SPECTREM AIR LIMITED

ANGLO AMERICAN EXPLORATION (AUSTRALIA) PTY LTD

SPECTREM SURVEY
OF THE LYND - BLOCK 1 AREA
(AUSTRALIA)

December 2009

AMENDED FOR EPM15915

KEYWORDS

Lynd - Block 1, Australia, Anglo American Exploration (Australia) Pty Ltd, SPECTREM, Airborne, Electromagnetic, Magnetic, Radiometric

SUMMARY

In November 2009, Spectrem Air Limited conducted an airborne electromagnetic survey over the Lynd - Block 1 area.

Good data quality was achieved for this 25 Hz Lynd 1 survey with X9 and Z9 noise levels were fairly low at around 200 PPM.

Unfortunately despite a very careful examination of the Spectrem AEM data no good sulphide conductors were detected in the Lynd 1 area.

However a few poor conductors were detected. These AEM anomalies, which have been given a D or lower grade rating, should be integrated with the available geological / GIS information and reviewed with the Spectrem team if necessary.

CONTRIBUTORS

Phil Klinkert

Shawn Letts

Jaco Smit

Louis Polomé

CIRCULATION LIST

Copies of this report have been sent to:

- M Webb – Chief Geophysicists – AAEA (Perth)
- A Kneeshaw – Exploration Manager – AAEA (Perth)
- SPECTREM's Archive

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1 INTRODUCTION

Between 10 to 21 November 2009, Spectrem Air Limited conducted an airborne electromagnetic, magnetic and radiometric survey over the Lynd Block 1 project in Australia. A total of 5 070 line kilometres were surveyed and ~1229 Line kilometres within EPM15915. The general location of the survey is shown in Figure 1.

Details of the survey can be found in Appendix 1. The system specifications are presented in Appendix 2 and the standard Spectrem Air data processing stream is described in Appendix 3.

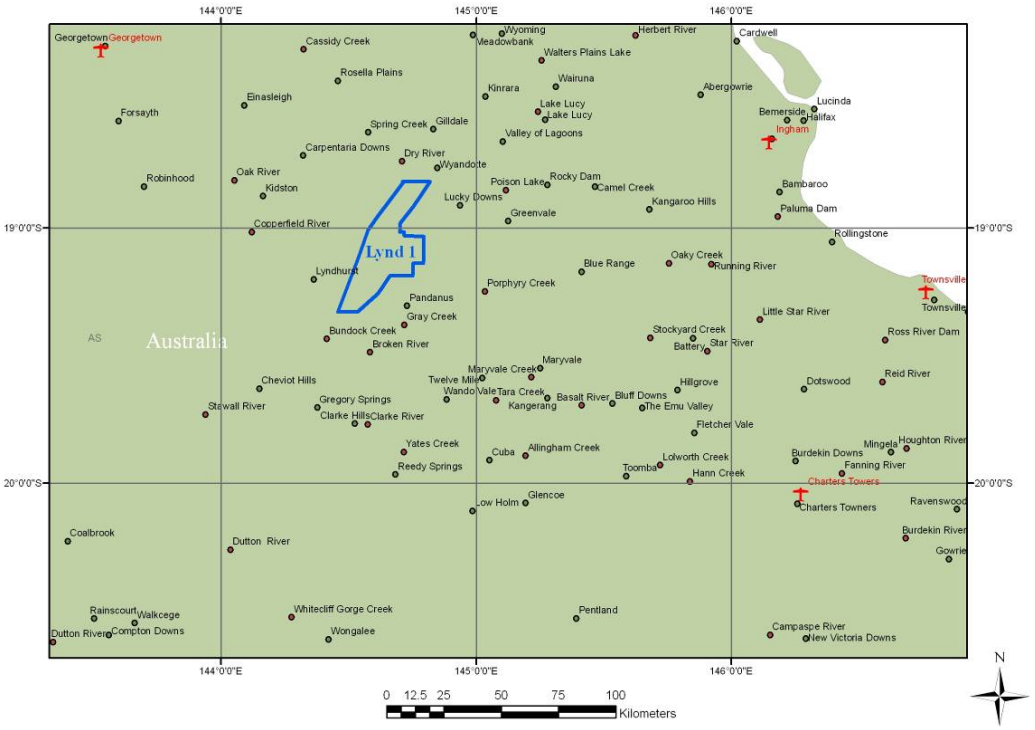

Figure 1 - Survey Location

A map of the total magnetic field (Figure 2) and of the conductivity Tau Z (Figure 3) of the Lynd Block 1 project within EMP15915 are shown below:

