey origins from barite-galena veinlets in black shale and/or quartz stockworks zones accompanied by brecciated and silicified shale. The broad geochemical anomaly of stream sediments may indicate that these vein-type mineralizations are common in the Southern I-4 area. But only confined barite-galena mineralized floats have been found and its Zn and Pb grade are not high, and quartz stockworks are small scale. Therefore there is a little possibility that an economically minable deposit exists in the area from Huai Hin Lek Fai valley to Huai Pu valley.

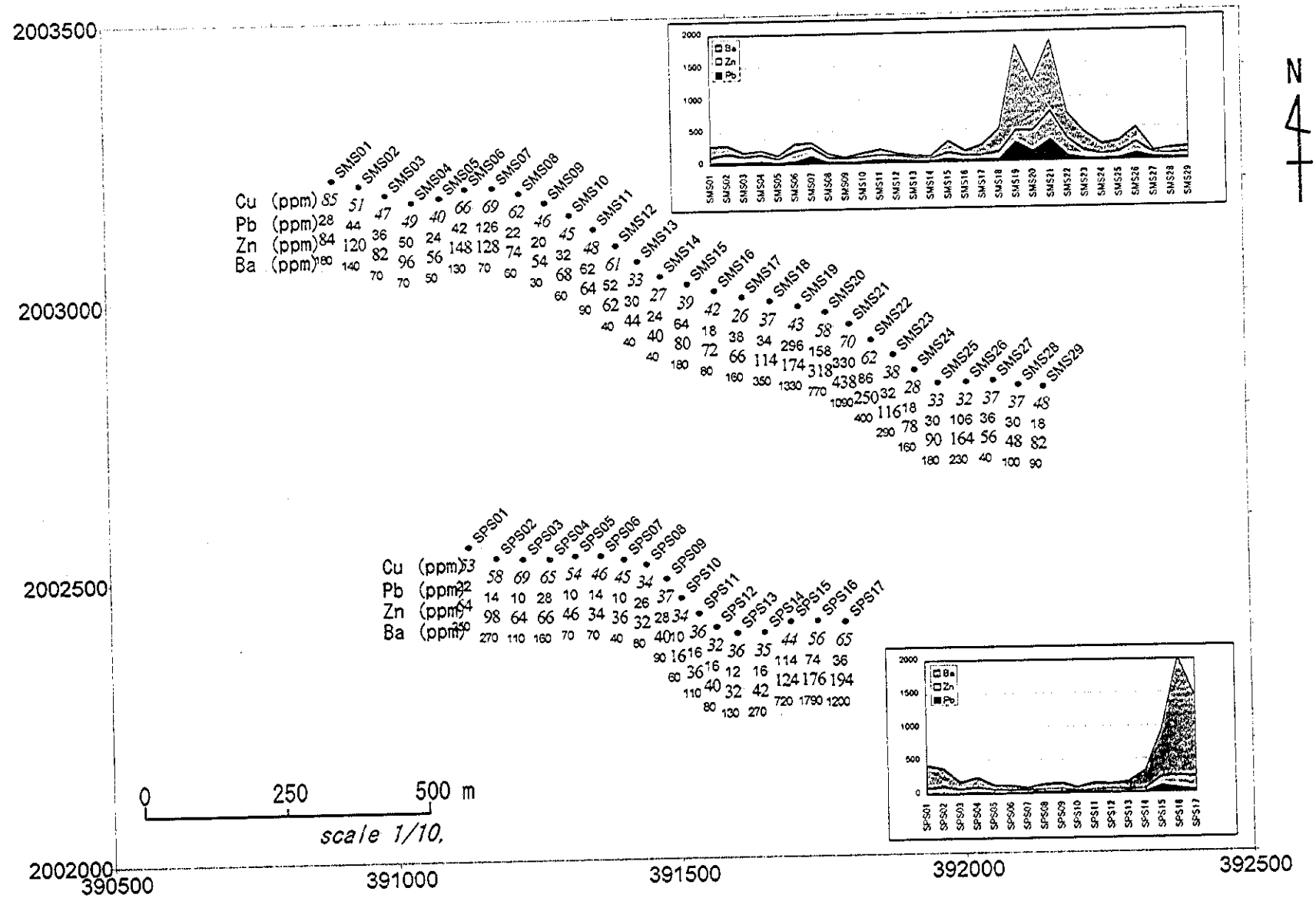

Fig. II-5-3 Cu, Pb, Zn and Ba content in the soil of the southern I-4 area

5-3 Geophysical Survey

5-3-1 Location and Amount of Survey

In this area, it set total line length of 9.8 km in amount which 1 × 1.3 km length with the direction of N20° E, 2 × 1.0 km length with the direction of N45° E and 4 (1 × 0.9 km , 1 × 1.6 km, 2 × 2.0 km) with the direction of N45° W. Line locations are shown in Fig. II-5-4.

Table II-5-1 Survey amounts of IP survey in I-4 Area

Phase	Length	Number of lines	Number of points
First Phase	9.8km	2.0kmx 2 lines 1.6kmx 1 lines 0.9kmx 1 lines 1.0kmx 2 lines 1.3kmx 1 lines	294

5-3-2 Result of the survey

The result of IP measurement and the 2-D analysis are shown in Fig. II-5-5 and II-5-6.

The apparent resistivity ranges from 26Ω·m to 4,896Ω·m and the chargeability shows the high value of a maximum of 58 mV·sec/V. It extracted the part that shows the apparent resistivity of less than 100Ω·m and the high chargeability above 20mV·sec/V from the result of N=1 of the IP method measurement and indicated in Fig. II-5-8. Also, Nam Mae Kanai mineral occurrence and a fault were shown all together, pulling out from the geological map.

In this area, a fault is estimated on the north and on the central part. It is the fault that was estimated from the geological survey result that it displayed by the solid line in the map and it intersects with line W·X·Y. The fault in especially on the north is running near station 1100. As it makes station 1100 a border, the tendency is seen from the IP survey result that low resistivity zone is distributed over the southeastern part and high resistivity zone distributed over the northwestern part. It thinks that the high resistivity zone corresponds to limestone that is distributed over the northern area and the low resistivity zone corresponds to sandstone/shale or chert. On the southern side, the estimated fault is running around station 1200 but the resistivity tendency around this isn't changing into clearly like the fault on the northern side. Incidentally, it is in the discontinuation part of the resistivity zone that is seen around station 1100 of line C that it was shown by the dotted line in the map, for the southern side shows high resistivity and for the northern side shows low resistivity.

Next, it examines about the southeastern part of the area where IP anomaly is seen.

As for the measurement result of line B and line A, the chargeability is very high approximately over all lines and the apparent resistivity is low, about 100Ω·m.

A mineral occurrence place is seen near station 800 of line B, and the rock sample collected around this shows high charging percentage. It thinks that these rocks contain either of galena and that they show high chargeability. When seeing the analysis result of 2-D, as for the resistivity in the southeastern part of line A·B, the deeper part of 200m above the sea is low with about 50Ω·m. The high chargeability seems to continue to the compared depth in line A

