Booroloola and Yiyintyi, Northern Territory Airborne Magnetic and Radiometric Geophysical Survey

Acquisition and Processing Report

for

Sandfire Resources NL

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Authorised for release by : ……..

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Survey flown: September - October 2011

by

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FAS JOB # 2251

CONTENTS

LIST OF TABLES

1. SURVEY OPERATIONS AND LOGISTICS

1.1 Introduction

Between the 23rd of September and the 4th October 2011, Fugro Airborne Surveys Pty. Ltd. (FAS) undertook an airborne magnetic and radiometric survey for Sandfire Resources N.L., over the Booroloola and Yiyintyi Project areas in the Northern Territory. The survey consisted of 3 areas flown in 13 flights. Total coverage of the survey area amounted to 3966.3 line kilometres. The survey was flown using an Aerocommander Shrike 500-S aircraft, registration VH-FGZ owned and operated by FAS. This report summarises the procedures and equipment used by FAS in the acquisition, verification and processing of the airborne geophysical data.

1.2 Survey Base

The survey was based out of Booroloola, Northern Territory. The survey aircraft was operated from Booroloola Airstrip with the aircraft fuel available on site. A temporary office was set up at the Booroloola Hotel/Motel, where all survey operations were run and the post-flight data verification was performed.

1.3 Survey Personnel

The following personnel were involved in this project:

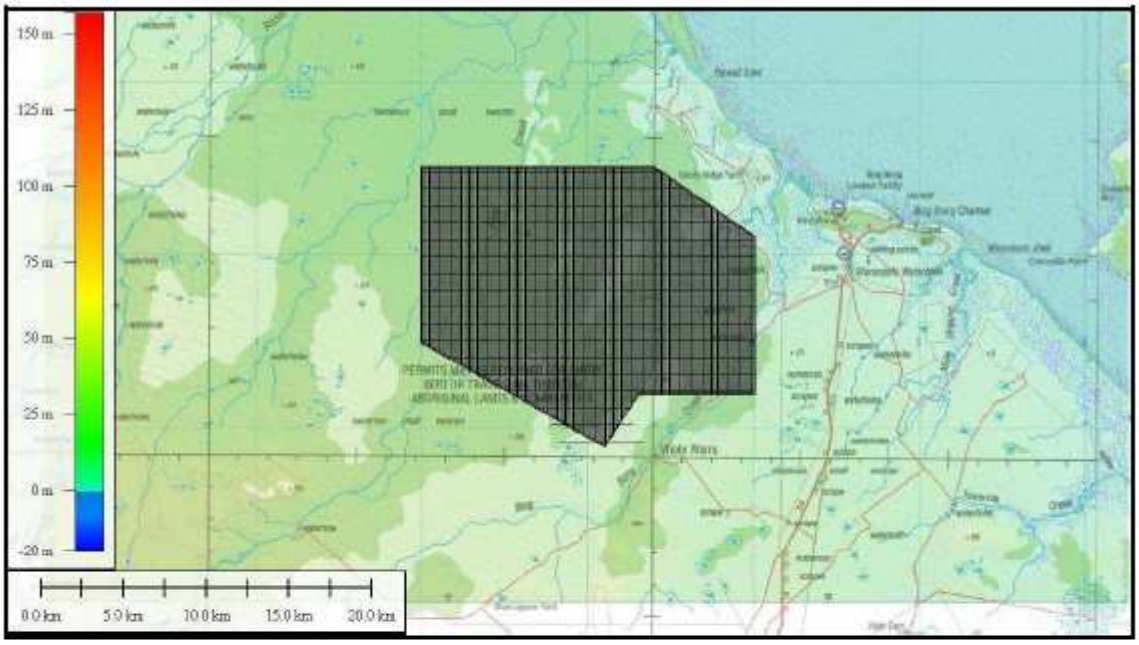
Project Supervision - Acquisition	Peter Johnson
- Processing	Denis Cowey
On-site Crew Leader	Dave Little
Pilot/s	Wayne Saunders
System Operator/s	Dave Little
Data Processing	Doug Gay

1.4 Survey Equipment

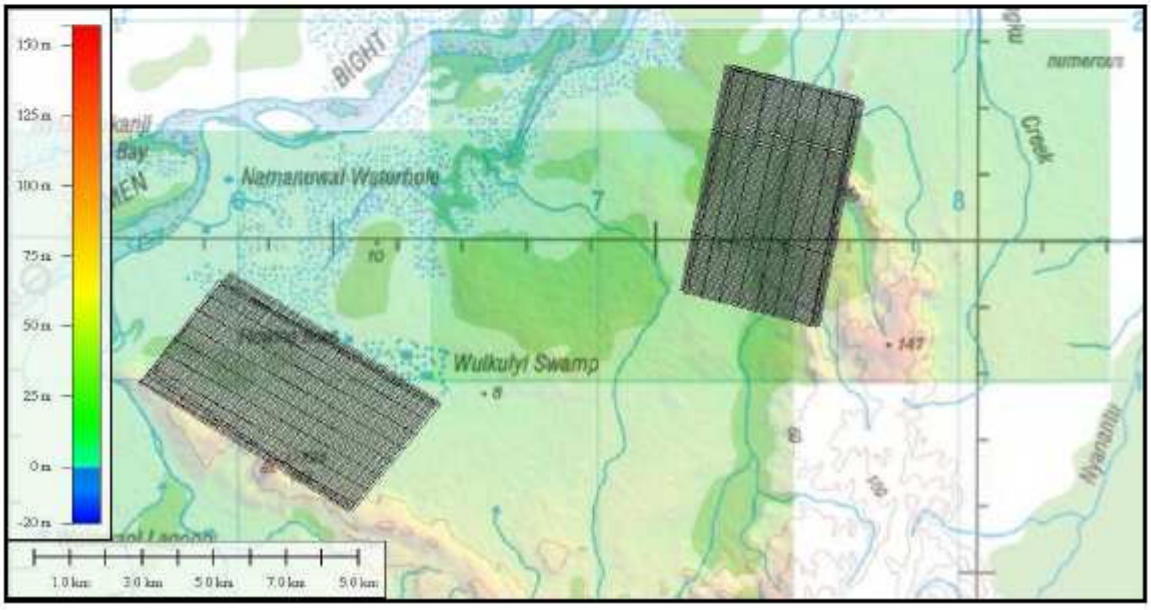
Survey Platform	-	Aerocommander Shrike 500-S VH-FGZ
Data Acquisition System	-	FAS digital acquisition system
Total Field Magnetometer	-	Scintrex CS-2 Caesium vapour
Vector Magnetometer	-	Billingsley TFM100-1E 3-axis
Magnetometer Compensator	-	Fugro FASDAS Mag Decoupler Unit Aeromagnetic Digital
Gamma-ray Spectrometer	-	Exploranium GR820 256 Channels
Gamma-ray Detector	-	8 NaI(Tl) crystals; 33.56 L down
Navigation System GPS	-	Fugro Omnistar in VBS (Virtual Base Station) mode, Novatel OEM4 GPS receiver
Base Station Magnetometers	-	2 x Scintrex Envi Mag
Altimeter	-	Collins ALT-50 radio altimeter
Barometer	-	Vaisala PMB100 altimeter
Thermometer	-	Honeywell HIH-3602-C temperature and humidity sensor

1.5 Area Map

Borroloola Flight Plan



Yiyintyi East and Yiyintyi West Flight Plan



1.6 General Disclaimer

It is Fugro Airborne Survey's understanding that the data and report provided to the client is to be used for the purpose agreed between the parties. That purpose was a significant factor in determining the scope and level of the Services being offered to the Client. Should the purpose for which the data and report is used change, the data and report may no longer be valid or appropriate and any further use of, or reliance upon, the data and report in those circumstances by the Client without Fugro Airborne Survey's review and advice shall be at the Client's own or sole risk.

