SURVEY AND LOGISTICS REPORT ON A HELICOPTER BORNE VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM) SURVEY

on the

HUCKITTA AREA

AUSTRALIA

for

MITHRIL RESOURCES LIMITED

by

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Project AA1003A
July, 2011

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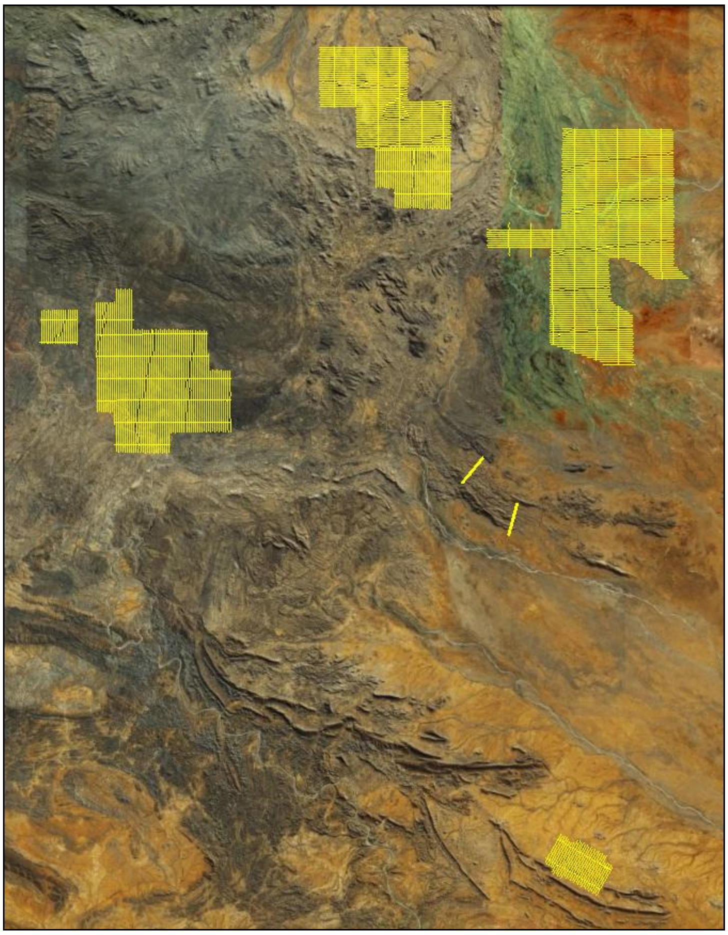
SURVEY AND LOGISTICS REPORT ON A HELICOPTER-BORNE VTEM SURVEY

1. SURVEY SPECIFICATIONS

1.1. General

Job Number	AA1003A
Client	Mithril Resources Limited.
Project Area	Huckitta Area
Location	Australia
Number of Blocks	8 + Ext
Total line kilometres	2650km
Survey date	5 - 22 May, 2011
Client Representative	Jim McKinnon-Matthews, General Manager - Geology Tel: +61 8 8378 8200 Fax: +61 8 8271 0037 jimm@mithrilresources.com.au
Client address	60 King William Road Adelaide, SA 50334, Australia

1.2. VTEM flight plan on Google EARTH™ Background



1.3. Survey block coordinates.

Easting UTM Z 53S	Northing UTM Z 53S
Block01	
530650.974	7432400.16
537477.01	7432477.29
537592.705	7441617.24
547735.345	7441694.37
547735.345	7434251.29
547735.345	7427772.34
543454.611	7429777.73
541719.179	7429854.86
541989.135	7425882.65
543955.958	7424571.43
544033.089	7420175
541642.048	7420136.44
536358.62	7422064.7
536474.315	7430587.6
530689.54	7430626.17
Block02	
515323.945	7449107.02
519556.237	7449103.1
523397.299	7449069.11
523397.299	7444072.33
527340.337	7444072.33
527306.345	7439823.37
518759.283	7439834.4
518731.353	7443549.03
515379.804	7443549.03
Block04	
520462.987	7439806.47
527340.337	7439857.36
527374.329	7434282.72
522222.551	7434332.27
522110.832	7436147.69
520462.987	7436203.55
Block05	
494923.925	7423334.28
502009.253	7423290.54
505114.552	7423203.07
505202.025	7419660.4
507213.908	7419572.93
507213.908	7414062.12
501659.361	7414018.38
501660.524	7412110.39
496629.652	7412225.18
496542.179	7415855.32
494967.662	7415942.79
Block05 Ext	
498300.004	7422800
494900.003	7422800
494900.003	7425800
496599.999	7425800
496599.999	7427000
498300.004	7427000
498300.004	7422800

Brumby	
489773.355	7422103.8
493186.08	7422103.8
493186.08	7425111.26
489773.355	7425111.26
489773.355	7422103.8
Bullhole	
535746.057	7374802.39
536612.076	7374302.39
536412.082	7373955.98
537494.613	7373330.98
537619.611	7373547.49
540650.701	7371797.49
542150.695	7374395.56
541284.675	7374895.56
541534.672	7375328.57
538936.596	7376828.58
538686.599	7376395.57
538080.381	7376745.57
538155.377	7376875.47
537246.05	7377400.46
535746.057	7374802.39
Gertrude	
528407.817	7409297.68
528254.608	7409426.23
530182.971	7411724.37
530336.18	7411595.81
Hills	
532684.364	7404567.23
532491.179	7404618.99
533267.636	7407516.77
533460.821	7407465.01

1.4. Survey block specifications

Survey block	Line spacing (m)	Line-km (contractual)	Line-km (delivered)	Flight direction	Line number
Block01	200	1098	1111	090-270	L10010 – L11080
	2000			000-180	T91010 – T91080
Block02	200	440	443	090-270	L20010 – L20470
	2000			000-180	T92010 – T92060
Block04	200	196	198	000-180	L40010 – L40350
	2000			090-270	T94010 – T94030
Block05 + Ext	200	690	697	000-180	L50010 – L50620
	2000			090-270	T95010 – T95070
Brumby	200	58	59	000-180	L49760 – L49920
	2000			090-270	T95062 – T95072
Bullhole	200	108	110	030-210	L30010 – L30290
	2000			120-300	T93010 – T93010
Gertrude	50	15	15	040-220	L70010 – L70050
Hills	50	15	15	015-195	L70060 – L70100

1.5. Survey schedule

Date	Flight #	Block	Nominal Production Km flown	Comments
06-May-11	1	N/A	N/A	Test Flight
07-May-11	2,3	N/A	N/A	Test Flight
08-May-11	N/A	N/A	N/A	Test Flight
09-May-11	6	Hills,Gert	31	Production
10-May-11	7-9	5	520	Production
11-May-11	10-12	5,2,Bull	229	Production
12-May-11	N/A	N/A	N/A	Mpi
13-May-11	N/A	N/A	N/A	Mpi
14-May-11	13	5 Ext	78	Production
15-May-11	14-16	1,5 Ext	398	Production
16-May-11	N/A	N/A	N/A	Test Flight
17-May-11	17	N/A	N/A	Test Flight
18-May-11	25,26	1	121	Production
19-May-11	27-29	1	436	Production
20-May-11	30-32	1,2	410	Production
21-May-11	33,34	2,4	281	Production
22-May-11	35	4	42	Production

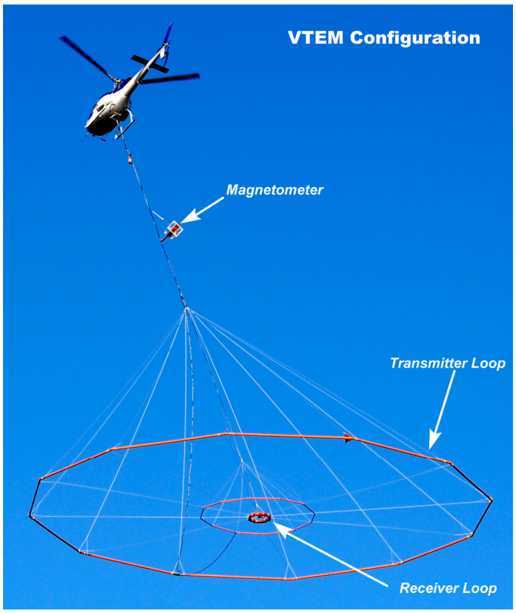
2. SYSTEM SPECIFICATIONS

2.1. Instrumentation

Survey Helicopter	
Model	AS 350 B3
Registration	VH-VTX
Nominal survey speed	80 km/h
Nominal terrain clearance	80 m
VTEM Transmitter	
Coil diameter	26 m
Number of turns	4
Pulse repetition rate	25 Hz
Peak current	200 Amp
Duty cycle	37%
Peak dipole moment	425,000 NIA
Pulse width	7.38 ms
Nominal terrain clearance	49 m
VTEM Receiver	
Coil diameter	1.2 metre
Number of turns	100
Effective area	113.1 m^2
Sampling interval	0.1 s
Nominal terrain clearance	49 m
Magnetometer	
Type	Geometrics
Model	Optically pumped cesium vapour
Sensitivity	0.02 nT
Sampling interval	0.1 s
Cable length	14 m
Nominal terrain clearance	69 m
Radar Altimeter	
Type	Terra TRA 3000/TRI 40
Position	Beneath cockpit
Sampling interval	0.2 s
GPS navigation system	
Type	NovAtel
Model	WAAS enabled OEM4-G2-3151W
Antenna position	Helicopter tail
Sampling interval	0.2 s
Base Station Magnetometer/GPS	
Type	Geometrics
Model	Cesium vapour
Sensitivity	0.001 nT
Sampling interval	1 s

2.2. VTEM Configuration

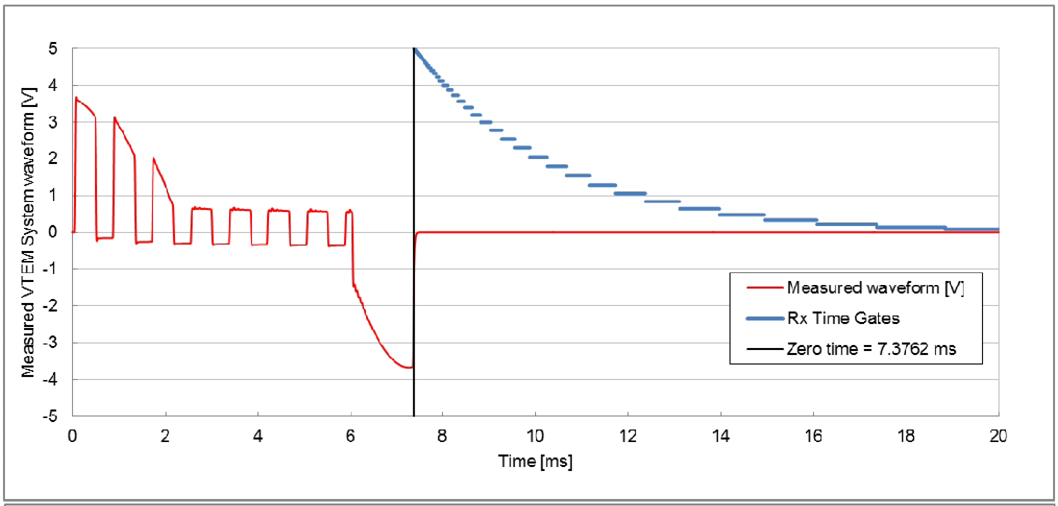
Configuration	
Cable angle with vertical	40 ˚
Cable length (EM receiver)	40 m
Cable length (Magnetometer)	14 m

