



BLIGH RESOURCES LIMITED

EXPLORATION LICENCE No. 27654

**SECOND ANNUAL EXPLORATION PROGRESS REPORT FOR BOOTU CREEK TWO
PROJECT, NT
(14/07/2011 - 13/07/2012)**

**MAP SHEETS 1:250,000 Tennant Creek (SE 53-14) and the 1:100,000
Flynn (5759)
GDA 94 ZONE 53**

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Executive Summary

Bligh Resources Ltd (Bligh) is an unlisted public company focused on the exploration and development of manganese, gold and copper throughout Australia with tenements in Western Australia, Northern Territory and New South Wales. Bligh's Northern Territory manganese prospect is known as the Bootu Creek Two Project (the tenement) and lies 36km south of the world class Bootu Creek Manganese Mine in the central Northern Territory. Bligh has pegged 43 exploration blocks covering 13,600ha of ground prospective for manganese with a small area excised from the centre of the lease which forms EL22786.

The tenement occurs within the Tomkinson Province, a 5 km thick succession of minor metamorphosed and weakly deformed shallow marine sedimentary rocks. The Bootu Creek Two Project area covers a north to south-trending regional syncline containing manganiferous sediments of the Bootu Creek Formation. Strata bound manganese mineralisation outcrops on both the eastern and western limbs, along the contact zone between the Bootu Creek Formation and the Attack Creek Formation. The mineralisation is at a consistent stratigraphic level, lying just below a laterally widespread sandstone unit that is approximately 50m above the base of the succession.

Manganese exploration and mining in the Bootu Creek manganese field commenced in 1954 at the Mucketty deposit. Renewed interest in the Bootu Creek manganese field resumed in the 1980s, when a number of exploration companies began searching for McArthur River-style base metals mineralisation.

BHP conducted exploration drilling in the mid 1990's but relinquished the ground in 1998. It was acquired by N. Scriven who formed a joint venture with OM Holdings Ltd. A series of exploration drill programs were conducted along the Bootu Syncline and outlined shallow, consistent, relatively high grade manganese mineralisation along much of the strike-length. Mineralisation can be traced around the syncline as a series of black ridges and knolls. There are several manganese rich exposures on the eastern limb; Gogo, Skekuma and Chugga while Mucketty Mine is located on the western limb.

Bligh had proposed the following exploration during the first two years:

- Digitisation of all historical data sets and review of open file reports
- Satellite and aerial photograph interpretation
- Geological reconnaissance and prospect scale mapping
- Rock sampling program
- Heritage surveys
- Widely spaced first pass air core or RC drill programs on discrete areas
- Possibly Geophysical surveys

A geological reconnaissance survey by Bligh in 2010 was curtailed due to heavy rain but did confirm that manganese and iron mineralisation outcrops within the nose of a mapped syncline. It is recommended that another mapping trip is completed to ensure nothing has been overlooked and so that sampling may take place.

After these two years most of the proposed exploration has been completed:

- Digitisation of all historical data sets and review of open file reports
- Satellite and aerial photograph interpretation
- Geological reconnaissance and prospect scale mapping
- Bligh has successfully completed an airborne VTEM survey over the whole tenement area and interpretation of results is underway at the time of writing this report.

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1. Background

Bligh Resources Ltd (Bligh) is an unlisted public company focused on the exploration and development of manganese, gold and copper throughout Australia. Bligh currently holds exploration tenements in Western Australia, Northern Territory and in New South Wales.

The Bootu Creek Two Project comprises one Exploration Licence 70km north of Tennant Creek, NT. Tenement details are as follows:

Tenement Number	Current Holder	Applied	Granted	Expiry	Blocks	Area (km ²)
EL27654	Bligh Resources Ltd	21/09/2009	14/07/2010	13/07/2016	43	136.27

1.1. Location and Access

The Bootu Creek Two Project area lies to the west of the Whittington Range and is located 40km south of the existing Bootu Creek Manganese Mine in the central Northern Territory. The lease is approximately 820km south-southeast of Darwin, 70km north of Tennant Creek and roughly 15km from the Stuart Highway (Figure 1).

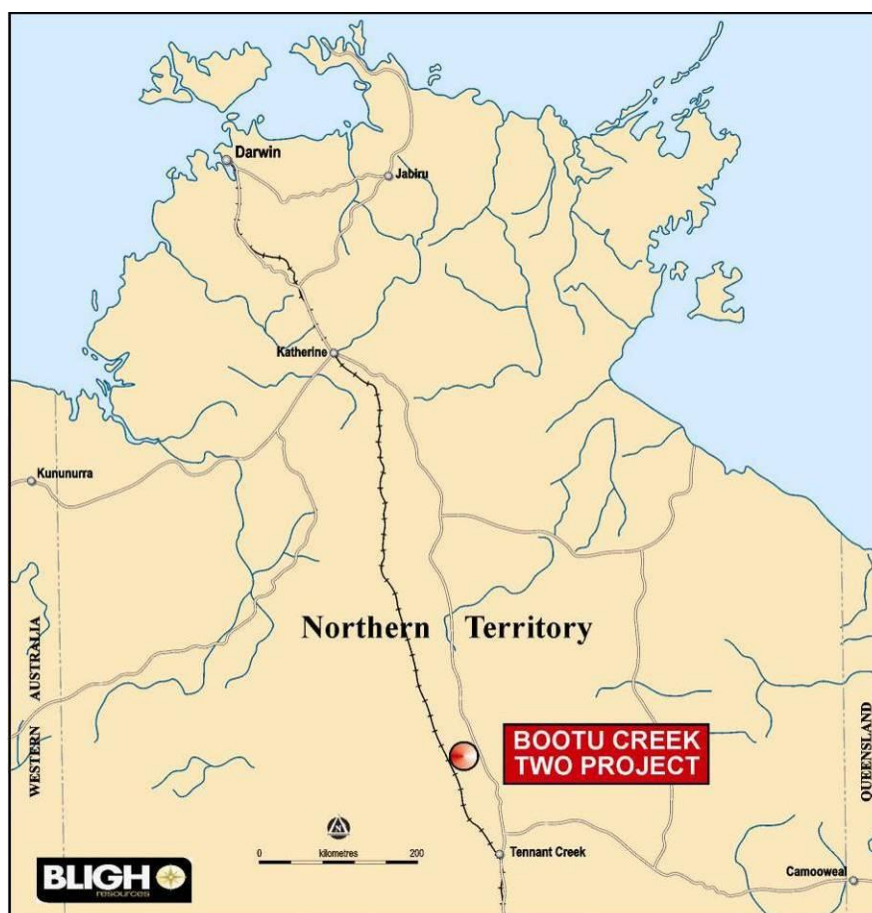


Figure 1 Bootu Creek Two Project Location

The tenement is approximately 10 km to the west of Stuart Highway. Access to the northern half of the tenement is from Stuart Highway and then via tracks while access to the southern half is via the road to Philip Creek homestead and station tracks. Areas of interest within the tenement are reached by navigating across country.

The Bootu Creek area is on the 1:250,000 Tennant Creek (SE 53-14) and the 1:100,000 Flynn (5759) map sheets.

Immediately south of the lease is the Banka Banka Station pastoral lease. The Darwin gas pipeline is located 45 km east of the tenement while the Alice Springs – Darwin railway which passes through Tennant Creek is located approximately 40 km west of the project area.

The climate is sub-tropical, with wet season rainfall of 50-125mm. The vegetation is mainly semi-arid scrubland, with areas of spinifex. The stream run-off is seasonal and the region has traditionally supported cattle ranching.

1.2. Regional Geology

The tenement occurs within the Tomkinson Province a 5 km thick succession of shallow marine sedimentary rocks which are weakly metamorphosed and weakly deformed. The Bootu Creek Formation and the Attack Creek Formation of the Tomkinson Province form part of a regional open, concentric synclinal fold which trends north-northwest. The western limb of this syncline has been offset by a north-northwest trending sinistral strike-slip fault that dips 50°E.

Manganese mineralisation occurs as shallowly dipping seams around the edges of the NWW- trending Bootu Syncline. The mineralisation is stratiform, regionally widespread and occurs near the base of the Bootu Formation a part of the 1805 – 1710 Ma Tomkinson Creek Group.

The mineralisation in the region is formed by the cumulative influence of a combination of processes, including low temp hydrothermal replacement and supergene enrichments. It is likely that there may be a sedimentological origin for at least some of the manganese.

1.3. Local Geology

The main lithological units of the tenement comprise sediments of the Proterozoic Attack Creek and Bootu Creek formations (Figure 2). The Bootu Creek Formation outcrops as a 2,200 m thick, extensive, low-relief plateau. This thick unit is dominated by widely bedded sandstone and conglomerate, which is interbedded with thin intervals of various saline shallow- water sediments.

The Attack Creek Formation dated at 1752 Ma consists of dolostones, limestones, thinly bedded siltstone and mudstone, chert and some beds of intraformed conglomerates. A conformable to locally erosive contact separates this unit from the Bootu Creek Formation.

The tenement covers part of a regional north-trending syncline which plunges gently at 25° to the south and is modified by several faults that are sub-parallel to the fold axis.

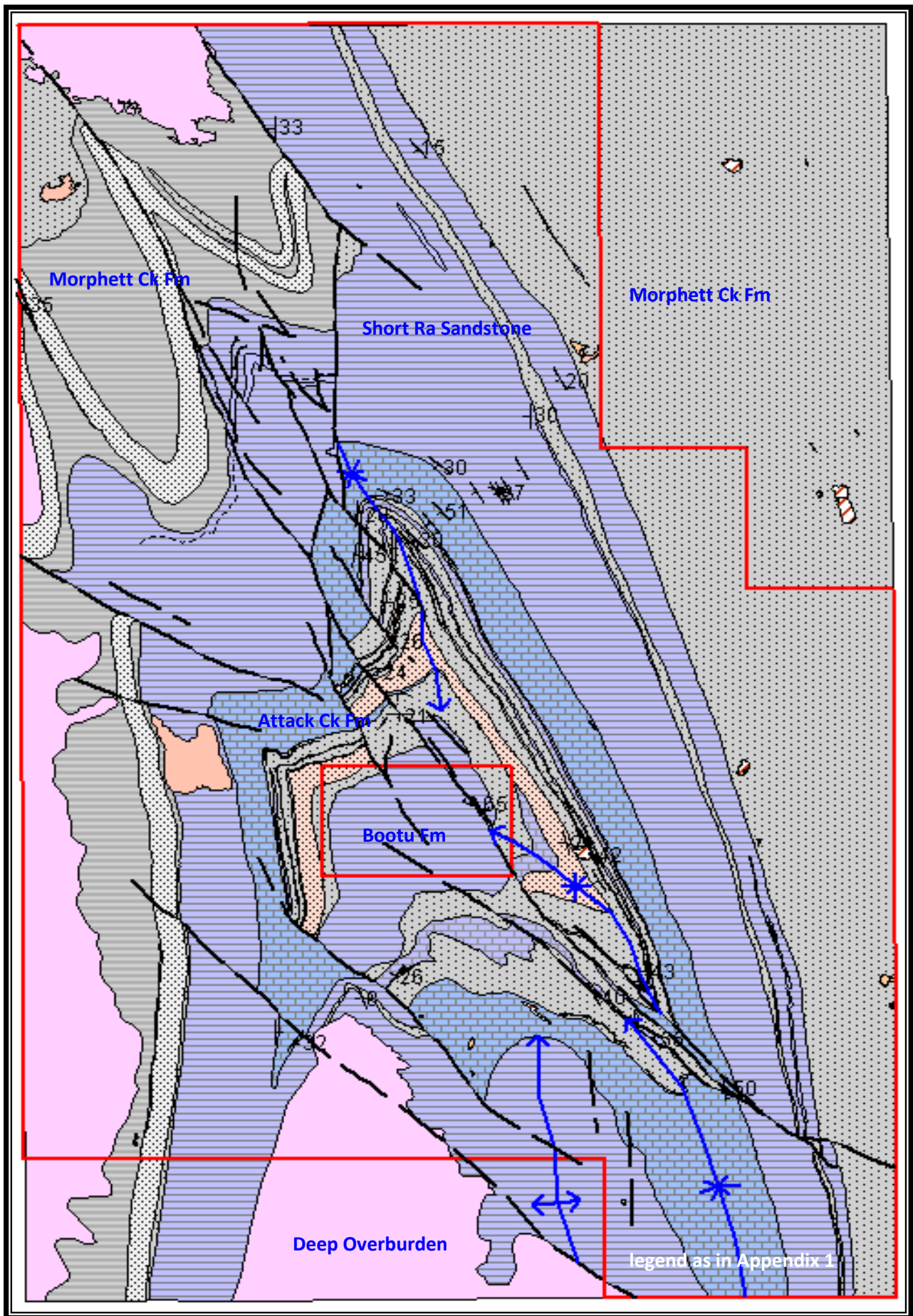


Figure 2 Geological Interpretation of Project area (Compass Geology)

The stratiform manganese mineralisation in the project area occurs near the base of the Bootu Creek Formation. It is at a consistent stratigraphic level, lying just below a laterally widespread sandstone unit that is approximately 50m above the base of the succession. Manganese occurs on both limbs of the syncline, near the disconformable contact with the underlying Attack Creek Formation. This bed-like manganiferous interval outcrops as a series of black ridges and knolls around the fold closure. There is a 17km long potential strike-length along this contact.

Typically, the mineralisation comprise a basal, high grade manganiferous shale several metres in width, overlain by a similar width of lower-grade, medium-grained manganiferous sandstone. The mineralization occurs as epigenetic lens and vein replacements of interbedded quartz arenite, dololomite and dolomitic siltstone and grade varies along strike. Manganese oxides predominantly consist of amorphous and massive cryptomelane, with minor psilomelane, pyrolusite and hollandite.

A succession of alternating siltstones and sandstones overlie the main bed of manganese mineralisation. These units contain small, sporadic patches of manganiferous mineralisation. Elsewhere the tenement is overlain by Cainozoic quartz-rich colluvial fan deposits, silcrete and alluvium.

2. Authority History

Bligh Resources Ltd was incorporated in New South Wales on 17 May 2008 as 'Tradebook Services Pty Limited'. The name was changed to "Bligh Resources Pty Limited" on 14 July 2009. It was converted to a public company and changed its name to "Bligh Resources Limited" on 17 December 2009.

Bligh Resources holds a number of tenements throughout Australia to explore for manganese, gold and copper including the Bootu Creek Two project is in the Northern Territory.

3. Previous Exploration History

Manganese exploration and mining in the Bootu Creek manganese field commenced in the 1954 at the Mucketty deposit, which is north of the present day Bootu Creek Manganese Mine. The five shallow open cuts produced 13,208 t at 42 % Mn as pyrolusite (manganese dioxide).

Renewed interest in the Bootu Creek manganese field resumed in the 1980s, when a number of exploration companies began searching for McArthur River style base metals mineralisation.

Minor drilling and rock chip sampling programs failed to find economic base metals or manganese mineralisation. However by the mid – 1990s BHP had intersected economic manganese mineralisation at depth on the eastern side of the Bootu Syncline, near Mucketty Mine. The best intercept was 15 m at 14.75% Mn.

After BHP relinquished the ground in 1998, it was acquired by N. Scriven who subsequently formed a joint venture with OM Holdings Ltd. The latter conducted a series of exploration drill programs along the Bootu Syncline and outlined shallow, consistent, relatively high grade manganese mineralisation along much of the strike-length.

Major RC and diamond drilling programs has established a total resource of 11.0 Mt at 26% Mn by September 2003 and mining began in November 2005. By the end of September 2007 Bootu Creek Mine has produced over 570,000 t of ore, this figure included 393,000 t at 42.45 % Mn.

In December 2009 OM holdings project resource was upgraded to 32.9 Mt at 23.1% Mn with an expected mine life of at least 15 years.

4. Exploration Rationale

The geology and structural setting of EL27654 is similar to that of OM Holding's Bootu Creek Manganese Mine which is situated 36 km to the north and has a 2009 resource of 32.9Mt at an average of 23.1% manganese.

Geological reconnaissance will be conducted for a 5-10 day field program, to complete the campaign conducted in 2010 which was curtailed due to rain. In addition to a rock sampling program, the program will examine rock types, structural relationships, sampling of targets generated from historical data sets and access issues.

Prospect – scale mapping has aided identifying areas of outcropping mineralisation and complementary mapping will aid in defining detailed structural relationships and provide a high level of confidence for planning further exploration. The stratigraphical relationships are a key to Mn and Cu mineralisation in the area.

Regional scale VTEM survey has been completed in May 2012 and data is being processed and interpreted at the time of writing this report.

A geochemical rockchip sampling program will be conducted over target areas by using grab or channel samples. Multi element assay method will be used to generated anomalies and drill targets. A geophysical method may be required if confidence levels are low that mineralisation does not persist at depth.

The first phase of exploration is anticipated to identify at least 5-10 prospects which will be subsequently tested, using either RC or air core drilling. An estimated 1-4,000 m of drilling will be conducted on the target zones during the 2012 field season.

5. Discussion

The areas of manganese iron enrichment that were visited in 2010 all occurred within the Attack Ck Formation.

The dolomites of the Attack Ck Fm are partially weathered and host broad areas of manganese iron enrichment. This enrichment is stratabound and some of the enrichment occurs preferentially within the nose of the syncline and within the area transected by NNW faulting, but much of it is not obviously structurally controlled in any way.

Mostly they appear to represent a relatively thin veneer of enrichment associated with the weathering of the dolomite in the regolith, although this can only be confirmed by drilling.

A few relatively large areas of enrichment also occur within the vuggy sandstones. These occur along ridge tops as flat layers with roots extending down into the sandstone beds. The sandstone-hosted enrichment tends to be higher in iron.

Some enrichment also occurs within a thin siltstone interbed flanked by sandstone.

Some manganese iron enrichment also occurs in low-lying areas of the Morphett Ck Fm sandstones to the east of the tenement. The enrichment is associated with the formation of laterite hardcap, and in effect a ferro-manganese laterite hardcap layer. Similar manganese enrichment can be seen on the

airphoto imagery in the southeast corner of the tenement, but was not visited in 2010 because of the early termination of mapping.

These enrichments will be visited during the next field work campaign planned to take place during the 2012 dry season.

6. Exploration Completed in Reporting Period

The following exploration activities was completed during the reporting year:

Helicopter borne Versatile Time-domain Electro-Magnetics survey (VTEM).

The survey consisted of helicopter borne EM using the versatile time-domain electromagnetic (VTEM plus) system with Z and X component measurements and aeromagnetics using a caesium magnetometer. A total of 785 line-km of geophysical data were acquired during the survey. The survey block was flown in an east to west (N 90° E azimuth) direction, with traverse line spacing of 200 metres.

VTEM allows mainly detecting conductive bodies in the ground. These bodies can be correlated with the mapping results compiled in 2010 in order to identify buried continuity of the mineralised outcrops.

Expenditure for these activities is outlined on the attached Northern Territory Mineral Expenditure Form.

7. Results and Discussion

An extended wet season and availability of a crew delayed the execution of the airborne VTEM survey.

Preliminary results are being compiled at the time this report is written. A preliminary report is annexed with this report.

Bligh Resources is waiting for the final results and interpretation of the VTEM survey to plan efficiently the next steps in the exploration of the tenement.

An area reduction of 50% of the EL is due on the 13th July 2012. As the full results for the VTEM survey will not be available to Bligh before this date, the company has applied for a waiver of reduction on the grounds that the cost for the VTEM surveys exceeds by far the expenditure commitment for EL 27654.

8. Proposed Exploration in next Reporting Year

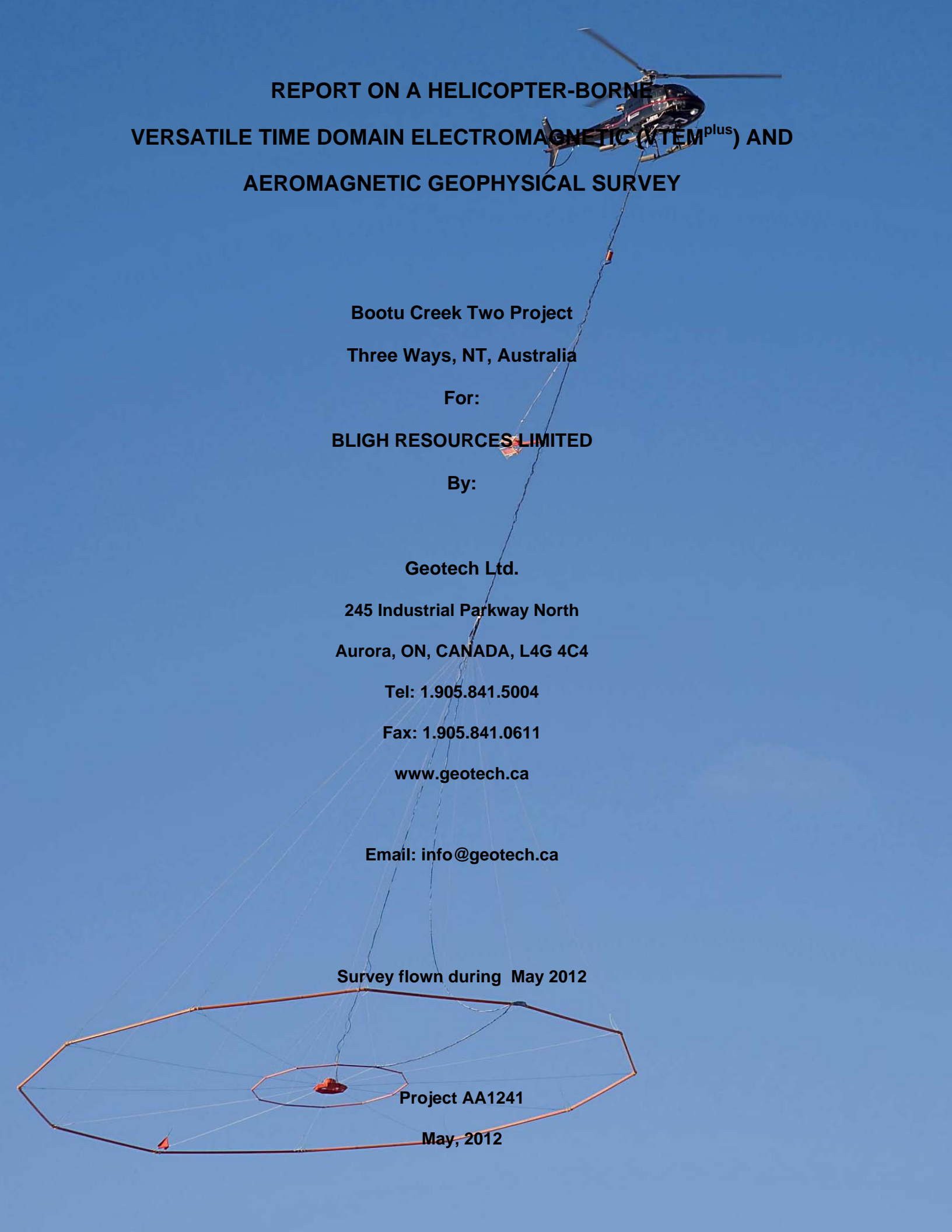
The following outlines the proposed exploration in the next reporting year:

- Final interpretation of the VTEM survey flown this year.
- Geological reconnaissance
- Completion of project scale mapping
- Rock chip sampling program
- Drilling of targets generated from VTEM interpretation and geological reconnaissance.