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2. SURVEY SPECIFICATIONS AND PARAMETERS

2.1 Area Co-ordinates

The areas were located within GDA94 MGA Zone 53, Central Meridian = 135
(Note - Co-ordinates in GDA94/MGA Zone 53)

Booroloola

Easting	Northing
640000	8271000
640000	8262000
633000	8262000
631000	8259000
620000	8265000
620000	8275000
634000	8275000

Yiyintyi East

Easting	Northing
573746	8318658
577070	8317825
575913	8311631
572444	8312539

Yiyintyi West

Easting	Northing
559476	8312704
565423	8309318
563111	8306510
557577	8310226

Survey Area Parameters

Job Number	-	2251
Survey Company	-	Fugro Airborne Surveys Pty Ltd
Date Flown	-	23rd September 2011 – 4th October 2011
Client	-	Sandfire Resources NL
Project Name	-	Booroloola and Yiyintyi Project, Northern Territory
Nominal Terrain Clearance	-	40 m
Traverse Line Spacing	-	100 m (Booroloola) 50 m (Yiyintyi East and West)
Traverse Line Direction	-	000 – 180 degrees (Booroloola) 105 – 285 degrees (Yiyintyi East) 039 – 219 degrees (Yiyintyi West)
Tie Line Spacing	-	975 m (Booroloola) 520 m (Yiyintyi East) 500 m (Yiyintyi West)
Tie Line Direction	-	090 – 270 degrees (Booroloola) 012 – 192 degrees (Yiyintyi East) 120 – 300 degrees (Yiyintyi West
Traverse Line Numbers	-	1000101 – 1020101 (Booroloola) 2000101 – 2012801 (Yiyintyi East) 3000101 – 3013601 (Yiyintyi West)
Tie Line Numbers	-	1900101 – 1901701 (Booroloola) 2900101 – 2900801 (Yiyintyi East) 3900101 – 3900801 (Yiyintyi West)
Line Kilometres	-	2823.2 km (Booroloola) 553.73 km (Yiyintyi East) 589.40 km (Yiyintyi West)
Total Line Kilometres	-	3966.33 km

2.2 Data Sample Intervals

Nominal data sample intervals.

Magnetometer	-	7 m (@10 Hz)
Radar Altimeter	-	7 m (@10 Hz)
Thermometer	-	70 m (@1 Hz)
Barometer	-	70 m (@1 Hz)
GPS	-	70 m (@1 Hz)
Spectrometer	-	70 m (@1 Hz)
Magnetic Base Station (ENVI Mag)	-	5 s

2.3 Survey Tolerances

As specified in the contract the following tolerances were used:

Traverse line deviation	-	+/- 50% of nominated line spacing over 1 km or more
Tie line deviation	-	+/- 50% of nominated tie line spacing over 1 km or more
Terrain clearance deviation	-	+/-10 m of nominal terrain clearance over 1 km or more, except where such lines breach air regulations, or in the opinion of the pilot, put aircraft and crew at risk.
Total magnetometer system noise	-	More than 0.1 nT continuously for more than 1 km
Magnetic diurnal variation	-	More than 10 nT in 10 minutes non-linear either on flight lines or tie lines.

3. AIRCRAFT EQUIPMENT AND SPECIFICATIONS

3.1 Aircraft

Manufacturer	-	Aerocommander
Model	-	Shrike 500S
Registration	-	VH-FGZ
Ownership	-	Fugro Airborne Surveys Pty Ltd

3.2 Navigation System

The GPS receiver was integrated as part of the acquisition system. Navigation displays were generated by the acquisition system software that displayed to the pilot a graphical representation of the line being flown. A pre-defined flight plan, with area boundaries and the start and end of the line co-ordinates, was loaded into memory and used for real-time navigation information. Position co-ordinates and other relevant GPS information were output and recorded by the acquisition computer.

3.3 Aircraft Magnetometers

The survey was flown using a Scintrex CS-2 ultra-high sensitivity Caesium vapour magnetometer sensor with the sensor mounted in the tail stinger of the aircraft. The sensor provides a Larmor signal that is processed by high precision counters embedded within the FASDAS to provide an operating range of 20,000 to 100,000 nT.

Specifications

Nominal Sensitivity:	-	0.001 nT
Still Air RMS Noise:	-	0.05 nT
Digital Recording Resolution:	-	0.001 nT
Magnetic Gradient Tolerance	-	>20,000 nT/m

3.4 Automatic Compensator

The magnetometer data, together with data from the 3-axis fluxgate, was integrated in the acquisition system to produce real time compensation for the effects of the aircraft's motion, i.e. from changes in attitude and heading. The compensation coefficients were calculated from compensation flights carried out before the survey commenced. The compensated output data, with a resolution and sensitivity of 0.001 nT at a sampling rate of 10 times per second, were recorded digitally.

3.5 Gamma Ray Spectrometer System

The radiometric acquisition system consisted of a 256 channel gamma-ray spectrometer and detector system with the following specifications:

Manufacturer:	Exploranium Inc.	
Model:	GR-820	
Number of channels:	256	
Crystal Volume:	33.56 L downward looking (thermally insulated)	
Sampling interval:	1 s	
Windows (keV):	Potassium:	1370 to 1570
	Uranium:	1660 to 1860
	Thorium:	2410 to 2810
	Total Count:	410 to 2810
	Cosmic:	4000 to >6000

Data checking in the survey system was carried out by the use of resolution procedures using known radiometric sources. To verify the system, real time display of individual crystal resolutions and system resolutions, real time display peak channel tracking information, real time display of the energy spectrum showing counts, cosmic level and system livetime were available. The survey system displayed to the operator any errors encountered in the spectrometer system.

3.6 Radar Altimeter

A Collins ALT-50 radio altimeter system was used to measure ground clearance. The radio altimeter indicator provides an absolute altitude display from 0 - 750 metres (0 - 2,500 feet) with a sensitivity of 4 mV/ft. Radar altimeter data were digitally recorded every 0.1 seconds.

Specifications

Range:	-	0 - 2500 ft
Accuracy:	-	1%
Resolution:	-	4 mV/ft

3.7 Barometric Altimeter

The output of the Paroscientific Digibaro Barometric Altimeter was used for calculating the barometric altitude of the aircraft. The atmospheric pressure was taken from a probe and fed to the transducer. The transducer uses a precise quartz crystal resonator whose frequency of oscillation varies with pressure induced stress. The temperature of the pressure sensor was also recorded. In conjunction with the area QNH pressure and ambient temperature, the barometric altitude was calculated.

Specifications

Range:	-	sea level to 10,000 ft
Accuracy:	-	5 ft
Resolution:	-	1 mV/ft

3.8 Flight Data Recording

All data recorded by the data acquisition system were stored in a digital format on the removable media drive located in the DAS. This data were then transferred to the field office computers for post-flight quality control examination.

3.9 Flight Following

An integral part of the Safety Management System provides for the installation of a Flight Following System that transmits a position via satellite at pre determined intervals. The Fugro OmniTRACK system is fitted to the aircraft and position information is transmitted every 4 minutes to the Omnistar Network control centre. This information can be monitored by accessing the Fugro web page where the updated flight path is displayed. The aircraft is also fitted with an emergency switch and activation of this by the pilot or crew will notify the Omnistar Network control centre immediately. They in turn will contact FAS personnel as per the Emergency Response Plan.

4. GROUND DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

4.1 Magnetic Base Station

Two Scintrex Envi Mag magnetometers were used to measure the daily variations of the Earth's magnetic field. The base stations were established in an area of low gradient, away from cultural influences. The base stations were run continuously throughout the survey flying period with a sampling interval of 2 seconds at a sensitivity of 0.01 nT. The base station data were closely examined after each day's production flying to determine if any data had been acquired during periods of out-of-specification diurnal variation. The base stations were located at Booroloola Airport, and positioned approximately 100 m apart.

4.2 GPS Base Station

A GPS base logging station was set up at the Booroloola Hotel/Motel. The GPS antenna was located outside room 3.

The GPS base system was comprised of a GPS receiver, a logging computer, an antenna and a power supply. Data was logged and displayed in real time on the logging computer screen. The logged base data was processed with the airborne GPS data to calculate the differentially post-processed position of the aircraft.

The GPS base station position was calculated by logging data continuously at the base position over a period of approximately 24 hours. These data were then statistically averaged to obtain the position of the base station.

The calculated GPS base position was (in WGS84):

16° 4' 19.19" S, 136° 18' 29.80" E, 69.46 m.

5. EQUIPMENT CALIBRATIONS AND DATA ACQUISITION CHECKS

5.1 Survey Calibrations

A series of calibrations were performed as follows:

5.1.1 Dynamic Magnetometer Compensation

Carrying a magnetometer through a varying field in a non-uniform orientation produces manoeuvre noise. To compensate for this manoeuvre noise a standard compensation test flight called a "comp box" was flown. The compensation file produced also removed the majority of the heading error. Aircraft compensation tests were flown on the 4 survey line headings and also at +/- 7½ and 15^{o} to the line headings (to accommodate for cross wind flying conditions). The data for each heading consists of a series of aircraft manoeuvres with large angular excursions: specifically pitches, rolls and yaws. This was done to artificially create the worst possible attitudes and rates of attitudinal change likely to be encountered while on line and compensate for any magnetic noise created by the aircraft's motion within the earth's magnetic field. The data was processed to obtain the real-time compensation terms. These coefficients were applied in real-time or later during post-processing if required. Note that this form of compensation will only remove those noise effects modelled in the manoeuvre test flight. Random motions of the stinger with respect to the aircraft airframe generally establish the noise floor for this type of installation. Details of the comp boxes flown for this survey are shown in the table below.