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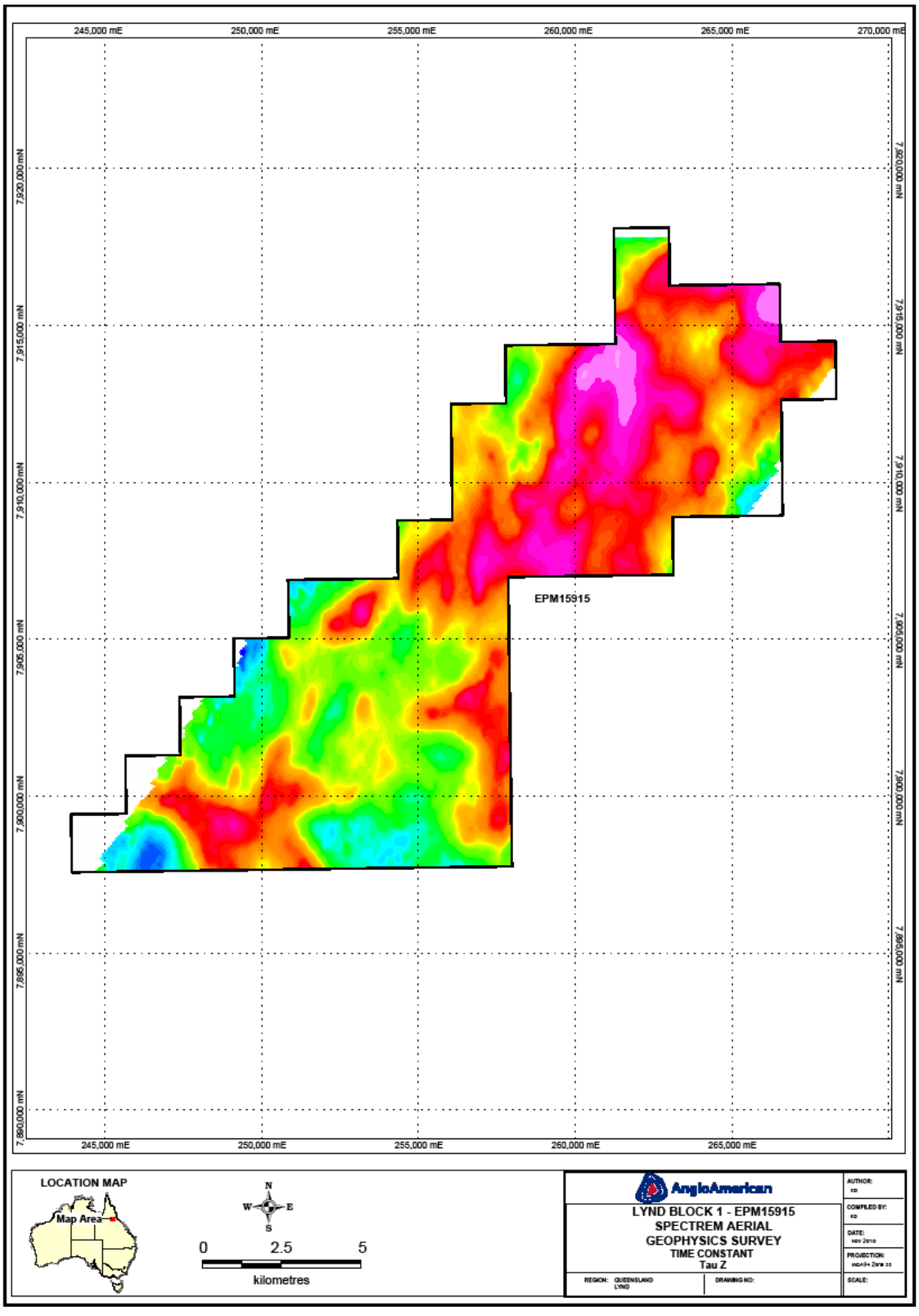

