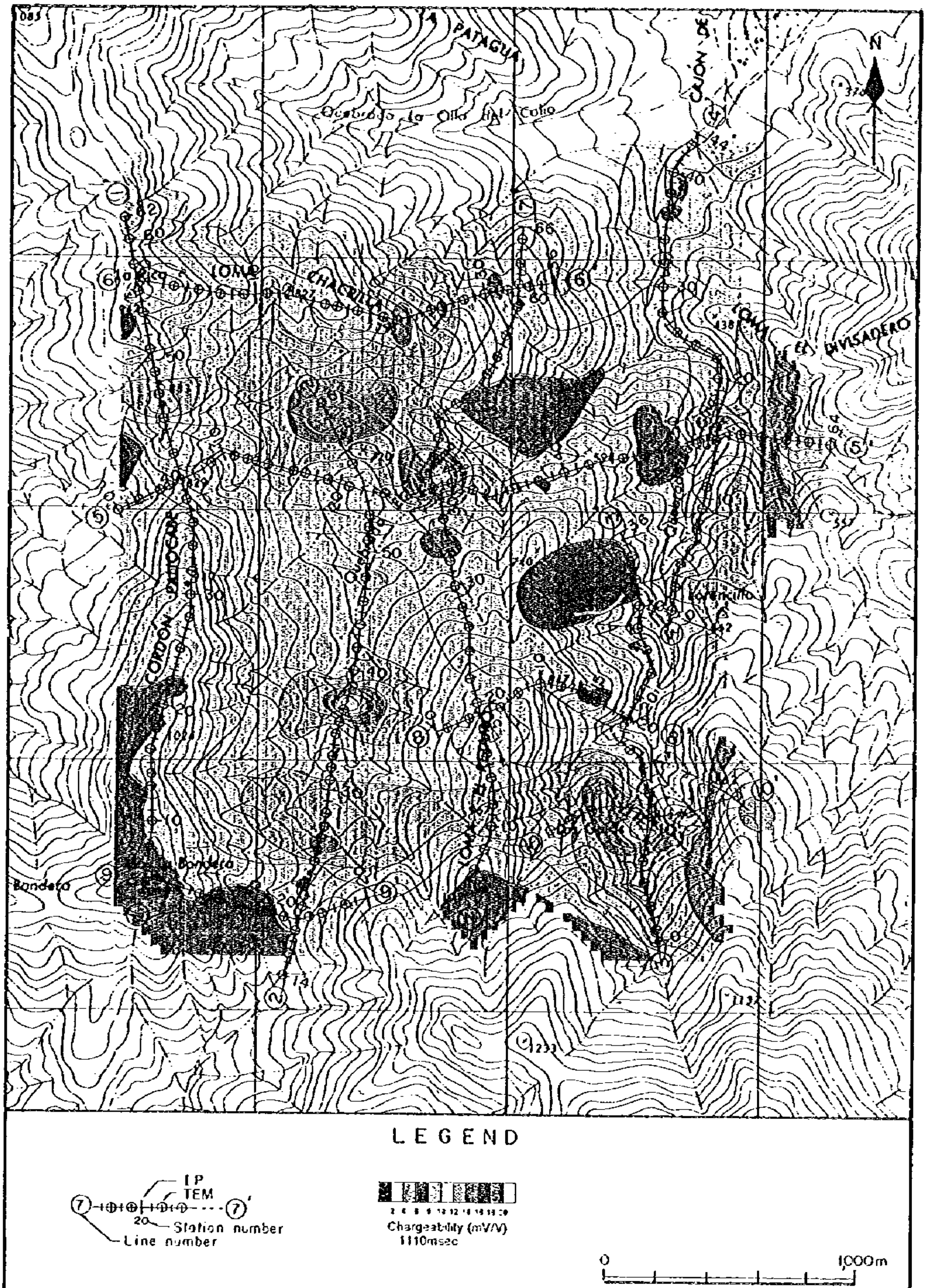


Fig.2-3-3(1) IP chargeability distribution (n=1)

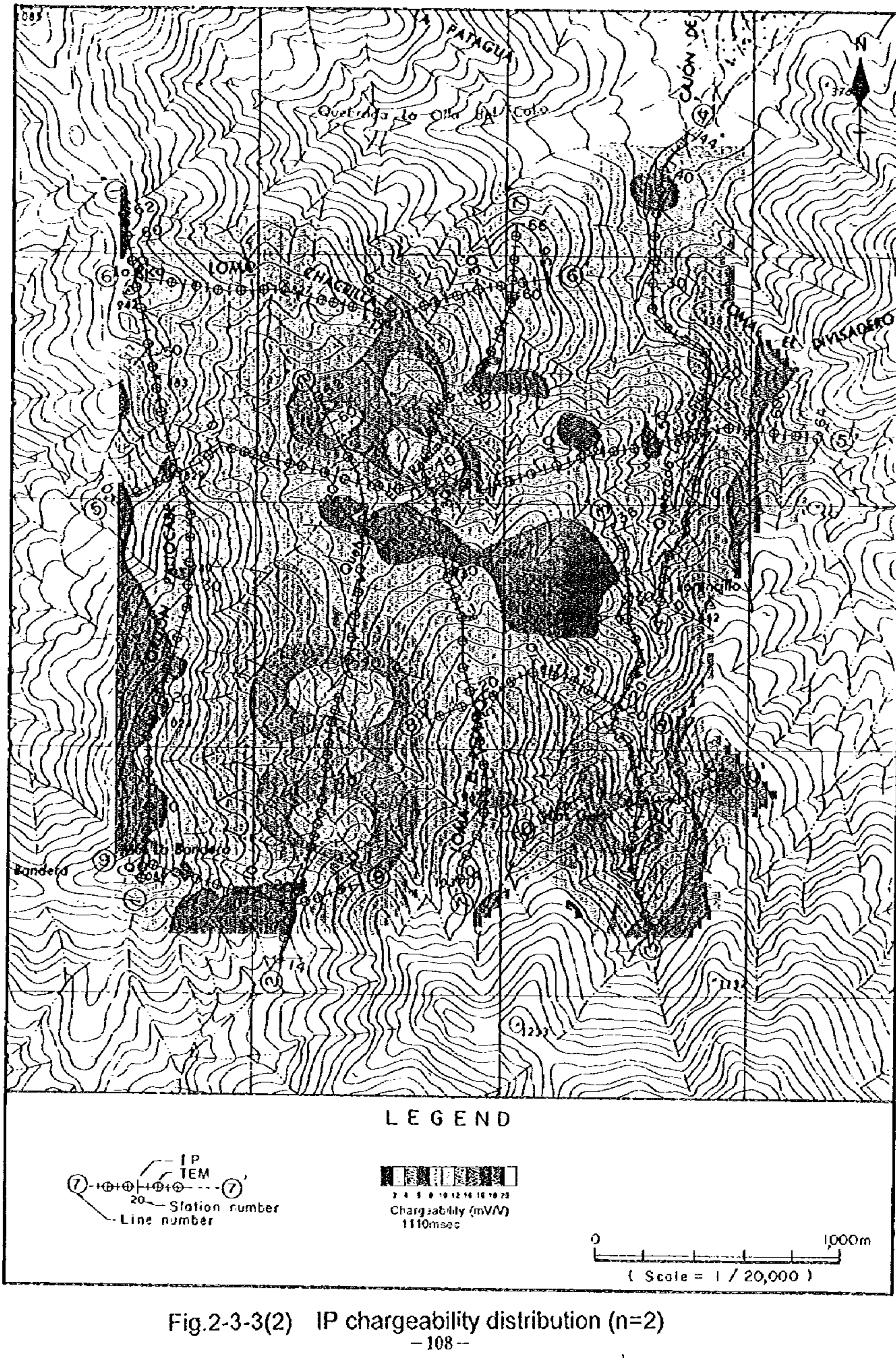


Fig.2-3-3(2) IP chargeability distribution (n=2)

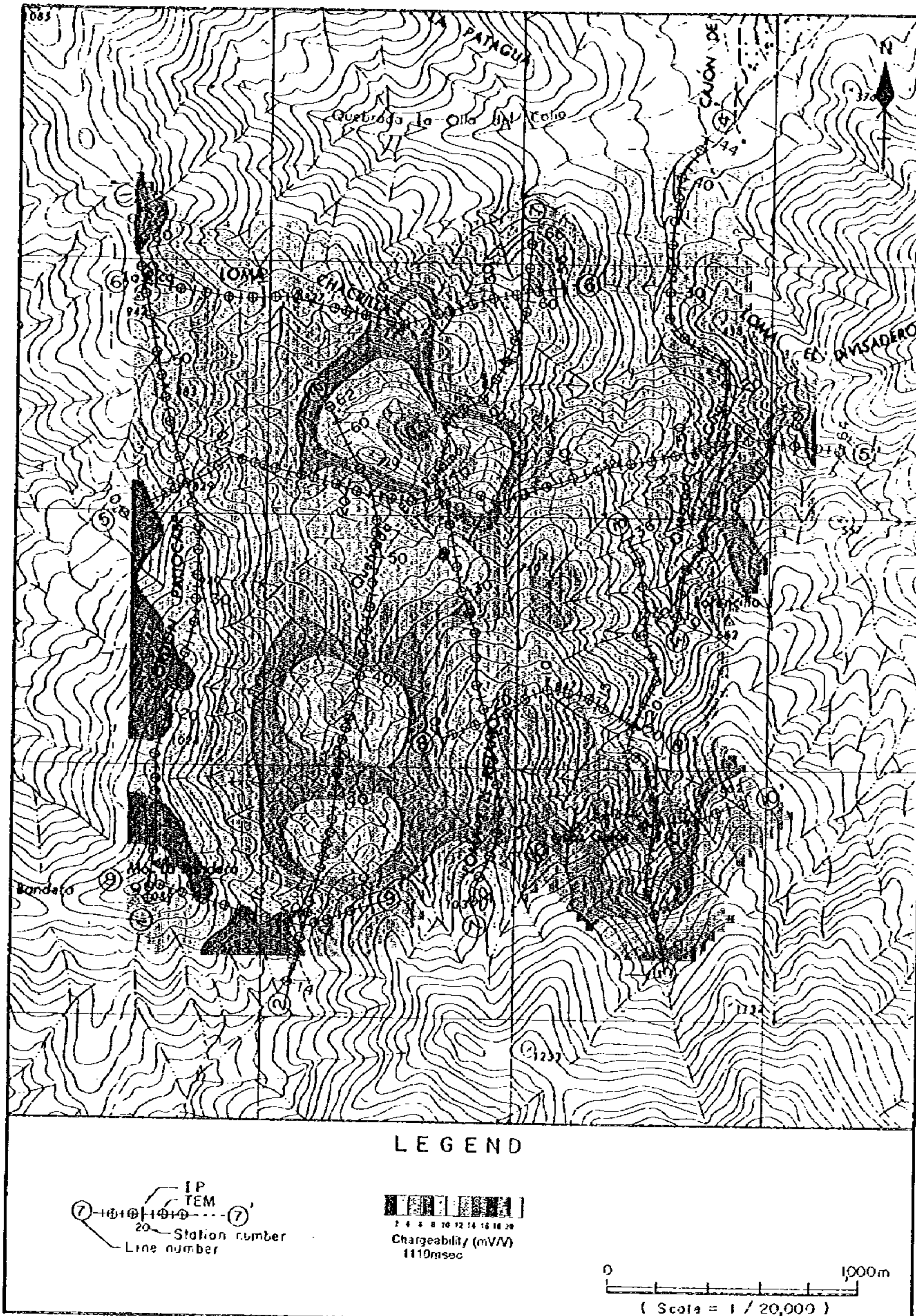


Fig.2-3-3(3) IP chargeability distribution (n=3)

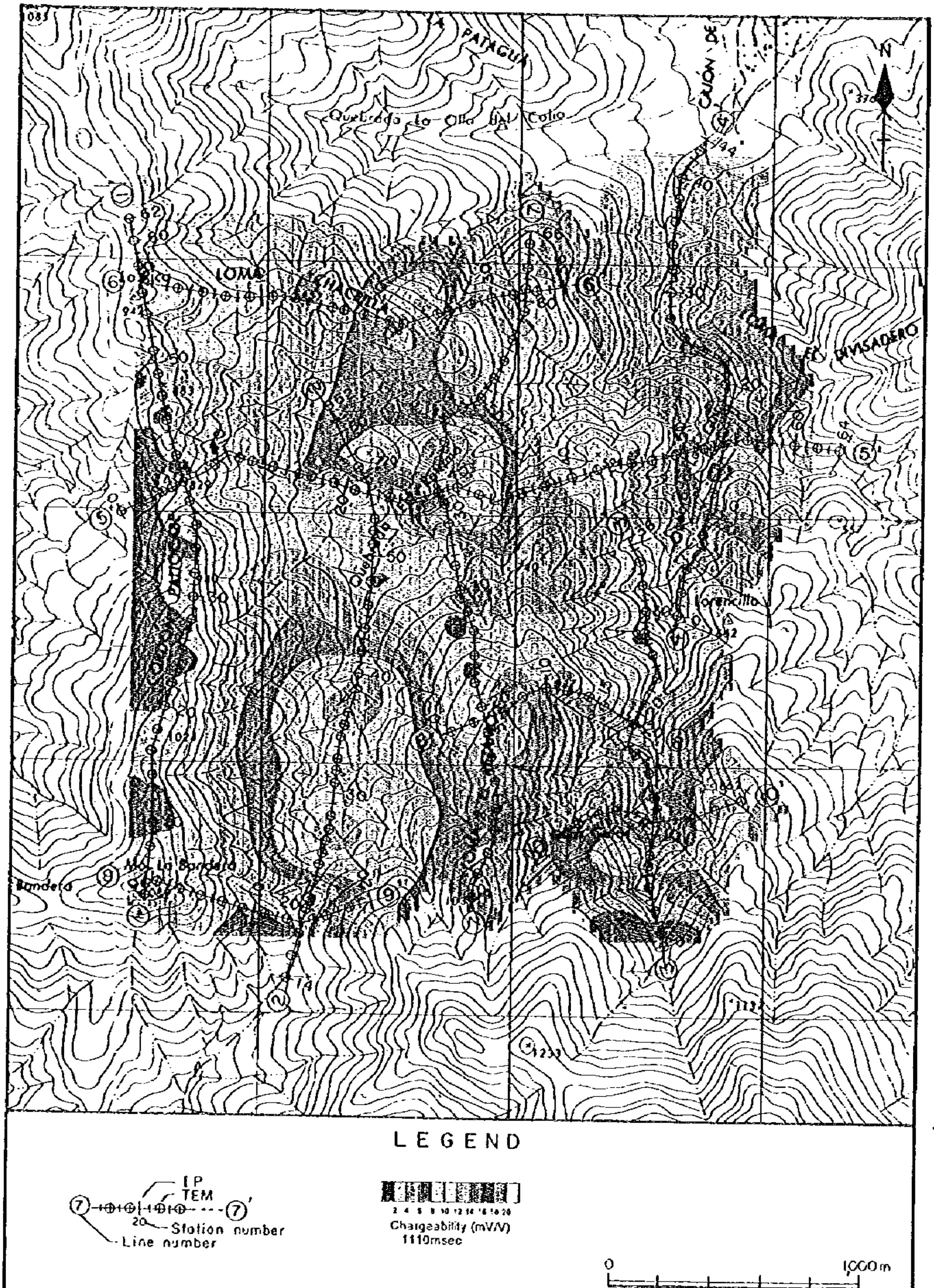


Fig.2-3-3(4) IP chargeability distribution (n=4)