Flown	Flights covered
23/09/2011	All Flights

***Table 1**: Magnetometer Compensation Details*

5.1.2 Parallax

Parallax error is caused by the physical difference in distance between the various sensors, the electronic delay and software timing in the acquisition system. Hence all variables are subjected to a displacement from the GPS co-ordinates. If these variables are processed without a position offset a parallax error will usually occur. The most suitable way to treat this problem is to use the 1 second radiometric data as a base with a zero correction. This will prevent interpolation of important variables (a filtering process). The co-ordinates were moved by linear interpolation and other data variables were displaced onto the radiometric data, without change.

Data	Parallax
GPS	-0.5 second
Magnetics	0 second
Radar Altitude	0 second
Pressure	0 second
Temperature	0 second

***Table 2**: Parallax Values*

5.1.3 Pad Calibrations

A series of tests were taken using a set of radiometric pads of known concentrations of Potassium, Uranium and Thorium. Each crystal pack was tested individually, with data accumulated for 15 minutes. The pad calibration data were processed to determine the radiometric stripping coefficients for each crystal pack. Where aircraft had more that one crystal pack installed, the average of the stripping coefficients were used in final data processing.

5.1.4 Background and Cosmic Calibration Stacks

High-level stacks were flown over the ocean away form the effects of any land based radon. Data were collected for ten minutes at altitudes starting at 1000 feet above sea level and incrementing to 10000 feet above sea level. The high-level stack data were processed to determine the cosmic and aircraft background coefficients.

5.1.5 Height Attenuation Calibrations

Low-level stacks were flown over the Carnamah Dynamic Test Range, Western Australia. Data were collected at altitudes of 130 feet above sea level (asl), 200 ft asl, 260 ft asl, 330 ft asl, 400 ft asl and 650 ft asl. The neighbouring salt lake was flown at the same altitudes, and the data were used as a radon test. A ground survey was carried out on the same day using a calibrated gamma-ray spectrometer.

The airborne and ground data were processed to determine radioelement sensitivity and height attenuation coefficients.

5.1.6 Daily Calibrations

A set of calibrations were performed each survey day as follows:
Magnetic base station time check
Spectrometer resolution test
Spectrometer button test

5.1.6.1 Magnetic Base Station Time Check

Prior to each day's survey all magnetic base stations were time checked and synchronised with the time on the aircraft survey system GPS receiver.

5.1.6.2 Spectrometer Resolution Test

Once the spectrometer had stabilised a Thorium source resolution check was carried out by placing the source in a cradle specially designed to ensure precisely repeatable locations.

5.1.6.3 Spectrometer Button Test

Thorium sample checks were performed on the spectrometer before and after each day's survey acquisition. Each sample was placed in a predetermined location and data recorded for 180 sec. Relative count rates above background were within +/- 5% of the average sample checks for the duration of the survey.

6. DATA VERIFICATION AND FIELD PROCESSING

All data verification was conducted at the field office at Booroloola for the duration of the survey. At the conclusion of each days survey all magnetic, radiometric, altimeter, flight path and diurnal data were downloaded onto the field office computer for preliminary verification. All raw aircraft data were backed up at the end of each day's survey. One copy was sent to the FAS office in Perth, the other copy remaining at the field office.

6.1 Magnetic Diurnal Data

Diurnal data recorded from the primary base station was downloaded onto the field office computer. The data was checked for spikes and erroneous readings. If invalid diurnal data occurred whilst survey data was being acquired the affected section was re-flown. The diurnal data was also checked to see that the change in diurnal readings during the course of the survey did not exceed the specified tolerances. When this occurred the affected part of the survey line was re-flown. The diurnal data was merged with the aircraft data and used in the verification of the magnetic data. Diurnal data recorded on the secondary base station was also downloaded onto the field office computer.

6.2 Height Data

Radar altimeter, barometric altimeter and GPS height data from the aircraft were transferred onto the field office computer.

6.2.1 Radar Altimeter Data

The radar altimeter data was verified to check that a reasonably constant height above the terrain was flown, readings during the course of the survey did not exceed the specified tolerances and for equipment reliability.

6.2.2 GPS Height Data

The aircraft's height above the WGS84 ellipsoid each second was determined by differentially post-processing the synchronised GPS data from the aircraft and GPS base station data. The GPS height of the aircraft was verified to check for data masking and for equipment reliability.

6.2.3 Barometric Altimeter Data

As a backup to the aircraft's GPS height, barometric height was also recorded. The barometric height of the aircraft was verified to check for equipment reliability. The barometric data were also used in the processing of the radiometric data.

6.2.4 Topographical Data

After verification parallax corrections were applied, the radar altitude was subtracted from the GPS height to give the elevation of the terrain above the WGS84 ellipsoid. It was not considered necessary to make any further corrections as this data was for verification purposes only.

6.2.5 Gridding and Inspection

The topographical data was gridded and grid image enhancements were computed and displayed on screen. These were inspected for inconsistencies and errors.

6.3 Flight Path Data

The flight path data from the aircraft and the GPS base station were transferred onto the field office computer. The aircraft's precise location each second was determined by differentially post-processing the synchronised GPS data from the aircraft and GPS base station data. The flight path was recovered and plotted daily to ensure it was within specification. Any data not within specification was re-flown. The flight path data was then merged with the rest of the aircraft and diurnal data. Both the aircraft and GPS base station recorded the data in the WGS84 datum.

6.4 Magnetic Data

The real-time compensated and uncompensated magnetic data from the aircraft recorded every 0.1 second were transferred onto the field office computer. The raw magnetic data was checked to identify noise and spikes. If the noise exceeded the specified tolerances the part of the line affected was re-flown. After the magnetic data were merged with the digital flight path the following sequence of operations were carried out to allow inspection and verification of the data:

6.4.1 Diurnal Correction

The synchronised digital diurnal data collected by the base station was first subtracted from the corresponding airborne magnetic readings to calculate a difference. The resultant difference was then subtracted from the base value to produce diurnally corrected magnetic data.

6.4.2 Parallax Correction

The diurnally corrected magnetic data was corrected for system parallax using the calculated value.

6.4.3 Preliminary Gridding and Inspection

The magnetic data were gridded and grid image enhancements were computed and displayed on screen. These were inspected for inconsistencies and errors.

6.5 Spectrometer Data

Spectrometer data from the aircraft were transferred onto the field office computer. The data was verified to check that readings during the course of the survey did not exceed the specified tolerances and for equipment reliability.

6.5.1 Parallax Correction

The raw window data were corrected for system parallax using the calculated value.

6.5.2 Preliminary Gridding and Inspection

The spectrometer data were gridded and grid image enhancements were computed and displayed on screen. These were inspected for inconsistencies and errors.

7. FINAL DATA PROCESSING

7.1 Aircraft Location

The aircraft's location each second was determined by differentially post-processing the synchronised GPS data recorded on both the aircraft and GPS base station. This data is recorded in the WGS84 datum.

7.2 Magnetic Data Processing

The processing procedures applied to the magnetic data are summarised below:

a) Apply any spike corrections to the compensated magnetic variables.
b) Interpolate undefined magnetic values.
c) Co-ordinate the data with post-processed GPS data.
d) Filter diurnal values and subtract them from individual compensated magnetic readings.

Area	Base	Base Value
All Areas	Booroloola Airstrip	48088 nT

***Table 3**: Diurnal Base Values*

e) Apply parallax correction.
f) Correct for regional effects of the earth's magnetic field by calculating the IGRF value at each fiducial using IGRF model 2010 and secular variation model. A base value was added back.

Area	IGRF Model	Base Value
All Areas	24/9/2011	47803 nT

***Table 4**: IGRF Base Values*

g) The data was height corrected using Taylor Drape to 40 m.
h) Using the tie lines (flown at 90 degrees to the traverse lines) a set of miss-tie values were determined. These miss-tie values reflected the differences in the magnetic value between the tie lines and traverse lines over the same geographical point. Using a least squares fit algorithm, which also takes into account the statistical variation inherent in DGPS positioning, a series of corrections were applied to the traverse line data. These allowed the data to be levelled to the same base value.
i) Following this, a Fugro proprietary micro-levelling process was applied in order to more subtly level the data.

