Maxwell modelling Varaldsøy - Norway

Modelling report

January 2010

SkyTEM ApS

Modelling Report – Varaldsøy
Preliminary version

Contents

Introduction

In January 2010 the data collected in October 2009 by SkyTEM ApS has undergone a 3D thin–plate modelling using the Maxwell software package. The modelling was carried out by Sara Thofte and Per Gisselø.

The model project requested by Norrbotten Exploration AB was planned to be undertaken in close contact with John Pedersen and Peter Wulff.

The 3D modelling of the TEM data gives a better estimate of the depth and orientation of the potential ore bodies creating the TEM anomalies. The Maxwell modelling describes the targets as thin or thick plates. In this survey all targets can be modelled as thin plates. Additionally, in one case it is additionally possible to model target as a thick plate as well as a thin plate (this is described later in this report). The location and depths to the plates are found and the plates are defined by their conductance, size, dip and strike. The improved knowledge is used to suggest drilling locations. SkyTEM ApS does not guaranty the successful intersection of ore bodies on behalf of the proposed drill locations.

Survey Outline

"Modelling report, Varaldsøy" covers Maxwell thin-plate modelling of TEM data from the Varaldsøy area carried out by SkyTEM ApS.

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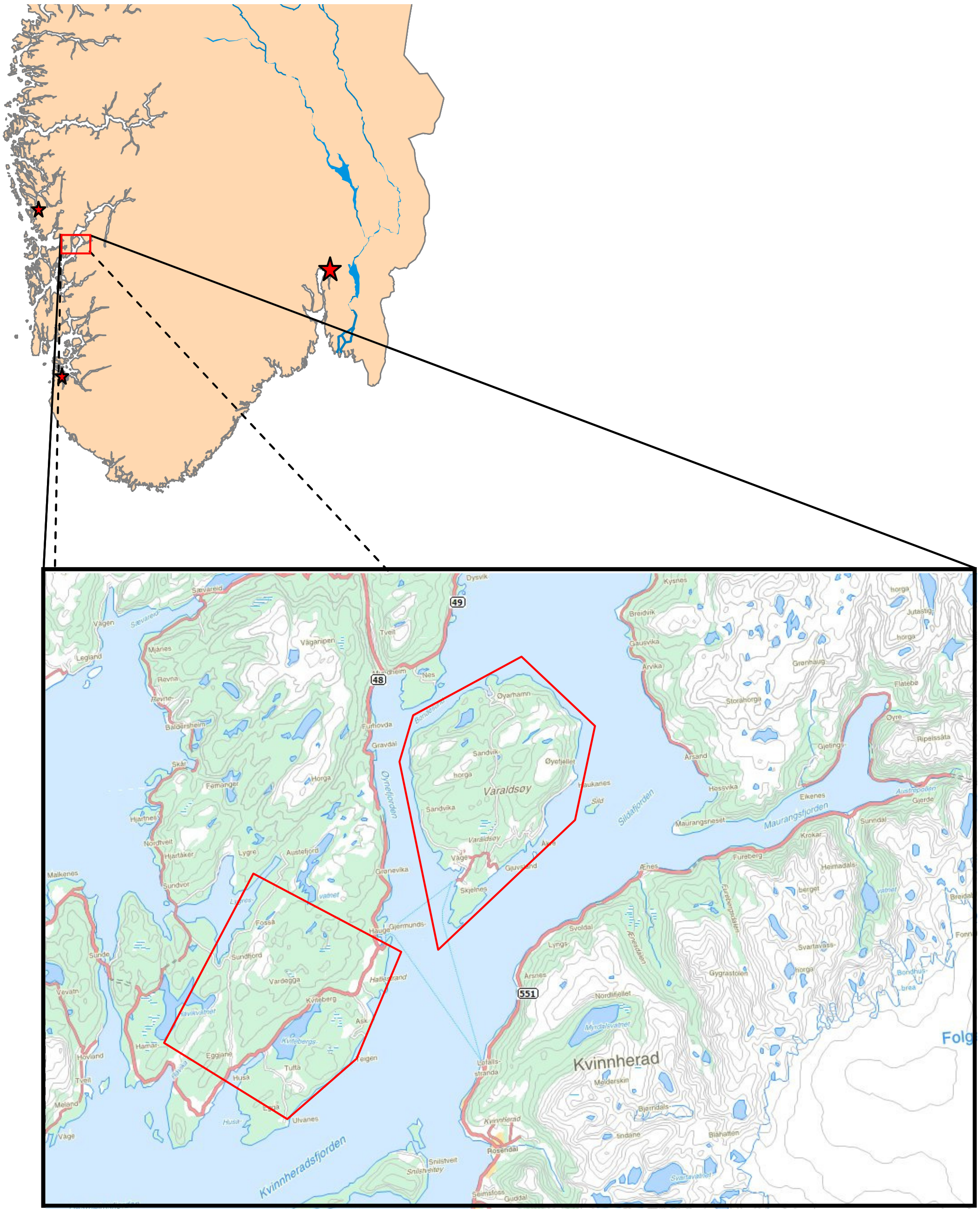


Figure 1. Project overview. The red boxes represent the outline of the survey areas. The North-eastern sub area contains the anomalies under investigation.

Definition of the area

Vertex points defining the North-eastern sub area and locations of the modelled anomalies are defined below. The Coordinate system used is UTM (WGS84) Zone 32 north.

Vertex points:

Vertex	Easting [m]	Northing [m]
1	334304	6674371
2	337140	6671889
3	337081	6669053
4	331074	6662415
5	329203	6670766
6	329951	6672204

Anomalies:

Anomaly	Easting [m]	Northing [m]
10	331485	6670000
14	334140	6668470
15	330090	6668750
16	331600	6669600
17	332220	6669800
18	332380	6669040
19	331870	6668650
22	330850	6669110
23	334180	6672730

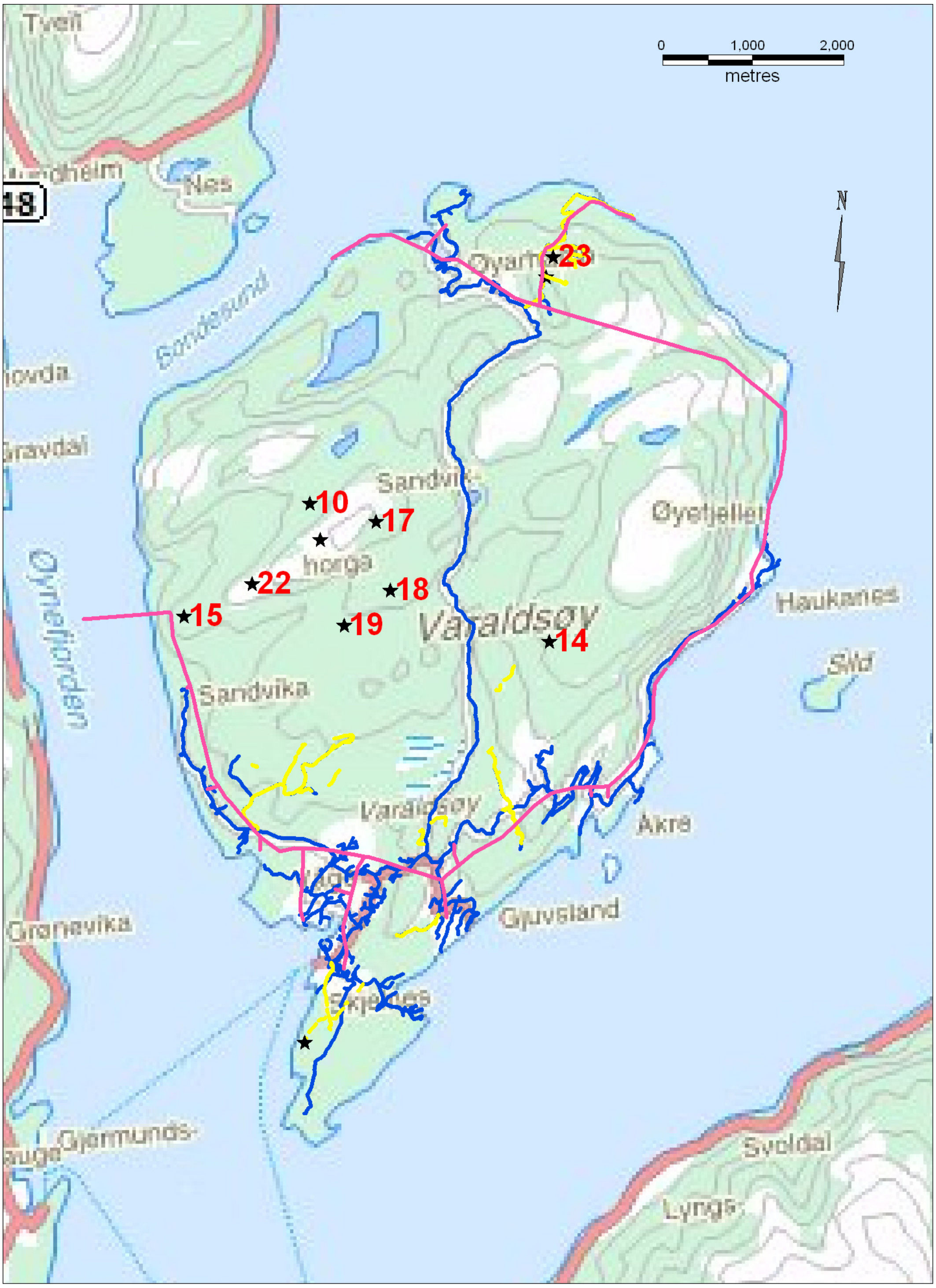


Figure 2. Modelled anomalies. Coordinates of the polygon corner points are defined in the table above. UTM (WGS84) Zone 32 north. Main power lines (pink), minor power lines (yellow) and mail roads (blue) are presented as well.

Plate modelling in General

The Maxwell software applied for the modelling interprets targets as thin- or thick plates. The host rock is assumed to be resistive and the plates are rectangular and conductive.

General comments on model parameters:

- Strike is given to the geophysical models as a priori information. This is done because strike is relatively well known from the geology and because most targets are detected mainly on one line witch provide limited information about the strike.
  In the Maxwell software strike is defined by a vector normal to dip direction, referred to as DD. Both the known strike in degrees relative to north and DD are presented in this report.
- Horizontal extend of a plate is related to the area covered by lines on witch the plate is detected.
- Conductivity multiplied with thickness of the plate is treated as one model parameter; conductance. Hence, the conductance contains information about conductivity as well as thickness of the plate.

Model validity

The fit to data in this area is very good compared with what we normally see. The uncertainty of the dip is generally higher than the uncertainties on the remaining model parameters.

Survey specific details

Thin-plate modelling

Excluding the anomalies in the area, the general EM-signal level is low. This implies that the host rock can be interpreted as a free space as used in the Maxwell inversion.
Generally, geological information about strike is incorporated in the geophysical modelling as a priori information. Information about dip is treated as additional information confirming inversion results. In case of conflict between the geological information and geophysical interpretation of dip, the geophysical inversion results are presented.
For all anomalies both a thick- and a thin-plate model has been tested. However, all targets have a best fit using the thin-plate model. Furthermore it has been investigated if more than one flight line can be included to fit the modelled plate. This is rarely the case. However, all lines neighbouring anomalies have been investigated in order to extract all available information from the data.

The majority of the anomalies are significant in one line exclusively which means:

- The strike direction is not dictated by data, it is incorporated in the geophysical modelling as a priori information.
- The anomalies originate from small targets compared with the distance between the survey lines (150 m).

Drill planning

The modelling has been performed in order to achieve the safest drilling plans. The drill holes are designed to penetrate the target perpendicular to the plate and at its centre.
Lengths of the holes are constructed to penetrate target and extend approximately 10 m on the far site of it. The holes are placed approximately in position with the line associated with the anomaly since this is where we have highest reliability of the model. The drilling plan has been made so the drill hole as far as possible intercept the target directly under the anomaly seen at the surface, since this is where we have the highest reliability of the model.

Geological information

The geological information on the Varaldsøy area was transferred from Peter Wulff to Per Gisselø during a meeting at SkyTEM ApS and by email.

All geological information is presented in appendix C and inversion resulta are presented in appendix D.
According to the geological information provided by Peter Wulff the general strike in the area is approximately NE.

Software description

Three separate pieces of software has been used in the data processing:

- "Skylab" for data extraction and pre-processing
- "TEM-reformat" for converting Skylab xyz-files to TEM files suitable for import in Maxwell
- "Maxwell 4.0" for the 3D thin plate modelling of the TEM data

Further documentation for the Maxwell 4.0 software can be found in appendix A.

Data processing

The data input for the thin-plate modelling is the SkyTEM data acquired during the SkyTEM survey carried out in October 2009. These data are presented in the xyz file created by Skylab.

XYZ-files

The xyz files are the main results of the SkyTEM survey, containing all the collected EM data and information for the interpretation and inversion.

Based on EM-measurements and the positions of all instruments a xyz ASCII file is produced. All parameters in the xyz-file refer to the centre of the frame.

The raw EM data are filtered based on the signal level, i.e. high level means a low number of transients in the stack and vice versa.

The xyz file is used as input to the inversion and interpretation software.

The projection of the xyz-files is UTM (WGS84) Zone 32N.

The header of the xyz-file gives the following information:

Parameter	Typical value	Explanation
Fid	23989 - 56879	Unique Fiducial number
Line	100101 to 105303	Line number
Flight	20091012.01	Name of flight
DateTime	39345.3230111921	DateTime format
Date	20091012	Date yyyymmdd
Time	074508.167	Time hhmmss.zzz
AngleX	2.890	Angle in flight direction [deg]
AngleY	-2.363	Angle perpendicular to AngleX [deg]
Height	36.5	Filtered Height measurement [m]
DTM	576.8	Digital Terrain Model [m.a.sl]
Current	117	Current [A]
Mag	0.0	Mag reading –Not active. See separate Magnetometer data file
N	6671520.650	UTM (WGS84) Zone 32N [m]
E	337128.519	UTM (WGS84) Zone 32N [m]
Alt	613.3	DGPS/GPS Altitude [m]
GdSpeed	69.2	Ground Speed [km/t]
2_Z2_8 - 2_Z2_30	1.1332E+000	Z-coil value: gate 8-30 [nV/Am^2]
4_X2_1 – 4X2_30	2.3272E+000	X-coil value: gate 8-30 [nV/Am^2]

TEM-files

The xyz-files are transformed by the reformat program supplied by Dr. James Reid, GeoForce, Australia to TEM files.