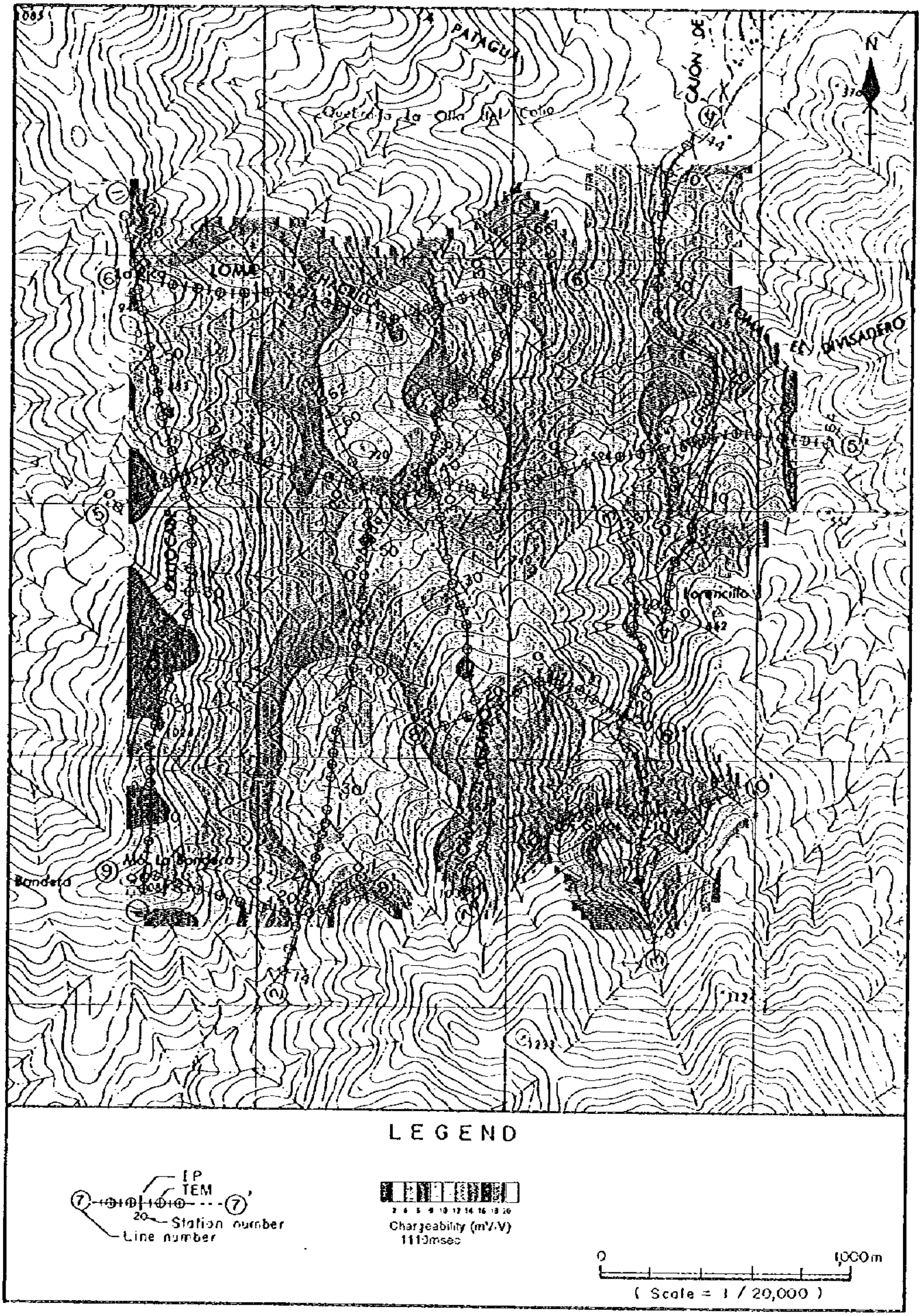


Fig.2-3-3(5) IP chargeability distribution (n=5)

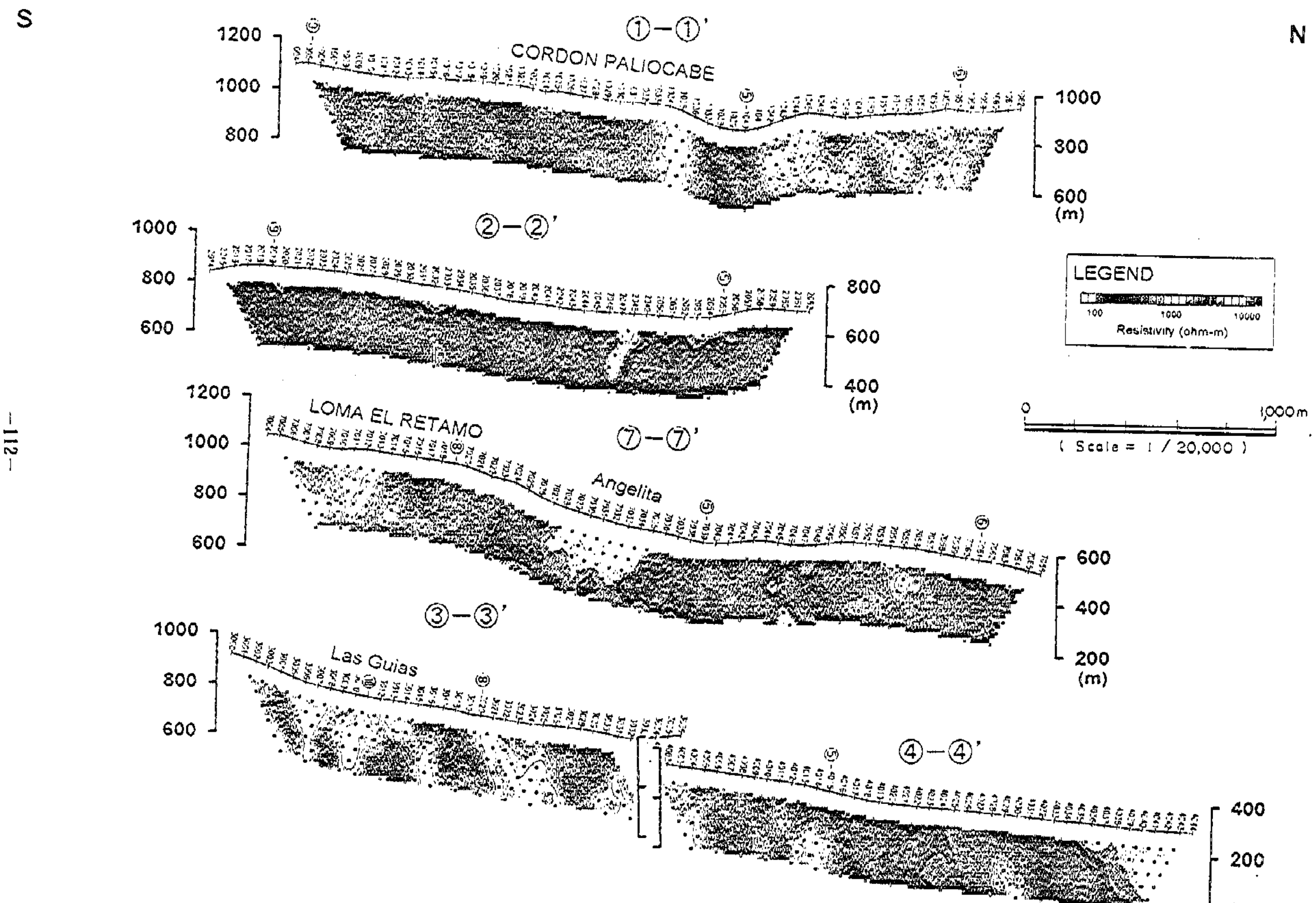


Fig.2-3-4(1) IP apparent resistivity pseudosection (N-S)

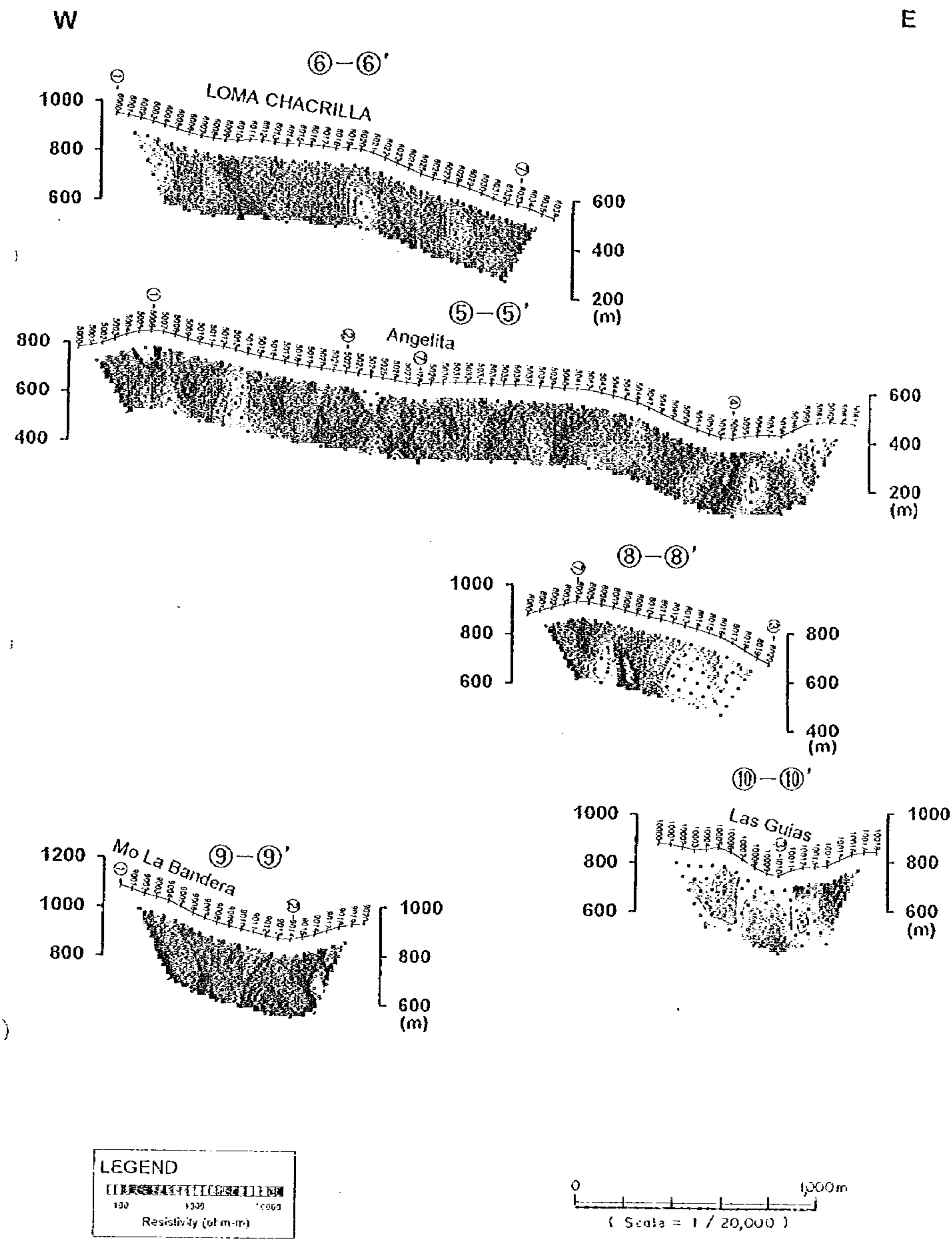


Fig.2-3-4(2) IP apparent resistivity pseudosection (E-W)

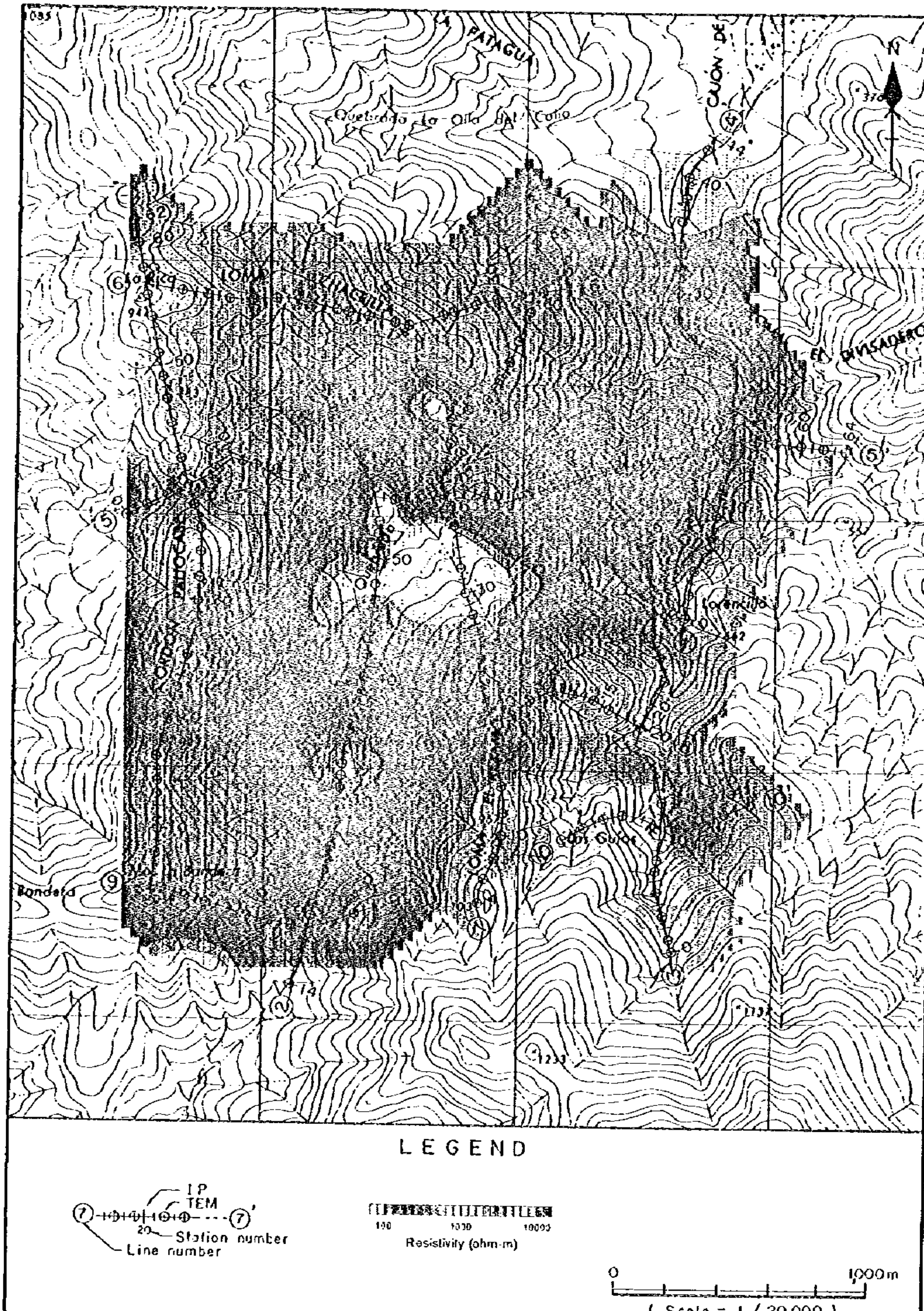


Fig.2-3-5(1) IP apparent resistivity distribution (n=1)

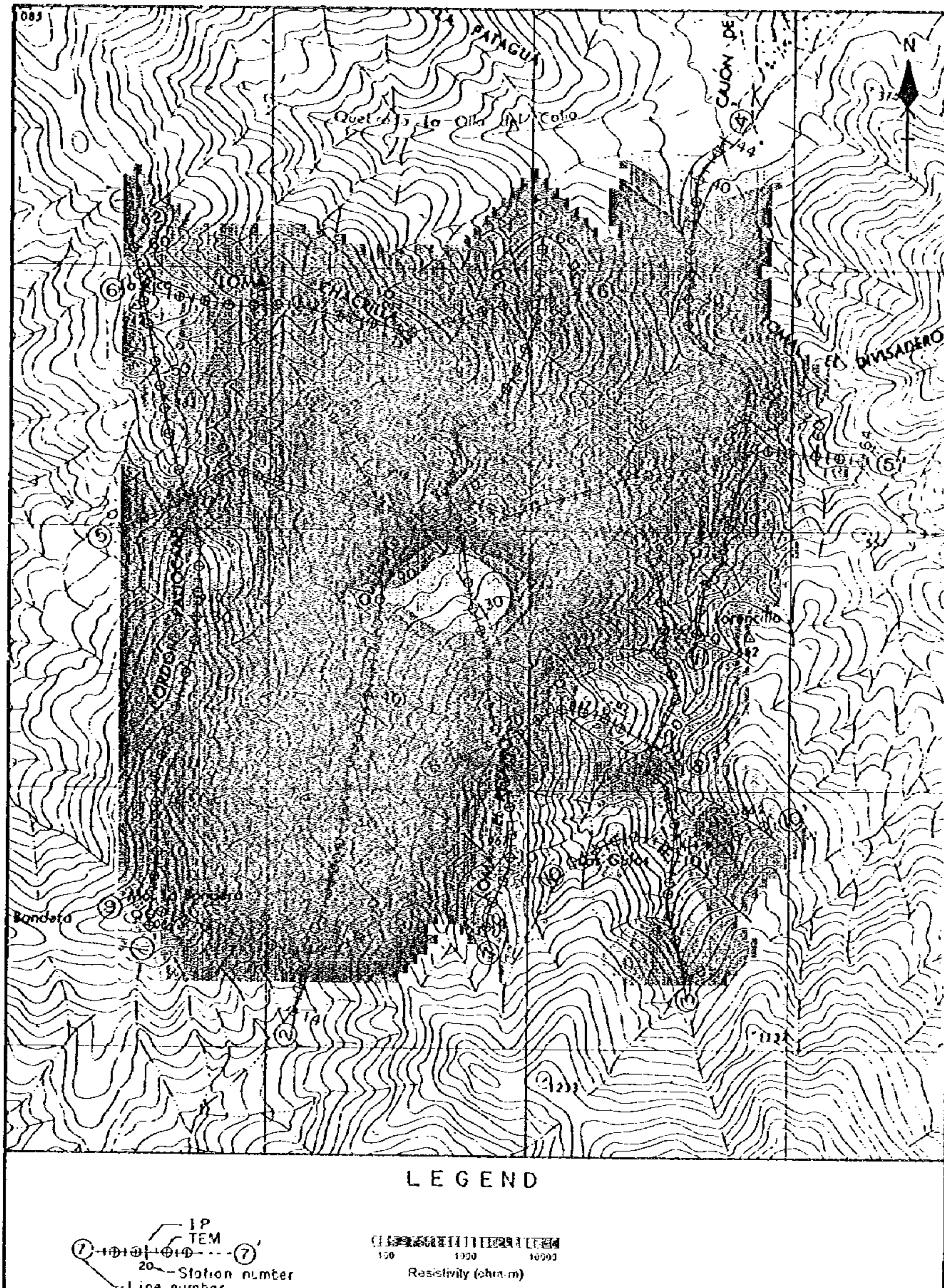


Fig.2-3-5(2) IP apparent resistivity distribution (n=2)

