Chapter 6 Siliana Prospect

6.1 General Geology

The summary geological plan of Siliana prospect are shown in Figure 79 respectively. The stratigraphy comprises, in its ascending order, the Triassic system, the Barremian, Aptien and Albien formations of the Cretaceous system, the Eocene and Oligocene formations of the Palaeogene sub-system, the Miocene and Pliocene formations of the Neogene subsystem and the Quaternary system. The Triassic system directly contacts with the Cretaceous system with a sudden change in rock facies, lacking the Jurassic system between the two in the surface outcrops. The lower and middle Miocene formations are also lacking in the Neogene subsystem.

The Triassic system, distributing in the northeastern to central part of the prospect, consists of varicolored gypsum, limestone, pitch-black dolomite, and alternations of white sandstone and green argillite. Smoky quartz occasionally occurs in association.

The Barremian of the Cretaceous system, as a whole, forms an argillaceous limestone body in the northeastern corner that comprises gray to greenish marl and yellowish limestone. The Aptien, distributing in the central part, includes thin sandstone beds, sandstone-argillite alternations, green to olive marl and grayish argillaceous limestone. The thin sandstone beds and the sandstone-argillite alternations exhibit primary sedimentary structures indicating water-flow directions at the time of sedimentation. The argillaceous limestone often contains fossils of echinoderms. The Albien, distributing in the eastern part, principally comprises bluish gray marl showing spicular-fragmental appearances on outcrops and is occasionally interbedded with thin layers of limestone or argillaceous limestone.

The Eocene and Oligocene of the Palaeogene subsystem, distributing in the southern part and sporadically in the northwestern part, consist of alternations of thin marl layers and glauconitic limestone beds. The limestone beds form geomorphologically outstanding cliffs and contain silicified fossils of oysters, shark teeth and nummulites.

The Miocene and the Pliocene of the Neogene Tertiary extensively distribute in the western part of the prospect and consist of red sandstones, black marl, yellow to red siltstones and red conglomerates.

The Quaternary system includes pink-colored siltstones, brown conglomerates and chalky limestone containing bituminous materials.

The geologic structure of the prospect is characterized by diapirs and faults trending in the NNE-SSW direction and in the WNW-ESE direction. The diapirs, consisting of the Triassic formations, are mushroom-shaped with their umbrellas uniformly extending westwards from the stems and dipping reversely against the general trends of strata. The faults trending in the NNE-SSW direction divides the prospect into the northwestern and the southeastern parts. The northeastern part consists mainly of the Triassic diapirs and the Miocene-Pliocene formations of Neogene Tertiary. The southeastern part is further subdivided into two parts by the faults trending in the NNE-SSW direction; the one comprises the Cretaceous system and the other, the Tertiary and the Quaternary systems.

6.2 Geophysical Prospecting

In the Siliana prospect, geophysical surveys using a gravity and IP methods are carried out along 8 measuring lines with a total line length of 18 km covering an area of 8 km^2 .

6.2.1 Methodology

(1) Layout of Measuring Lines

The base line A0 of 4 km long is laid out along the contact zone between the Triassic systems and the Cretaceous systems. The 7 measuring lines of 2 km long, the line numbers from A1 through A7, are set perpendicular to the base line.

(2) Gravity Survey

The gravity measurement is conducted on the base line and all measuring lines in the prospect. The same methodrogy of the measurements and analyses in the Bou K'hil prospect, which is described on the 3.2.1, is applied to this prospect.

(3) IP Survey

The IP survey is carried out on the 8 lines, the base line and all the measuring by using the same measurement equipments of the Bazina Kebira prospect. The same methodrogy of the measurements and analyses in the Bou K'hil prospect, which is described on the 3.2.1, is applied to this prospect.

6.2.2 Gravity Survey

(1) Regional Gravity Distribution (Figures 17)

The Siliana prospect is located at the southwestern side of an extensive rectangular area of the regional gravity high exceeding 10 mgal which is distributed to southeastward from the vicinity of the Lambert coordination (455,500,355,500) and is also situated on a saddle of the steep gravity gradient zone. The gravity decreases steeply towards an extensive gravity low in the El Aroussa plain spreading in the southern parts. A belt of the steep gravity gradient runs in the NW-SE direction, which suggests an existence of the regional geological structure.

(2) Gravity Distribution of the Prospect (Figure 60)

The belt of the steep gravity gradient extends uniformly towards the NW-SE direction on the regional gravity distribution. However the gravity contour intervals become narrower in the southern side of a line connecting the Mahjobia and Siliana workings

