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Geophysical profile measurements over interpreted lineaments in the Laxemar area

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August 2004

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Abstract

This report presents the execution and the results from geophysical profile measurements performed over interpreted lineaments in the Laxemar area, Oskarshamn. The lineaments have been identified from elevation and airborne geophysical data as topographic lows, magnetic lows and, in some cases, resistivity lows.

The investigations were executed at eight different locations along geophysical group of profiles. Three parallel profiles were surveyed at each location. Magnetic measurements were performed along all profiles and electric resistivity measurements were performed along each central profile. Electromagnetic slingram measurements were performed at five profile groups that were not close to any major power line.

The magnetic measurements confirmed the existence of low magnetic rocks related to the lineaments. The magnetic lows were in some cases displaced from the topographic lows.

The resistivity measurements were performed as pseudosections that have been inverted to vertical resistivity sections. Corresponding sections of induced polarisation were obtained as by-products. Low resistivity structures were identified at all locations. The resistivity lows were located at roughly the same positions as the topographic lows.

An east-west striking lineament in the southern part of the area was covered by the group of profiles no 1 (near Kvarnstugan) and group no 2 (near Åby). The lineament seems to be related to a 50 to 100 m wide subvertical structure of low resistivity.

A south-north striking lineament in the western part of the area was covered by profile group no 3 (south of Mederhult). This lineament seems to be related to a c 80 m wide low-resistivity structure that dips steeply to the west.

An east-west striking lineament in the central part of the area was covered by profile group no 4 (near Hultenäs), group no 5 (south of Ärnhult) and group no 6 (north-west of Lilla Laxemar). This lineament seems to be related to a c 60 to 80 m wide low-resistivity structure. The structure has a complex geometry but most likely dips steeply towards north.

A SW–NE striking lineament in the north-eastern part of the area was covered by the group of profiles no 7 (north of Lilla Laxemar). This lineament seems to be related to a rather narrow (20 to 30 m) subvertical structure of low resistivity.

Two SW–NE striking lineaments in the eastern part of the area were covered by the group of profiles no 8 (west of Lilla Laxemar). The lineaments seem to be related to two structures of moderate resistivity. Both structures seem to dip towards north-west. One of these lineaments is often referred to as the Äspö shear zone.

The slingram measurements were influenced by telephone lines and other cultural features. Reliable data could only be obtained along a few profiles and the low-resistivity structures created anomalies in the quadrature components in these cases.

Sammanfattning

Denna rapport presenterar utförandet och resultatet av markgeofysiska mätningar utförda över tolkade lineament i Laxemarområdet, Oskarshamn. Lineamenten har definierats från topografiska och flygeofysiska data som topografiska, magnetiska och i vissa fall resistivitetsminima.

Undersökningarna genomfördes på åtta olika plaster längs med geofysiska profilmattor. Data samlades in längs tre parallella profiler på varje plats. Magnetiska mätningar utfördes längs samtliga profiler och elektriska resistivitetsmätningar utfördes längs varje centralprofil. Elektromagnetiska mätningar utfördes längs de uppsättningar av profiler som inte var nära någon kraftledning.

De magnetiska mätningarna bekräftade förekomsten av lågmagnetisk berggrund relaterad till lineamenten. Dessa magnetiska minima var emellertid i flera fall lateralt förskjutna i förhållande till topografiska minima.

Resistivitetsmätningarna utfördes i form av pseudosektioner som inverterades till vertikalsektioner. Motsvarande sektioner för inducerad polarisation erhölls som biprodukt. Lågresistiva strukturer indikerades på samtliga platser. I position korrelerade dessa till topografiska minima.

Ett öst-västligt strykande lineament i södra delen av området undersöktes med profilmatta nr 1 (vid Kvarnstugan) och nr 2 (vid Åby). Lineamentet förefaller vara relaterat till en ca 50 till 100 m bred lågresistiv subvertikal struktur.

Ett nord-sydligt strykande lineament i den västra delen av området undersöktes med profilmatta nr 3 (söder om Mederhult). Detta lineament förefaller vara relaterat till en ca 80 m bred struktur med låg resistivitet som stupar brant mot väst.

Ett öst-västligt strykande lineament i den centrala delen av området undersöktes med profilmatta nr 4 (nära Hultenäs), nr 5 (söder om Ärnhult) och nr 6 (nordväst om Lilla Laxemar). Detta lineament förefaller vara relaterat till en ca 60 till 80 m bred lågresistiv struktur med komplex geometri. Strukturen stupar förmodligen brant mot norr.

Ett SW–NE-strykande lineament i den nordöstra delen av området undersöktes profilmatta nr 7 (norr om Lilla Laxemar). Detta lineament förefaller vara relaterat till en smal subvertikal lågresistiv struktur.

Två SW–NE strykande lineament i den östra delen av området undersötes med profilmatta nr 8 (väster om Lilla Laxemar). Bägge lineamenten förefaller vara relaterade till strukturer med måttlig elektrisk resistivitet. Stupningen på dessa verkar vara mot nordväst. Det ena av dessa lineament brukar ofta relateras till som Äspö skjuvzon.

Slingrammätningarna stördes av kulturella störningskällor som t ex telefonledningar. Pålitliga data kunde endast erhållas längs vissa profiler och de lågresistiva strukturerna gav då upphov till anomalier i imaginärkomponenten.

Contents

1 Introduction

This document reports the results gained by the geophysical profile measurements over interpreted lineaments in the Laxemar area /1/, which is one of the activities performed within the site investigation at Oskarshamn. The work was carried out in accordance with activity plan AP PS 400-04-040 (SKB internal controlling document). In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

The geophysical survey was carried out along group of profiles each containing three parallel profiles, Figure 1-1. Electric resistivity was measured as pseudosections along each central profile and magnetic measurements were carried out along all profiles. Electromagnetic slingram measurements were carried out along those group of profiles that were not situated close to any power line.

Table 1-1. Controlling documents for the performance of the activity (SKB internal controlling documents).

Activity plan	Number	Version
Markgeofysiska profilmätningar i Laxemar	AP PS 400-04-040	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för magnetometri	SKB MD 212.004	1.0
Metodbeskrivning för slingrammätning	SKB MD 212.007	1.0
Metodbeskrivning för resistivitetsmätning	SKB MD 212.005	1.0

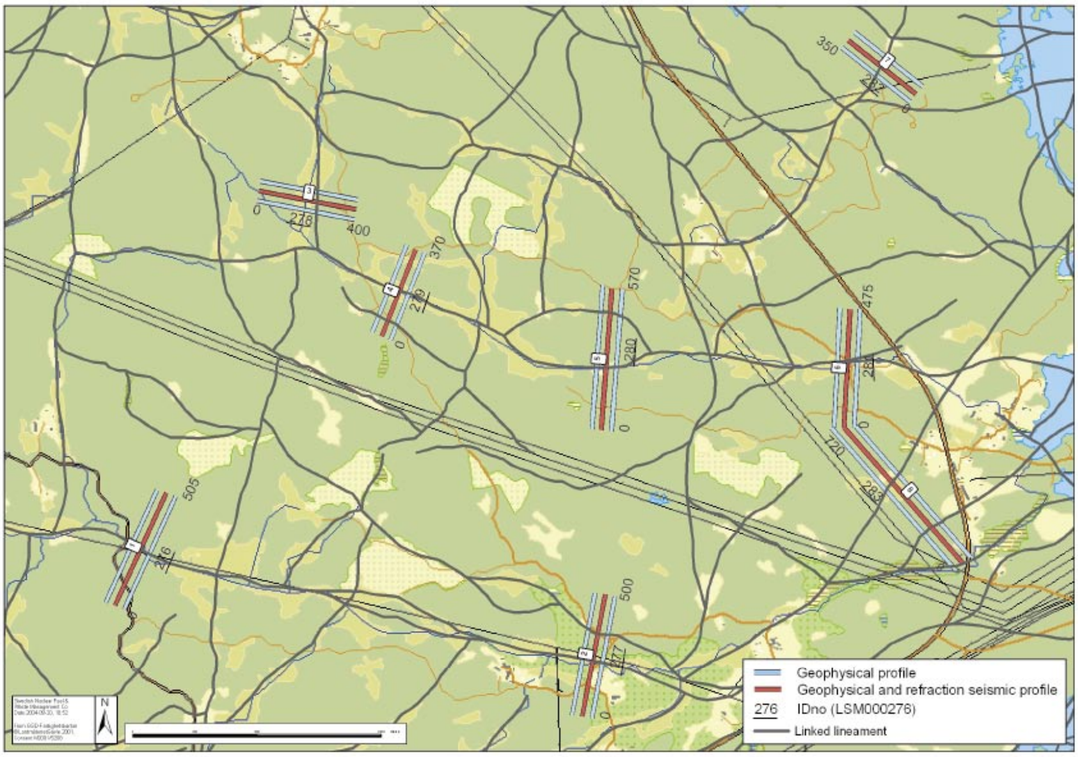

Figure 1-1. Location of geophysical profiles for ground geophysical measurements over interpreted lineaments in the Laxema area /1/. Along the red profiles refraction seismic measurements were also performed /2/.

2 Objective and scope

The purpose of ground geophysical measurements across lineaments is to gain knowledge about the physical properties of the corresponding geological structures. Information about geometry like e.g. width and dip can also be obtained. Water-bearing fractures and/or high porosity in the rock is expected to have low electric resistivity whereas the magnetic susceptibility of rock is often low in altered, oxidized rock due to destruction of ferromagnetic minerals.

The main objective of these investigations is to provide supportive information to the structural and to some extent the bedrock geological model of the area especially in some areas of key importance e.g. to obtain information of geophysical properties and anomalies over and in the vicinity of interpreted lineaments in the Laxemar area, Oskarshamn /1/.

3 Execution

3.1 Instrumentation and field work

3.1.1 Magnetic total field survey

The magnetic total field survey was conducted with two Gem Systems GSM-19 magnetometers of which one was used as a diurnal base station. One reading was registered every 10 seconds and was used to make a diurnal correction of the data collected with the mobile magnetometer. The magnetometers were time synchronized every morning before starting the survey. Magnetic readings were taken along profiles with a station interval of 10 m. Magnetic measurements were performed along all profiles.

Diurnal base station location:	1548325E/6366910N
Magnetic base level	50811 nT

3.1.2 Electromagnetic slingram survey

The slingram survey was conducted with an HLEM APEX Parametrics MaxMin I-9 utilising the frequencies 440, 3520, 7040 and 14080 Hz. The lowest frequency was included to enable estimations of incorrect coil separation and/or orientation effects on the data. Measurements were made with a coil separation of 100 m and with a station interval of 20 or 25 m. Slingram measurements were conducted along all three profiles along the group of profiles no 3, 4, 5, 6 and 7 (LSM000278, LSM000279, LSM000280, LSM000281 and LSM000282).

3.1.3 Resistivity survey

Electric resistivity was measured with the Pole-Dipole configuration using a Scintrex IPR-12 receiver (Figure 3-1) and a Scintrex IPC-8 250W transmitter (Figure 3-2). The station separation interval was 25 m and 8 dipoles were employed. The dipole length was 25 m. The measurements were performed with the current electrode (Figure 3-3) at lower profile coordinate compared to the potential electrodes. Induced polarisation (IP) data were obtained as a by-product of the resistivity measurements. IP was measured in the time domain as chargeability at 11 channels ranging from 310 to 810 ms. Results in Chapter 4 are presented as the integrated chargeability over the entire time window of measurement. Resistivity measurements were conducted along the central profile of each group of profiles.