The TEM files contain a header with the following information used to define the system control parameters in Maxwell:

System parameter	Typical value	Explanation
Datatype	TEM	Data description
Config	Airborne	Configuration type
Bfreq	25	Data recording frequence
Airbornetype	In_loop	TX symmetry
Units	nV/Am^2	Data unit
RXarea	31.2	Receiver loop area
Offtime	10	Measuirng offtime [ms]
Ontime	10	Measuirng ontime [ms]
Turnoff	0.046	Frontgate time [ms]
TXarea	314	TX loop area [m^2]
Turns	4	TX loop number of turns
Timesstart	0.0037, 0.0101, …	Gate start measuring time [ms]
Timesend	0.0074,0.0138, …	Gate end measuring time [ms]

The actual data imported to Maxwell is given as defined in the columns below:

Parameter	Typical value	Explanation
Line	100101	Flight line number
Fid	23989	Unique Fiducial number
Dum1	20091012.000	Date yyyymmdd
Dum2	190047.000	Time hhmmss.zzz
Lasalt	197.500	Filtered Height measurement [m]
Curr	116.870	Current [A]
E	337128.519	UTM (WGS84) Zone 32N [m]
N	6671520.650	UTM (WGS84) Zone 32N [m]
Component	Z or X	Z- or X-coil value in CH1 – CH30
CH1 – CH30	0.24681E+01	Z- or X-coil value: gate 1-30 [nV/Am^2]

Maxwell modelling

The general procedure followed in the modelling of the thin plates is described below:

1. Import of TEM data
2. Setup of data and system parameters in the Line Editor
3. Calculation of terrain level (GPSALT – LASALT)
4. Check of line path
5. Look through profiles in order to identify anomalies for modelling (Figure 5). The location of the anomalies are chosen by Norrbotten Exploration AB and shown in Figure 2
6. Compare the chosen anomalies with the geological information and make short list of anomalies to be modelled (made by John Pedersen and Peter Wulff from Norrbotten Exploration AB and Per Gisselø and Sara Thofte form SkyTEM Aps in cooperation)
7. Setup a plate geometry according to the geological information and run a forward model
8. Adjust plate parameters to obtain a reasonable fit between measured and modelled anomalies
9. Select the parameters that are allowed to change during the inversion
10. Run inversion
11. Compare the measured and modelled results (Figure 4)
12. Evaluate the modelled plate parameters according to the geological information
13. Repeat steps 7 to 11 until an acceptable model has been obtained
14. Plan drill holes for the obtained plate model (Figure 5)
15. Transfer plate and drill hole parameters to data table
16. Repeat steps 6 to 14 for all the anomalies on the short list
17. Print figures for data delivery

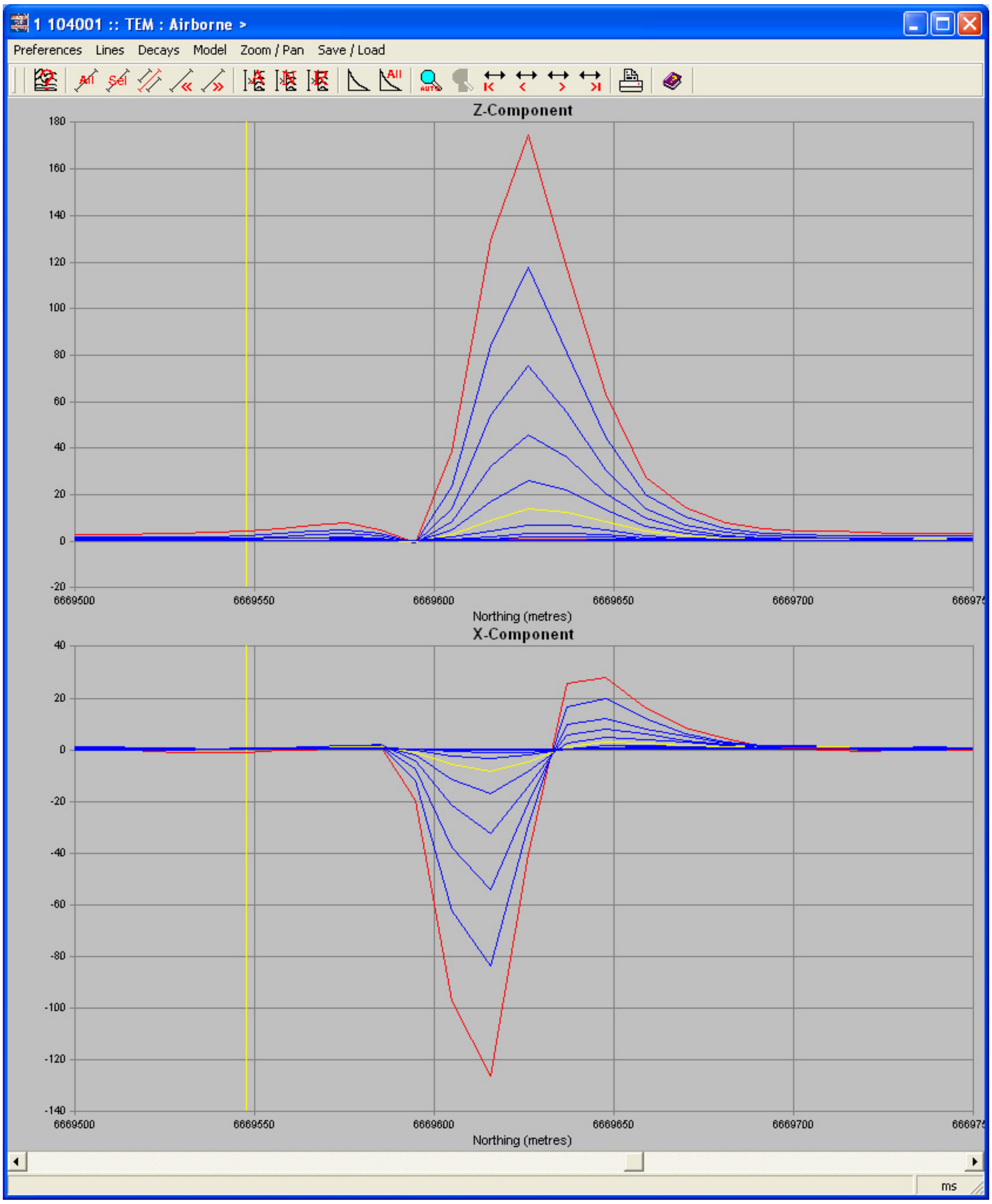


Figure 3. Profile view from Maxwell showing TEM Z- (upper profile) and X-component (lower profile) along one flight line (blue and red lines). Here a typical thin plate response from line 10401 (anomaly 18) of the survey is shown.

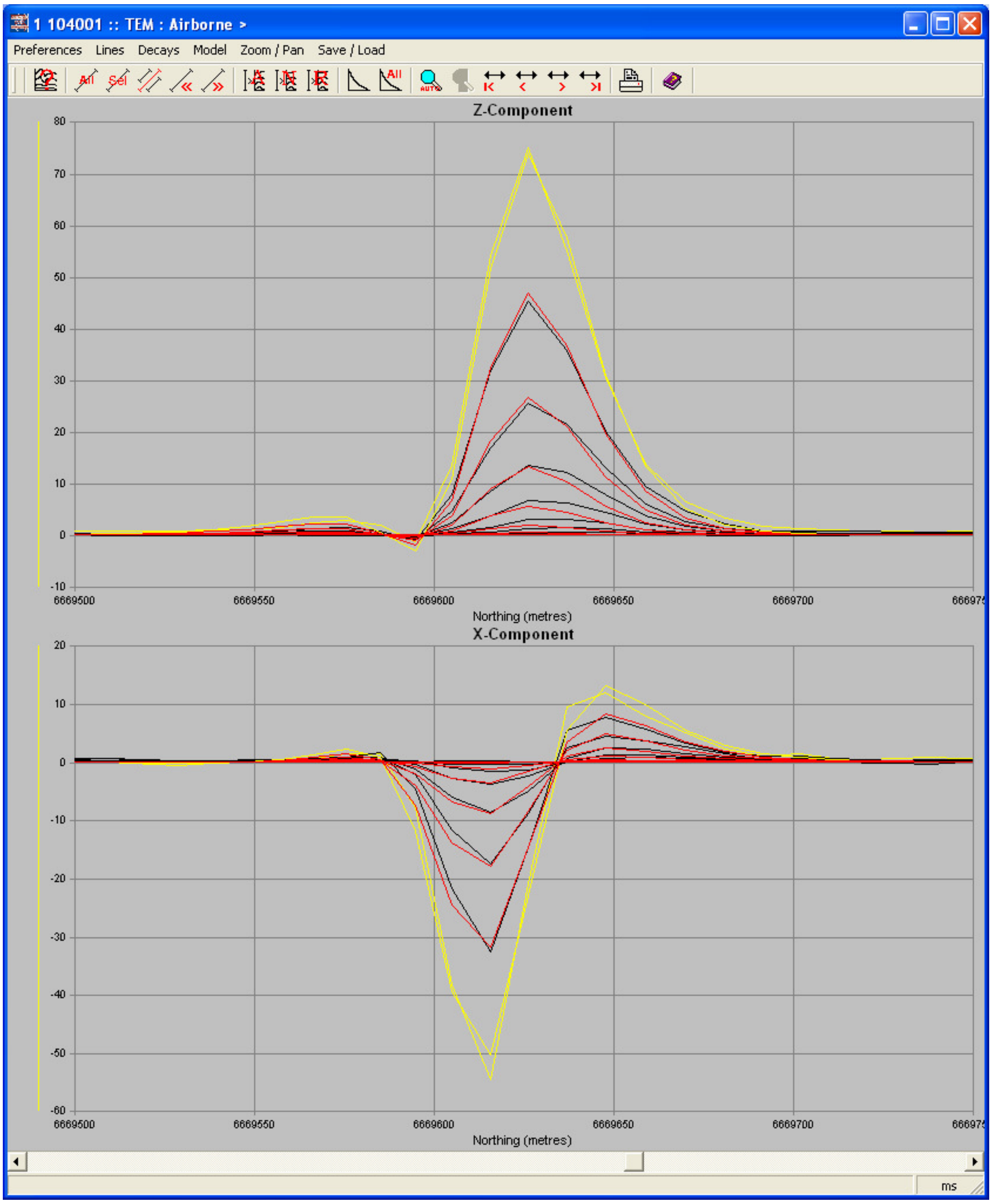


Figure 4. Profile view from Maxwell showing measured SkyTEM data (black lines) and modelled response of the thin plate (red lines). Yellow lines indicate measured and modelled response for a chosen gate. A very good fit between measured and modelled data is evident (Anomaly 18).

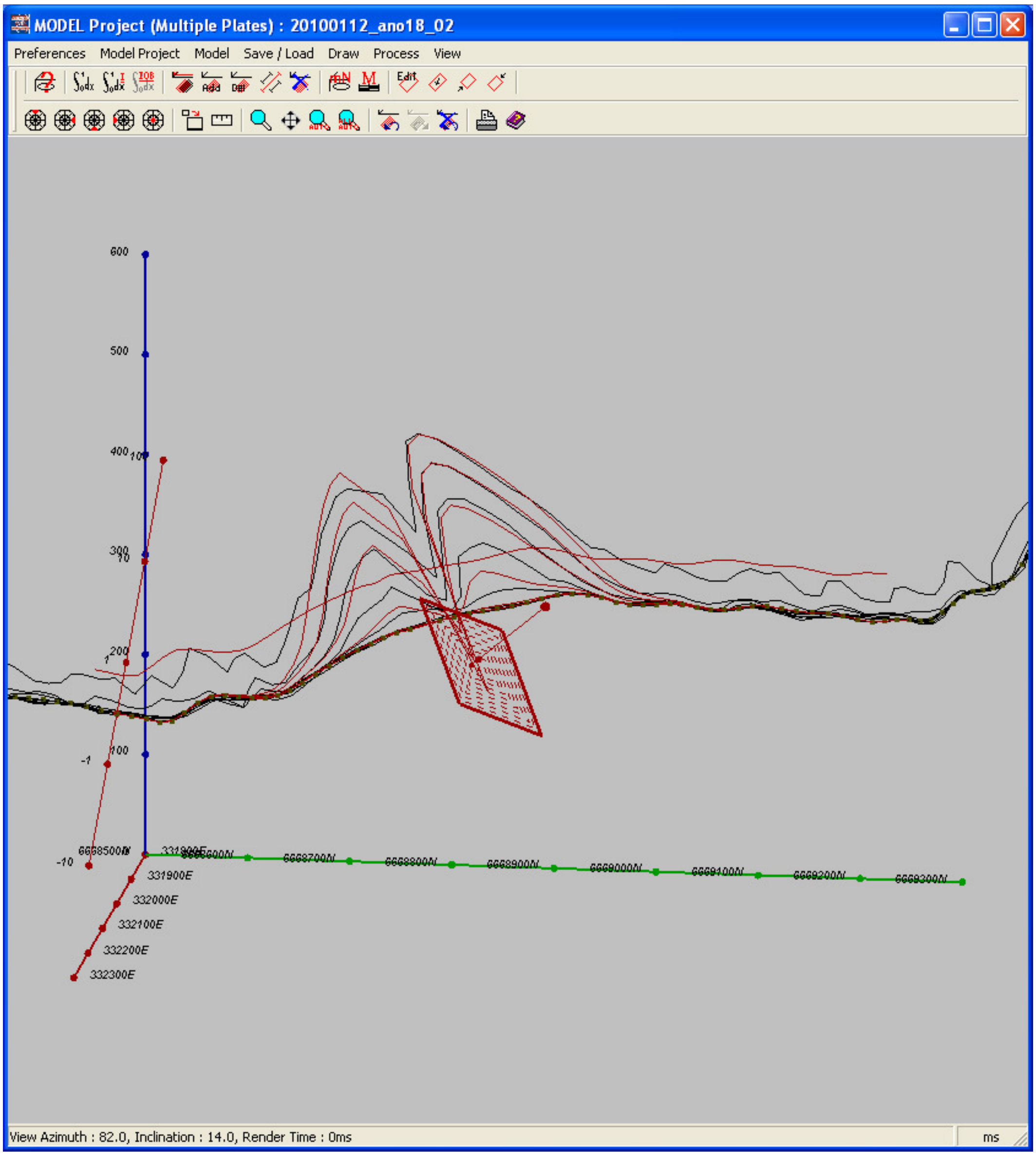


Figure 5. Model view form Maxwell showing the plate model (red plate) and the terrain surface (thick black line) with the data and model response curves draped on the terrain surface. In addition the location of drill holes suggested to intersect the modelled thin plate is shown (thin red line).

Model limitations

During modelling the aim is to obtain the best fit on the largest anomaly. This will give rise to some discrepancies in the fit on the flanks and on secondary anomalies. The main reason is that the model is based on simple planar bodies, while the geological bodies generally will have a more complex geometry and orientation. However in this survey the conductive contrasts between the host rock and the conductive targets are strong hence this effect is not significant. Another limiting factor is the terrain surface which will also influence the modelled results.

The anomalies presented here all have very good fit to data and the uncertainties are generally low compared to what we expect to see. This might be explained by the strong conductive contrast between host rock and targets and that the targets seem to be planar with steep dip.

Evaluation of model results

Nine anomalies have been chosen for modelling. The chosen anomalies and drill plans are listed below. In Appendix C a table containing all inversion results, comments and drill plans are given. All the models fit data very well. In the following paragraph inversion results are presented and each modelled target commented.

Inversion Results

Anomaly 10 (line 104001)

This is a small anomaly and it is only seen weakly on its neighbouring lines therefore the modelling is performed on one line only. The modelled dip is steep in NW direction. Geologically the dip is expected to be steep in SE direction; this can not be modelled. However, since the dip of the plate is steep the difference between NW and SE is not significant. Strike is given to the geophysical model as a priori information.

Name of model:	*20100111_ano10_01*
Name of relevant line:	*104001*
Error:	*6.85*
Dip:	*75.4 NW*
Strike:	*(DD 325) = 55 degrees*
Strike length:	*150 m*
Dip length:	*120 m*
Depth:	*0.7 m*
Conductance:	*19 S*

Planned Drill hole (anomaly 10)

Position:	*E: 331475, N: 6669993*
Dip:	*70 degrees*
Azimuth:	*145 degrees*
Hole length:	*100 m*

Anomaly 14 (line 102701)

This anomaly is detected on its neighbouring lines indicating a significant horizontal extent. The inversion result gives a nearly horizontal plate dipping weakly in NW direction. This is in agreement with the geological information. The model states 16 degrees dip where the geological information indicates a 35 degrees dip. The plate is approximately square with 80 degrees strike differing 20 degrees from the geologically expected strike direction of 60 degrees. This is not alarming since the strike direction is not of significant importance in case of a square and nearly horizontal target.
Modelling including neighbouring lines, on both sides of line 102701, provides information about the extent of the plate. Line 102601 east of line 102701 shows a tiny anomaly, indicating that the extent of the plate does not exceed to this line. The anomaly is clearly detected west of line 102701 on line 102801 and 102901 and weakly on line 103001. This corresponds with the modelled plate extending Westward across line 102801 and 102901 and not line 103010. The final inversion result includes line 102701 exclusively.

Name of model:	*20100114_ano14_01*
Name of relevant line:	*102701*
Error:	*3.4*
Dip:	*16 NW*
Strike:	*(DD 350) 80 degrees*
Dip length:	*457 m*
Strike length:	*455 m*
Depth:	*0 m*
Conductance:	*9 S*

Planned Drill hole (anomaly 14)

Position:	*E: 334000, N: 6668450*
Dip:	*60 degrees*
Azimuth:	*120 degrees*
Hole length:	*80 m*

Anomaly 15

No EM anomaly observed in data and plate modelling not possible.

Anomaly 16 (104001)

This shallow anomaly has a high conductance although the extent is limited as it is seen exclusively on line 104001. In agreement with the geology the dip is modelled to 63 degrees NW direction. Strike is given to the geophysical model as a priori information.

Name of model:	*20100118_ano16*
Name of relevant line:	*104001*
Error:	*14.52*
Dip:	*68.5 NW*
Strike:	*(DD 330) 60 degrees*
Dip length:	*54 m*
Strike length:	*47 m*
Depth:	*8 m*
Conductance:	*34.6 S*

Planned Drill hole (anomaly 16)

Position:	*E: 331590, N: 6669630*
Dip:	*30 degrees*
Azimuth:	*150 degrees*
Hole length:	*47 m*

Anomaly 17 (103601)

This shallow anomaly has a high conductance. It is detected on line 103501 and to the east on line 103601 but not West on line 103601. This is in agreement with the modelled plate extending further East than West of line 103601. In agreement with the geology the dip is 41 degrees NW direction. Strike is given to the geophysical model as a priori information.