Bligh Resources has budgeted drilling of 50 aircore and RC holes on EL27654. This drilling program is planned to take place during the 2012 winter season.

9. Appendices

Appendix A – preliminary results of VTEM survey flown over EL27654 in May 2012.



**REPORT ON A HELICOPTER-BORNE
VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM^{plus}) AND
AEROMAGNETIC GEOPHYSICAL SURVEY**

Bootu Creek Two Project

Three Ways, NT, Australia

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Survey flown during May 2012

Project AA1241

May, 2012

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REPORT ON A HELICOPTER-BORNE VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM^{plus}) and AEROMAGNETIC SURVEY

Bootu Creek Two Project
Three Ways, NT, Australia

EXECUTIVE SUMMARY

During May 4th to May 8th, 2012 Geotech Airborne Pty Ltd. carried out a helicopter-borne geophysical survey over the Bootu Creek Two Project situated approximately 52 kilometres northwest of Tennant Creek, NT, Australia respectively.

Principal geophysical sensors included a versatile time domain electromagnetic (VTEM^{plus}) system, and a caesium magnetometer. Ancillary equipment included a GPS navigation system and a radar altimeter. A total of 785 line-kilometres of geophysical data were acquired during the survey.

In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as the following maps:

- Electromagnetic stacked profiles of the B-field Z Component,
- Electromagnetic stacked profiles of dB/dt Z Components,
- Colour grids of a B-Field Z Component Channel,
- Total Magnetic Intensity (TMI),
- Analytic Signal of Total Magnetic Intensity, and
- EM Time-constant dB/dt Z Component (Tau), are presented.

Digital data includes all electromagnetic and magnetic products, plus ancillary data including the waveform.

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set.

1. INTRODUCTION

1.1 General Considerations

Geotech Airborne Pty Ltd. performed a helicopter-borne geophysical survey over the Bootu Creek Two Project situated approximately 52 kilometres northwest of Tennant Creek, NT, Australia respectively (Figure 1 & Figure 2).

Bill Guy represented BLIGH RESOURCES LIMITED during the data acquisition and data processing phases of this project.

The geophysical surveys consisted of helicopter borne EM using the versatile time-domain electromagnetic (VTEM plus) system with Z and X component measurements and aeromagnetics using a caesium magnetometer. A total of 785 line-km of geophysical data were acquired during the survey.

The crew was based out of Three Ways (Figure 2) in NT, Australia for the acquisition phase of the survey. Survey flying started on May 4th and was completed on May 8th 2012.

Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final data processing followed immediately after the end of the survey. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in May, 2012.



Figure 1: Property Location

1.2 Survey and System Specifications

The Bootu Creek Two Project is situated approximately 52 kilometres northwest of Tennant Creek, NT, Australia (Figure 2).

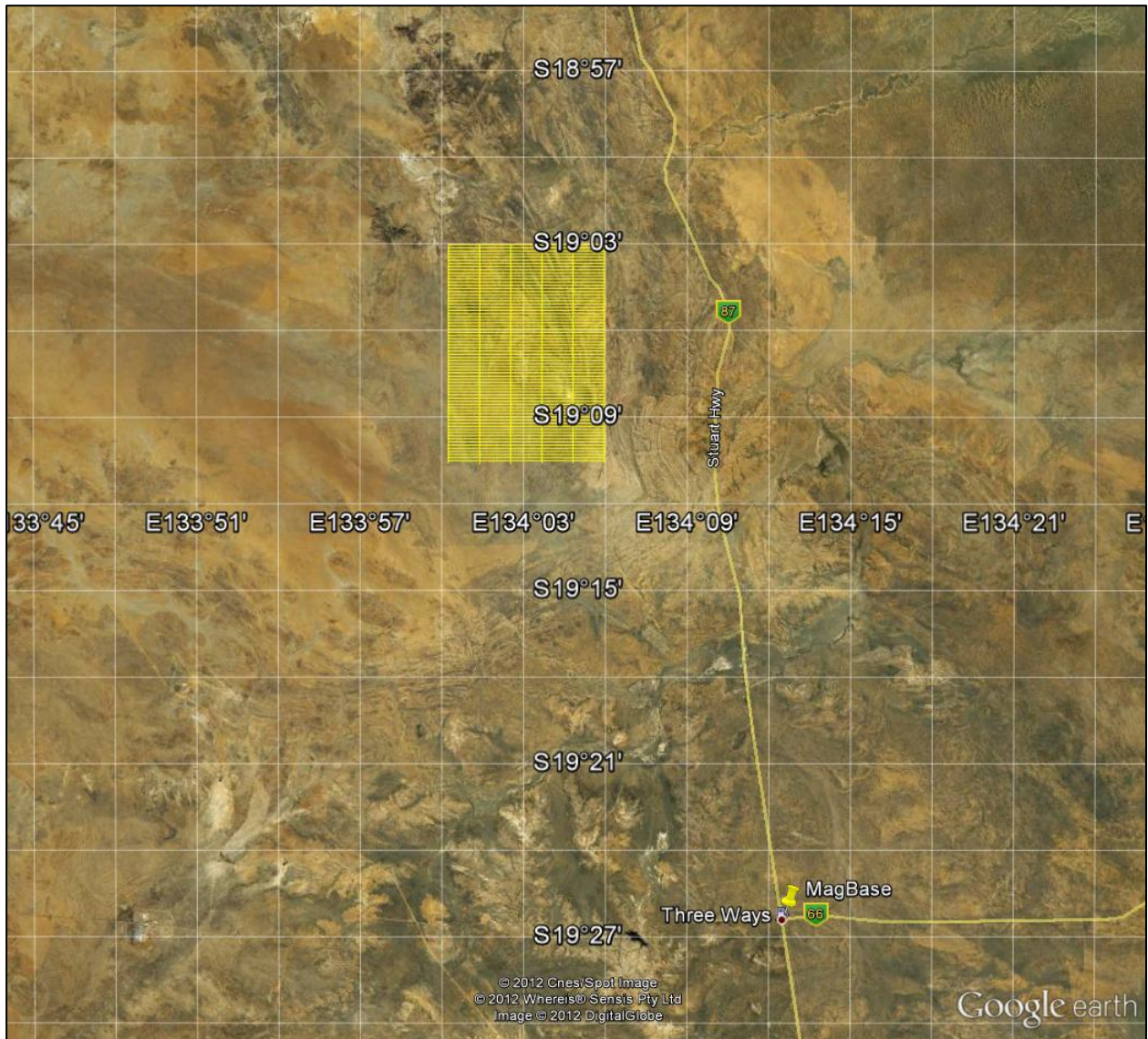


Figure 2: Survey areas location on Google Earth

The survey block was flown in an east to west ($N 90^\circ E$ azimuth) direction, with traverse line spacing of 200 metres as depicted in Figure 3. Tie lines were flown perpendicular to the traverse lines ($N 0^\circ E$ azimuth) at a spacing of 2000 metres respectively. For more detailed information on the flight spacing and direction see Table 1.

1.3 Topographic Relief and Cultural Features

Topographically, the Bootu Creek Two Project exhibits a highly moderate relief with an elevation ranging from 308 to 410 metres above mean sea level over an area of 141 square kilometres (Figure 3).

The survey block has various rivers and streams running through the survey area. There are visible signs of culture such as roads located to the north and east of the survey area. Special care is recommended in identifying these features along with any other potential cultural features from other sources that might be recorded in the data.

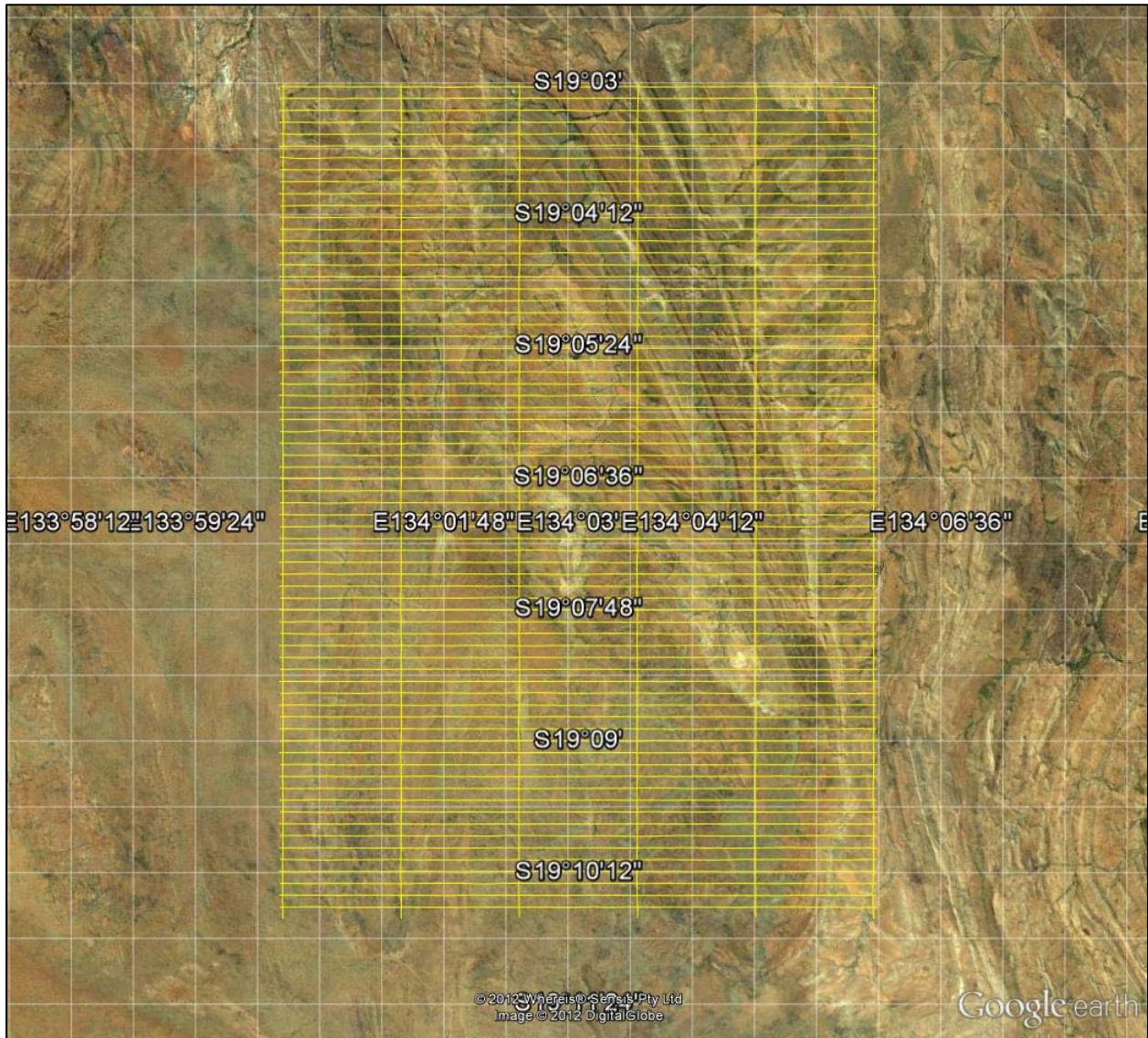


Figure 3: Flight path over a Google Earth Image

2. DATA ACQUISITION

2.1 Survey Area

The survey block (see Figure 3, and Appendix A) and general flight specifications are as follows:

Table 1: Survey Specifications

Survey block	Traverse Line spacing (m)	Area (Km ²)	Planned ¹ Line-km	Actual Line-km	Flight direction	Line numbers
Bootu Creek Two	Traverse: 200 Tie: 2000	141	785	703.6	N 90° E / N 270° E	L10010 – L10700
				83.8	N 0° E / N 180° E	T90010 – T90060
TOTAL		141	785	787.4		

Survey block boundaries co-ordinates are provided in Appendix B.

2.2 Survey Operations

Survey operations were based out of Three Ways, NT, Australia from May 4th to May 8th, 2012. The following table shows the timing of the flying.

Table 2: Survey schedule

Date	Crew location	Comments
26-Apr-2012	Three Ways, NT	Utility vehicle being serviced
27-Apr-2012	Three Ways, NT	Utility vehicle being serviced
28-Apr-2012	Three Ways, NT	Truck has arrive in Broome
29-Apr-2012	Three Ways, NT	Crew has arrived in Halls Creek
30-Apr-2012	Three Ways, NT	Crew has arrived at Victoria River
1-May-2012	Three Ways, NT	Crew has arrived in Renner Springs
2-May-2012	Three Ways, NT	Crew mobilized
3-May-2012	Three Ways, NT	VTEM 24 has been assembled/read for test
4-May-2012	Three Ways, NT	Production 10.4 km
5-May-2012	Three Ways, NT	No Production
6-May-2012	Three Ways, NT	Production 506.4km
7-May-2012	Three Ways, NT	Production 44 km
8-May-2012	Three Ways, NT	Production 224.2

¹ Note: Actual Line kilometres represent the total line kilometres in the final database. These line-km normally exceed the Planned line-km, as indicated in the survey NAV files.

2.3 Flight Specifications

During the survey the helicopter was maintained at a mean altitude of 71 metres above the ground with an average survey speed of 80 km/hour. This allowed for an actual average EM bird terrain clearance of 36 metres and a magnetic sensor clearance of 58 metres.

The on board operator was responsible for monitoring the system integrity. He also maintained a detailed flight log during the survey, tracking the times of the flight as well as any unusual geophysical or topographic features.

On return of the aircrew to the base camp the survey data was transferred from a compact flash card (PCMCIA) to the data processing computer. The data were then uploaded via ftp to the Geotech office in Aurora for daily quality assurance and quality control by qualified personnel.

2.4 Aircraft and Equipment

2.4.1 Survey Aircraft

The survey was flown using a Eurocopter Aerospatiale (Astar) 350 B3 helicopter, registration VH-VTX. The helicopter is owned and operated by United Aero Helicopters. Installation of the geophysical and ancillary equipment was carried out by a Geotech Ltd crew.

2.4.2 Electromagnetic System

The electromagnetic system was a Geotech Time Domain EM (VTEM^{plus}) system. VTEM, with the serial number 24 had been used for the survey. The configuration is as indicated in Figure 5.

The VTEM^{plus} Receiver and transmitter coils were in concentric-coplanar and Z-direction oriented configuration. The receiver system for the project also included a coincident-coaxial X-direction coil to measure the in-line dB/dt and calculate B-Field responses. The EM bird was towed at a mean distance of 35 metres below the aircraft as shown in Figure 5 and Figure 6. The receiver decay recording scheme is shown in Figure 4.

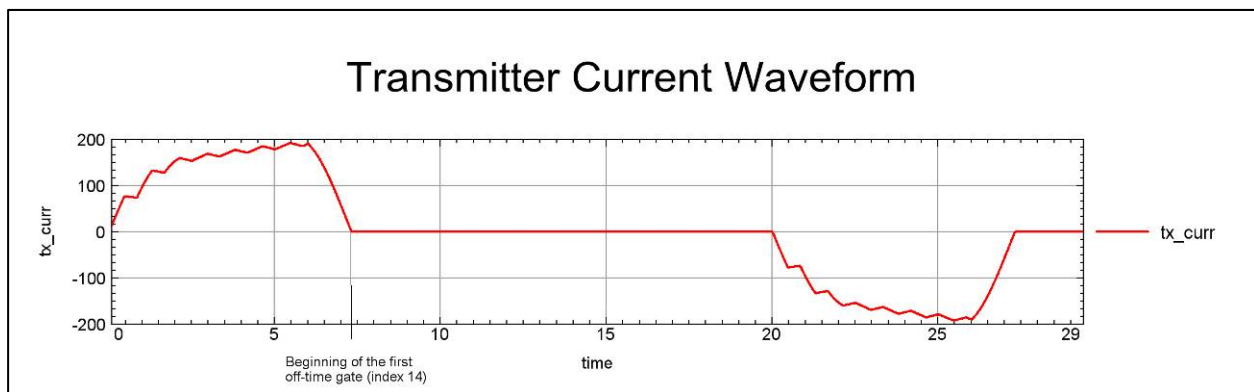


Figure 4: VTEM Waveform & Sample Times

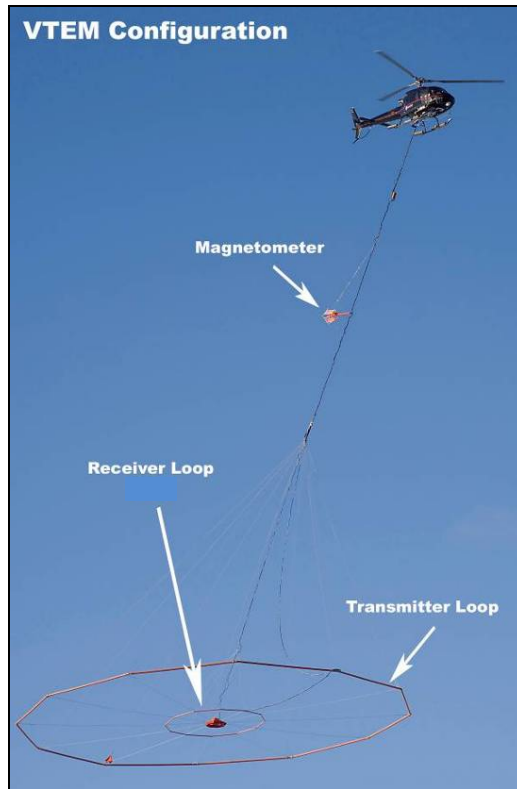


Figure 5: VTEM^{plus} Configuration, with magnetometer.

The VTEM decay sampling scheme is shown in Table 3 below. Thirty-two time measurement gates were used for the final data processing in the range from 0.083 to 9.286 msec.

Table 3: Off-Time Decay Sampling Scheme

VTEM Decay Sampling Scheme			
Index	Middle	Start	End
Milliseconds			
13	0.083	0.078	0.090
14	0.096	0.090	0.103
15	0.110	0.103	0.118
16	0.126	0.118	0.136
17	0.145	0.136	0.156
18	0.167	0.156	0.179
19	0.192	0.179	0.206
20	0.220	0.206	0.236
21	0.253	0.236	0.271
22	0.290	0.271	0.312
23	0.333	0.312	0.358
24	0.383	0.358	0.411
25	0.440	0.411	0.472
26	0.505	0.472	0.543
27	0.580	0.543	0.623
28	0.667	0.623	0.716
29	0.766	0.716	0.823
30	0.880	0.823	0.945
31	1.010	0.945	1.086
32	1.161	1.086	1.247
33	1.333	1.247	1.432
34	1.531	1.432	1.646
35	1.760	1.646	1.891
36	2.021	1.891	2.172
37	2.323	2.172	2.495
38	2.667	2.495	2.865
39	3.063	2.865	3.292
40	3.521	3.292	3.781
41	4.042	3.781	4.341
42	4.641	4.341	4.987
43	5.333	4.987	5.729
44	6.125	5.729	6.581
45	7.036	6.581	7.560
46	8.083	7.560	8.685
47	9.286	8.685	9.977

Z Component: 13-47 time gates
X Component: 20-47 time gates.

VTEM^{plus} system specification:

Transmitter

- Transmitter loop diameter: 26 m
- Effective Transmitter coil area: 2123 m²
- Number of turns: 4
- Transmitter base frequency: 25 Hz
- Peak current: 191 A
- Pulse width: 7.32 ms
- Wave form shape: trapezoid
- Peak dipole moment: 407,541 nIA
- Actual average EM Bird terrain clearance: 36 metres above the ground

Receiver

- X Coil diameter: 0.32 m
- Number of turns: 245
- Effective coil area: 19.69 m²
- Z-Coil coil diameter: 1.2 m
- Number of turns: 100
- Effective coil area: 113.04 m²

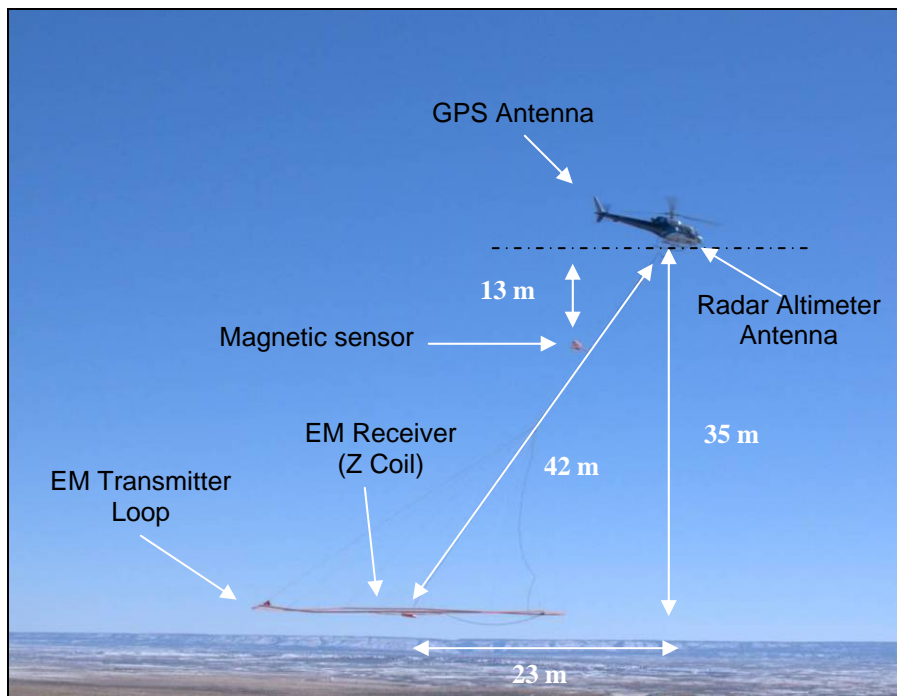


Figure 6: VTEM^{plus} System Configuration

2.4.3 Airborne magnetometer

The magnetic sensor utilized for the survey was Geometrics optically pumped caesium vapour magnetic field sensor mounted 13 metres below the helicopter, as shown in Figure 6. The sensitivity of the magnetic sensor is 0.02 nanoTesla (nT) at a sampling interval of 0.1 seconds.