The position of the remote current electrode was:

LSM000276:	1546447E/ 6364967N
LSM000277:	1548471E/ 6364440N
LSM000278:	1546575E/ 6367363N
LSM000279:	see LSM00278
LSM000280:	1548605E/ 6365326N
LSM000281:	1549614E/ 6365644N
LSM000282:	1550461E/ 6367202N
LSM000283:	1549288E/ 6366733N

Figure 3-1. *Scintrex IPR-12 receiver for electric resistivity measurements.*

Figure 3-2. *Scintrex IPC-8 250W transmitter for electric resistivity measurements.*

Figure 3-3. *Current electrodes for resistivity measurements.*

3.2 Data processing and interpretation

3.2.1 Magnetic data

The only processing performed on the magnetic data was the removal of diurnal variations recorded by the base magnetometer.

The magnetic total field anomaly from each group of profiles was interpolated to a grid with a node spacing of 5 by 5 m. Based on these grids, contour maps have been produced. No numerical modelling has been performed on the magnetic data.

3.2.2 Electromagnetic slingram data

The profiles were marked at even <u>horizontal</u> distances. Elevation variations will therefore introduce errors since the actual coil separation will be greater than the nominal separation. This effect was corrected for; although the corrections were quite small since elevation differences in general were quite moderate along the profiles. The real component of the lowest frequency was checked for false anomalies caused by incorrect coil separation/orientation. No geological conductors are expected to produce significant anomalies for this component. No such false anomalies of significant magnitude were indicated. However, large portions of the profiles were affected by noise due to cultural objects as telephone lines and fences. This noise will mask the appearance of anomalies caused by geological conductors.

The slingram data were plotted as profile graphs. No numerical modelling was meaningful due to the noise caused by cultural features.

3.2.3 Resistivity data

The resistivity and IP data were entered into the inversion program ResixIP2DI. Vertical sections of resistivity and chargeability were produced assuming 2D geometry perpendicular to the profiles. The program produces sections that minimizes the difference between field data and synthetic data and at the same minimizes local variability in the sections. A preferred vertical direction of structures was entered into the program. It should be noted that there is no unique inverse solution to the problem and that the final result to some extent is dependent upon e.g. the setting of smoothness parameters. Different settings of parameters in the program were tested. The inversion result did however not vary much between different settings. Deviations of geological structures from the assumed 2D geometry will also produce errors.

Chargeability contrasts were in general quite small. Some of the inverted chargeability sections are therefore somewhat noisy.

The inverted resistivity and chargeability were contoured and plotted together with elevation data.

3.3 Nonconformities

The group of profiles no 7 was by the survey team marked from 0 in south-east with the profiles trending towards north-west. According to the activity plan the profile was trending from north-west towards south-east. The profile LSM000309 was by the survey team put north of the profile LSM000308 (group of profiles no 3). According to the activity plan it was the opposite. No major conformity occurred due to that the profiles were measured according to the surveylines.

4 Results

The results from the ground geophysical surveys are presented below. The co-ordinated lineaments /1/ that has been the targets for the investigation can be seen in Figures 4-1 and 4-2. Shaded relief elevation data is shown as a back-drop in Figure 4-1 whereas high-pass filtered, reduced-to-the-pole aeromagnetic data are shown in Figure 4-2.

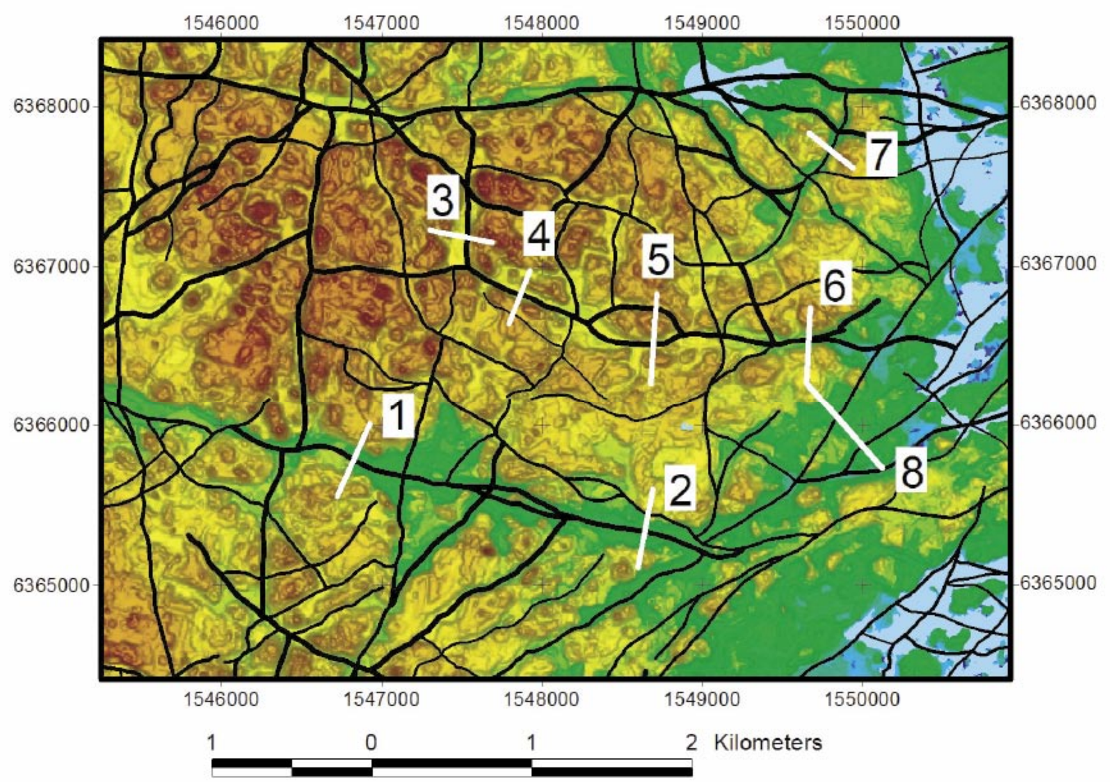

Figure 4-1. *Shaded relief elevation map of the Laxemar area. Linked lineaments /1/ are shown in black where the line thickness is proportional to the "weight" /1/ of the lineament. The central profile of each group of profiles in the investigation is shown with a white labelled line. Label 1 to 8 correspond to LSM000276 to LSM000283.*

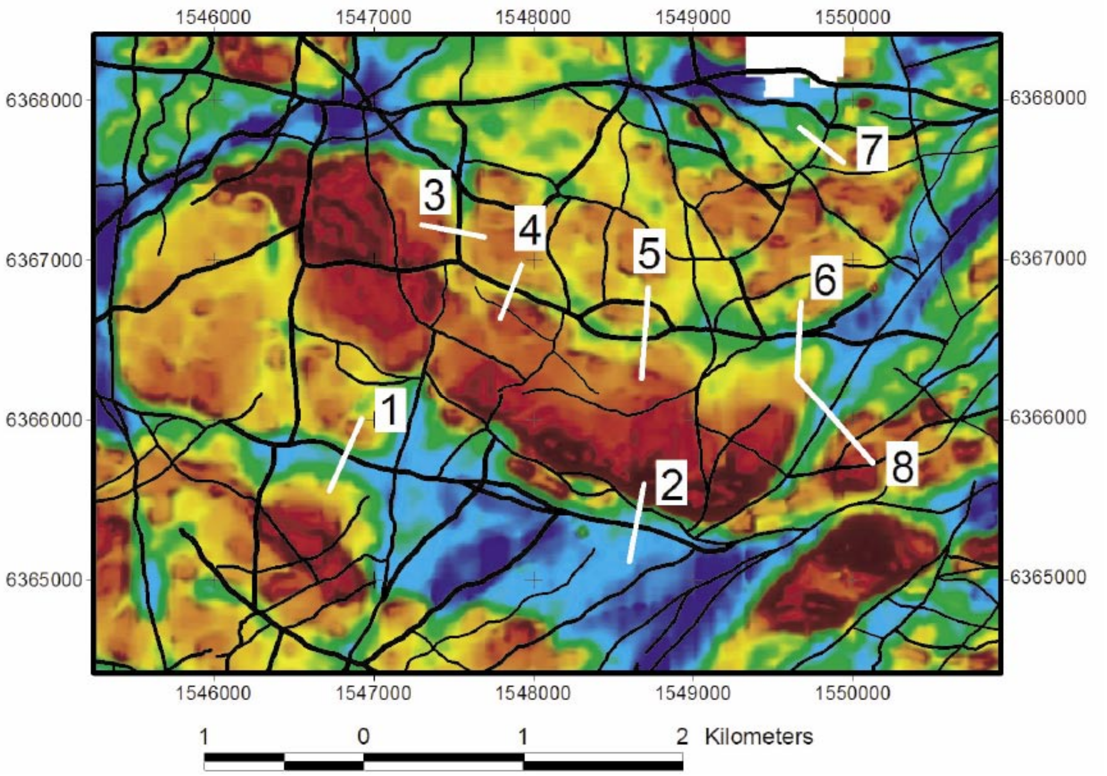

Figure 4-2. *High-pass filtered, reduced-to-the-pole aeromagnetic map of the Laxemar area.Linked lineaments /1/are shown in black where the line thickness is proportional to the "weight" /1/ of the lineament. The central profile of each group of profiles in the investigation is shown with a white labelled line. Label 1 to 8 correspond to LSM000276 to LSM000283.*

4.1 Group of profiles no 1

The group of profiles 1 consists of the profiles LSM000276, 304 and 305, where LSM000276 is the central profile. The group of profiles is located close to Kvarnstugan.

The target for the profile group 1 was an east-west striking lineament (ZSMNW042A) in the southern part of the Laxemar area. The ground magnetic data can be seen in Figure 4-3. A magnetic low coincides with the interpreted lineament. The width of the corresponding structure is however difficult to estimate since low-magnetic rocks are present to the south. The northern part of the area is characterized by magnetic structures striking WNW.

Inverted resistivity and chargeability sections for profile group 1 are shown in Figure 4-4. A low-resistivity structure coincides with the interpreted lineament. The width of the structure is almost 100 m and the resistivity is rather low (~2,500 Ωm) in the central part of the structure. The dip seems to be subvertical. A less prominent but significant low-resistivity structure can be seen at coordinate 450 in Figure 4-4. It appears to dip to the south and coincides with a magnetic low (Figure 4-3) that strikes NW-SE. Low-chargeability anomalies seem to be related to both low-resistivity structures. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained.

No slingram data were acquired for the group of profiles no 1.

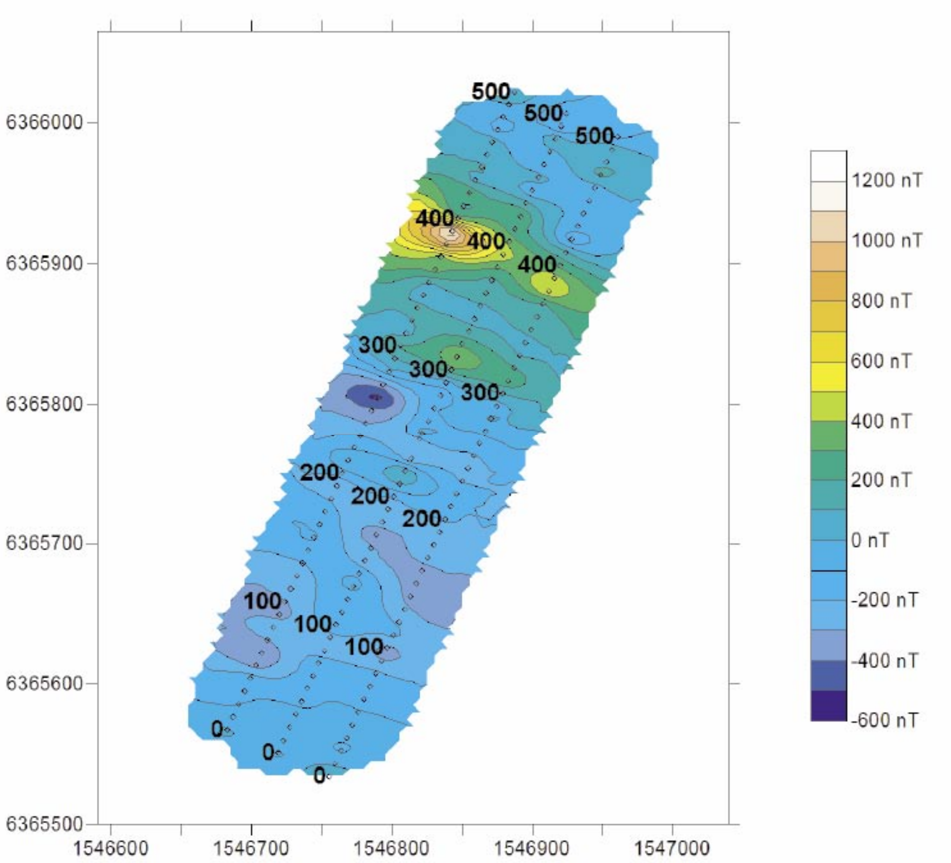

Figure 4-3. *Contour map of ground magnetic data from profile group 1. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