Name of model:	*20100112_ano17_01*
Name of relevant line:	*103601*
Error:	*9.73*
Dip:	*41 NW*
Strike:	*(DD 330) 60 degrees*
Dip length:	*300 m*
Strike length:	*34 m*
Depth:	*4.2 m*
Conductance:	*56 S*

Planned Drill hole (anomaly 17)

Position:	*E: 332160, N: 6669777*
Dip:	*60 degrees*
Azimuth:	*90 degrees*
Hole length:	*50 m*

Anomaly 18 (103901)

Anomaly 18 is moved approximately 350 m westward of the original locatin provided by Norrbotten Exploration AB. .
New location: E: 332030, N: 6668844

The anomaly is detected on line 103801, 103901 and 104001, most significantly on line 103901. Therefore the anomaly is mowed approximately 350 m westward. In the following this location is referred to as anomaly 18, its coordinates are**:** E: 332030, N: 6668844

The shallow anomaly has a 68 degrees dip in NW direction in agreement with the geology. Strike is given to the geophysical model as a priori information. Modelling including both line 103901 and 104001 and confirm both strike and size of the plate. In the final inversion result only line 103901 is included.

Name of model:	*20100112_ano18_02*
Name of relevant line:	*103901*
Error:	*21.33*
Dip:	*68 NW*
Strike:	*(DD 320) 50 degrees*
Dip length:	*150 m*
Strike length:	*120 m*
Depth:	*1.6 m*
Conductance:	*20 S*

Planned Drill hole (anomaly 18)

Position:	*E: 332045, N: 6668926*
Dip:	*40 degrees*
Azimuth:	*180 degrees*
Hole length:	*95 m*

Anomaly 19 (104101)

This anomaly originates from a multiple plate structure obtained by two or three plates and it is possibly connected with anomaly 18. Plate 1 is the main target. Plate 2 is nearly horizontal and extends perpendicular to the general strike direction and plate 3 is rather small with high conductance. The known strike direction is given to the geophysical model as a priori information for plate 1 and 3.

Name of model:	*20100112_ano19_01*
Name of relevant line:	*104101*
Error:	*16.54*

Plate 1 (main target)

Plate 1 Strikes 50 degrees in agreement with the geology and it is nearly vertical dipping in direction SE. According to the geology the dip is in NW direction which can not be modelled. However, the plate is nearly vertical and the disagreement might not be alarming.

Dip:	*78 SE*
Strike:	*(DD 140) 50 degrees*
Dip length:	*430 m*
Strike length:	*80 m*
Depth:	*1 m*
Conductance:	*40 S*

Plate 2

Plate 2 Strikes 50 degrees in agreement with the geology and it is dipping nearly vertical in NW direction. The dip direction is in correspondence with the geology but it is more vertical than expected. Plate 3 is modelled to have a high conductance. An alternative interpretation is that the plate is slightly bigger with a lower conductance (conductance 50 S and dip length 25m). The presented result is the smaller of the two. However, the conductance might be slightly overestimated.

Dip:	*102 SE*
Strike:	*(DD 140) 50 degrees*
Dip length:	*253 m*
Strike length:	*18 m*
Depth:	*3.8 m*
Conductance:	*50 S*

Plate 3

Plate 3 is a possible explanation to the peculiar appearance of this anomaly. It strikes 140 degrees and dip 63.9 degrees is NE direction. The strike of this plate is perpendicular to the general strike in the survey area.

Dip:	*63.9 NW*
Strike:	*(DD 50) 1400 degrees*
Dip length:	*192 m*
Strike length:	*30 m*
Depth:	*6 m*
Conductance:	*55 S*

Planned Drill hole 1 (anomaly 19, plate 1)

Position	*E: 331800, N: 6668600*
Dip:	*20 degrees*
Azimuth:	*100 degrees*
Hole length:	*140 m*

Planned Drill hole 2 (anomaly 19, plate 2)

Position:	*E: 331770, N: 6668707*
Dip:	*40 degrees*
Azimuth:	*170 degrees*
Hole length:	*31 m*

Planned Drill hole 3 (anomaly 19, plate 3)

Position:	*E: 331840, N: 6668550*
Dip:	*40 degrees*
Azimuth:	*220 degrees*
Hole length:	*50 m*

Anomaly 22 (104101)

The anomaly can be interpreted as a thin or a thick plate the most likely solution, form a geophysical point of view, is the thin plate. The alternative thick plate solution is presented as well.

Thin Plate solution

The anomaly is weakly seen on its neighbouring lines on both sides, a bit more significant West of the anomaly than East of the anomaly. This correspond with the horizontal extend of the plate. The known strike direction is given to the geophysical model as a priori information. The modelled NW dip direction is in agreement with the geology.

Name of model:	*20100115_ano22_thin*
Name of relevant line:	*104602*
Error:	*22.41*
Dip:	*44.9 NW*
Strike:	*(DD 325) 55 degrees*
Dip length:	*159 m*
Strike length:	*66 m*
Depth:	*2.1 m*
Conductance:	*16.9 S*

Planned Drill hole (Thin Plate)

Position:	*E: 330820, N: 6669115*
Dip:	*35 degrees*
Azimuth:	*180 degrees*
Hole length:	*100m*

Thick Plate solution

Name of model:	*20100113_ano22_01*
Name of relevant line:	*104602*
Error:	*24.00*
Dip:	*12.2 NW*
Strike:	*(DD 330) 60 degrees*
Dip length:	*370 m*
Strike length:	*69.4 m*
Thickness:	*30 m*
Depth:	*13 m*
Rotation:	*-50.5*
Conductivity:	*0.65 S*

***Planned Drill hole** (Thick Plate)*

Position:	*E: 330850, N: 6669120*
Dip:	*80 degrees*
Azimuth:	*180 degrees*
Hole length:	*82 m*

Anomaly 23 (102701)

The anomaly is approximately 100 m from a power line and a main road and very close to minor power line. This makes interpretation very uncertain and the signal might be due to artefacts and not geology.
The following is the best suggestion provided by the geophysical 3D modelling.
The anomaly is clearly detected on the neighbouring lines on both sides of the anomaly which provide information regarding the horizontal extent of the structure. Inversion including all three lines can not be performed successfully. The final result presented here is based on inversion on line 101701 exclusively.
The model fit is obtained by two plates. The biggest plate (plate 1) is the main target; it is shallow and nearly horizontal. The second plate (plate 2) is found at depth 37 m, dipping steeply. The dip is in NE direction in disagreement with the geological information. The expected 65 degrees dip corresponds with plate 2. The known strike direction is given to the geophysical model as a priori information.

Name of model:	*20100113_ano23_flatplate*
Name of relevant line:	*101701*
Error:	*14.66*

Plate 1

Dip:	*1.7 NW*
Strike:	*(DD 330) 60 degrees*
Dip length:	*352 m*
Strike length:	*52 m*
Depth:	*0.4 m*
Conductance:	*78.4 S*

Planned Drill hole 1 (plate 1)

Position:	*E: 334150, N: 6672675*
Dip:	*60 degrees*
Azimuth	*90 degrees*
Hole length	*30 m*

Plate 2

Dip:	*66 NW*
Strike:	*(DD 330) 60 degrees*
Dip length:	*190.7 m*
Strike length:	*63 m*
Depth:	*33.6 m*
Conductance:	*23.2 S*

Planned Drill hole 2 (plate 2)

Position:	*E: 334140, N: 6672715*
Dip:	*35 degrees*
Azimuth	*120 degrees*
Hole length	*60 m*

Data delivery
Data is delivered digitally and uploaded to ftp site:
User name: sky3
Password: asd61
Ftp://sky3:asd61@dl.skytem.eu

A digital copy of this model report with all appendixes is delivered in PDF format.

Appendix

Software
The modelling software Maxwell 4.0 is presented in Appendix A.

Data delivery
Data delivery is described in Appendix B

Geological and geophysical information
Geological and geophysical comments and inversion results are presented in table format containing plate and drill parameters in Appendix C.

Inversion Results
PDF plots of the measured and modelled responses, cross sections and 3D views of the modelled plate and drill holes and model parameters are presented in Appendix D.

Appendix A

Software Documentation

- Mawell 4.0 Software

680 Jarrah Rd, Mundaring
W.A. 6073 AUSTRALIA
Ph: +61 8 9295 1456
Fax: +61 8 9295 1429
www.emit.iinet.net.au
email: info@emit.iinet.net.au

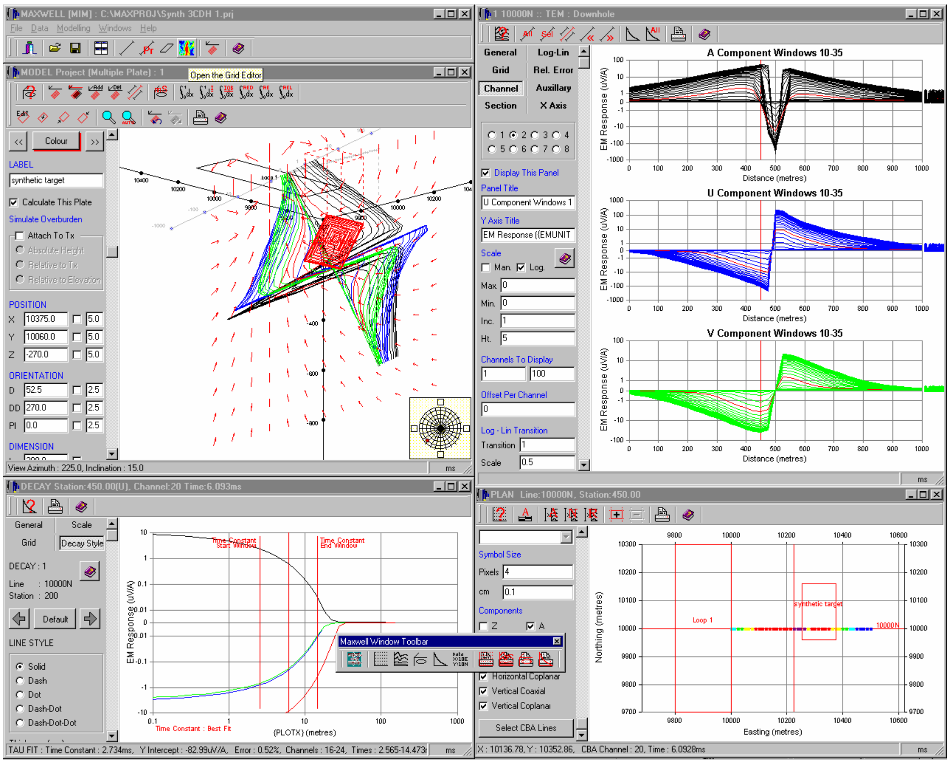
EMIT

ElectroMagnetic Imaging Technology

Maxwell 4.0

Modeling, Presentation and Visualization of EM and Electrical Geophysical Data

- Work with time or frequency domain data – any EM survey with any instrument type
- Ground or airborne, borehole, moving-loop, fixed-loop
- 3-D visualization of plate and other models with OpenGL
- Read and write industry standard file formats, including AMIRA, Geosoft, PEM, Arcview shape
- Modeling of B or dB/dt responses in any units for loop or dipole tx and rx including all normalization required
- Linked plan, profile, section, decay and model displays
- Utilities to load EM data into Geosoft database
- Totally unique forward and inverse plate modeling
- Import and create grid files for display in plan or section
- Execute third-party modeling routines from within Maxwell
- Jointly model data from different EM systems
- Automated overburden response calculation features
- Powerful tool to set or check attributes of each field/model line.
- High quality hardcopy
- Plot primary field lines
- Decay and spectrum analysis, decay constant calculation
- Carry out synthetic modeling
- Build templates to speed graphical presentation
- Save templates, models, system descriptions and sessions
- Custom tools and file-handling routines developed
- Regularly updated on-line help, tutorial, documentation



Maxwell has been written by people who understand what's required of EM geophysical processing and modeling software. It is a unique environment that makes EFFICIENT use of your time and effort. Maxwell has grown into the 21st Century with new features and user support that make it a tool that you can't afford not to have if you interact with EM data.

Geophysical Technology Development for Mineral Exploration, Groundwater and the Environment.

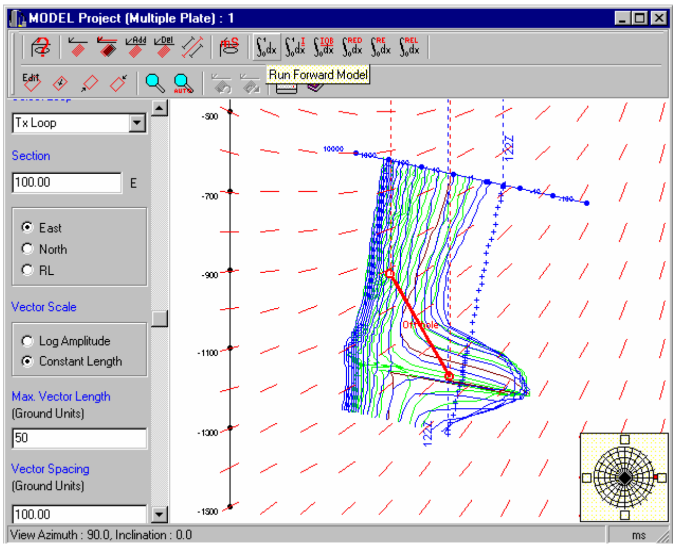
EMIT is a Geosoft Plus Partner and Maxwell provides a powerful interface to Geosoft's Oasis Montaj v5+.

PLAN

View the location of all data, airborne or ground. Define sub-areas for modeling or display. Create effective colored plans of a particular channel, frequency or component to illustrate anomalies and facilitate modeling & quality control. Grid, contour and image data within Maxwell or import a grid file to use as a base for the plan.

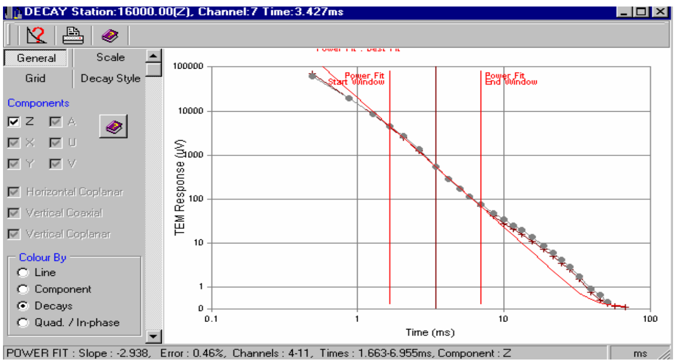
MODEL

Plate and "plate in host" multi-ribbon thin sheet models included, layered earth to be included shortly. Run external modeling algorithms (including plate, prism, 2.5-D and 3-D) with this powerful 3-D graphic interface. Drag-and-drop plate models. Automatically setup variable overburden models, even for moving-loop surveys. Create a synthetic survey simply with any geometry, transmitter waveform, units, window times and frequencies. Select tx-rx horizontal and vertical separation to model airborne responses. Plot primary field lines in any plane. Plot field and model data in the same presentation with user-selection of colors and symbols. Import files of loop coordinates and borehole geometry information.



DECAY/SPECTRUM

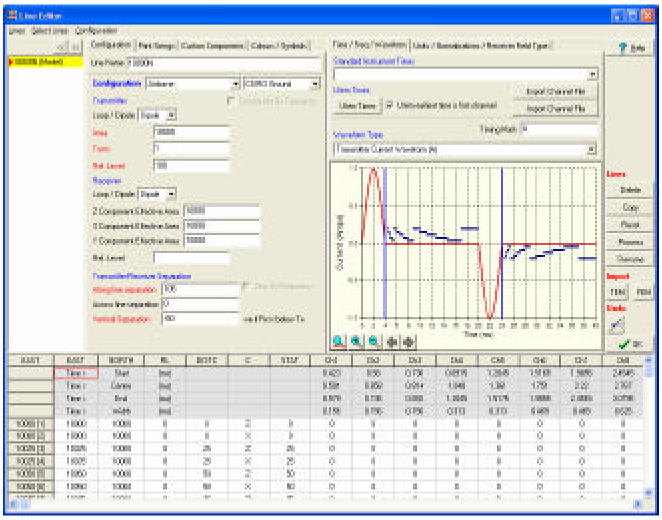
Automatically bring up decays by double-clicking in a profile window. Compare field and model responses. Calculate exponential decay constants and power law decay rates over ranges of times. View EM response versus frequency for frequency domain data.