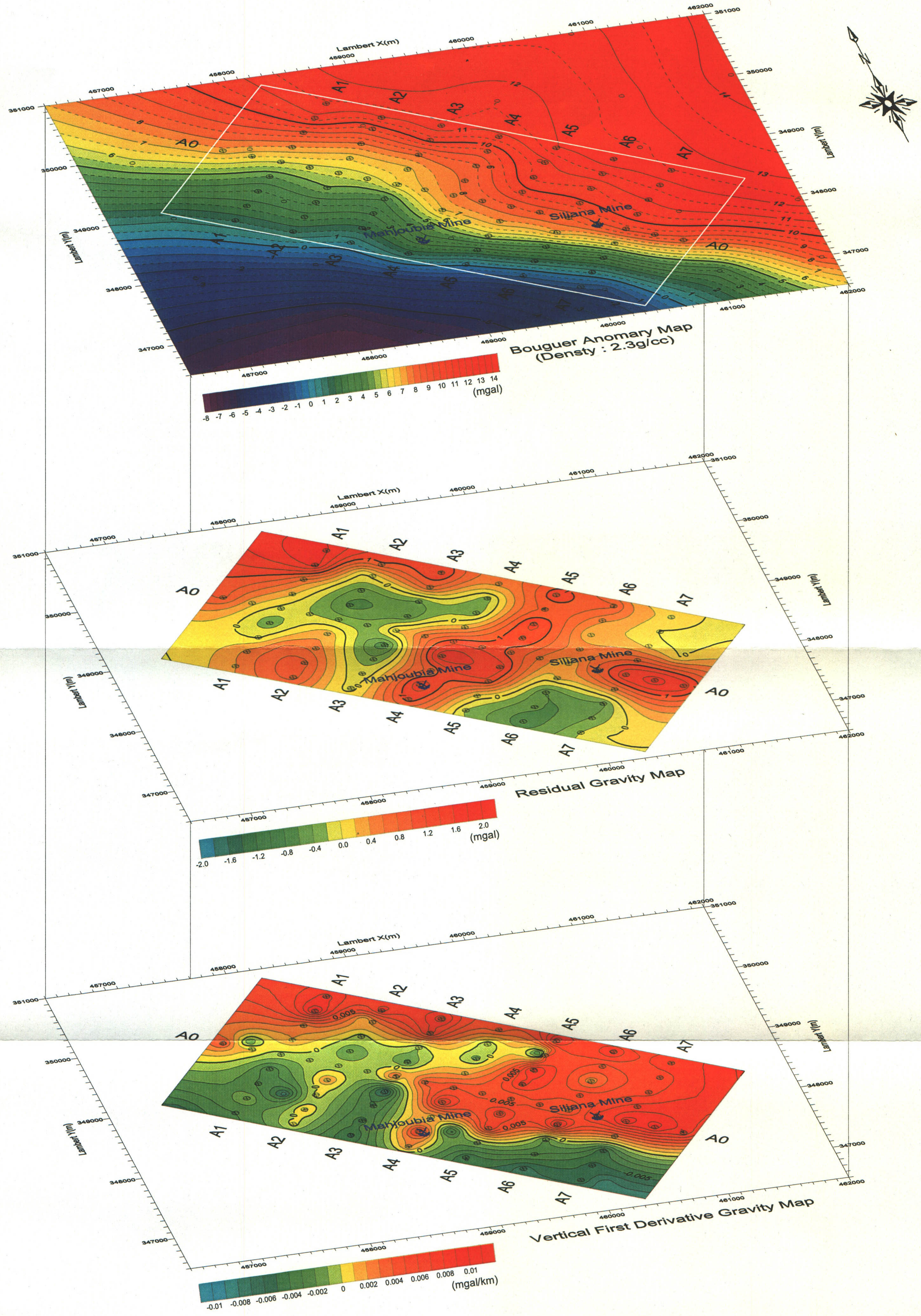

Figure 60 Panel diagram of gravity survey plan map in Siliana prospect

and the direction of the gravity contours changes to the WNW-ESE direction. The gravity contours trend to be distorted in the vicinity of the line A4, which is running through the Mahjobia working and the geological structures are possibly different between the northwestern and southeastern sides divided by the line A4.

Both Mahjobia and Siliana workings are situated at the border of a change in pattern on the gravity distribution described above. The Mahjobia working is also situated at the boundary of the gravity distribution along the line A-4 and is considered to correspond to an intersection between two borders of different geological structures.

(3) Residual Gravity Anomaly (Figure 60)

Six residual gravity anomalies are distributed in the prospect, two low anomalies below - 0.2 mgal in the central and southern parts and four high anomalies exceeding 0.8 mgal surrounding the low anomalies. The low anomaly in the central parts extends towards northeast and is divided into two zones centering the stations A3-75 and A4-150 at the extremity of the anomaly. The low anomaly corresponds to an area where the Triassic dolomite with high density is distributed and therefore that is considered to suggest an existence of the other rocks with low density at depth. The low anomaly in the southern parts is situated in the northern margin of the El Aroussa plain covered by the unconsolidated layers of the Quaternary system. High anomaly extending towards the NE-SW direction through the Mahjobia working in the central parts of the prospect is characteristic among the high anomalies. The Siliana working is situated in the northwestern vicinity of small high anomaly, extending towards the NW-SE direction along the base line A0 in the southeastern parts of that. High anomaly is stretching towards east and west around the northeastern end of the line A1.

(4) First Vertical Derivative Gravity Anomaly (Figure 60)

The positive zone of the first derivative gravity exceeding 0.005mgal/km extends from the central parts to the northern and eastern parts of the prospect. The negative zones are distributed in the southern and western parts. The 0mgal/km contours in the southern parts, which can be correlated to the faults and/or geological boundaries, are divided to three zones. The 0mgal/km contour in the northern parts is running generally towards west. The 0mgal/km contour in the central parts extends towards the NNE-SSW direction at the stations between A3-100 and A4-0, and crosscuts at the southern parts towards A7-50 in the east-southeastern parts. The general trends in first derivative gravity distribution are apparently different from that in the residual gravity anomaly. The locations of an individual anomaly are correlated with that of the residual gravity anomaly. The Mahjobia working is situated in a zone of small high anomalies aligned in along the NNE-SSW direction and the Siliana working is situated at the margin of high anomaly zone extending along the base line A0 in the eastern parts of the prospect.

(5) Cross Section Analysis

The cross section analysis of the Siliana prospect is principally carried out assuming three layer's gravity structure and the depth of gravity model is determined. Those three layers are composed of the low density layers with density differences 0.10g/cm^3 of the Cretaceous system, -0.05g/cm^3 of the Tertiary system and/or -0.20g/cm^3 of the Quaternary system and the gravity basement with density difference of 0.00 g/cm^3 that is correlated to the Triassic system.

In the section A4 crosscutting the central parts of the prospect in the NE-SW direction longitudinally through the Mahjobia deposit, the gravity basement that is correlated to the Triassic system rises to near the surface of the stations between A4-5 and A4-10, between A4-30 and A4-55 and between A4-125 and A4-180. The gravity basement distributed widely appears to divide the thick layer with density difference of 0.10 g/cm^3 that is correlated to the Cretaceous system. The boundary between the gravity basement and the layer with high density suggests an existence of the fault. The Mahjobia working is situated at the border between the gravity basement and the layer with high density.

In the section A5 crosscutting in the NE-SW direction at 500m to the southeast from the cross section A4, the surface layer of low density with density difference of -0.05 g/cm^3 correlated to the Tertiary system extends to the southwestward from station A5-50 and the surface layer of high density with density difference of -0.10 g/cm^3 correlated to the Cretaceous system extends to northeastward from station A5-50. Boundary of both layers forms the structure similar to the fault. The gravity basement rises to about 100m below the surface of the stations between A5-80 and A5-110 in the central parts. The thin surface layer of low density with density difference of -0.20 g/cm^{3}correlated to the Quaternary system extends to the vicinity of the Siliana River in the northeastern end of the cross section.