Figure 2 (amended) - An image of the EM Tau Z (LYND - Block 1 within EPM15915)

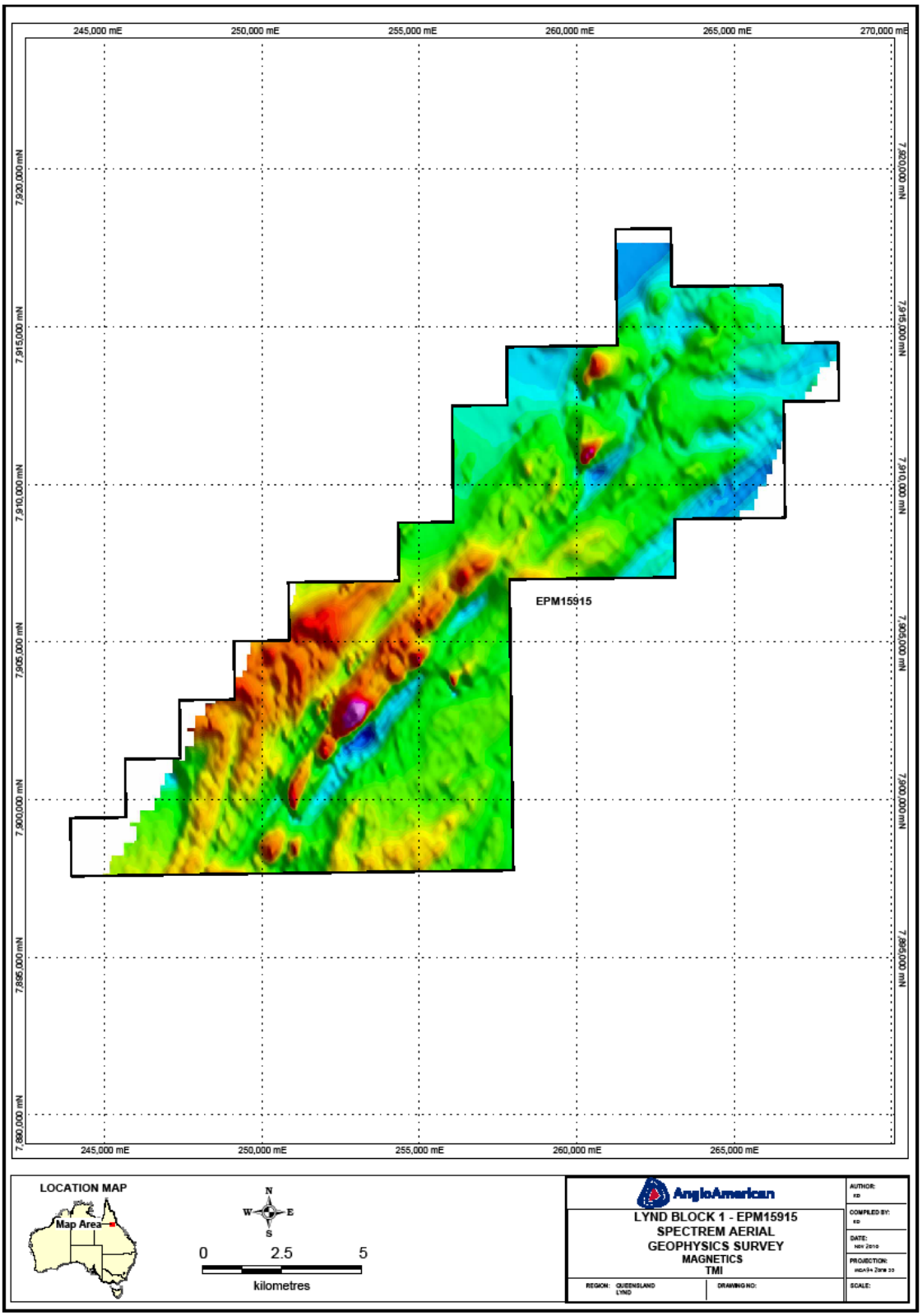

Figure 3 (amended) - An image of the Total Field Magnetic Intensity (LYND - Block 1 within EPM15915)

2 APPENDIX 1: SURVEY DETAILS WITHIN EPM15646

2.1.1 Logistics

The specific details of the survey were as follows:

Base of operations	Ingam - Australia
Flying Dates	25 September to 06 November 2009
Survey type	Electromagnetic, magnetic, radiometric, terrain
Aircraft type	DC3 – TP67
EM Base Frequency	25 Hz
Nominal aircraft altitude	90 m
Nominal aircraft speed	60 m/s
Acceptable Kilometres flown: LYND - Block 1	5 070 line kilometres
Kilometres flown within EPM15915	**1229 Line kilometres**
Nominal flight-line spacing LYND - Block 1	200 m
Nominal flight-line direction: LYND - Block 1	90 degrees
Nominal tie-line spacing: LYND - Block 1	2 000 m
Nominal tie-line direction: LYND - Block 1	00 degrees

2.1.2 Datum

All coordinates provided in this report, in maps and in processed digital data-sets have the following datum parameters.

Datum	WGS84
Projection	UTM 55 S
Type	Transverse Mercator

3 APPENDIX 2: SYSTEM SPECIFICATIONS

SPECTREM simultaneously takes electromagnetic, total field magnetic and radiometric measurements. Both the electromagnetic and magnetic sensors are towed behind the aircraft in "birds" while the radiometric crystals are installed inside the cabin. The geometry of the system is shown below in Figure 2. Other system specifications are listed below.

3.1.1 EM system

Transmitter height above ground	107 m
Tx – Rx vertical separation	37.1 m
Tx – Rx horizontal separation	122.9 m
Transmitter coil axis	Vertical
Receiver coil axes	X : horizontal, parallel to flight direction Y : horizontal, perpendicular to flight Z : vertical, perpendicular to flight direction
Current waveform	Square wave
Base frequencies for this survey	25 Hz
Transmitter loop area	420 m^2
RMS current	920 to 960 amperes
RMS dipole moment	386 400 to 403 200 $A.m^2$
Recording Rate	5 Hz
Window distribution	Pseudo-binary
Digitising rate	38 400 Hz /component

Window Times for 25 Hz

Frequency	Window	Window Center	Window Width (µs)
25	1	26.0	26.0
25	2	65.1	52.1
25	3	143.2	104.2
25	4	299.5	208.3
25	5	612.0	416.7
25	6	1237.0	833.3
25	7	2487.0	1666.7
25	8	4987.0	3333.3
25	9	9987.0	6666.7
25	10	16653.6	6666.7

3.1.2 Magnetic system

Bird height above ground	71 m
Bird location	19 m below and 41 m behind centre of
Sensor	Scintrex CS-2 Sensor with SPECTREM Counter/Sync System
Recording Rate	5 Hz
Sensitivity	0.01 nT

Resolution	0.1 nT

3.1.3 Positioning system

Sensor	Novatel OEMV-3 GPS receiver with Fugro Omnistar differential corrections
Recording Rate	5 Hz

3.1.4 Other sensors

Radar Altitude	Collins with 5 Hz sampling with 0.3 m
Laser Altitude	Riegl with 5 Hz sampling with 0.03 m
Barometric Pressure	Rose Mount with 1 Hz sampling
Temperature (OAT)	PT-100 RTD with 1 Hz sampling
Analogue Chart Recorder	RMS GR-33

4 APPENDIX 3: DATA PROCESSING

The EM data were processed in Johannesburg using Oasis Montaj and proprietary software.

4.1 Electromagnetic Processing

4.1.1 Aircraft Processing

Some of the most important EM data processing was carried out on the aircraft as it acquired the data. The first processing stage was stacking the data to 512 samples. The data was then deconvolved to remove system response and transformed to a square wave. A square transmitter waveform was chosen as a periodic approximation of the step response.

In the next stage of processing the data was binned into 8 channels or windows. As the SPECTREM system makes its measurement while the transmitter is switched on, it is necessary to separate the primary (transmitted) field from the (induced) secondary field. The assumption is made that the induced field will have decayed to a minimal amount at the time the last channel is sampled. As the last channel only measured the primary field, it can be subtracted from the other channels to separate the secondary field. Hence there are actually 8 channels with geological information in the final data.