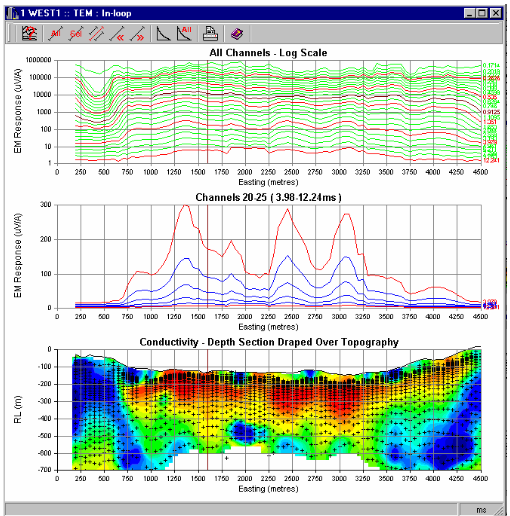
SERVICE & SUPPORT EMIT is keen to incorporate users' suggestions into its Maxwell software and to respond quickly to questions. Updated software and help files are regularly emailed to Maxwell users.

MAXWELL LINE EDITOR

A powerful tool to set parameters of model and field data lines in Maxwell. Set the properties of the EM system so that modeling is straightforward. Check the actual values of the field data and model responses—they can be changed, deleted or sorted. Tool to speed the import of EM system waveforms and window times. Set or check all the relevant properties of the data including units, normalizations, transmitter and receiver details.



PROFILE/SECTION



Create the style of profile you want to look at on screen and in hardcopy. Logarithmic or linear scales, multiple panels, ranges of channels and frequencies. Color by channel number, frequency, component, line. Plot auxiliary parameters such as power line noise monitor, transmitter current or other geophysical data. Add sections as located grids with selectable color palette, draped on topography if required. Choose scales, symbols, grids, line styles, labels, title blocks and logos. Save the plot style in a template for use with other data. Batch plot all lines from your project without having to setup each one. Automatically extracts annotation values from your data.

THIRD-PARTY MODELING

Maxwell provides graphical interfaces which can be employed with third-party or in-house modeling codes. The Maxwell GUI allows the design and visualization of models that include conductive plates, prisms, layered hosts and 2.5-D and 3-D meshes. Maxwell can launch the modeling algorithms and retrieve the results seamlessly.

Appendix B

Digital data

The digital data are:

└ *Report*

The report and appendices (PDF-format)

└ *Maxwell project files*

Appendix C

Geological and Geophysical comments prior to modeling

Target ID	East	North	Type	Comments from Norrbotten Exploration	Line number	Geophyscal evaluation by SkyTEM ApS
10	331485	6670000	Conductor	NE-end is the known occurrence Fjeld 2. In stratigraphic level including two larger occurrences.	104001	Slightly increased EM response. Possibly small and shallow Plate structure.
14	334140	6668470	Conductor	Looks like the Gråskolt occurrence and is on the same stratigraphic level as "Alteration zone 1".	102701	Increased EM signal, unlikely to be plate structure
15	330090	6668750	Conductor	Probably reflects the Sandvikfjell occurrence. Seems at depth to merge with target 22. Both target 15 and target 22 are sickel-shaped and their concave sides face eachother. Could this reflect a vertical conductor similar to target 18?	105102	No significant EM response. 100m distance to powerline.
16	331600	6669600	Conductor	Along strike from the Sandvikfjell occurrence. May lower its host rocks total magnetic intensity. Seems connected to target 17.	104001	Significantly increased EM response, Propably from Plate structure. Medium depth (untill gate 30)
17	332220	6669800	Conductor	Along strike from the Sandvikfjell occurrence. Seems to lower its host rocks total magnetic intensity. Seems connected to target 16.	103601	Significant EM response propably plate structure. Medium deepth (untill gate 30)
18	332380	6669040	Conductor	At low depths there are two parallel conductors. Could this pattern reflect a vertical conductor?	103901	No significant EM response at the location at line 103601. At line 103901 there is a significant Plate response which could relate to the weak response at line 103601. All this might be connected with anomaly 19.
19	331870	6668650	Conductor	This large conductor gets stronger at depth.	104101	Significantly increased EM response. Could originate frome a complicated Plate structure. Medium depth (untill gate 30)
22	330850	6669110	Conductor	May reflect the Sandvikfjell NE-termination. Seems at depth to merge with target 15. Both target 15 and target 22 are sickel-shaped and their concave sides face eachother. Could this reflect a vertical conductor similar to target 18?	104602	Significant EM response. Appeares to originate from Plate structure. Shallow structure (untill gate 26)
23	334180	6672730	Conductor	A known graphite schist but insular as opposed to the larger ones along the island's SE-coast. Is there anything else than graphite?	101701	Increased EM signal, possibly plate structure. 100m distance to main powerline and 100m distance to main road on line with minor powerline.

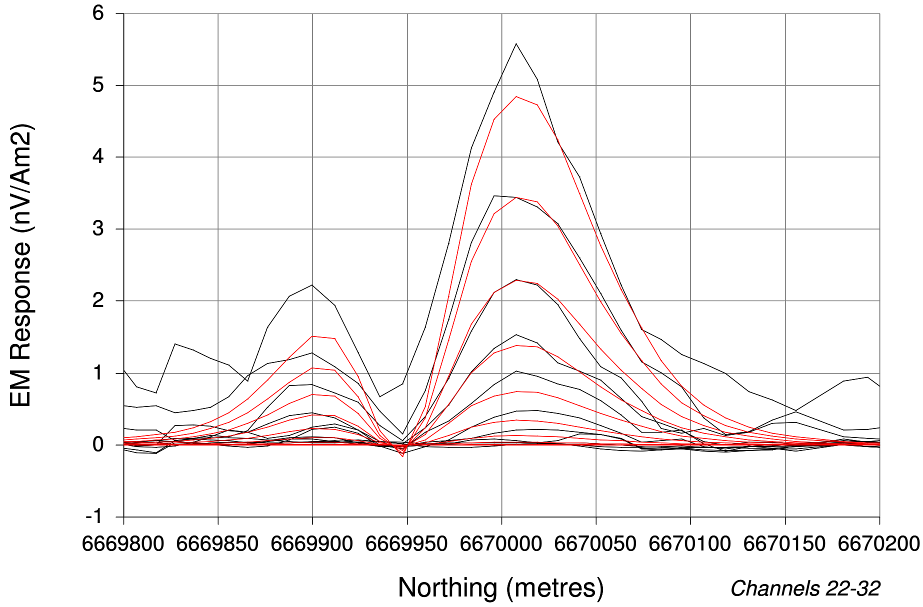
Geological information and Geophysical results

Target ID	Expected Strike	Modeled Strike	Expected Dip	Modeled Dip	Modeled Size	Depth of Planned Drill Hole
10	55	55	Steep SE	75.4 NW	150m x 120m	100m
14	60	80	35 NW	16 NW	457m x 455m	80m
15	55	NOT	60 NW	NOT	NOT	NOT
16	60	60	30-60 NW	68.5 NW	54m x 47m	47m
17	60	60	30-60 NW	41 NW	300m x 34m	50m
18	50	50	Uncertain, maybe rather flat towards NW	68 NW	150m x 120m	95m
19	50	Plate1: 50 Plate 2: 50 Plate 3: 50	45NW	Plate1: 78SE Plate2: 2NW Plaate3: 102SE	Plate1: 430m x 80m Plate2: 30m x 192m Plate3: 253m x 18m	Plate 1 and 2: 140m Plate 3: 31m
22	55	Thin Plate: 55 (Thick Plate: 60)	60 NW	Thin Plate: 44.9NW (Thick Plate: 12.2NW)	Thin Plate: 159m x 66m (Thick Plate: 370m x 69.4m x 30m)	Thin Plate: 100m (Thick Plate: 82m)
23	60	60	65SE	Plate 1: 1.7 NW Plate 2: 66 NW	Plate 1: 352m x 52m Plate 2: 190.7m x 63m	Plate 1: 30m Plate 2: 60m

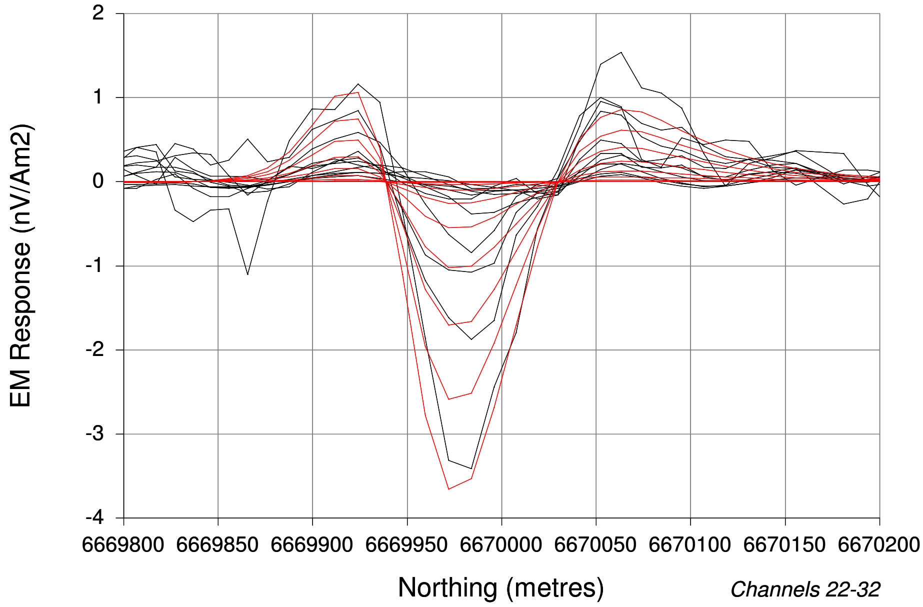
Appendix D
Inversion Results

Inversion Results
Anomaly 10 (line 104001)

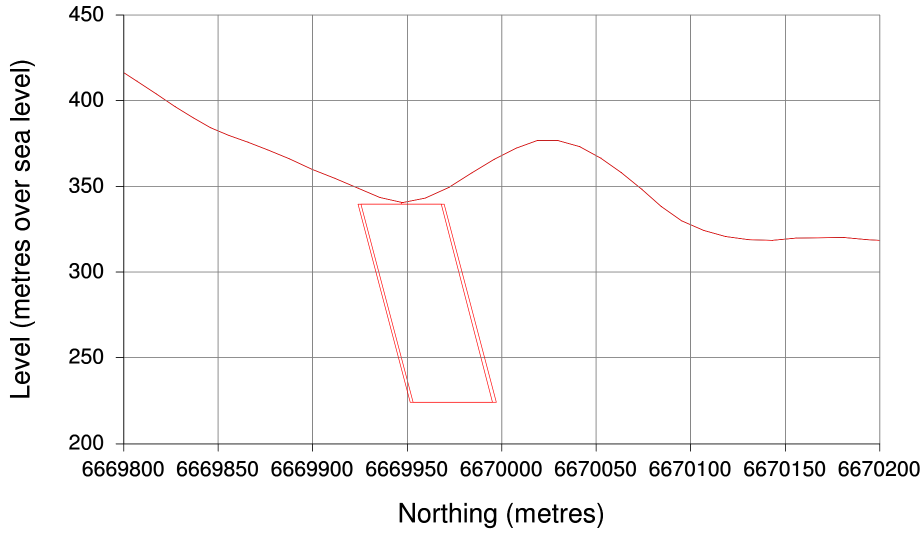
Z Component

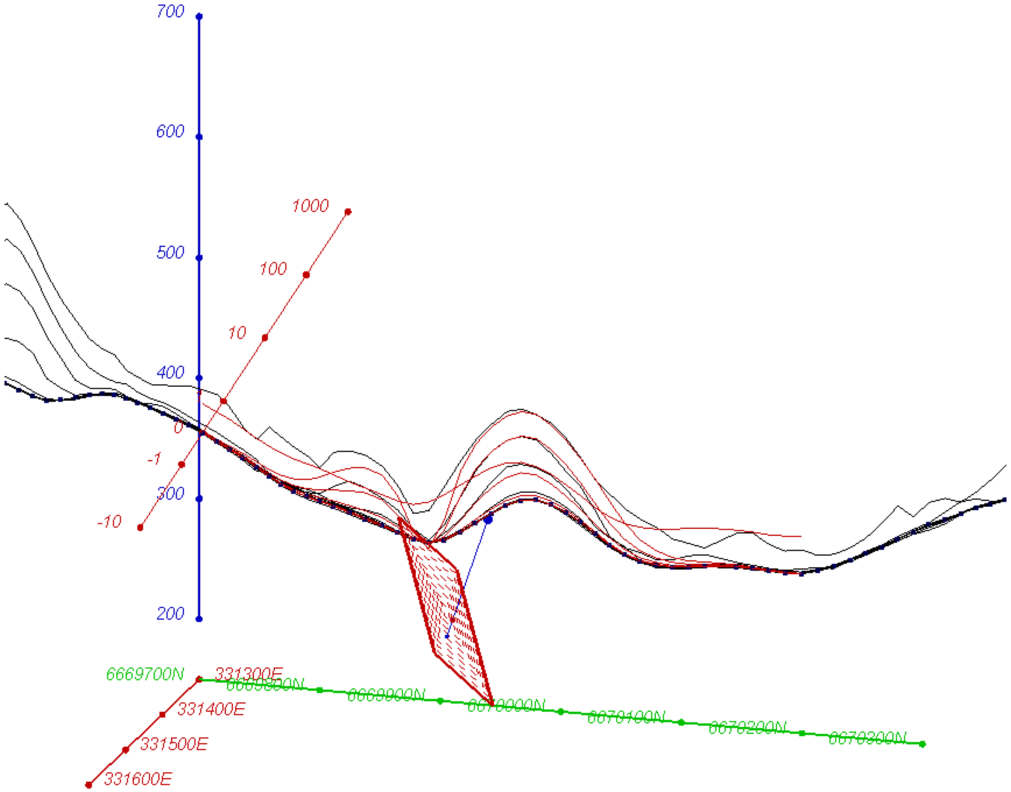


X Component



Plates





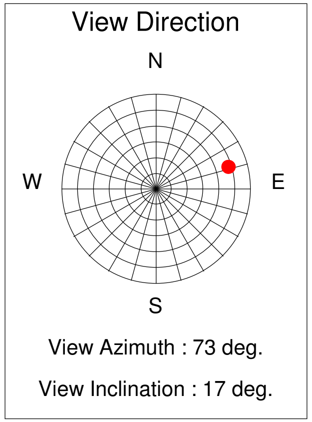


PLATE PARAMETERS

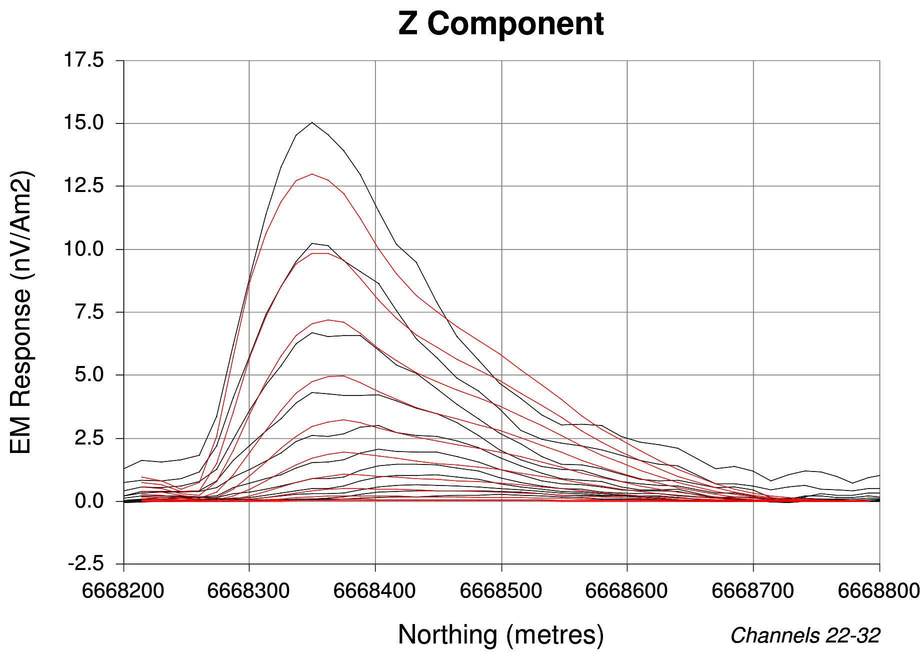
Name	1
X	331488
Y	6669947
Z	340
Length	150
Depth Extent	120
Dip	75.4
Dip Dir.	325
Plunge	0
Cond-Th.	19