2.4.4 Radar Altimeter

A Terra TRA 3000/TRI 40 radar altimeter was used to record terrain clearance. The antenna was mounted beneath the bubble of the helicopter cockpit (Figure 6).

2.4.5 GPS Navigation System

The navigation system used was a Geotech PC104 based navigation system utilizing a NovAtel's WAAS (Wide Area Augmentation System) enabled GPS receiver, Geotech navigate software, a full screen display with controls in front of the pilot to direct the flight and a NovAtel GPS antenna mounted on the helicopter tail (Figure 6). As many as 11 GPS and two WAAS satellites may be monitored at any one time. The positional accuracy or circular error probability (CEP) is 1.8 m, with WAAS active, it is 1.0 m. The co-ordinates of the block were set-up prior to the survey and the information was fed into the airborne navigation system.

2.4.6 Digital Acquisition System

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 4.

Table 4: Acquisition Sampling Rates

Data Type	Sampling
TDEM	0.1 sec
Magnetometer	0.1 sec
GPS Position	0.2 sec
Radar Altimeter	0.2 sec

2.5 Base Station

A combined magnetometer/GPS base station was utilized on this project. A Geometrics Caesium vapour magnetometer was used as a magnetic sensor with a sensitivity of 0.001 nT. The base station was recording the magnetic field together with the GPS time at 1 Hz on a base station computer.

The base station magnetometer sensor was installed (134°12'35.87"E, 19°26'12.13"S); away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.

3. PERSONNEL

The following Geotech Ltd. personnel were involved in the project.

Field:

Project Manager:	Adam Ellis (Office)
Data QC:	Peter Holbrook (Office)
Crew chief:	Victor Wijaya
Operator:	Leon Lovelock

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – United Aero Helicopters.

Pilot:	Steve Stanley
Mechanical Engineer:	n/a

Office:

Preliminary Data Processing:	Peter Holbrook
Final Data Processing:	Deepak Kumar
Final Data QA/QC:	Alexander Prikhodko
Reporting/Mapping:	Corrie Laver

Data acquisition phase was carried out under the supervision of Andrei Bagrianski, P. Geo, Chief Operating Officer. The processing and interpretation phase was under the supervision of Alexander Prikhodko, P. Geo. The customer relations were looked after by Keith Fisk.

4. DATA PROCESSING AND PRESENTATION

Data compilation and processing were carried out by the application of Geosoft OASIS Montaj and programs proprietary to Geotech Ltd.

4.1 Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the GDA94 Datum, Map Grid of Australia zone 53 coordinate system in Oasis Montaj.

The flight path was drawn using linear interpolation between x, y positions from the navigation system. Positions are updated every second and expressed as UTM easting's (x) and UTM northing's (y).

4.2 Electromagnetic Data

A three stage digital filtering process was used to reject major spheric events and to reduce system noise. Local spheric activity can produce sharp, large amplitude events that cannot be removed by conventional filtering procedures. Smoothing or stacking will reduce their amplitude but leave a broader residual response that can be confused with geological phenomena. To avoid this possibility, a computer algorithm searches out and rejects the major spheric events.

The signal to noise ratio was further improved by the application of a low pass linear digital filter. This filter has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations with a wavelength less than about 1 second or 15 metres. This filter is a symmetrical 1 sec linear filter.

The results are presented as stacked profiles of EM voltages for the time gates, in linear - logarithmic scale for the B-field Z component and dB/dt responses in the Z and X components. B-field Z component time channel recorded at 2.021 milliseconds after the termination of the impulse is also presented as contour colour images. Fraser Filter X component is also presented as a colour image. Calculated Time Constant (TAU) with anomaly contours of Calculated Vertical Derivative of TMI is presented in Appendix C and E. Resistivity Depth Image (RDI) is also presented in Appendix C and F.

VTEM receiver coil orientation Z-axis coil is oriented parallel to the transmitter coil axis and both are horizontal to the ground. The X-axis coil is oriented parallel to the ground and along the line-of-flight. This combined two coil configuration provides information on the position, depth, dip and thickness of a conductor. Generalized modeling results of VTEM plus data are shown in Appendix D.

In general X-component data produce cross-over type anomalies: from "+ to -" in flight direction of flight for "thin" sub vertical targets and from "- to +" in direction of flight for "thick" targets. Z component data produce double peak type anomalies for "thin" sub vertical targets and single peak for "thick" targets.

The limits and change-over of "thin-thick" depends on dimensions of a TEM system.

Because of X component polarity is under line-of-flight, convolution Fraser filter (FF, Figure 7) is applied to X component data to represent axes of conductors in the form of

grid map. In this case positive FF anomalies always correspond to “plus-to-minus” X data crossovers independently of direction of flight.

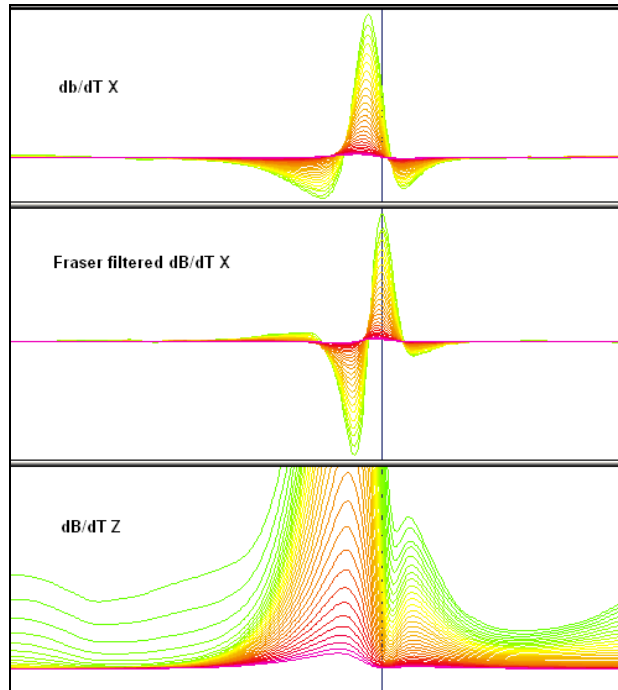


Figure 7: Z, X and Fraser filtered X (FFx) components for “thin” target

4.3 Magnetic Data

The processing of the magnetic data involved the correction for diurnal variations by using the digitally recorded ground base station magnetic values. The base station magnetometer data was edited and merged into the Geosoft GDB database on a daily basis. The aeromagnetic data was corrected for diurnal variations by subtracting the observed magnetic base station deviations.

Tie line levelling was carried out by adjusting intersection points along traverse lines. A micro-levelling procedure was applied to remove persistent low-amplitude components of flight-line noise remaining in the data.

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of approximately 50 metres at the mapping scale. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.

5. DELIVERABLES

5.1 Survey Report

The survey report describes the data acquisition, processing, and final presentation of the survey results. The survey report is provided in two paper copies and digitally in PDF format.

5.2 Maps

Final maps were produced at a scale of 1:20,000 for best representation of the survey size and line spacing. The coordinate/projection system used was GDA94 Datum, Map Grid of Australia zone 53. All maps show the mining claims, flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as EM profiles, a late-time gate gridded EM channel, and a color magnetic TMI contour map. The following maps are presented on paper;

- VTEM dB/dt profiles Z Component, Time Gates 0.220 – 7.036 ms in linear – logarithmic scale.
- VTEM B-Field profiles Z Component, Time Gates 0.220 – 7.036 ms in linear – logarithmic scale.
- VTEM B-field late time Z Component Channel 36, Time Gate 2.021 ms colour image.
- Fraser Filtered dB/dt X Component Channel 35, Time Gate 1.760 ms
- VTEM dB/dt Calculated Time Constant (TAU) with contours of anomaly areas of the Calculated Vertical Derivative of TMI
- Reduced to Pole of TMI (RTP) colour image and contours.

5.3 Digital Data

- Two copies of the data and maps on DVD were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj and ASEG-GDF format as well as the maps in Geosoft Montaj Map and PDF format.
- DVD structure.

Data contains databases, grids and maps, as described below.

Report contains a copy of the report and appendices in PDF format.

Databases in Geosoft GDB format, containing the channels listed in Table 5.

Table 5: Geosoft GDB Data Format

Channel name	Units	Description
X_UTM:	metres	UTM Easting WGS84 Zone 53 South
Y_UTM:	metres	UTM Northing WGS84 Zone 53 South
X_MGA:	metres	Map Grid of Australia zone 53 - GDA94
Y_MGA:	metres	Map Grid of Australia zone 53 - GDA94
Z:	metres	GPS antenna elevation (above Geoid)
Longitude:	Decimal Degrees	WGS 84 Longitude data
Latitude:	Decimal Degrees	WGS 84 Latitude data
Radar:	metres	helicopter terrain clearance from radar altimeter
Radarb:	metres	Calculated EM bird terrain clearance from radar altimeter
DEM:	metres	Digital Elevation Model
Gtime:	Seconds of the day	GPS time
Mag1:	nT	Raw Total Magnetic field data
Basemag:	nT	Magnetic diurnal variation data
Mag2:	nT	Diurnal corrected Total Magnetic field data
Mag3:	nT	Levelled Total Magnetic field data
CVG	nT/m	Calculated Vertical Derivative of TMI
RTP	nT	Reduced To Pole of TMI
RTP_CVG	nT/m	Calculated Vertical Derivative of Reduced To Pole of TMI
SFz[13]:	$pV/(A*m^4)$	Z dB/dt 0.083 millisecond time channel
SFz[14]:	$pV/(A*m^4)$	Z dB/dt 0.096 millisecond time channel
SFz[15]:	$pV/(A*m^4)$	Z dB/dt 0.110 millisecond time channel
SFz[16]:	$pV/(A*m^4)$	Z dB/dt 0.126 millisecond time channel
SFz[17]:	$pV/(A*m^4)$	Z dB/dt 0.145 millisecond time channel
SFz[18]:	$pV/(A*m^4)$	Z dB/dt 0.167 millisecond time channel
SFz[19]:	$pV/(A*m^4)$	Z dB/dt 0.192 millisecond time channel
SFz[20]:	$pV/(A*m^4)$	Z dB/dt 0.220 millisecond time channel
SFz[21]:	$pV/(A*m^4)$	Z dB/dt 0.253 millisecond time channel
SFz[22]:	$pV/(A*m^4)$	Z dB/dt 0.290 millisecond time channel
SFz[23]:	$pV/(A*m^4)$	Z dB/dt 0.333 millisecond time channel
SFz[24]:	$pV/(A*m^4)$	Z dB/dt 0.383 millisecond time channel
SFz[25]:	$pV/(A*m^4)$	Z dB/dt 0.440 millisecond time channel
SFz[26]:	$pV/(A*m^4)$	Z dB/dt 0.505 millisecond time channel
SFz[27]:	$pV/(A*m^4)$	Z dB/dt 0.580 millisecond time channel
SFz[28]:	$pV/(A*m^4)$	Z dB/dt 0.667 millisecond time channel
SFz[29]:	$pV/(A*m^4)$	Z dB/dt 0.766 millisecond time channel
SFz[30]:	$pV/(A*m^4)$	Z dB/dt 0.880 millisecond time channel
SFz[31]:	$pV/(A*m^4)$	Z dB/dt 1.010 millisecond time channel
SFz[32]:	$pV/(A*m^4)$	Z dB/dt 1.161 millisecond time channel
SFz[33]:	$pV/(A*m^4)$	Z dB/dt 1.333 millisecond time channel
SFz[34]:	$pV/(A*m^4)$	Z dB/dt 1.531 millisecond time channel
SFz[35]:	$pV/(A*m^4)$	Z dB/dt 1.760 millisecond time channel
SFz[36]:	$pV/(A*m^4)$	Z dB/dt 2.021 millisecond time channel
SFz[37]:	$pV/(A*m^4)$	Z dB/dt 2.323 millisecond time channel
SFz[38]:	$pV/(A*m^4)$	Z dB/dt 2.667 millisecond time channel
SFz[39]:	$pV/(A*m^4)$	Z dB/dt 3.063 millisecond time channel
SFz[40]:	$pV/(A*m^4)$	Z dB/dt 3.521 millisecond time channel
SFz[41]:	$pV/(A*m^4)$	Z dB/dt 4.042 millisecond time channel
SFz[42]:	$pV/(A*m^4)$	Z dB/dt 4.641 millisecond time channel
SFz[43]:	$pV/(A*m^4)$	Z dB/dt 5.333 millisecond time channel
SFz[44]:	$pV/(A*m^4)$	Z dB/dt 6.125 millisecond time channel

Channel name	Units	Description
SFz[45]:	$\text{pV}/(\text{A}^*\text{m}^4)$	Z dB/dt 7.036 millisecond time channel
SFz[46]:	$\text{pV}/(\text{A}^*\text{m}^4)$	Z dB/dt 8.083 millisecond time channel
SFz[47]:	$\text{pV}/(\text{A}^*\text{m}^4)$	Z dB/dt 9.286 millisecond time channel
BFz	$(\text{pV}*\text{ms})/(\text{A}^*\text{m}^4)$	Z B-Field data for time channels 14 to 47
SFx[20]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.220 millisecond time channel
SFx[21]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.253 millisecond time channel
SFx[22]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.290 millisecond time channel
SFx[23]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.333 millisecond time channel
SFx[24]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.383 millisecond time channel
SFx[25]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.440 millisecond time channel
SFx[26]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.505 millisecond time channel
SFx[27]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.580 millisecond time channel
SFx[28]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.667 millisecond time channel
SFx[29]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.766 millisecond time channel
SFx[30]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 0.880 millisecond time channel
SFx[31]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 1.010 millisecond time channel
SFx[32]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 1.161 millisecond time channel
SFx[33]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 1.333 millisecond time channel
SFx[34]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 1.531 millisecond time channel
SFx[35]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 1.760 millisecond time channel
SFx[36]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 2.021 millisecond time channel
SFx[37]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 2.323 millisecond time channel
SFx[38]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 2.667 millisecond time channel
SFx[39]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 3.063 millisecond time channel
SFx[40]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 3.521 millisecond time channel
SFx[41]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 4.042 millisecond time channel
SFx[42]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 4.641 millisecond time channel
SFx[43]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 5.333 millisecond time channel
SFx[44]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 6.125 millisecond time channel
SFx[45]:	$\text{pV}/(\text{A}^*\text{m}^4)$	X dB/dt 7.036 millisecond time channel
BFz	$(\text{pV}*\text{ms})/(\text{A}^*\text{m}^4)$	Z B-Field data for time channels 14 to 45
BFx	$(\text{pV}*\text{ms})/(\text{A}^*\text{m}^4)$	X B-Field data for time channels 20 to 45
SFxFF	$\text{pV}/(\text{A}^*\text{m}^4)$	Fraser Filtered X dB/dt
Nchan_BF		Latest time channels of TAU calculation
Nchan_SF		Latest time channels of TAU calculation
Tau_BF	ms	Time constant B-Field
Tau_SF	ms	Time constant dB/dt
PLM:		60 Hz power line monitor

Electromagnetic B-field and dB/dt Z component data is found in array channel format between indexes 13 – 47 as described above.

- Database of the VTEM Waveform “AA1241_waveform_final.gdb” in Geosoft GDB format, containing the following channels:
 - Time: Sampling rate interval, 5.2083 microseconds
 - Rx_Volt: Output voltage of the receiver coil (Volt)
 - Tx_Current: Output current of the transmitter (Amp)
- Grids in Geosoft GRD and ER Mapper format, as follows:
 - BFz36: B-Field Z Component Channel 36 (Time Gate 2.021 ms)
 - CVG_RTP: Calculated Magnetic Vertical Gradient (nT/m)

SFxFF35: Fraser Filtered dB/dt X Component Channel 35 (Time Gate 1.760 ms)
TauBF: B-Field Z Component, Calculated Time Constant (ms)
TauSF: dB/dt Z Component, Calculated Time Constant (ms)
TMI: Total Magnetic Intensity (nT)
RTP: Reduced to Pole of TMI
DEM: Digital Elevation Model
SFz: VTEM dB/dT for three selected time gates (early 20, middle 30, late 40)

A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 50 metres was used.

- Maps at 1:20,000 in Geosoft MAP format, as follows:
AA1241_20k_bb_dBdtz: dB/dt profiles Z Component, Time Gates 0.220 – 7.036 ms in linear – logarithmic scale.
AA1241_20k_bb_Bfield: B-field profiles Z Component, Time Gates 0.220 – 7.036 ms in linear – logarithmic scale over total magnetic intensity.
AA1241_20k_bb_BFz36: B-field late time Z Component Channel 36, Time Gate 2.021 ms color image.
AA1241_20k_bb_RTP: Reduced to Pole of TMI (RTP) color image and contours.
AA1241_20k_bb_SFxFF: Fraser Filtered dB/dt X Component
AA1241_20k_bb_TauSF: dB/dt Calculated Time Constant (TAU) with contours of anomaly areas of the Calculated Vertical Derivative of Reduced To Pole of TMI

where bb represents the block name

Maps are also presented in PDF format.

The topographic vectors were taken from Australian Government - Geoscience Australia at 1:250,000 scale
<https://www.ga.gov.au>

- A Google Earth file *AA1241_FP.kml* showing the flight path of the block is included. Free versions of Google Earth software from:
<http://earth.google.com/download-earth.html>

6. CONCLUSIONS AND RECOMMENDATIONS

A helicopter-borne versatile time domain electromagnetic (VTEM plus) geophysical survey has been completed over the Bootu Creek Two Project situated approximately 52 kilometres northwest of Tennant Creek, NT, Australia respectively.

The total area coverage for all properties is 141 km². Total survey line coverage is 787.4 line kilometres. The principal sensors included a Time Domain EM system and a magnetometer. Results have been presented as stacked profiles, and contour color images at a scale of 1:20,000.

Based on the geophysical results obtained, the area roughly consists of four conductive zones. All of these zones are considered as moderate to high conductive anomalies.

The North Eastern long zone with ~500 m width and around 6000 m length is oriented south-north. This zone is associated with N-S magnetic gradient. The high conductor is considered as a sub horizontal layer of about 200m thickness from surface depth of about 50m (*Appendix C - L10220 RDI*).

The central part of survey blocks have three anomalous zone associated with moderate to high conductors and are too associated with another N-S magnetic gradient. This area looks the most promising area in the whole block. There seems to have five moderate to high conductors. The length of conductors varies from 500m to 1800m. The estimated depth of the conductive layers are around 30 to 70 meters (*Appendix C - L10220, L10510 RDI & 3D Resistivity-Depth Image (RDI)*).

The western part seems to have a very a high conductive area and looks some regional high conductive feature is passing through. High Magnetic gradients are associated with the feature. The high conductor is considered as a sub horizontal layer of about 250m thickness from surface depth of about 20m (*Appendix C - L10220, L10510 L10680 RDI & 3D Resistivity-Depth Image (RDI)*).

The southern zone seems to have one high conductive anomaly with 400m width and 250m thickness from surface depth of about 50m. This seems to be on the edge of survey block. N-S high magnetic gradient are associated with this anomaly (*Appendix C - L10680 RDI & 3D Resistivity-Depth Image (RDI)*).

If the conductors correspond to an exploration model on the area it is recommended picking anomalies with conductance grading and center localization of the targets, detail resistivity depth imaging and plate Maxwell modelling with test drillhole parameters prior to ground follow up and drill testing.

Respectfully submitted⁵,



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Geotech Airborne Pty Ltd.



Deepak Kumar
Geotech Ltd.



Alexander Prikhodko, P.Geo.
Geotech Ltd.

June 2012

⁵Final data processing of the EM and magnetic data were carried out by Deepak Kumar, from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Alexander Prikhodko, P.Geo., PhD, Senior Geophysicist, VTEM Interpretation Supervisor.