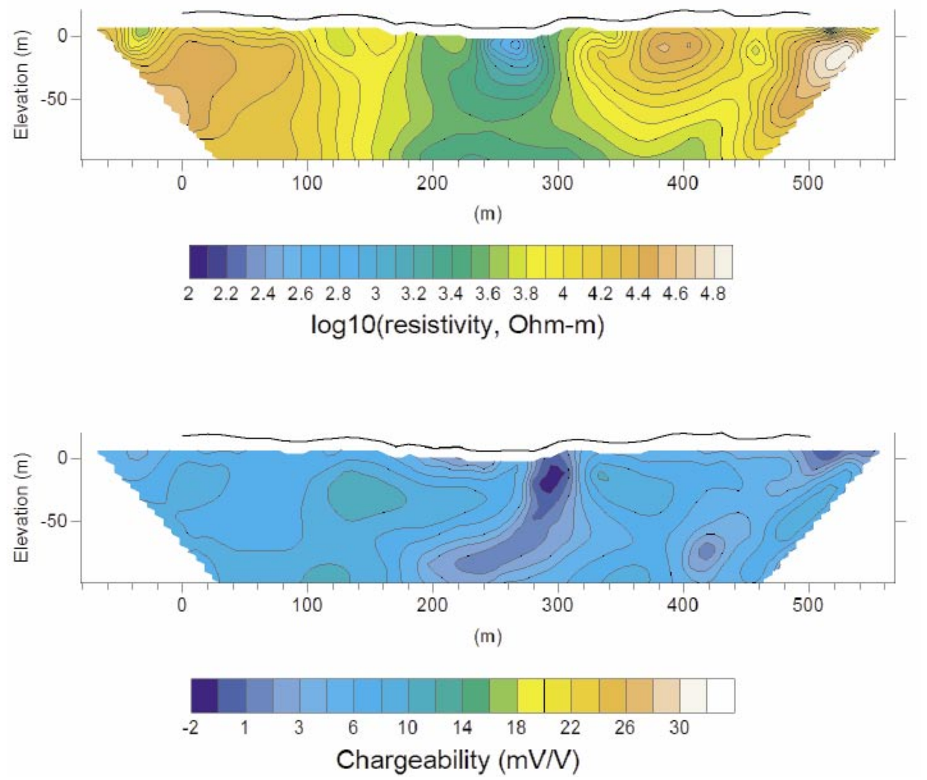

Figure 4-4. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of profile group 1 (LSM000276). The black lines show elevation data along the profile.*

4.2 Group of profiles no 2

The group of profiles 2 consists of the profiles LSM000277, 306 and 307, where LSM000277 is the central profile. The group is located close to Åby.

The target for the group of profiles no 2 was the same east-west striking lineament (ZSMNW042A) as for group 1. The profiles also cross the lineament XSM0006A2 further north. The ground magnetic data can be seen in Figure 4-5. A magnetic low that can be related to the lineament ZSMNW042A can be seen at profile coordinates 220 m. The width of the corresponding structure is however difficult to estimate since low-magnetic rocks are present to the south. The position of the lineament XSM0006A2 corresponds approximately to the transition to strongly magnetic rocks in the northern part of the area.

Inverted resistivity and chargeability sections for the group of profiles no 2 are shown in Figure 4-6. A low-resistivity structure coincides with the interpreted lineament ZSMNW042A. This structure is shifted approximately 30 m to the north relative the low-magnetic anomaly. The width of the structure is around 50 to 60 m and the resistivity is rather low (< 2,500 Ωm) in the central part of the structure. The dip seems to be subvertical. A less prominent but significant low-resistivity structure can be seen at coordinate 440 in Figure 4-6. It appears to dip to the south and coincides roughly with a magnetic low (Figure 4-5) that strikes WNW. No low resistivity structure can be seen at

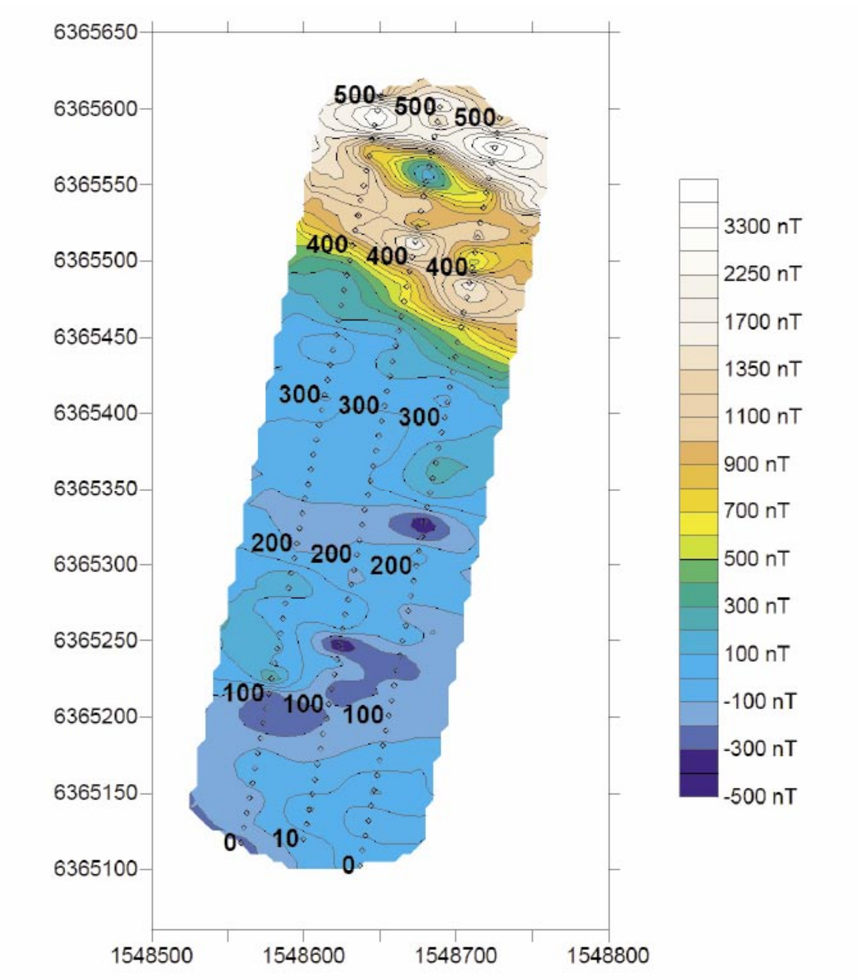

Figure 4-5. Contour map of ground magnetic data from profile group 2. Measurement stations are shown with symbols. Labels indicate local line-coordinates.

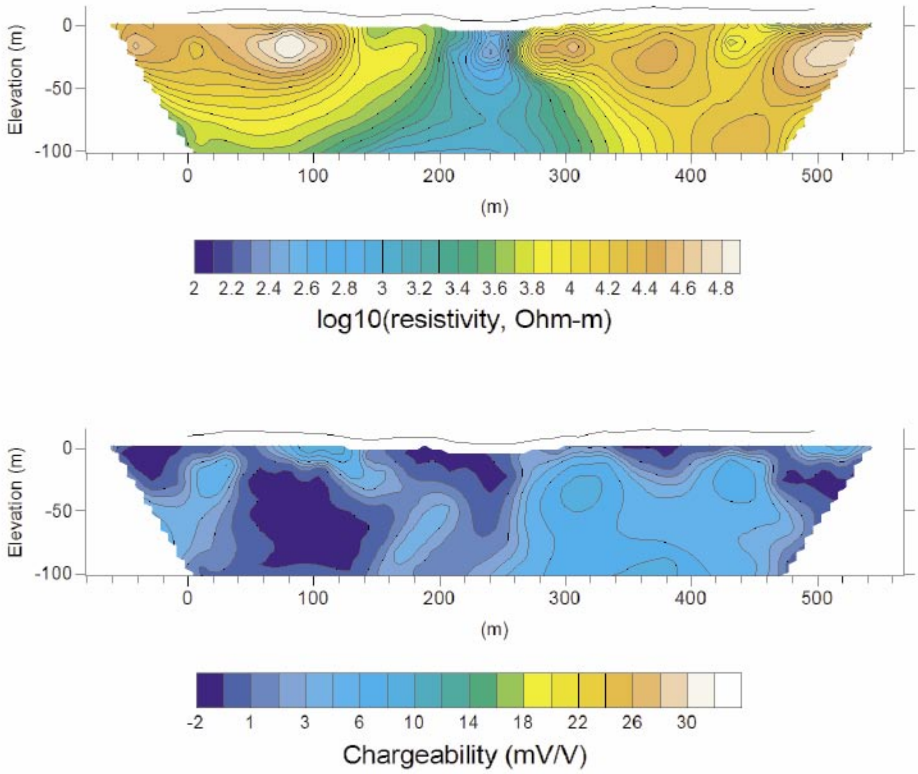

Figure 4-6. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of profile group 2 (LSM000277). The black lines show elevation data along the profile.*

the position of XSM0006A2. A low-chargeability anomaly seems to be related to the major low-resistivity structure. The chargeability contrasts are however quite small along the profile and the shape of the anomaly is therefore poorly constrained.

No slingram data were acquired for the group of profiles no 2.

4.3 Group of profiles no 3

The group of profiles no 3 consists of the profiles LSM000278, 308 and 309, where LSM000278 is the central profile. The group is located south of Mederhult.

The target for profile group 3 was a south-north striking lineament (ZSM0059B) in the western part of the Laxemar area. The ground magnetic data can be seen in Figure 4-7. An almost 100 m wide magnetic low that can be related to the lineament ZSM0059B can be seen at profile coordinates 200 to 290 m.

Inverted resistivity and chargeability sections for the group of profiles no 3 are shown in Figure 4-8. A low-resistivity structure coincides with the interpreted lineament. The centre of this structure is shifted approximately 50 m to the west relative the low-magnetic anomaly. The width of the structure is around 70 to 80 m and the resistivity is rather low (~3,000 Ωm) in the central part of the structure. The dip seems to be steeply to the west. A less prominent low-resistivity structure can be seen at coordinate 0 in Figure 4-8. It coincides roughly with a magnetic low (Figure 4-7). Low-chargeability anomalies seem to be related to the both low-resistivity structures. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained.