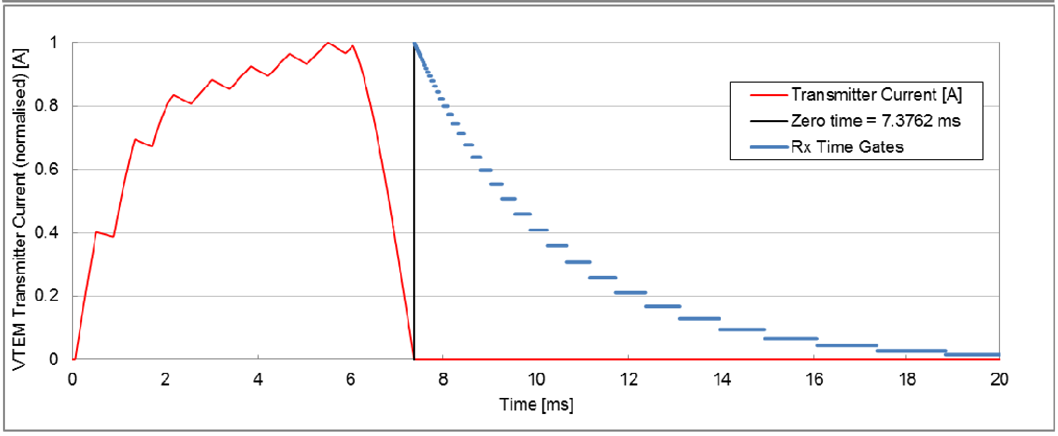


2.3. VTEM decay sampling scheme

B-field VTEM Decay Sampling scheme				
Array	Microseconds			
Index	Middle	Start	End	Width
13	83	78	90	12
14	96	90	103	13
15	110	103	118	15
16	126	118	136	18
17	145	136	156	20
18	167	156	179	23
19	192	179	206	27
20	220	206	236	30
21	253	236	271	35
22	290	271	312	40
23	333	312	358	46
24	383	358	411	53
25	440	411	472	61
26	505	472	543	70
27	580	543	623	81
28	667	623	716	93
29	766	716	823	107
30	880	823	945	122
31	1010	945	1086	141
32	1161	1086	1247	161
33	1333	1247	1432	185
34	1531	1432	1646	214
35	1760	1646	1891	245
36	2021	1891	2172	281
37	2323	2172	2495	323
38	2667	2495	2865	370
39	3063	2865	3292	427
40	3521	3292	3781	490
41	4042	3781	4341	560
42	4641	4341	4987	646
43	5333	4987	5729	742
44	6125	5729	6581	852
45	7036	6581	7560	979
46	8083	7560	8685	1125
47	9286	8685	9977	1292
48	10667	9977	11458	1482

2.4. VTEM Transmitter Waveform over one half-period (May 2011)





3. PROCESSING

3.1. Processing parameters

Coordinates	
Projection	MAP GRID AUS ZONE 53
Datum	GDA 94
Spherics rejection (EM and Magnetic data)	
Non-linear filter	4 point
Non-linear filter sensitivity	0.0001
Low-pass filter wavelength	15 fids
Lag correction of other sensors to EM receiver position	
GPS	18 m
Radar	28 m
Magnetometer	17 m

3.2. Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the UTM 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 eastings (x) and UTM northings (y).

3.3. Electromagnetic Data

A three stage digital filtering process was used to reject major sferic events and to reduce system noise. Local sferic 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 sferic 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 the specified filter wavelength.

3.4. 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 the traverse lines. A micro-levelling procedure was then applied. This technique is designed to remove persistent low-amplitude components of flight-line noise remaining after tie line levelling.

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 a quarter of the line spacing. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.

3.5. Digital Terrain Model

Subtracting the radar altimeter data from the GPS elevation data creates a digital elevation model.

4. DELIVERABLES

VTEM Survey and logistics report		
Format	PDF	
Copies	2 x Digital (DVD/CD) 2 x Hard copy	
Database		
Format	Digital Geosoft (.GDB)	
Channels	Name	Description
	X_UTM	X positional data (UTM Z53S / WGS84)
	Y_UTM	Y positional data (UTM Z53S / WGS84)
	X_MGA	X positional data (MGA Z53 / GDA94)
	Y_MGA	Y positional data (MGA Z53 / GDA94)
	Lon	Longitude data
	Lat	Latitude data
	Z	GPS antenna elevation (metres above sea level)
	Radar	Helicopter terrain clearance from radar altimeter (metres above ground level)
	RxAlt	EM Receiver and Transmitter terrain clearance (metres above ground level)
	DTM	Digital terrain model (metres)
	Gtime	UTC time (seconds of the day)
	MagTF	Raw Total Magnetic field data (nT)
	MagBase	Magnetic diurnal variation data (nT)
	MagDiu	Total Magnetic field diurnal variation and lag corrected data (nT)
	MagTieL	Tie-line leveled Total Magnetic field data (nT)
	MagMicL	Microleveled Total Magnetic field data (nT)
	dBdtZ[13] to dBdtZ[48]	dB/dtZ, Time Gates 83 μs to 10667 μs ($pV/A/m^4$)
	BfieldZ[13] to BfieldZ[48]	BfieldZ, Time Gates 83 μs to 10667 μs ($pV*m/A/m^4$)
	PLM	Power line monitor

Grids		
Format	Digital Geosoft (.GRD and .GI)[1]	
Grids	Name	Description
	AA1003A_***blk***[2]_Mag	Total Magnetic field (nT)

[1] A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information.
[2] _***blk*** indicates the block name.

Maps		
Format	Digital Geosoft (.MAP)	
Scale	Block01, Brumby and Block05 - 1:30 000 Block02 and 04 - 1:20 000 Bullhole - 1:10 000 Gertrude and Hills – 1:5000	
Maps	Name	Description
	AA1003A_***blk***_Mag	Total Magnetic field colour contours
	AA1003A_***blk***_dBdtZ_Log	VTEM dB/dtZ profiles, Time Gates 0.667 – 9.286 ms in linear - logarithmic scale
	AA1003A_***blk***_BfieldZ_Log	VTEM BfieldZ profiles, Time Gates 0.667 – 9.286 ms in linear - logarithmic scale

Waveform		
Format	Digital Excel Spreadsheet (AA1003A_VTEM_Waveform.xls)	
Columns	Name	Description
	Time	Sampling rate interval, 5.208 µs
	Volt	Output voltage of the receiver coil (volt)
	Current	Transmitter current (normalised to 1A peak)

Google Earth Flight Path file	
Format	Google Earth AA1003A_FlightPath.kml
	Free version of Google Earth software can be downloaded from, http://earth.google.com/download-earth.html

5. PERSONNEL

Geotech Airborne Limited Personnel	
Operator / Crew chief	Jon Lambert / Jon Hilton
Data Processing (Preliminary)	Pete Holbrook
Data Processing (Final) /Reporting	Matt Holbrook
Final data supervision	Malcolm Moreton Data Processing Manager (malcolm@geotechairborne.com)
Overall project management	Keith Fisk Managing Partner and Director (keith@geotechairborne.com)

APPENDIX A

GENERALIZED MODELING RESULTS OF THE VTEM SYSTEM
(by Roger Barlow and Alexander Prikhodko)

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 bi-polar, 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 A-1 to A-16). The Maxwell TM 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 90º to about 30º. The method is not sensitive enough where dips are less than about 30º.

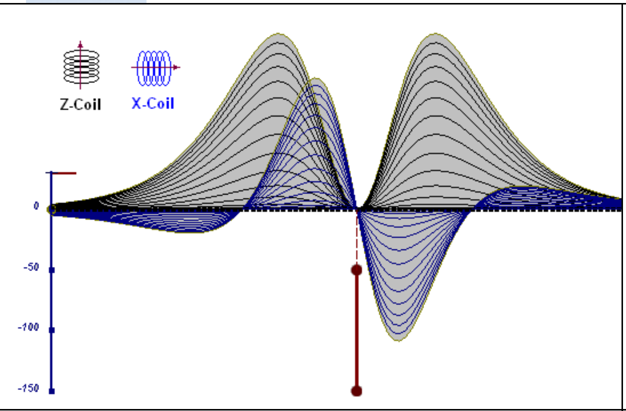


Fig A-1: Vertical thin plate

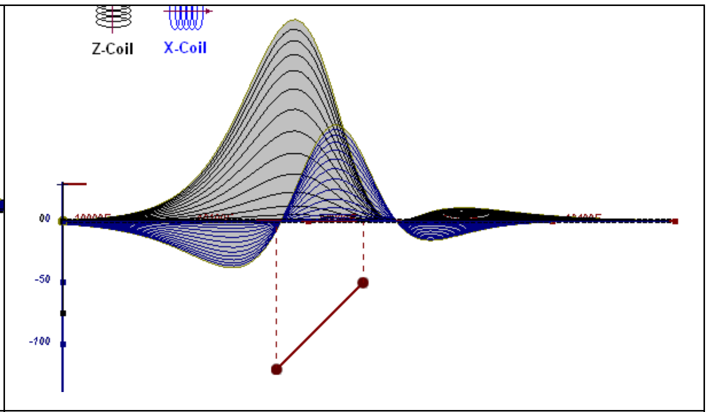


Fig A-2: Inclined thin plate

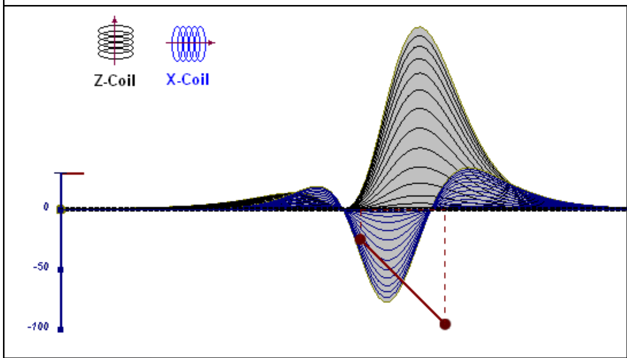


Fig A-3: Inclined thin plate

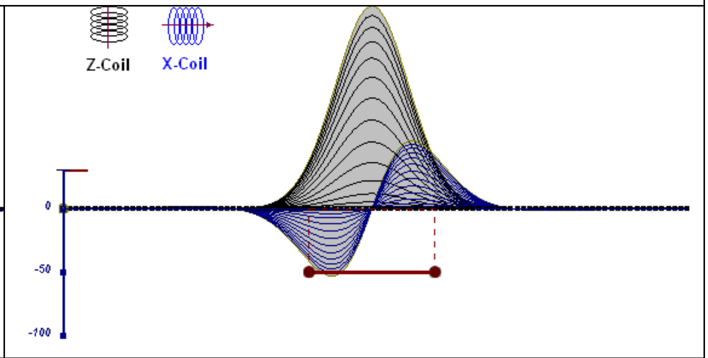


Fig A-4: Horizontal thin plate

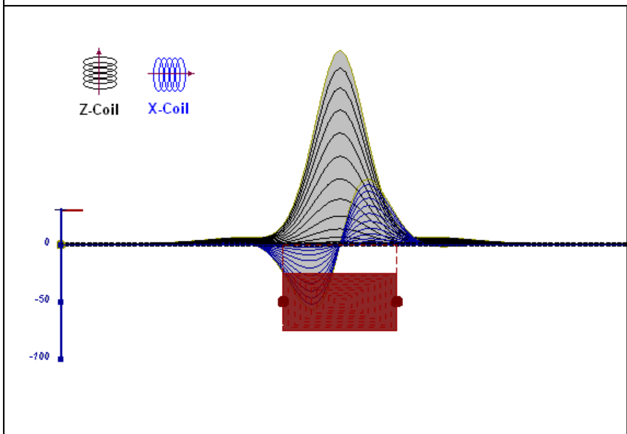


Figure A-5: Horizontal thick plate (linear scale of the response)