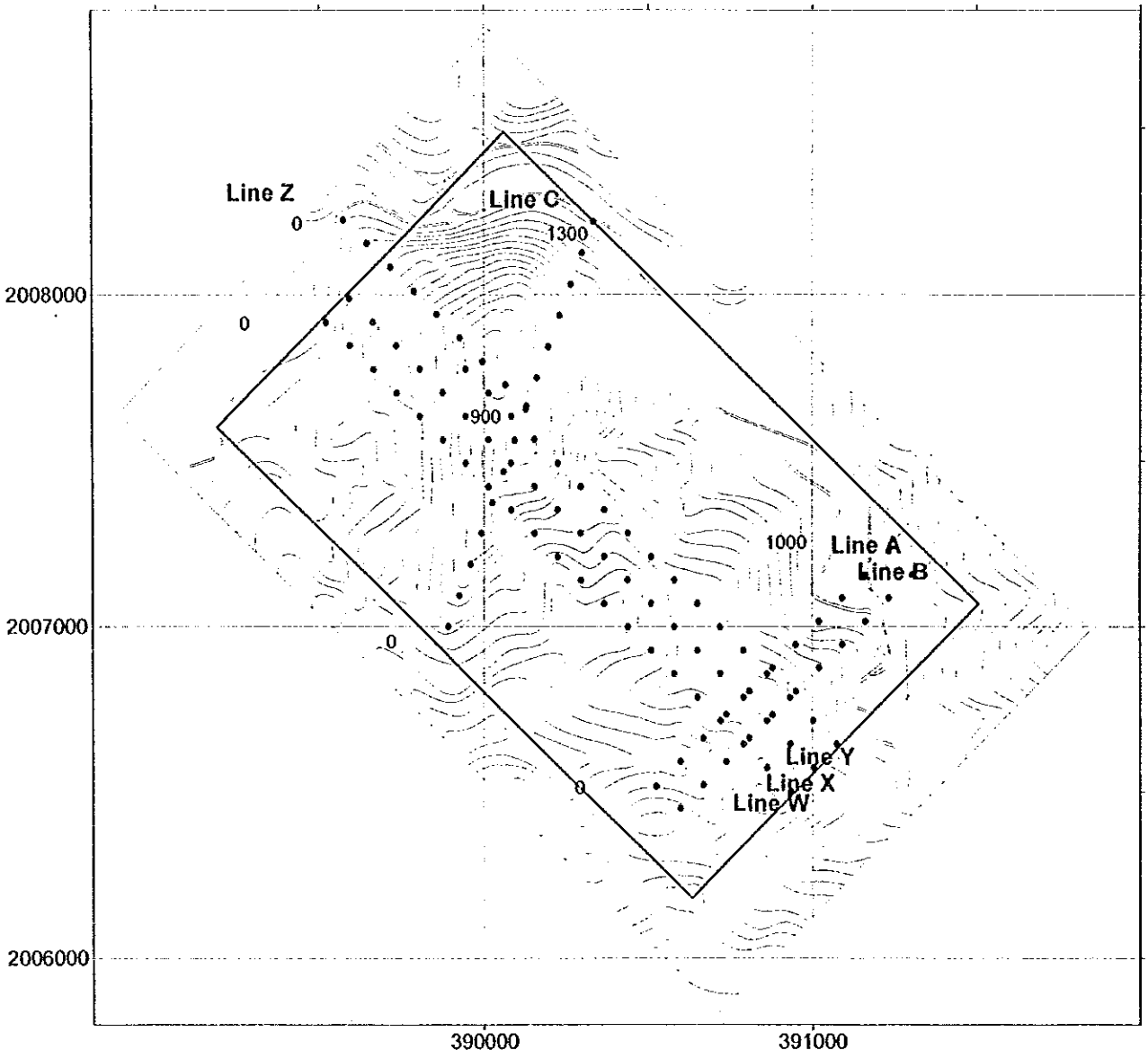

Fig.II-5-4 Location of survey line in the I-4 area

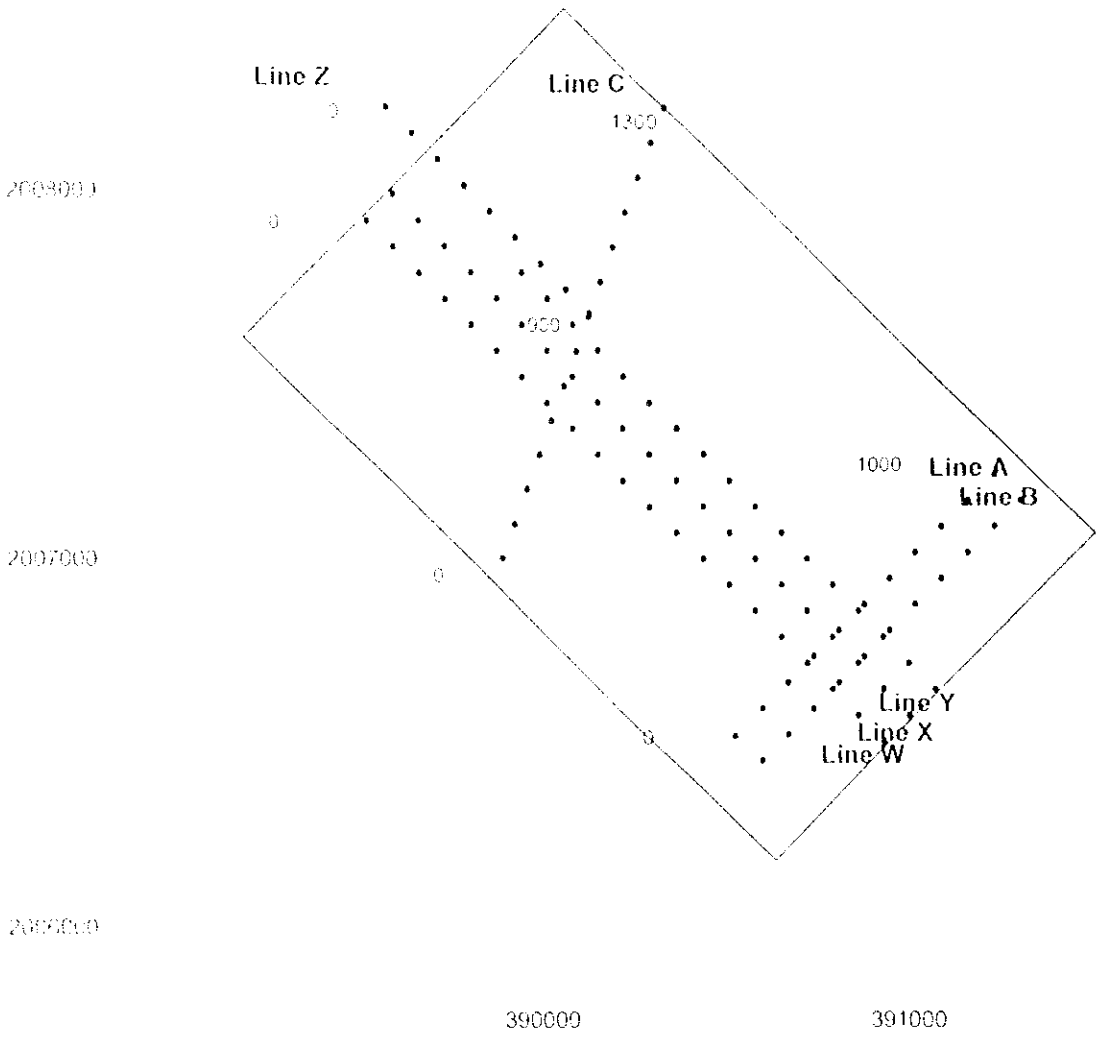

Fig.II-5-1 Location of survey line in the I-1 area

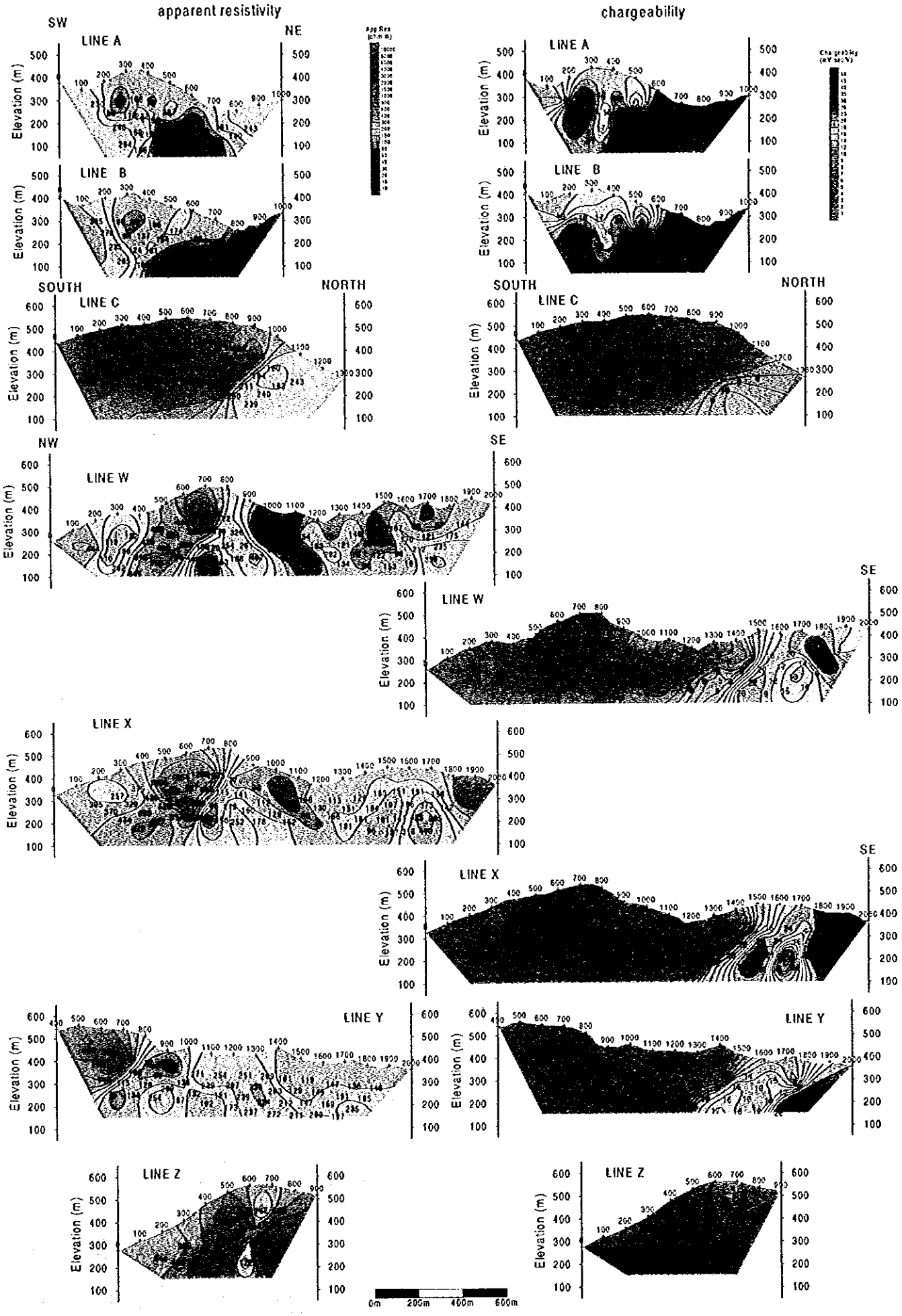

Fig.II-5-5 Pseudosection of apparent resistivity and chargeability of the I-4 area