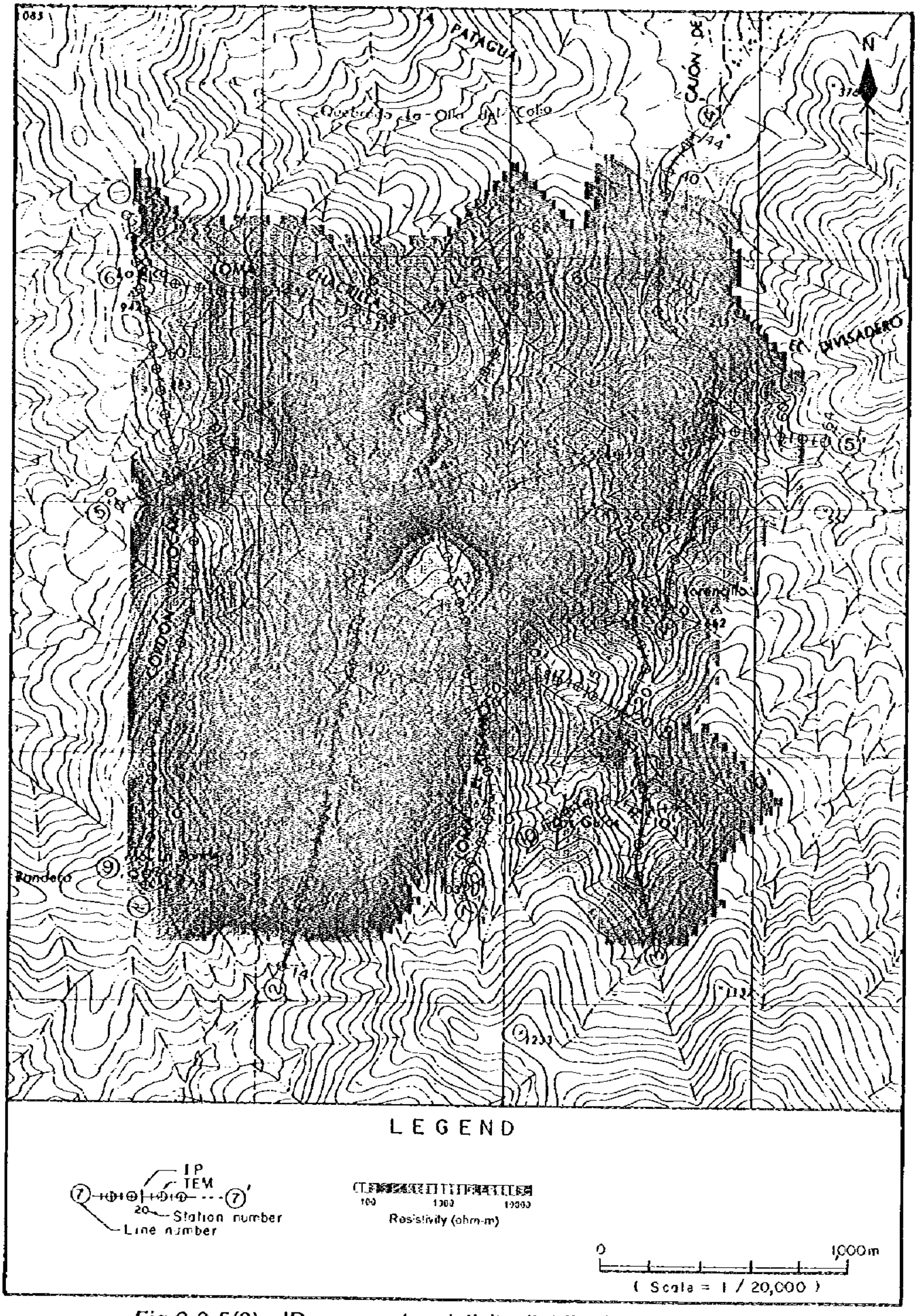


Fig.2-3-5(3) IP apparent resistivity distribution (n=3)

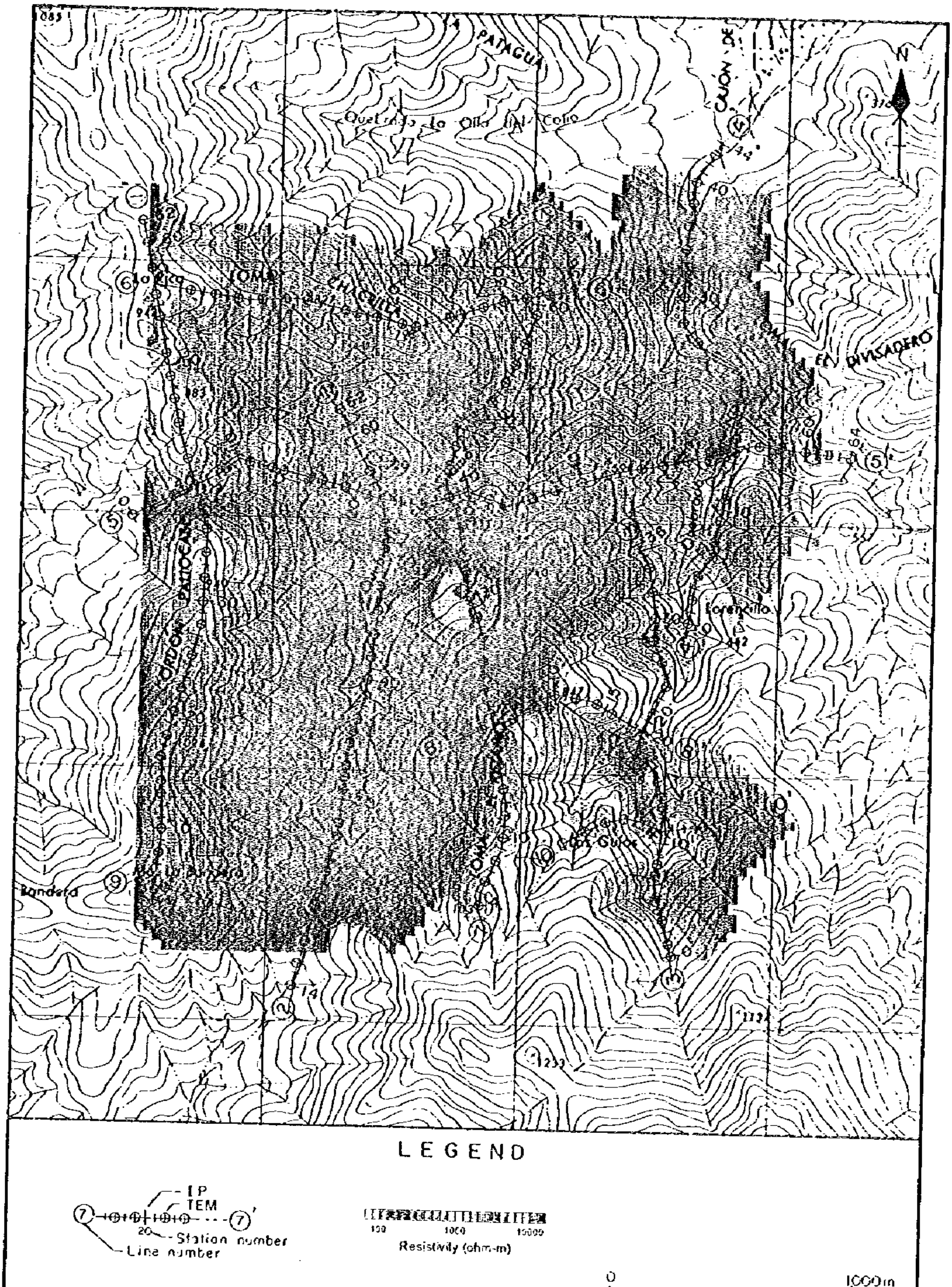


Fig.2-3-5(4) IP apparent resistivity distribution (n=4)

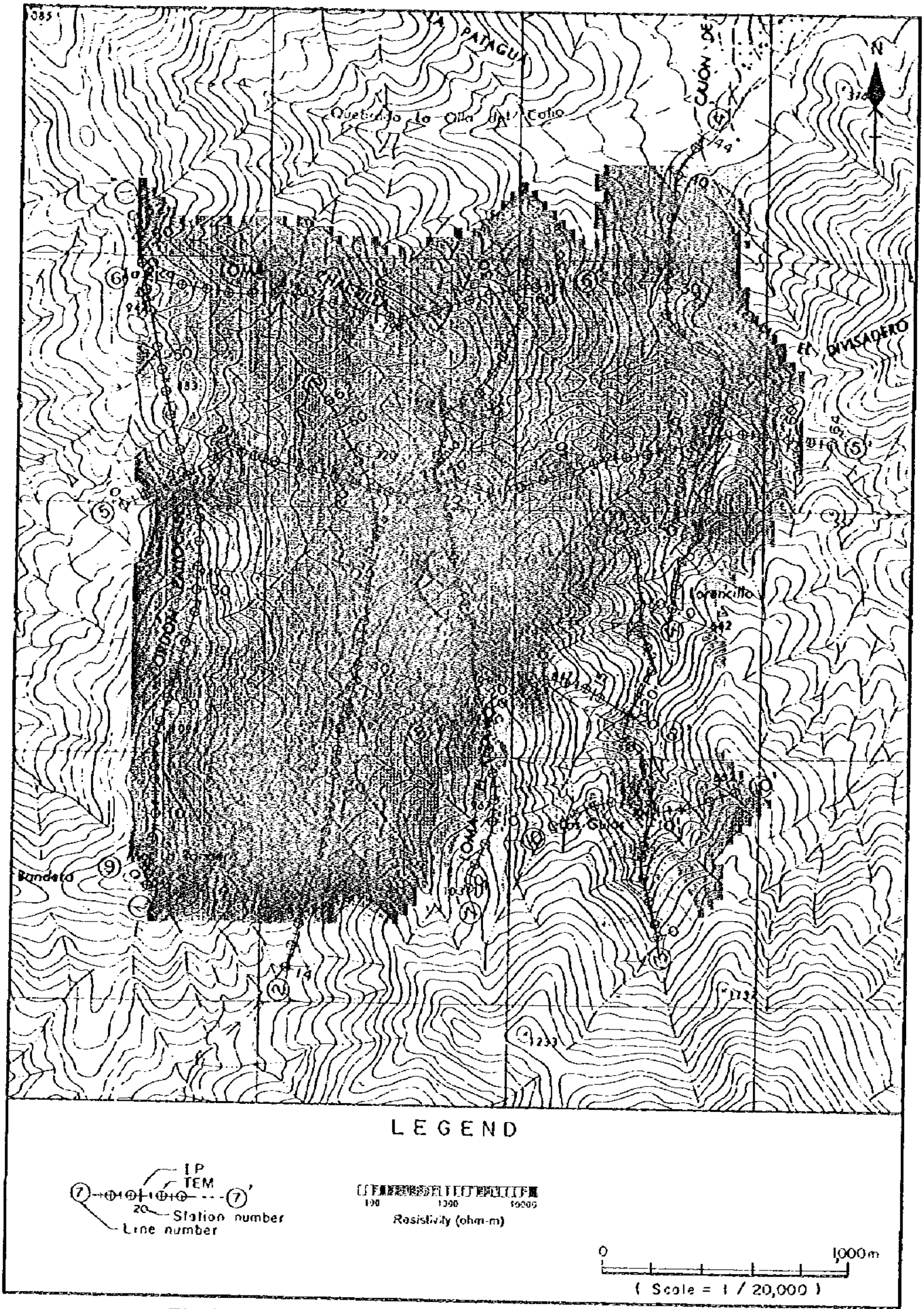


Fig.2-3-5(5) IP apparent resistivity distribution (n=5)

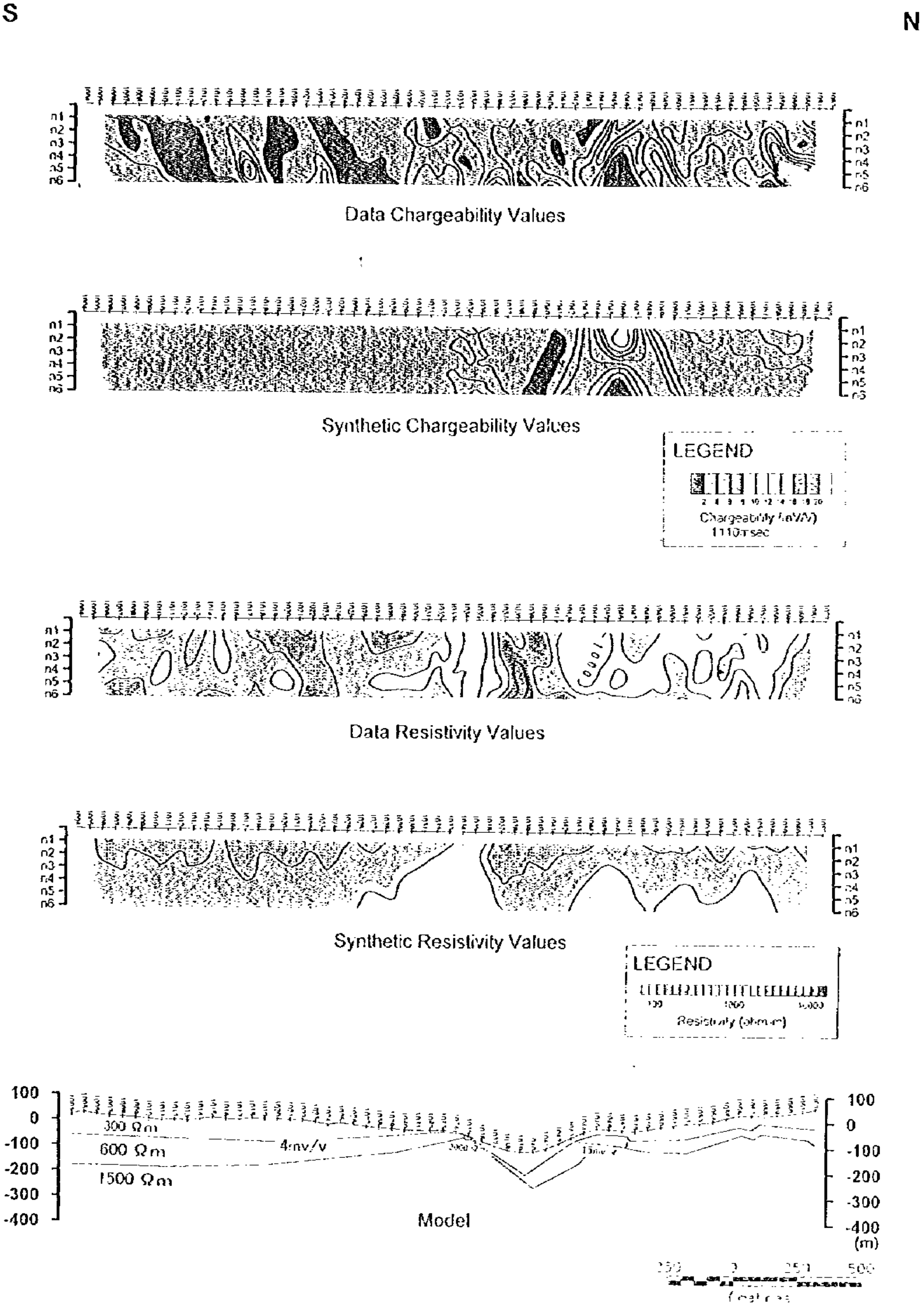


Fig.2-3-6(1) Comparison of observed and synthetic IP data (Line 1)