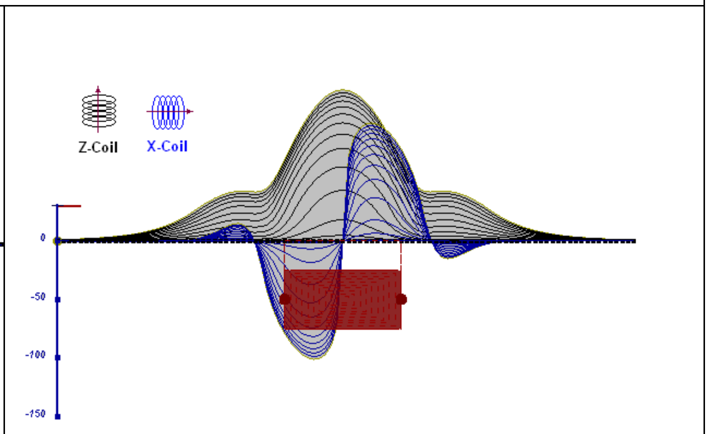


Figure A-6: Horizontal thick plate (log scale of the response)

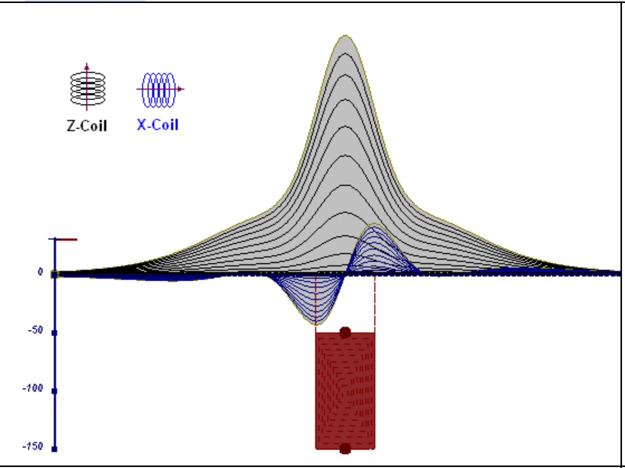


Figure A-7: Vertical thick plate (linear scale of the response). 50 m depth

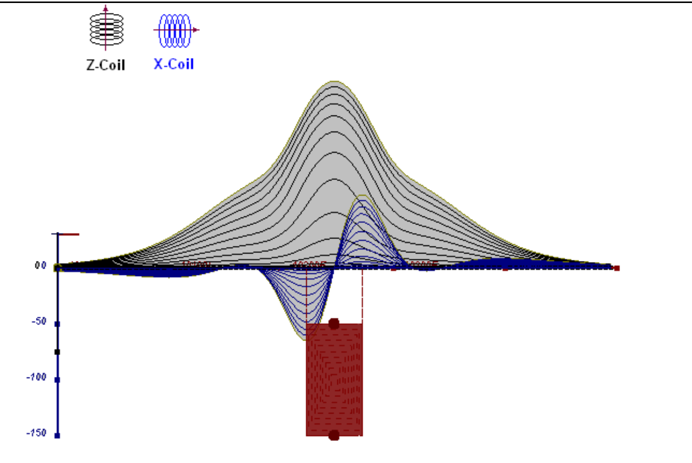


Figure A-8: Vertical thick plate (log scale of the response). 50 m depth

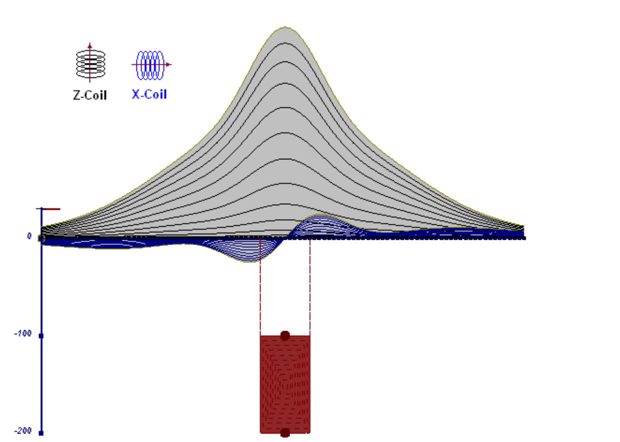


Fig A-9: Vertical thick plate (linear scale of the response). 100 m depth

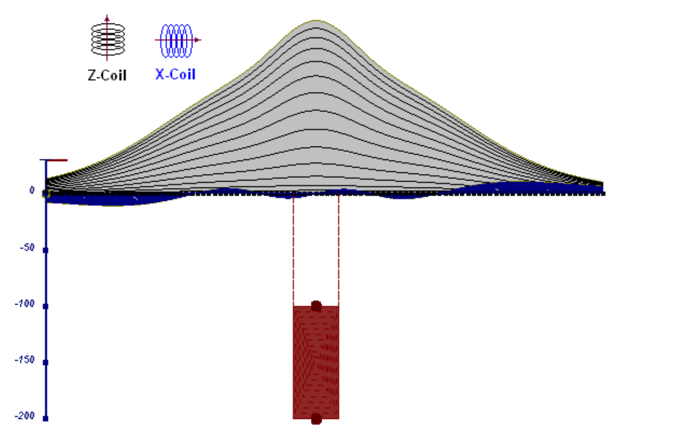


Fig A-10: Vertical thick plate (linear scale of the response). Depth/hor.thickness=2.5

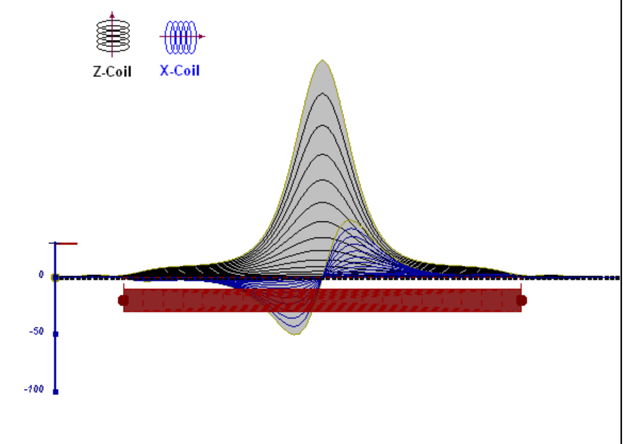


Fig A-10: Horizontal thick plate (linear scale of the response)

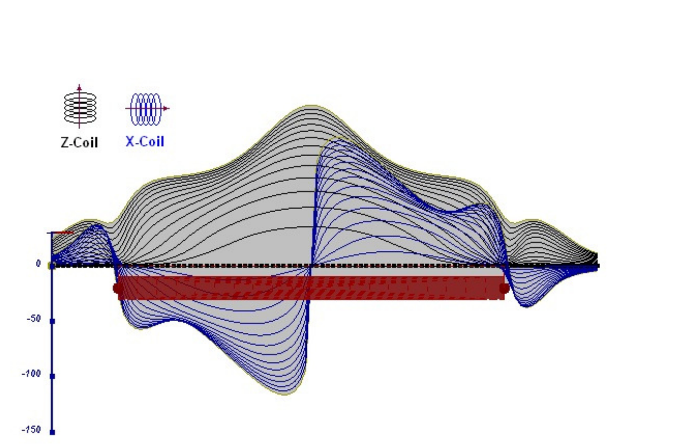


Fig A-11: Horizontal thick plate (log scale of the response)