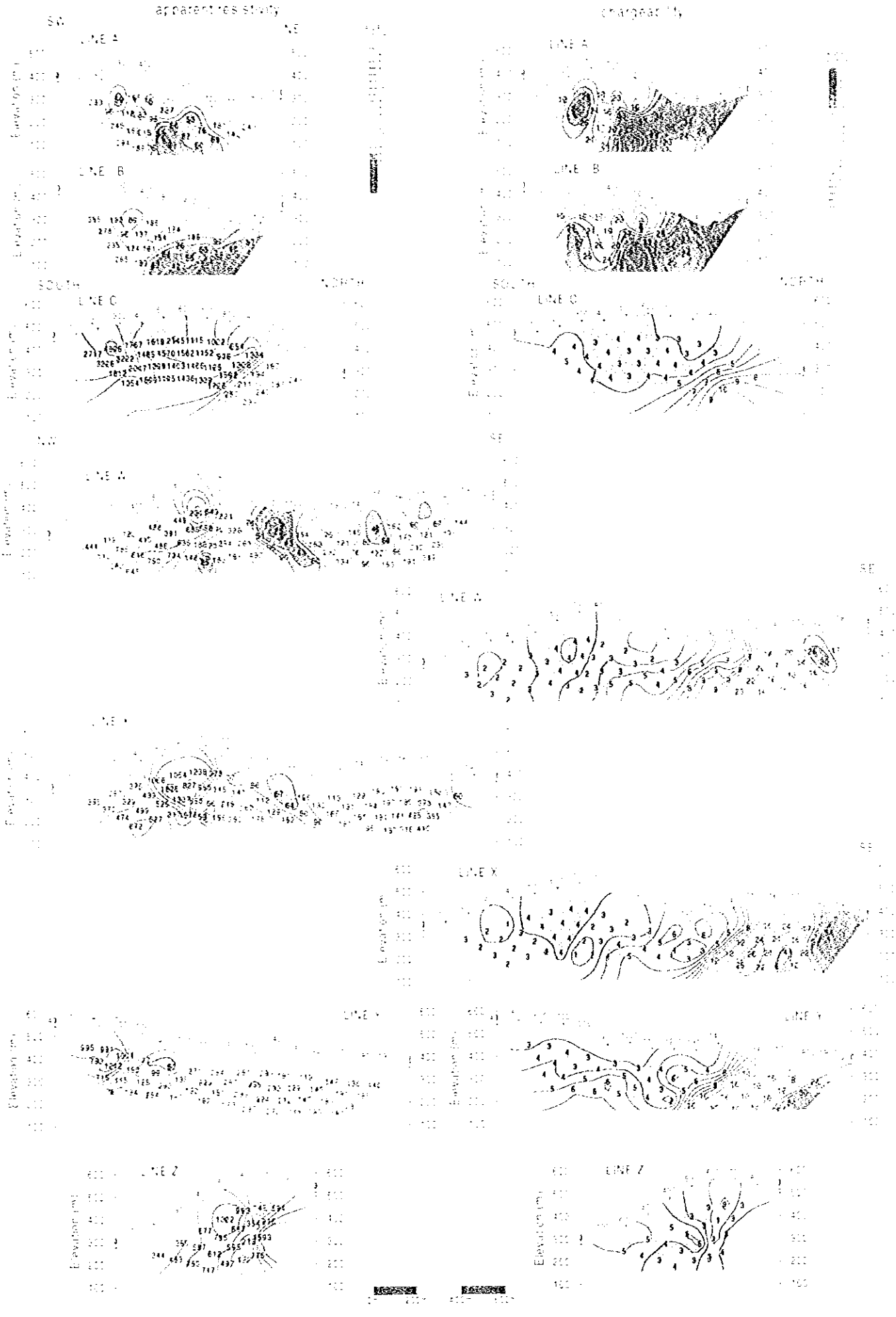

Fig.II-5-5 Pseudosection of apparent resistivity and chargeability of the I-4 area

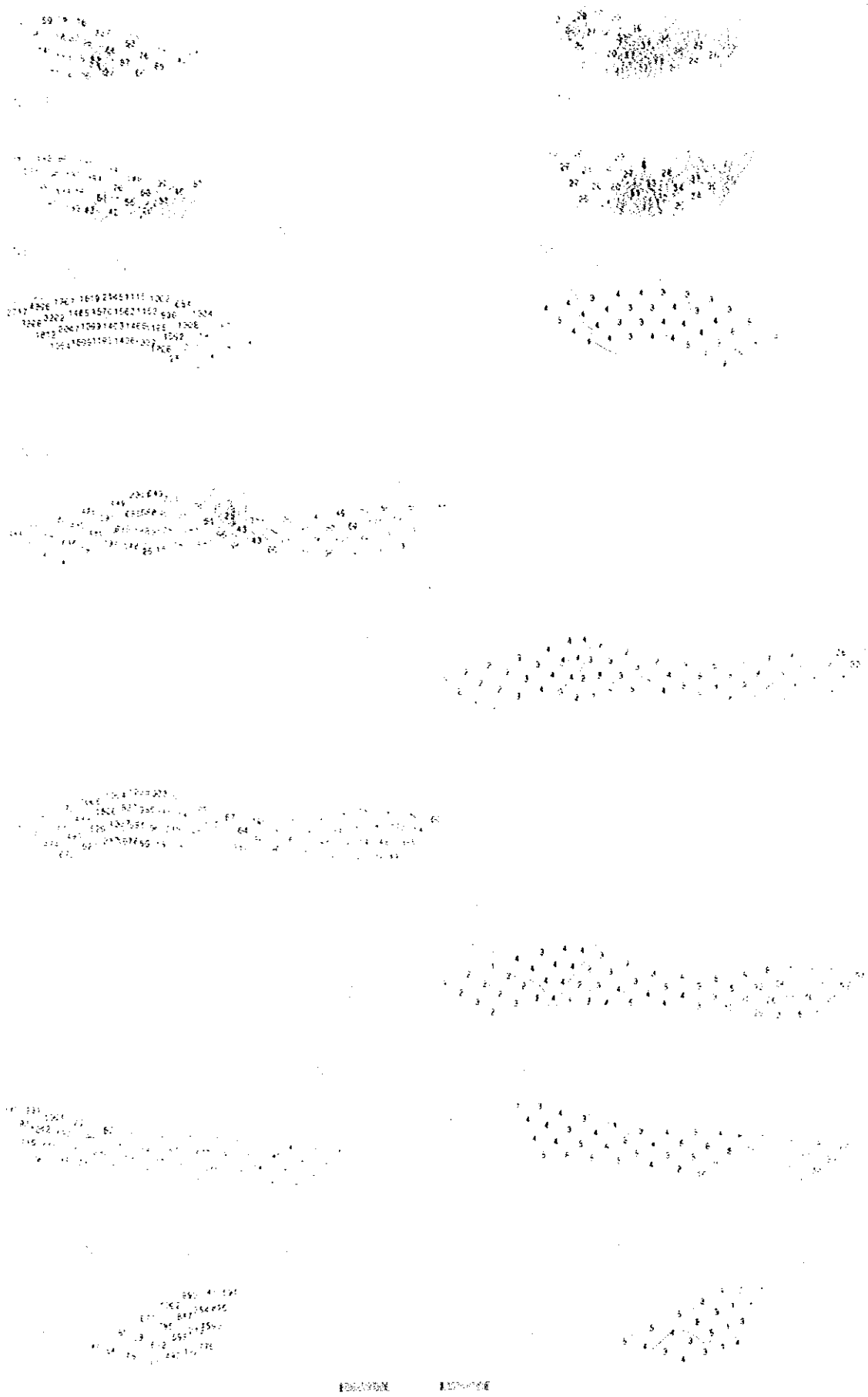

Fig.II-5-5 Pseudosection of apparent resistivity and chargeability of the Lei area