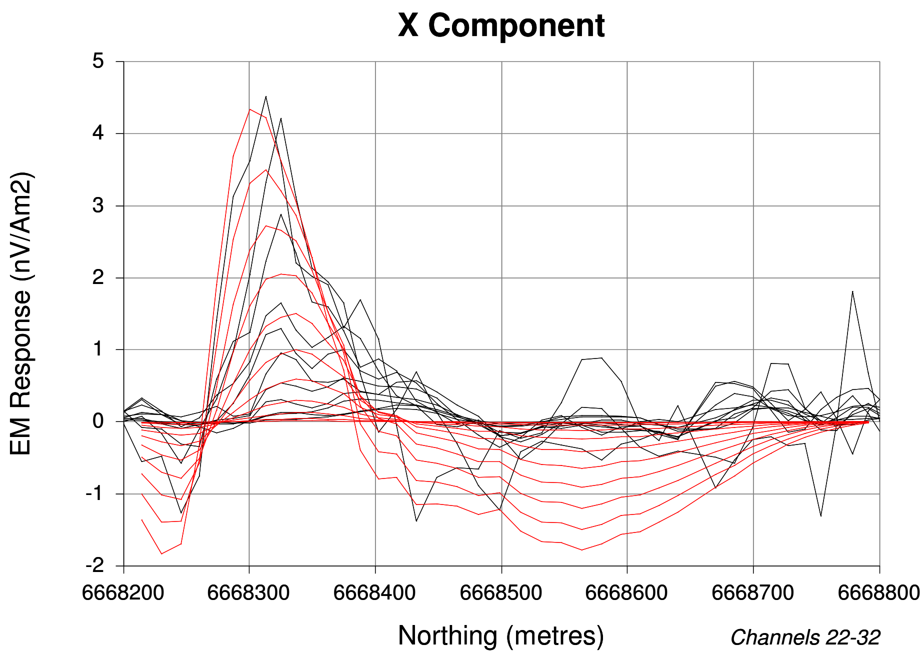
Inversion Results

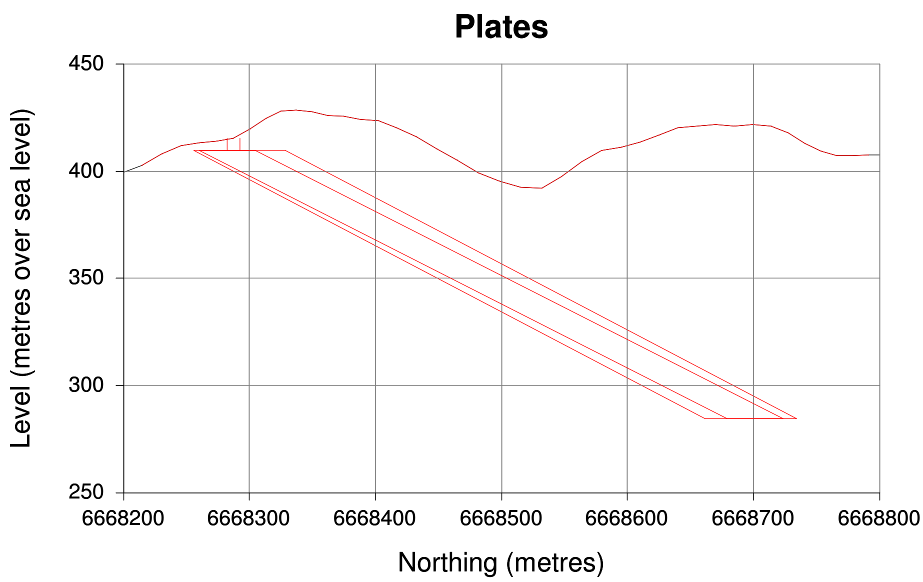
Anomaly 10

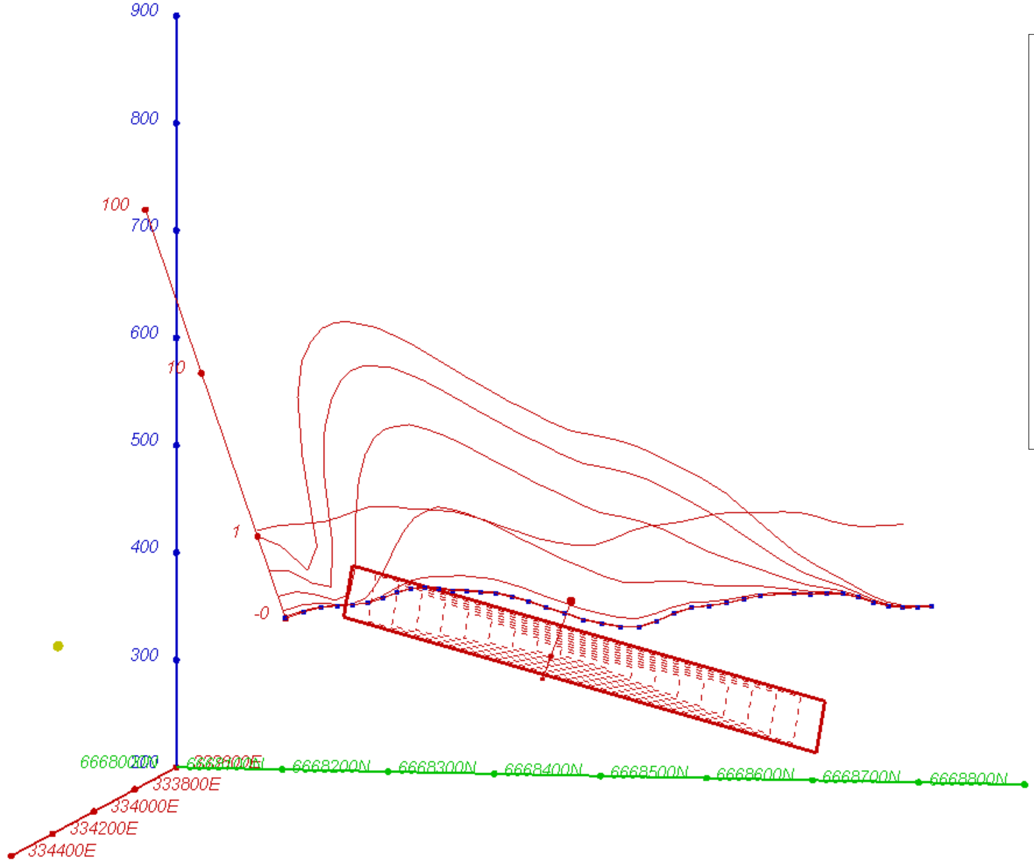
Line 104001

Inversion Results
Anomaly 14 (line 102701)

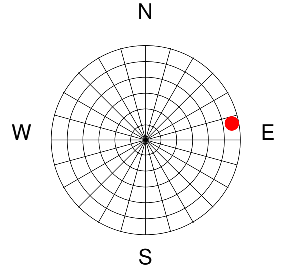








View Direction



View Azimuth : 79 deg.

View Inclination : 6 deg.

PLATE PARAMETERS

Name	1
X	334001
Y	6668240
Z	410
Length	457
Depth Extent	455
Dip	16
Dip Dir.	350
Plunge	0
Cond-Th.	9

Electromagnetic Imaging Technology

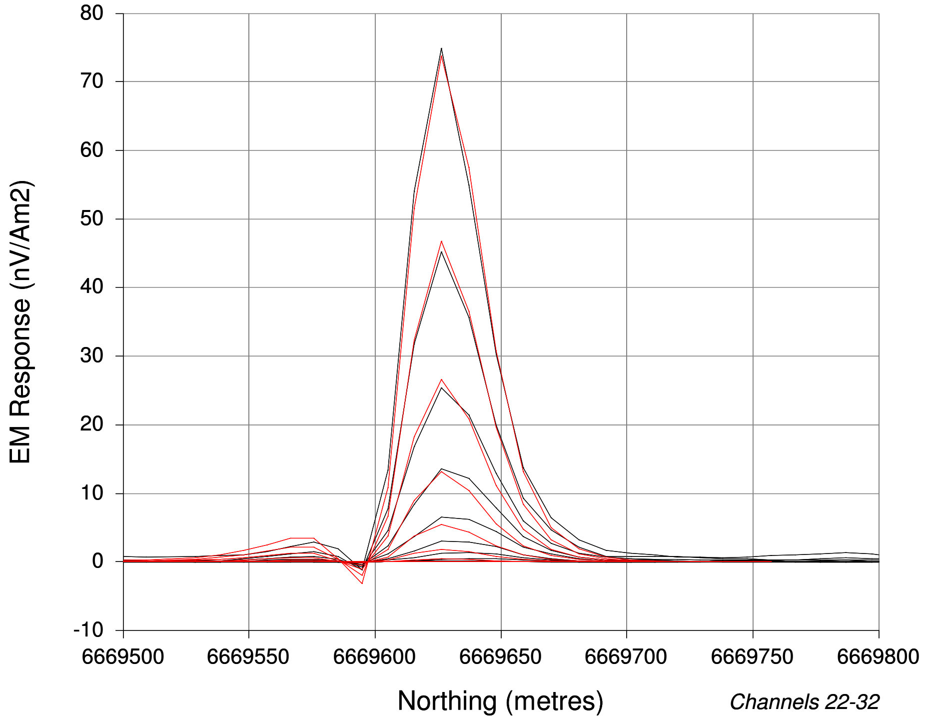
Inversion Results

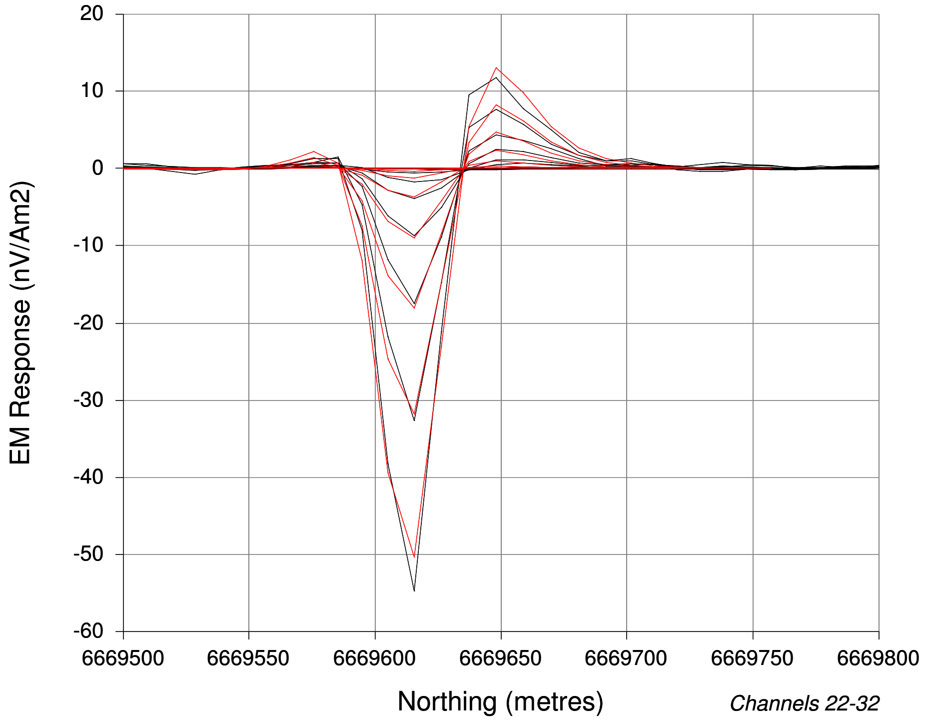
Anomaly 14

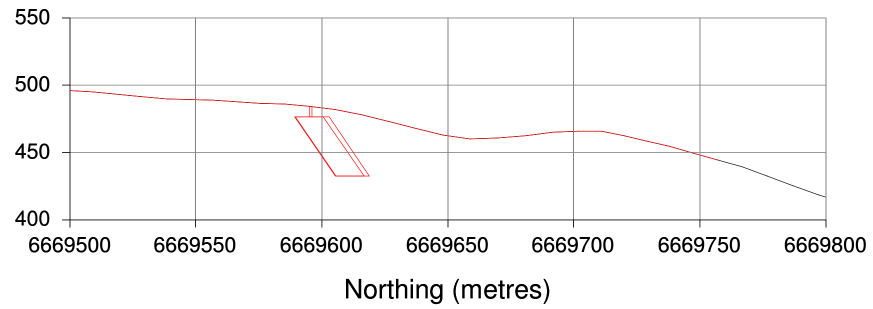
Line 102701

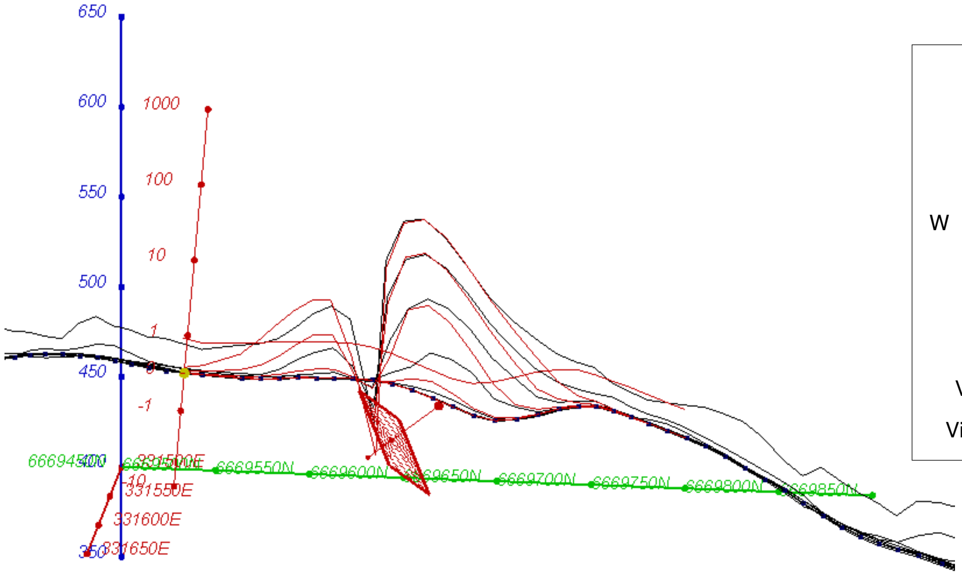
Drawn :	
Job No. :	

Inversion Results
Anomaly 16
line 104001









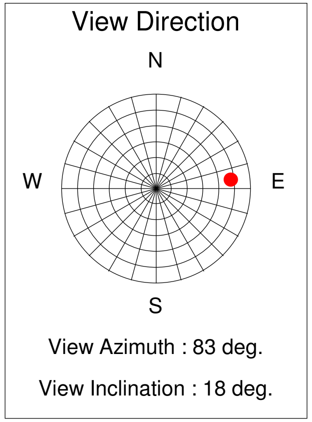


PLATE PARAMETERS

Name	1
X	331611
Y	6669600.8
Z	476.2
Length	54
Depth Extent	47
Dip	68.5
Dip Dir.	330
Plunge	0
Cond-Th.	34.6