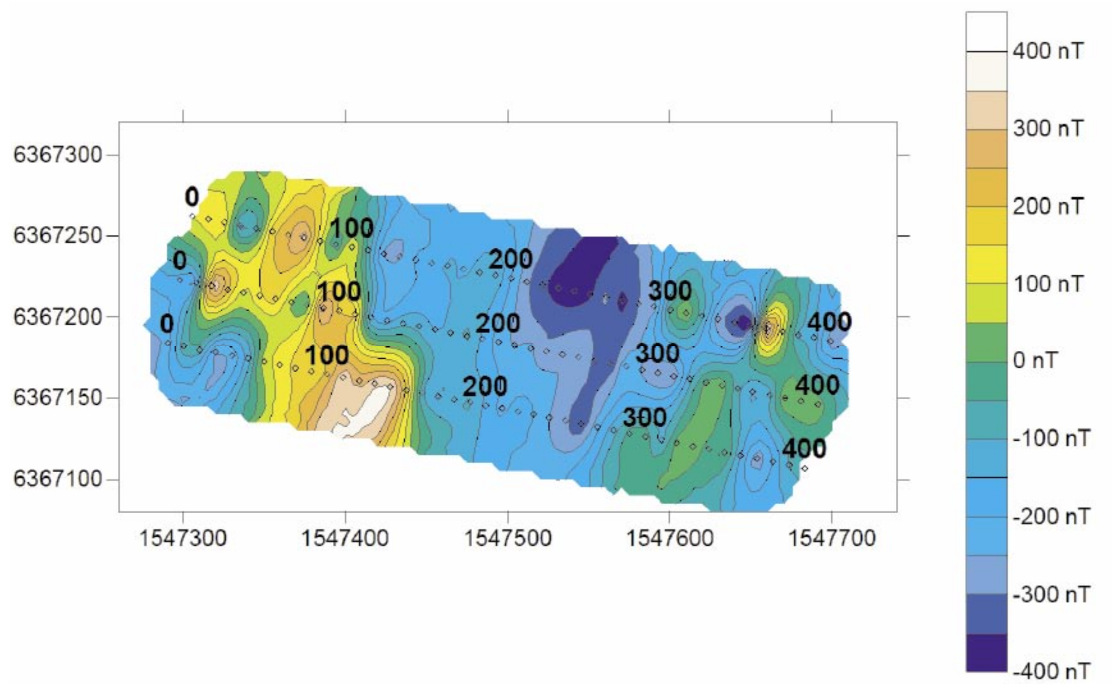

Figure 4-7. *Contour map of ground magnetic data from profile group 3. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

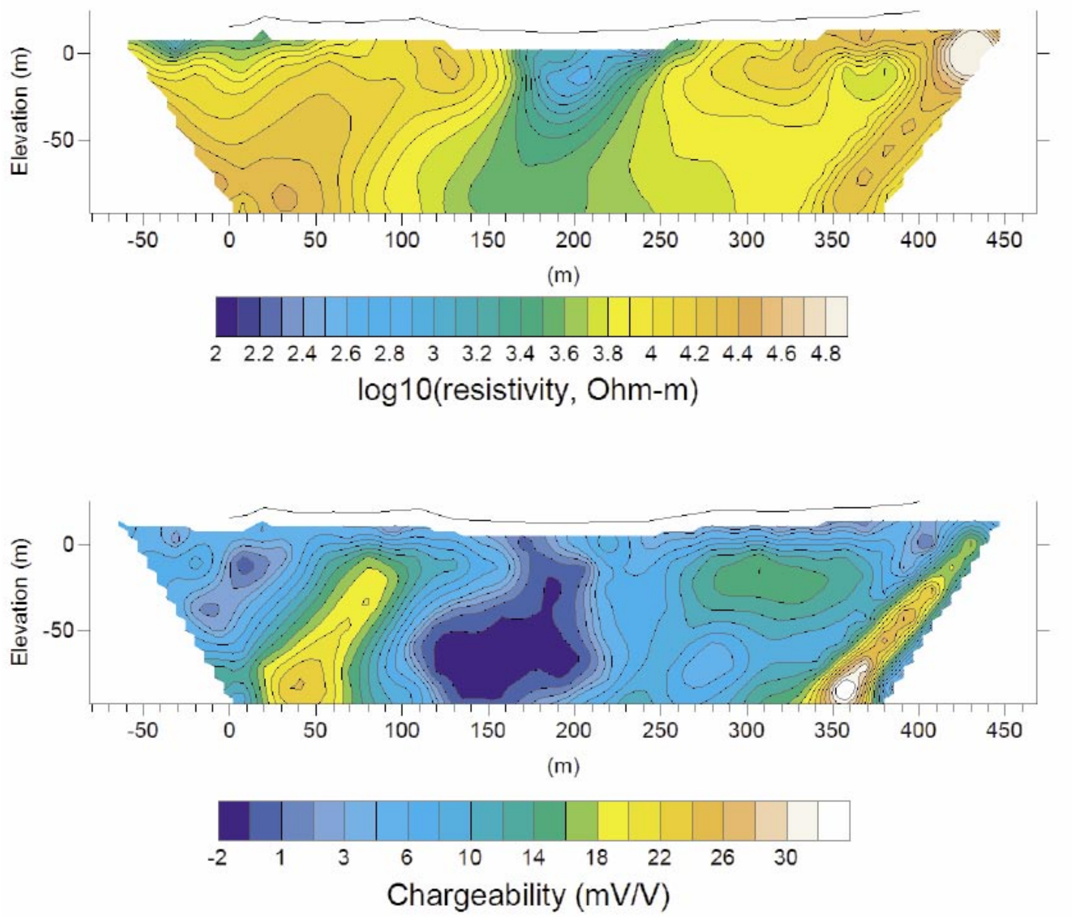

Figure 4-8. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of profile group 3 (LSM000278). The black lines show elevation data along the profile.*

The peculiar anomalies in the easternmost part of the sections are probably the effect of a road bank.

Slingram data for the three profiles can be seen in Figure 4-9. The measurements were severely affected by a telephone line close to a road in the eastern part of the area. Anomalies can however be seen in the imaginary components at coordinate 200 m along all three profiles. The minima at the centre of the anomalies have a magnitude of 11 to 14% relative background for the highest frequency (14 kHz). The position of the slingram anomaly corresponds well to the low-resistivity structure in Figure 4-8. No dip estimates can be made based on the slingram data since the eastern shoulder of the anomalies is affected by noise caused by the telephone line.

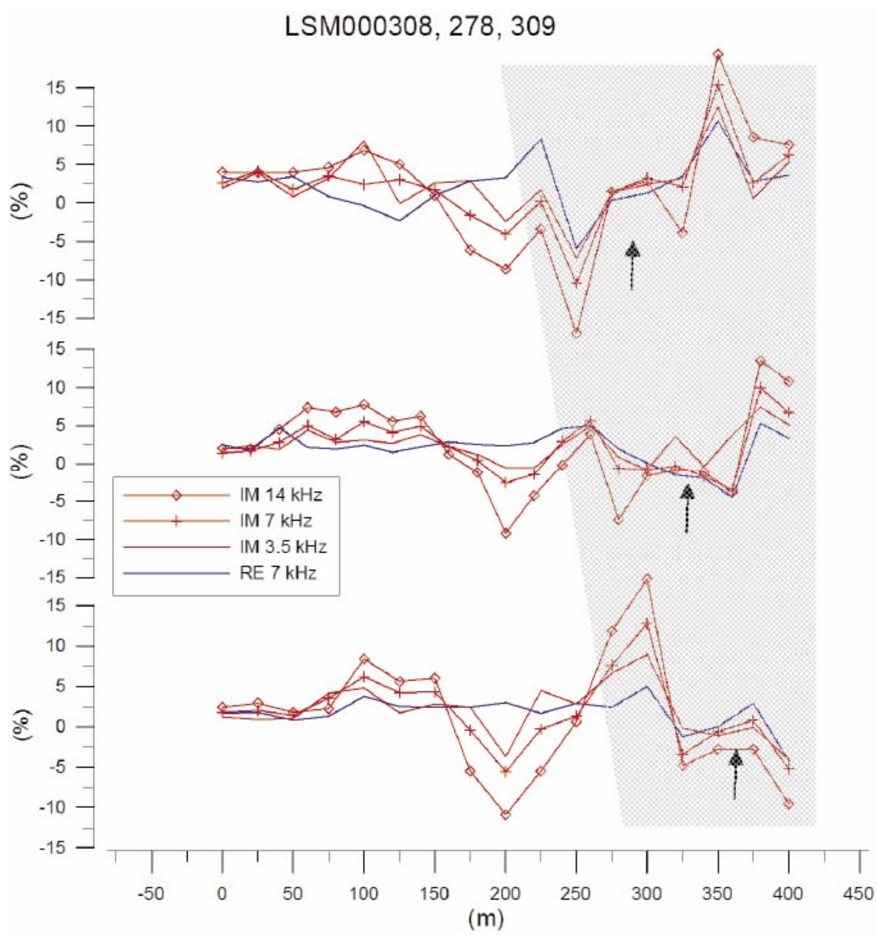

Figure 4-9. *Slingram data for profile group 3 (LSM000308 top, LSM000278 centre, LSM000309 bottom). The arrows indicate the position of a telephone line according to the field notes. The shaded area indicates those data that have been severely affected by the telephone line.*

4.4 Group of profiles no 4

The group of profiles no 4 consists of the profiles LSM000279, 310 and 311, where LSM000279 is the central profile. The group is located near Hultenäs.

The target for profile group 4 was an east-west striking lineament (ZSMEW007A) in the central part of the Laxemar area. The profiles also cross the lineament XSM0234A1. The ground magnetic data can be seen in Figure 4-10. A magnetic low can be seen at profile coordinates around 160 m. Two more less continuous minima can be seen at around 80 and 320 m. The former of these corresponds in position to XSM0234A1.

Inverted resistivity and chargeability sections for the group of profiles no 4 are shown in Figure 4-11. A low-resistivity structure coincides with the interpreted lineament ZSMEW007A. The centre of this structure is shifted approximately 50 m to the north relative the low-magnetic anomaly. The width of the structure is around 60 m and the resistivity is fairly low (~4,000 Ωm) in the central part of the structure. The dip seems to be steeply to the north. A less prominent low-resistivity structure can be seen at coordinate 330 in Figure 4-11. It coincides roughly with a magnetic low (Figure 4-10). This structure

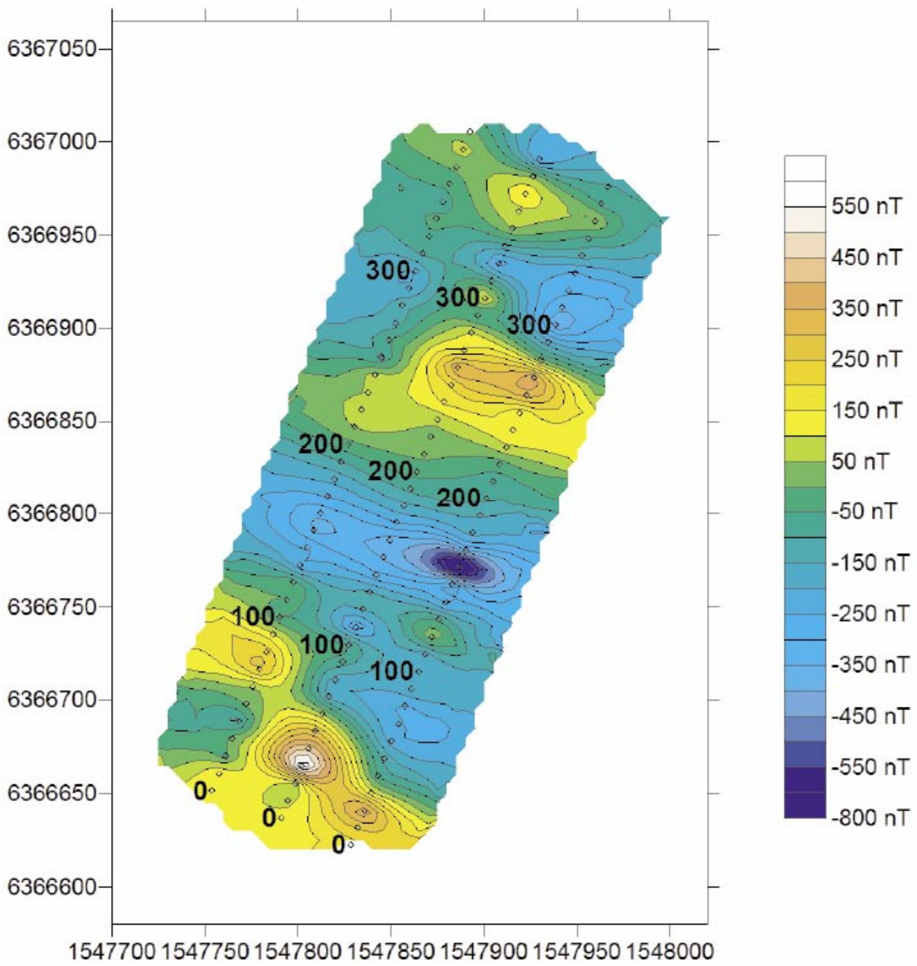

Figure 4-10. *Contour map of ground magnetic data from profile group 4. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

appears to be dipping to the south. The dip is however not well determined since the two low-resistivity structures overlap at depth. Low-chargeability anomalies seem to be related to both the low-resistivity structures. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained.