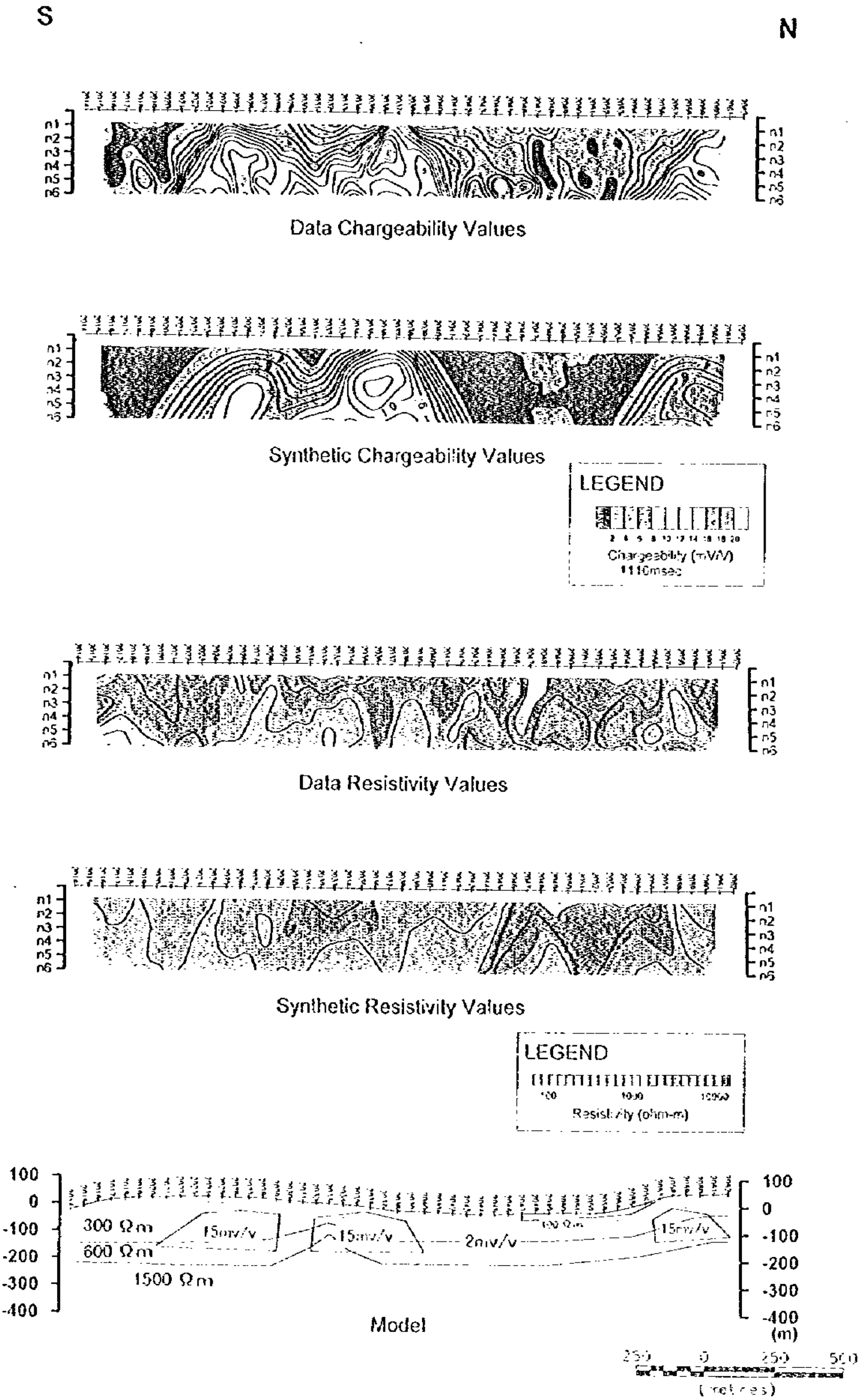


Fig.2-3-6(2) Comparison of observed and synthetic IP data (Line 2)

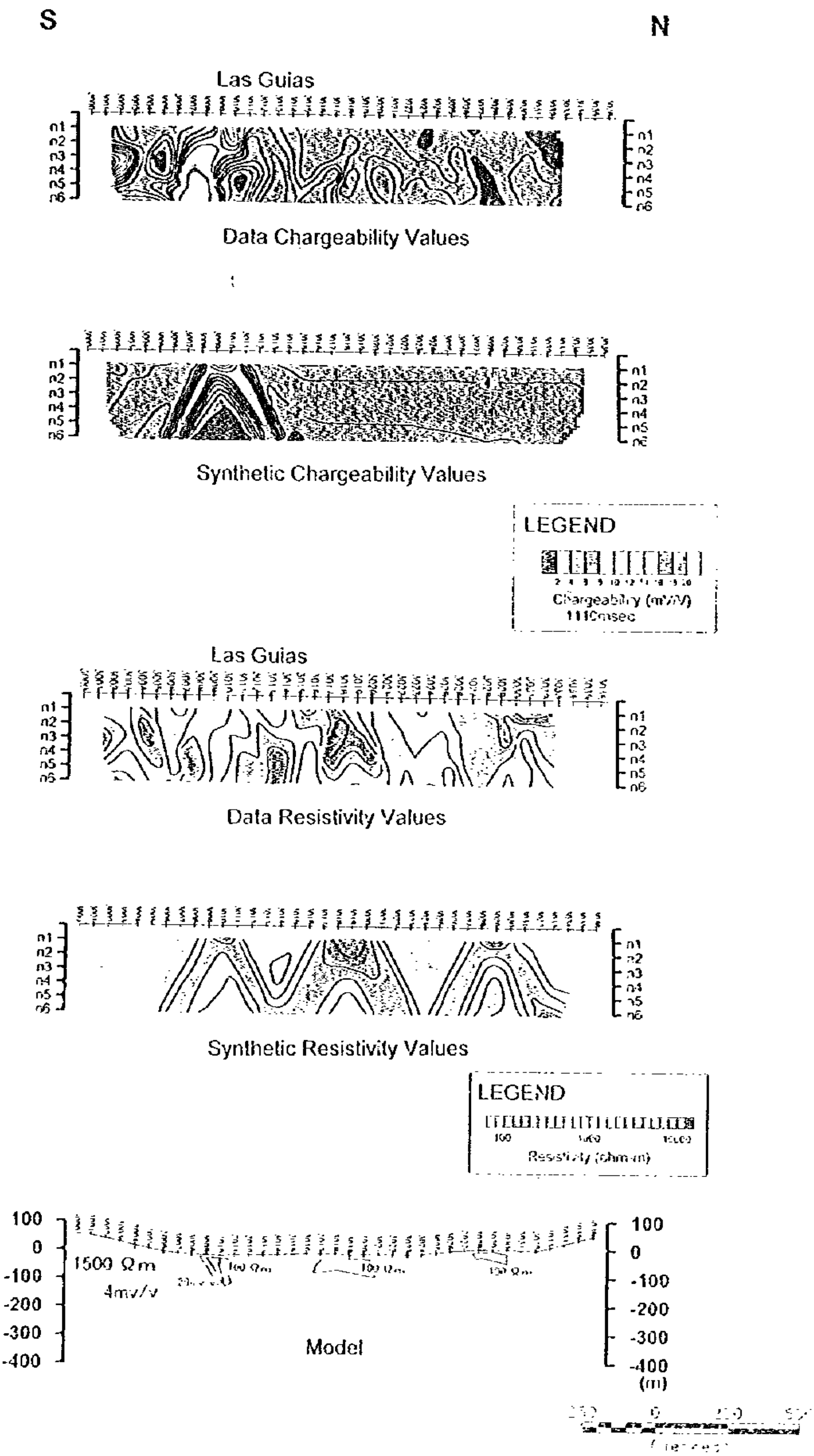


Fig.2-3-6(3) Comparison of observed and synthetic IP data (Line 3)

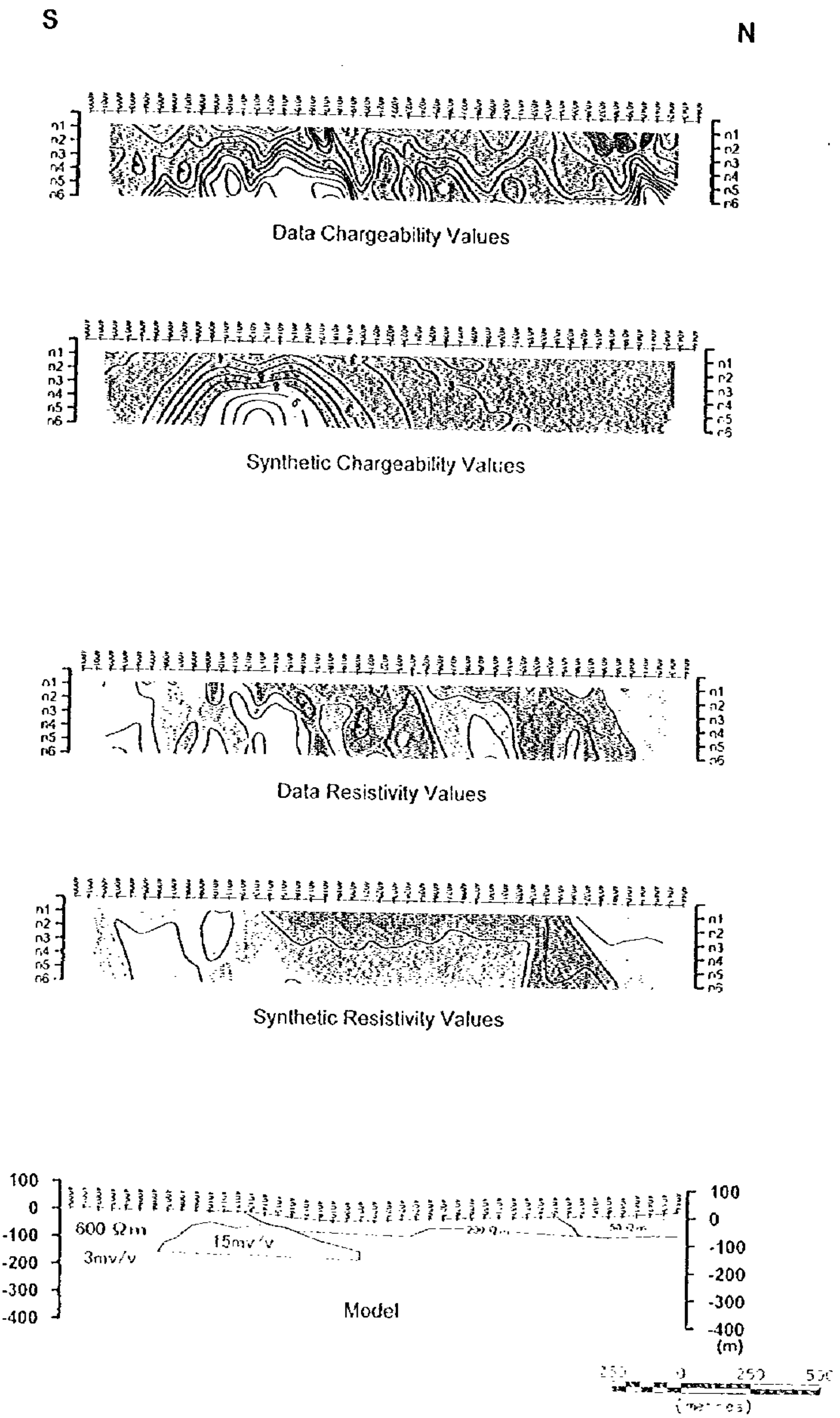


Fig.2-3-6(4) Comparison of observed and synthetic IP data (Line 4)

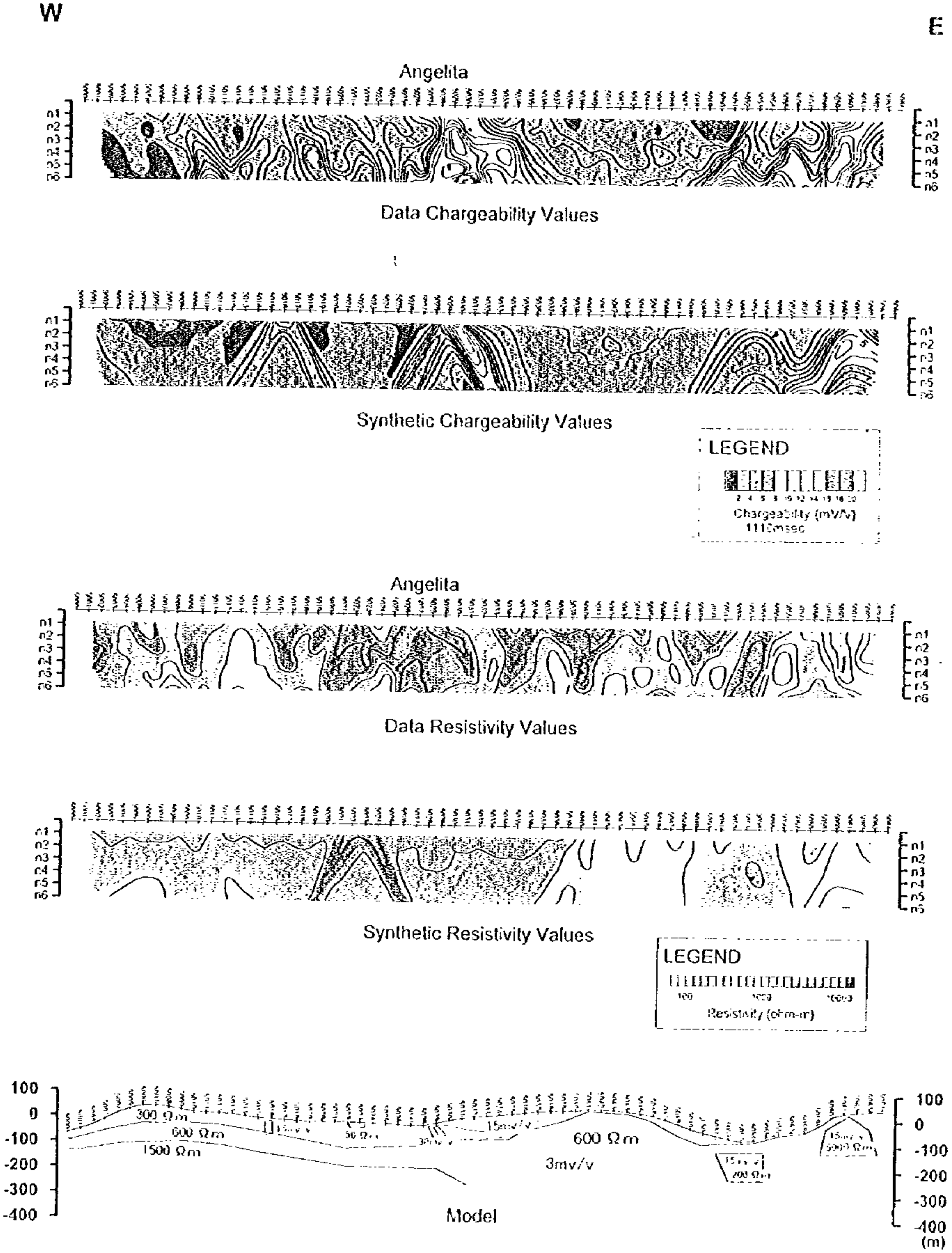


Fig.2-3-6(5) Comparison of observed and synthetic IP data (Line 5)