7.2.1 Gridding

The final levelled magnetic data were gridded using a bi-directional spline algorithm. The Booroloola data was gridded with a cell size of 25 m and the Yiyintyi areas were gridded with a cell size of 12.5 m.

7.3 Radiometric Data Processing

The radiometric data was processed using the standard IAEA window processing technique as summarised below.

a) Co-ordinate the data with post-processed GPS data.
b) Apply spike corrections to the radar altimeter, temperature and pressure values.
c) Apply parallax corrections to altimeter, temperature and pressure values.
d) Apply NASVD filtering to the 256 channel radiometric data.
e) Apply Energy Recalibration to the NASVD filtered 256 channel radiometric data.
f) Correct for dead time.
g) Calculate the equivalent terrain clearance at STP (standard temperature and pressure).
h) Remove aircraft background.
i) Remove cosmic background.
j) Window the 256 channel data using the IAEA standard energy windows.
k) Remove radon background.
l) Apply stripping ratios.
m) Apply height corrections.

n) Using the tie lines (flown at 90 degrees to the traverse lines) a set of miss-tie values were determined. These miss-tie values reflected the differences in the value between the tie lines and traverse lines over the same geographical point. Using a least squares fit algorithm, which also takes into account the statistical variation inherent in DGPS positioning, a series of corrections were applied to the traverse line data. These allowed the data to be levelled to the same base value.

o) Following this, a Fugro proprietary micro-levelling process was applied in order to more subtly level the data.

7.3.1 NASVD Filtering

The radiometrics were produced with NASVD smoothing. Using the NASVD technique, the raw spectra were first smoothed using 7 principal components for the Booroloola and Yiyintyi East areas, and 5 principal components for the Yiyintyi West area. Eigenvectors and statistics on the NASVD processing results were used for analysis.

7.3.2 Energy Recalibration

The spectral drift was checked by monitoring the position of the Potassium, Uranium and Thorium peaks on average spectra along flight lines. The peak positions were determined by using a Gaussian fitting method. Energy recalibration was applied to the spectra using a linear regression (LSQ fit) to determine the slope and intercept.

7.3.3 Dead Time

Gamma-ray spectrometers require a finite time to process each pulse from the detectors. While one pulse is being processed, any other pulse that arrives will be rejected. Consequently the 'live time' of a spectrometer is reduced by the time taken to process all pulses reaching the spectrometer. The spectra are normalised to counts per second by dividing by the live time.

7.3.4 STP Altitude

The radar altimeter data was converted to effective height at standard temperature and pressure using the expression:

STPAlt = RAlt * (P/1013) * (273 / (T+273))
where:

RAlt = the observed radar altitude in m
T = the measured air temperature in deg C
P = the barometric pressure in hPa

7.3.5 Cosmic and Aircraft Background Removal

The 256 channel aircraft and cosmic spectra for the aircraft were calculated from the high-level test data with the aircraft and cosmic backgrounds derived using least squares fitting applied on a channel by channel basis.

The aircraft background was removed by subtracting the computed aircraft background spectra from the dead time corrected spectra. The 256 channel cosmic background spectrum that is removed is calculated by multiplying the 256 channel cosmic factor values by the cosmic counts recorded. The effect of cosmic radiation is removed from the spectra by subtracting the resultant cosmic spectrum.

Window	Aircraft Background	Cosmic Stripping Ratio
Total Count	21.0	0.9000
Potassium	6.20	0.0530
Uranium	0.70	0.0420
Thorium	0.90	0.0510

***Table 5**: Aircraft Background and Cosmic Stripping Ratios*

7.3.6 Window Definitions

The 256 channel data were summed into the standard IAEA windows.

Window	Peak Energy (keV)	Energy Window (keV)			GR-820 Channel Window		
Total Count	-	410	-	2810	34	-	234
Potassium	1460	1370	-	1570	115	-	131
Uranium	1765	1660	-	1860	139	-	155
Thorium	2614	2410	-	2810	201	-	234
Cosmic	-	4000	-	6000		-	

***Table 6**: IAEA Window Definitions*

7.3.7 Radon Correction

Radon corrections were applied using the spectral ratio method.

Stripping	Value
Total Count	13.154
Potassium	0.783
Thorium	0.061
Radon	1.875
Ground (1)	0.370
Ground (2)	0.677
Ground (3)	0.701

***Table 7**: Radon Stripping Values*

7.3.8 Spectral Stripping

Spectral stripping was applied to the Potassium, Uranium and Thorium windows. The stripping coefficients were corrected for STP altitude.

Stripping	Value	STP adjustment (/m)
Alpha	0.2569	0.00049
Beta	0.3736	0.00065
Gamma	0.7416	0.00069
A	0.0591	0
B	0.0002	0
G	-0.0169	0

***Table 8**: Spectral Stripping Ratios*

7.3.9 Height Correction

The background corrected and stripped window data were corrected for variations in the density altitude of the detector.

Window	Attenuation coefficient (m^{-1})
Total Count	-0.0072
Potassium	-0.0099
Uranium	-0.0086
Thorium	-0.0067

***Table 9**: STP Altitude Coefficients*

7.3.10 Gridding

The final radiometric data were gridded using a minimum curvature algorithm. The Booroloola and Yiyintyi East data was gridded with a cell size of 25 m and the Yiyintyi West data was gridded with a cell size of 12.5 m.

7.4 Digital Terrain Model

The processing procedures applied to the terrain data are summarised below:

a) Apply any spike corrections to the raw radar altimeter data. The radar altimeter was extensively de-spiked due to trees in the survey area.
b) Interpolate undefined values.
c) Co-ordinate the data with post-processed GPS data.
d) Apply parallax corrections.
e) Subtract the aircraft's height above ground from the aircraft's height above the WGS84 ellipsoid and correct for radar altimeter/GPS sensor separation.
f) Derive surface topography values with respect to mean sea level (referenced to the geoid) by correcting the WGS84 ellipsoid values with geoid-ellipsoid separation values.
g) Using the tie lines (flown at 90 degrees to the traverse lines) a set of miss-tie values were determined. These miss-tie values reflected the differences in the value between the tie lines and traverse lines over the same geographical point. Using a least squares fit algorithm, which also takes into account the statistical variation inherent in DGPS positioning, a series of corrections were applied to the traverse line data. These allowed the data to be levelled to the same base value.
h) Following this, a FAS proprietary micro-levelling process was applied in order to more subtly level the data.

7.4.1 Gridding

The final levelled digital terrain data were gridded using a bi-directional spline algorithm. The Booroloola and Yiyintyi East data was gridded with a cell size of 25 m and the Yiyintyi West data was gridded with a cell size of 12.5 m.

The accuracy of the elevation calculation is directly dependent on the accuracy of the two input parameters, radar altitude and GPS altitude. The radar altitude value may be erroneous in areas of heavy tree cover, where the altimeter reflects the distance to the tree canopy rather than the ground. The GPS altitude value is primarily dependent on the number of available satellites. Although post-processing of GPS data will yield X and Y accuracies in the order of 1-2 metres, the accuracy of the altitude value is usually much less, sometimes in the ±5 metre range. Further inaccuracies may be introduced during the interpolation and gridding process.

Because of the inherent inaccuracies of this method, no guarantee is made or implied that the information displayed is a true representation of the height above sea level. Although this product may be of some use as a general reference, THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.

APPENDIX I – Weekly Operations Report

System: FASDAS
Aircraft: VH-FGZ

Total Job kms: 4002.371 Kms

Plan Kms Remain: 0.000 Kms
% Complete: 100.000 %

17966.1 Hrs - Progressive M/R Hrs at the start of job, prior to mobilisation

18031.0 Hrs - The hours the Periodic Inspection is actally due at start of the job

Job Number: 2251
Contract Number: CM6784
Job Name: Borroloola
Area Names: Borroloola, Yiyintyi East, Yiyintyi West
Client: Sandfire Resources P/L