In the section A6 crosscutting in the NE-SW direction through the vicinity of the Siliana deposit at 500m to the southeast from the cross section A5, the same as the gravity distribution of the cross section A5, the low density layer with density difference of -0.05g/cm^3, correlated to the Tertiary system, extends towards southwest from the station A6-60 in the southwestern parts and the layer with density difference of 0.10 g/cm^3, correlated to the Cretaceous system, extends to near the surface in the northeastern parts of the cross section. Boundary of both layers forms the structure similar to the fault. The gravity basement correlated to the Triassic system rises to about 100m below the surface at the stations between A6-140 and A6-180 in the central parts of the cross section.

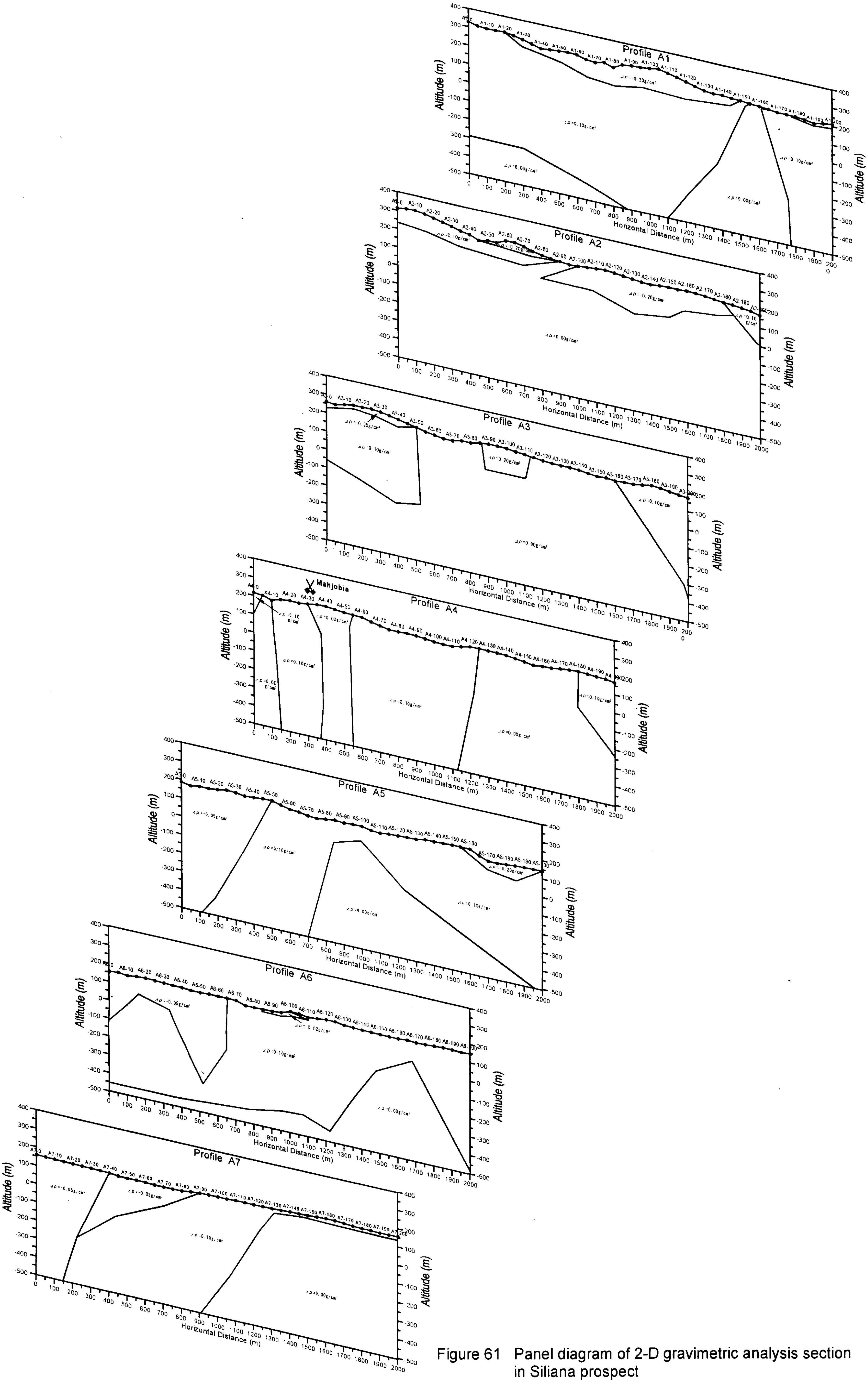

Figure 61 Panel diagram of 2-D gravimetric analysis section in Siliana prospect

6.2.3 IP Survey

(1) Modeled Resistivity and Chargeability

The panel diagram of all modeled resistivity sections in this prospect is shown Figure 62, the panel diagram of all modeled chargeability sections Figure 63. The panel diagram of modeled resistivity plan maps sliced at the altitudes of 150m, 50m and -50m is presented Figure 64, the panel diagram of modeled chargeability plan maps sliced at the same altitudes Figure 65.

Modeled resistivity in the prospect is ranging between 0.3 and 510 Ωm and an average value of about 22 Ωm is only approximately 10 percent of that in the Bazina Kebira prospect.

The resistivity distribution in this area is characterized by the distribution of two low resistivity zones less than 10 Ωm, which extends towards the southwestern parts in the NW-SE direction and in the vicinity of the lines A5 and A6 with the NE-SW or N-S directions. Western side of the former low resistivity zone is correlated to the distribution of the Cretaceous limestone, that agrees with the laboratory test results of the sample indicating relatively high resistivity, and the latter low resistivity zone is considered to correlate with the Quaternary system extending along the Siliana River. Both resistivity zones intersect at the southwestern parts of line A6. The low resistivity anomalies less than 10Ωm are distributed at shallow depth of the stations between A0-10 and A0-80 in the northwestern parts of the base line A0, and at depth of the stations between A2-80 and A0-140 in the central parts of the base line A0. The high resistivity anomaly exceeding 100Ωm is distributed at shallow depth around the station A0-150 in the central parts of the prospect. The high resistivity zone exceeding 100Ωm is distributed at depth of the section covering the stations from A1-120 to A3-130 with the NW-SE direction in the northeastern side. This high resistivity zone can be correlated to the distribution of the Triassic dolomite, the samples of which indicate the high resistivity at the laboratory test.