Slingram data for the three profiles can be seen in Figure 4-12. The measurements were severely affected by a telephone line in the southern-central part of the area. Anomalies can however be seen in the imaginary components at coordinate 225 m along the two eastern profiles (LSM000279, LSM000311). The minima at the centre of the anomalies have a magnitude of around 8 to 10% relative background for the highest frequency (14 kHz). The position of the slingram anomaly corresponds well to the low-resistivity structure in Figure 4-11. No dip estimates can be made based on the slingram data, since the southern shoulder of the anomalies is affected by noise caused by the telephone line.

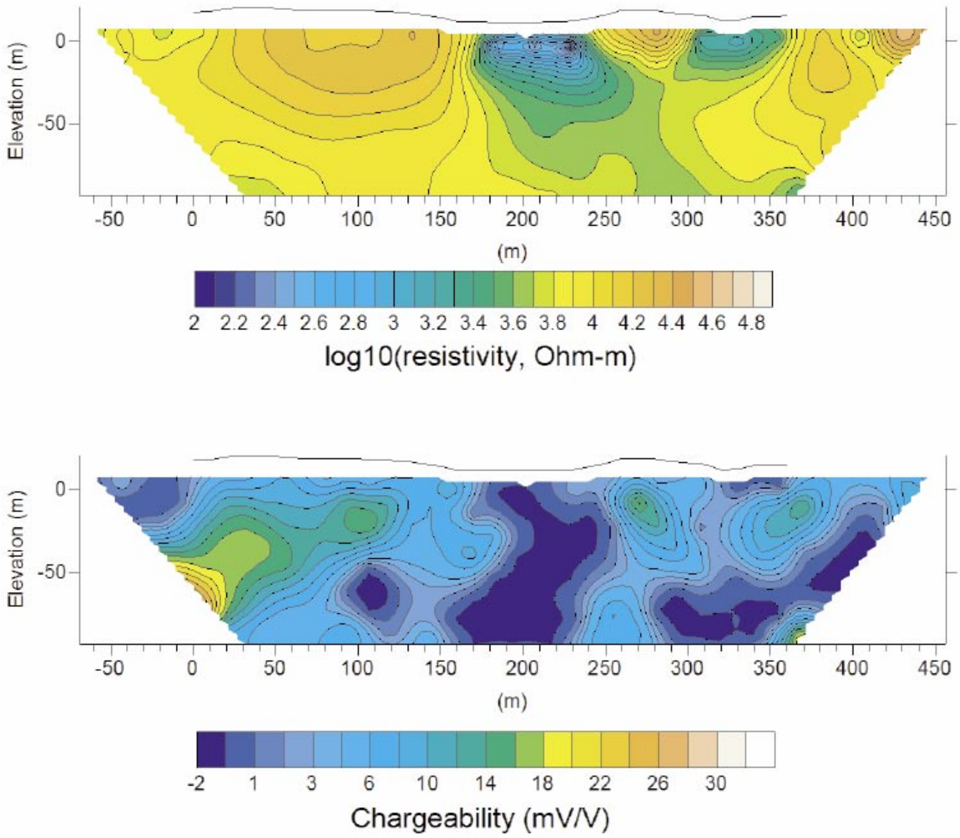

Figure 4-11. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of profile group 4 (LSM000279). The black lines show elevation data along the profile.*

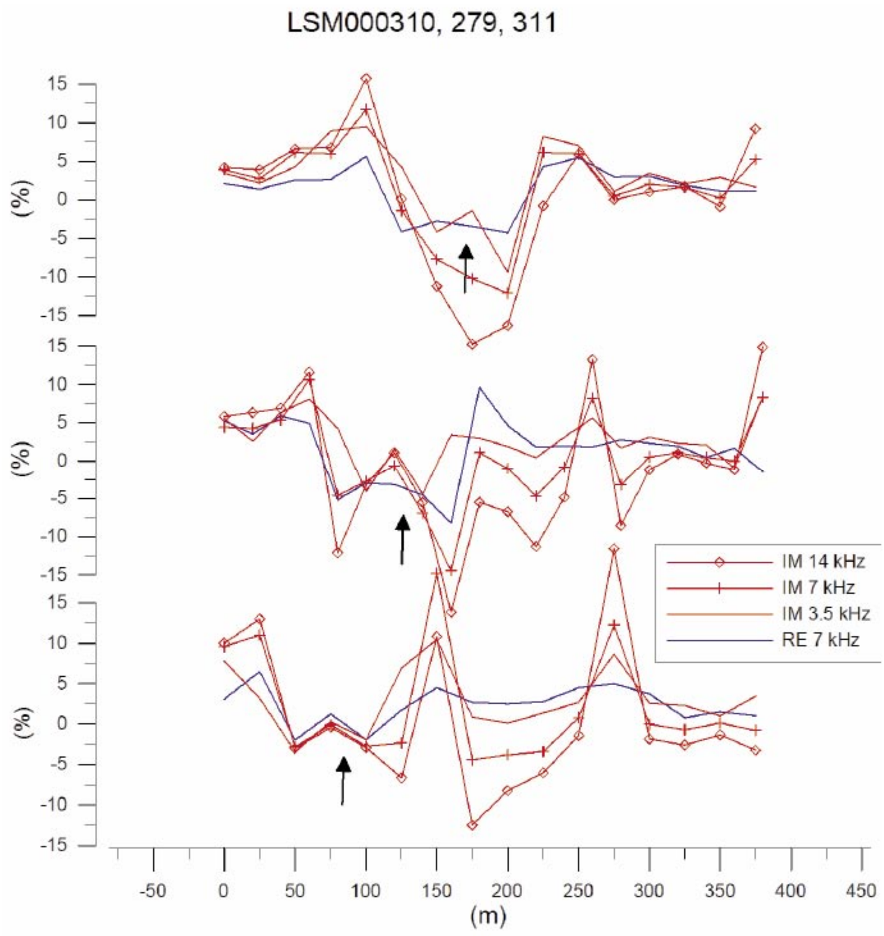

Figure 4-12. Slingram data for profile group 4 (LSM000310 top, LSM000279 centre, LSM000311 bottom). The arrows indicate the position of a telephone line according to the field notes.

4.5 Group of profiles no 5

The group of profiles no 5 consists of the profiles LSM000280, 312 and 313, where LSM000280 is the central profile. The group is located south of Ärnhult.

The target for profile group 5 was the same east-west striking lineament (ZSMEW007A) as for group 4 in the central part of the Laxemar area. Further north the profiles also cross the lineament ZSMEW007B, which is a branch of the main lineament. The ground magnetic data can be seen in Figure 4-13. Three low-magnetic structures cross the area. The most prominent one crosses the central profile at line-coordinate 230 m. The strike direction is SW-NE which is not the same as the general direction of ZSMEW007A. The position of the crossover is however more or less the same. Another magnetic low strikes SE–NW and crosses the central profile at line-coordinate 90 m and a third, WNW-striking magnetic low crosses the central profile at line-coordinate 480 m. The position of the latter magnetic low coincides well with ZSMEW007B. The magnetic pattern is rather complex in the area with structures in both SE–NW and SW–NE directions, in some cases overlapping each other.

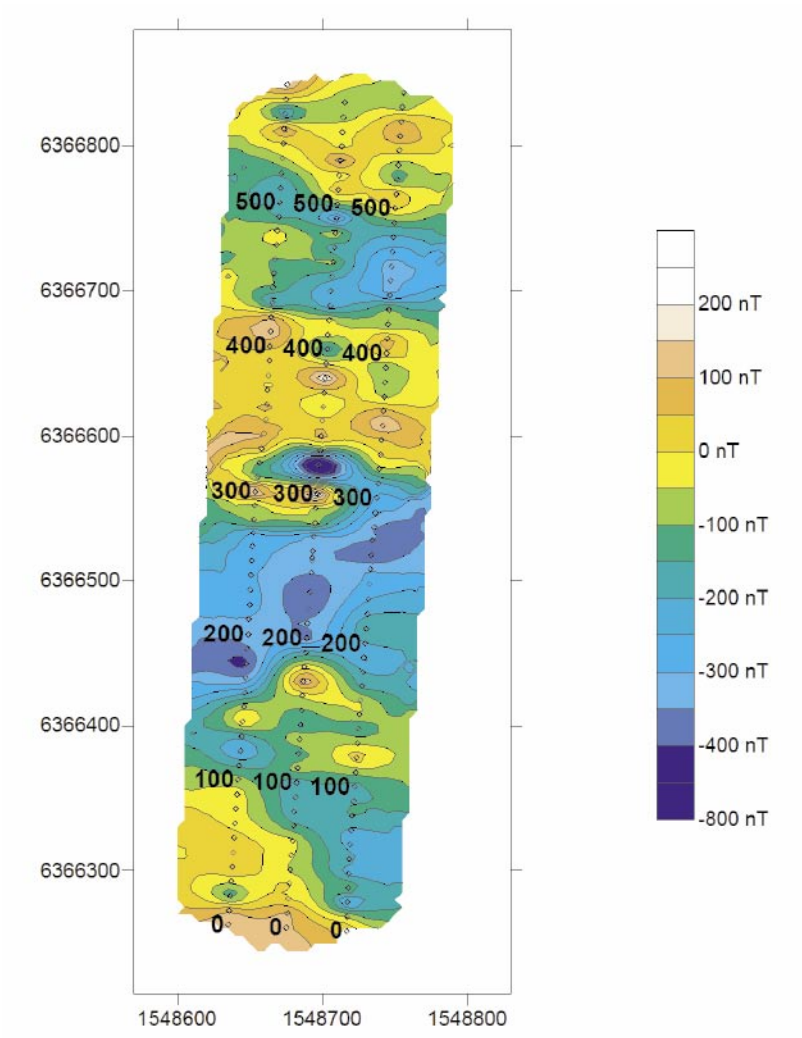

Figure 4-13. *Contour map of ground magnetic data from profile group 5. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

Inverted resistivity and chargeability sections for the group of profiles no 5 are shown in Figure 4-14. A low-resistivity structure coincides with the interpreted lineament ZSMEW007A. The centre of this structure is shifted approximately 50 m to the north relative the low-magnetic anomaly. The structure has a rather complex shape. The deeper part appears to be offset to the north relative the near-surface part. The shape of the structure in Figure 4-14 should not be over-interpreted though, since 3D geometry might cause effects in 2D inversion that are difficult to foresee. The width of the structure is around 60 m and the resistivity is fairly low (~4,000 Ωm) in the central part of the structure. The dip is subvertical or possibly towards north. A less prominent low-resistivity structure can be seen at coordinate 450 m in Figure 4-14. It coincides roughly with the position of ZSMEW007B. This structure appears to be dipping to the north. A low-chargeability anomaly seems to be related to the northern low-resistivity structure. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained.

Slingram data for the three profiles can be seen in Figure 4-15. The measurements were severely affected by telephone lines. Anomalies can however be seen in the imaginary components at coordinate 275 m. The minima at the centre of the anomalies have a magnitude of around 5 to 8% relative background for the highest frequency (14 kHz). The position of the slingram anomaly corresponds well to the main low-resistivity structure in Figure 4-14. No dip estimates can be made based on the slingram data, since the southern shoulder of the anomalies is affected by noise caused by a telephone line. It can be noted the strike direction of the low-resistivity structure appears to be almost perpendicular to the profiles which is not the same as the direction of the closest low-magnetic structure. The northern low-resistivity structure does not cause a significant slingram anomaly.