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	FAS Scrub	Time Start	Time End	Engine Hours on M/R	Hours to Periodic Inspectio	Job Hrs to Date	Prod. to Date	FAS Scrubs to Date	Stdby Days	Activity Contribution	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc
##########																
Julian Day 262																
Monday																
									64.9							
Date 20-Sep														1.00	MO	D.Little arrives Kununurra from Perth
Julian Day 263																
Tuesday																
									64.9							
Date 21-Sep														0.50	MO	D.Little Kununurra to Katherine N.T
Julian Day 264														0.50	MO	W.Saunders arrives Kununurra
Wednesday																
									64.9							
Date 22-Sep														0.50	MO	D.Little arrives Borroloola
Julian Day 265		W.S				11:00:00	14:00:00	3.0						0.50	MO	W.Saunders arrives Borroloola
Thursday																
									61.9	3.0						
Date 23-Sep	1	W.S	D.L			7:30:00	8:40:00	1.2						0.30	SAF	Area1 recce - comp box, returned GPS failure
Julian Day 266	2	W.S	D.L			10:00:00	11:15:00	1.3						0.50	SAF	Area 2 and 3 recce, awaiting PTW
														0.20	MA	50 hour engine oil change
Friday																
									59.4	5.5						
Date 24-Sep	3	W.S			392.118	7:30:00	10:25:00	2.9						0.50	S	Flt data scrubbed due GR820 failure on start-up.
Julian Day 267	4	W.S		307.873	125.737	11:20:00	14:35:00	3.3						0.50	P & R & S	Tie lines and reflights scrubbed due GPS
Saturday																
									53.2	11.7	307.873	517.855				
Date 25-Sep														1.00	PDO	W.Saunders PDO, used due GPS failure
Julian Day 268															Comment	FGZ to ferry to Darwin for GPS repairs
Sunday																
									53.2	11.7	307.873	517.855				
Totals This Week: ►				**307.873**	**517.855**	Week Hours:►		**11.6**	▲: A/C Hrs to Next Service					**6.00**		

System: FASDAS
Aircraft: VH-FGZ

Total Job kms: 4002.371 Kms

Plan Kms Remain: 0.000 Kms
% Complete: 100.000 %

17966.1 Hrs - Progressive M/R Hrs at the start of job, prior to mobilisation

18031.0 Hrs - The hours the Periodic Inspection is actally due at start of the job

Job Number: 2251
Contract Number: CM6784
Job Name: Borroloola
Area Names: Borroloola, Yiyintyi East, Yiyintyi West
Client: Sandfire Resources P/L

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	FAS Scrub	Time Start	Time End	Engine Hours on M/R	Hours to Periodic Inspectio	Job Hrs to Date	Prod. to Date	FAS Scrubs to Date	Stdby Days	Activity Contribution	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc
################						10:00:00	12:55:00	2.9						1.00	E	Ferry to Darwin for GPS repairs
Julian Day 269																
Monday																
									50.3	14.6	307.873	517.855				
Date 27-Sep						11:00:00	13:50:00	2.8						1.00	E	Return ferry to Borroloola
Julian Day 270																
Tuesday																
									47.5	17.4	307.873	517.855				
Date 28-Sep	5	W.S		379.749		6:35:00	11:50:00	5.3						0.50	P	Area 2
Julian Day 271	6	W.S		295.216	34.296	13:00:00	15:25:00	2.4						0.50	P & R & S	Reflight lines from flt3 Area 1.
Wednesday																
									39.8	25.1	982.838	552.151				
Date 29-Sep	7	W.S		777.560	45.641	6:35:00	12:05:00	5.5						0.50	P & R & S	Refly lines due GPS and diurnal.
Julian Day 272	8	W.S		234.439	30.628	13:30:00	15:30:00	2.0						0.50	P & R & S	Refly lines due GPS. Reflights due poor GPS.
Thursday																
									32.3	32.6	1994.837	628.420				
Date 30-Sep	9	W.S		651.201		8:00:00	13:55:00	5.9						0.60	P	Completed Area 2, continued Area 1
Julian Day 273														0.40	LOG	delayed take-off due to fog and fuel problems.
Friday																
									26.4	38.5	2646.038	628.420				
Date 1-Oct	10	W.S		448.000		6:30:00	12:05:00	5.6						1.00	P	
Julian Day 274																
Saturday																
									20.8	44.1	3094.038	628.420				
Date 2-Oct														1.00	PDO	S.Saunders P.D.O
Julian Day 275																
Sunday																
									20.8	44.1	3094.038	628.420				
Totals This Week: ►				**2786.165**	**110.565**	Week Hours:►		**32.4**	▲: A/C Hrs to Next Service					**7.00**		

System: FASDAS
Aircraft: VH-FGZ

Total Job kms: 4002.371 Kms

Plan Kms Remain: 0.000 Kms
% Complete: 100.000 %

17966.1 Hrs - Progressive M/R Hrs at the start of job, prior to mobilisation

18031.0 Hrs - The hours the Periodic Inspection is actally due at start of the job

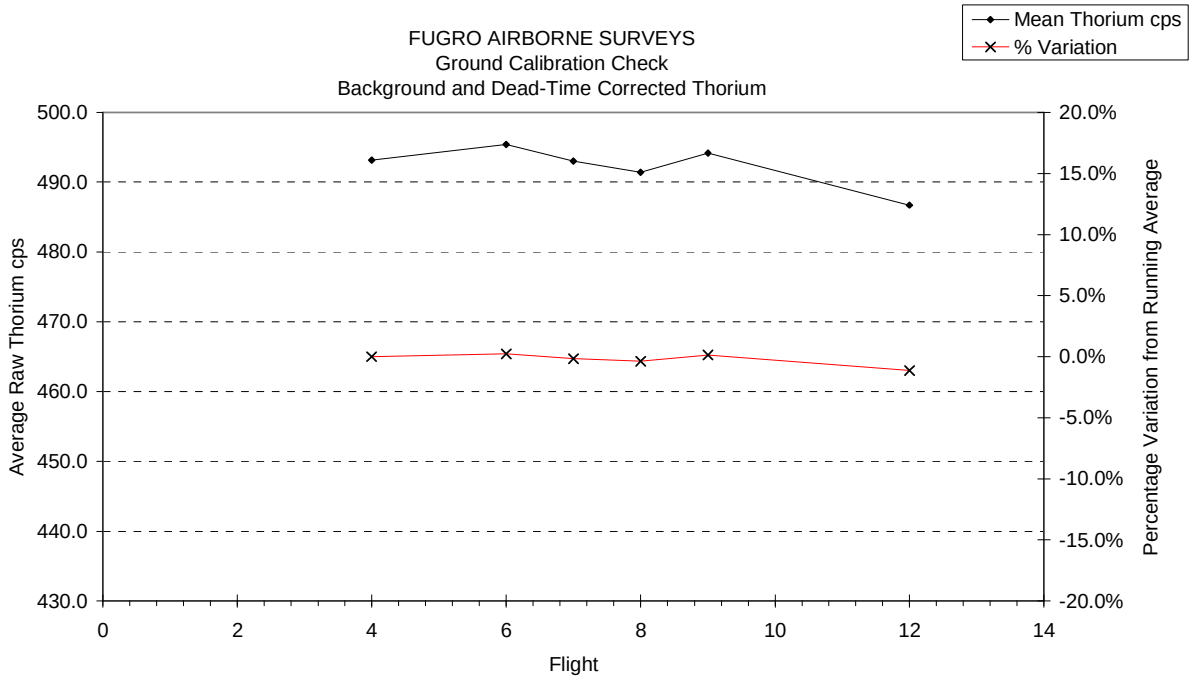
Job Number: 2251
Contract Number: CM6784
Job Name: Borroloola
Area Names: Borroloola, Yiyintyi_East, Yiyintyi_West
Client: Sandfire Resources P/L

Date	Flt	Pilot initials	On board Oper initials	Production inc. Reflights Exc. Scrubs	FAS Scrub	Time Start	Time End	Engine Hours on M/R	Hours to Periodic Inspectio	Job Hrs to Date	Prod. to Date	FAS Scrubs to Date	Stdby Days	Activity Contribution	Activity	COMMENTS Weather, Data delivery Aircraft movement, etc
03-October-2011	11	W.S		654.892		6:40:00	12:15:00	5.6						0.50	P & R	Reflys due poor GPS solution.
Julian Day 276	12	W.S		253.441		13:00:00	15:00:00	2.0						0.50	P	
Monday																
									13.2	51.7	4002.371	628.420				
Date 4-Oct	13	W.S	D.L			7:00:00	8:10:00	1.2						0.25	TF	Compensation and check box
Julian Day 277														0.25	MO	D.Little de-mob to Daly Waters
						17:30:00	20:24:00	2.9						0.25	MO	W.S ferries FGZ to Kununurra
Tuesday						21:22:00	1:49:00	4.4						0.25	MO	W.S ferries FGZ to Newman
									4.7	60.2	4002.371	628.420				
Date 5-Oct														0.50	MO	D.Little Daly Waters to Kununurra
Julian Day 278						2:37:00	3:56:00	1.3						0.25	MO	W.S ferries FGZ to Meekatharra
						6:37:00	9:00:00	2.4						0.25	MO	W.S ferries FGZ to Jandakot
Wednesday																
									1.0	63.9	4002.371	628.420				
Date 6-Oct														1.00	MO	Airnorth flts cancelled due maint issues.
Julian Day 279																
Thursday																
									1.0	63.9	4002.371	628.420				
Date 7-Oct																
Julian Day 280																
Friday																
									1.0	63.9	4002.371	628.420				
Date 8-Oct																
Julian Day 281																
Saturday																
									1.0	63.9	4002.371	628.420				
Date 9-Oct																
Julian Day 282																
Sunday																
									1.0	63.9	4002.371	628.420				
Totals This Week: ►				**908.333**		Week Hours:►		**19.8**	▲: A/C Hrs to Next Service					**4.00**		