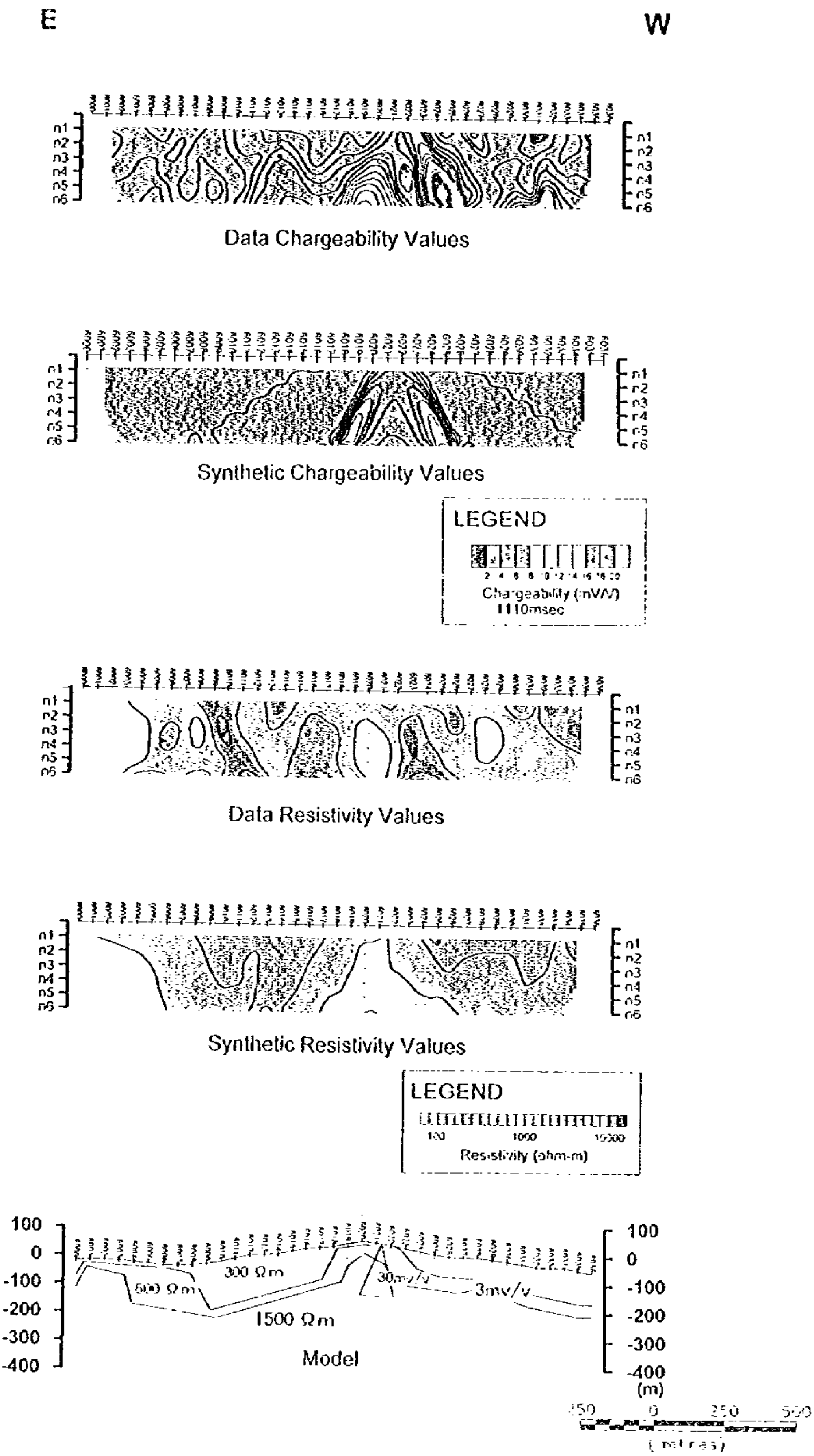


Fig.2-3-6(6) Comparison of observed and synthetic IP data (Line 6)

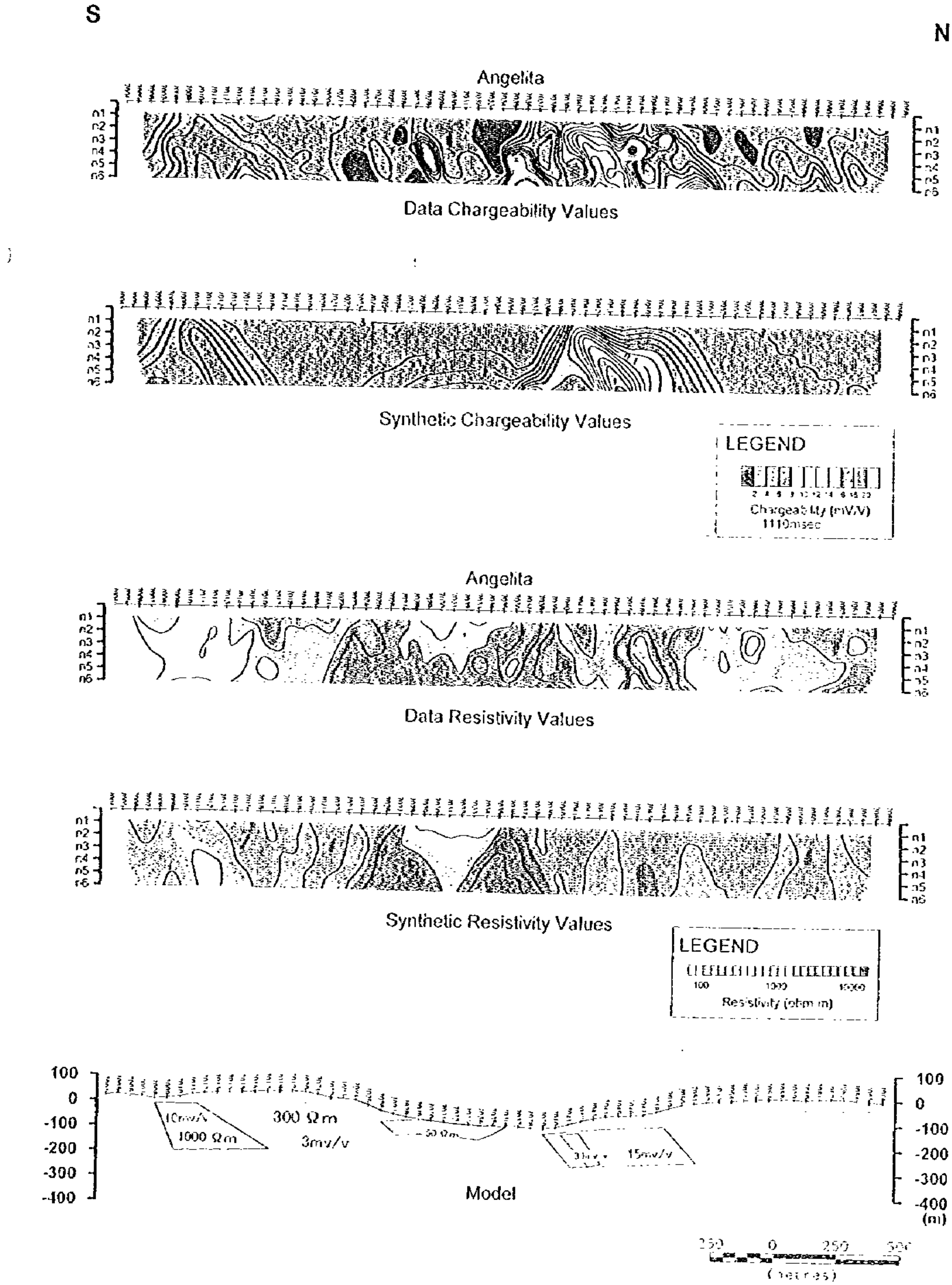


Fig.2-3-6(7) Comparison of observed and synthetic IP data (Line 7)

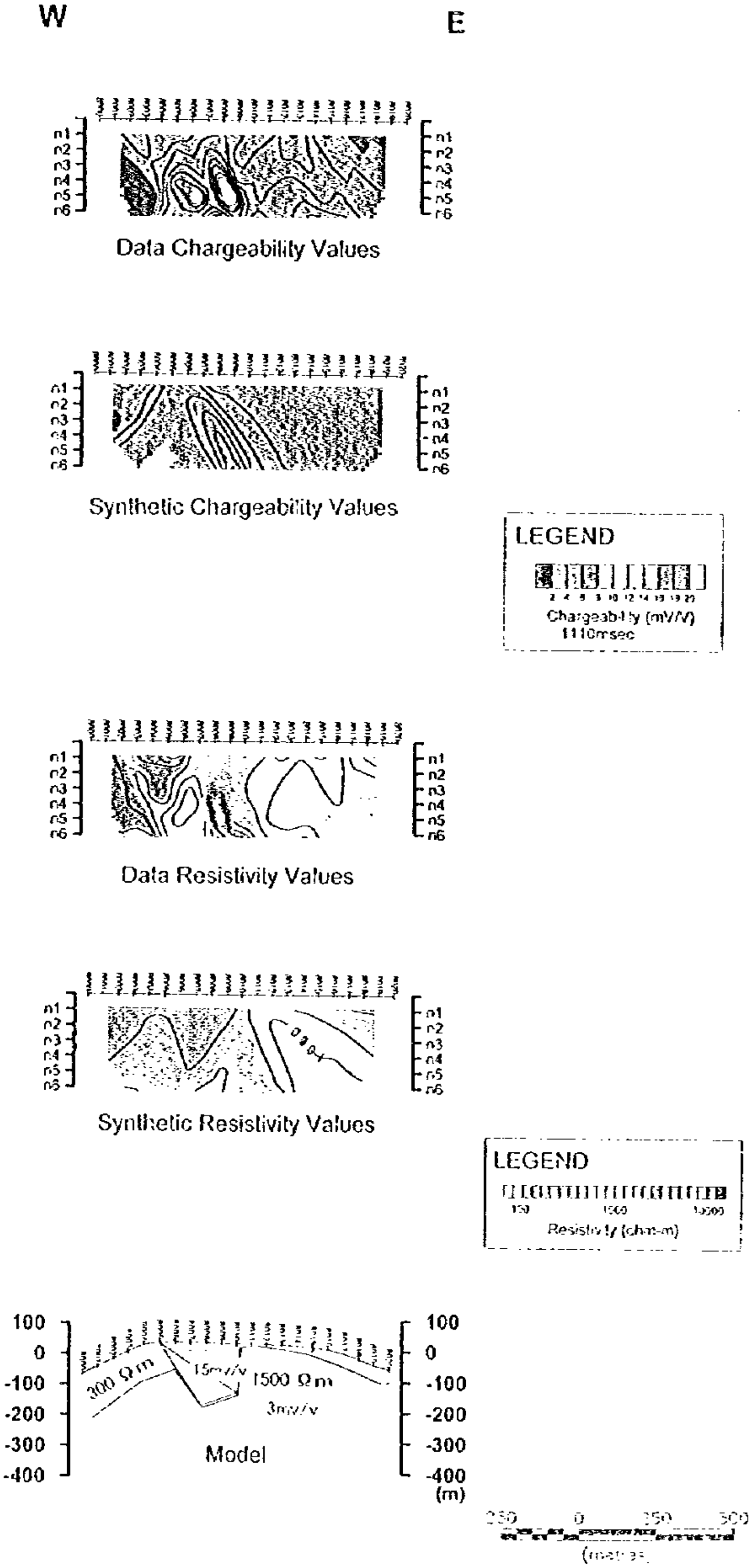


Fig.2-3-6(8) Comparison of observed and synthetic IP data (Line 8)

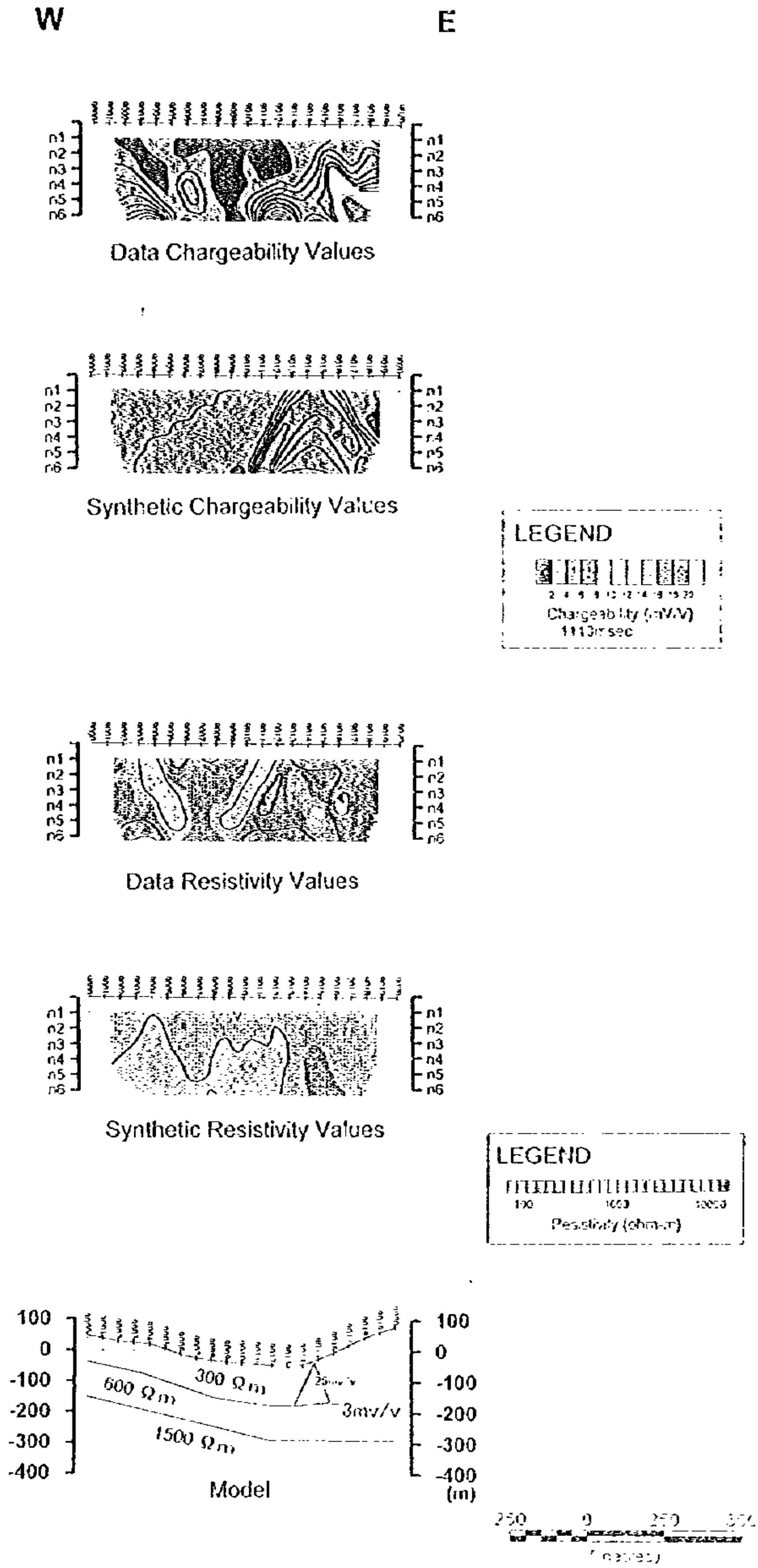


Fig.2-3-6(9) Comparison of observed and synthetic IP data (Line 9)

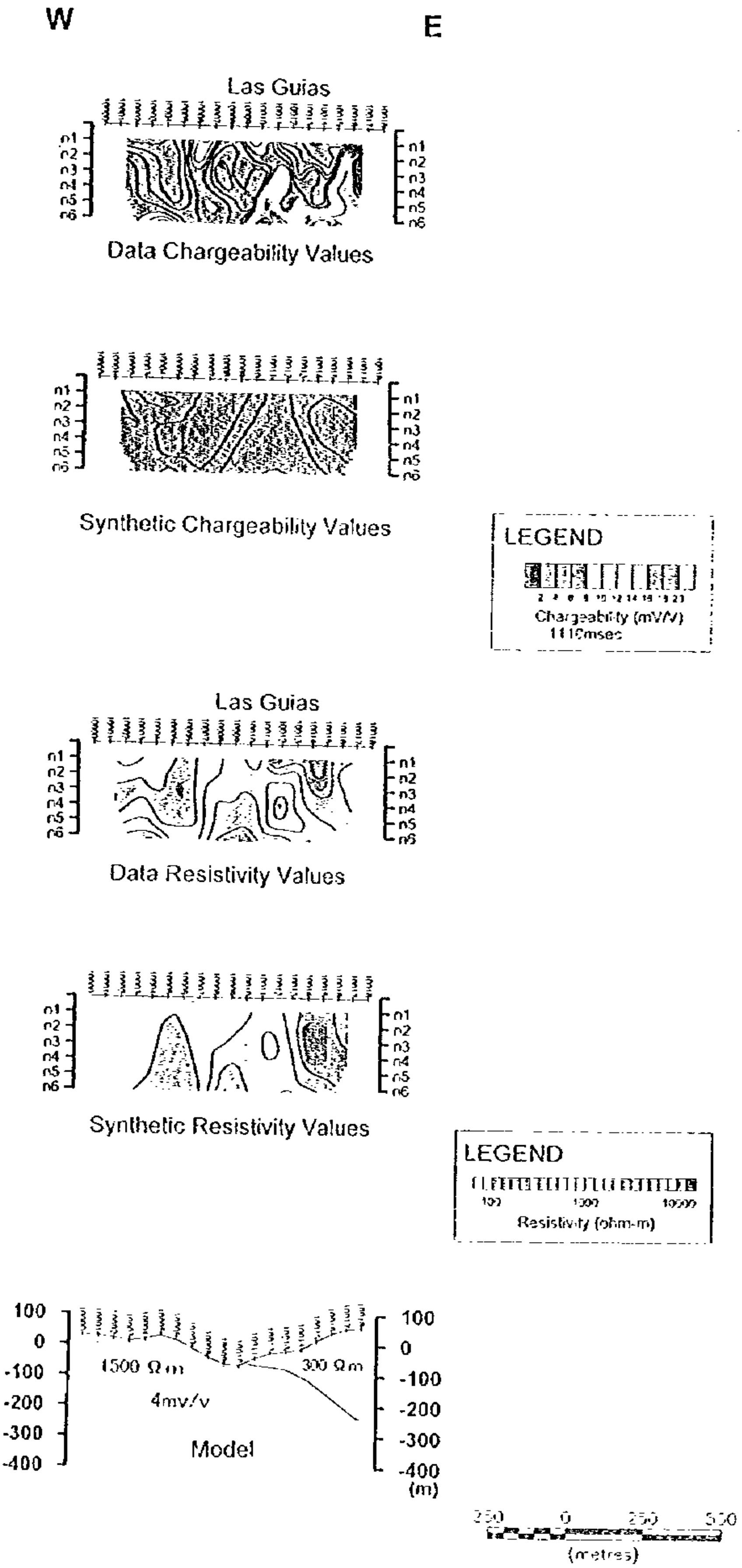


Fig.2-3-6(10) Comparison of observed and synthetic IP data (Line 10)

(3) TEM survey

Resistivity sections and maps derived from the TEM survey results are presented in Fig.2-3-7(1) through 2-3-8(2). The location of IP anomalies (red line) and the shallow IP resistivity structure (blue line) have been superimposed upon the TEM resistivity sections.