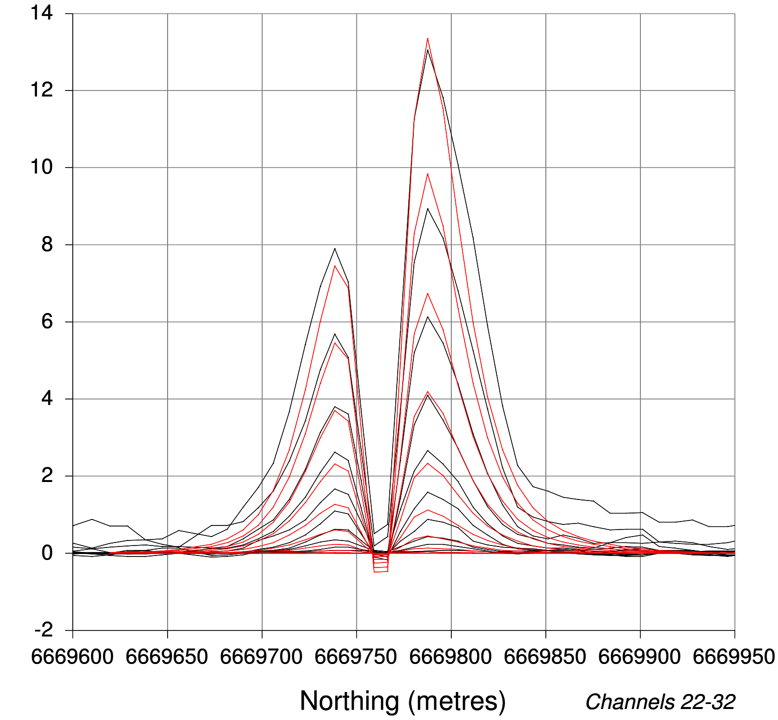
Inversion Results

Anomaly 16

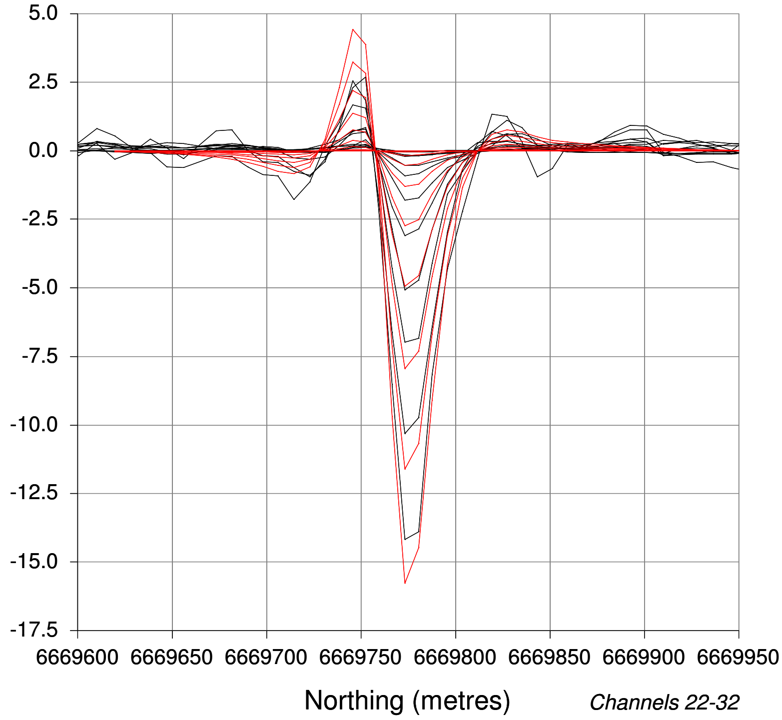
Line 104001

Inversion Results
Anomaly 17
line 103601

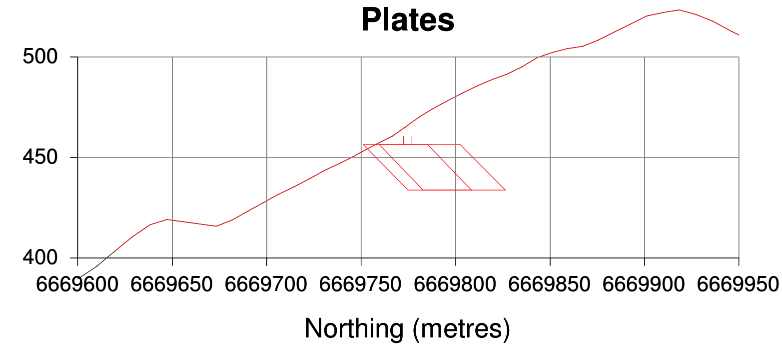
Z-Component

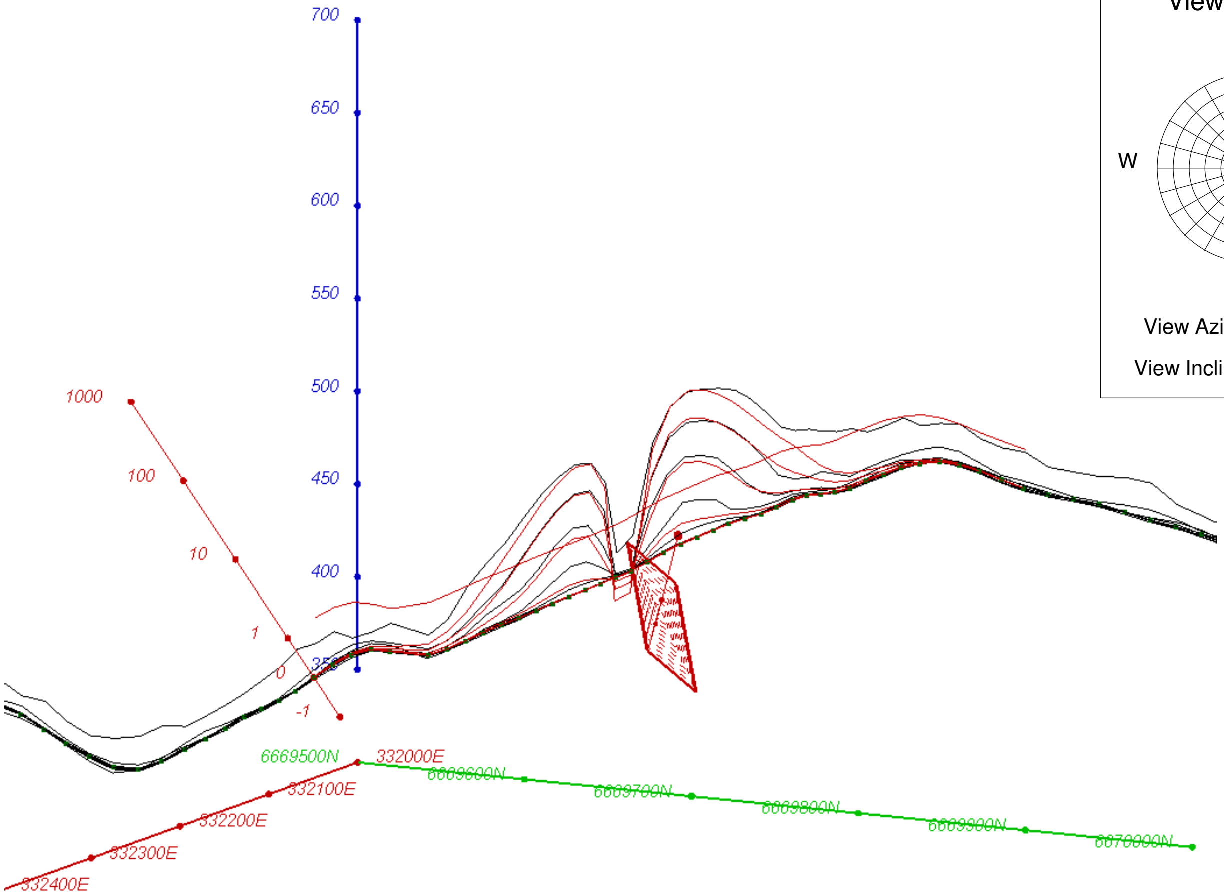


X-Component



Plates





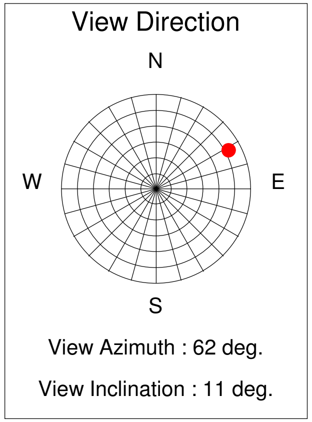


PLATE PARAMETERS

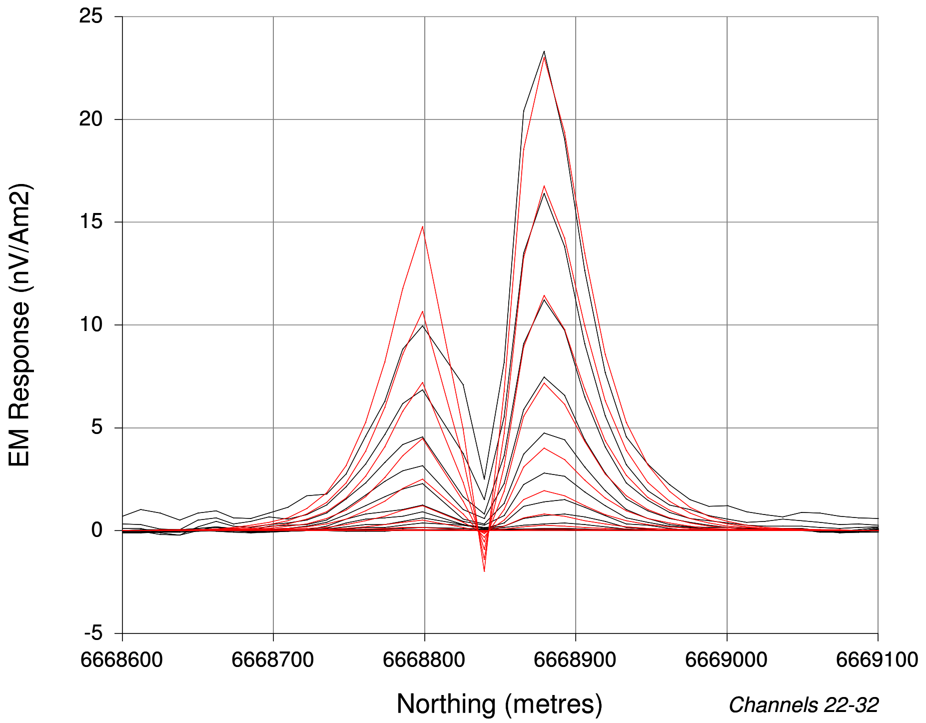
Name	1
X	332235
Y	6669792.6
Z	456.4
Length	300
Depth Extent	34
Dip	41
Dip Dir.	330
Plunge	0
Cond-Th.	56

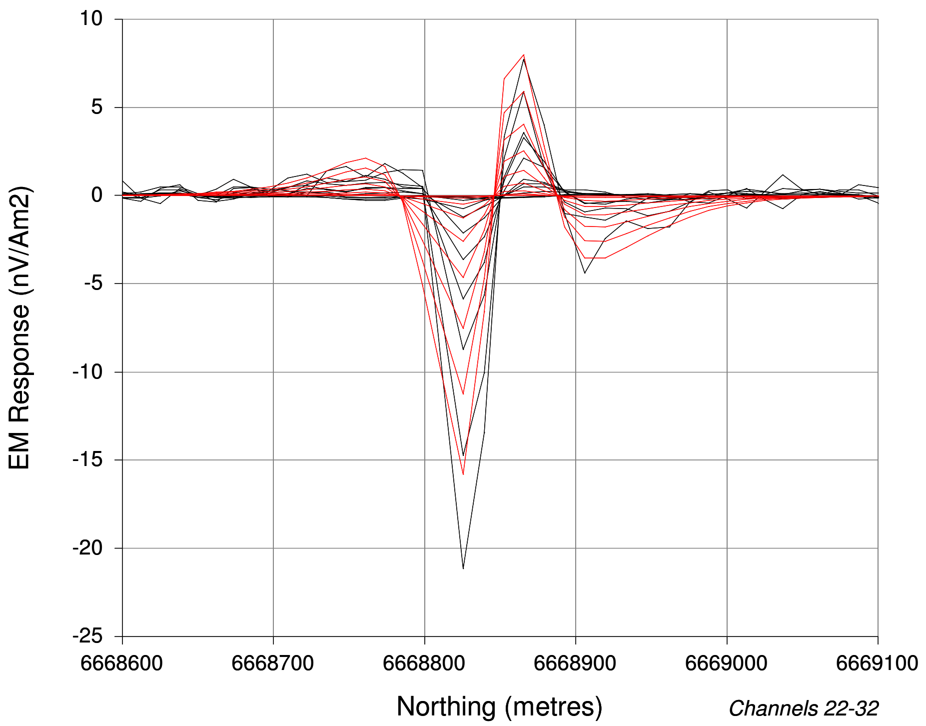
Inversion Results

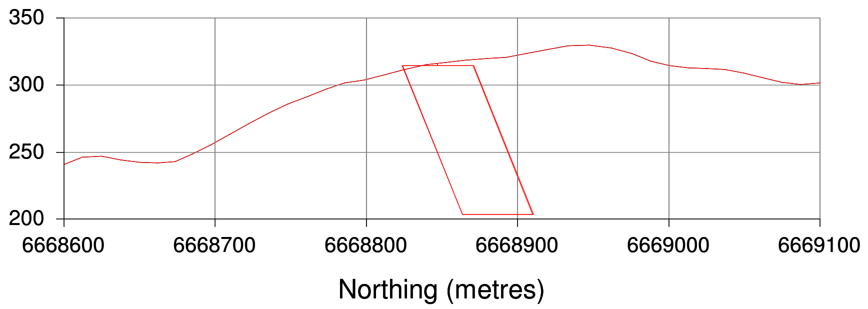
Anomaly 17

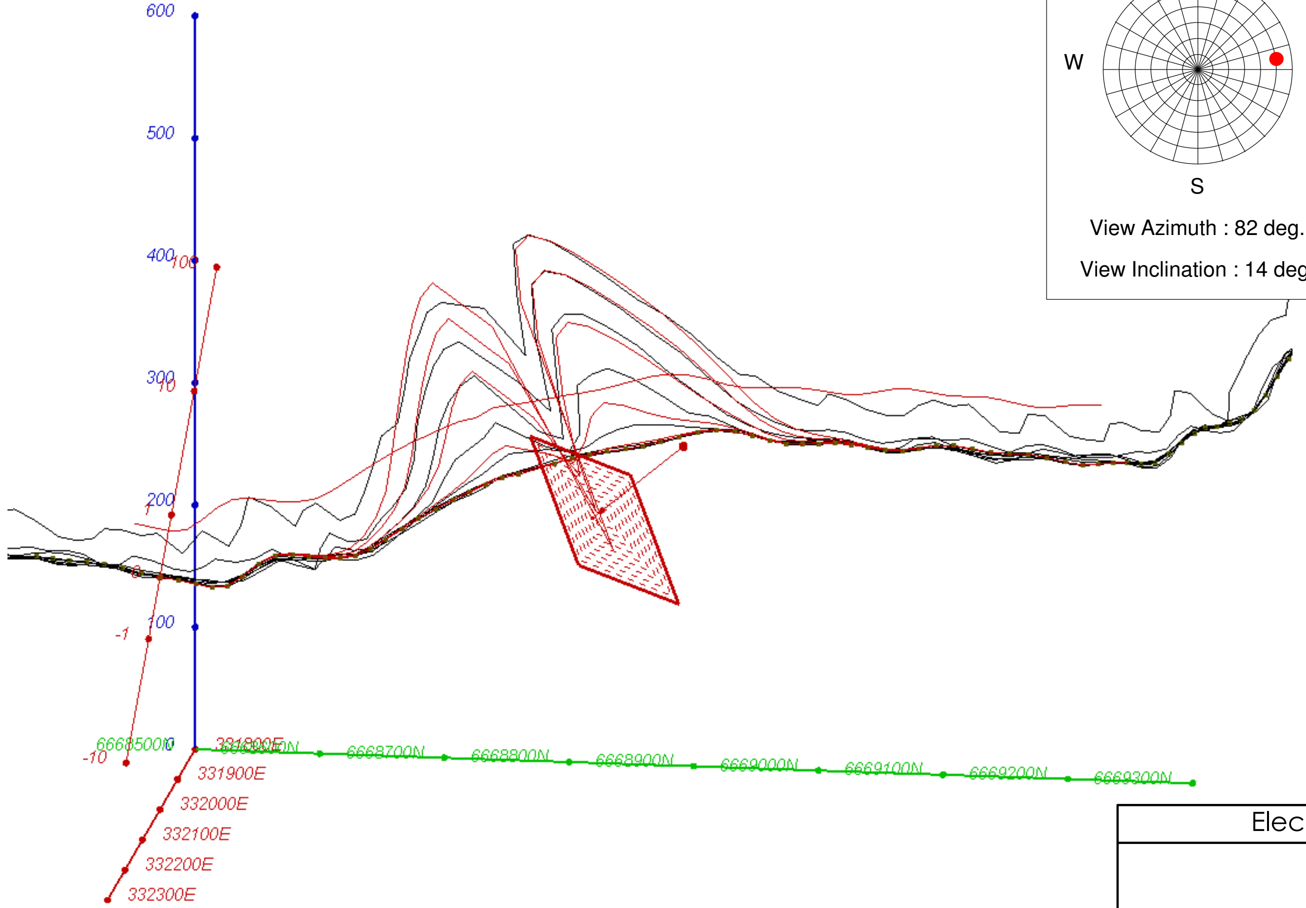
Line 103601

Inversion Results
Anomaly 18
line 103901









View Direction

N
W
E
S

View Azimuth : 82 deg.

View Inclination : 14 deg.