Modeled chargeabilities in this prospect are generally low and its maximum and approximate average values are 5 mV/V and 2 mV/V respectively. The useful chargeability can not be observed in some areas due to the low resistivity, where the negative chargeability is Modeled just on a calculation. Two small chargeability anomalies are detected at shallow depth of the section around the stations between A6-190 and A6-200, and between A0-360 and A7-120 in the eastern parts of the prospect.

(2) Interpretation

IP survey results superimposed over the geological map and the residual gravity anomaly map is shown in Figure 66.

The Triassic system can be indicated as the bodies with the low density and high resistivity on the plan the same as that of the Bazina and Kebira prospects. However

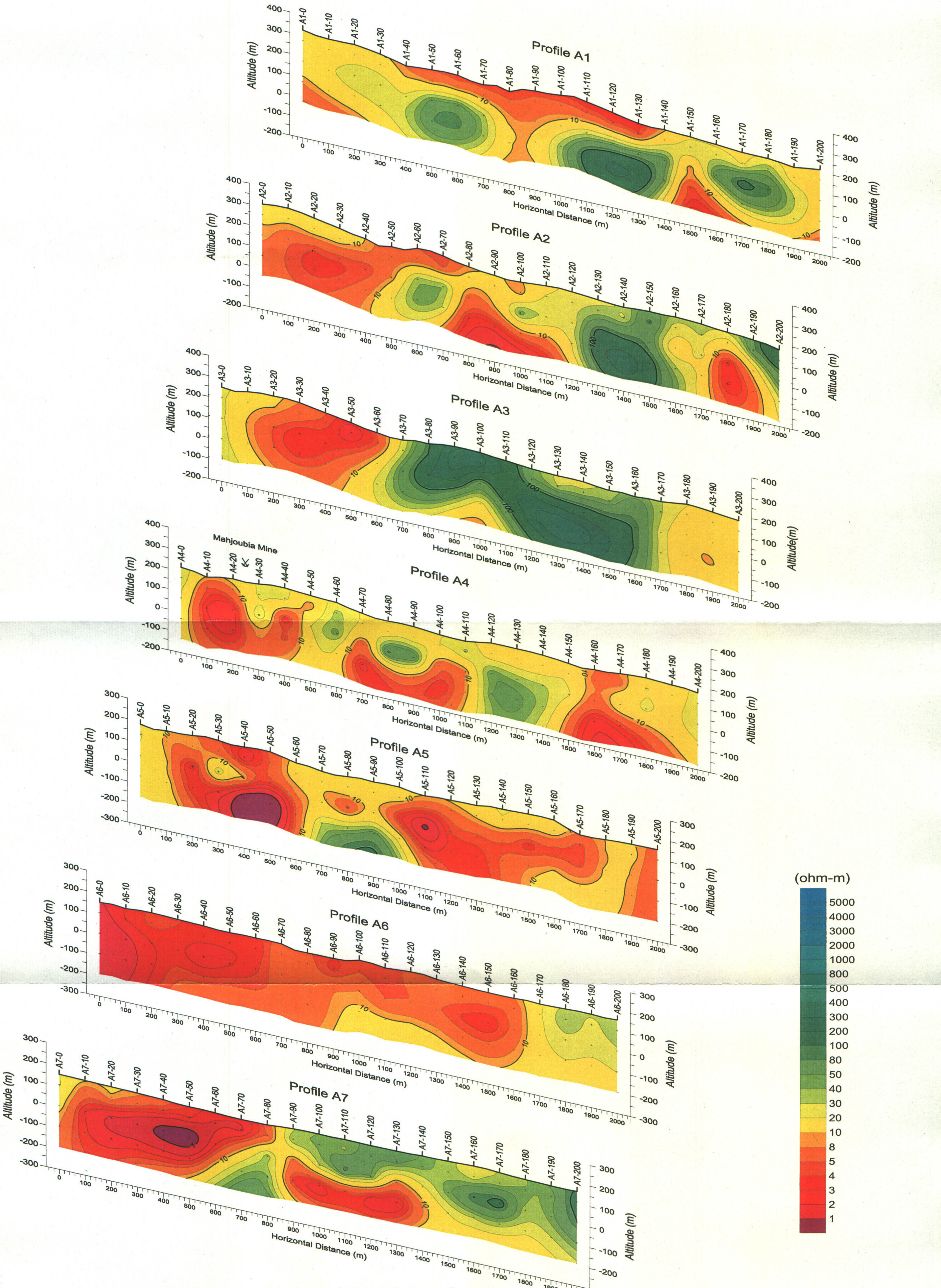

Figure 62 Panel diagram of modeled resistivity section in Siliana prospect

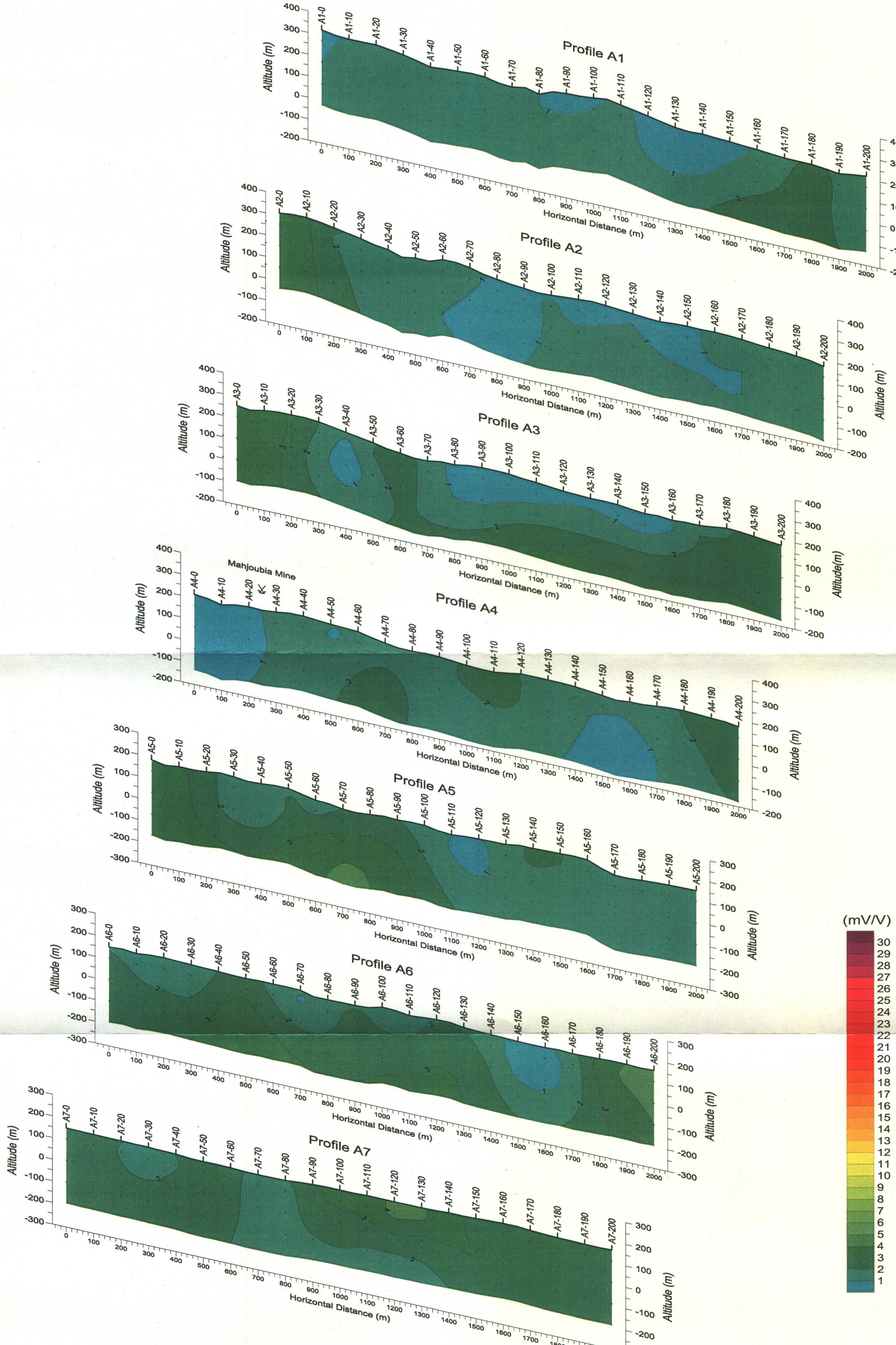

Figure 63 Panel diagram of modeled chargeability section