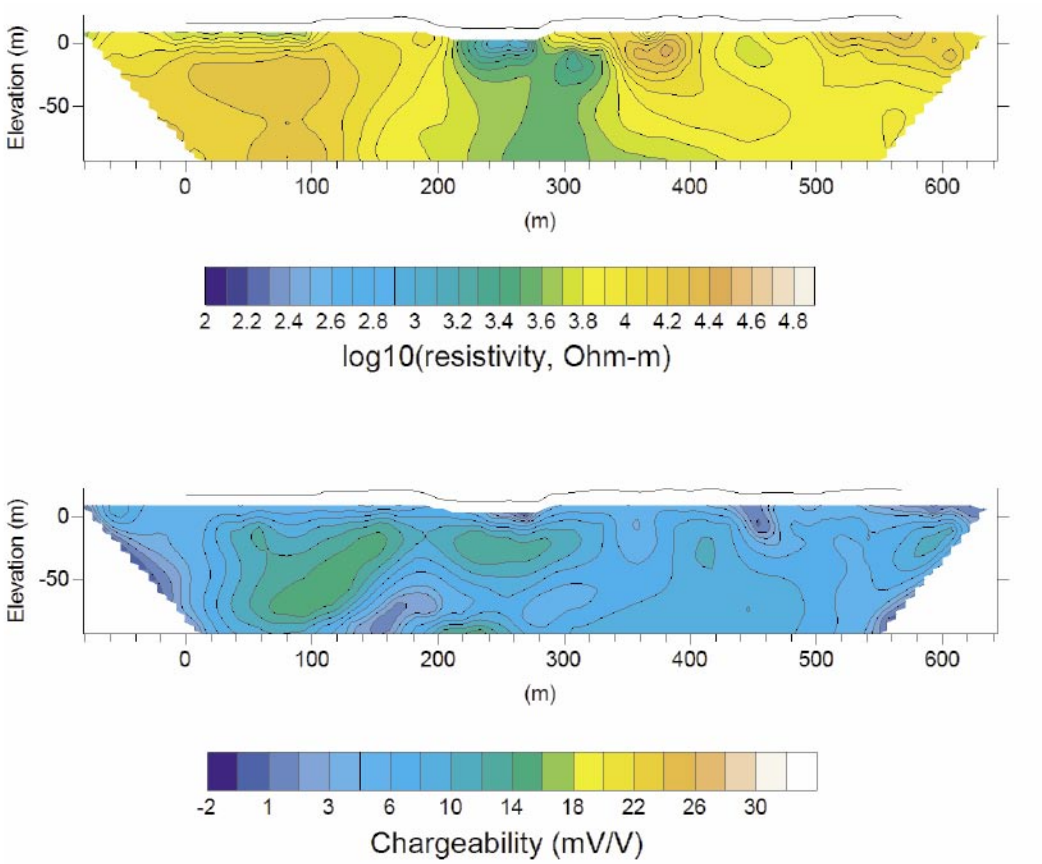

Figure 4-14. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of profile group 5 (LSM000280). The black lines show elevation data along the profile.*

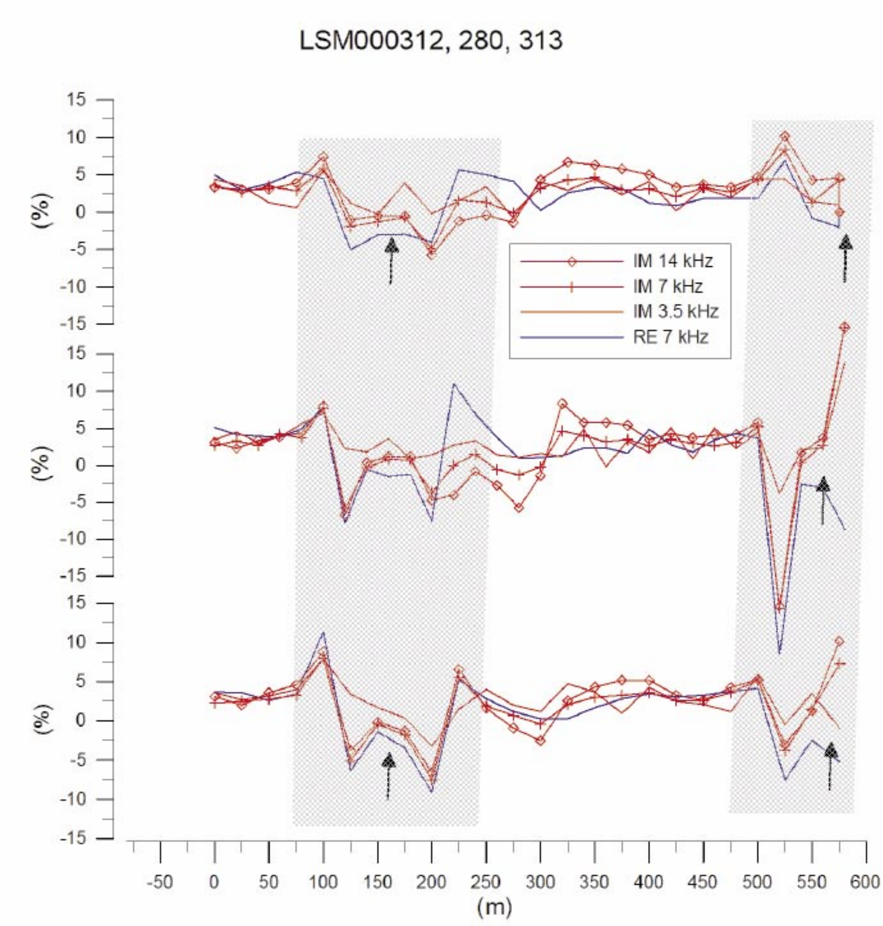

Figure 4-15. *Slingram data for profile group 5 (LSM000312 top, LSM000280 centre, LSM000313 bottom). The arrows indicate the position of telephone lines according to the field notes. The shaded areas indicate those data that have been severely affected by the telephone lines.*

4.6 Group of profiles no 6

The group of profiles no 6 consists of the profiles LSM000281, 314 and 315, where LSM000281 is the central profile. The group is located north-west of Lilla Laxemar.

The target for the group of profiles no 6 was the same east-west striking lineament (ZSMEW007A) as for groups 4 and 5 in the central part of the Laxemar area. The lineament XSM0044A1 terminates at ZSMEW007A in the central part of the survey area. The ground magnetic data can be seen in Figure 4-16. Three low-magnetic structures cross the area. The most prominent one is more than 100 m wide and crosses the central profile at line-coordinate 230 m. The strike direction is ENE. The position of the magnetic low corresponds well with ZSMEW007A and the termination of XSM044A1. Another magnetic low strikes EW and crosses the profiles at line-coordinate 90 m and a third, ENE-striking magnetic low crosses the central profile at line-coordinate 0 m, where the profile group joins the end of group 8.

Inverted resistivity and chargeability sections for the group of profiles no 6 are shown in Figure 4-17. A low-resistivity structure coincides approximately with the interpreted

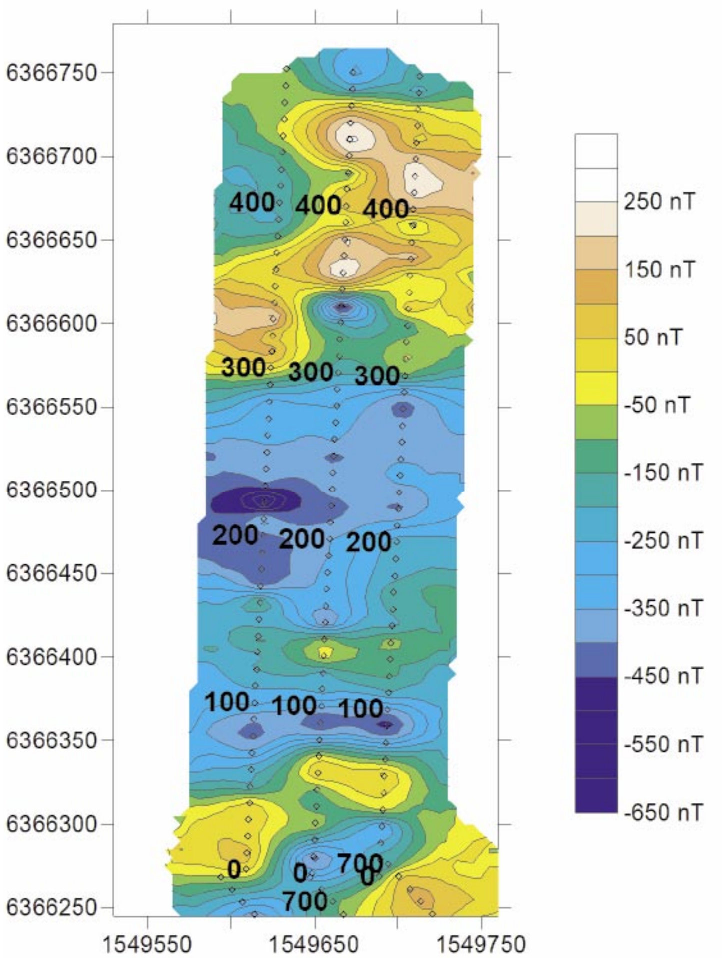

Figure 4-16. *Contour map of ground magnetic data from the profile group 6. Measurement stations are shown with symbols. Labels indicate local line-coordinates. The northern end of group 8 can be seen in the southern part of the map.*

lineament ZSMEW007A. The centre of this structure is shifted approximately 40 m to the north relative the centre of the low-magnetic anomaly. The width of the structure is around 60 m and the resistivity is fairly low (~4,000 Ωm) in the central part of the structure. The dip is towards north. The magnetic lows further south have no corresponding low-resistivity structure. A low-chargeability anomaly seems to be related to the low-resistivity structure. The chargeability contrasts are however quite small along the profile and the shape of the anomaly is therefore poorly constrained.

Slingram data for the three profiles can be seen in Figure 4-18. The measurements were severely affected by cultural features. Any possible anomaly due to geological conductors is masked by cultural noise (telephone lines and fences).