PLATE PARAMETERS

Name	1
X	332055
Y	6668845
Z	315
Length	150
Depth Extent	120
Dip	68
Dip Dir.	320
Plunge	0
Cond-Th.	20

Electromagnetic Imaging Technology

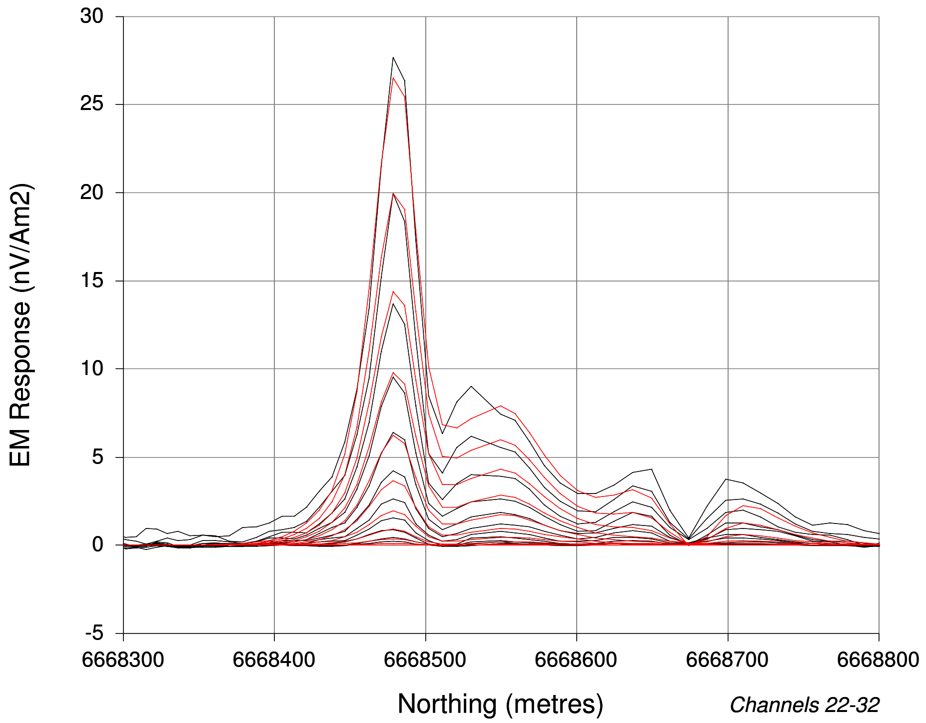
Inversion Results

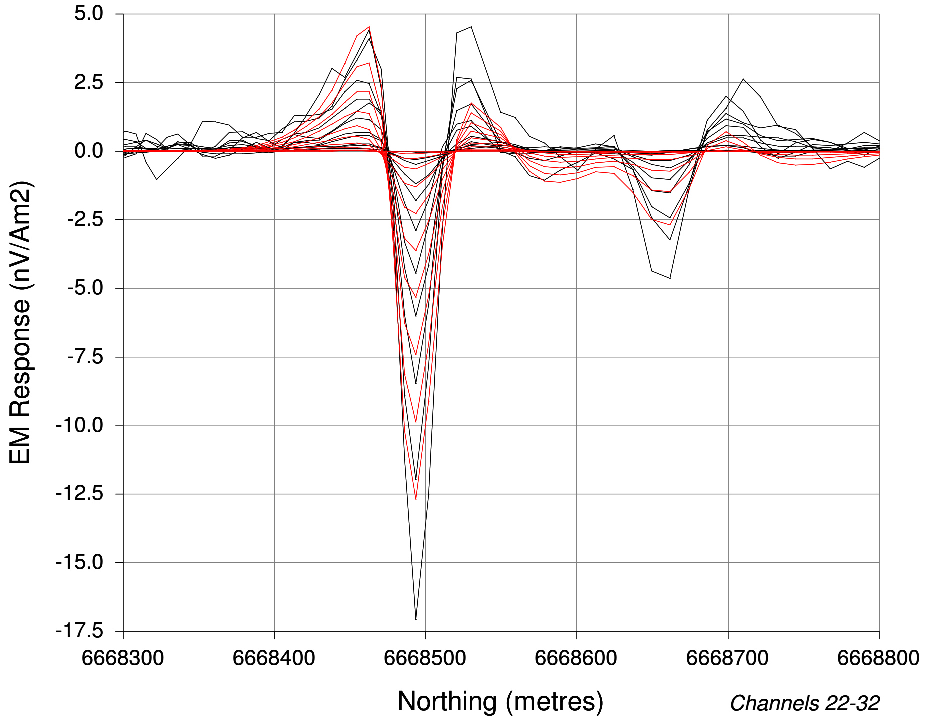
Anomaly 18

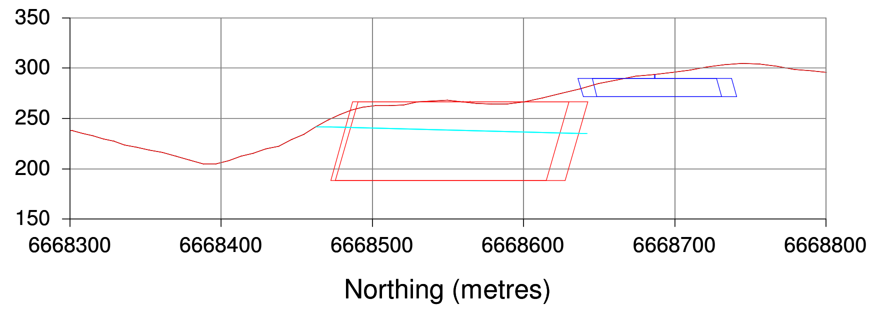
Line 103901

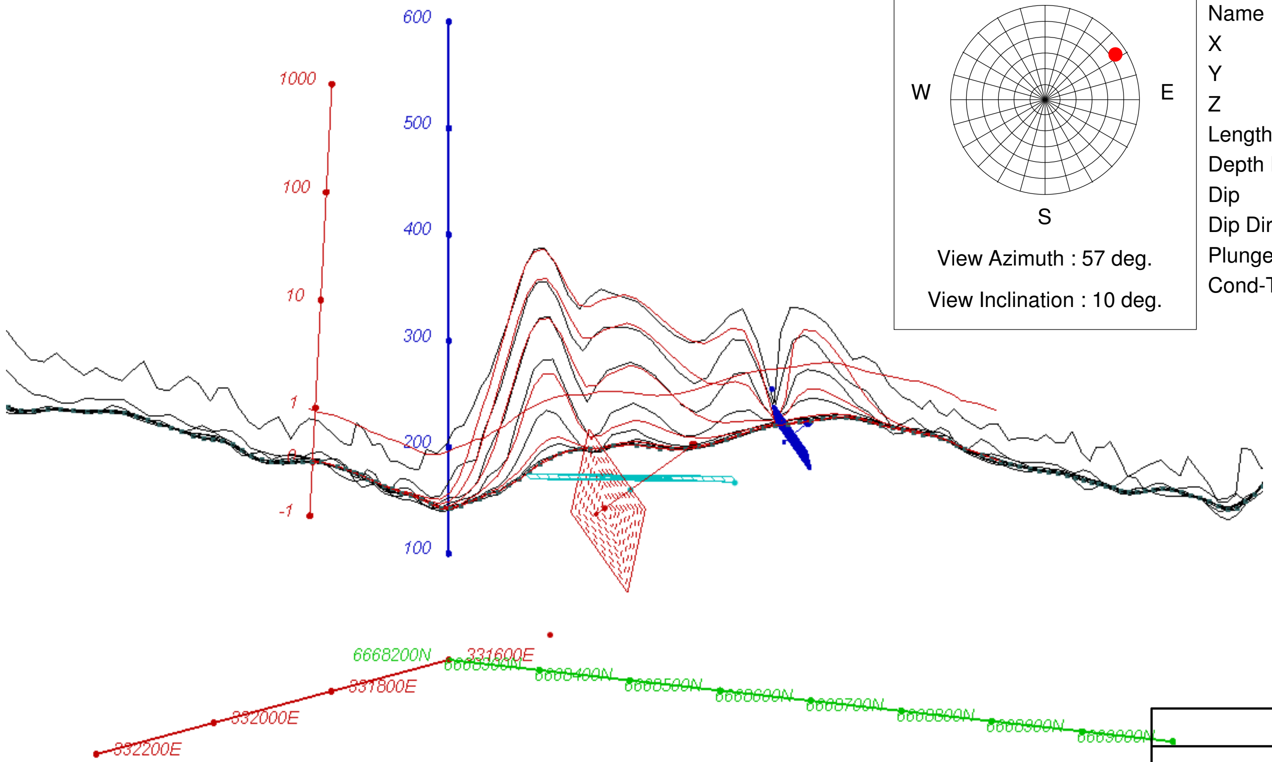
Drawn :	
Job No. :	

Inversion Results
Anomaly 19
line 104101









View Direction

N

W

E

S

View Azimuth : 57 deg.

View Inclination : 10 deg.

PLATE PARAMETERS

Name	1	2	3
X	331931	331890	331770
Y	6668601	6668476	6668687
Z	267	242	290
Length	430	30	253
Depth Extent	80	192	18
Dip	78	2	102
Dip Dir.	140	320	140
Plunge	0	0	0
Cond-Th.	40	55	50

Electromagnetic Imaging Technology

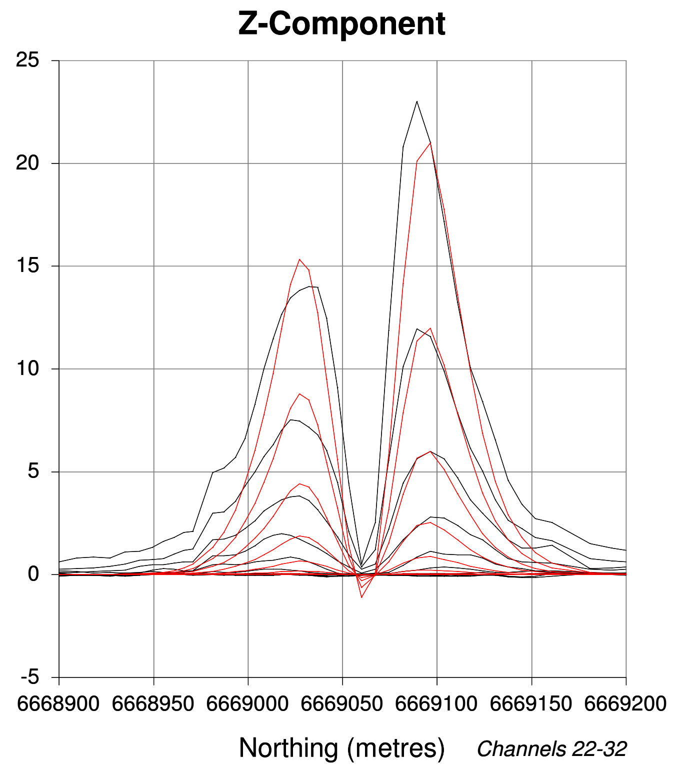
Inversion Results

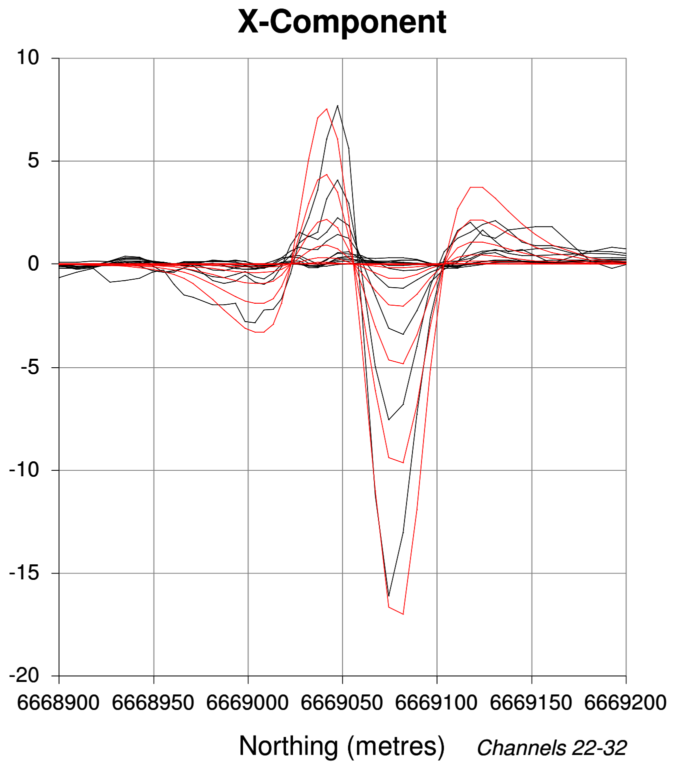
Anomaly 19

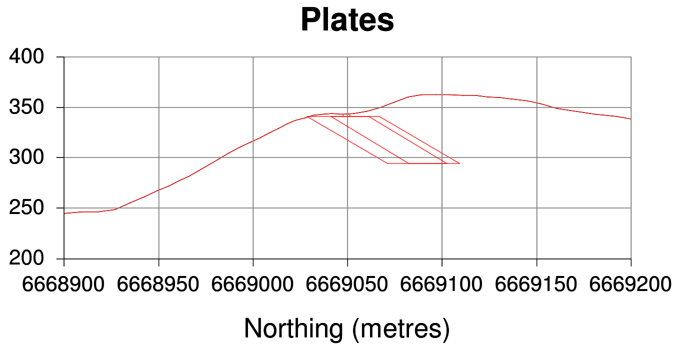
Line 104101

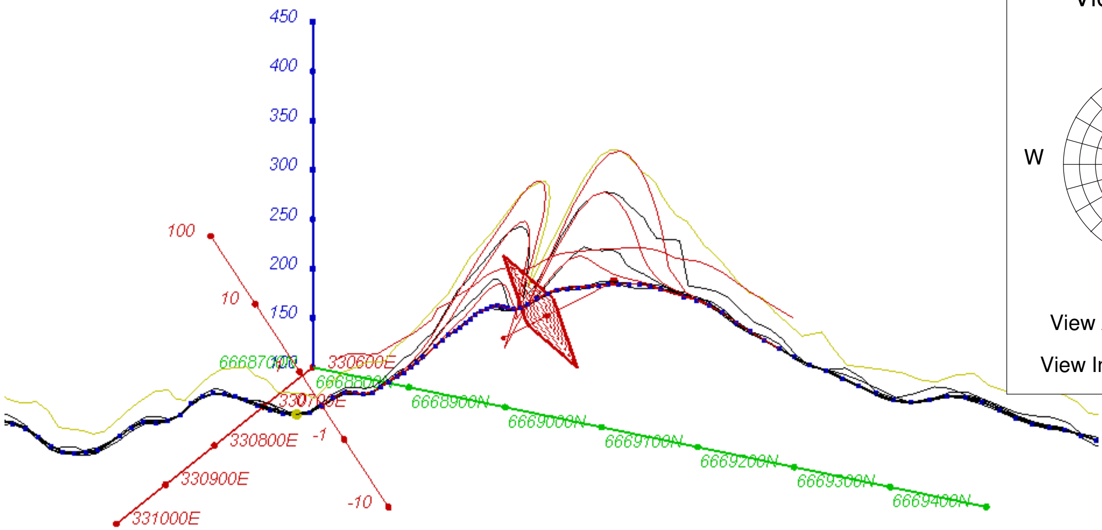
Drawn :	
Job No. :	

Inversion Results
Anomaly 22
Thin Plate
line 104602

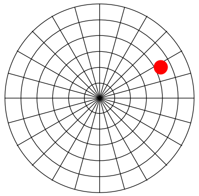








View Direction



View Azimuth : 63 deg.

View Inclination : 24 deg.