The resistivity structure consists of tree layers in most of sections. There is a conductive layer at the surface, underlain by a moderately resistive layer and a resistive basement.[1] There is good correlation between the IP resistivity results and the shallow TEM resistivity structure.

The resistivity sections will be described in the order in which they are presented in the plates, from top to bottom. Prominent features of the resistivity sections are as follows:

Line 1) The structure along Line 1 can be approximated by a tree layer model. There is a conductive layer at the surface, underlain by a layer of moderate resistivity and a conductive basement. The middle resistive layer is intermittent with conductive zones.

Line 2) In this section there is a conductive surface layer, resistive second layer and conductive basement in the north half of the survey line. In the southern half of the line, these units are overlain by a resistive layer and the conductive basement is not evident.

Line 7) Along Line 7 there is a conductive layer at the surface, underlain by a layer of moderate resistivity and a conductive basement. There are two conductive zones in the middle resistive layer.

Lines 3) and 4) Survey lines 3 and 4 are nearly continuous and shall be discussed together. Line 3 is generally composed of three layers. There is a resistive overburden, underlain by a conductive layer and a resistive basement. The conductive layer is interrupted by a zone of moderate resistivity near the south end of line 3. These layer follow topography to the north and the resistive overburden pinches out near the south end of line 4, with a local resistive surface layer near the middle of the line.

Line 6) In the eastern half of line 5 there are three layer. The surface layer is resistive and underlain by a conductive layer with a deep resistive basement. This section follows topography to the west and is discontinuous near the center of the line, where the conductive layer appears to be down dropped. Near the west end of the line, the resistive surface layer pinches out, the conductive layer is uplifted and the basement becomes more resistive.

Line 5) In the east half of line 5 there is intermittent resistive overburden underlain by a conductive layer and a resistive basement. The section is the same at the extreme west end of the line. From the intersection of line 1 to the intersection of 7, however, the section is quite different. Surface resistivities are low and the basement is generally shallow and resistive with anomalous conductive zones.

Line 8) At the east and west ends of this line there is a conductive surface layer, a resistive second layer and a conductive basement. The middle layer is thicker and more resistive in the west. The center of this section is conductive throughout.

Line 9) This section is composed of three layers. A conductive surface layer is underlain by a thick resistive layer and a conductive basement.

Line 10) This section is predominantly resistive with a conductive layer at intermediate depths in the west half of the section.

The depth of penetration of the IP method is limited and, while zones of anomalous chargeability derived from the IP data may appear shallow, they may extend to greater depth. Ore samples which were tested had high chargeabilities and low resistivities. Therefore, a conductive body which is located in a high chargeability zone and which extends to depth beneath a shallow IP anomaly may imply the possible presence of a highly chargeable body at the depth.

Five conductive bodies in zones of high chargeability which extend from the surface to the depth, are as follows:

i). Line 2 - from station 2022 to 2026 and 2032 to 2039, 300m depth

ii) Line 4 - from station 4006 to 4020, > 300 m depth

iii) Line 5 - from station 5029 to 5031, 300 m

iv) Line 6 - from station 6020 to 6022, > 300 m depth

v) Line 8 - from station 8005 to 8010, > 300 m depth

## 3-5 Summary of geophysical survey

The summary of geophysical survey is as follows:

Rock tests determined the mean resistivity and chargeability values, by rock type, to be; andesite - 4390 Ω m and low chargeabilty, Ocoita - 4100 Ω m and low chargeabilty, and Ocoita with bornite-chalcocite - 54 Ω m and

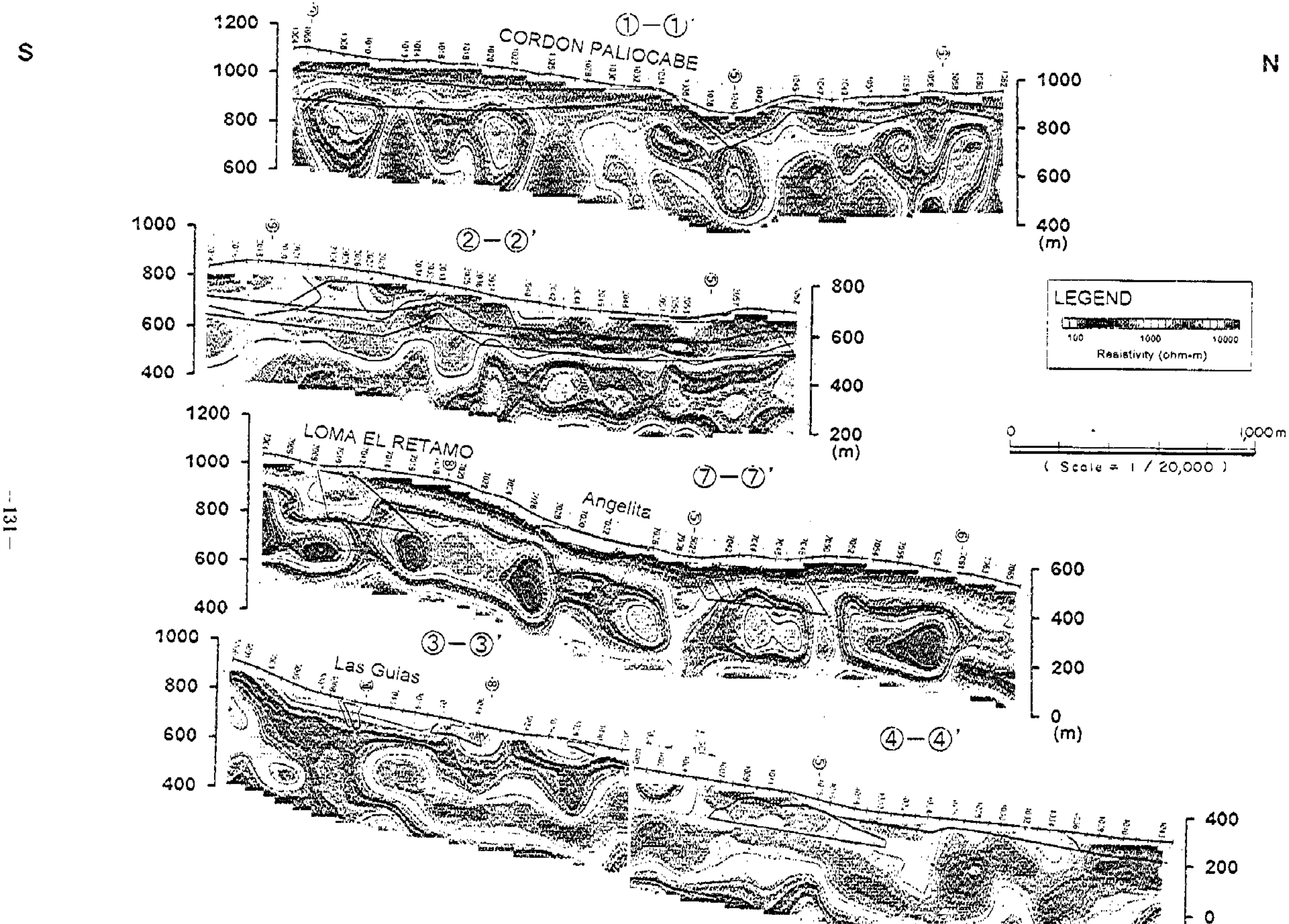


Fig.2-3-7(1) TEM resistivity cross section (N-S)

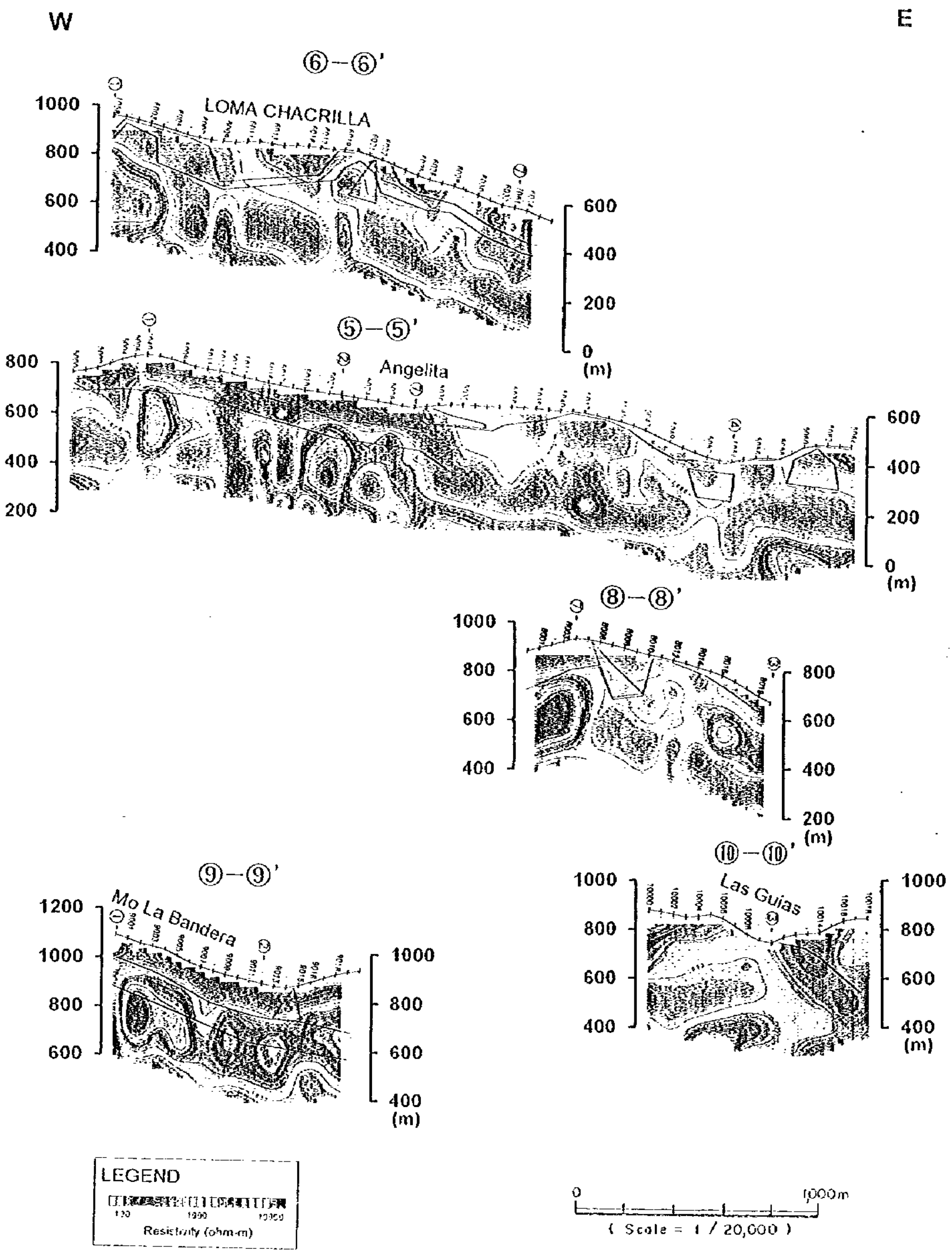


Fig.2-3-7(2) TEM resistivity cross section (E-W)

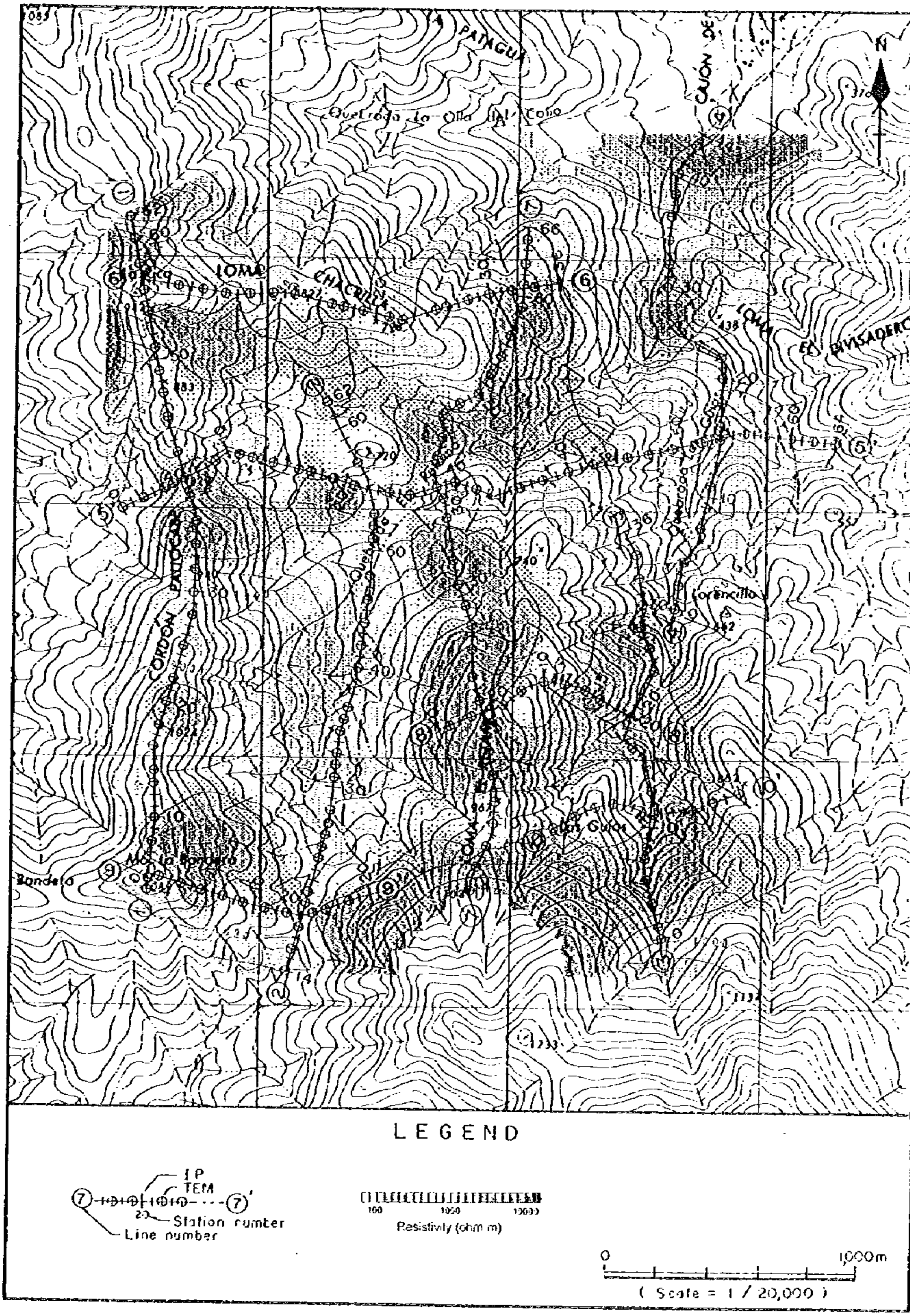


Fig.2-3-8(1) TEM resistivity distribution (-150m depth)