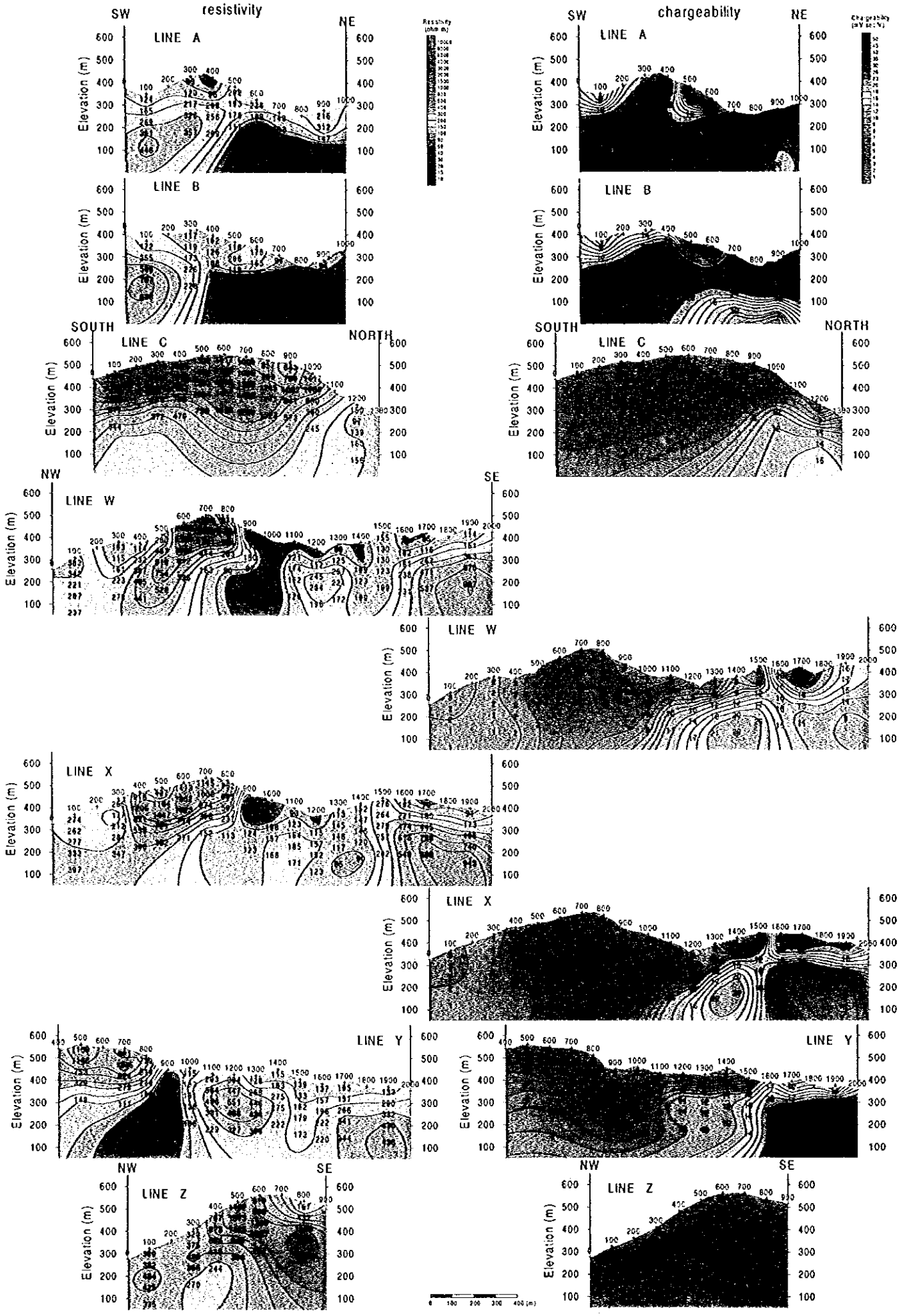

Fig.II-5-6 Results of model simulation of the I-4 area

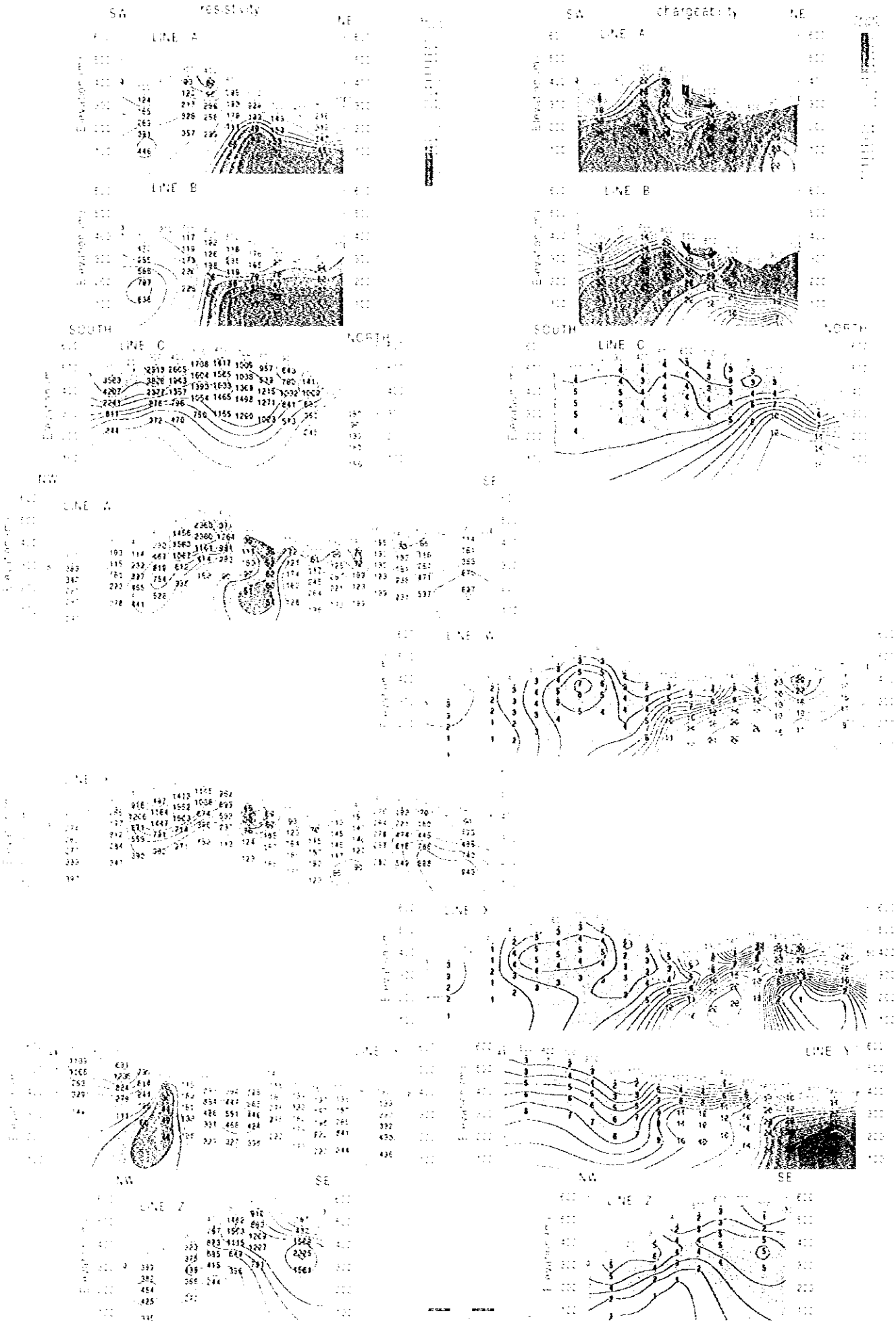

Fig.II-5-6 Results of model simulation of the I-4 area

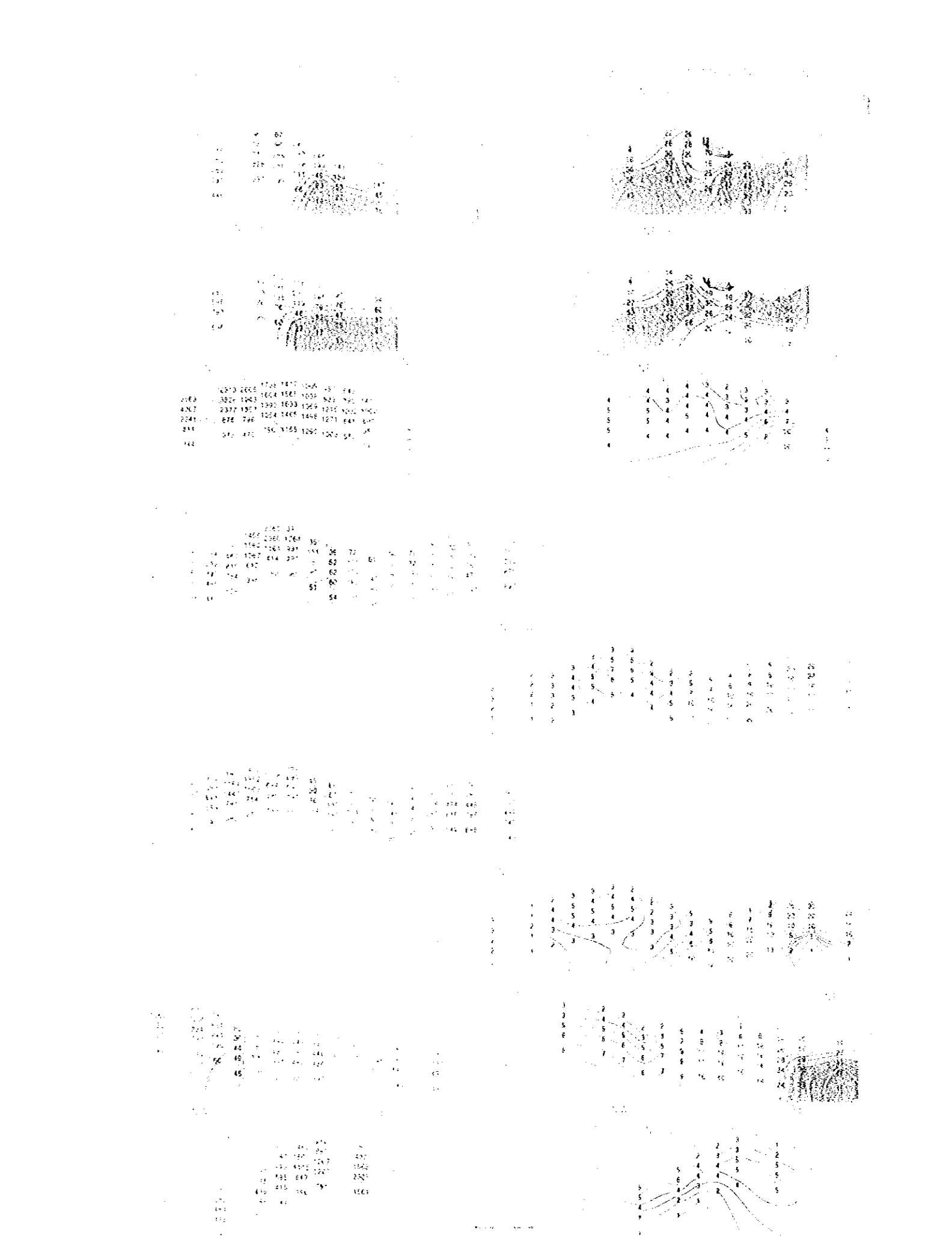

Fig. II-3-6 Results of model simulation of the I-Canea

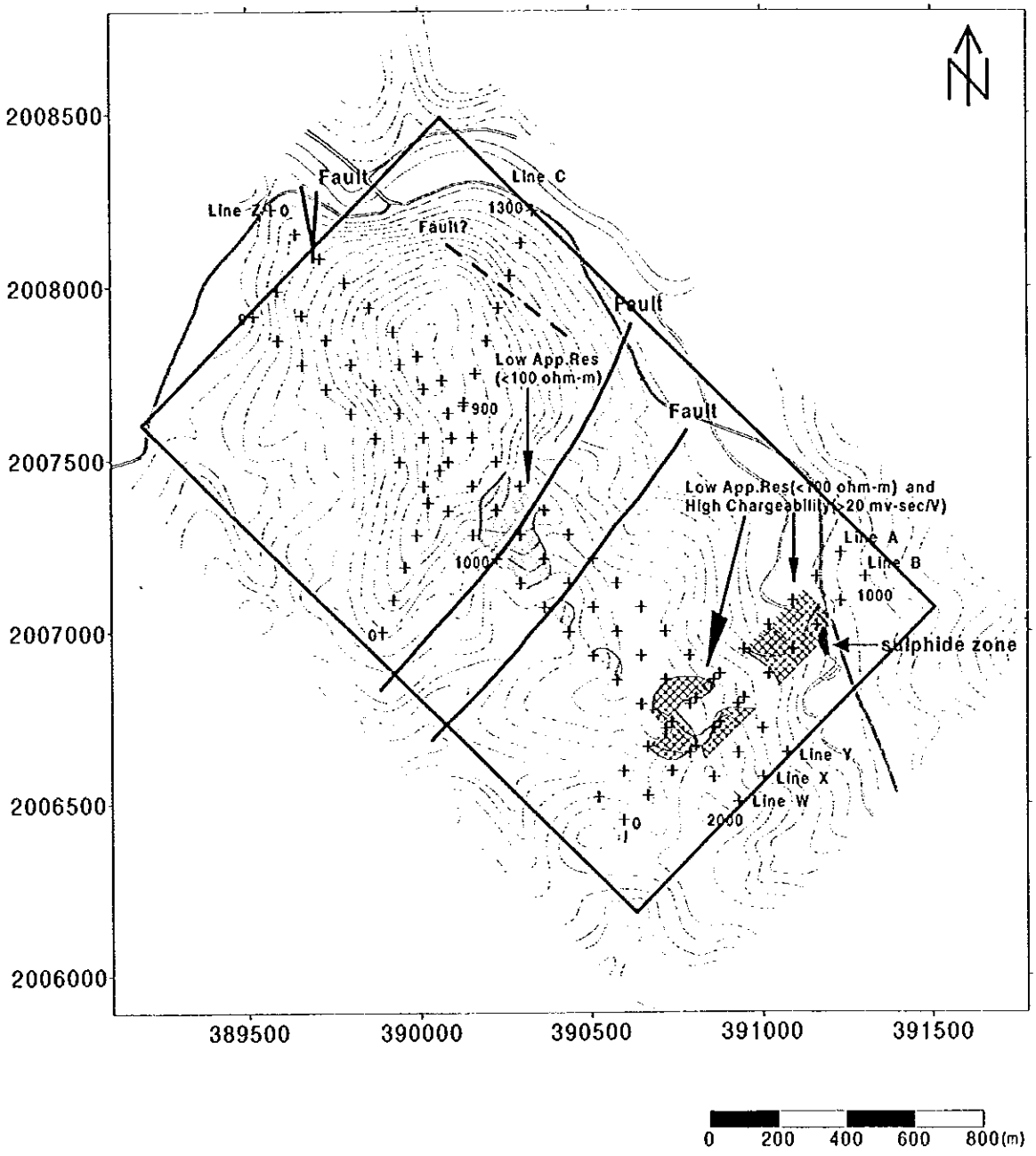

Fig.II-5-7 Integrated plan map of the I-4 area

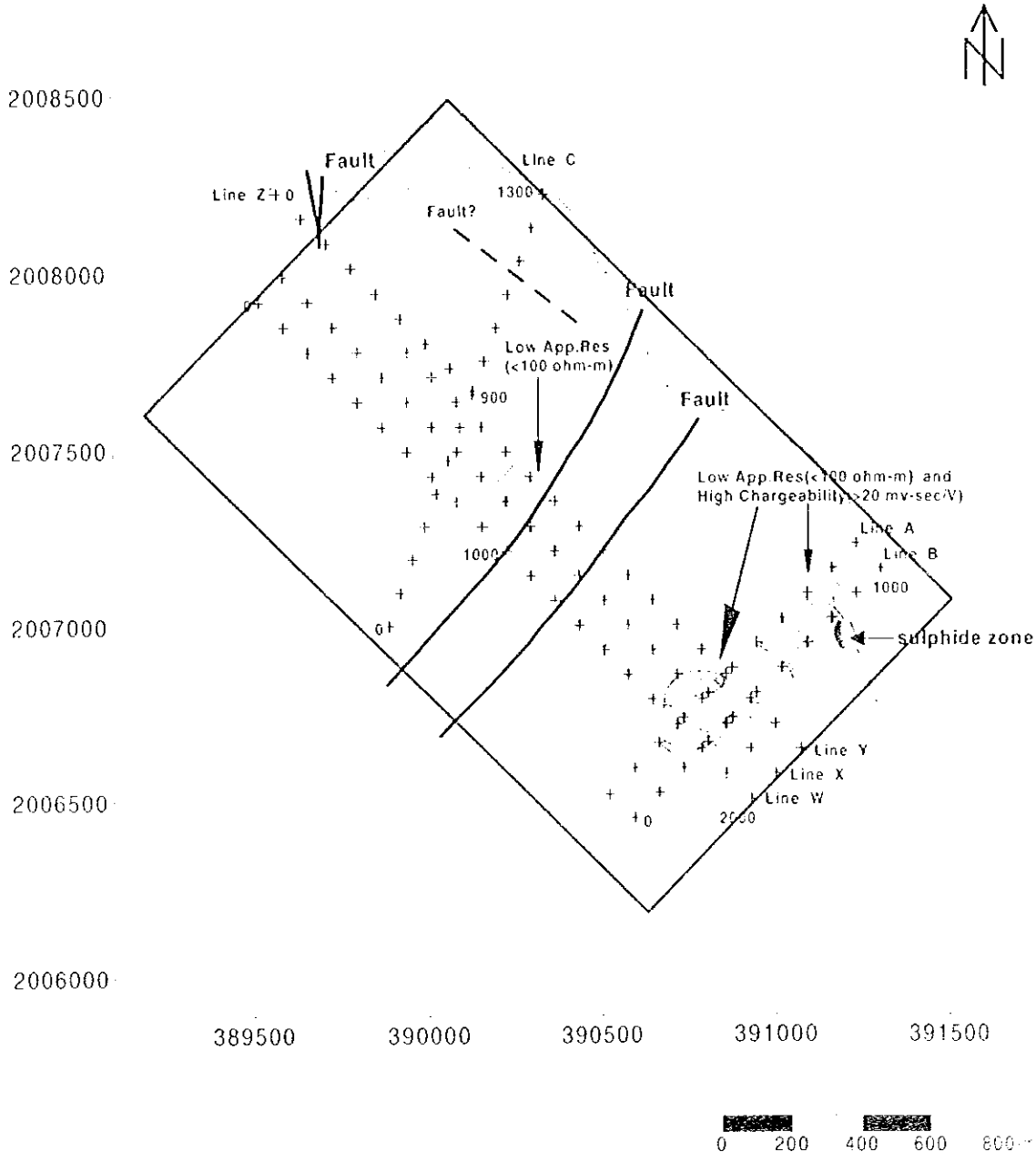

Fig.II-5-7 Integrated plan map of the I-4 area

from surface of the ground vicinity but it shows the tendency which chargeability becomes low in the deeper part of 100m above the sea in line B.

As for the part where line A·B and line W·X·Y intersect, the shallowness shows the apparent resistivity of about 100Ω·m and the chargeability shows about 30 mV·sec/V. When seeing the analysis result of 2-D, the western side from station 300 in line A·B shows the resistivity from 100Ω·m to 700Ω·m, and the chargeability is about 30 mV·sec/V and results in continuing to the depth. Seeing the 2-D analysis result of line W·X, the chargeability of line A·B and the intersecting part is high chargeability till 300 m above the sea, but in deeper part chargeability rather becomes low value. It thinks that this shows a thing with the strong tendency that the IP anomaly of the line intersection part is extended along line A·B. Furthermore in line W·X, in the part with the rather deep about 200m above the sea between station 1300 and 1400, the distribution (about 100Ω·m of resistivity) of the chargeability with 20 mV·sec/V is analyzed.