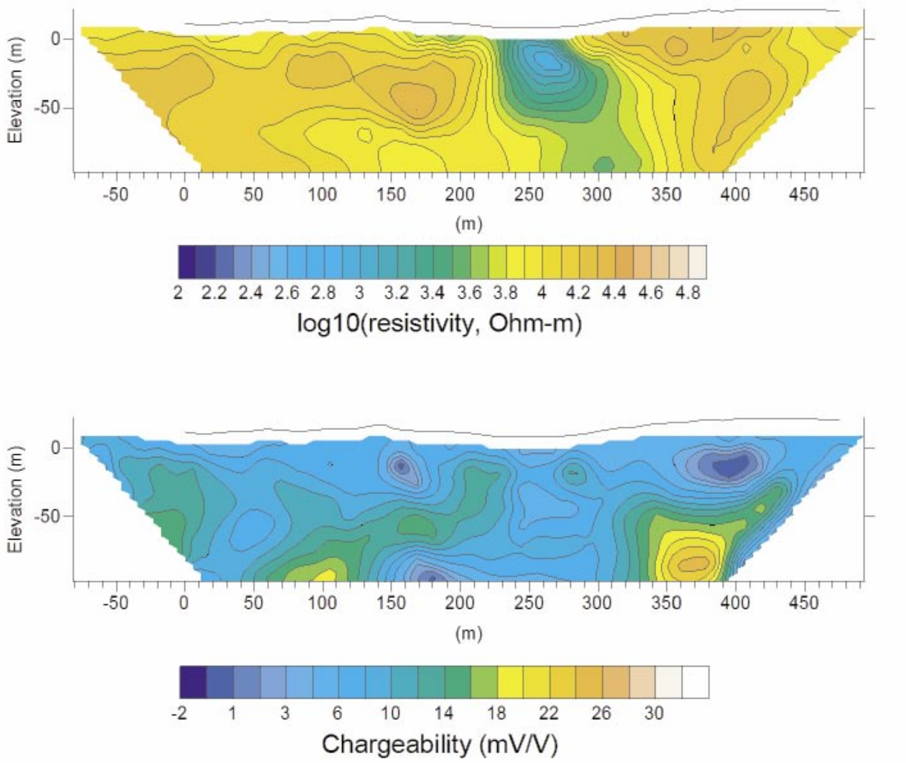

Figure 4-17. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of the profile group 6 (LSM000281). The black lines show elevation data along the profile.*

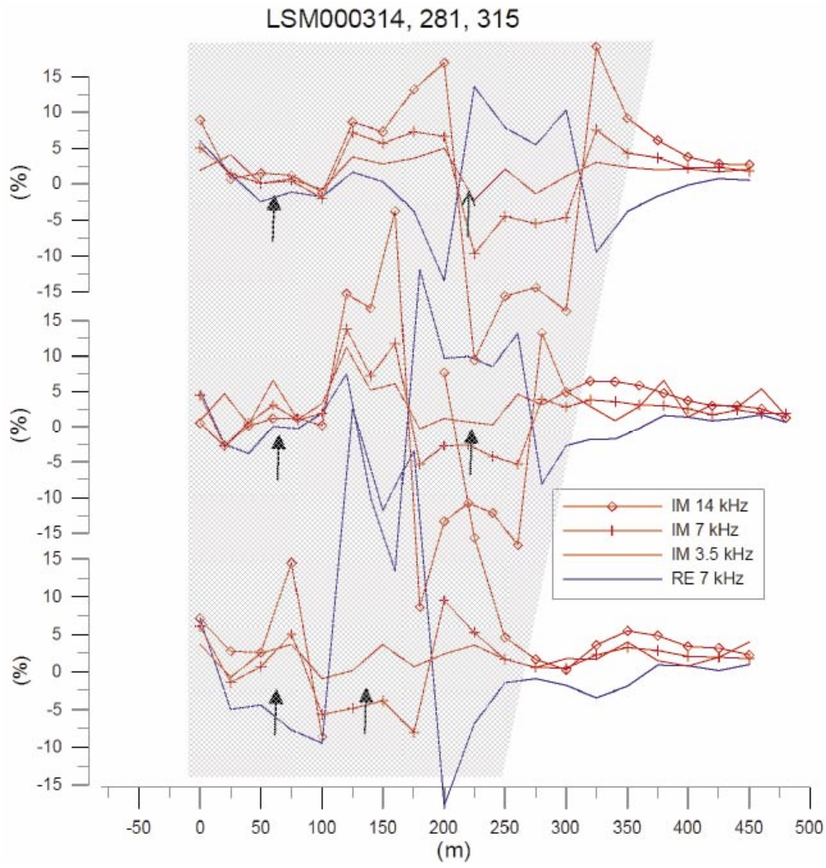

Figure 4-18. *Slingram data for the profile group 6 (LSM000314 top, LSM000281 centre, LSM000315 bottom). The arrows indicate the position of cultural features according to the field notes. The shaded area indicates those data that have been severely affected by the cultural features.*

4.7 Group of profiles no 7

The group of profiles no 7 consists of the profiles LSM000282, 316 and 317, where LSM000282 is the central profile. The group is located north-east of Lilla Laxemar.

The target for the group of profiles no 7 was a SW–NE striking lineament (ZSMNE040A) in the north-eastern part of the Laxemar area. The ground magnetic data can be seen in Figure 4-19. A low-magnetic structure crosses the area at line-coordinate 180 m. The strike direction is SW–NE and the position corresponds well with ZSMNE040A. Another magnetic low with the same direction crosses the profiles at line-coordinate 40 m.

Inverted resistivity and chargeability sections for the group of profiles no 7 are shown in Figure 4-20. A low-resistivity structure coincides approximately with the interpreted lineament ZSMNE040A and the magnetic low mentioned above. The width of the structure is around 20 m. The width of the structure is significantly less than the dipole length and the survey and the resistivity is therefore difficult to estimate, but it is probably is fairly low (~4,000 Ωm). The dip appears to be steep although low resistivity in the lower right of the section makes the dip somewhat uncertain. The low resistivity at depth is most likely an effect of 3D-geometry but the presence of saline ground-water can not be excluded to be the cause. A less prominent low-resistivity structure can be seen at line-coordinate 50 m, which is approximately the same as a magnetic low mentioned above. Low-chargeability anomalies seem to be related to the low-resistivity structures. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained.

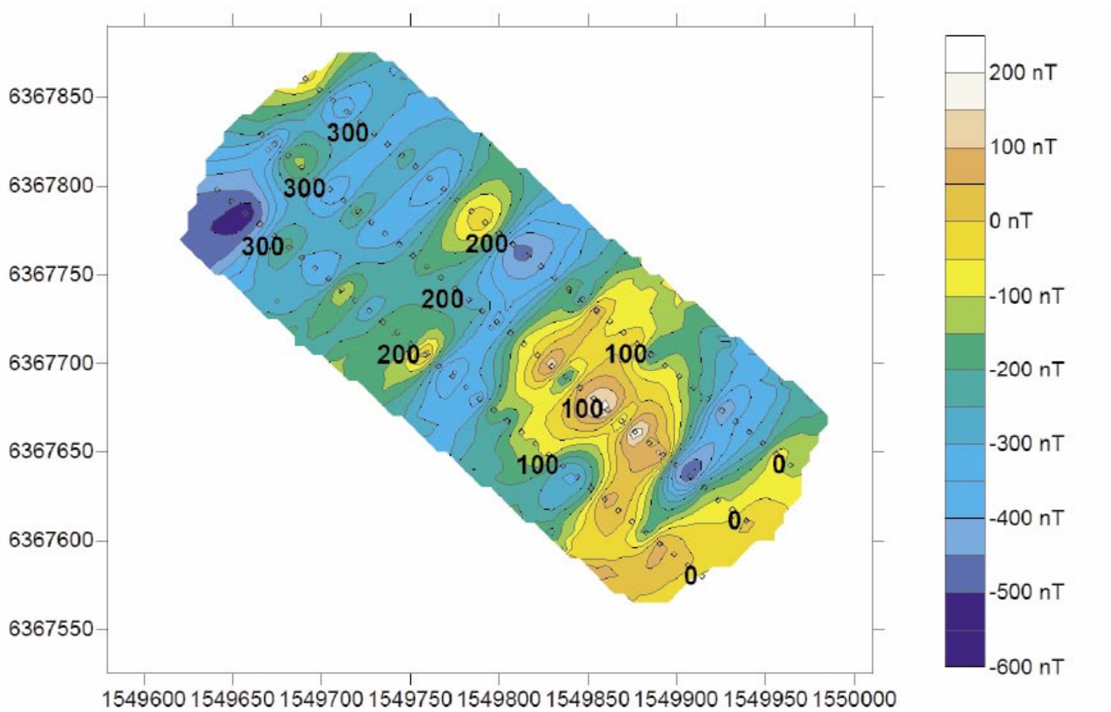

Figure 4-19. *Contour map of ground magnetic data from the profile group 7. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

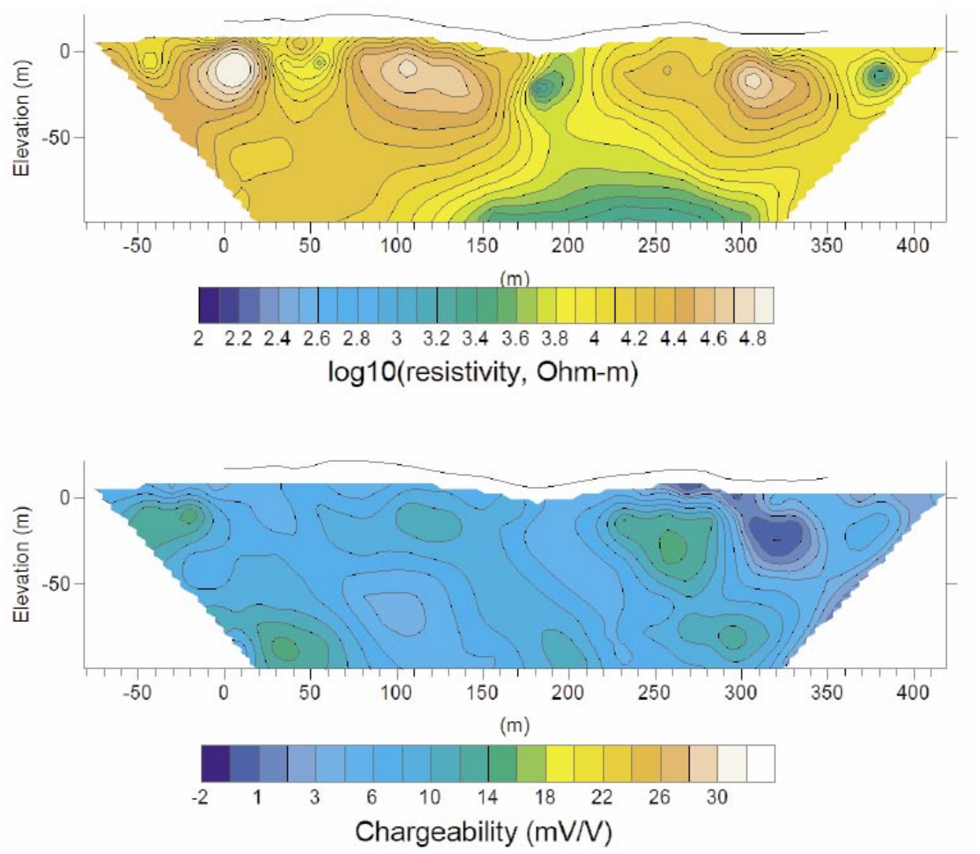

Figure 4-20. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of the profile group 7 (LSM000282). The black lines show elevation data along the profile. Note that the coordinate 0 starts in south-east.*

Slingram data for the three profiles can be seen in Figure 4-21. The measurements were severely affected by a telephone line at the beginning of the profiles. A weak slingram anomaly can however be seen at line-coordinate 200 m for profiles LSM00282 and 317 for the imaginary components. The position of the anomaly coincides with the low-resistivity structure in Figure 4-20. The minima at the centre of the anomalies have a magnitude of around 2% relative background for the highest frequency (14 kHz).