APPENDIX II – Thorium Button Test

AIRCRAFT VH-FGZ

Flt#	Pre/Post Flt	Th in 501/601	Th in 502/602	Th Counts Actual	Th Counts Used	Running Average	Allowed Min	Allowed Max	% Change
4	post	202.3	695.5	493.1	493.1	493.1	468.5	517.8	0.0%
6	post	200.8	696.2	495.4	495.4	494.3	469.6	519.0	0.2%
7	pre	194.4	687.4	493.0	493.0	493.9	469.2	518.5	-0.2%
8	post	202.5	693.9	491.4	491.4	493.2	468.6	517.9	-0.4%
9	post	204.4	698.5	494.1	494.1	493.4	468.8	518.1	0.1%
12	post	199.4	686.1	486.7	486.7	492.3	467.7	516.9	-1.1%



APPENDIX III – Final Located Data Formats

Headers for final data files

Booraloola

Description File for 0.1 sec Magnetics Data

```
COMM JOB NUMBER:                                                    2251
COMM AREA NUMBER:                                                      1
COMM SURVEY COMPANY:                                 Fugro Airborne Surveys
COMM CLIENT:                                          Sandfire Resources NL
COMM SURVEY TYPE:                                  Magnetic and Radiometric
COMM AREA NAME:                                                Booraloola
COMM STATE:                                                Western Australia
COMM COUNTRY:                                                     Australia
COMM SURVEY FLOWN:                          23 September - 03 October 2011
COMM LOCATED DATA CREATED:                           02 November 2011
COMM
COMM DATUM:                                                         GDA94
COMM PROJECTION:                                                      MGA
COMM ZONE:                                                             53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                         100 m
COMM TRAVERSE LINE DIRECTION:                              000 - 180 deg
COMM TIE LINE SPACING:                                              975 m
COMM TIE LINE DIRECTION:                                   090 - 270 deg
COMM NOMINAL TERRAIN CLEARANCE:                                      40 m
COMM FINAL LINE KILOMETRES (in the 10 Hz dataset):                2838.14 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                              1000103 - 1020101
COMM TIE LINE NUMBERS:                                   1900101 - 1901701
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     640000    8271000
COMM     640000    8262000
COMM     633000    8262000
COMM     631000    8259000
COMM     620000    8265000
COMM     620000    8275000
COMM     634000    8275000
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                 VH-FGZ Aerocommander AC500S
COMM
COMM MAGNETOMETER:                              Scintrex CS2 Cesium Vapour
COMM INSTALLATION:                                                 Stinger
COMM
COMM RESOLUTION:                                                0.001 nT
COMM RECORDING INTERVAL:                                           0.1 s
COMM
COMM RADAR ALTIMETER:                                        Collins Alt-50
COMM RECORDING INTERVAL:                                           0.1 s
COMM
COMM NAVIGATION:                             real-time differential GPS
COMM RECORDING INTERVAL:                                           1.0 s
```

```
COMM
COMM ACQUISITION SYSTEM:                                          Fugro DAS
COMM
COMM BASE MAGNETOMETER:                                    Scintrex Envi-Mag
COMM RECORDING INTERVAL:                                              5 s
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                    0.5 s
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                          base value 48088 nT
COMM
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM IGRF CORRECTION APPLIED                             base value 47803 nT
COMM IGRF MODEL 2010 extrapolated to                              2011/09/24
COMM
COMM DATA HAVE BEEN HEIGHT CORRECTED (TAYLOR DRAPE) to 40m AGL
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                      0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (RADAR ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM ------------------------------------------------------------------------
COMM DISCLAIMER
COMM ------------------------------------------------------------------------
COMM It is Fugro Airborne Survey’s understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by Fugro Airborne Survey exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and Fugro Airborne Survey
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved Fugro Airborne Survey's use of any
COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information. Fugro
COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters, radar altitude and GPS altitude. The radar altitude value
```

```
COMM may be erroneous in areas of heavy tree cover, where the altimeter
COMM reflects the distance to the tree canopy rather than the ground. The
COMM GPS altitude value is primarily dependent on the number of available
COMM satellites. Although post-processing of GPS data will yield X and Y
COMM accuracies in the order of 1-2 metres, the accuracy of the altitude
COMM value is usually much less, sometimes in the ±5 metre range. Further
COMM inaccuracies may be introduced during the interpolation and gridding
COMM process. Because of the inherent inaccuracies of this method, no
COMM guarantee is made or implied that the information displayed is a true
COMM representation of the height above sea level. Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM ------------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                                UNITS      NULL               FORMAT
COMM Line Number                                     -99999             I7
COMM Flight Number                                   -99                I4
COMM Date (yyyymmdd)                                 -9999999           I9
COMM Fiducial Number                                 -9999.9            F8.1
COMM Time (UTC seconds past midnight)     s          -9999.9            F8.1
COMM Easting                              m          -99999.99          F10.2
COMM Northing                             m          -999999.99         F11.2
COMM Longitude                            deg        -999.9999999       F13.7
COMM Latitude                             deg        -99.9999999        F12.7
COMM GPS Altitude                         m          -999.99            F8.2
COMM Radar Altitude                       m          -999.99            F8.2
COMM Compensated TMI                      nT         -99999.999         F11.3
COMM Diurnal                              nT         -9999.99           F9.2
COMM Final TMI                            nT         -99999.999         F11.3
COMM Digital Terrain Model                m          -999.99            F8.2
```

Description File for 1.0 sec Windowed Radiometrics Data

```
COMM JOB NUMBER:                                                      2251
COMM AREA NUMBER:                                                        1
COMM SURVEY COMPANY:                                 Fugro Airborne Surveys
COMM CLIENT:                                          Sandfire Resources NL
COMM SURVEY TYPE:                                  Magnetic and Radiometric
COMM AREA NAME:                                                 Booraloola
COMM STATE:                                                Western Australia
COMM COUNTRY:                                                     Australia
COMM SURVEY FLOWN:                          23 September - 03 October 2011
COMM LOCATED DATA CREATED:                            02 November 2011
COMM
COMM DATUM:                                                           GDA94
COMM PROJECTION:                                                        MGA
COMM ZONE:                                                               53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                           100 m
COMM TRAVERSE LINE DIRECTION:                                 000 - 180 deg
COMM TIE LINE SPACING:                                                975 m
COMM TIE LINE DIRECTION:                                      090 - 270 deg
COMM NOMINAL TERRAIN CLEARANCE:                                        40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset):                  2823.2 km
COMM
COMM LINE NUMBERING
COMM
```

```
COMM TRAVERSE LINE NUMBERS:                                  1000103 - 1020101
COMM TIE LINE NUMBERS:                                       1900101 - 1901701
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     640000    8271000
COMM     640000    8262000
COMM     633000    8262000
COMM     631000    8259000
COMM     620000    8265000
COMM     620000    8275000
COMM     634000    8275000
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                 VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                           256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                              33.56 l
COMM RECORDING INTERVAL:                                           1.0 s
COMM
COMM RADAR ALTIMETER:                                      Collins Alt-55
COMM RECORDING INTERVAL:                                           0.1 s
COMM
COMM NAVIGATION:                             real-time differential GPS
COMM RECORDING INTERVAL:                                           1.0 s
COMM
COMM ACQUISITION SYSTEM:                                       Fugro DAS
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                   0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                   0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                   0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NASVD FILTERING APPLIED TO 256 CHANNEL DATA
COMM WINDOW DATA EXTRACTED USING IAEA STANDARD WINDOWS
COMM PARALLAX CORRECTION APPLIED                                   0.0 s
COMM COSMIC, AIRCRAFT AND RADON BACKGROUNDS REMOVED
COMM STRIPPING CORRECTIONS APPLIED
COMM HEIGHT CORRECTED TO                                        40 m AGL
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                  21.0
COMM POTASSIUM                                                     6.2
COMM URANIUM                                                       0.7
COMM THORIUM                                                       0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                  0.900
COMM POTASSIUM                                                    0.053
COMM URANIUM                                                      0.042
COMM THORIUM                                                      0.051
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                       0.2569
COMM BETA                                                        0.3736
COMM GAMMA                                                       0.7416
COMM a                                                           0.0591
```

```
COMM b                                                          0.0002
COMM c                                                         -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                     0.00049
COMM BETA                                                      0.00065
COMM GAMMA                                                     0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                                13.150
COMM POTASSIUM                                                   0.782
COMM THORIUM                                                     0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                  1.875
COMM GROUND (C2)                                                 0.370
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                               -0.0072
COMM POTASSIUM                                                 -0.0099
COMM URANIUM                                                   -0.0086
COMM THORIUM                                                   -0.0067
COMM
COMM ------------------------------------------------------------------------
COMM DISCLAIMER
COMM ------------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by Fugro Airborne Survey exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and Fugro Airborne Survey
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved Fugro Airborne Survey's use of any
COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information. Fugro
COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM ------------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                      UNITS           NULL                FORMAT
COMM Line Number                                -99999              I7
COMM Flight Number                              -99                 I4
COMM Date (yyyymmdd)                            -9999999            I9
COMM Fiducial Number             s              -9999.9             F8.1
COMM Time (local)                s              -9999.9             F8.1
COMM Easting                     m              -99999.99           F10.2
COMM Northing                    m              -999999.99          F11.2
COMM Longitude                   deg            -999.9999999        F13.7
COMM Latitude                    deg            -99.9999999         F12.7
COMM GPS Altitude                m              -999.99             F8.2
COMM Radar Altitude              m              -999.99             F8.2
```

```
COMM Uncorrected Total Count    cps            -9999.9            F8.1
COMM Uncorrected Potassium      cps            -999.9             F7.1
COMM Uncorrected Uranium        cps            -999.9             F7.1
COMM Uncorrected Thorium        cps            -999.9             F7.1
COMM Raw Cosmic                 cps            -99                I4
COMM Final Total Count          cps            -9999.9            F8.1
COMM Final Potassium            cps            -999.9             F7.1
COMM Final Uranium              cps            -999.9             F7.1
COMM Final Thorium              cps            -999.9             F7.1
```