APPENDIX A

SURVEY BLOCK LOCATION MAP



Survey Overview of the Blocks

APPENDIX B

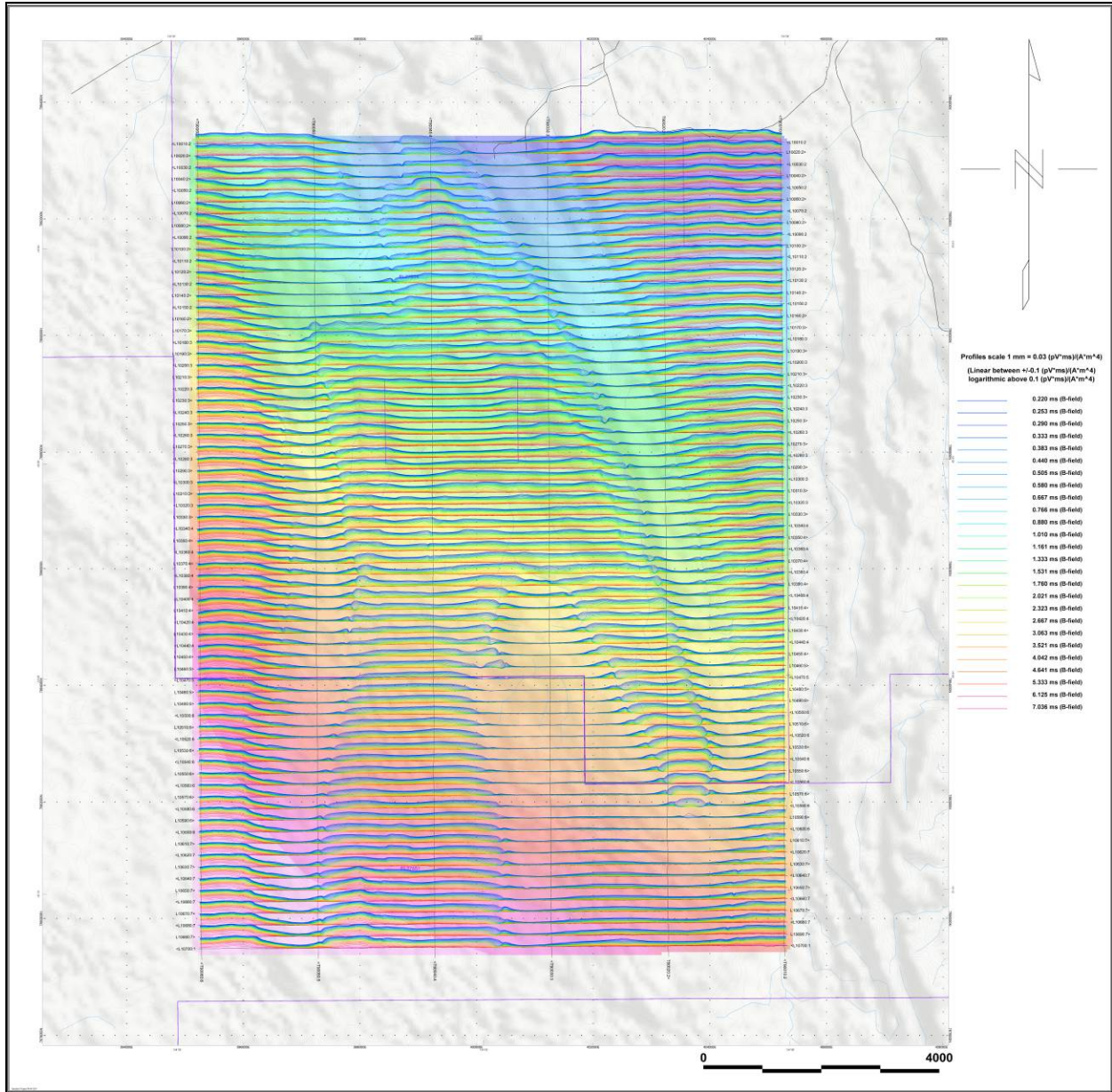
SURVEY BLOCK COORDINATES (WGS 84, UTM Zone 53 South)

Bootu Creek Two Project

X	Y
395279.4	7879350
405287.7	7879405
405215.9	7893338
395200.1	7893283
395279.4	7879350

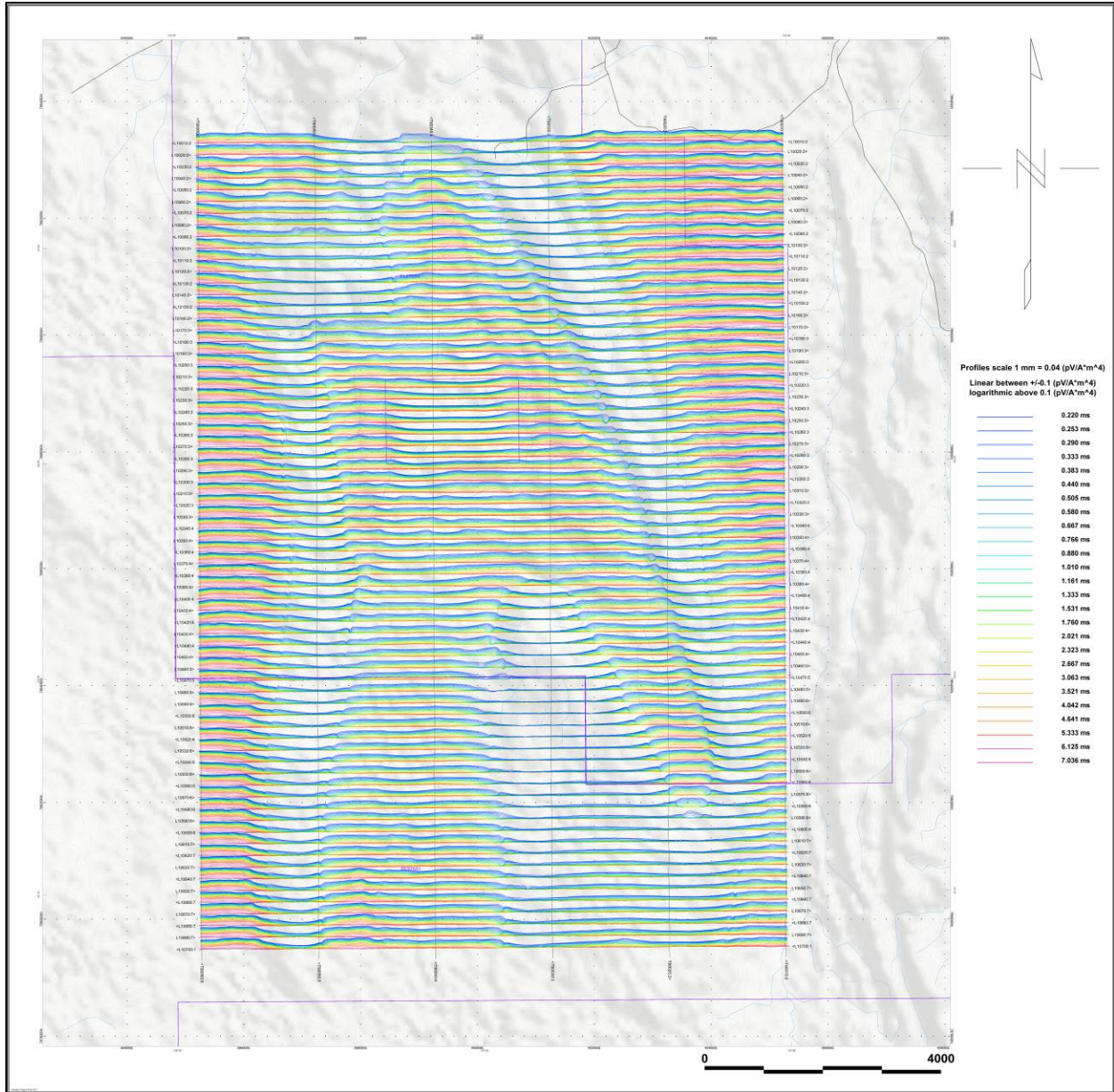
APPENDIX C

GEOPHYSICAL MAPS¹

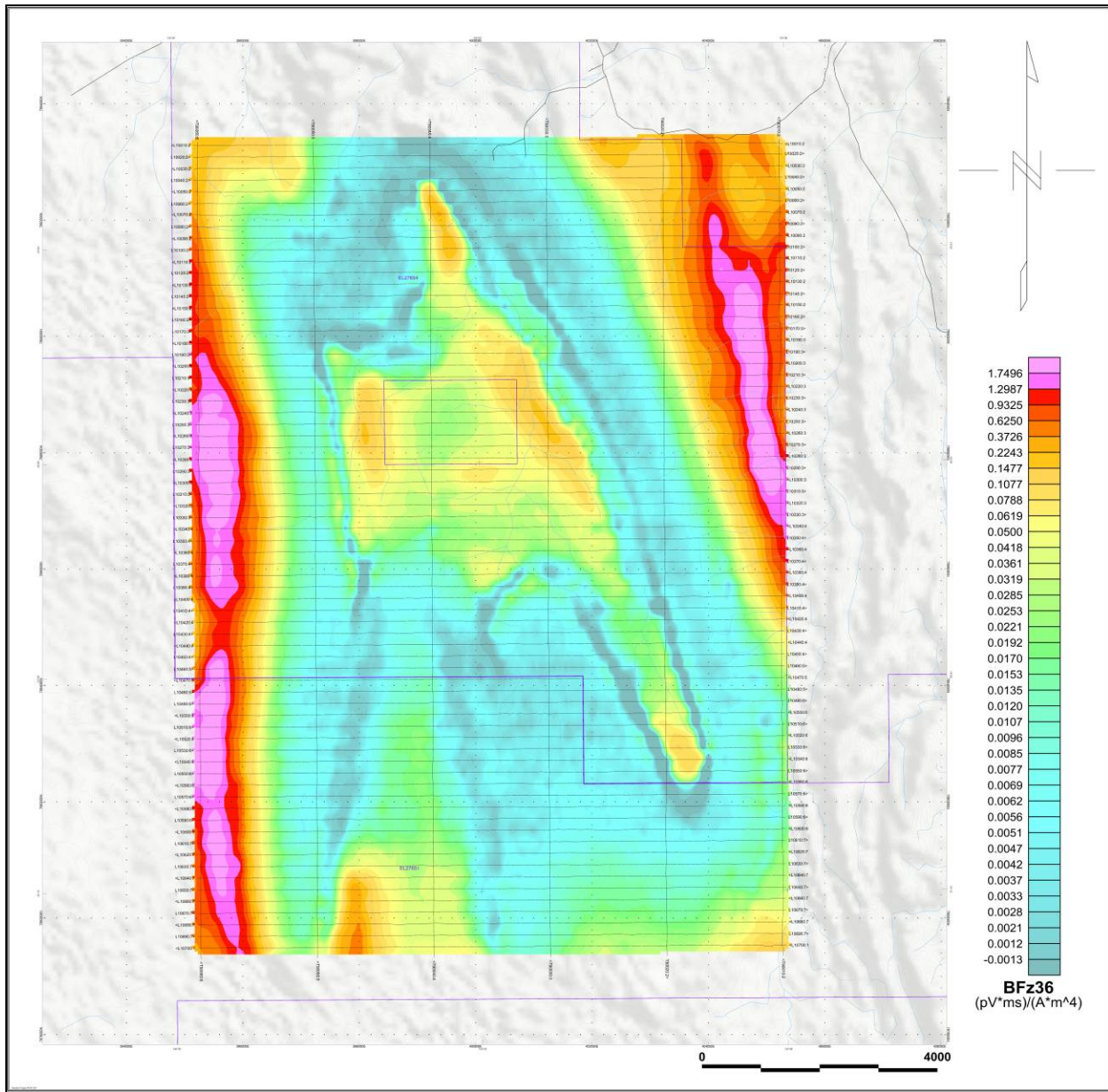


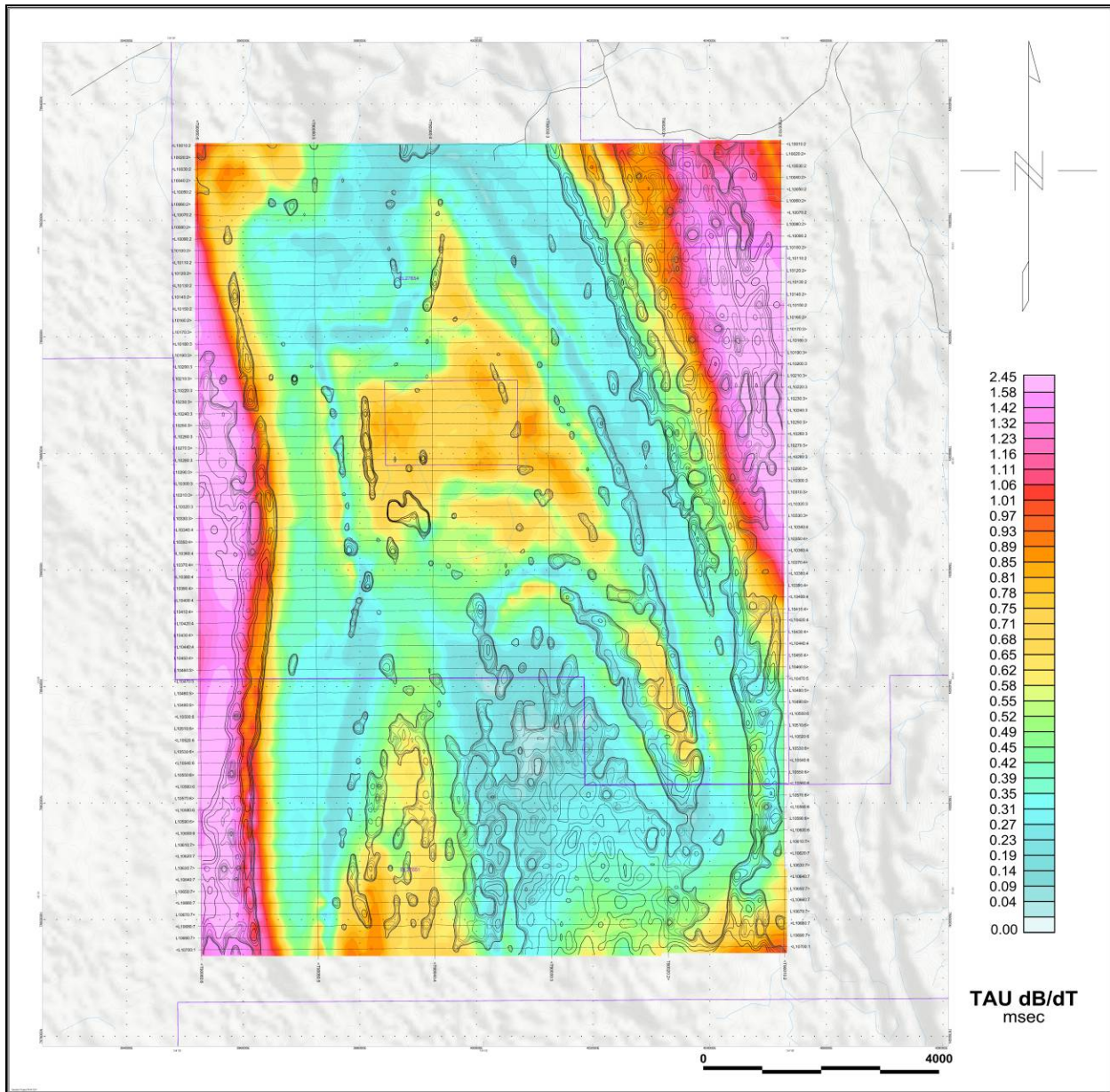
VTEM B-Field Z Component Profiles, Time Gates 0.220 to 7.036 ms

¹ Full size geophysical maps are also available in PDF format on the final DVD

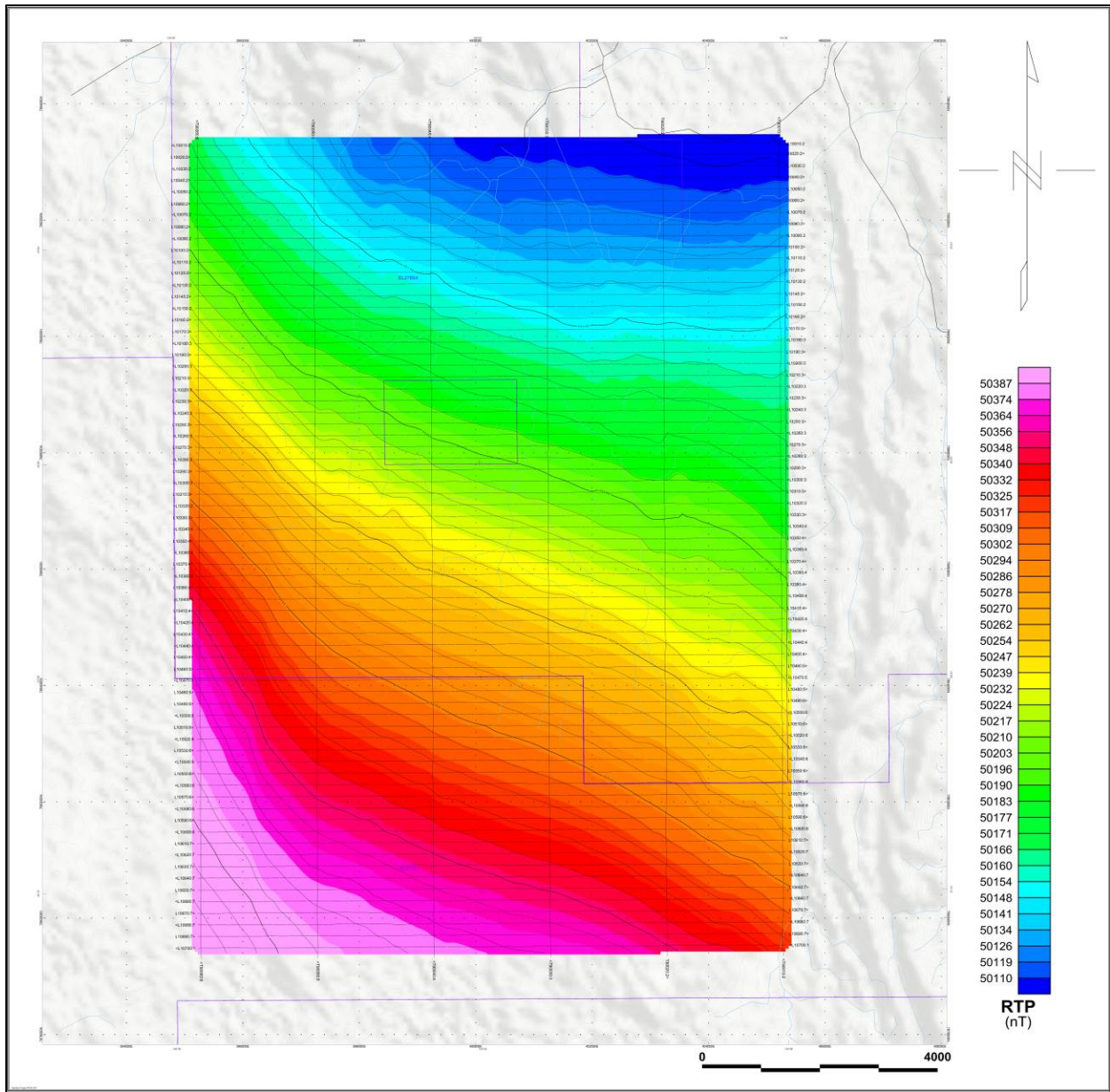


VTEM dB/dt Z Component Profiles, Time Gates 0.220 to 7.036 ms

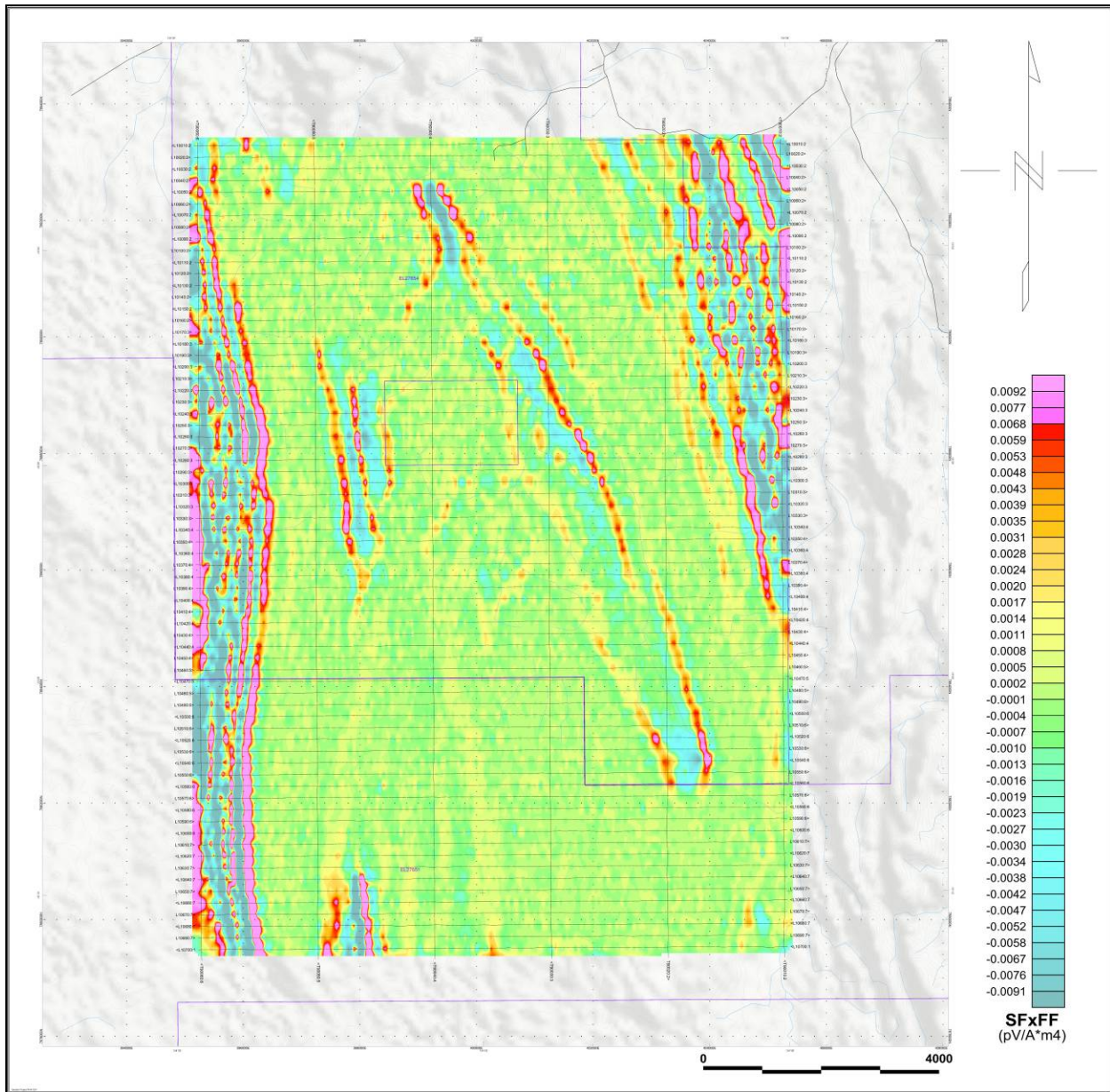




dB/dt Calculated Time Constant (Tau) with contours of anomaly areas of the Calculated Vertical Derivative of Reduced To Pole of TMI