in Siliana prospect

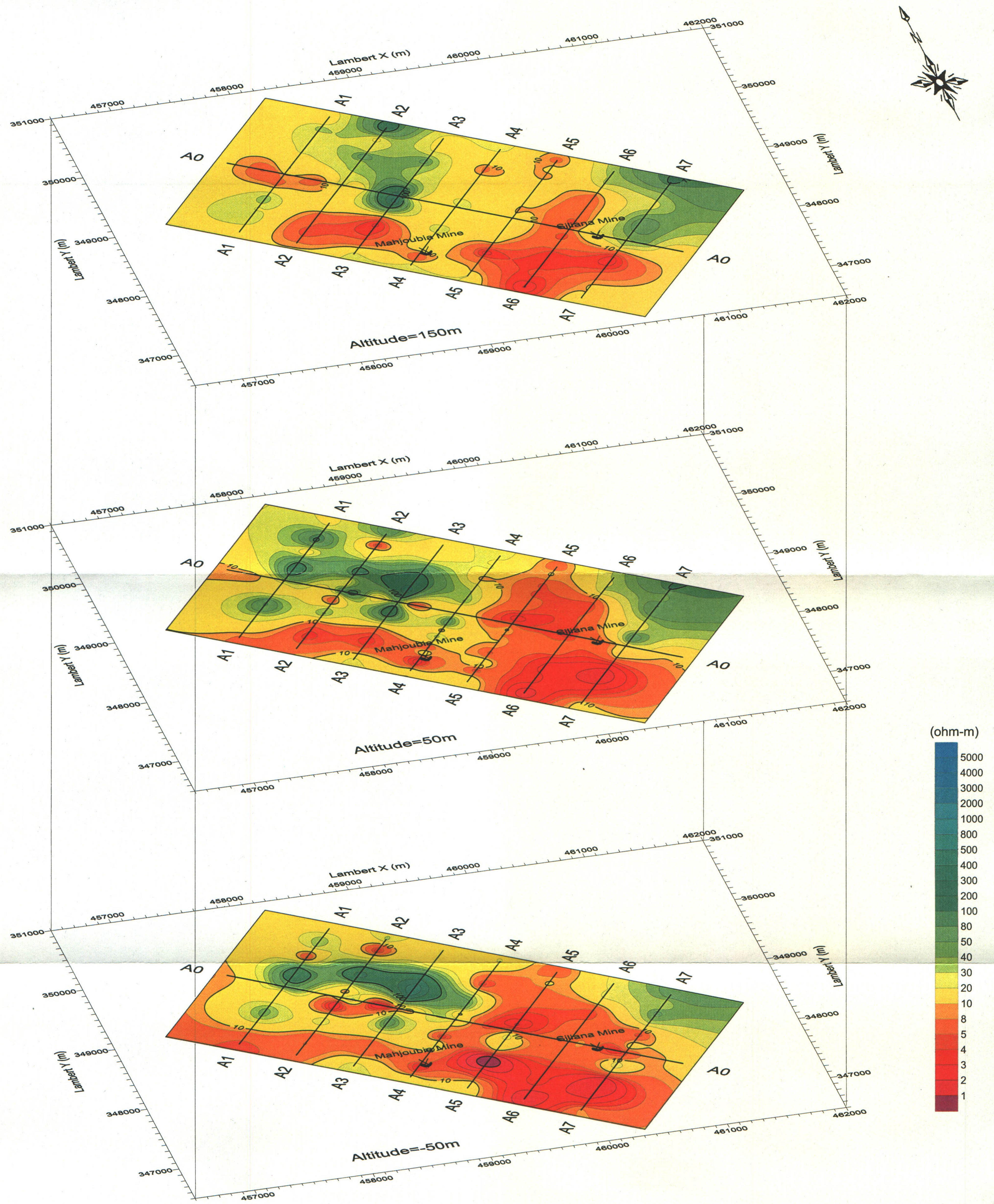

Figure 64 Panel diagram of modeled resistivity plan map in Siliana prospect

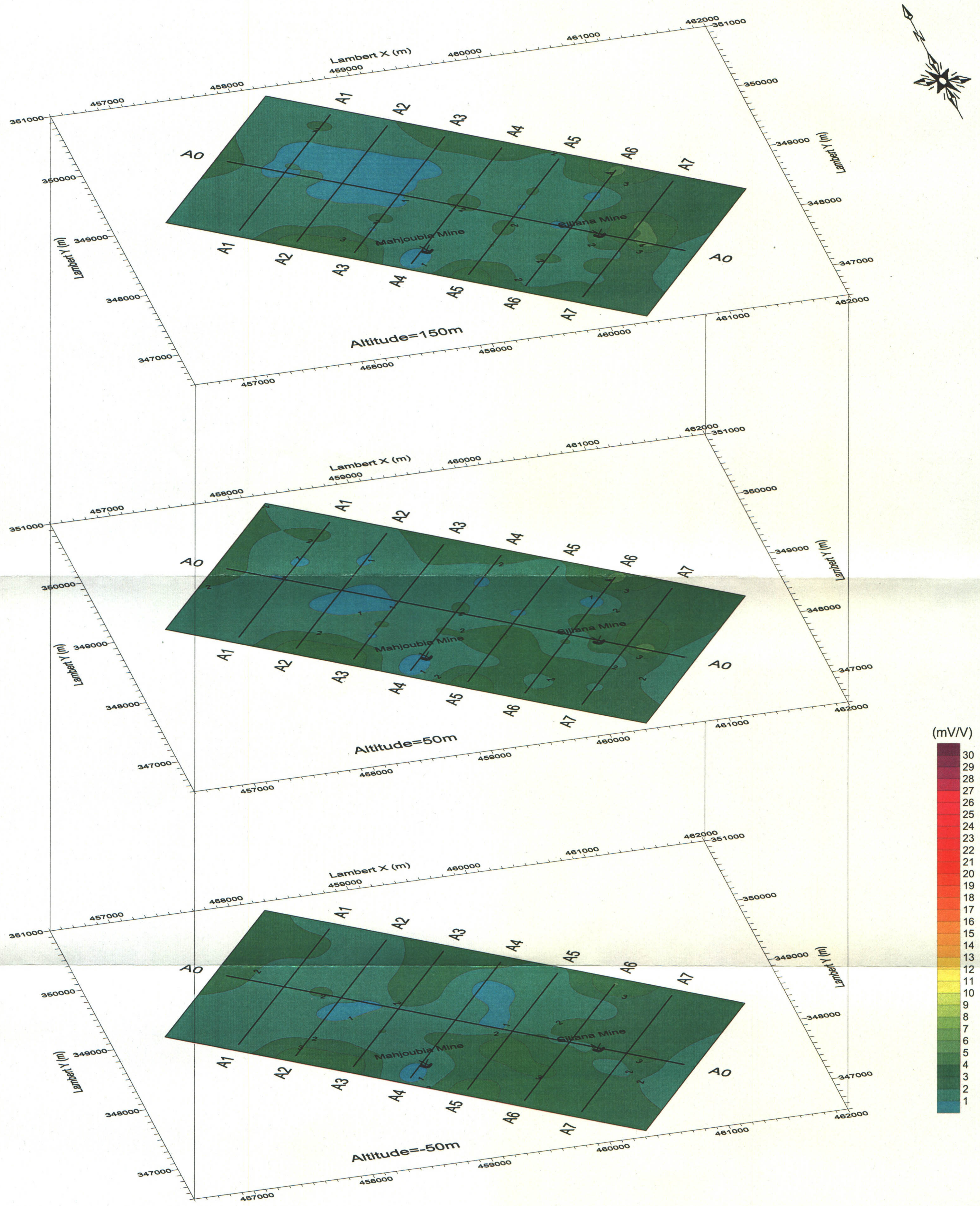

Figure 65 Panel diagram of modeled chargeability plan map in Siliana prospect

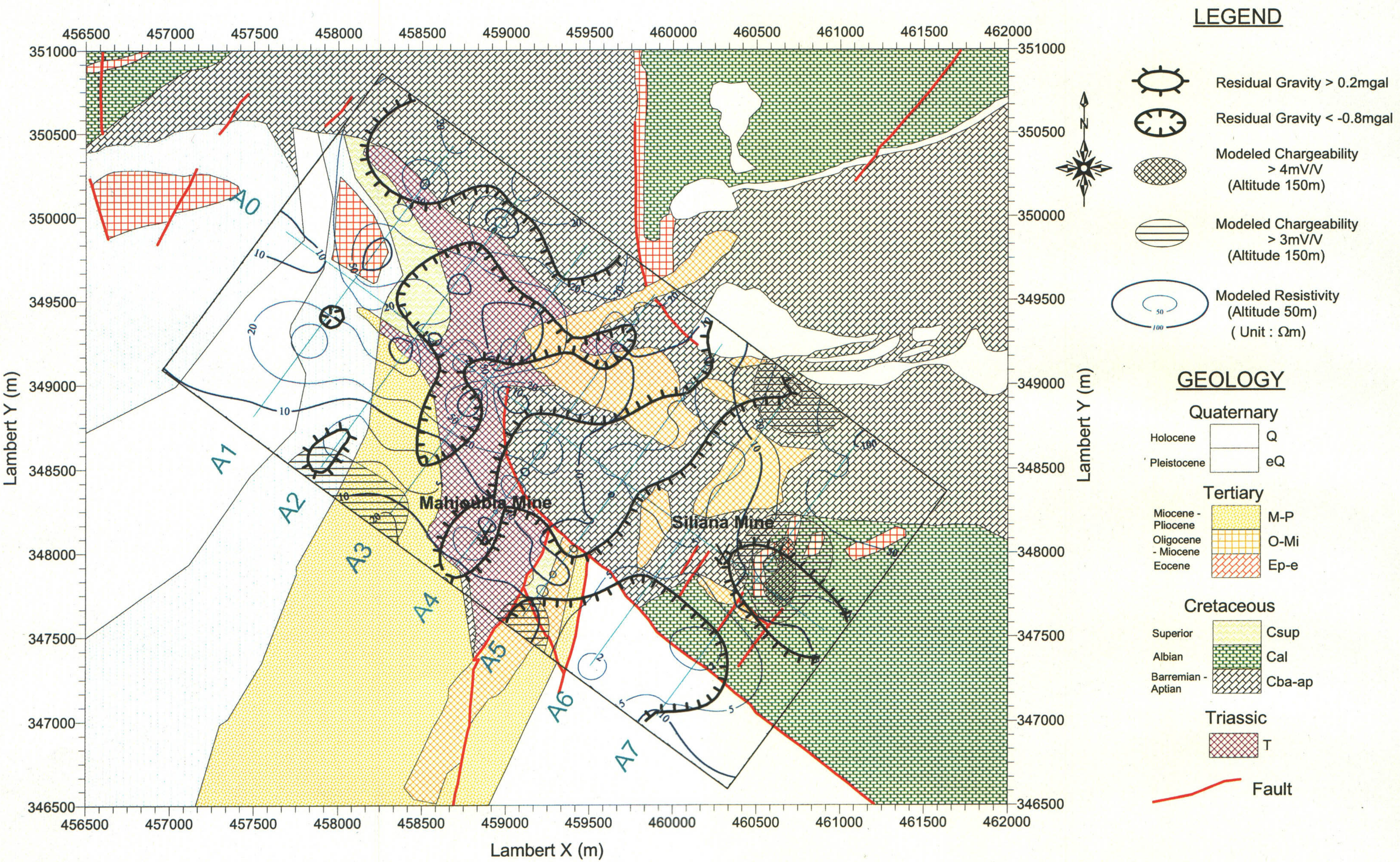

Figure 66 Interpreted geophysical survey map in Siliana prospect

the low resistivity layer extends towards upper at the lower parts of the high resistivity section in the distribution zone of the Triassic system. Therefore the zone of the low density and high resistivity is possibly correlated to the Diapir with low density. The low resistiviy is dominated over the survey area and the fault can not be easily inferred on the plan. However the inferred faults are detected as a line of the resistivity discontinuity on the cross section and the resistivity distribution is considered to reflect rather well the geological strata.