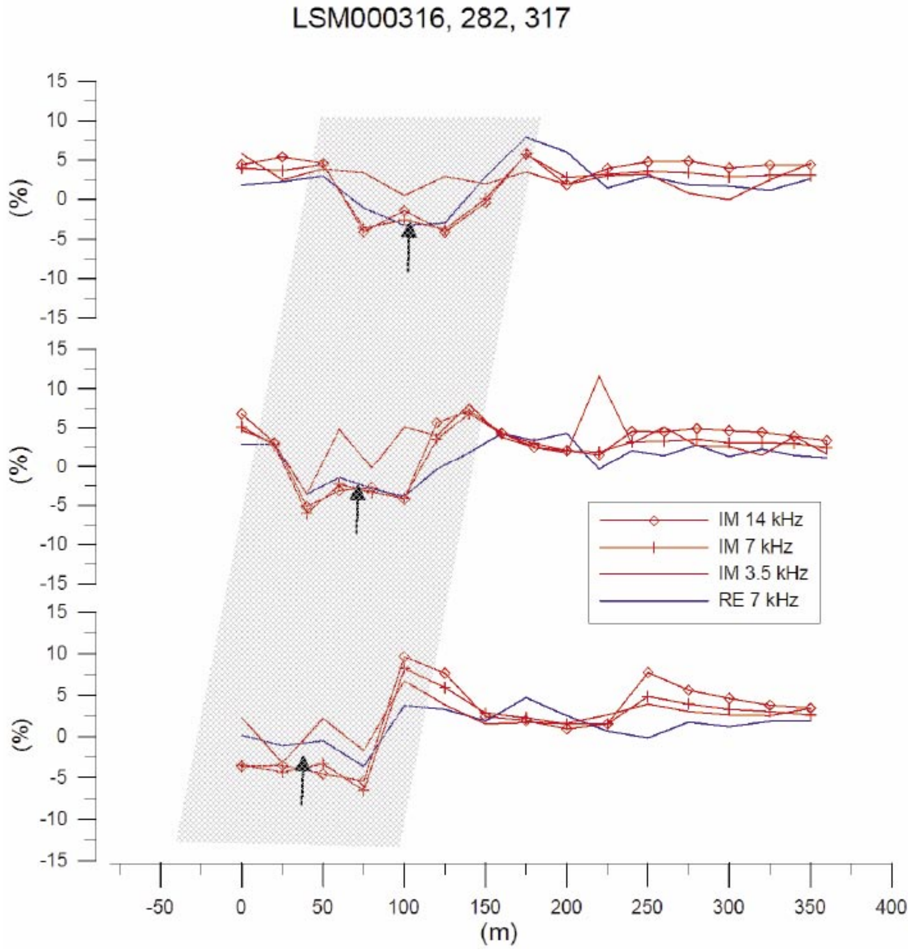

Figure 4-21. *Slingram data for the profile group 7 (LSM000316 top, LSM000282 centre, LSM000317 bottom). The arrows indicate the position of cultural features according to the field notes. The shaded area indicates those data that have been severely affected by the cultural features. Note that the coordinate 0 starts in south-east.*

4.8 Group of profiles no 8

The group of profiles no 8 consists of the profiles LSM000283, 318 and 319, where LSM000283 is the central profile. The group is located west of Lilla Laxemar.

The targets for profile group 8 were two SW–NE striking interpreted lineaments (ZSMNE005A and ZSMNE012A) in the eastern part of the Laxemar area. ZSMNE005A is commonly referred to as the Äspö shear-zone. The ground magnetic data can be seen in Figure 4-22. Four low-magnetic structures trending NE to NNE crosses the area with their centres at line-coordinates 150, 360, 510 and 720 m respectively. The last one is the same magnetic low that was noted for profile group 6. The magnetic low at 360 m is around 100 m wide.

Inverted resistivity and chargeability sections for profile group 8 are shown in Figure 4-23. Two low-resistivity structures can be seen at line-coordinates 210 and 450 m. This is more or less in-between the magnetic lows mentioned above. The resistivity of the structures is quite moderate, only slightly below background. The very low resistivity close to the surface is most likely due to clayey soil cover. The dip appears to be towards north-west. Low-chargeability anomalies seem to be related to the low-resistivity structures. The chargeability contrasts are however quite small along the profile and the shape of the anomalies is therefore poorly constrained. The host rock to the structures appears to have lower resistivity in the south-eastern part of the profile relative the north-western part.

No slingram data were acquired for profile group 8.

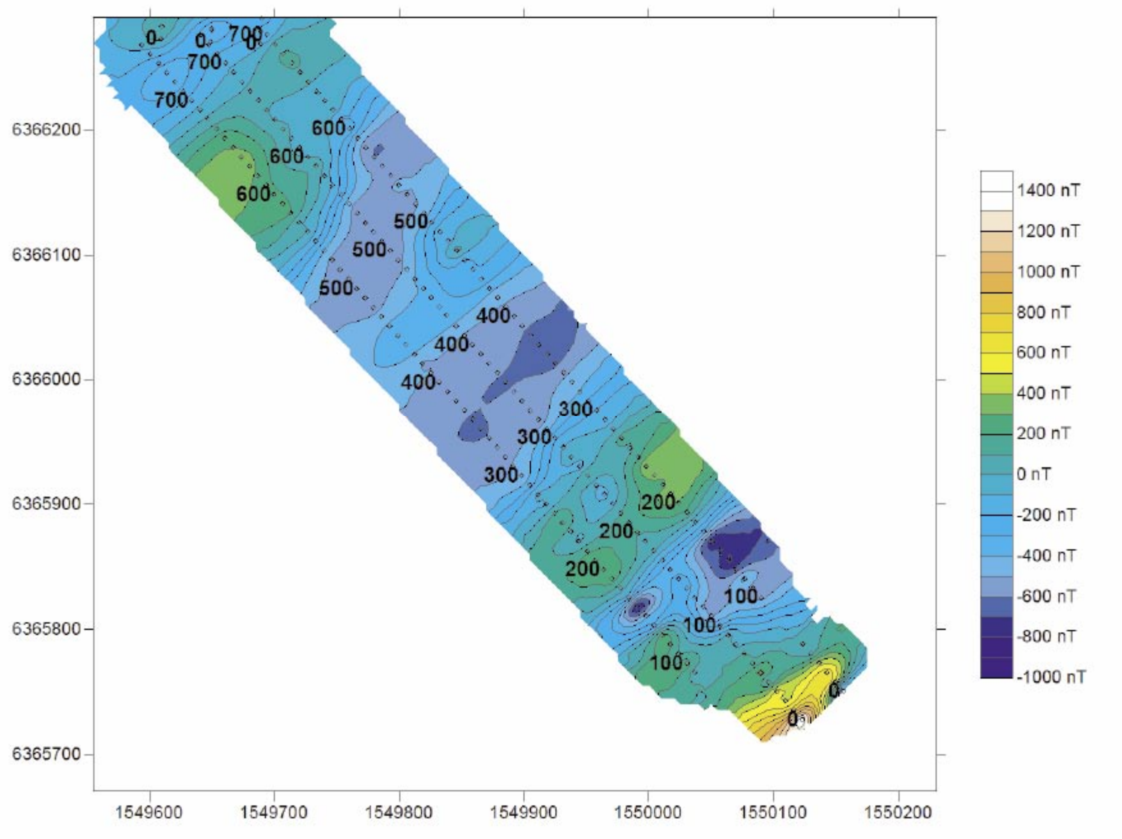

Figure 4-22. *Contour map of ground magnetic data from the group of profiles no 8. Measurement stations are shown with symbols. Labels indicate local line-coordinates.*

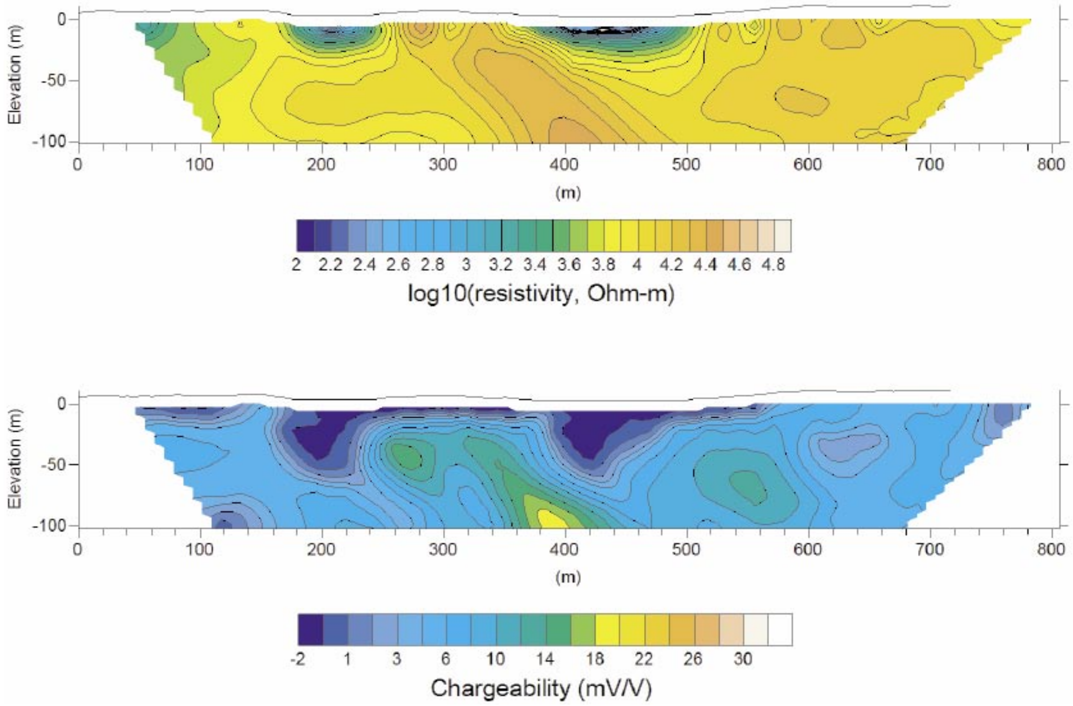

Figure 4-23. *Inverted resistivity (top) and chargeability (bottom) sections for the central profile of the group of profiles no8 (LSM000283). The black lines show elevation data along the profile. Note that the coordinate 0 starts in south-east.*

4.9 Data delivery

The following data have been delivered to SKB: Raw and processed magnetic, resistivity and slingram data, magnetic grids and inverted resistivity and chargeability sections (as text and grid files). Maps have also been delivered as geo-referenced bitmap images.

The delivered data have been inserted in the database (SICADA) of SKB. The SICADA reference to the present activity is field note no 366. The SICADA reference to the line survey data is field note no 365.

5 Conclusions

Low-magnetic and low-resistivity structures that can be related to the target lineaments have been identified at all profile group locations. The low-resistivity structures correlate very well to topographic lows. The magnetic lows are however in many cases shifted laterally to the resistivity/elevation anomalies. Low resistivity is the effect of water-bearing fractures and/or high porosity in the rock whereas magnetic lows, related to deformation, is the effect of destruction of ferro-magnetic minerals due to alteration (oxidation). The difference in position of the two types of anomalies might therefore be the effect of different generations of deformation along the lineaments. The magnetic lows are probably related to an early, possibly partly ductile, deformation whereas the resistivity lows probably are due to brittle deformation causing water bearing fractures.

Estimated bulk resistivity values for the low-resistivity structures are given in Chapter 4 based upon the inverted sections. It should however be noted that these values in many cases are higher than the lowest apparent resistivity values found in the raw data, even for the largest transmitter-receiver separations. The estimates are thus to be treated as conservative. Portions of the structure may have lower resistivity.

Most significant low-resistivity structures seem to have low chargeability. This will be consistent with a situation where most of the electric conduction is along water-bearing fractures. Increased electric conductivity due to chlorite- and/or clay-alteration would in most cases be accompanied by an increase in chargeability. Such alteration might still occur but probably to a limited extent.

Most of the low-resistivity structures had fairly simple geometry in the inverted sections. An exception was the structures related to the lineament ZSMEW007A in the central part of the Laxemar area. The magnetic lows related to this lineament were also laterally displaced from the resistivity/elevation anomaly and in one case of a different strike direction. This implies that the lineament might be the effect of a complex deformation process that most likely consisted of more than one phase.

The low-resistivity structures of profile group 8 (corresponding interpreted lineaments: ZSMNE005A and ZSMNE012A) are of a different character compared to the major resistivity anomalies of the other profile groups. The resistiviy of these structures is just slightly lower than the resistivity of the host rock. This indicates that the brittle component related to these lineaments might be of less magnitude compared to the other lineaments. ZSMNE005A is often referred to as Äspö shear-zone.

The slingram measurements were severely affected by cultural features like telephone lines and fences. However, at those profile sections where good data were obtained, slingram anomalies coincided with the major resistivity anomalies.

References

/1/ **Triumf C-A, 2004.** Oskarshamn site investigation. Joint interpretation of lineaments. SKB P-04-49. Svensk Kärnbränslehantering AB.

/2/ **Lindqvist G, 2004.** Oskarshamn site investigation. Refraction seismic measurements in Laxemar. SKB P-04-134. Svensk Kärnbränslehantering AB.