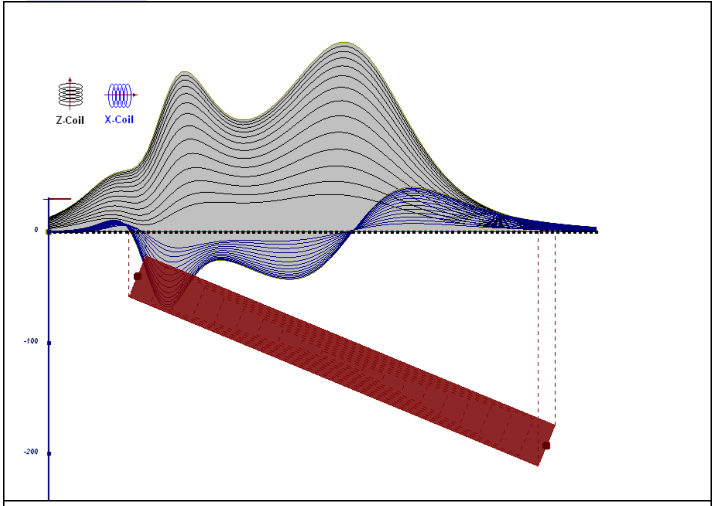


Fig A-12: Inclined long thick plate

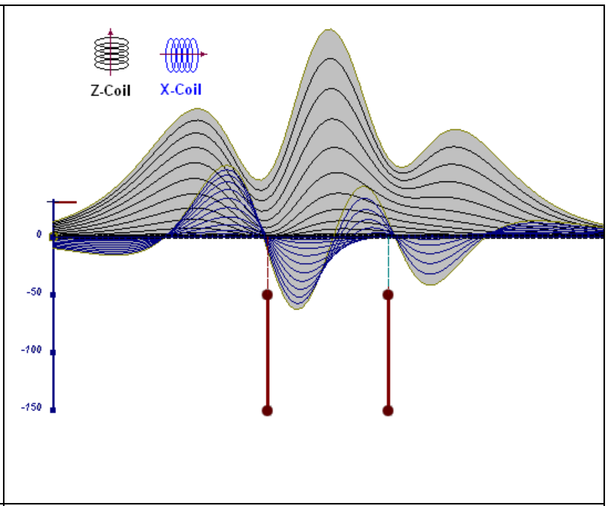


Fig A-13: Two vertical thin plates

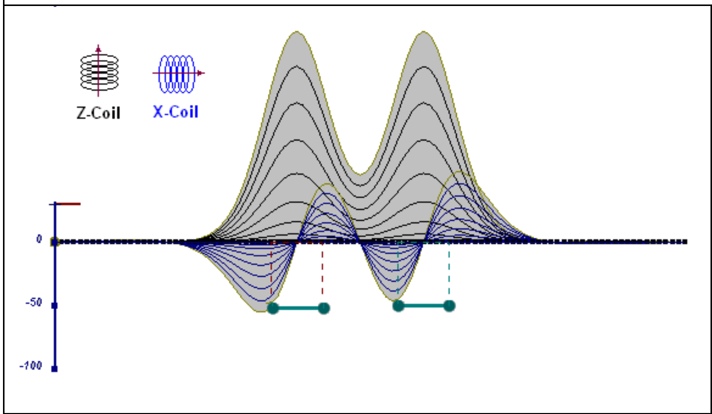


Fig A-14: Two horizontal thin plates

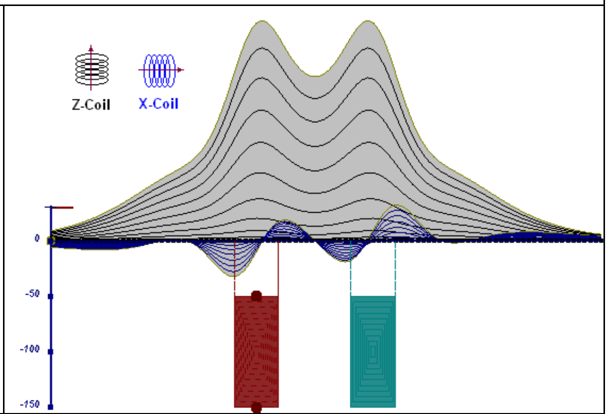


Fig A-15: Two vertical thick plates

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

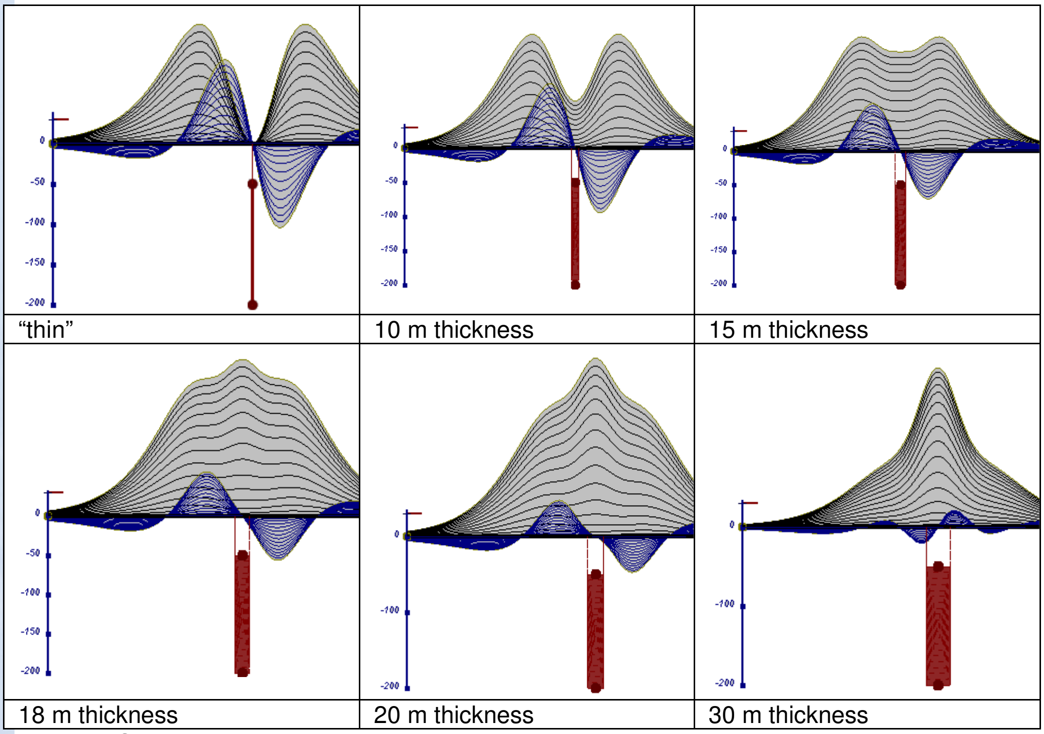


Fig A-16 Conductive vertical plate, depth 50 m, strike length 200 m, depth extend 150 m.

General Interpretation Principals

Magnetics

The total magnetic intensity responses reflect major changes in the magnetite and/or other magnetic minerals content in the underlying rocks and unconsolidated overburden. Precambrian rocks have often been subjected to intense heat and pressure during structural and metamorphic events in their history. Original signatures imprinted on these rocks at the time of formation have, it most cases, been modified, resulting in low magnetic susceptibility values.

The amplitude of magnetic anomalies, relative to the regional background, helps to assist in identifying specific magnetic and non-magnetic rock units (and conductors) related to, for example, mafic flows, mafic to ultramafic intrusives, felsic intrusives, felsic volcanics and/or sediments etc. Obviously, several geological sources can produce the same magnetic response. These ambiguities can be reduced considerably if basic geological information on the area is available to the geophysical interpreter.

In addition to simple amplitude variations, the shape of the response expressed in the wave length and the symmetry or asymmetry, is used to estimate the depth, geometric parameters and magnetization of the anomaly. For example, long narrow magnetic linears usually reflect mafic flows or intrusive dyke features. Large areas with complex magnetic patterns may be produced by intrusive bodies with significant magnetization, flat lying magnetic sills or sedimentary iron formation. Local isolated circular magnetic patterns often represent plug-like igneous intrusives such as kimberlites, pegmatites or volcanic vent areas.

Because the total magnetic intensity (TMI) responses may represent two or more closely spaced bodies within a response, the second derivative of the TMI response may be helpful for distinguishing these complexities. The second derivative is most useful in mapping near surface linears and other subtle magnetic structures that are partially masked by nearby higher amplitude magnetic features. The broad zones of higher magnetic amplitude, however, are severely attenuated in the vertical derivative results. These higher amplitude zones reflect rock units having strong magnetic susceptibility signatures. For this reason, both the TMI and the second derivative maps should be evaluated together.

Theoretically, the second derivative, zero contour or colour delineates the contacts or limits of large sources with near vertical dip and shallow depth to the top. The vertical gradient map also aids in determining contact zones between rocks with a susceptibility contrast, however, different, more complicated rules of thumb apply.

Concentric Loop EM Systems

Concentric systems with horizontal transmitter and receiver antennae produce much larger responses for flat lying conductors as contrasted with vertical plate-like conductors. The amount of current developing on the flat upper surface of targets having a substantial area in this dimension, are the direct result of the effective coupling angle, between the primary magnetic field and the flat surface area. One therefore, must not compare the amplitude/conductance of responses generated from flat lying bodies with those derived from near vertical plates; their ratios will be quite different for similar conductances.

Determining dip angle is very accurate for plates with dip angles greater than 30º. For angles less than 30º to 0º, the sensitivity is low and dips can not be distinguished accurately in the presence of normal survey noise levels.

A plate like body that has near vertical position will display a two shoulder, classic **M** shaped response with a distinctive separation distance between peaks for a given depth to top.

It is sometimes difficult to distinguish between responses associated with the edge effects of flat lying conductors and poorly conductive bedrock conductors. Poorly conductive bedrock conductors having low dip angles will also exhibit responses that may be interpreted as surfacial overburden conductors. In some situations, the conductive response has line to line continuity and some magnetic correlation providing possible evidence that the response is related to an actual bedrock source.

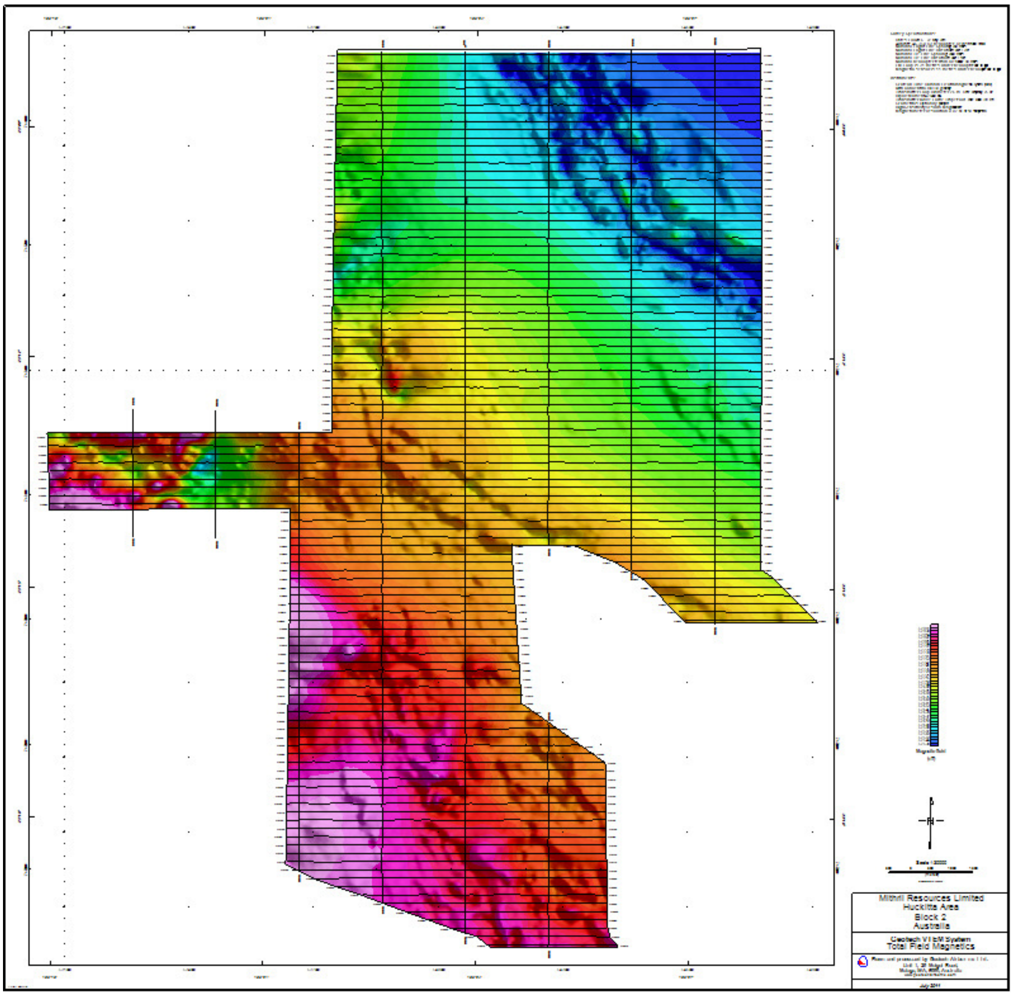
The EM interpretation process used, places considerable emphasis on determining an understanding of the general conductive patterns in the area of interest. Each area has different characteristics and these can effectively guide the detailed process used.

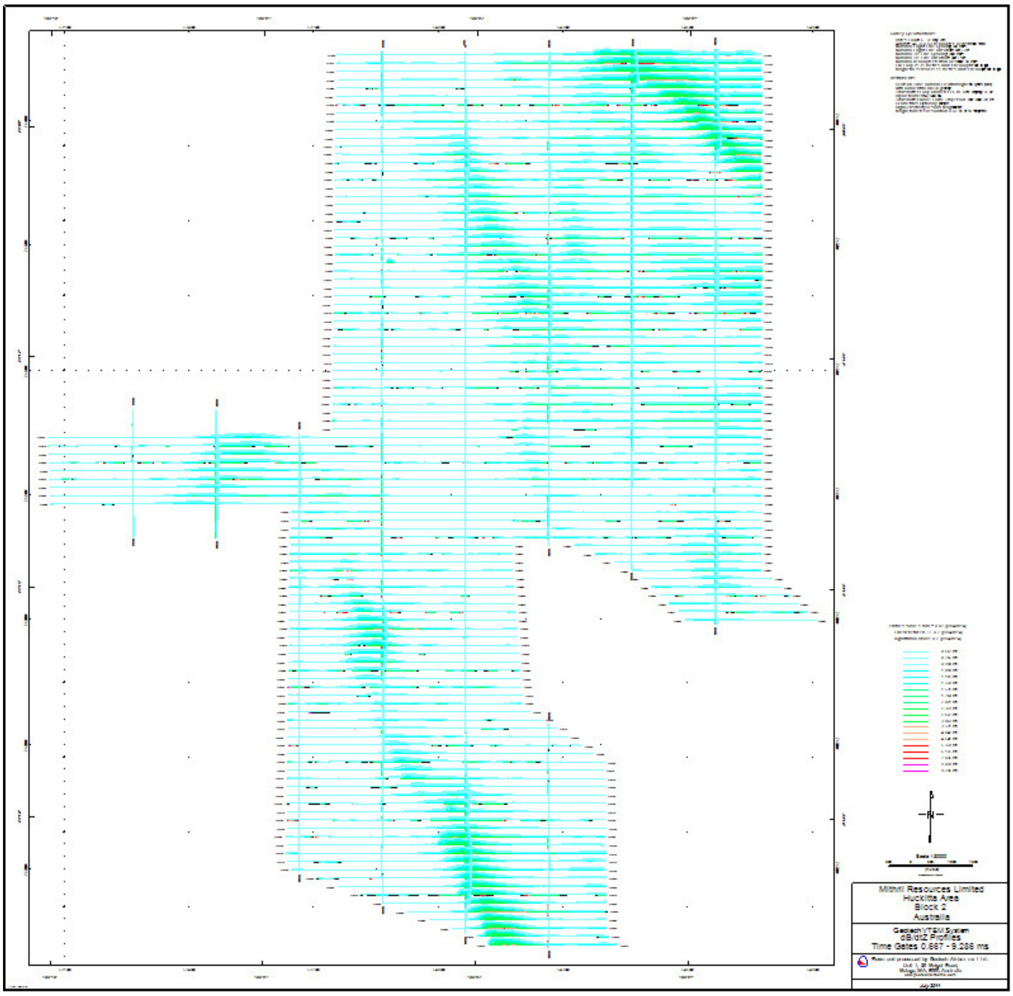
The first stage is to determine which time gates are most descriptive of the overall conductance patterns. Maps of the time gates that represent the range of responses can be very informative. Next, stacking the relevant channels as profiles on the flight path together with the second vertical derivative of the TMI is very helpful in revealing correlations between the EM and Magnetics. Key lines can be profiled as single lines to emphasize specific characteristics of a conductor or the relationship of one conductor to another on the same line.