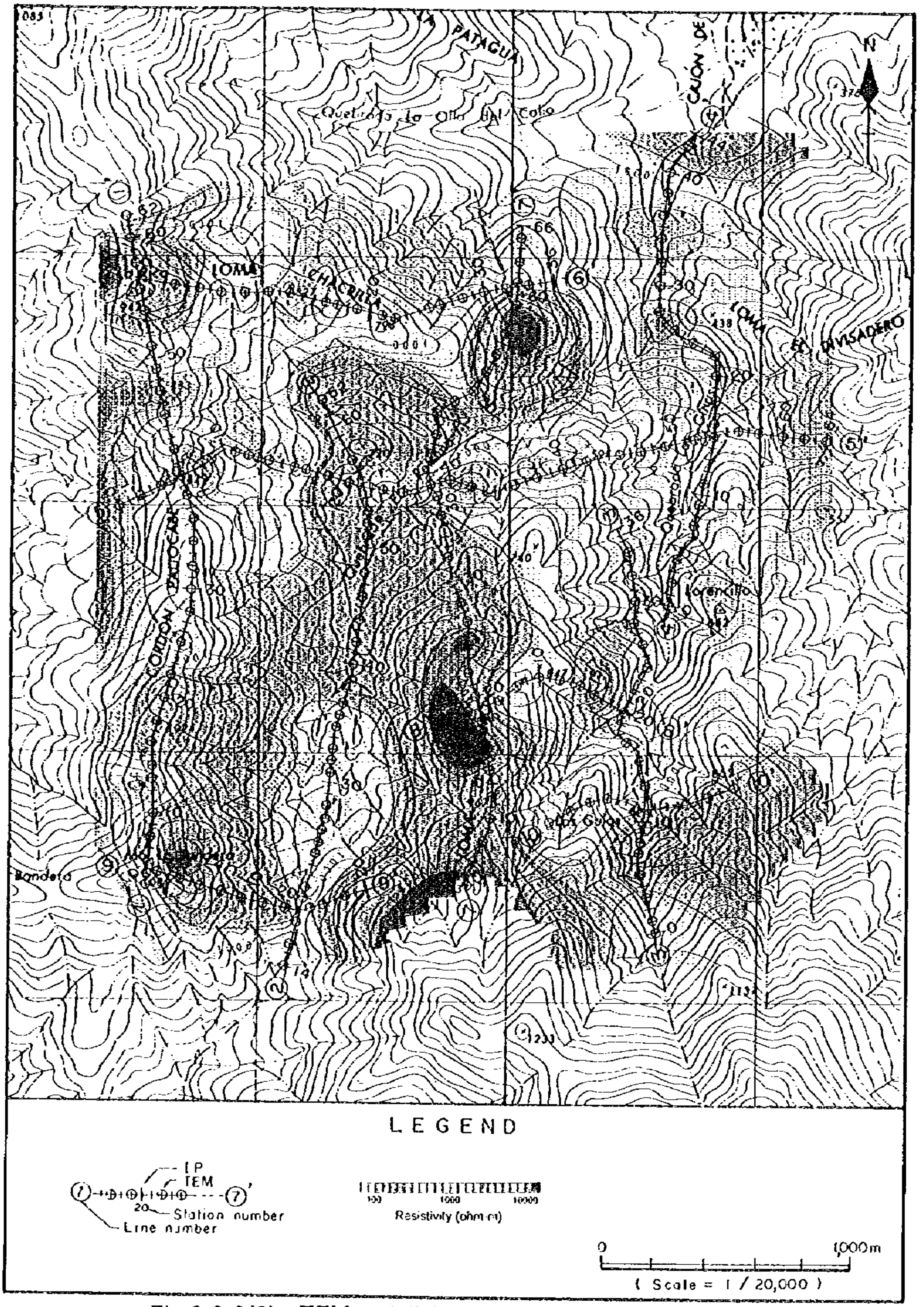


Fig.2-3-8(2) TEM resistivity distribution (-300m depth)

45mv/v chargeabilty. It is obvious that the geoelectrical properties of ocoita with bornite-chalcocite are significantly different from other rocks in the survey area. Therefore, it is possible to find shallow bornite-chalcocite type deposits within the Ocoita formation by locating zones of anomalous geoelectrical properties.

The results of the IP survey show the shallow resistivity structure to consist of tree layers in general. There is a conductive layer, 300 Ω m, at the surface, underlain by a moderately conductive layer, 600 Ω m, and a layer of moderate resistivity, 1500 Ω m. The depth of boundary between the second conductive layer and the resistivity layer is 100 m to 200 m beneath the surface. The average chargeability in the area is 2 to 4 mv/v. Areas of anomalously high chargeability (over 10 mv/v) and low resistivity (less 600 Ω m) have been detected by the forward modeling, however.

TEM measurements were also made at 195 of the stations along the IP survey lines. These soundings revealed a general resistivity structure consisting of tree layers. There is a conductive layer of less than 600 Ω m at the surface. This is underlain by a second layer of moderate resistivity, around 600 Ω m, and a third resistive layer. The shallow resistivity structures derived from the TEM data agree well with those derived from the IP data.

Geophysically anomalous zones are as follow:

i) Zone A is located south of Las Guias mine where the Ocoita formation is shallow. This zone has high chargeability (20mv/v) and low resistivity (100 Ω m), and extends from surface to a depth of 100 m. The anomaly is located in the Ocoita formation near surface and very near the Las Guias mine ore body.

   This implies the presence of a bornite-chalcocite type deposit similar to the deposit at the Las Guias mine.

ii) B zone is located in Loma El Retamo, about 500 meters west of the mine, near the edge of the Ocoita formation outcrop. This zone is anomalously chargeable (10 mv/v) and moderately resistive (1000 Ω m). It extends from surface to 150m depth. This zone is located at shallow depth, in the Ocoita formation, near an andesite dike.

   This anomaly may result from the presence of bornite-chalcocite mineralization or the andesite dike.

iii) C zone is located near the edge of the Ocoita formation in Loma El Retamo about 800 meters northwest of the mine. This is a zone of high chargeability (15 mv/v) and low resistivity (300 Ω m) from 200 m to 300 m beneath the surface, shallow in the Ocoita formation. There is a NW-SE fault near the body.

This anomaly may be caused by the presence of bornite-chalcocite mineralization or by water in the fault zone.

iv) D zone is located in the valley near Loma El Retamo, about 1100 meters northwest of the mine. The anomalous bodies in this zone have high chargeabilities (15 mv/v) and low resistivities (300 Ω m). They extend from 150 to 300m depth. In spite of the vast extent of these bodies, no alteration zone was detected in this area by the geological survey. There is a dike which strikes NW-SE south of this zone.

The anomalous nature of this zone implies the presence of a sulfide mineralization or a wet fracture zone possibly caused by the dike .

v) E zone is located near Angelita mine. The geological survey detected an alteration zone in this area. There is a zone of high chargeability (15mv/v) and low resistivity (300 Ω m) from 200 m to 300 m depth. There are many pits in this zone and a chalcopyrite-pyrite bearing quartz vein is visible in those pits. On the surface, there is a malachite alteration zone. Faults, striking N-S and NW-SE surround this zone.

The anomalies detected here may be caused by the presence of chalcopyrite-pyrite quartz vein type mineralization which is continuous to depth, or a water bearing fracture zone caused by faulting.

vi) F zone is located about 2000 meters northwest of Loma Chacrilla. In this zone chargeabilty (30mv/v) is high and resistivity (1500 Ω m) is moderate from 200m to 300 m depth. The geology and alteration of this zone is the same as E zone.

This implies the presence of a sulfide minerals, or a wet fracture zone related to faulting.

vii) G zone is about 1700 meters north of Las Guias mine. In this zone there are high chargeabilities (15mv/v) and low resistivities (300 Ω m), from 200m to 300m depth. There is an Ocoita dike and a fault near this zone.

These anomalies may, therefore, imply the presence of bornite-chalcocite mineralization, or they may be related to fractures caused by the intrusion of the dike or faulting.

While zones of anomalous chargeability are seen in this survey area, the chargeability of these zones is lower than the average value for samples of Ocoita with bornite-chalcocite mineralization. This implies that, if ore exists in the anomalous areas, its grade is lower than that at the Las Guias mine.

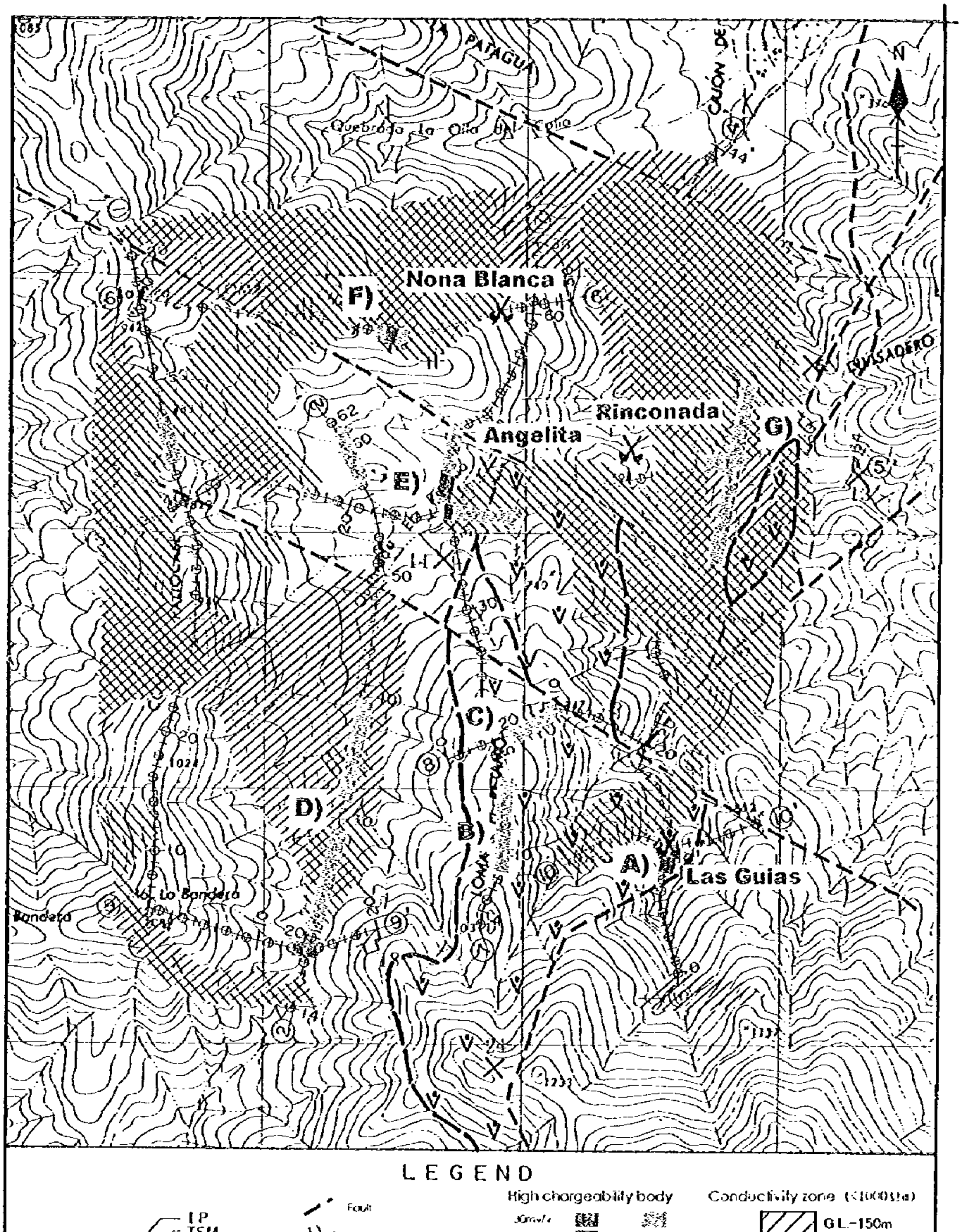


Fig.2-3-9 Geophysical Interpretation Map

# PART 3 CONCLUSIONS AND RECOMMENDATIONS FOR THE DECOND YEARS SURVEY

## Chapter 1 Conclusions

### 1-1 Conclusions

### 1-1-1 Geological survey

The area is underlain by the Jurassic Horqueta Formation and Cretaceous Lo Prado Formation, from the bottom. The Horqueta Formation is divided into two members. The Lower Horqueta Member is mainly composed of marine andesite lava and andesitic pyroclastic rocks, and the Upper Horqueta Member is mainly composed of continental andesite lava, partly Ocoita, and andesitic pyroclastic rocks intercalated by thin beds of sandstone and shale. The Lo Prado Formation is composed of marine dacite to andesite lava and andesitic pyroclastic rocks accompanied with sandstone, shale, and limestone. ranodiorite, quartz diorite, andesite, and dacite intruded into the above mentioned formations. The formations trend roughly north to south, and gently dip to the east, about 30 degrees, showing a monoclinic structure. NW-SE stretching faults are dominant in the area.

The age determination test result has revealed that the intrusion age of the Tantehue Quartz Diorite is Jurassic to Cretaceous, that of the Alhue Granodiorite is middle Cretaceous, and that of the andesite dikes is late Cretaceous to Paleogene, at least two stages. The Ocoita, which is presumably associated with the copper mineralization, shows the age of middle Cretaceous, and is probably of intrusive judging from its occurrence and geochemical character.

More than 30 mineral occurrences have been confirmed in the survey area, and all of them are of copper mineralization. Around 65% of the occurrences are in the andesitic rocks in the Upper Horqueta Member, and the rest are in the various rocks in the Lo Prado Formation. But no mineral occurrence has been recognized in the The Lower Horqueta Member. Only the Las Guias and Mona Blanca Mines have been operated in the past. According to the trench prospecting, the scale of the mineral occurrences is several thousand tones in many cases except the Las Guias Deposit. The three ore shoots in the Las Guias Deposit align NW-SE, and dip about 70 degrees to the north. The ore shoots are 30 x 20 x 6 meters in size, estimating from the size of the mined-out caves. The mineral occurrences seem not controlled by faults.

The mineral occurrences in the Horqueta Formation are of net-work or disseminated ore mainly composed of malachite, and those in the Lo Prado Formation are of chalcopyrite-pyrite quartz vein and disseminated ore. However, only the ore shoots in the Lass Guias Deposit are of bornite-chalcocite net-work or disseminated ore, and accompanied by secondary malachite net-work or disseminated ore. The all mineral occurrences except the chalcopyrite-pyrite quartz veins abruptly disappear in the depth, and do not transform to barren quartz veins or alteration zones.

Any alteration except regional diagenesis has not occurred in the mineral occurrence zones in the Horqueta Formation. But the mineral occurrence zones in the Lo Prado Formation has undergone weak silicification, sericitization, and kaolinization.

The homogenized temperature of the liquid inclusions in the chalcopyrite-pyrite quartz veins, the quartz veins cutting the bornite-chalcocite mineral occurrences, and the barren quartz and calcite veins have been measured. The result shows that 200 to 265 degrees for the first, 170 degrees for the second, and 130 degrees for the third. It indicates that several kinds of hydrothermal solution having different temperature were active in the area. The salt density for these is classified into following populations with no relation to the homogenized temperature; less than 0.3%, 0.3% to less than 5.0%, 5.0% to less than 10.0%, and more than 10.0%. The difference of the density between the lowest and highest populations is more than 7%. Even the salt density obtained from one specimen is clearly separated into these four populations. It is supposed that several kinds of hydrothermal solution having different salt density were active in the area.

Based on the above mentioned results, it is inferred that the mineral occurrences in the area were formed by several different kinds of ore solution having different temperature, salt density, and activity stage. No data indicating the homogenized temperature and salt density in the bornite-chalcocite ores is obtained in the survey.

The constituent minerals of the occurrences are bornite, chalcocite, digenite, chalcopyrite, pyrite, hematite, malachite, chrysocolla, azurite, and atacamite. These minerals replaced the host rocks, and a little alteration minerals are locally seen around there. The close paragenesis of bornite-chalcocite-digenite, colloform texture, and exsolution texture of djurleite from chalcocite indicate the mineralization under low temperature.

The stable isotopic study for δ O and δ S has been performed to infer the mineralization mechanism through the study of the origin and behavior of the ore solution. The result has revealed that the δ O shows high values of 13.4% to 16.3% to SMOW, and it suggests that the primary solution reacted with sedimentary or metamorphosed rocks during its transference process. The δ S shows 18.8% to 19.4% to CDT, and it suggests that the sulfuric acid originated from the sea water was enclosed in the deep ground, reduced by some heat source, transferred, transformed to hydrogen sulfide during the process, and finally the stable isotope ratio was homogenized. During a series of the process, it is presumed that copper ions were solved in the solution, and bornite and chalcocite minerals were deposited under the low temperature condition, controlled by the suitable geological structure.

Based on the characteristics of the mineralization and geochemistry, and field occurrence of the minerals, following ore genesis and ore-forming process are idealized.

① Intrusion of the Ocoita -- Middle Cretaceous

The rock has undergone all mineralization.