Description File for 1.0 sec Raw 256 Channel Radiometrics Data

```
COMM JOB NUMBER:                                                    2251
COMM AREA NUMBER:                                                      1
COMM SURVEY COMPANY:                                 Fugro Airborne Surveys
COMM CLIENT:                                          Sandfire Resources NL
COMM SURVEY TYPE:                                 Magnetic and Radiometric
COMM AREA NAME:                                                Booraloola
COMM STATE:                                                Western Australia
COMM COUNTRY:                                                  Australia
COMM SURVEY FLOWN:                          23 September - 03 October 2011
COMM LOCATED DATA CREATED:                                  02 November 2011
COMM
COMM DATUM:                                                         GDA94
COMM PROJECTION:                                                      MGA
COMM ZONE:                                                             53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                         100 m
COMM TRAVERSE LINE DIRECTION:                                 000 - 180 deg
COMM TIE LINE SPACING:                                              975 m
COMM TIE LINE DIRECTION:                                      090 - 270 deg
COMM NOMINAL TERRAIN CLEARANCE:                                      40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset):                 2823.2 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                                 1000103 - 1020101
COMM TIE LINE NUMBERS:                                      1900101 - 1901701
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     640000    8271000
COMM     640000    8262000
COMM     633000    8262000
COMM     631000    8259000
COMM     620000    8265000
COMM     620000    8275000
COMM     634000    8275000
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                  VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                            256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                                33.56 l
COMM RECORDING INTERVAL:                                             1.0 s
COMM
COMM RADAR ALTIMETER:                                        Collins Alt-50
COMM RECORDING INTERVAL:                                             0.1 s
COMM
COMM NAVIGATION:                              real-time differential GPS
```

```
COMM RECORDING INTERVAL:                                          1.0 s
COMM
COMM ACQUISITION SYSTEM:                                      Fugro DAS
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                  0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                  0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                  0.0 s
COMM
COMM BAROMETRIC DATA
COMM PARALLAX CORRECTION APPLIED                                  0.0 s
COMM
COMM TEMPERATURE DATA
COMM PARALLAX CORRECTION APPLIED                                  0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NO PROCESSING APPLIED TO RAW 256 CHANNEL RADIOMETRIC DATA
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                 21.0
COMM POTASSIUM                                                    6.2
COMM URANIUM                                                      0.7
COMM THORIUM                                                      0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                 0.900
COMM POTASSIUM                                                   0.053
COMM URANIUM                                                     0.042
COMM THORIUM                                                     0.051
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                      0.2569
COMM BETA                                                       0.3736
COMM GAMMA                                                      0.7416
COMM a                                                          0.0591
COMM b                                                          0.0002
COMM c                                                         -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                     0.00049
COMM BETA                                                      0.00065
COMM GAMMA                                                     0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                                13.150
COMM POTASSIUM                                                   0.782
COMM THORIUM                                                     0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                  1.875
COMM GROUND (C2)                                                 0.370
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                               -0.0072
COMM POTASSIUM                                                 -0.0099
COMM URANIUM                                                   -0.0086
COMM THORIUM                                                   -0.0067
COMM
COMM ----------------------------------------------------------------------
COMM DISCLAIMER
COMM ----------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
```

```
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by Fugro Airborne Survey exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and Fugro Airborne Survey
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved Fugro Airborne Survey's use of any
COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information. Fugro
COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM ------------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                        UNITS          NULL               FORMAT
COMM Line Number                                 -99999             I7
COMM Flight Number                               -99                I4
COMM Date (yyyymmdd)                             -9999999           I9
COMM Fiducial Number               s             -9999.9            F8.1
COMM Time (local)                  s             -9999.9            F8.1
COMM Easting                       m             -99999.99          F10.2
COMM Northing                      m             -999999.99         F11.2
COMM Longitude                     deg           -999.9999999       F13.7
COMM Latitude                      deg           -99.9999999        F12.7
COMM GPS Altitude                  m             -999.99            F8.2
COMM Radar Altitude                m             -999.99            F8.2
COMM Raw Cosmic                    cps           -99                I4
COMM Barometric Pressure           hPa           -999.99            F8.2
COMM Temperature                   deg C         -9.9               F5.1
COMM Livetime                      s             -9.999             F7.3
COMM Raw 256 Channel Radiometrics  counts        -999               256I5
```