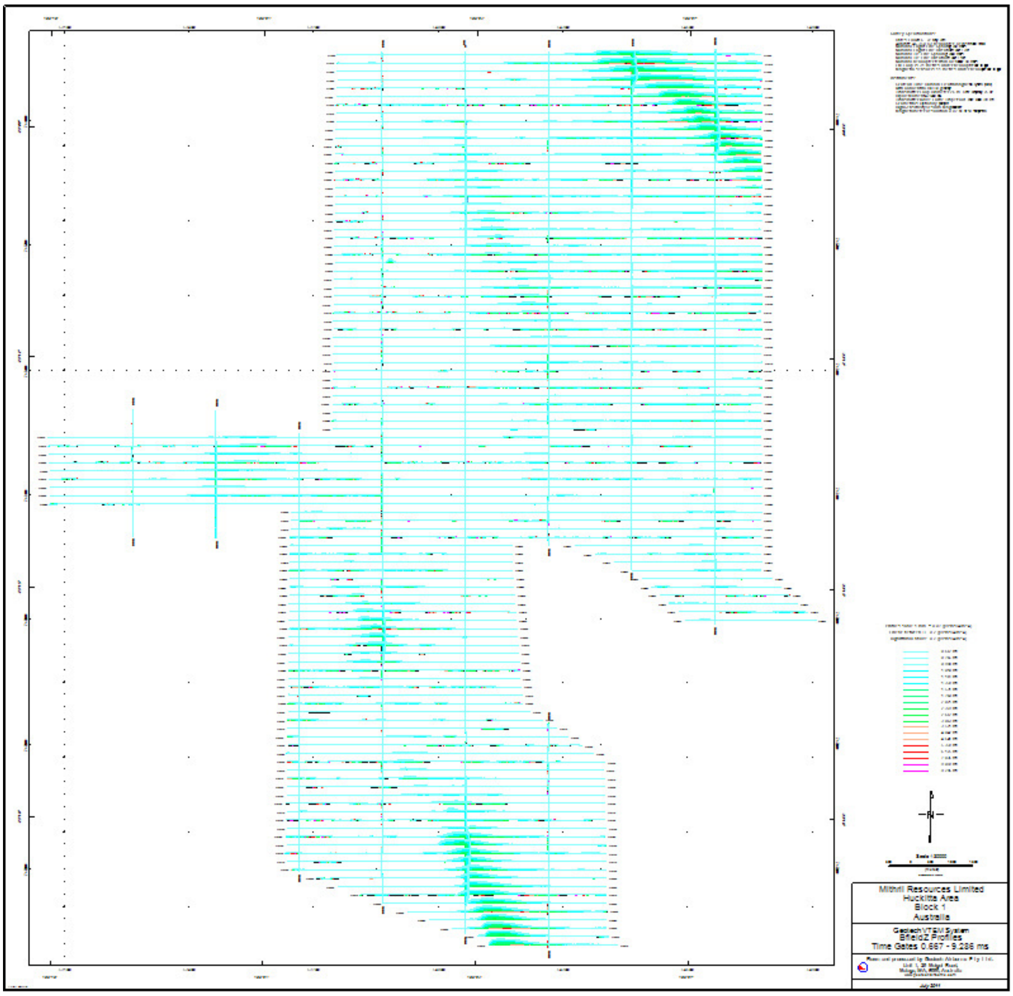
Resistivity Depth sections can be constructed to show the relationship of conductive overburden or conductive bedrock with the conductive anomaly.

APPENDIX B

GEOPHYSICAL MAP IMAGES
(not to scale)


Mithril Resources Limited
Huckitta Area
Block 2
Australia
Geotech VTEM System
Total Field Magnetics


N
Mithril Resources Limited
Hucklitta Area
Block 2
Australia
Geotech VTEM System
dB/dtZ Profiles
Time Gates 0.667 - 9.286 ms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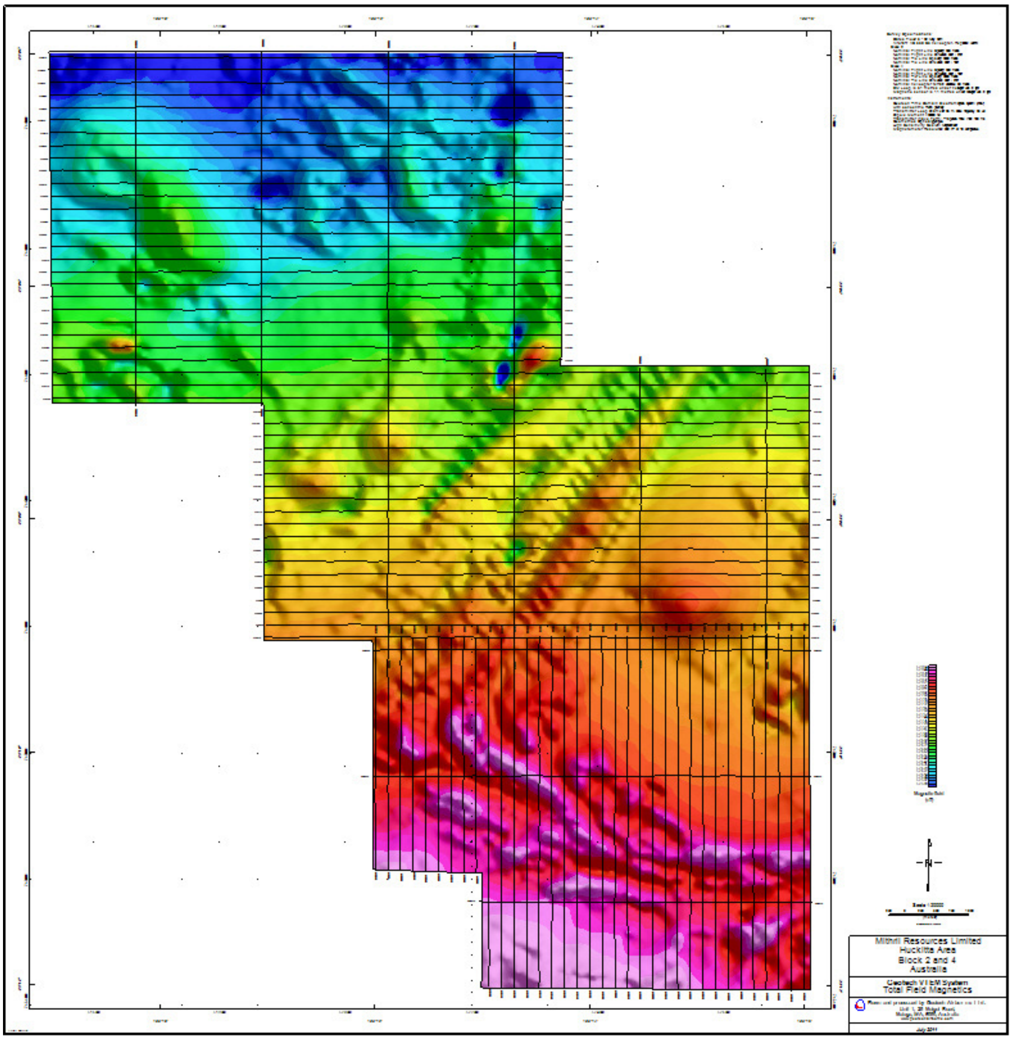
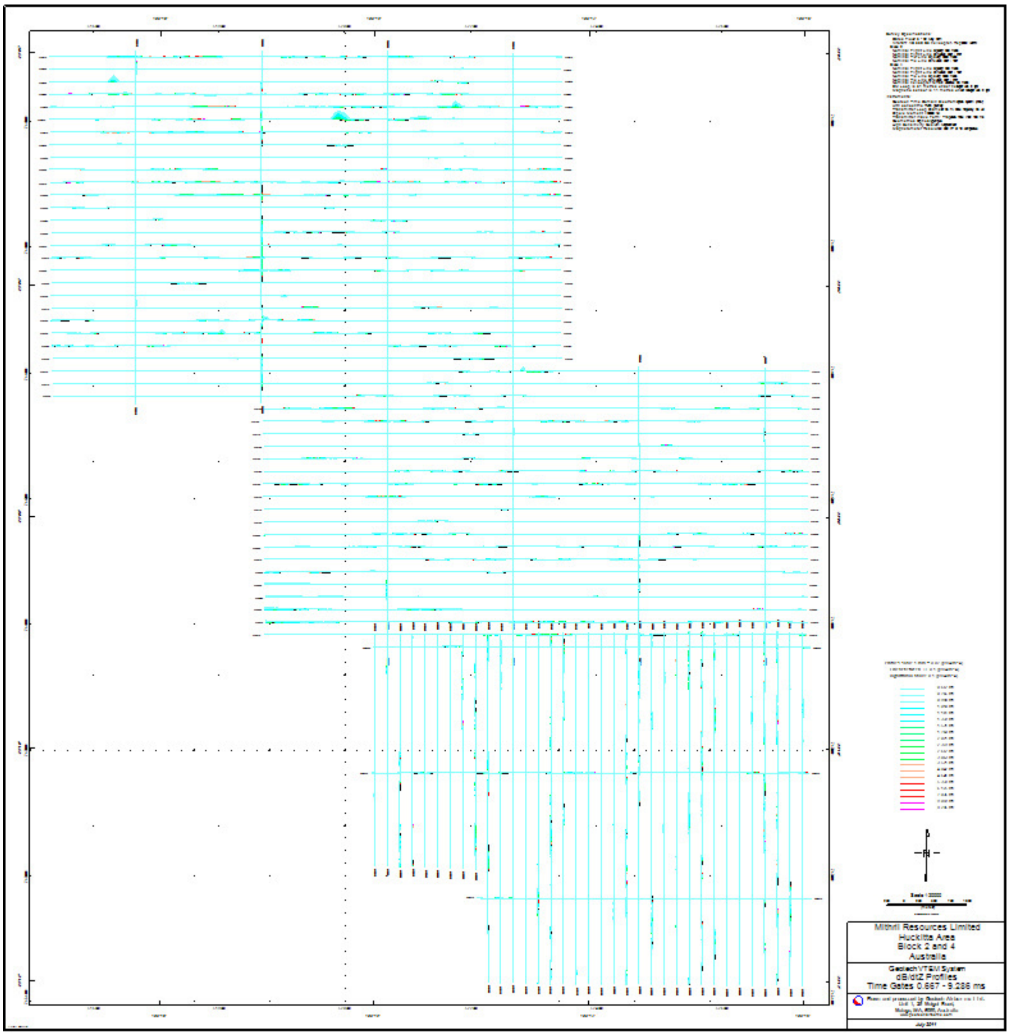
Hucklitta Area
Block 1
Australia
Geotech VTEM System
BfieldZ Profiles
Time Gates 0.667 - 9.286 ms
July 2011