② Primary replacement mineralization of bornite and chalcocite forming ore shoots of the Las Guias Deposit -- since Paleogene

The ore shoots exist in the Ocoita, being discordant to the surrounding sedimentary rock formations, and extend to the andesite dikes in the area. The geochemical copper content in the Ocoita is abnormally high compared with all other rocks in the area. From the microscopic observation results, it is judged that the copper minerals are of primary mineralization, replaced host rocks. It is presumed that the minerals were deposited under the low temperature condition, based on the mineral assemblage and traces of weak alteration around the ore minerals. Also, the phenomena suggest that the mineralization could be closely related with the physical character of the Ocoita, porous and heterogeneous. This type of mineralization forms relatively large-scale high grade ore deposits.

③ Primary mineralization of chalcopyrite-pyrite quartz vein -- since Paleogene

The veins exist in the underground of the Las Guias and Angelita Mines, and in the Lo Prado Formation. Judging from its occurrences, the mineralization is of presumably after the above mentioned bornite-chalcocite mineralization stage. These two mineralization are probably brought under the different physical and chemical conditions, judging from the different mineral assemblages. The geochemical survey result has revealed that the Au-Sb-Pb content in the Lo Prado Formation tends to higher than that in the Horqueta Formation, and it supports the above mentioned presumption. This type of mineralization is significantly small-scale, and no economical ore has been found yet.

④ Secondary copper mineralization mainly of malachite

This mineralization is overlapped previously mentioned all other mineral occurrences, being in the last stage. The occurrences of this type mineralization are controlled by cracks and druses in the bornite-chalcocite ore shoots and host rocks in the Las Guias Mine, and by spaces of cracks and banded structures in the chalcopyrite-pyrite quartz veins. These occurrences clearly show later stage one than other stages such as vein forming. It is quite possible that the mineralization was brought from existing primary ores through oxidation and transfer process. This type of the mineral occurrences are small-scale, and no economical one has been found yet.

### 1-1-2 Geochemical Survey

Four hundred and ten rock samples and 152 soil samples have been analyzed to estimate potential for buried copper ores. Analyzed 15 elements for both categories are as follows; Au, Ag, As, Sb, Hg, Cd, Co, Cu, Fe, Pb, Mn, Mo, Ni, V, and Zn.

Some investigations to know relations between geochemical concentration of each element and mineralized zones, between copper anomalies and content of other elements, correlation of copper content in each formation and andesitic rocks, and principal component analysis have been performed to achieve the above mentioned object. The results of the investigation have revealed following points.

* Cu anomaly zones in the rocks are well coincident to the distribution of the mineral occurrences, and well reflect ore minerals. No relation between other elements than copper and mineral occurrences has been recognized.
* High content zones for Au, Ag, and Sb are coincident to a part of Cu anomalies, however, generally no clear correlation is recognized between Cu anomalies and high content zones of other elements.
* Cu anomalies in the soil are smaller-scale than those in the rocks, and sit in the anomalies in the rocks. Accordingly, anomalies in the rocks can represent anomalies in the soil.
* Cu is concentrated in the andesitic rocks in the Horqueta Formation, especially in the Ocoita, appearing the Ocoita itself shows big Cu anomalies in some places. It might be caused by its high porosity compared with other rocks, allowing seepage of mineral solution.
* High marked zones for the principal component analysis are well coincident to mineral occurrences, reflecting locations of mineralized zones.

Based on the above mentioned results, the relation between extracted anomaly zones or high marked zones and mineralized zones has been investigated. The result is summarized as follows.

① Cu anomaly

Cu anomaly zones, A-1 to A-19, cover about 80% of the all mineral occurrences in the area. It can be said that the copper anomaly map itself is a good petrochemical prospecting map for copper in the area. Among these anomalies, some anomalies appeared in barren areas will be described in the following.

* Anomalies A-2 and A-3 are situated adjacent to Anomaly A-1, and can be a part of

A-1.

* Anomalies A-5 and A-6 might represent one anomaly. The anomalies are of large-scale, and situated in the Lower Horqueta Member. Because the relation between the geology and mineralization in the area is not clear, these anomalies will be investigated together with other studies.

* Anomaly A-13 can be a part of Anomaly A-14 situated on the southwest of the anomaly.

* Anomalies A-12, A-16, and A-18 are not reliable because of a few numbers of samples.

② High marked zones for rock geochemistry

Twenty-six high marked zones have been detected in the rock geochemistry. Among them, R-1, R-4, R-5, R-9, R-12, R-14, and R-16 show relatively large-scale distribution, and cover about 80% of the total mineral occurrences. It well reflects those mineral occurrences, and it can be said that the rock geochemical anomaly map is a good prospecting map for copper in the area. Accordingly, the anomalies appeared in barren areas will be described in the following.

* High marked zone R-2 is duplicated on an Au anomaly zone in the rock. In spite of no detail geologic setting data is available, it can be a good target for prospecting.

* High marked zone R-3 can be a part of R-4 situated on the southwest of the anomaly.

* High marked zone R-5 is of large-scale and situated in the Lower Horqueta Member. No relation between the anomaly and the geological setting, therefore, it will be investigated together with other studies.

* High marked zones R-21 and R-22 are not reliable because of a few numbers of samples.

③ High marked zones for soil geochemistry

Five high marked zones have been detected in the soil geochemistry. Among them, S-2 covers about 75% of the total mineral occurrences, and well reflects those mineral occurrences. It can be said that the soil geochemistry map is a good prospecting map for copper in the area. Accordingly, the anomalies appeared in barren area will be described in the following.

* High marked zone S-1 is of large-scale and situated in the Lower Horqueta. No detail geological setting is known, therefore, it will be investigated together with other studies.

* High marked zones S-4 and S-5 are not reliable because of a few numbers of samples.

④ Integrated interpretation

Some duplicative anomaly zones extracted from the above mentioned various categories have been extracted to select favorable prospecting targets. The appraisal for those targets is as follows.

* Anomaly zones G-1, G-2, G-3 can be unified to one. The anomaly zone is coincident to a high Au zone, and worth further prospecting. It is possible that the presumed mineral occurrence by the anomaly is associated with a dacite dome.
* Anomaly zone G-4 reflects the mineral occurrences in the Las Guias Mine, but the location of the anomaly is out of the mineral right area.
* Anomaly zone G-5 reflects a small-scale gold occurrence, but it is worth further prospecting.
* Anomaly zones G-6 and G-7 are not reliable because of a few numbers of samples.

In conclusion, the whole area, which contains many surface mineral occurrences and the Ocoita showing high content of Cu, forms itself an anomaly zone, and is a natural contamination zone. It could be, therefore, very difficult to utilize such geochemical survey methods for prospecting of buried mineral deposits. But , if there are some mineral occurrences like as same type and scale mineralization above mentioned, they should be recognized by the geochemical survey exploration method.

### 1-1-3 Geophysical survey

The Induced Polarization method (IP method) and Transient Electro-Magnetic method (TEM method) have been utilized in the survey. The measured survey lines and points are 20 kilometers and 1,800 points for IP method, and 20 kilometers and 190 points for TEM method. The results for both surveys are summarize as follows.

* The laboratory test result has revealed that the average resistivity and polarizability for principal constituent rocks in the area are 4,390 ohm-meter and 0 mV/V for andesitic rocks and secondary copper bearing andesitic rocks, 4,100 ohm-meter and 0 mV/V for Ocoita, 54 ohm-meter and 45 mV/V for Ocoita accompanied by bornite-chalcocite net-work or dissemination. There are clear differences between barren rocks and bornite-chalcocite bearing rocks for both, resistivity and polarizability.

It is judged that if suitable scale of bornite-chalcocite ore is in the andesitic rock in the shallow subsurface, it is possible to detect such ore by the geophysical methods.

* The result of the IP survey has revealed that the shallow subsurface resistivity structure is of three layers. The resistivity for the first and second layers is low, 300 to 600 ohm-meter, and that for the third layer is medium, 1,500 ohm-meter. The depth of

the boundary between the second and third layers is about 100 meters. The background of the polarizability shows 2 to 4 mV/V, and anomalies showing 10 to 20 mV/V have been detected in many spots. Some of them are accompanied with low resistivity anomalies.

* The result of the TEM survey has revealed that the resistivity structure in the deep ground is of two layers, the upper low resistivity layer showing lower than 1,000 ohm-meter and the lower medium resistivity layer showing higher than 1,000 ohm-meter. The depth of the boundary between two layers is about 100 meters, and it is coincident to the boundary shown by the IP survey result. Some low resistivity zones have been detected in several places extending further deep ground.

From the investigation of the resistivity structure and polarizability, seven anomalies, A to G, have been extracted. The outline of the anomalies and the interpretation for them are as follows.

① Anomaly zone A situated in the south of the Las Guias Mine area:

A low resistivity zone showing 100 ohm-meters with high polarizability of 20 mV/V extends to the depth of about 100 meters. But the low resistivity zone disappears at the depth of 300 meters. The anomaly is situated in the shallow part of the Ocoita, which is the host rock of the Las Guias Deposit. It is, therefore, possible that the anomaly indicates the same type of ore as the bornite-chalcocite ore in the Las Guias.

② Anomaly zone B situated at El Remota, about 500 meters to the west of the Las Guias Mine:

A medium resistivity showing 1,000 ohm-meter with high polarizability of 10 mV/V extends to the depth of 150 meters. The low resistivity zone disappears at the depth of 300 meters. The anomaly zone is situated in the shallow part of the Ocoita, which is the host rock of the Las Guias Deposit. It is possible that the anomaly indicates the same type of mineral occurrence as the bornite-chalcocite ore in the Las Guias.

③ Anomaly zone C situated at El Remota, about 800 meters to the west of the Las Guias Mine:

A low resistivity zone showing 300 ohm-meter with high polarizability of 15 mV/V extends to the depth of 200 meters. The low resistivity zone possibly extends to the depth of 300 meters. It is possible that the anomaly zone indicates the same type of mineral occurrence as the bornite-chalcocite ore in the Las Guias or an aquifer associated with a fault stretching NW to SE.

④ Anomaly zone D along a stream on the west side of El Remota Hill, about 1,100 meters west of the Las Guias Mine:

A low resistivity zone showing 300 ohm-meter with high polarizability of 15 mV/V extends to the depth of 150 meters. It is possible that the low resistivity zone extends to the depth of 300 meters. The anomaly zone has been detected only in the survey line "2", however, it is a large-scale anomaly zone. No mineral occurrence or alteration zone is seen in the vicinity area corresponding to such large-scale of anomaly. The anomaly zone is situated along a gentle stream, and a dike exists on the west of the anomaly. It is possible that the anomaly is caused by the topographic feature and sheared zones controlled by the dike nearby the anomaly.

⑤ Anomaly zone E in the Angelita Mine:

A low resistivity zone showing 300 ohm-meter with high polarizability of 15 mV/V, partly 30 mV/V, extends to the depth of 200 meters. It is possible that a part of the anomaly extends to the depth of 300 meters. Many prospecting pits exist around there, but they are of small-scale. Mineral occurrences around there are mainly composed of secondary copper minerals such as malachite, and any primary mineral such as bornite is not seen there. Faults stretching north to west and NW to SE around the anomaly. Chalcopyrite-pyrite quartz veinlets are seen in the underground of the mine. Judging from the above mentioned facts, there are two possibilities that the anomaly reflects expanded chalcopyrite-pyrite quartz veins in the depth or an aquifer associated with sheared zones controlled by faults.

⑥ Anomaly zone F situated about 2,000 meters northwest of Chaquilla:

A medium resistivity zone showing 1,500 ohm-meter with high polarizability of 30 mV/V extends to the depth of 150 meters. It is possible that the low resistivity zone extends to the depth of 300 meters. The geological setting and character of the mineralization are same those of Anomaly zone F, but no chalcopyrite-pyrite quartz vein is seen there. It is possible that the anomaly reflects some sulfide ores judging from its higher polarizability than that of Anomaly F. Besides there is still some possibility that the anomaly reflects an aquifer associated with a fault or sheared zone.

⑦ Anomaly zone G situated about 1,700 meters north of the Las Guias Mine:

A low resistivity zone showing 300 ohm-meter with high polarizability of 15 mV/V extends to the depth of 200 meters. It is possible that a part of the anomaly zone extends further depth of 300 meters. The anomaly zone is situated along a valley, and there are a Ocoita dike and fault stretching north to south. It is possible that the anomaly zone reflects a bornite-chalcocite mineral occurrence or an aquifer controlled by a faults or sheared zone.

The above mentioned anomaly zones indicate a potential for buried sulfide ores, however, its scale might be small judging from its low polarizability values, lower than about 60% of the value for the ore (45 mV/V). It is also possible that the anomalies reflect some aquifer controlled by the space in the rocks etc.

### 1-2 Potential for Ore Deposit

Based on the results of the geological, geochemical, and geophysical surveys, the potential for ore deposits in the area is summarized as follows.

(1) Many mineral occurrences in the Horqueta Formation, mainly consisting of malachite are of small-scale. All of those are of small-scale, specially to the downward. If those occurrences are accompanied with ore shoots of bornite and chalcocite, those would be of nearly same-scale as that of the Las Guias Deposit.

(2) As the results of the integral interpretation for the mineralization in the area, it is judged that some potential for ore shoots of bornite-chalcocite exists in brecciated parts of the Ocoita.

(3) The hydrothermal veins in the Lo Prado Formation are of smaller-scale than those in the Horqueta Formation, and its associated alteration is also weak. Judging from these facts, the potential for large-scale ores is low.

(4) The geochemical anomalies found in the area cover the all mineral occurrences found by the geological survey, and it is estimated that the geochemical survey result well reflects the location of the mineral occurrences. An anomaly situated in the Lower Horqueta Member is not associated with a mineral occurrence, however it might reflect, in spite of a few samples, the same grade of geochemical character as that of the Upper Horqueta Member, judging from the geological survey result. It is judged that the ore potential in the geochemical anomaly zones in the Lower Horqueta Member is low.

(5) Some potential for sulfide ores, in some grade, is in the seven anomalies detected by the geophysical survey.

## Chapter 2 Recommendations for Second Year's Program

Based on the all survey results in this year, followings are recommended for the next year.

(1) The principal characteristics of the geology ,geochemistry, mineralization etc. have been almost interpreted. Therefore, the future exploration program should be planned after interpretation of the drilling survey result as follows.

(2) If more geophysical survey is planned in this year, it should be limited in the Ocoita distribution area by the means of the geological and geochemical survey results.

(3) Geophysical anomaly zone E is situated around Angelita Mine accompanying many green copper mineral occurrences and some chalcopyrite-pyrite quartz veinlet, also it has possibility with bornite-chalcopyrite ore deposits. Therefore anomaly E should be confirmed by drilling. The same type another mineral occurrences in the survey area should be re-estimated based on the result of drilling.

(4) A drilling program for the geophysical anomaly D is also recommended to confirm the cause.

# Reference


1 Metanogenica de yacimientos de Cu tipo manto , Universidad de Concepcion , Departamento de ciencia de la tierra, No 7, Concgeso Geologico Chileno , Vo 12, p 1, 559-1, 564. 1994.

2 Yacimientos de Cu tipo manto como mineralizaciones economicas en sistemas geotermales Mesozoicos andinos, relacion al metamorfismo, volcanismo y ambiente geotectonico. Universidad de Concepcion , Departamento de ciencias de la tierra , No 7, Congreso Geologico Chileno , Vol 11, p 1, 565-1570. 1994.

3 Proyecto Cholqui region Metropolitana-Chile, ENAMI, Santiago de Chile, 1995.

4 Geochemical trends in Mesozoic-Tertiary volcanic rocks from the Andes in ventral Chile, and tectonic implications, B. Levi et al , Journal of South American Earth Sciences, Vol. 1, NO. 1, pp. 63-74, 1988.

5 Low-grade regional metamorphism in the Mesozoic-Cenozoic volcanic sequences of the Central Andes. B. Levi et al, J. METAMORPHIC Geol. , No 7, pp 487-495, 1989.

6 Jurassic and Early Cretaceous island arc volcanism, extension, and subsidence in the Coast Range of central Chile, Mario Vergara et al, GSA Bulletin, Vol. 107 NO. 12, pp 1, 427-1, 440, 1995.

7 Revista Geologica de Chile, Vol. 21, No 2, SERNAGEOMIN, 1994.

8 Diagnostico gelogicomineromiinas Angelita, Rinconada, Bello Horizonte, Area Caliocabe , Region Metropolitina. . Melipilla, M. Arava, ENAMI Gerencia Quinta region, 1992.

9 Estudio gelogico y minero regional de Melipilla. Oficina Santiago y Sur, Inf, No. 12, ENAMI.

10 Informe del mineral de Huilmay del Departamento de Melipilla Comuna de Alhue. Sera La Plama de ENAMI.

11 Rock Geochemistry in mineral Exploration, Handbook of Exploration Geochemistry. G. J. S. Govett, Elsevier Scientific Publishing Company, 1983.

12 Geonics limited, 1993, PROTTEM 57D ( C ) Operating Manual.

13 Interpex limited, 1994, RESIXIP2D User's Manual.

14 Interpex limited, 1996, TEMIX XL User's Manual.