As the object of prospecting in the I-4 area, the neighborhood between station 500 and 800 of line A· B and the neighborhood of the intersecting area of line A·B and line W·X are given from above result. Especially, it thinks that about the neighborhood between station 500 and 800 of the line A and B suits a close prospecting because the anomaly area is wide and shallow from the results of 2-D analysis.

5-4 Drilling survey

5-4-1 Drilling Work

1. Outline of Work

Drilling survey MJTM-4 in the I-4 area was performed to confirm the mineralization related Nam Mae Kanai mineral occurrence with high geochemical anomaly of Pb and Zn, and high chargeability zone of IP survey.

Location of drilling point is shown in Fig. II-5-1. The Length of MJTM-4 was 210.20m.

A drilling team consists of one operator and 3 to 4 workers per shift except movement and assembling, and dismantlement and withdrawal. Each hole was drilled 24 hours by three shifts as a rule.

2. Drilling method and used drilling machines

The drilling is carried out by a wire-line method using only HQ size.

The type of drilling machine were the MPR-3 that was the caterpillar mounted type of the Drillcorp South East Asia.

5-4-2 Result of the drill hole MJTM-4

Geology and mineralization around MJTM-4 are shown in Fig. II-5-8 and Fig.II-5-9.

There is consist of Devonian to Carboniferous shale and chert. The bed trends NW-SE and dips southwest gently.

Mineralization zone ranging from 20 to 30 m in deep dips steeply and 4m width. This zone is precisely continued to quartz veins with sulfide in north-end of outcrop along Mae Kanai river.