4.1.2 Profile data

The spikes in the line data have been removed using a 3 point Naudy filter. The line data have also been drift corrected and micro-levelled. The drift is particularly noticeable on the later time channels and has been applied to channels 4 to 8. This is an iterative process, with the assumption that there is a constant drift on a single line. This is reasonable if the lines are short. The processing steps are:

- The channel data are clipped retaining the data in the resistive areas where the response should be close to zero.
- The average of the clipped data is then calculated and subtracted from the channel data.

The steps are then repeated, refining the correction.

Decorrugation and micro-levelling has been applied to all the channels to reduce small residual errors that have not been corrected through the drift correction method.

4.1.3 Apparent Conductivity

The apparent conductivity was calculated from its channel amplitudes and the aircraft height. An apparent conductivity is the conductivity of a half space that would produce an amplitude equivalent to the measured response. It is useful in providing a physically sensible unit and partially compensates for aircraft ground clearance variations. The unit for apparent conductivity is milliSiemens/meter.

4.1.4 Grids

The data were gridded using an Akima spline. System lag was corrected before gridding.

A decorrugation filter was applied to reduce the herringbone effects created by geometrical asymmetry inherent in AEM systems

4.2 Magnetic Processing

The leveling processing included:

- Tie-line levelling
- Decorrugation
- Micro-levelling

4.2.1 Tie-line Levelling

Tie line levelling is used to remove the diurnal variation and errors due to instrument drift, both are assumed to vary slowly over time.

Tie-line levelling is an iterative process:

- Calculate the mis-closures at the crossover points of the tie and traverse lines. The mis-closure is the difference between the magnetic value on the tie line and the traverse line. The mis-closures are weighted by the gradient of the total field at the crossover point.

$$Weight = 1 / e^{(0.1 \times gradient)}$$

- The error is approximated by a piecewise polynomial as a function of time along a flight and then along a tie line.

These steps are repeated until a good fit has been obtained.

4.2.2 Decorrugation

This is a grid based operation designed to reduce the residual errors that the tie-line leveling does not remove. These are due to inaccuracies in the crossovers, localised diurnal activity, and local altitude variations.

Elongated anomalies with the following characteristics are removed:

- 2 times the line spacing perpendicular to the line direction
- 2 times the tie line spacing parallel to the line direction
- small dynamic range

4.2.3 Micro-levelling

Applies the corrections made to the grid to the profile data and thereby enhances the line data by removing the final residual errors. The micro-levelled data are then gridded. The lag correction is 40m.

4.3 DEM processing

Initially, the GPS height and the radar altimeter channels are visually inspected and any spikes or discontinuities are removed. A Low Pass or Naudy Filter is then applied to both channels. The GPS height channel is then gridded and the resultant grid is checked. Due to the nature of the GPS data, it is normally necessary at this stage to perform some degree of decorrugation on the grid with the corrections then written back to the database.

The radar altimeter channel is then subtracted from the corrected GPS height channel in the database and the resultant channel is gridded and verified.

4.4 Radiometric Processing

The processing of the radiometric data uses the full 256 channel spectra for most of the corrections. This processing allows us to use the information from the full spectrum to enhance the regions of interest in the spectrum, namely, potassium, uranium and thorium.

5 APPENDIX 4: DELIVERABLES

5.1 Digital Products

5.1.1 Grids / Profile / Map Data

(Grids supplied in Geosoft format)

	Grids	Line Data	Maps
EM Data			
EMX1 to EMX8 / EMZ1 to EMZ8	Y	Y	-
Tau X or Tau Z	Y	-	Y
Anomaly Map	N/A	N/A	N/A
Conductivity Grids at Various Depths	-	-	-
TF Magnetic Data			
TFMI	Y	Y	Y
Terrain			
DEM	Y	Y	-
Radiometric Data			
TC, K, U, Th	Y	Y	-
CDI Data			
CDI Data - Individual Lines (All lines & Tie Lines)	-	Y	-
Conductivity 3D Voxel Model	-	-	-
Interpretation			
Preliminary Geological Interpretation	-	-	-

5.1.2 Report

- Logistics report.

6 APPENDIX 5: SOFTWARE VERSIONS

SpecDAS acquisition	1.16
Spectrem processing - SDALOG	1.06
Spectrem processing - SDASPEC	4.01
Spectrem processing - LEVEL	1.03
Autopick	EMPICK 1.03
Geosoft	6.3 (30) HF2
CDI	1.00