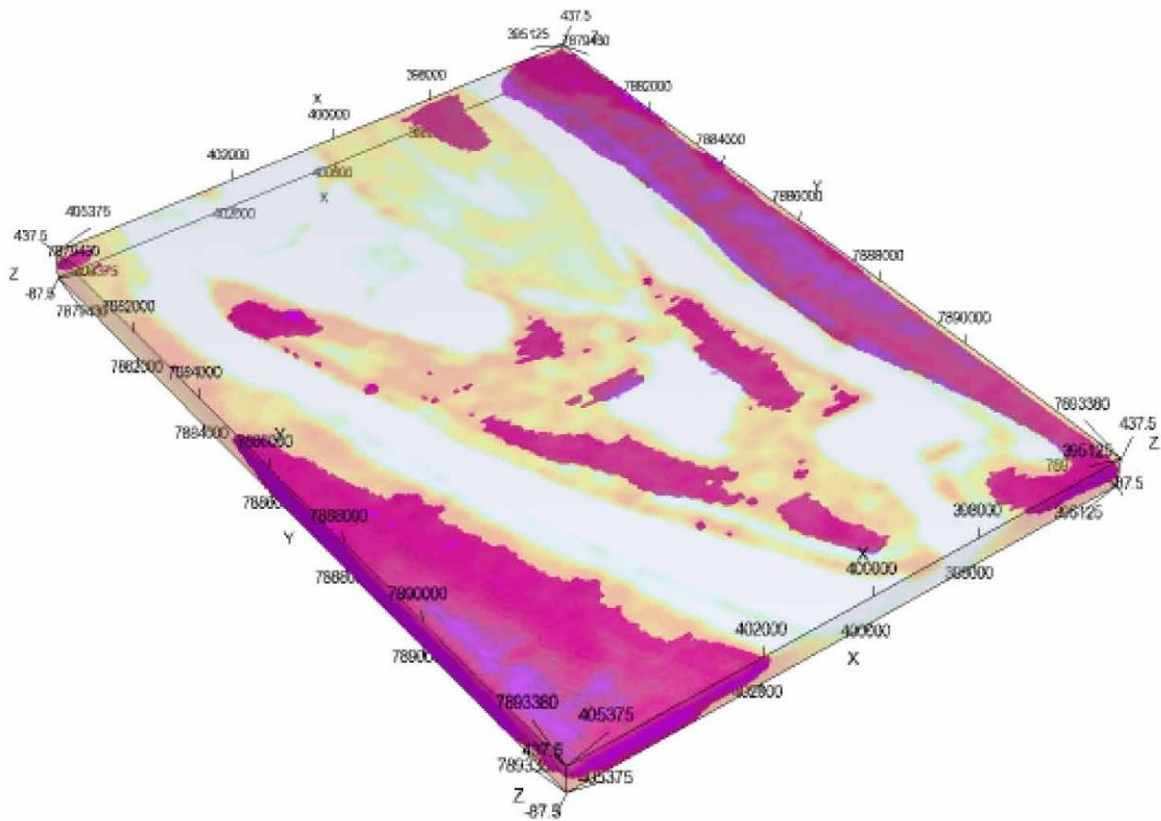
Reduced to Pole of TMI (RTP)



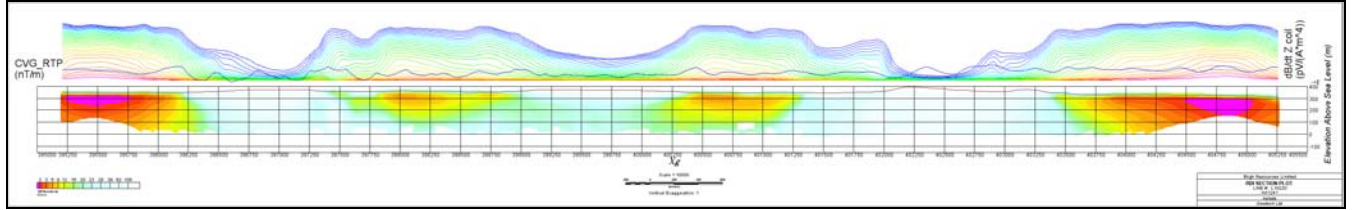
Fraser Filtered dB/dt X Component, Channel 35, Time Gate 1.760 ms

RESISTIVITY DEPTH IMAGE (RDI) MAPS

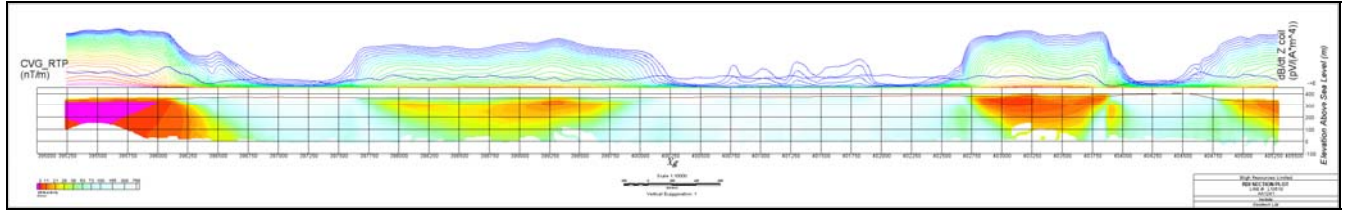
3D Resistivity Depth Images (RDI)



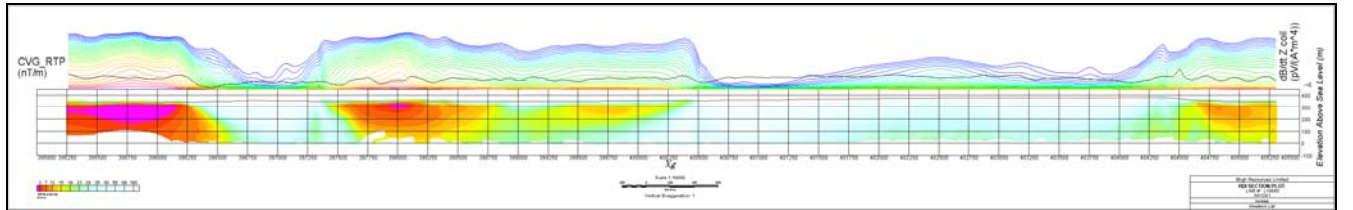
Bootu Creek Two Project



RDI Sections - Line 10220



RDI Sections - Line 10510



RDI Sections - Line 10680

APPENDIX D

GENERALIZED MODELING RESULTS OF THE VTEM SYSTEM

Introduction

The VTEM system is based on a concentric or central loop design, whereby, the receiver is positioned at the centre of a transmitter loop that produces a primary field. The wave form is a bipolar, modified square wave with a turn-on and turn-off at each end.

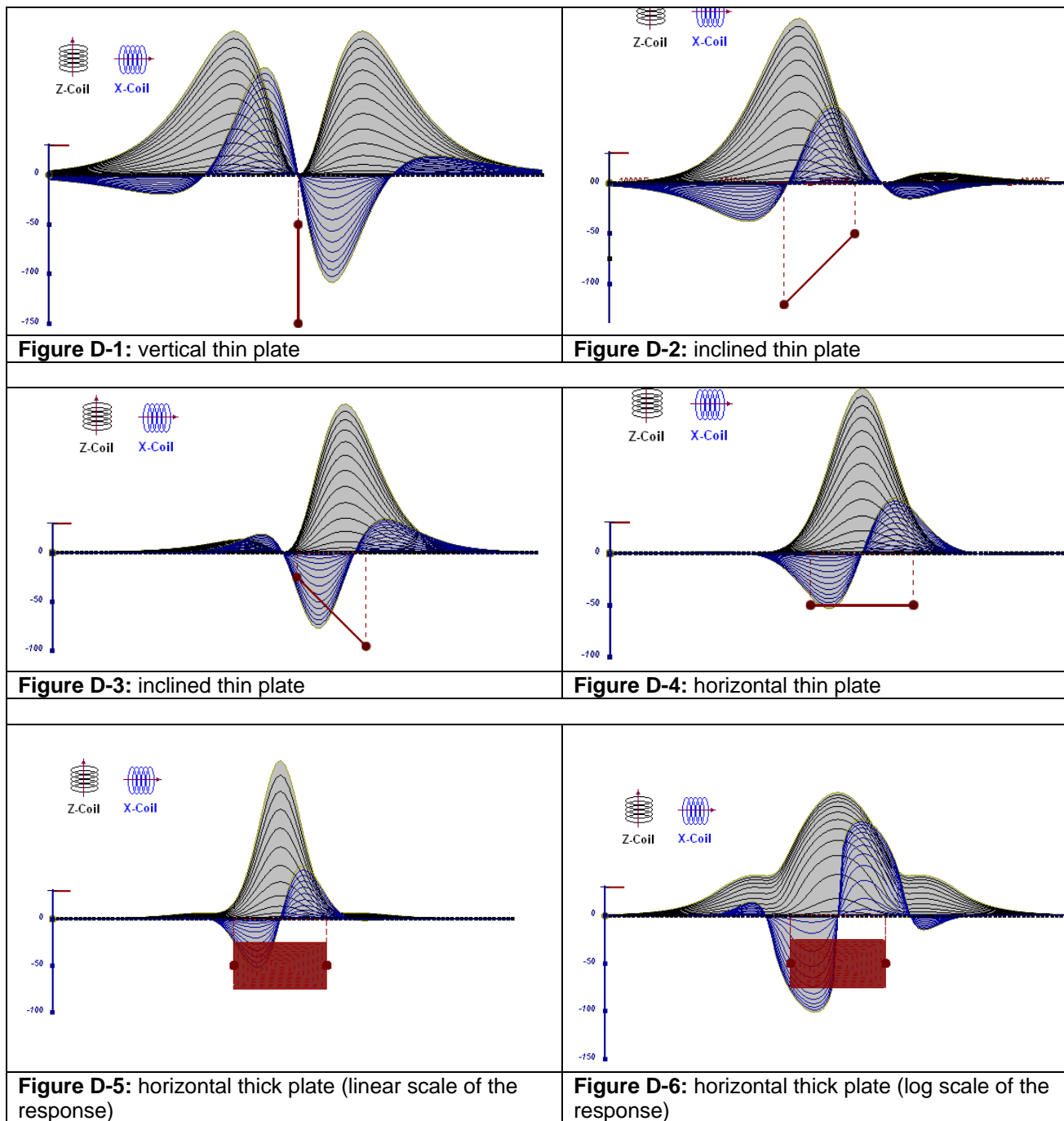
During turn-on and turn-off, a time varying field is produced (dB/dt) and an electro-motive force (emf) is created as a finite impulse response. A current ring around the transmitter loop moves outward and downward as time progresses. When conductive rocks and mineralization are encountered, a secondary field is created by mutual induction and measured by the receiver at the centre of the transmitter loop.

Efficient modeling of the results can be carried out on regularly shaped geometries, thus yielding close approximations to the parameters of the measured targets. The following is a description of a series of common models made for the purpose of promoting a general understanding of the measured results.

A set of models has been produced for the Geotech VTEM® system dB/dT Z and X components (see models D1 to D15). The Maxwell™ modeling program (EMIT Technology Pty. Ltd. Midland, WA, AU) used to generate the following responses assumes a resistive half-space. The reader is encouraged to review these models, so as to get a general understanding of the responses as they apply to survey results. While these models do not begin to cover all possibilities, they give a general perspective on the simple and most commonly encountered anomalies.

As the plate dips and departs from the vertical position, the peaks become asymmetrical.

As the dip increases, the aspect ratio (Min/Max) decreases and this aspect ratio can be used as an empirical guide to dip angles from near 90° to about 30° . The method is not sensitive enough where dips are less than about 30° .



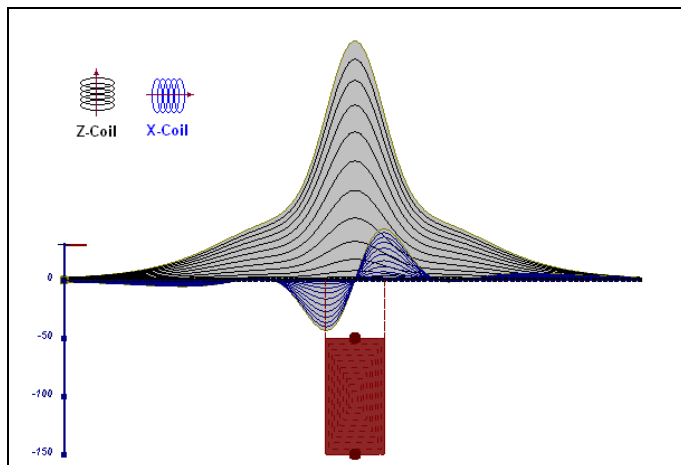


Figure D-7: vertical thick plate (linear scale of the response). 50 m depth

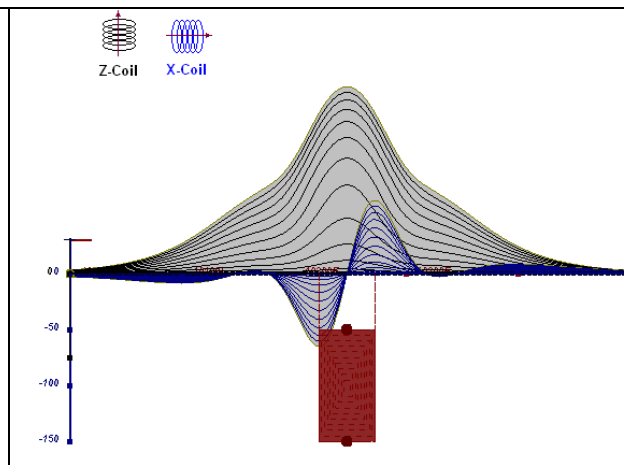


Figure D-8: vertical thick plate (log scale of the response). 50 m depth

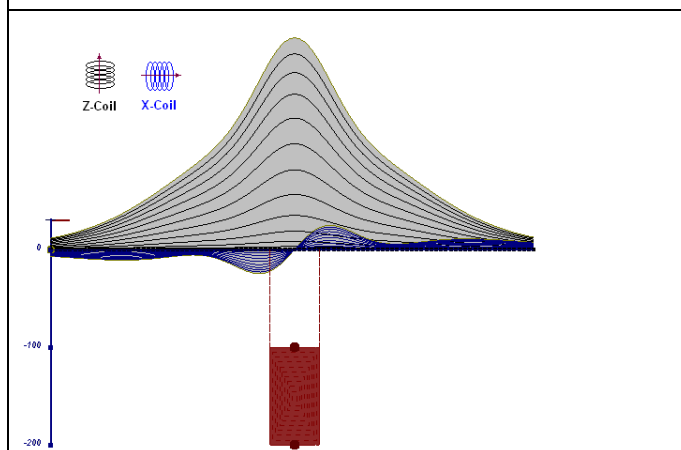


Figure D-9: vertical thick plate (linear scale of the response). 100 m depth

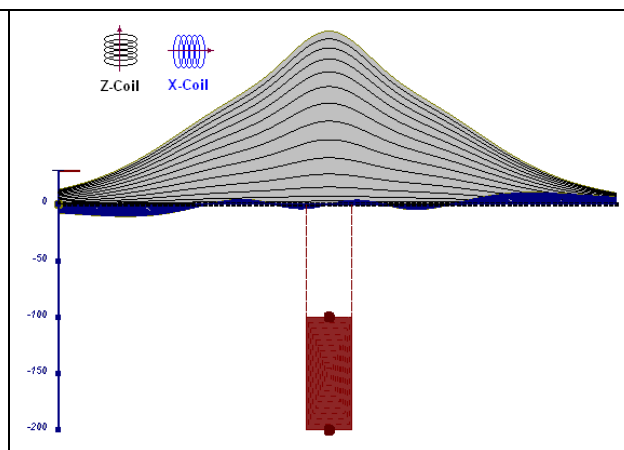


Figure D-10: vertical thick plate (linear scale of the response). Depth/hor.thickness=2.5

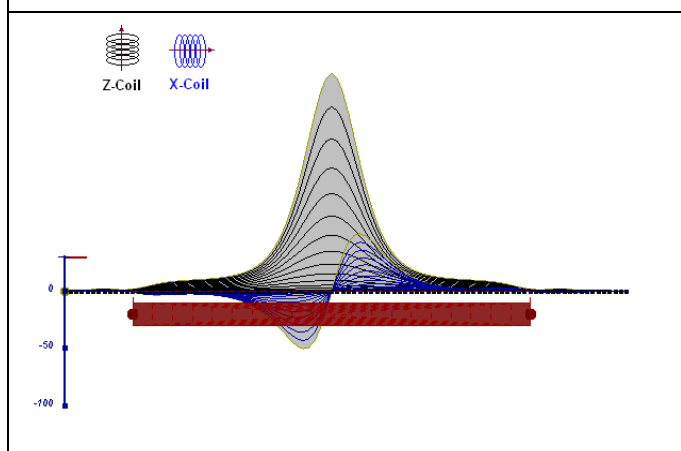


Figure D-10: horizontal thick plate (linear scale of the response)

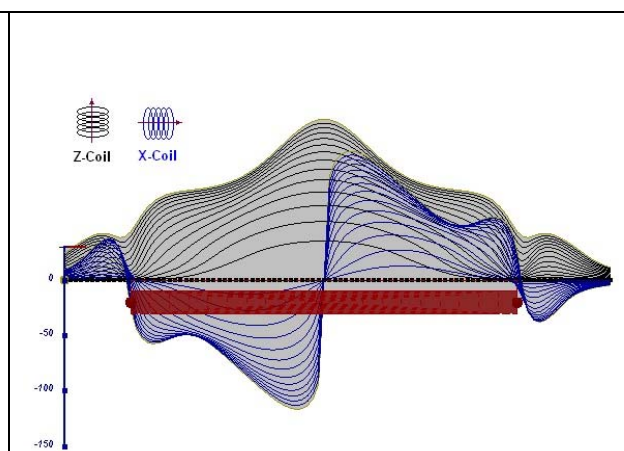


Figure D-11: horizontal thick plate (log scale of the response)

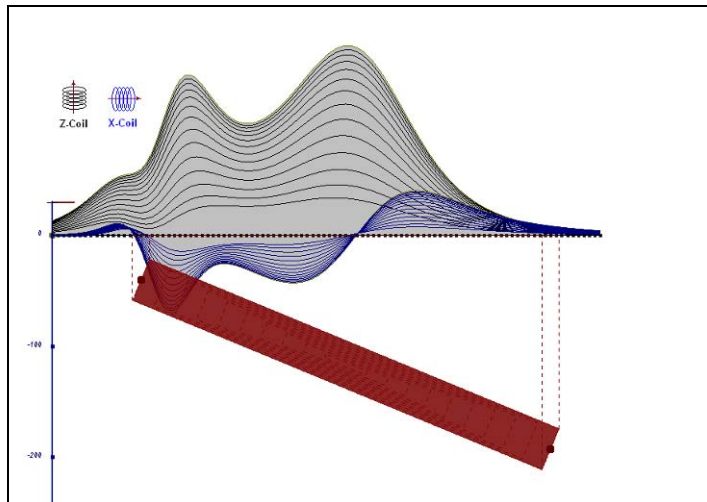


Figure D-12: inclined long thick plate

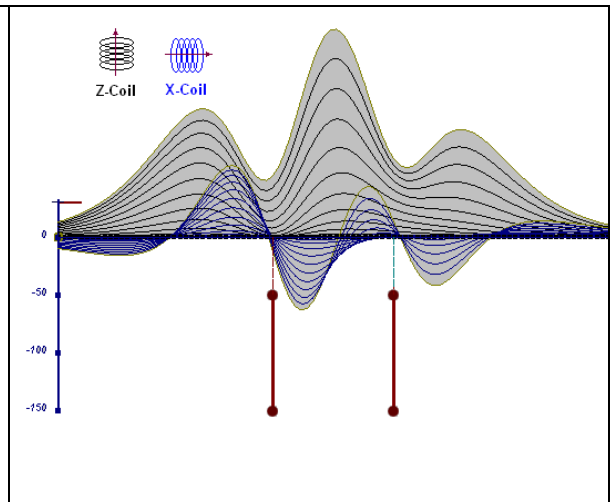


Figure D-13: two vertical thin plates

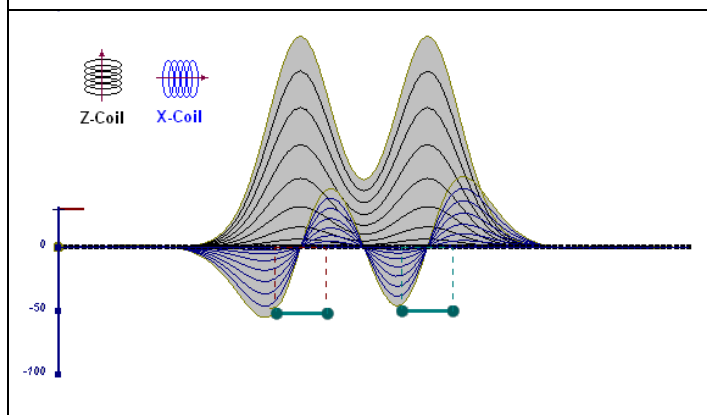


Figure D-14: two horizontal thin plates

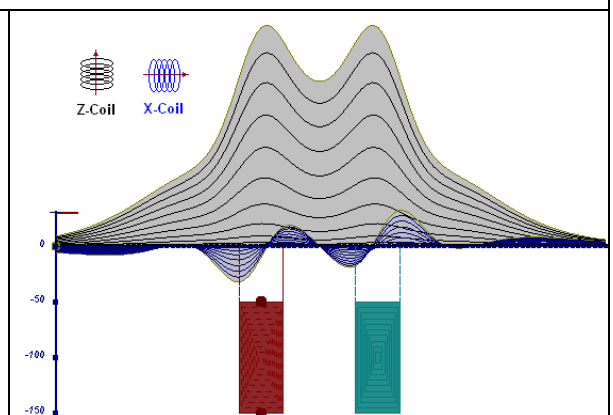


Figure D-15: two vertical thick plates

The same type of target but with different thickness, for example, creates different form of the response:

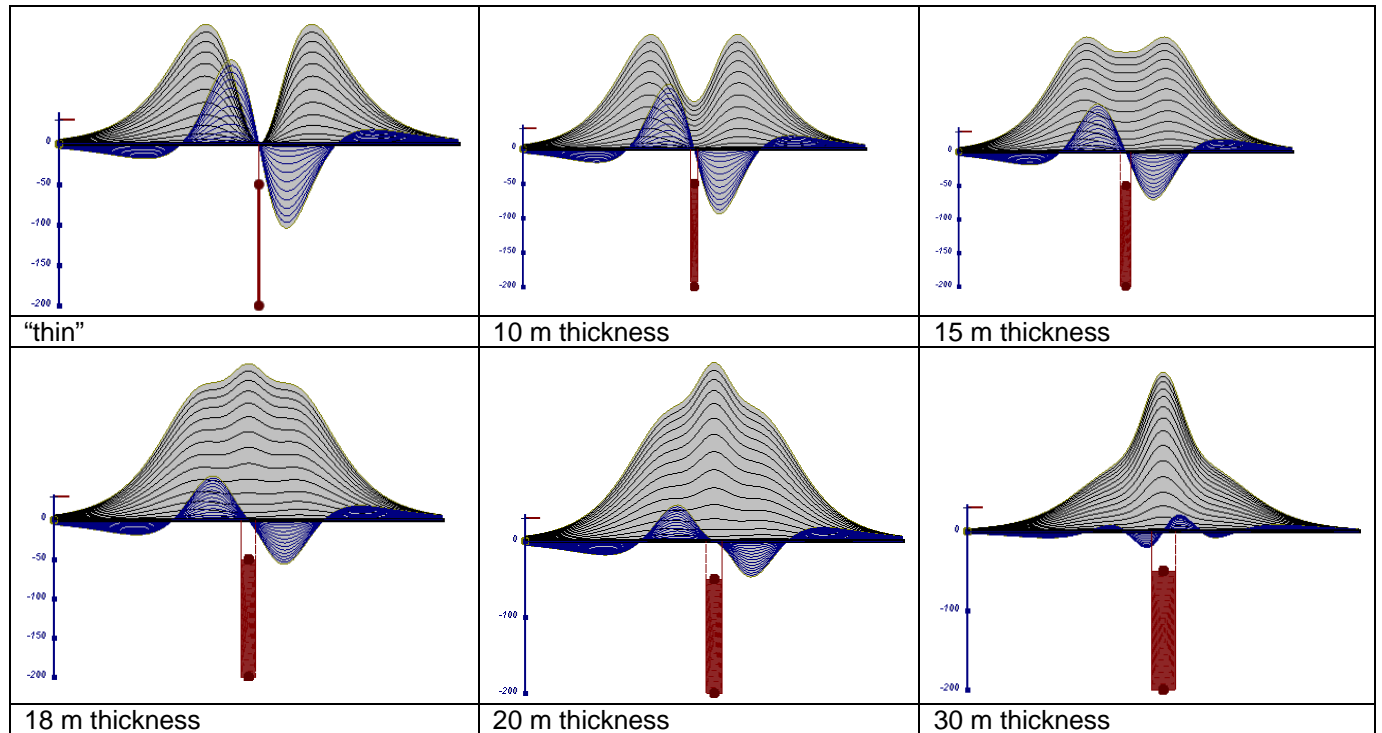


Figure D-16: Conductive vertical plate, depth 50 m, strike length 200 m, depth extend 150 m.