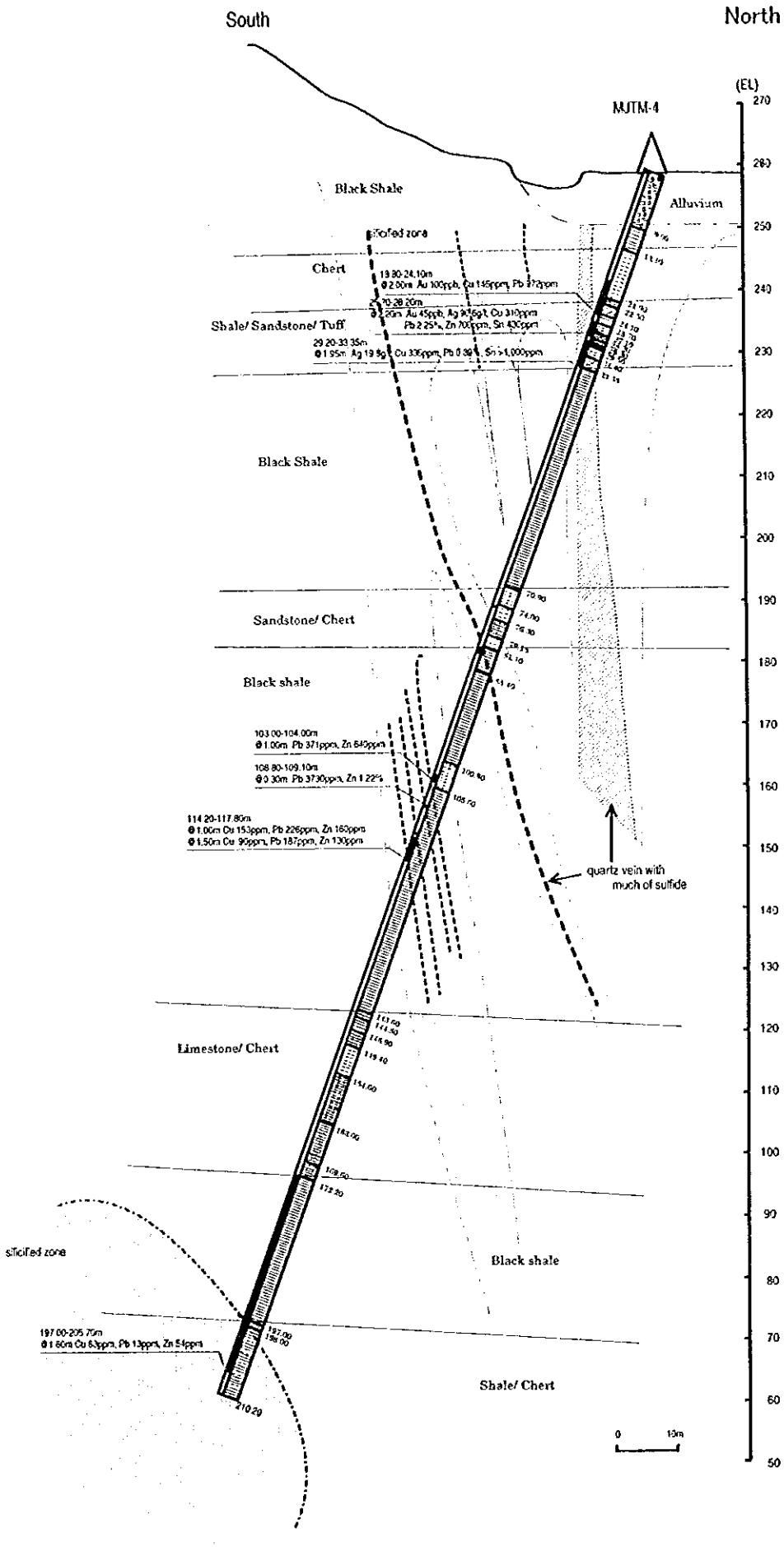

Fig. II-5-8 Interpretation profile of MJTM-4 in the I-4 area

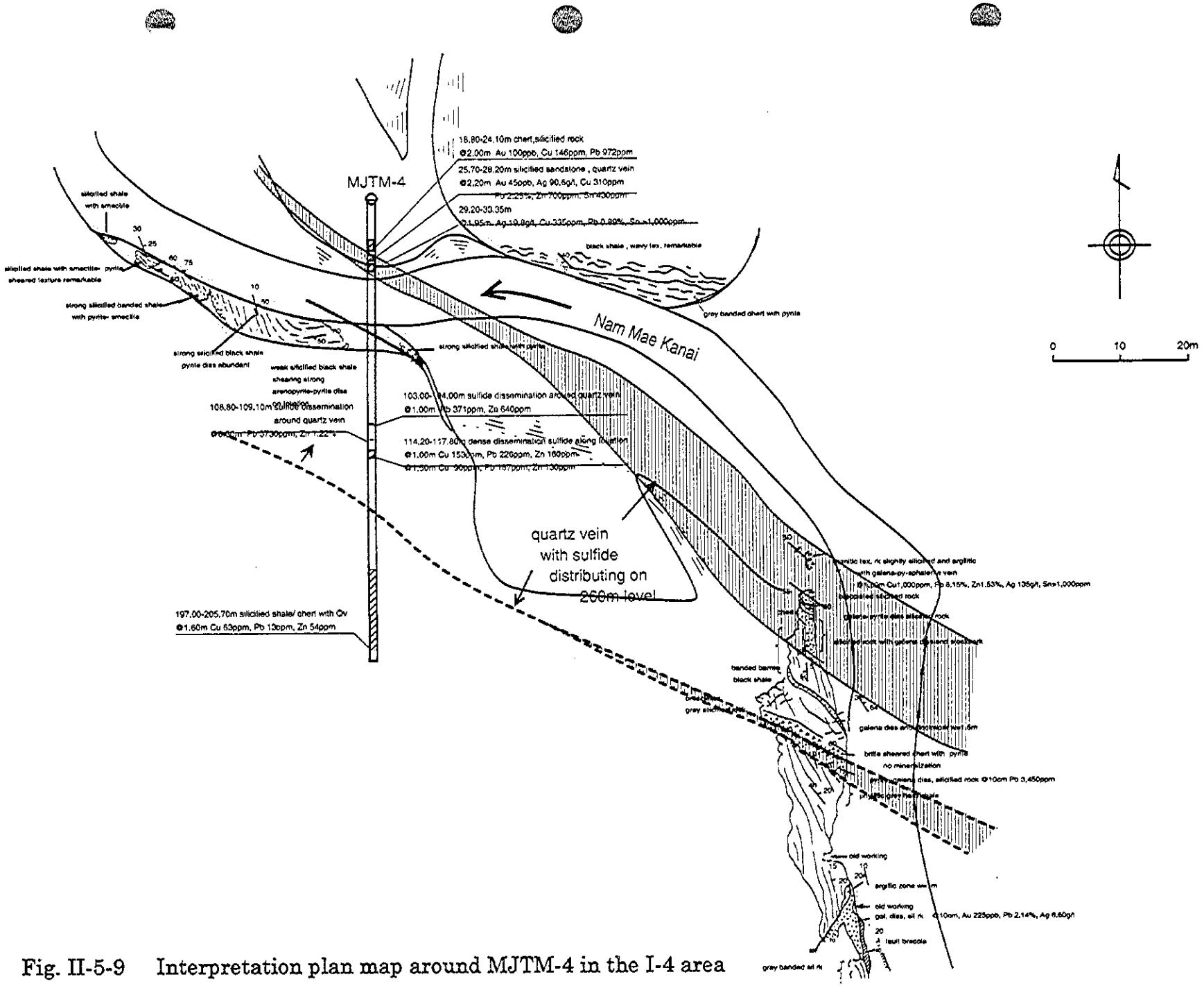

Fig. II-5-9 Interpretation plan map around MJTM-4 in the I-4 area

The width of Mineralization zone is 12m, partly hidden by gravel. The length between MJTM-4 and outcrop is about 100m. A float of galena-quartz vein is existing far from MJTM-4 about 150m in northwest. If mineralization ought to be continued there, its length is more than 250m. Ore assay samples are not so much. The assay samples show is 19.8～135g/t Ag, 310～1,000ppm Cu, 0.89～8.15% Pb, >1,000ppm Sn.

A sulfide vein and disseminated zone with weak silicification dip 60 degree to north. This part ought to be correlated with pyrite-galena disseminated silicified rock in the central of outcrop by comparing the nature of vein. An assay datum is obtained at the outcrop. It is 0.3% Pb.

Mineralization zones, such as quartz vein and calcite-quartz vein with sulfide, between 105m and 120m dip steeply 70 to 80 degree. This zone might converge to the mineralized zone at 80m as it goes to up. Assay data of Pb-Zn with 1m width is only a few hundred ppm, but in special a datum shows 0.37% Pb, 1.22% Zn in a section of 30cm. A low resistivity and high chargeability zone of last IP survey ought to be correlated with the pyrite disseminated part in shale and not with massive sulfide mass. No mineralization occurs in the carbonate rocks ranging from 140 to 170 m.

5-5 General Discussion

The I-4 area can be divided into two blocks, northwestern part and southeastern part, by a fault in the NE-SW direction located in the central part of the area. The northwestern part consists of the Ordovician sedimentary rocks and the southeastern part consists of the Permian to Triassic sedimentary rocks.

The alternating beds of shale and sandstone with limestone lenses are occupied in the lower part. The upper part of the Ordovician sedimentary rocks is limestone in the northwestern part, respectively. The Ordovician rocks show a synclinal structure in the form of a ship bottom plunging on the north side.

The Permian to Triassic sedimentary rocks in the southeastern part consist of alternating beds of black shale and sandstone intercalating limestone lenses in the lower part and a platy chert in the upper part. These rocks show a monoclinal structure with a northwest strike inclining toward the southwest.

Although a remarkable sign of mineralization is not observed in the limestone distribution area, small floats of gossan and floats of a quartz vein are found on a slope in the northwestern side of the mountain. There are also a lot of floats of a colorless idiomorphic calcite vein in this neighborhood. The geochemical survey revealed that geochemical anomalies of Zn, Pb, F, Sb, and As are distributed in a wide range in this area. The distribution of these geochemical anomalies seems to be predominated by a north - south system fault or fracture system. Particularly, a chargeability is low in correspondence with this high anomaly zone in the northwestern part of the area having high Zn anomaly like in the Dong Noi area. However, compared to its neighborhood, a relatively low resistivity area is observed. There probably indicate that this is a mineralized zone. The Zn anomaly is 200 to 1,000 ppm, which is lower by one digit than in the

Dong Noi area. The characteristic of this area differs from that of the Dong Noi area in that the Zn anomaly is not accompanied by the Cd anomaly. Judging from the fact that this area has cracks and high F anomaly values, it is assumed that this is a halo of mineralization that formed fluorite deposits. In any case, since the distribution of the anomaly can be seen well from the urban area of Mae Sariang and is adjacent to the precincts of a temple, it is difficult to explore this ore deposit. However, since a mineralization like this was discovered in the Ordovician limestone, it is highly possible that other ore deposits exist in other Ordovician limestone bodies to the north of this area.

Floats of barite, galena-quartz vein, and quartz vein are distributed in places in the area covered by the Permian to Triassic sedimentary rocks. In addition, a lot of pyrite disseminations are observed in a chert layer along the national highway at the east end of the area.

Three or four several meter wide stockwork vein zones of galena-arsenopyrite are observed in an outcrop of strongly silicified shale extending over 70 m north and south along the banks of Nam Mae Kanai at the east end of the area. The vein stands steeply at N 45 to 50° W in the extension direction. Silicified rocks with pyrite dissemination are distributed on this extension about 100 m downstream.