The chargeability obtained in this prospect is considerably low and the chargeability anomaly is not detected at the known mineralized site. The chargeability anomalies exceeding 4mV/V detected in the vicinity of the southeastern end of the line A6 in the northeastern parts of the survey area and at shallow depth around an intersection between the lines A0 and A7. The vein accompanied by the weak mineralization is recognized for the latter anomaly. Notwithstanding that an indication of the mineralization is not recognized in the former anomaly zone, which is also considered an interesting anomaly, because this anomaly is situated in the vicinity of the high resistivity zone and the gravity basement rise correlated to the Triassic system. The chargeability anomalies exceeding 4mV/V detected at deeper part of the intersection by the lines A0 and A5 in the central parts of the survey area. This anomaly is also considered a promising anomaly, because this is situated in the vicinity of the high resistivity zone and the gravity basement rise correlated to the Triassic system and furthermore the weakly mineralized vein is recognized at near the surface around the anomaly zone.

6.3 Drilling Investigation

The geological summary plan of the Sliana prospect is shown in Figure 67, incorporating the drill hole locations. As shown in the figure, the geology of the prospect comprises the Triassic diapir, the Cretaceous carbonates (limestone, marl, limestone-marl and sandstone-argillite alternations), sedimentary rocks (marl, sandstone, argillite and conglomerate) of the Tertiary system (Eocene, Oligocene, Miocene and Pliocene) and the Quaternary system. The Cretaceous system contains the Mahjoubia and Siliana mineral occurences.

One drill hole, MJTK-A1 was put down along the geophysical survey lines, A5 of the 2st Year Campaign in this prospect, in order to locate new prospective ore deposits and to verify the IP anomaly outlined by the geophysical survey. The columnar hole section and the geological profile along the section including the hole are shown in Figures 156 and 148 respectively.