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APPENDIX E

EM TIME CONSTANT (TAU) ANALYSIS

Estimation of time constant parameter¹ in transient electromagnetic method is one of the steps toward the extraction of the information about conductance's beneath the surface from TEM measurements.

The most reliable method to discriminate or rank conductors from overburden, background or one and other is by calculating the EM field decay time constant (TAU parameter), which directly depends on conductance despite their depth and accordingly amplitude of the response.

Theory

As established in electromagnetic theory, the magnitude of the electro-motive force (emf) induced is proportional to the time rate of change of primary magnetic field at the conductor. This emf causes eddy currents to flow in the conductor with a characteristic transient decay, whose Time Constant (Tau) is a function of the conductance of the survey target or conductivity and geometry (including dimensions) of the target. The decaying currents generate a proportional secondary magnetic field, the time rate of change of which is measured by the receiver coil as induced voltage during the Off time.

The receiver coil output voltage (e_0) is proportional to the time rate of change of the secondary magnetic field and has the form,

$$e_0 \propto (1 / \tau) e^{-(t / \tau)}$$

Where,

$\tau = L/R$ is the characteristic time constant of the target (TAU)

R = resistance

L = inductance

From the expression, conductive targets that have small value of resistance and hence large value of τ yield signals with small initial amplitude that decays relatively slowly with progress of time. Conversely, signals from poorly conducting targets that have large resistance value and small τ , have high initial amplitude but decay rapidly with time¹ (Figure E-1).

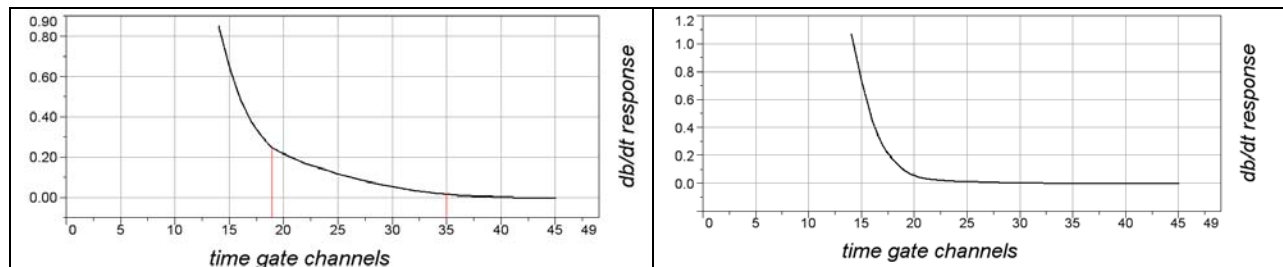


Figure E-1: Left – presence of good conductor, right – poor conductor.

¹ McNeill, JD, 1980, "Applications of Transient Electromagnetic Techniques", Technical Note TN-7 page 5, Geonics Limited, Mississauga, Ontario.

EM Time Constant (Tau) Calculation

The EM Time-Constant (TAU) is a general measure of the speed of decay of the electromagnetic response and indicates the presence of eddy currents in conductive sources as well as reflecting the “conductance quality” of a source. Although TAU can be calculated using either the measured dB/dt decay or the calculated B-field decay, dB/dt is commonly preferred due to better stability (S/N) relating to signal noise. Generally, TAU calculated on base of early time response reflects both near surface overburden and poor conductors whereas, in the late ranges of time, deep and more conductive sources, respectively. For example early time TAU distribution in an area that indicates conductive overburden is shown in Figure 2.

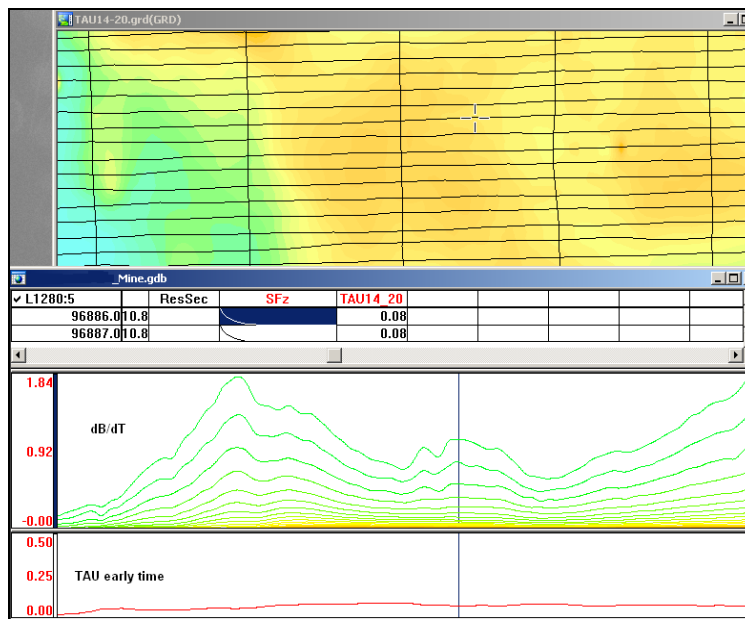


Figure E-2: Map of early time TAU. Area with overburden conductive layer and local sources.

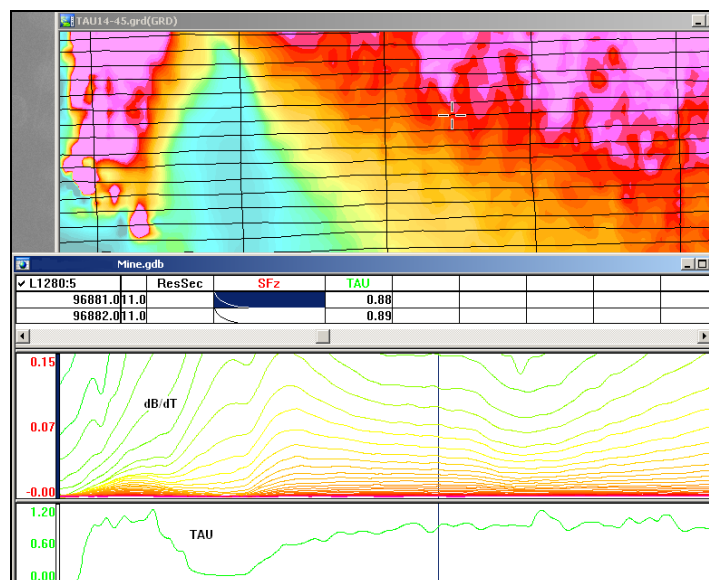


Figure E-3: Map of full time range TAU with EM anomaly due to deep highly conductive target.

There are many advantages of TAU maps:

- TAU depends only on one parameter (conductance) in contrast to response magnitude;
- TAU is integral parameter, which covers time range and all conductive zones and targets are displayed independently of their depth and conductivity on a single map.
- Very good differential resolution in complex conductive places with many sources with different conductivity.
- Signs of the presence of good conductive targets are amplified and emphasized independently of their depth and level of response accordingly.

In the example shown in Figure 4 and 5, three local targets are defined, each of them with a different depth of burial, as indicated on the resistivity depth image (RDI). All are very good conductors but the deeper target (number 2) has a relatively weak dB/dt signal yet also features the strongest total TAU (Figure 4). This example highlights the benefit of TAU analysis in terms of an additional target discrimination tool.

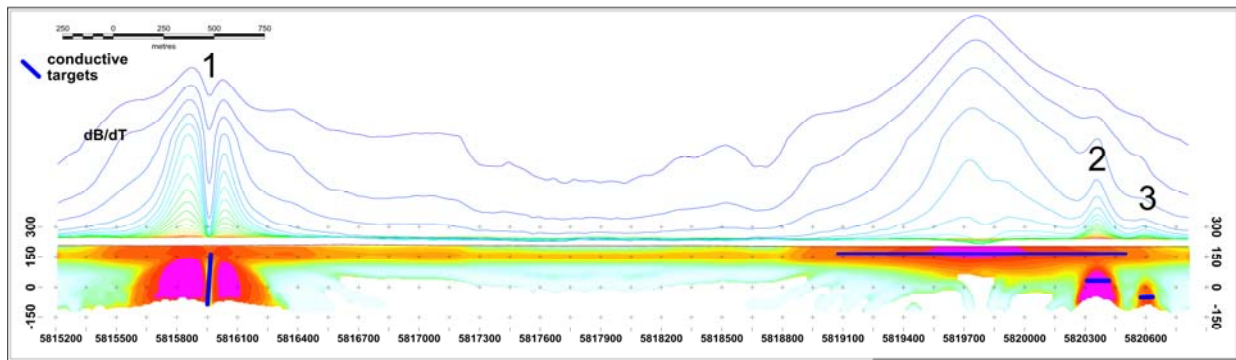


Figure E-4: dB/dt profile and RDI with different depths of targets.

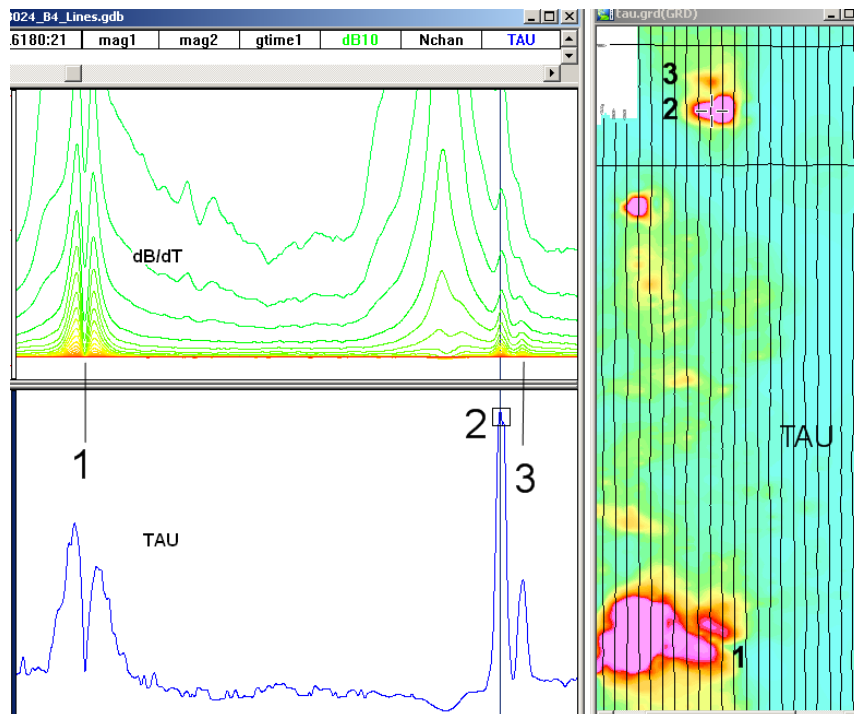


Figure E-5: Map of total TAU and dB/dt profile.

The EM Time Constants for dB/dt and B-field were calculated using the “sliding Tau” in-house program developed at Geotech2. The principle of the calculation is based on using of time window (4 time channels) which is sliding along the curve decay and looking for latest time channels which have a response above the level of noise and decay. The EM decays are obtained from all available decay channels, starting at the latest channel. Time constants are taken from a least square fit of a straight-line (log/linear space) over the last 4 gates above a pre-set signal threshold level (Figure F6). Threshold settings are pointed in the “label” property of TAU database channels. The sliding Tau method determines that, as the amplitudes increase, the time-constant is taken at progressively later times in the EM decay. Conversely, as the amplitudes decrease, Tau is taken at progressively earlier times in the decay. If the maximum signal amplitude falls below the threshold, or becomes negative for any of the 4 time gates, then Tau is not calculated and is assigned a value of “dummy” by default.

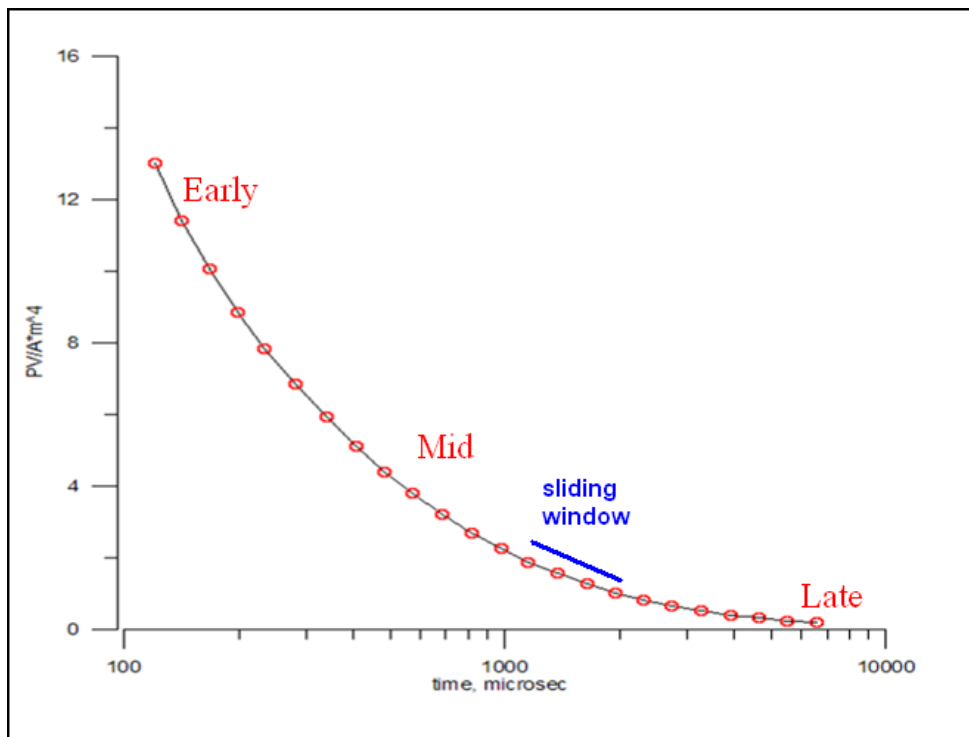


Figure E-6: Typical dB/dt decays of VTEM data

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² by A.Prikhodko

APPENDIX F

TEM RESISTIVITY DEPTH IMAGING (RDI)

Resistivity depth imaging (RDI) is a technique used to rapidly convert EM profile decay data into an equivalent resistivity versus depth cross-section, by deconvolving the measured TEM data. The used RDI algorithm of Resistivity-Depth transformation is based on the scheme of the apparent resistivity transform of Maxwell A. Meju (1998)¹ and TEM response from a conductive half-space. The program is developed by Alexander Prikhodko and is depth-calibrated based on forward plate modeling for VTEM system configuration (Fig. 1-10).

RDIs provide reasonable indications of conductor relative depth and vertical extent, as well as accurate 1D layered-earth apparent conductivity/resistivity structure across VTEM flight lines. Approximate depth of investigation of a TEM system, image of secondary field distribution in half-space, effective resistivity, initial geometry and position of conductive targets is the information obtained on the basis of the RDIs.

Maxwell forward modeling with RDI sections from the synthetic responses (VTEM system)

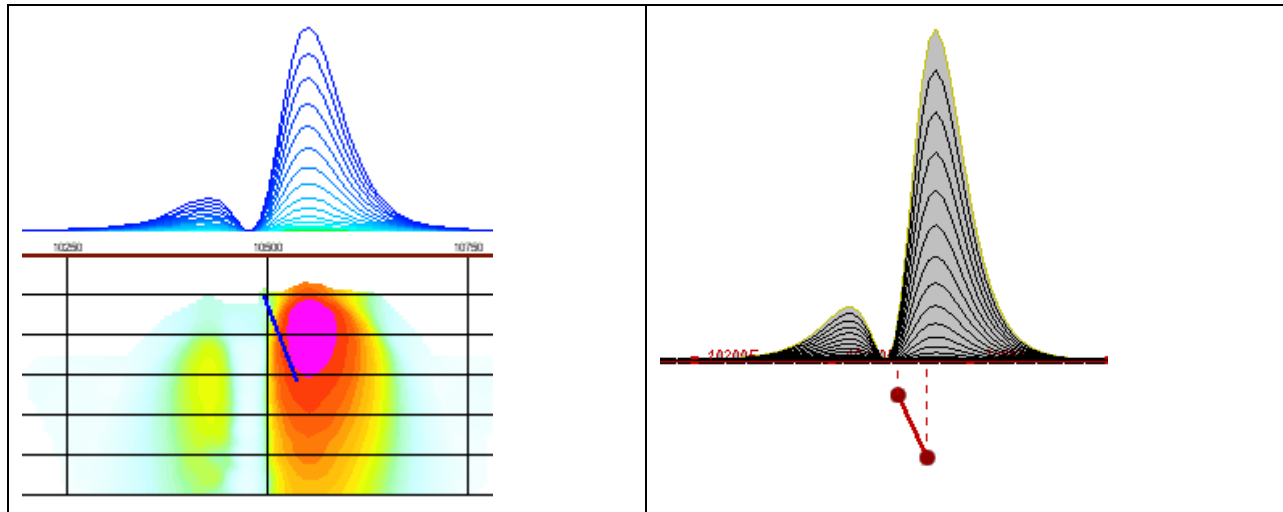


Figure F-1: Maxwell plate model and RDI from the calculated response for a conductive “thin” plate (depth 50 m, dip 65 degree, depth extend 100 m).

¹ Maxwell A. Meju, 1998, Short Note: A simple method of transient electromagnetic data analysis, *Geophysics*, **63**, 405–410.

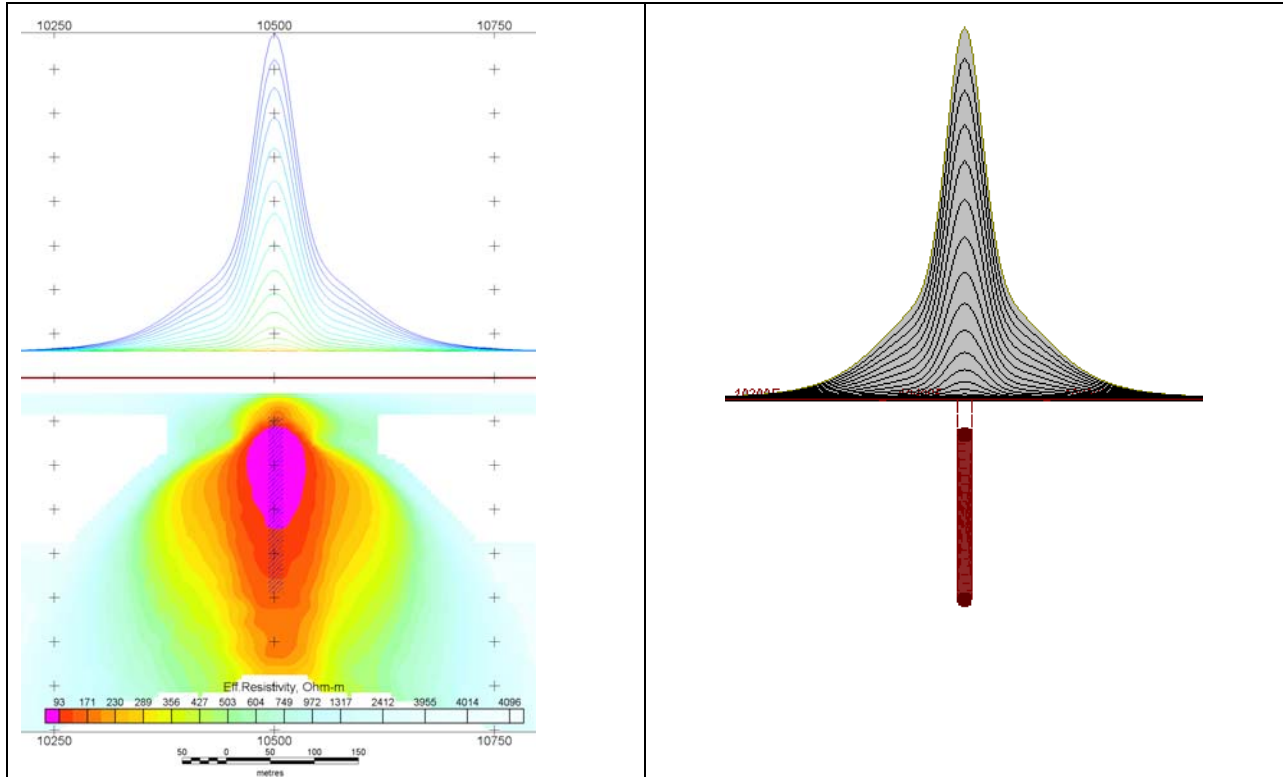


Figure F-2: Maxwell plate model and RDI from the calculated response for “thick” plate 18 m thickness, depth 50 m, depth extend 200 m).