Mithril Resources Limited
Huckitta Area
Block 2 and 4
Australia
Total Field Magnetics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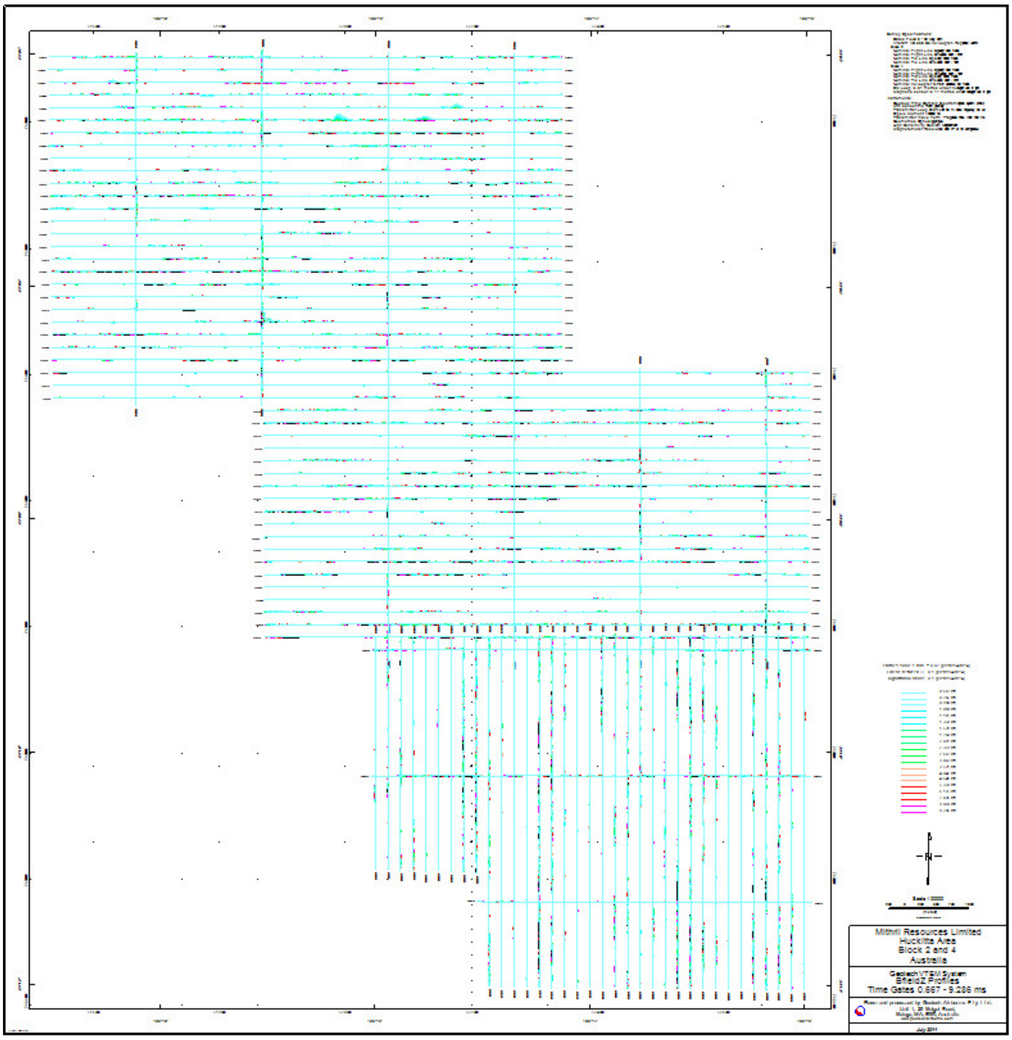
Huckitta Area
Block 2 and 4
Australia
Geotech VTEM System
dB/dtZ Profiles
Time Gates 0.667 - 9.286 ms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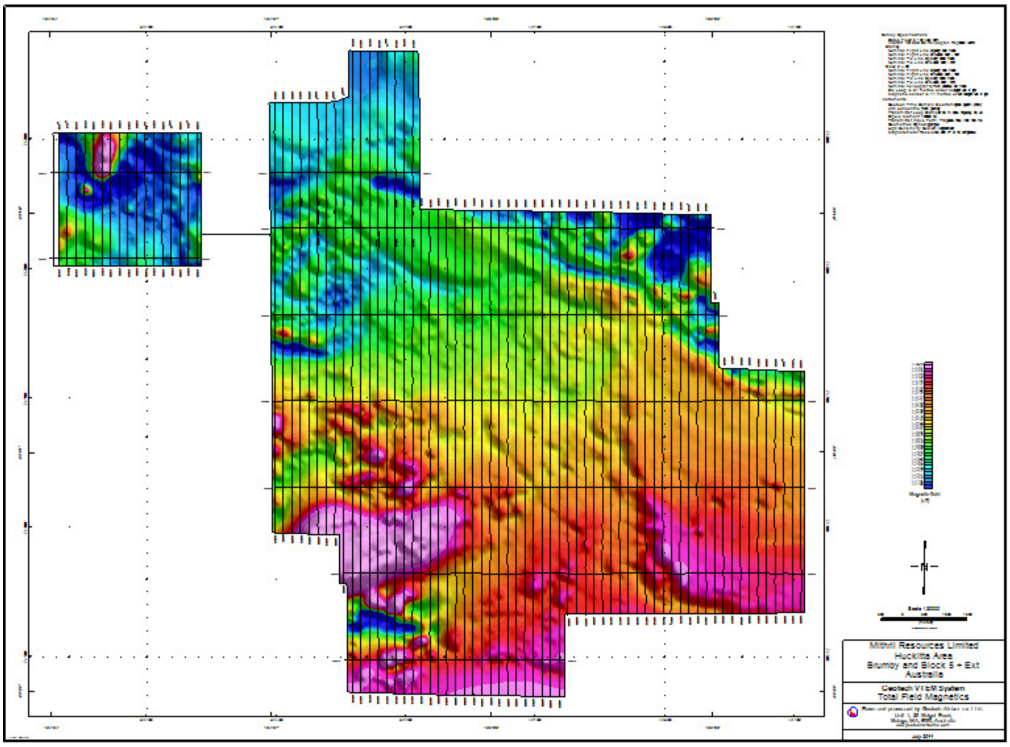
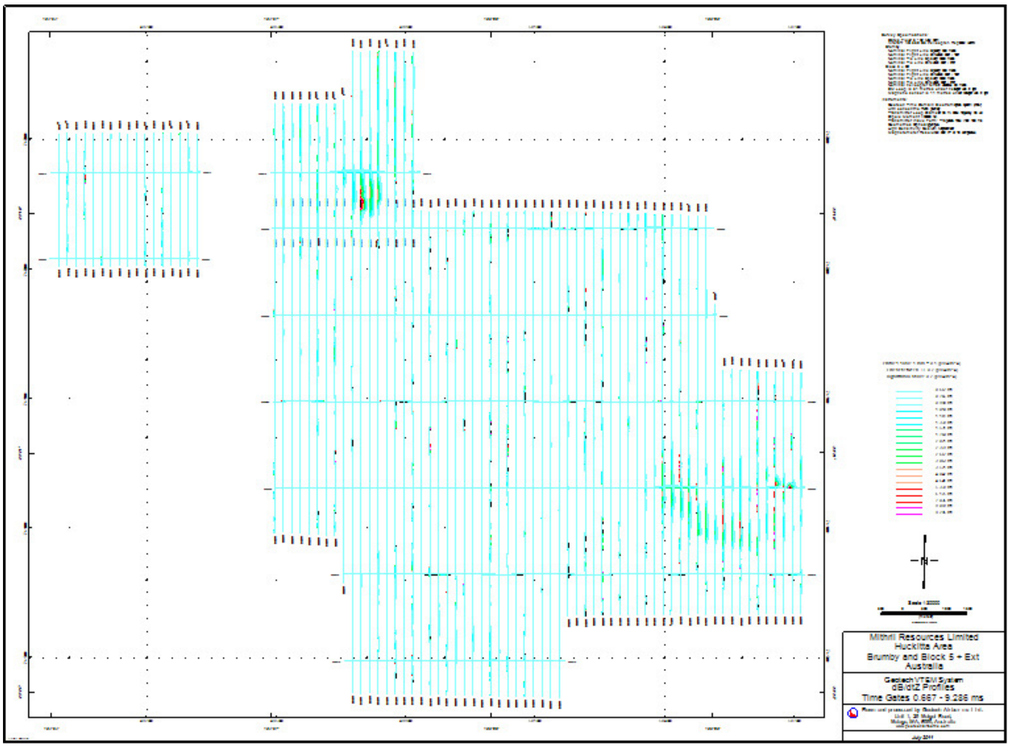
Huckitta Area
Block 2 and 4
Australia
Geotech VTEM System
BfieldZ Profiles
Time Gates 0.667 - 9.286 ms