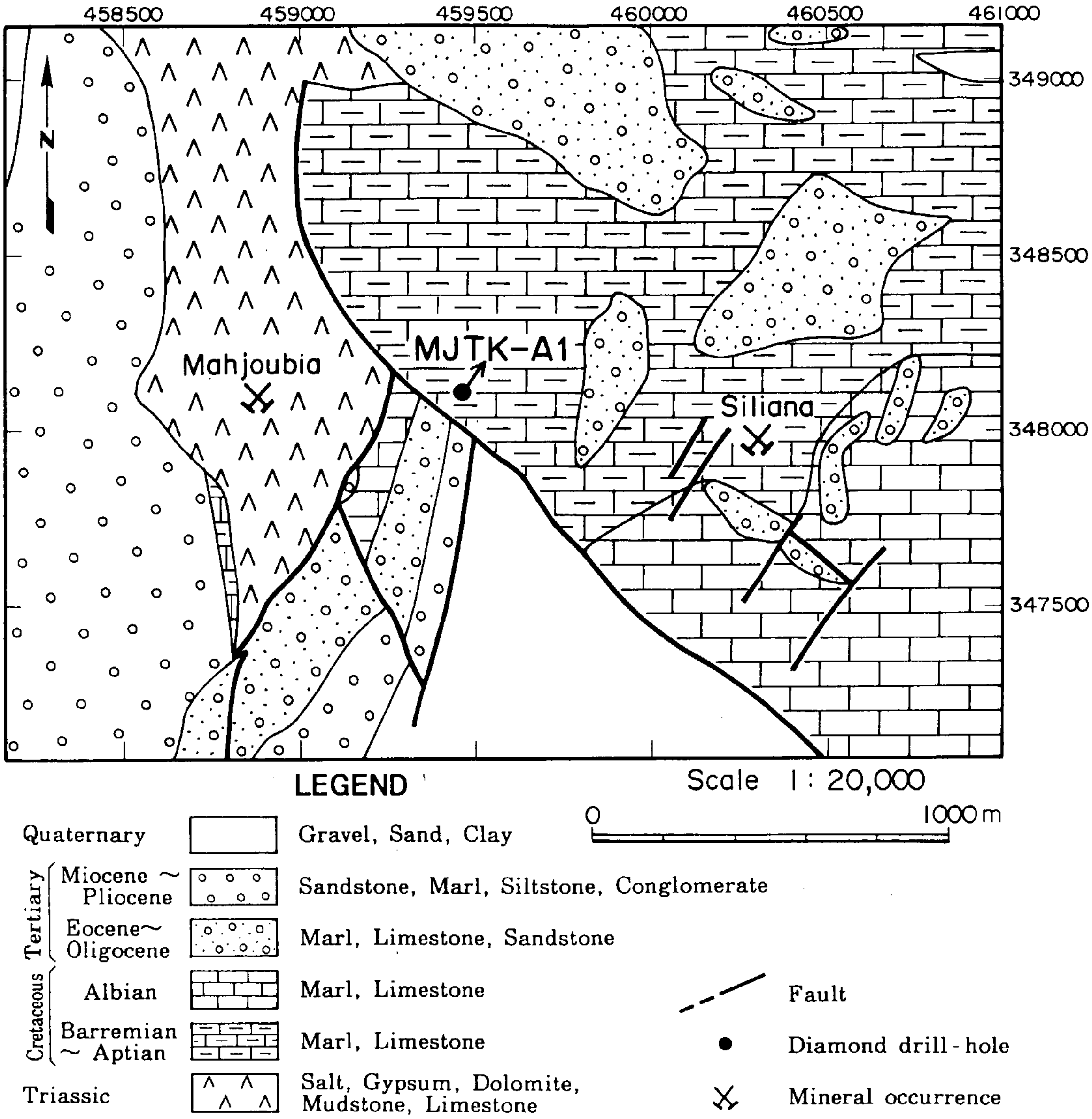

Figure 67 Geology and Drill Hole Location of the Siliana Prospect

The geology of this hole comprises marl from 0.00 to 93.20m, marl-limestone alternation from 93.20 to 163.40m, brecciated limestone from 163.40 to 175.30m and marl-limestone alternation from 175.30 to 198.80m, end of the hole, all of which are correlated to the carbonates of the Barremian to Albian stages of the Cretaceous system.

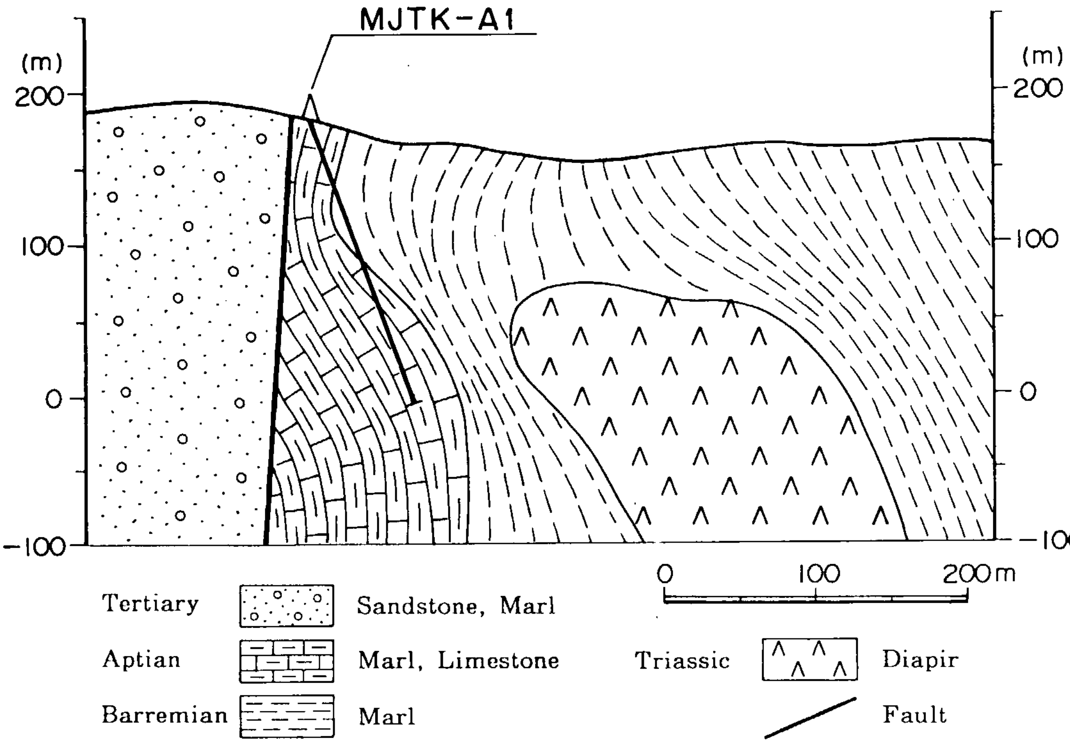

Figure 68 Geological Profile along the Hole, MJTK-A1

The hole was unable to make advance beyond the depth of 198.80m due to steam blowout, which made it impossible to verify the chargeability anomaly. However, minor Pb and Zn mineralization was encountered at the depths from 112.90 to 119.30m, from 135.00 to 140.00m, from 174.50 to 179.50m and from 190.65 to 197.70m, with the maximum grades of Pb and Zn at 0.33% for 1m section and at 0.64% for 1m section respectively. Therefore, it is confirmed that Pb-Zn mineralization exists between the Mahjoubia and the Siriana showings.