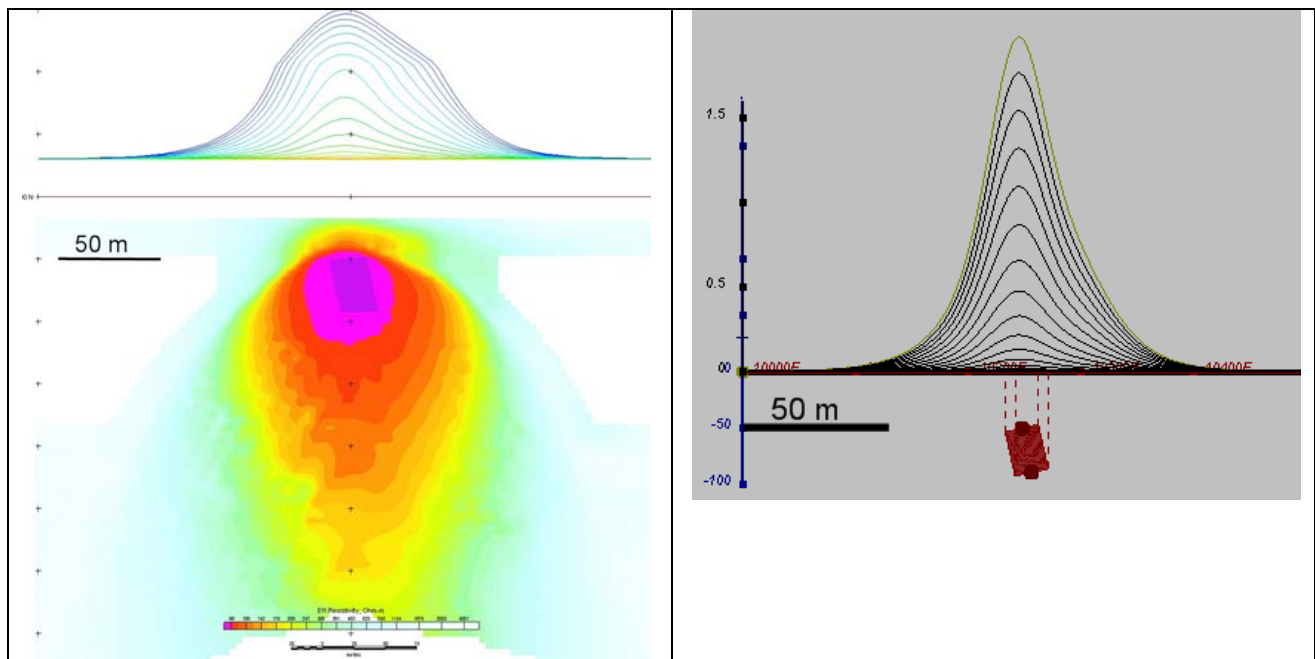


Figure F-3: Maxwell plate model and RDI from the calculated response for bulk (“thick”) 100 m length, 40 m depth extend, 30 m thickness

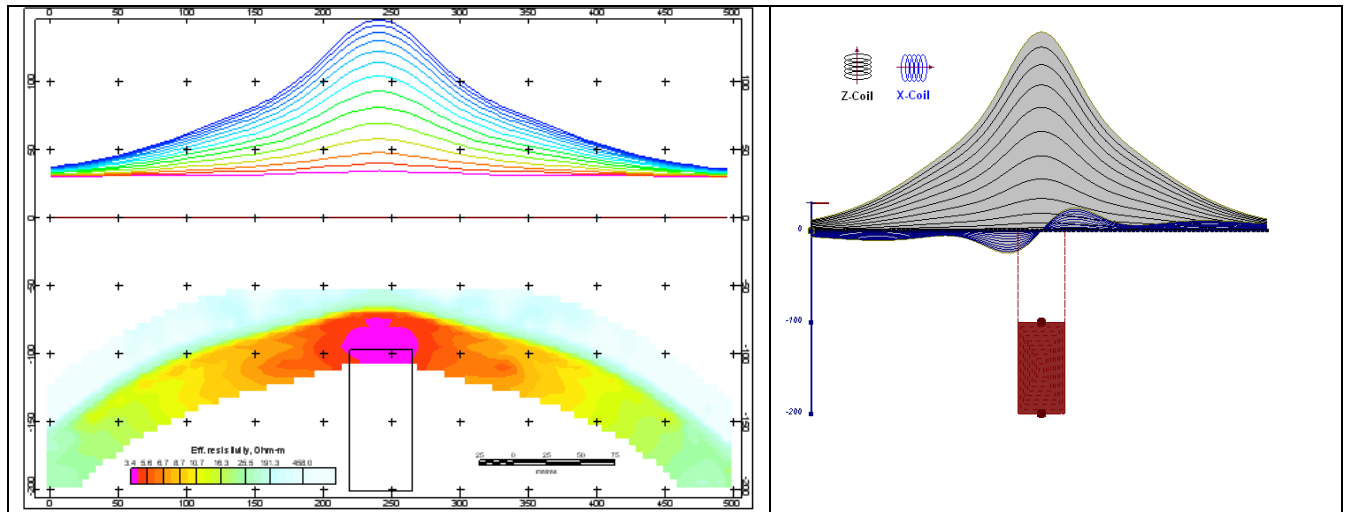


Figure F-4: Maxwell plate model and RDI from the calculated response for “thick” vertical target (depth 100 m, depth extend 100 m). 19-44 chan.

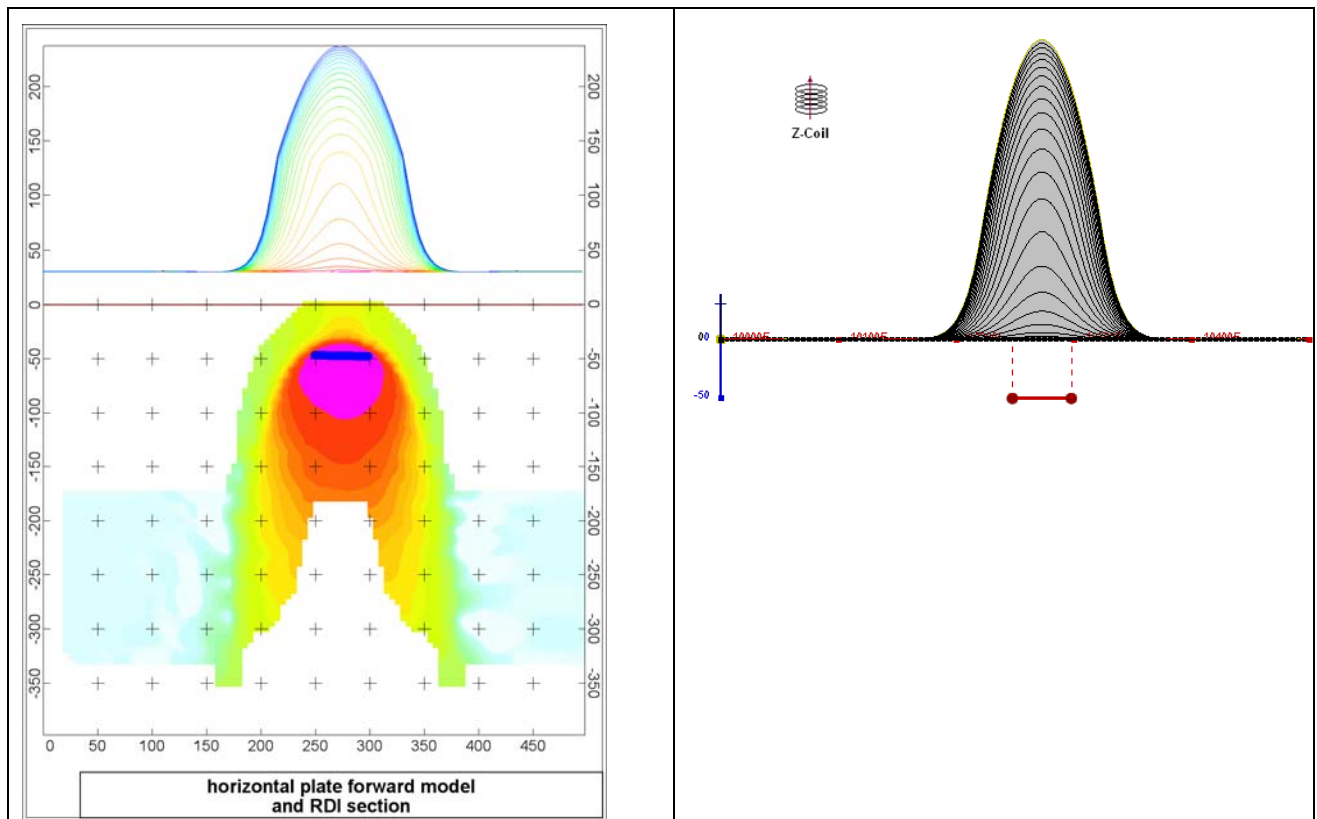


Figure F-5: Maxwell plate model and RDI from the calculated response for horizontal thin plate (depth 50 m, dim 50x100 m). 15-44 chan.

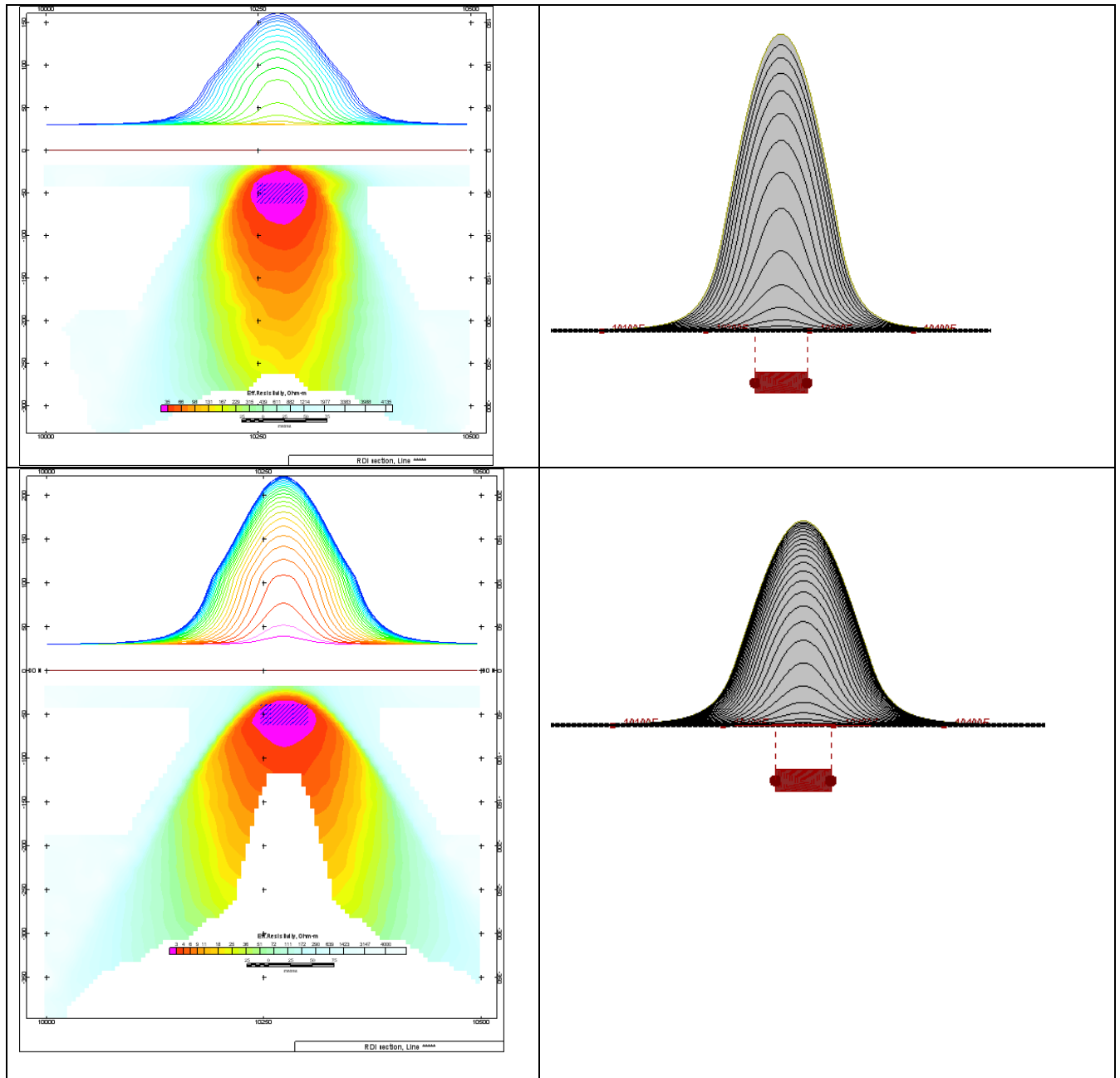


Figure F-6: Maxwell plate model and RDI from the calculated response for horizontal thick (20m) plate – less conductive (on the top), more conductive (below)

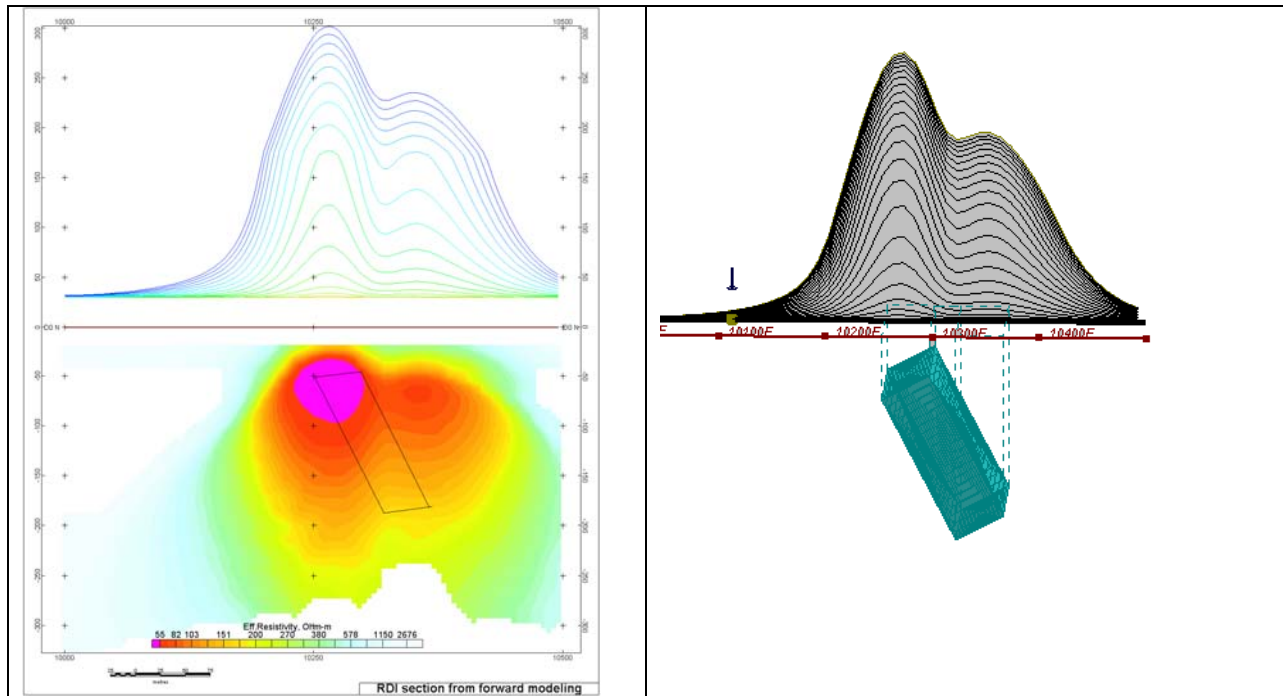


Figure F-7: Maxwell plate model and RDI from the calculated response for inclined thick (50m) plate. Depth extends 150 m, depth to the target 50 m.

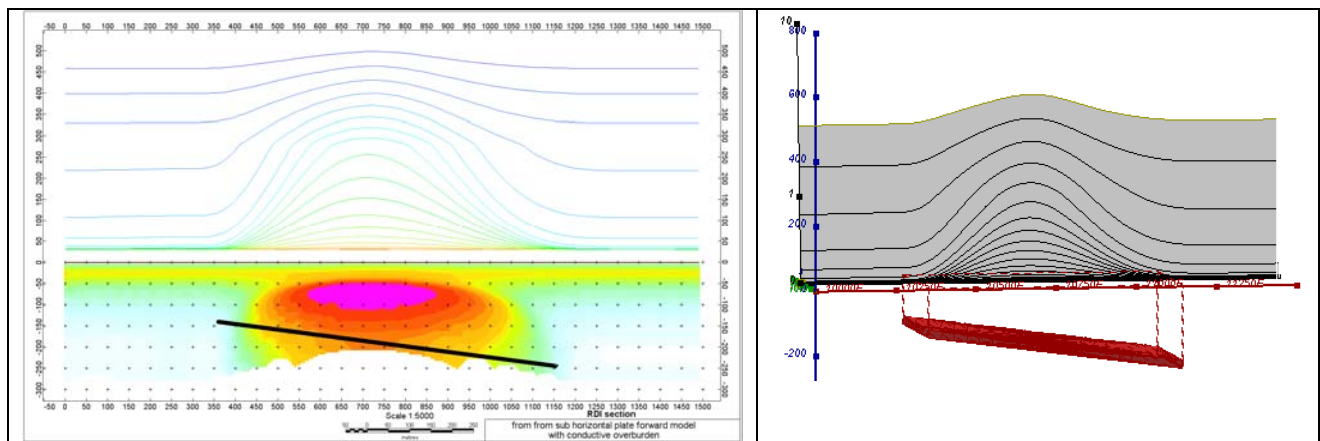


Figure F-8: Maxwell plate model and RDI from the calculated response for the long, wide and deep sub horizontal plate (depth 140 m, dim 25x500x800 m) with conductive overburden.

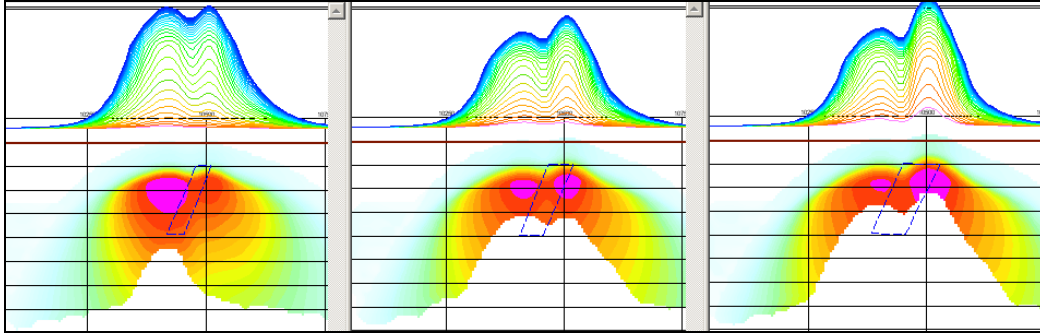


Figure F-9: Maxwell plate models and RDIs from the calculated response for “thick” dipping plates (35, 50, 75 m thickness), depth 50 m, conductivity 2.5 S/m.

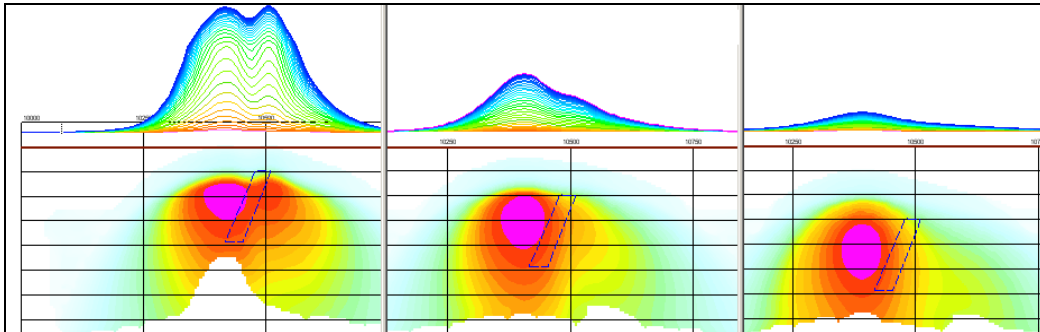


Figure F-10: Maxwell plate models and RDIs from the calculated response for “thick” (35 m thickness) dipping plate on different depth (50, 100, 150 m), conductivity 2.5 S/m.