Mithril Resources Limited
Huckitta Area
Brumby and Block 5 + Ext
Australia
Geotech VTEM System
Total Field Magnetics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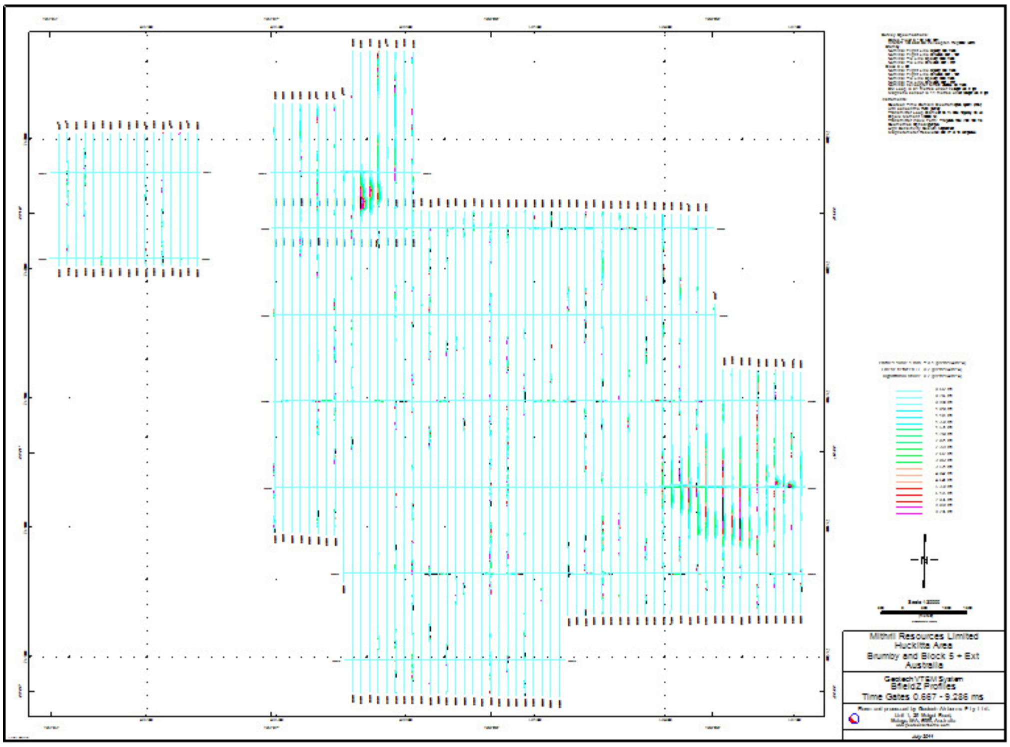
Huckitta Area
Brumby and Block 5 + Ext
Australia
Geotech VTEM System
dB/dtZ Profiles
Time Gates 0.667 - 9.286 ms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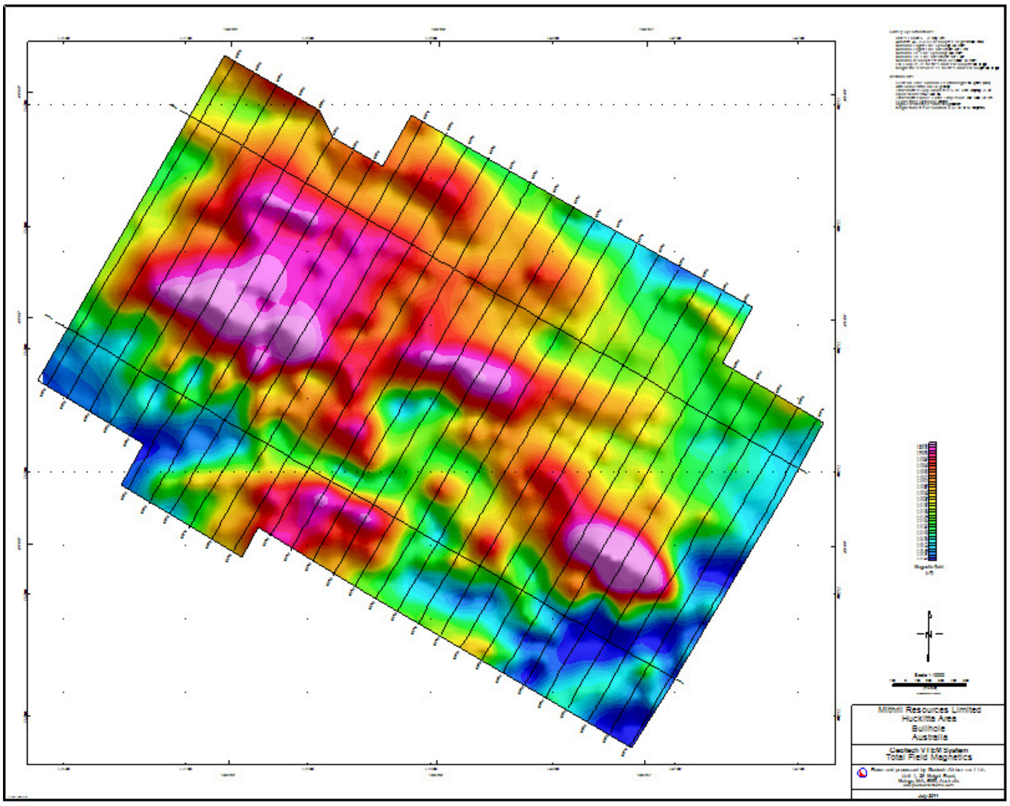
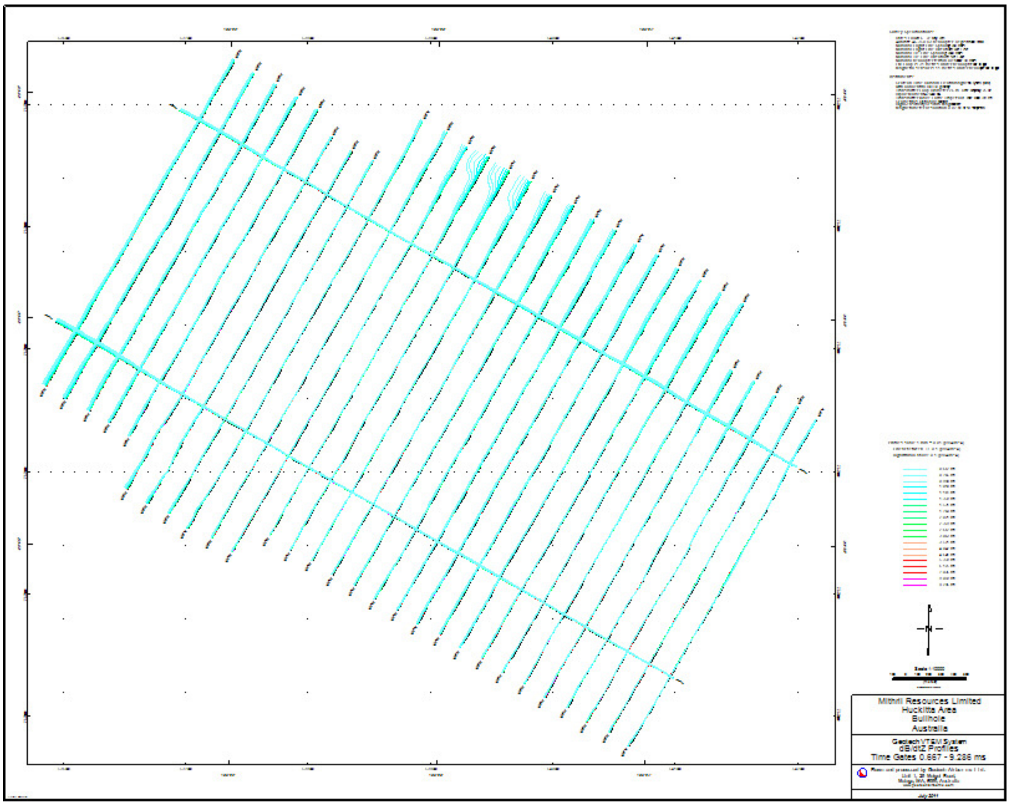
Huckitta Area
Brumby and Block 5 + Ext
Australia
Geotech VTEM System
BfieldZ Profiles
Time Gates 0.667 - 9.286 ms


Mithril Resources Limited
Huckitta Area
Bullhole
Australia
Total Field Magnetics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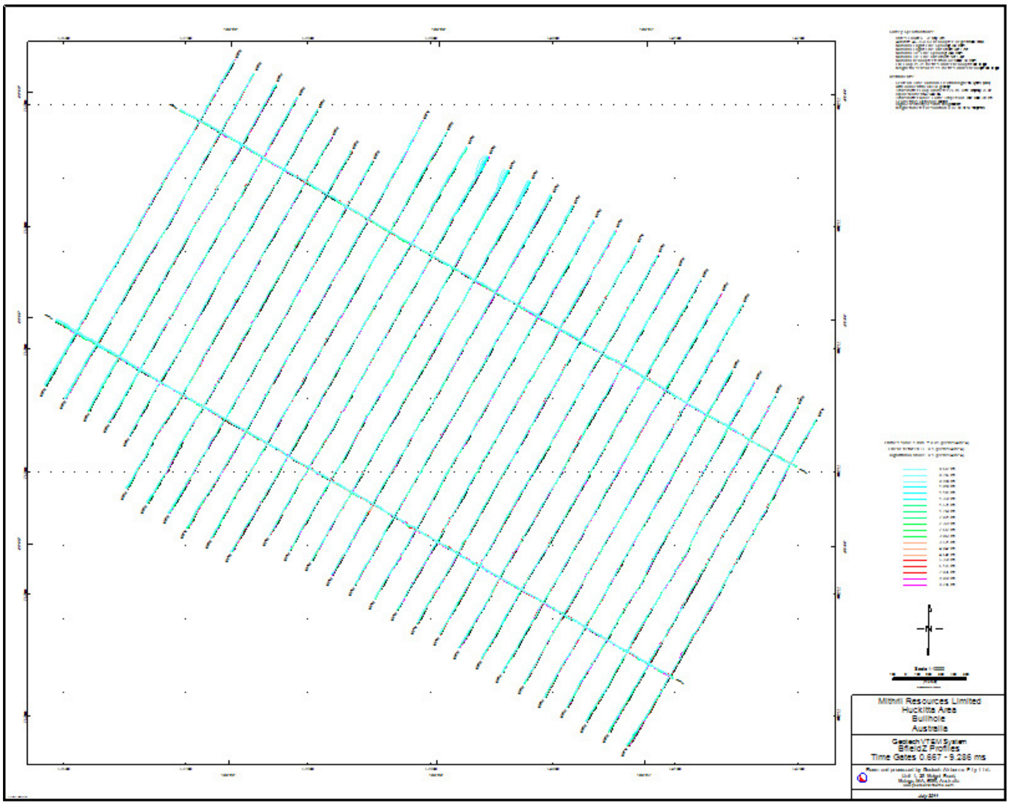
Huckitta Area
Bullhole
Australia
Geotech VTEM System
dB/dZ Profiles
Time Gates 0.667 - 9.286 ms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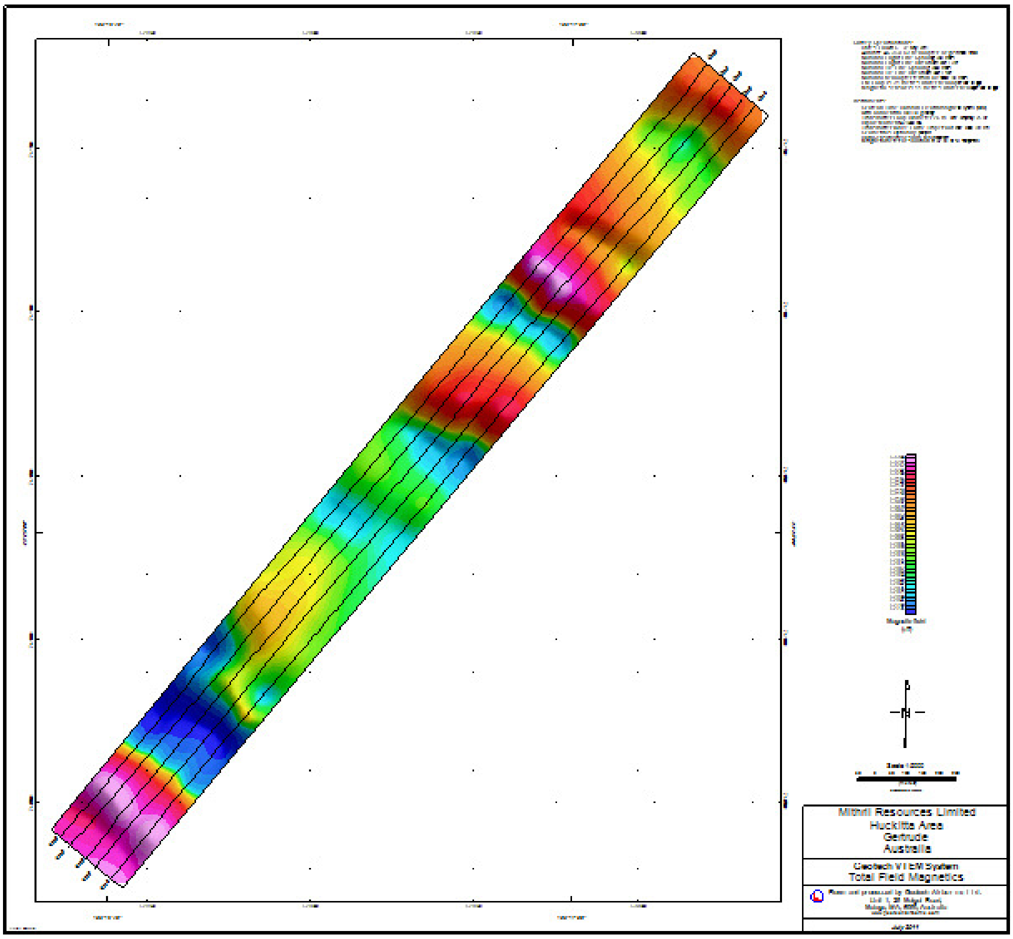
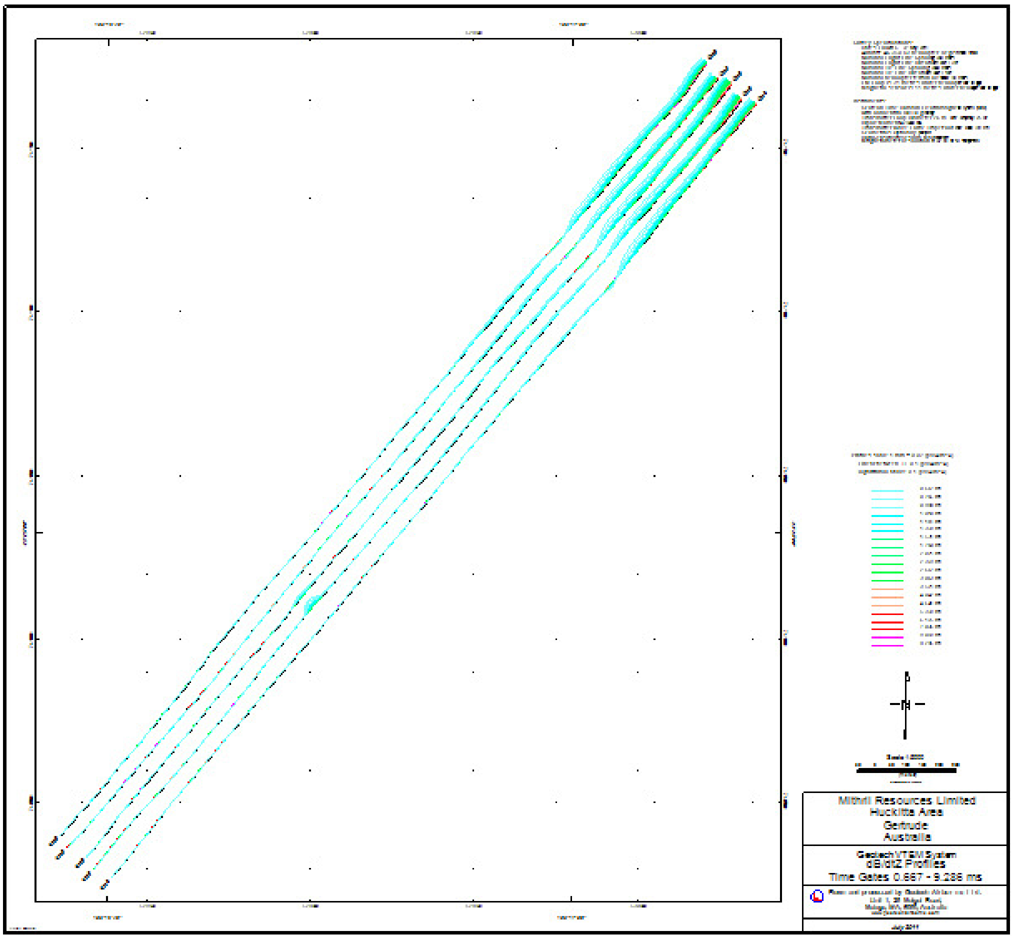
Huckitta Area
Bullhole
Australia
Geotech VTEM System
Bfield/dZ Profiles
Time Gates 0.667 - 9.286 ms