Both geochemical survey and IP exploration show that geochemical anomaly of Pb, Zn, Cu, Ba, As, Sb, and Sn, low resistivity, and high chargeability zones are distributed in correspondence with its extension direction from this silicified rock outcrop. The geochemical anomaly zone also shows a stretch in the NW-SE direction that is the same as the direction of the vein observed in the outcrop. Judging from these facts, as shown in the model simulation cross sections of resistivity and chargeability, it is assumed that subsurface network veins are larger in scale and higher grade than that observed in outcrop. The Pb and Zn geochemical anomaly zones show the highest value and it is assumed that the center of the orebody is beneath survey points 600 to 700 along traverse line A where a high chargeability zone is distributed under the ground.

Similar geochemical and high chargeability anomaly zones run parallel with this mineralized zone, and are distributed from the ridge on the southwest side from this zone to its west slope. It is thought that a zone equivalent in scale exists. However, unlike the mineralized zone in the eastern part, the lower part of this point shows a high resistivity.

Since a lot of similar floats with small veins are observed in the Mae Sariang area, it is likely that vein-type mineral occurrences are distributed on a small scale in various places. A possibility was also suggested that the geochemical anomaly in the Huai Pu · Huai Mae Pan areas that are adjacent to the south side of this area and have a similar geological environment is a vein type ore showing similar to this.

The Southern I-4 area is mainly underlain by Devonian-Carboniferous sedimentary rocks. Permian limestone is in a north striking fault contact with Devonian-Carbonifeous formation in the western part of the area.

The Devonian-Carbonifeous formation mainly consists of black shale with fine alternation and graded beds of shale and sandstone, but contains thick chert beds and the beds alternating

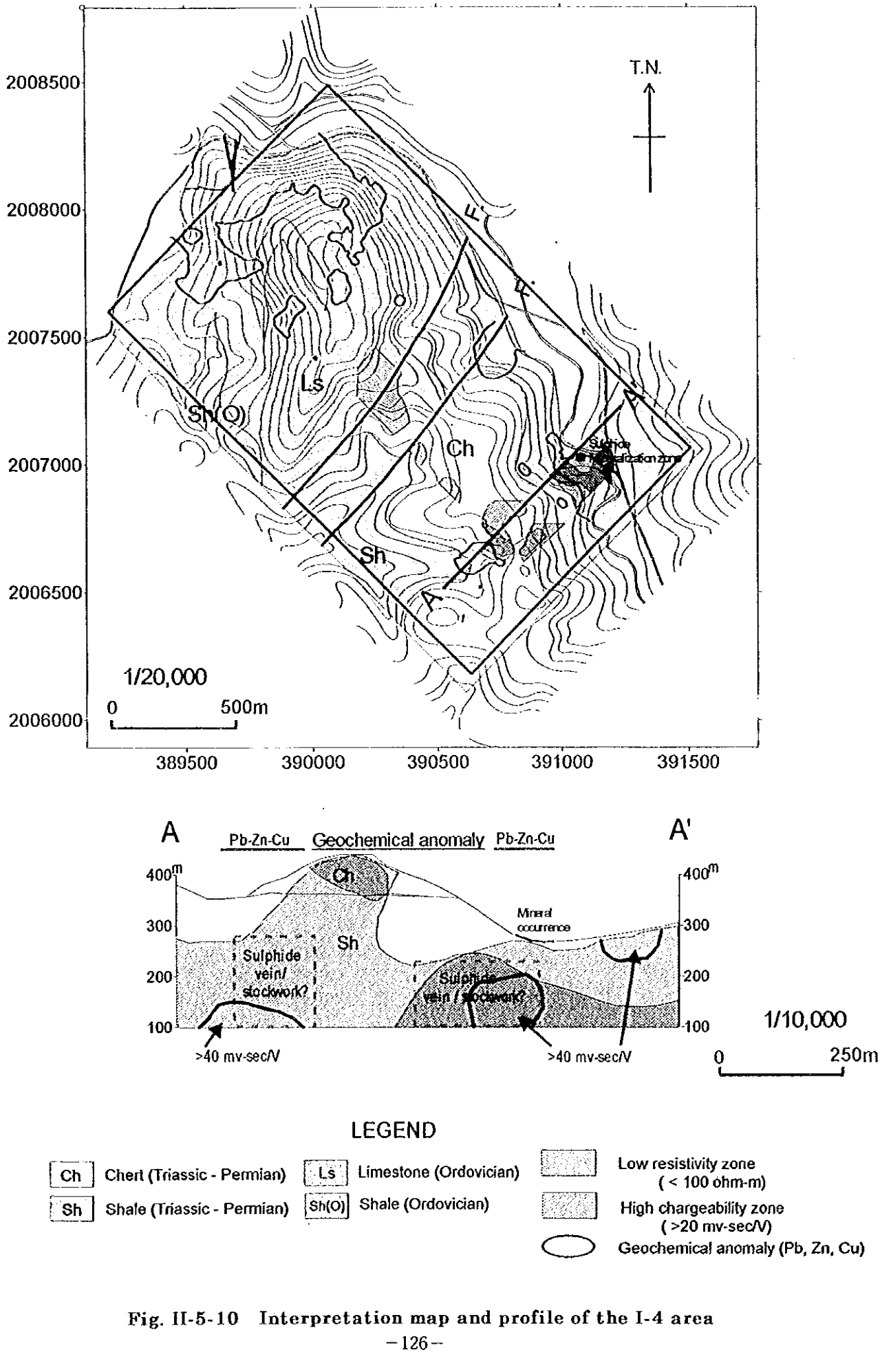

Fig. II-5-10 Interpretation map and profile of the I-4 area

limestone and chert. Black shale rarely contains several ten centimeters dolomite lenses. The rocks in the southwestern part have been subjected to the contact metamorphism by a granite batholith intruding to the east of the area. Black shale has been metamorphosed to micaceous schistose pelitic hornfels, and the calcareous part of the alternating rock contains a large amount of calc-silicate minerals. Pelitic biotite hornfels also occurs in places in Huai Pu valley.

The Permian limestone is composed of gray to white massive limestone, and contains a small amount of the laminated argillaceous limestone.

The Devonian-Carbonifeous rocks are cut by several northeast striking faults. They are observed complexly folded in the field, but the fold as a whole is a series of northeast trending syncline and anticline. A north-south striking fault divides into the Devonian-Carboniferous rocks and Permian rocks.

Some floats with galena-barite veinlets are found in places in Huai Pu valley, but no outcrop has been confirmed. The chemical composition of a galena-barite sample shows 615 ppm Pb and 140 ppm Zn. These values are rather lower than those of the samples collected in Nam Mae Pan neighboring south on Huai Pu.

Some small quartz stockworks zones less than 10 meters wide in brecciated and silicified shale occur in the upper stream of Huai Pu valley. One of the samples shows 188 ppm Cu, 341 ppm Pb, and 560 ppm Zn, but other samples contain very low content of copper, lead and zinc.

Two soil geochemical sampling lines crossing a general geologic trend are arranged on two ridges in Huai Pu valley. Some high values of Pb, Zn and Ba in soil are detected on black shale. These values are almost the same level as those in regional stream sediments geochemical samples.

This means that the anomaly detected by regional stream sediments geochemical survey on Phase 1 survey origins from barite-galena veinlets in black shale and/or quartz stockworks accompanied by brecciated and silicified shale. The broad geochemical anomaly of stream sediments may indicate that these vein-type mineralizations are common in the Southern I-4 area. But only confined and low-grade floats with galena-barite veinlets have been found in the field survey, and quartz stockworks are very small scale. There is no discovery other type mineralization in the area. Therefore there is a little possibility that an economically minable deposit exists in the Southern I-4 area.

The drill hole MJTM-4 in the I-4 area could encounter the mineralization extending from Nam Mae Kanai occurrence. The mineralized zone at the depth ranging from 20 to 30 m is almost vertical and about 4 m wide. It is inferred from a plane projection that the mineralized zone is an extension of veinlets with 12 m wide in the northernmost of Nam Mae Kanai occurrence. This vein continues horizontally about 250 m on the assumption that the vein continues to the slope 150 m northwest of the drilling site, where floats of galena-barite-quartz vein occur and its grade was 16.8 % Pb. The estimated width of mineralized zone from MJTM-4 to the occurrence ranges from 4 to 12 m, and the distance is about 100 m. It is inferred that the mineralization extends to the southeast side and to the deeper part. The estimated grade ranges from 19.8 to 135 g/t Ag,

310 to 1,000 ppm Cu, 0.89 to 8.15 % Pb, and more than 0.1 % Zn based on the chemical analysis of core samples, but all length of mineralized core is not analized.

Other two mineralized zones are observed at the 81 m depth and the depth ranging from 105 to 120m. The former zone is corresponded to the pyrite-galena disseminated silicified rock on the surface, that is Nam Mar Kanai occurrence, by its similar characteristic of mineralization. Usually the grade is not high as a whole, but this zone frequently contains highly mineralized parts; for example 0.37 % Pb and 1.22 % Zn by 30 cm core sample.

Judging from the geology of MJTM-4 and its surrounding area, the mineralization of the Nam Mae Kanai occurrence extends to the N50° W direction and is accompanied by silicification and smectite argillic halo. The alteration zone is about 100 m wide and 300 m long.

An alternation bed of carbonate rock and chert occurs at the depth ranging from 140 to 170 m in MJTM-4, but no mineralization is observed. Therefore it appears that the zinc and lead mineralization replacing a carbonate rock may not exist in the I-4 area.

Another area overlapping with the geochemical anomaly, low-resistivity and high-chargeability zone is detected to the west of Mae Kanai occurrence. The area has also high potential because of the same characteristic with the occurrence. Further exploration needs to confirm the mineralized rocks at this area.