PLATE PARAMETERS

Name	1
X	330840.4
Y	6669033
Z	341
Length	159
Depth Extent	66
Dip	44.9
Dip Dir.	325
Plunge	0
Cond-Th.	16.9

Electromagnetic Imaging Technology

Inversion Results

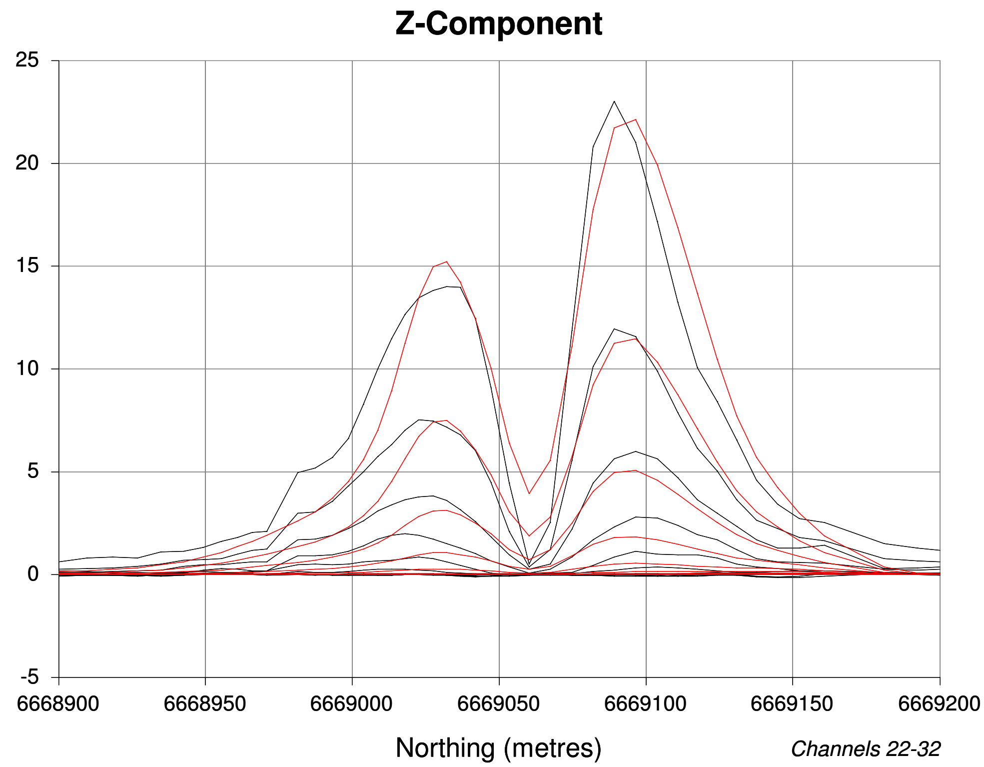
Anomaly 22

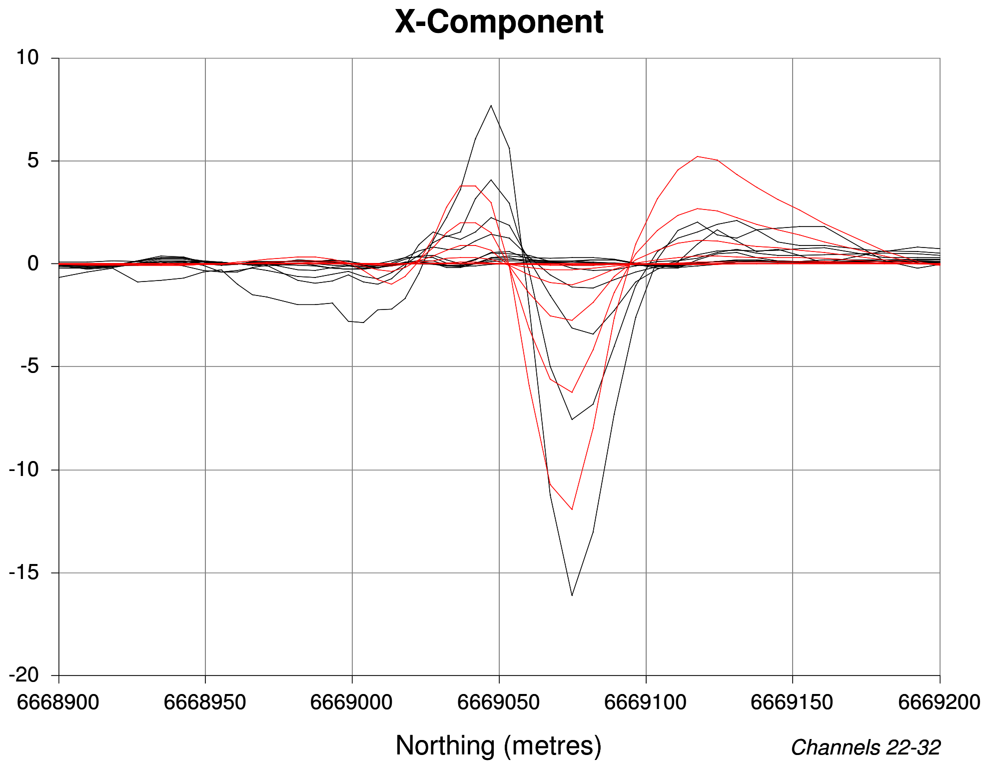
Thin Plate

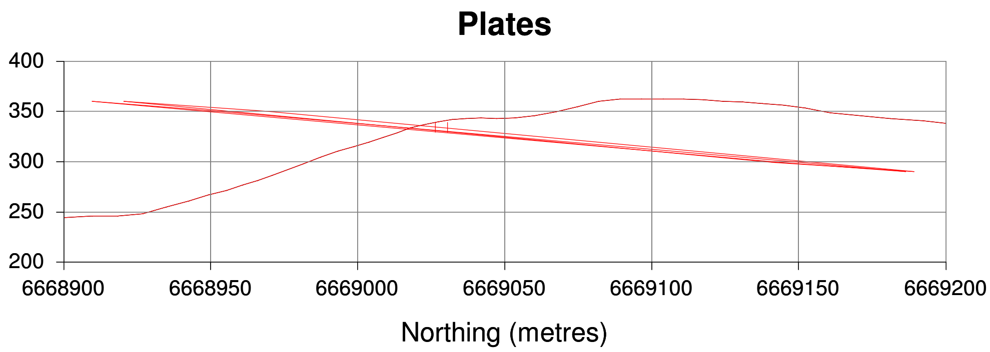
Line 104602

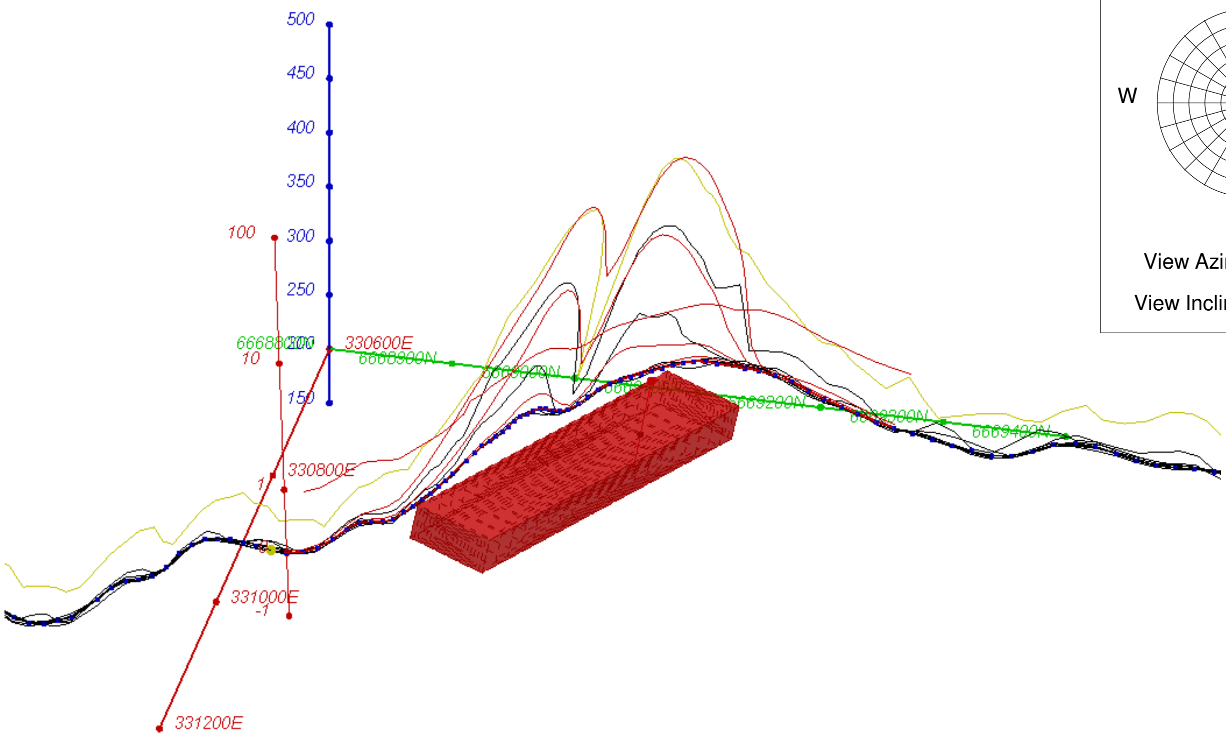
Drawn :	
Job No. :	

Inversion Results
Anomaly 22
Thick Plate
line 104602





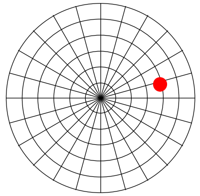




View Direction

N

W



E

S

View Azimuth : 77 deg.

View Inclination : 31 deg.

PLATE PARAMETERS

Name	1
X	330931.7
Y	6669047.1
Z	330
Length	370
Depth Extent	69.4
Dip	12.2
Dip Dir.	330
Plunge	-50.5
Cond-Th.	19.5

Electromagnetic Imaging Technology

Inversion Results

Anomaly 22

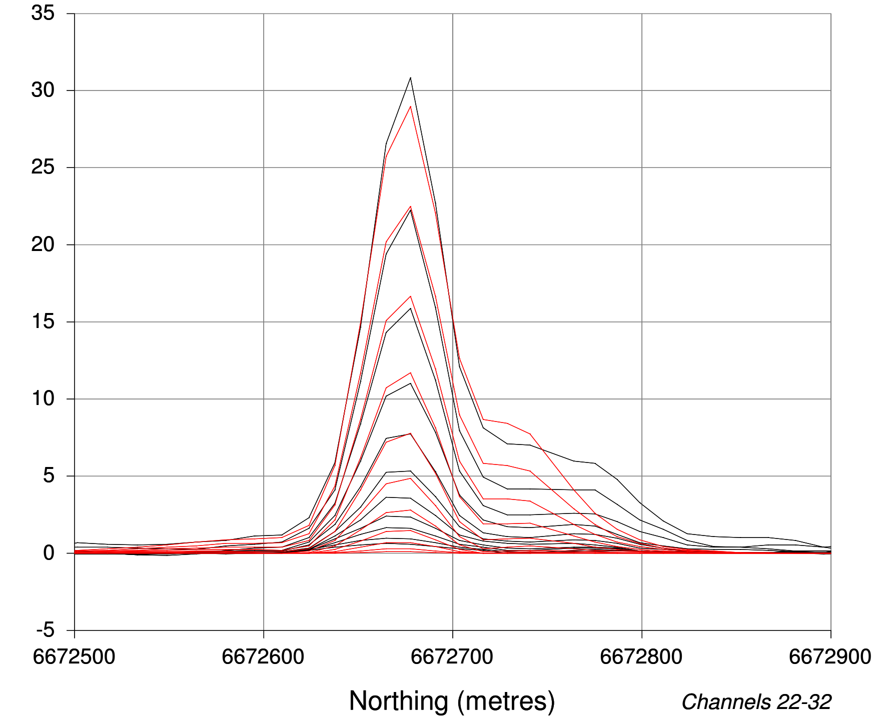
Thick Plate

Line 104602

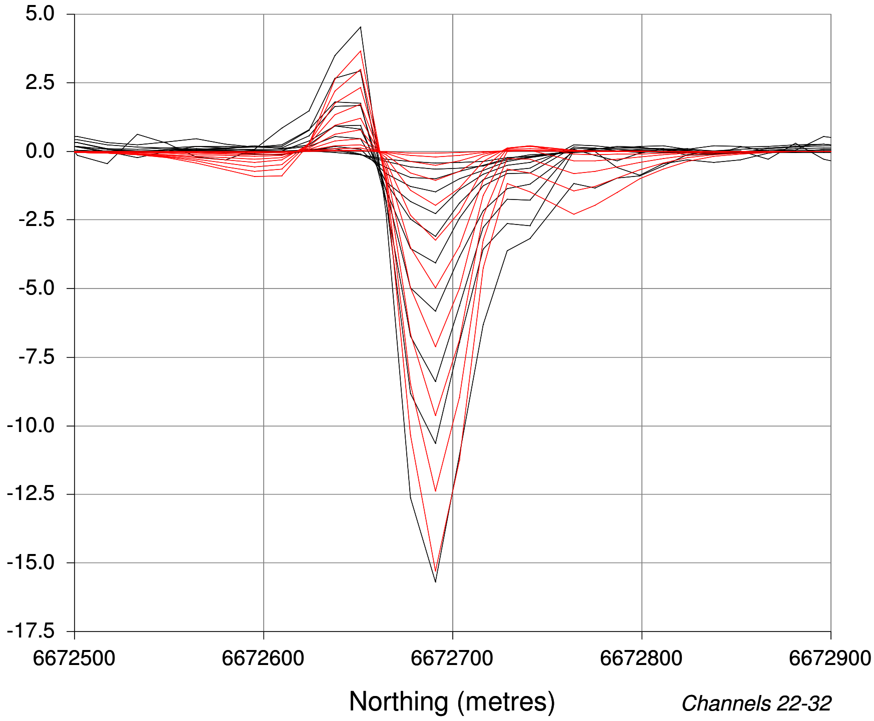
Drawn :	
Job No. :	

Inversion Results
Anomaly 23
line 101701

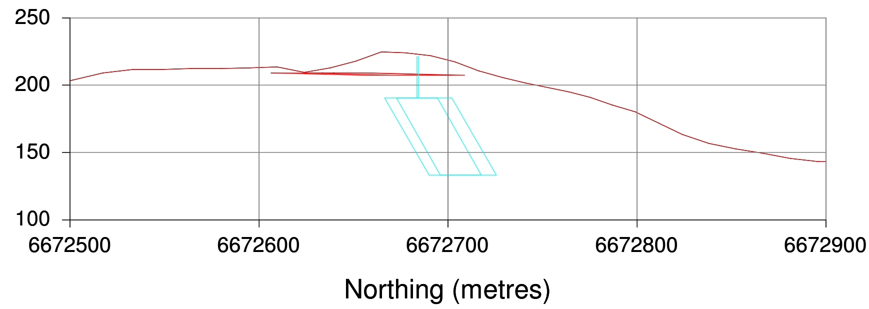
Z-Component

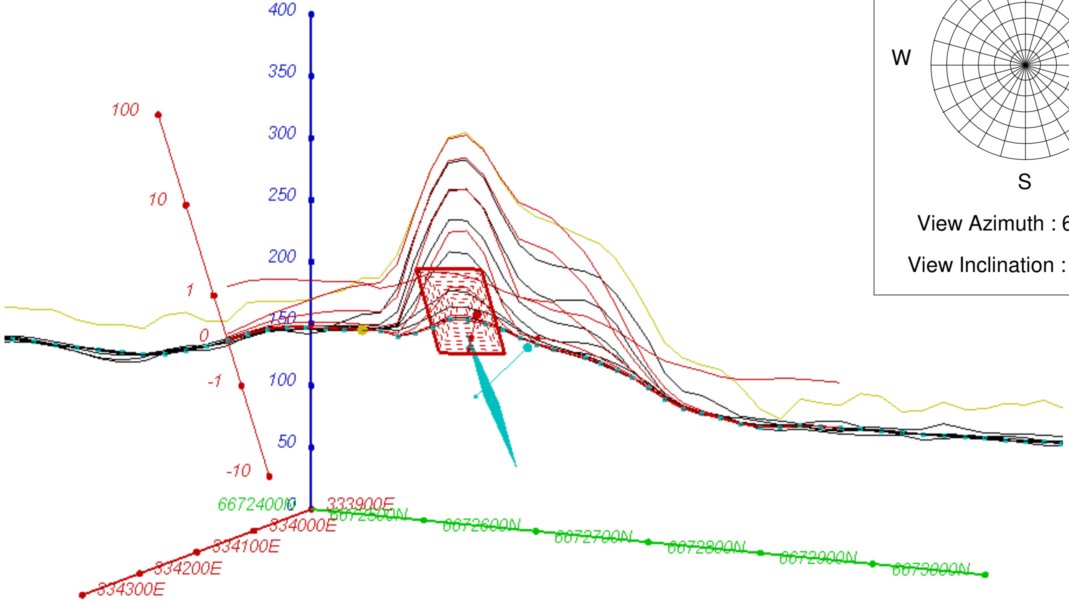


X-Component



Plates





View Direction

N

W E

S

View Azimuth : 63 deg.

View Inclination : 11 deg.

PLATE PARAMETERS

Name	1	2
X	334080	334177.8
Y	6672595.4	6672687.6
Z	209	190.7
Length	353	262
Depth Extent	52	63
Dip	1.7	66
Dip Dir.	330	330
Plunge	0	0
Cond-Th.	78.4	23.2

Inversion Results

Anomaly 23

Line 101701