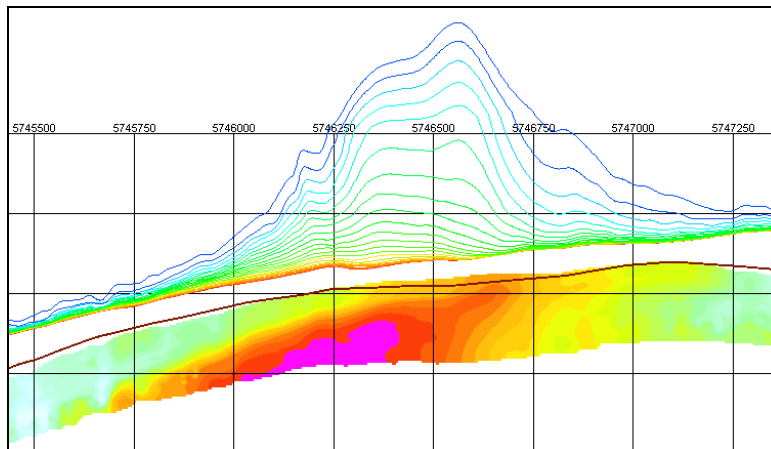
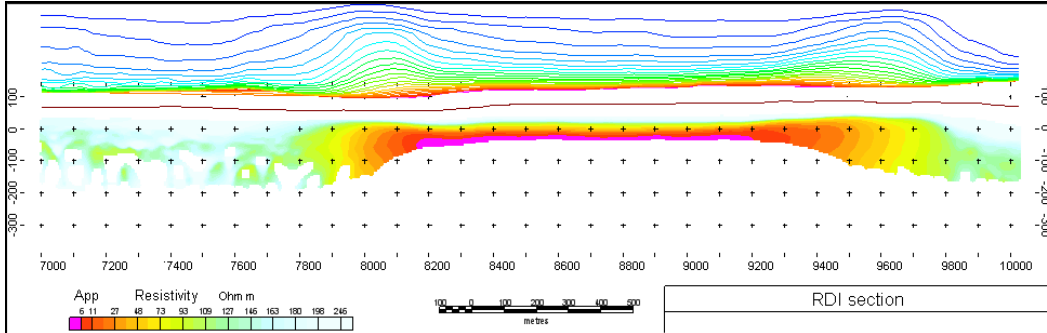
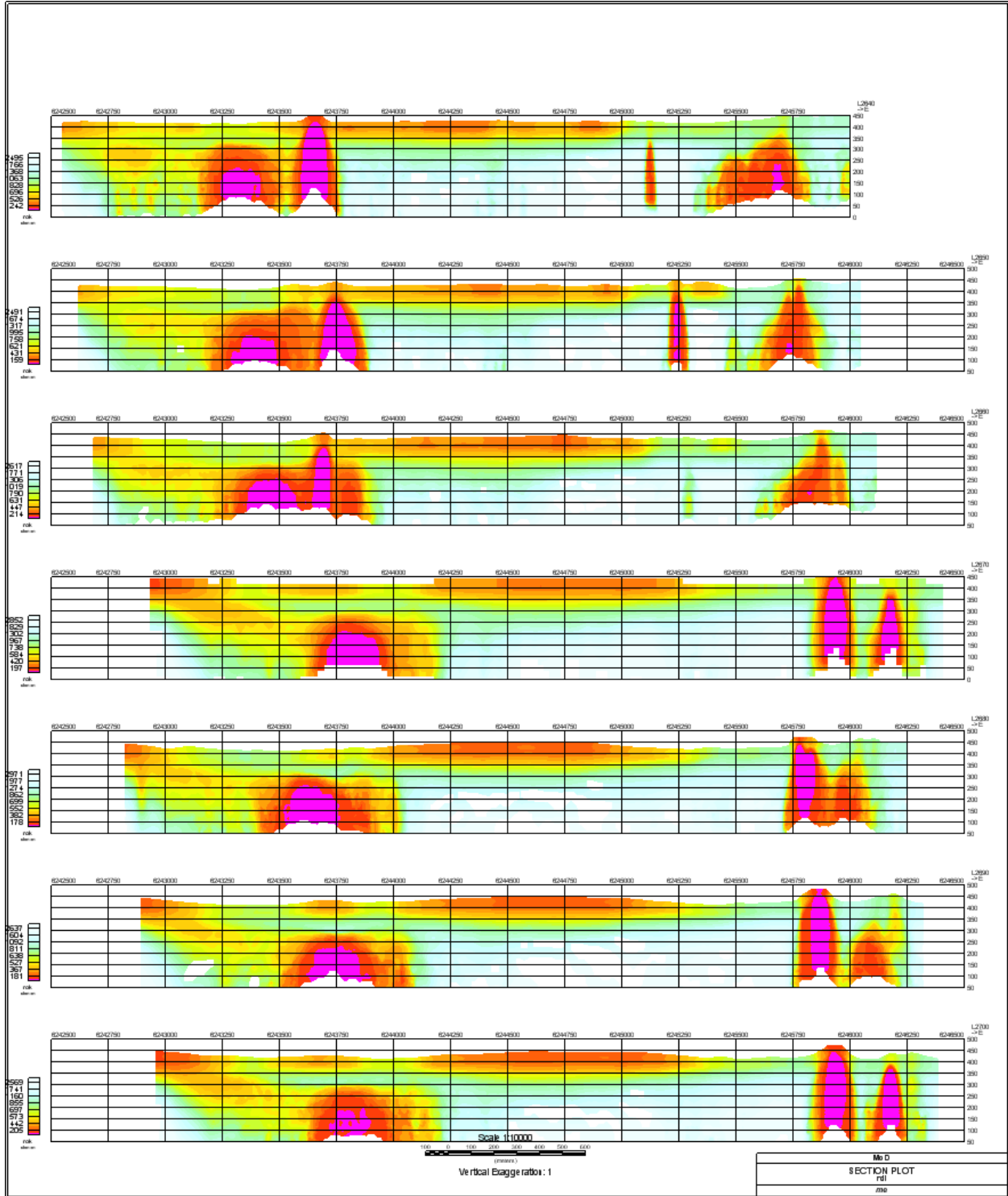


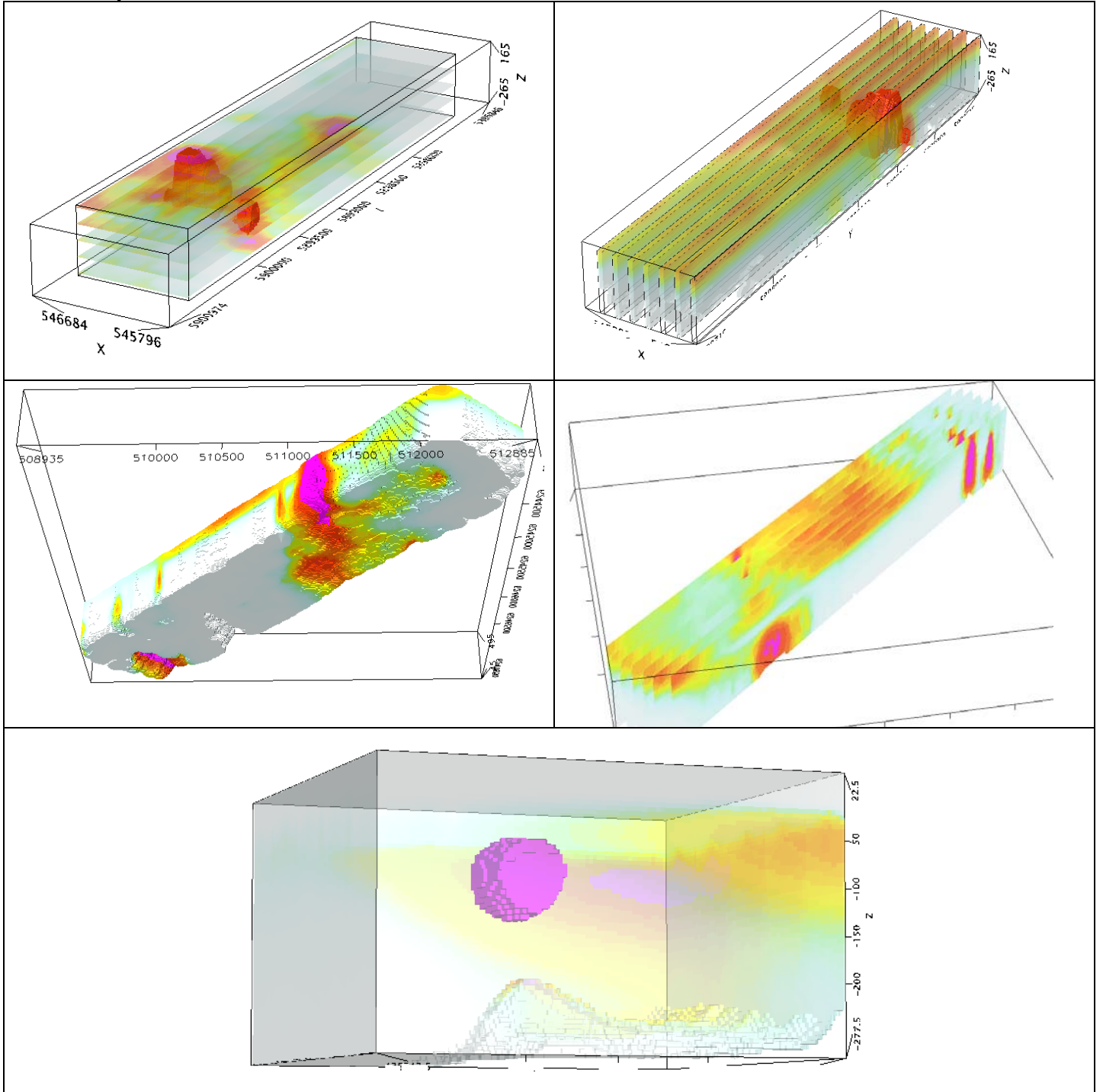
Figure F-11: RDI section for the real horizontal and slightly dipping conductive layers

FORMS OF RDI PRESENTATION

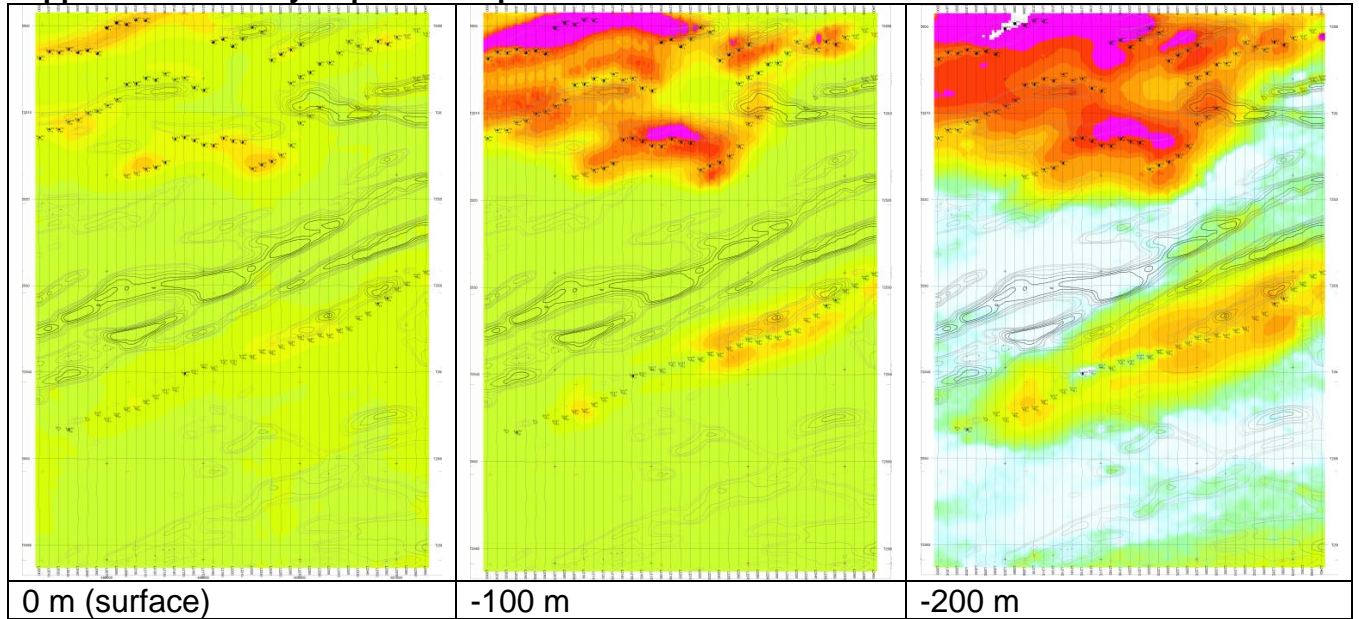
Presentation of series of lines



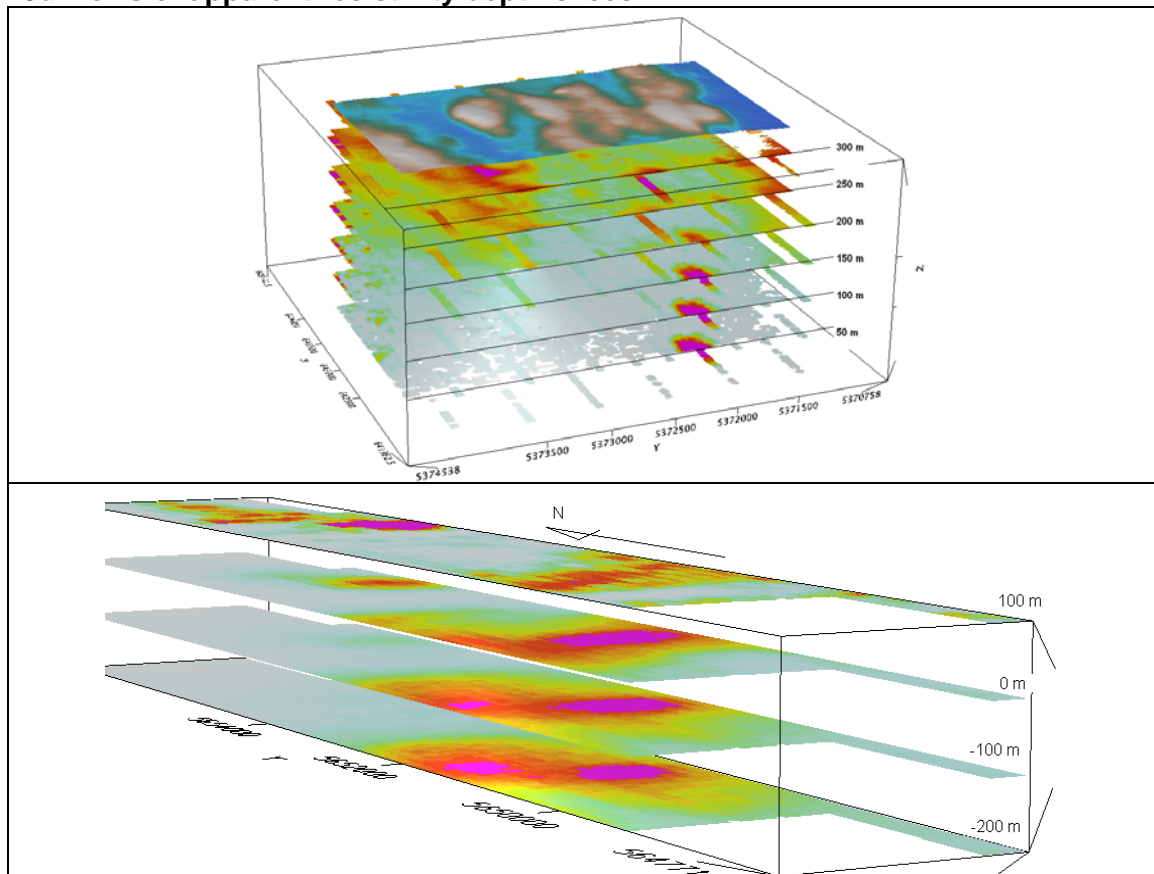
3d presentation of RDIs



Apparent Resistivity Depth Slices plans:

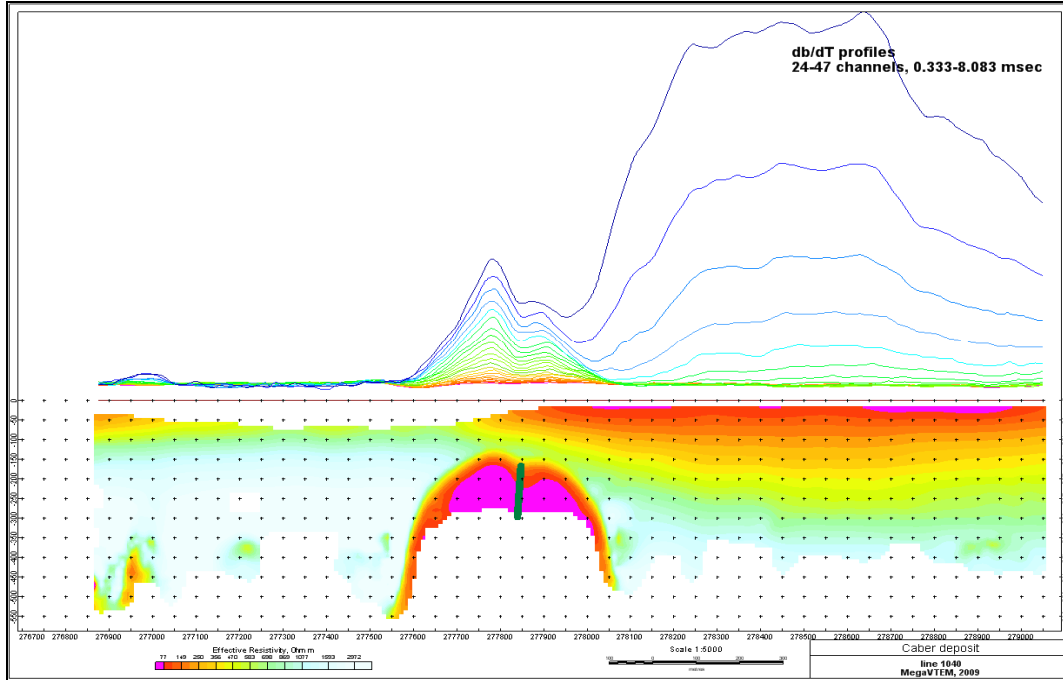


3d views of apparent resistivity depth slices:

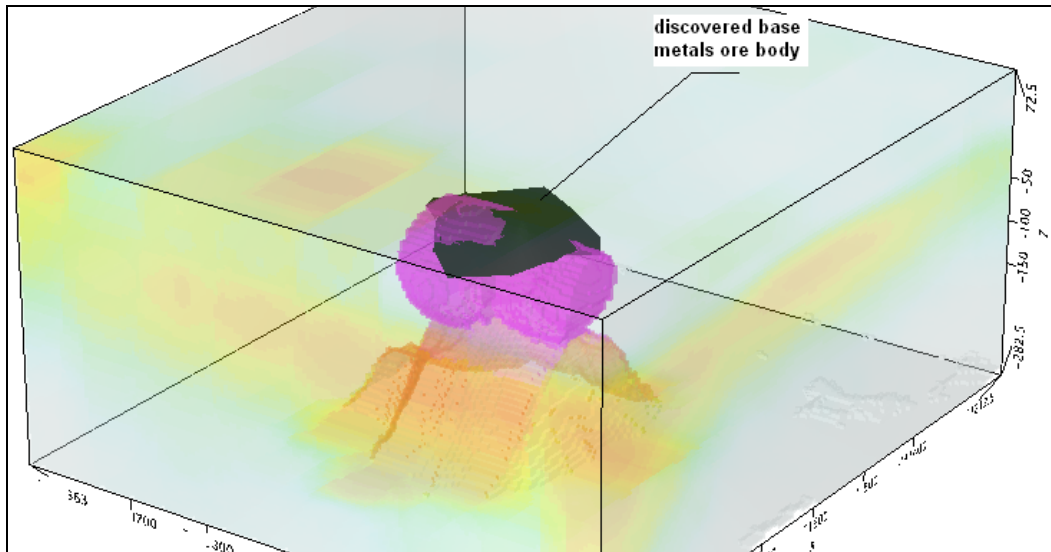


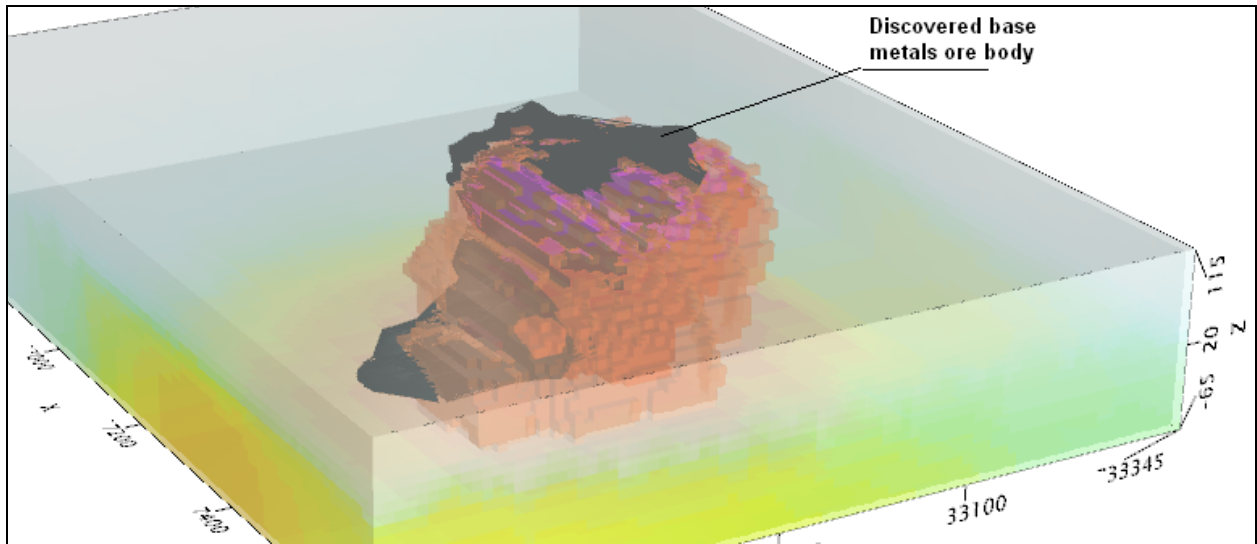
Real base metal targets in comparison with RDIs:

RDI section of the line over Caber deposit (“thin” sub vertical plate target and conductive overburden).



3d RDI voxels with base metals ore bodies (Middle East):





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April 2011