Part III Conclusions and recommendations

Chapter I Conclusions

1-1 Phase I exploration

1-1-1 Satellite Images Analysis

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

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

2) crossing point of continuous lineaments,

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

4) high density area of short or discontinuous lineaments

1-1-2 Mae Sariang Area

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

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

1-1-3 Don Noi Area

The mineralization in Don Noi area is considered to be as follows:
ore solution which has gone up along the fault of north-south system bordering between Cambrian sandstone and Ordovician has formed a vein type ore body which mainly consists of galena, barite and pyrite. The remained solution has diffused and replaced along some particular horizons of limestone in the surroundings to form zinc mineralization. Their features resemble with those of Mae Sod mineral deposit owned by Padeang Industry Inc. Mineralization seems to have occurred at various horizons in limestone.

1-1-4 I-4 Area

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

In the northern side of the area, Ordovician limestone formation distributes and geochemical anomalies of Zn, Pb and F are recognized in the limestone. The distribution of anomalies suggests a high possibility that the distribution is controlled by the N-S fracture system. The anomaly levels are lower than those of Don Noi district by one figure. The fact that there is no anomaly of

Cd is also different from Don Noi district. Judging from the fact that there are the mineralization of zinc at a certain level in this rock. This area has a difficult social condition than other areas, the development of a mine may be impossible if a ore-body will be discovered

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

1-2 Phase II exploration

1-2-1 Dong Noi Area

On the result of the trenching and drilling survey, it is made clear that the geochemical soil anomaly of Zn, Cd, Pb and Mn does not indicate the strata-bound or massive ore deposit embedded into limestone, but the galena-sphalerite dissemination related to dolomitization and the galena-sphalerite dissemination of fissures or shear zone in limestone located to the upper part of the skarn-type mineralization. The fluid inclusion examination revealed the existence of a high salinity ore fluid which needed to form a strata-bound or massive ore deposits, but it is inferred that this year's field did not have the geologic condition such as a large porous and/or fractured carbonate body to precipitate a large amount of ore minerals. The same mineral indication widely occurs in the northwestern part of the area, where detailed exploration has not been completed.

The soil geochemical anomaly of Cu, Pb and A is derived from the skarn-type mineralization adjacent a buried granite body. This anomaly extends northward from Dong Noi lead occurrence along a north striking fault. It can be interpreted that the skarn-type Cu, Pb and Ag mineralization intersected by the drill holes MJTM-3 and MJTM-5 is consistent with the north-south extending high chargeability zone with 100 m in diameter and more than 800 m in length obtained by the last year's IP survey. The ore assays of drill core samples range from 0.05 to 1.30 % Cu, from 1.4 to 46.4 g/t Ag, and from 0.02 to 12% Pb. Farther drillings and ore assays are necessary to confirm the reserve and grade of an ore deposit.

The outcrops of gossans were found on the ridge in the southern part of the Dong Noi area for the first time by this phase detailed geologic survey, and the geochemical soil sampling and the IP geophysical survey was carried out around the gossan zone. The gossan channel samples contain ranging from 600 to 800 ppm Cu. Though the values of all pathfinder elements in soil samples could not be obtained high values compared with those in the northern part of the area, the soil samples contain rather high copper content more than 100 ppm and a weak gold anomaly ranging from 30 to 40 ppb on the gossan zone. The IP survey is detected a low resistivity and high chargeability anomaly deeper than 800 meters above sea level, that is 200 m underground. The result of the geochemical survey and the IP survey may lead the existence of the vein-type or

stockwork-type ore deposit under the gossan zone.

1-2-2 Mae Kanai Area

The Mae Kanai area is underlain by the Paleozoic sedimentary rocks. Triassic granite is distributed on the west side of the sedimentary rocks. The sedimentary rocks mainly consist of Ordovician shale, sandstone and limestone, but Silurian-Devonian sandstone is south and north, in fault contact with Ordovician rocks. Shale and sandstone unit are dominant in the Ordovician on the surface, but it is inferred that limestone is widely distributed under the shale and sandstone unit.

More than seven gossan zones with several hundreds meters in diameter occur on the Ordovician shale and sandstone. These gossans contain highly concentrated zinc. Especially high zinc content is obtained from the samples of the gossan zone south of Ban Sam Lung. They normally range from 0.7 to 0.8 %, and the maximum value is 1.54 % from 5 m channel sample. The gossans of other zones commonly contain high Zinc content ranging from 0.2 to 0.3 %.

The ordinary geochemical survey and the MMI geochemical survey are revealed the anomalies around gossan zones. The following anomaly areas are delineated on the result of the geochemical survey.

1) The area around the points ranging from 200 to 500 of Line B and Line C
2) The gossan zone southeast of Ban Sam Lung
3) The area from the F-1000 on a gossan zone to Line E
4) The periphery area around the points ranging from 800 to 900 of Line D

As the result of 2-D analysis of the IP survey, the resistivity discontinuity is found along the north striking fault from Line A to Line C, and the low resistivity distributes at the east part of this discontinuity. The chargeability shows highest value near B-500 station, and the center of the high chargeability is shifting to C-300 station. Therefore the most significant area based on the result of the geophysical survey is an area around B-500 station, where the resistivity shows low value and the chargeability shows high value. It is interpreted that this IP anomaly is accompanied by a fault-related mineralization because it is situated at a periphery of the fault zone and very near from the gossan zone.

A wide low-resistivity zone along a fault extends from B-1000 station to C-1600 station, and a high-chargeability zone extends from D-1800 station to F-1800 station. A gossan zone occurs zone near C-1600 station between these two IP anomalies. The low resistivity zone, the gossan zone and the high chargeability zone continue to the direction of the fault. Therefore it may be also accompanied by a fault-related mineralization.

The promising areas led by the geochemical survey and the geophysical survey are as follows.

1) The area from a gossan zone to a fault, ranging from 300 to 600 stations of Line B and Line C. It overlaps with zinc anomaly, low-resistivity and IP high-chargeability zone.
2) The gossan zone and the high-chargeability zone east of Ban Sam Lung. Gossan contains high zinc content, and the zone overlaps with geochemical copper-lead-zinc

MMI anomaly area. Here is also found a low-resistivity zone.

The characteristic of geochemistry and geophysical anomaly suggests that the fault-related mineralizations are expected in these areas.

1-2-3 I-4 Area and Southern I-4 Area

The Southern I-4 area is mainly underlain by the Devonian-Carboniferous sedimentary rocks.

The western part of the area is cut by a north striking fault, and the Permian limestone crops out on the west side of the fault. The Devonian-Carboniferous rocks are complexly folded on outcrops, but the fold as a whole is a series of northeast trending syncline and anticline.

The floats with galena-barite veinlets are occasionally found in places in Huai Pu valley. The chemical composition of a galena-barite sample shows 615 ppm Pb and 140 ppm Zn. Some small quartz stockworks zones less than 10 meters wide in brecciated and silicified shale occur in the upper stream of Huai Pu valley, and the maximum value obtained by chemical analysis is 188 ppm Cu, 341 ppm Pb and 560 ppm Zn.

Two soil geochemical sampling lines were arranges on the ridges in Huai Pu valley. Some high values of Pb, Zn and Ba in soil are detected on black shale. These values are almost the same level as those in regional stream sediments geochemical samples of last year's survey.

The result of the geological survey and the geochemical survey indicate that the anomaly detected by regional stream sediments geochemical survey origins from barite-galena veinlets in black shale and/or quartz stockworks accompanied by brecciated and silicified shale. Only confined and low-grade samples floats of barite-galena veinlets have been found in the field survey, and quartz stockworks are very small scale. There is no discovery other type mineralization in the area. Therefore there is a little possibility that an economic minable deposit exists in the Southern I-4 area.

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

Other two mineralized zones are observed at the 81 m depth and the depth ranging from 105 to 120m. The former zone is corresponded to the pyrite-galena disseminated silicified rock on Nam Mar Kanai occurrence by its similar characteristic of mineralization. Usually the grade is not high as a whole, but this zone frequently contains highly mineralized parts; for example 0.37 % Pb and 1.22 % Zn by 30 cm core sample.

1-3 Phase III exploration

1-3-1 Dong Noi Area

Taking into consideration the results of mineral occurrence surveys and drilling survey, we reached the following conclusion:

In the area with geochemical anomalies in zinc and lead values extending in the western half of Dong Noi area where limestone was distributed, hydrothermal ore solution in temperature of 140-250℃ and with high salinity rose up through joints in limestone and bedding place of fissures, formed silicificated zone on a certain horizon in relatively upper layers, caused occurrence of wide-ranged dolomitization and zinc/lead mineralization right above it, and at the same time formed quartz vein which changed joint systems and a specific horizon, precipitating galena and sphalerite.

The quartz vein in dolomitized zone was in width of 80 cm and its grade values were 7.86%Zn and 2.82%Pb. The sample extracted from 20 m section including this quartz vein also showed high values of 1.60%Zn and 1.43%Pb, and existence of zinc body was expected. However, since the structure to form quartz vein changes open joints and the part along bedding of a certain specific horizon, it is necessary to explain more in detail rock faces and the geological structure to estimate the position of its existence.

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

1-3-2 Mae Kanai area

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

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

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

The present gossan zone is distributed only along the ridge and on a slow eastern slope of the land surface of the Mae Kanai area. Taking into consideration the fact that the bedding face was a slow slope inclined to east as well as our boring results, the gossan zone is considered to have been formed a few to fifteen meters away from the border between the limestone and general sedimentary rocks toward the side of sedimentary rocks or on the border in some part, and at present its upper face is almost in conformity with the land surface. In view of the fact that gossan zones occur almost on the same level, in the district surrounded by MJTM-8 Hole, MJTM-9 Hole and DMR's MK-3 Hole, it is quite possible that the horizon of the gossan may be beneath the land surface and that the gossan zone may have been hidden under it. Moreover, we presume that IP anomalies may be distributed at the east end of profile lines E and D for geophysical exploration on a slope inclined to east right under the land surface and that massive sulfide minerals may exist under the land surface.

Chapter 2: Recommendations for the Future

2-1 Dong Noi area

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

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

2-2 Mae Kanai area

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

2-3 I-4 area

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

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