Mithril Resources Limited
Huckitta Area
Gertrude
Australia
Geotech VTEM System
Total Field Magnetics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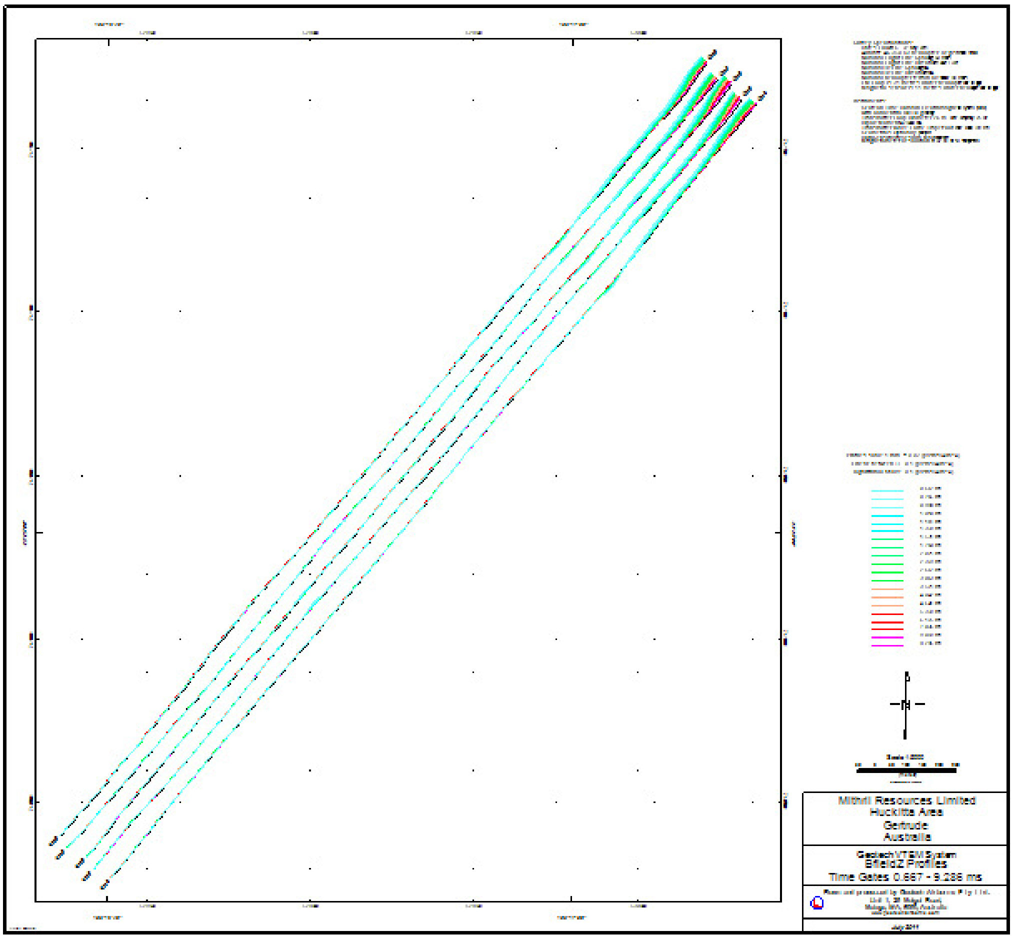
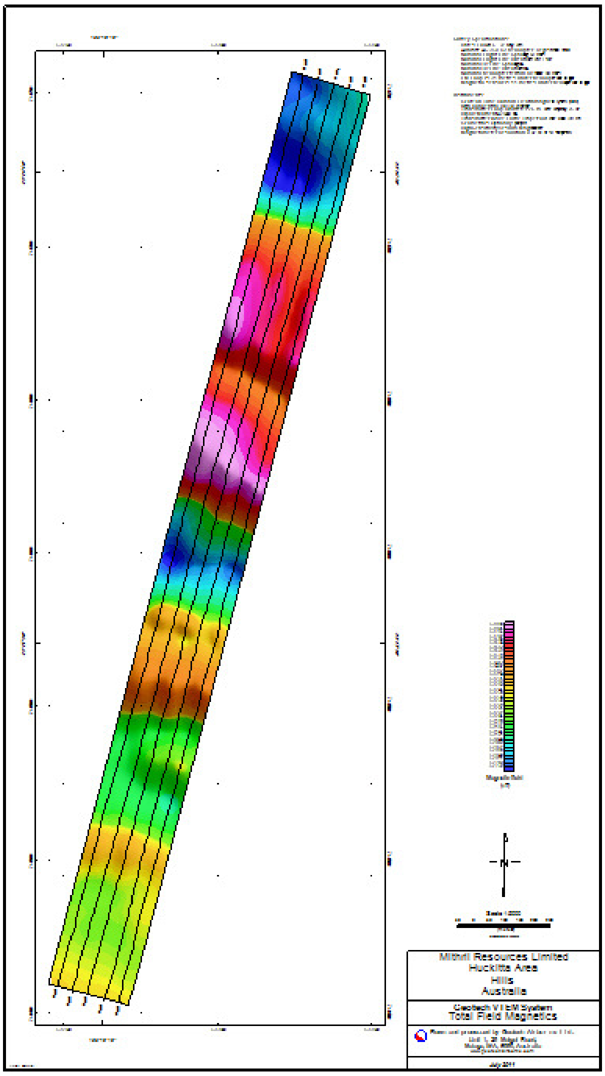
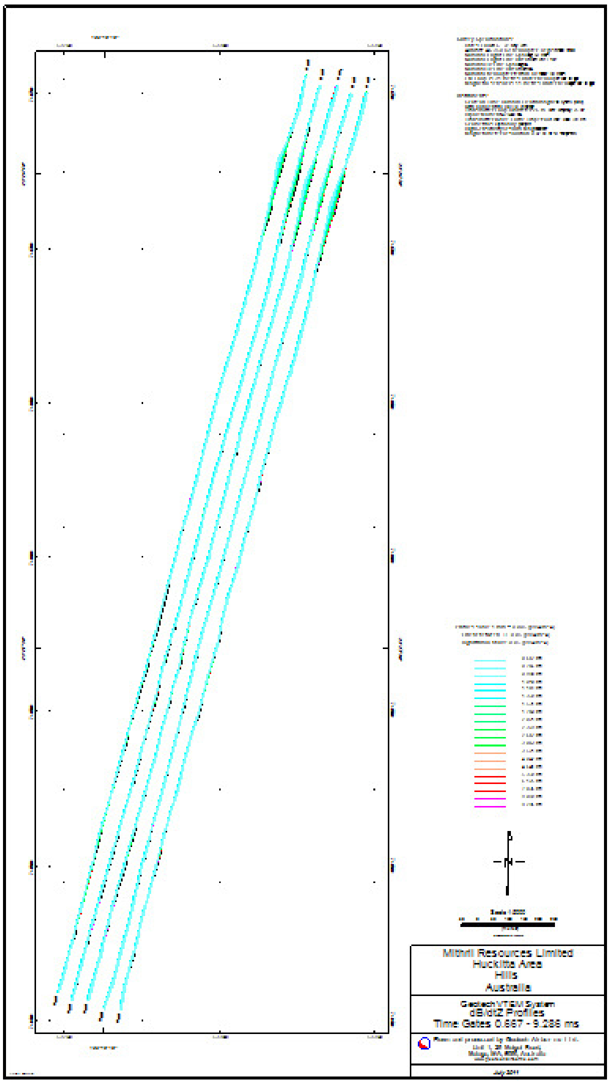
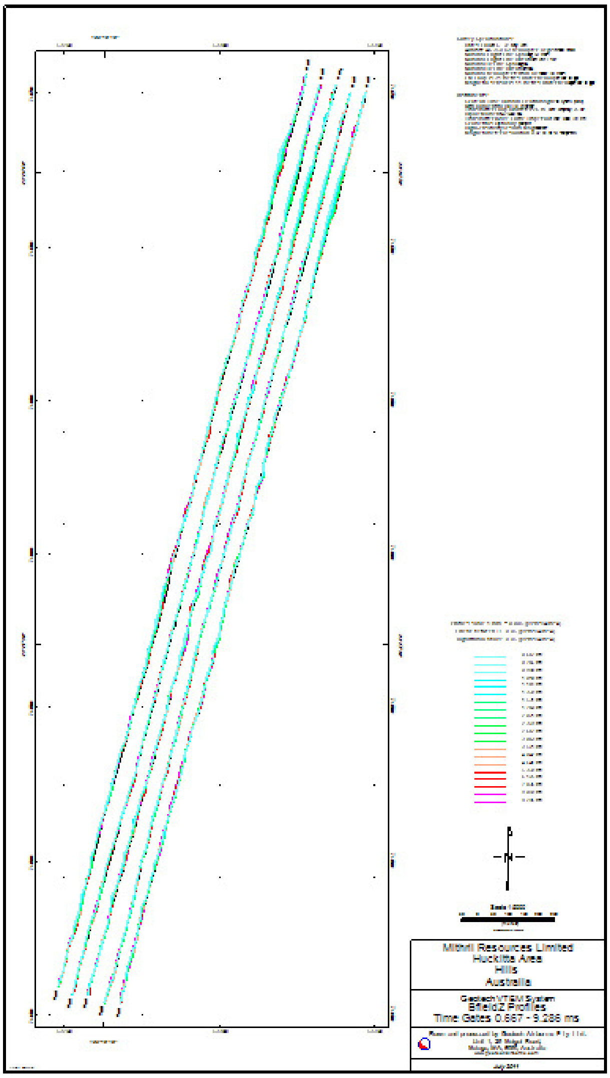
Huckitta Area
Gertrude
Australia
Geotech VTEM System
dB/dZ Profiles
Time Gates 0.667 - 9.286 ms


Mithril Resources Limited
Huckitta Area
Gertrude
Australia
Geotech VTEM System
BfieldZ Profiles
Time Gates 0.667 - 9.286 ms


Mithril Resources Limited
Huckitta Area
Hills
Australia
Geotech VTEM System
Total Field Magnetics


Mithril Resources Limited
Huckitta Area
Hills
Australia
Geotech VTEM System
dB/dtZ Profiles
Time Gates 0.667 - 9.286 ms


Mithril Resources Limited
Huckitta Area
Hills
Australia
Geotech VTEM System
BfieldZ Profiles
Time Gates 0.667 - 9.286 ms