Yiyintyi East

Description File for 0.1 sec Magnetics Data

```
COMM JOB NUMBER:                                                  2251
COMM AREA NUMBER:                                                    2
COMM SURVEY COMPANY:                          Fugro Airborne Surveys
COMM CLIENT:                                   Sandfire Resources NL
COMM SURVEY TYPE:                           Magnetic and Radiometric
COMM AREA NAME:                                        Yiyintyi East
COMM STATE:                                        Western Australia
COMM COUNTRY:                                              Australia
COMM SURVEY FLOWN:                    23 September - 04 October 2011
COMM LOCATED DATA CREATED:                          02 November 2011
COMM
COMM DATUM:                                                    GDA94
COMM PROJECTION:                                                 MGA
COMM ZONE:                                                        53
COMM
COMM SURVEY SPECIFICATIONS
```

```
COMM
COMM TRAVERSE LINE SPACING:                                          50 m
COMM TRAVERSE LINE DIRECTION:                                 105 - 285 deg
COMM TIE LINE SPACING:                                               520 m
COMM TIE LINE DIRECTION:                                      012 - 192 deg
COMM NOMINAL TERRAIN CLEARANCE:                                      40 m
COMM FINAL LINE KILOMETRES (in the 10 Hz dataset):                562.84 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                              2000101 - 1012801
COMM TIE LINE NUMBERS:                                   2900101 - 2900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     573746    8318658
COMM     577070    8317825
COMM     575913    8311631
COMM     572444    8312539
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                 VH-FGZ Aerocommander AC500S
COMM
COMM MAGNETOMETER:                              Scintrex CS2 Cesium Vapour
COMM INSTALLATION:                                                Stinger
COMM
COMM RESOLUTION:                                                0.001 nT
COMM RECORDING INTERVAL:                                           0.1 s
COMM
COMM RADAR ALTIMETER:                                        Collins Alt-50
COMM RECORDING INTERVAL:                                           0.1 s
COMM
COMM NAVIGATION:                             real-time differential GPS
COMM RECORDING INTERVAL:                                           1.0 s
COMM
COMM ACQUISITION SYSTEM:                                        Fugro DAS
COMM
COMM BASE MAGNETOMETER:                                  Scintrex Envi-Mag
COMM RECORDING INTERVAL:                                             5 s
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                   0.5 s
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                        base value 48088 nT
COMM
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM IGRF CORRECTION APPLIED                           base value 47803 nT
COMM IGRF MODEL 2010 extrapolated to                           2011/09/24
COMM
COMM DATA HAVE BEEN HEIGHT CORRECTED (TAYLOR DRAPE) to 40m AGL
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
```

```
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (RADAR ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM ------------------------------------------------------------------------
COMM DISCLAIMER
COMM ------------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
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COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and Fugro Airborne Survey
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved Fugro Airborne Survey's use of any
COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information. Fugro
COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
COMM calculation is directly dependent on the accuracy of the two input
COMM parameters, radar altitude and GPS altitude. The radar altitude value
COMM may be erroneous in areas of heavy tree cover, where the altimeter
COMM reflects the distance to the tree canopy rather than the ground. The
COMM GPS altitude value is primarily dependent on the number of available
COMM satellites. Although post-processing of GPS data will yield X and Y
COMM accuracies in the order of 1-2 metres, the accuracy of the altitude
COMM value is usually much less, sometimes in the ±5 metre range. Further
COMM inaccuracies may be introduced during the interpolation and gridding
COMM process. Because of the inherent inaccuracies of this method, no
COMM guarantee is made or implied that the information displayed is a true
COMM representation of the height above sea level. Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM ------------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                              UNITS      NULL              FORMAT
COMM Line Number                                   -99999            I7
COMM Flight Number                                 -99               I4
COMM Date (yyyymmdd)                               -9999999          I9
COMM Fiducial Number                               -9999.9           F8.1
COMM Time (UTC seconds past midnight)   s          -9999.9           F8.1
COMM Easting                            m          -99999.99         F10.2
COMM Northing                           m          -999999.99        F11.2
COMM Longitude                          deg        -999.9999999      F13.7
```

```
COMM Latitude                          deg        -99.9999999          F12.7
COMM GPS Altitude                      m          -999.99              F8.2
COMM Radar Altitude                    m          -999.99              F8.2
COMM Compensated TMI                   nT         -99999.999           F11.3
COMM Diurnal                           nT         -9999.99             F9.2
COMM Final TMI                         nT         -99999.999           F11.3
COMM Digital Terrain Model             m          -999.99              F8.2
```

Description File for 1.0 sec Windowed Radiometrics Data

```
COMM JOB NUMBER:                                                        2251
COMM AREA NUMBER:                                                          2
COMM SURVEY COMPANY:                                  Fugro Airborne Surveys
COMM CLIENT:                                           Sandfire Resources NL
COMM SURVEY TYPE:                                   Magnetic and Radiometric
COMM AREA NAME:                                                 Yiyintyi East
COMM STATE:                                                  Western Australia
COMM COUNTRY:                                                       Australia
COMM SURVEY FLOWN:                          23 September - 04 October 2011
COMM LOCATED DATA CREATED:                                   02 November 2011
COMM
COMM DATUM:                                                             GDA94
COMM PROJECTION:                                                          MGA
COMM ZONE:                                                                 53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                             50 m
COMM TRAVERSE LINE DIRECTION:                                  105 - 285 deg
COMM TIE LINE SPACING:                                                520 m
COMM TIE LINE DIRECTION:                                       012 - 192 deg
COMM NOMINAL TERRAIN CLEARANCE:                                         40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset):                   553.73 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                                 2000101 - 2012801
COMM TIE LINE NUMBERS:                                      2900101 - 2900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     573746    8318658
COMM     577070    8317825
COMM     575913    8311631
COMM     572444    8312539
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                    VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                             256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                                  33.56 l
COMM RECORDING INTERVAL:                                               1.0 s
COMM
COMM RADAR ALTIMETER:                                          Collins Alt-50
COMM RECORDING INTERVAL:                                              0.1 s
COMM
COMM NAVIGATION:                                 real-time differential GPS
COMM RECORDING INTERVAL:                                               1.0 s
COMM
COMM ACQUISITION SYSTEM:                                            Fugro DAS
COMM
COMM DATA PROCESSING
```

```
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                    0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NASVD FILTERING APPLIED TO 256 CHANNEL DATA
COMM WINDOW DATA EXTRACTED USING IAEA STANDARD WINDOWS
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM COSMIC, AIRCRAFT AND RADON BACKGROUNDS REMOVED
COMM STRIPPING CORRECTIONS APPLIED
COMM HEIGHT CORRECTED TO                                         40 m AGL
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                    21.0
COMM POTASSIUM                                                       6.2
COMM URANIUM                                                         0.7
COMM THORIUM                                                         0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                    0.900
COMM POTASSIUM                                                      0.053
COMM URANIUM                                                        0.042
COMM THORIUM                                                        0.051
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                         0.2569
COMM BETA                                                          0.3736
COMM GAMMA                                                         0.7416
COMM a                                                             0.0591
COMM b                                                             0.0002
COMM c                                                            -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                        0.00049
COMM BETA                                                         0.00065
COMM GAMMA                                                        0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                                   13.150
COMM POTASSIUM                                                      0.782
COMM THORIUM                                                        0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                     1.875
COMM GROUND (C2)                                                    0.677
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                                  -0.0072
COMM POTASSIUM                                                    -0.0099
COMM URANIUM                                                      -0.0086
COMM THORIUM                                                      -0.0067
COMM
COMM ------------------------------------------------------------------------
COMM DISCLAIMER
COMM ------------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
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COMM review and advice shall be at the Client's own or sole risk.
COMM
```

```
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COMM or part to any third party, and such party relies thereon, that party
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COMM
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COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM ------------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                      UNITS           NULL              FORMAT
COMM Line Number                                -99999            I7
COMM Flight Number                              -99               I4
COMM Date (yyyymmdd)                            -9999999          I9
COMM Fiducial Number             s              -9999.9           F8.1
COMM Time (local)                s              -9999.9           F8.1
COMM Easting                     m              -99999.99         F10.2
COMM Northing                    m              -999999.99        F11.2
COMM Longitude                   deg            -999.9999999      F13.7
COMM Latitude                    deg            -99.9999999       F12.7
COMM GPS Altitude                m              -999.99           F8.2
COMM Radar Altitude              m              -999.99           F8.2
COMM Uncorrected Total Count     cps            -9999.9           F8.1
COMM Uncorrected Potassium       cps            -999.9            F7.1
COMM Uncorrected Uranium         cps            -999.9            F7.1
COMM Uncorrected Thorium         cps            -999.9            F7.1
COMM Raw Cosmic                  cps            -99               I4
COMM Final Total Count           cps            -9999.9           F8.1
COMM Final Potassium             cps            -999.9            F7.1
COMM Final Uranium               cps            -999.9            F7.1
COMM Final Thorium               cps            -999.9            F7.1
```

Description File for 1.0 sec Raw 256 Channel Radiometrics Data

```
COMM JOB NUMBER:                                                  2251
COMM AREA NUMBER:                                                    2
COMM SURVEY COMPANY:                              Fugro Airborne Surveys
COMM CLIENT:                                       Sandfire Resources NL
COMM SURVEY TYPE:                               Magnetic and Radiometric
COMM AREA NAME:                                            Yiyintyi East
COMM STATE:                                          Western Australia
COMM COUNTRY:                                                Australia
COMM SURVEY FLOWN:                      23 September - 04 October 2011
COMM LOCATED DATA CREATED:                           02 November 2011
COMM
COMM DATUM:                                                       GDA94
COMM PROJECTION:                                                    MGA
COMM ZONE:                                                           53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                        50 m
COMM TRAVERSE LINE DIRECTION:                             105 - 285 deg
```

```
COMM TIE LINE SPACING:                                              520 m
COMM TIE LINE DIRECTION:                                  012 - 192 deg
COMM NOMINAL TERRAIN CLEARANCE:                                      40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset):                553.73 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                           2000101 - 2012801
COMM TIE LINE NUMBERS:                                2900101 - 2900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     573746    8318658
COMM     577070    8317825
COMM     575913    8311631
COMM     572444    8312539
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                              VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                        256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                           33.56 l
COMM RECORDING INTERVAL:                                         1.0 s
COMM
COMM RADAR ALTIMETER:                                    Collins Alt-50
COMM RECORDING INTERVAL:                                         0.1 s
COMM
COMM NAVIGATION:                             real-time differential GPS
COMM RECORDING INTERVAL:                                         1.0 s
COMM
COMM ACQUISITION SYSTEM:                                      Fugro DAS
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                 0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                 0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                 0.0 s
COMM
COMM BAROMETRIC DATA
COMM PARALLAX CORRECTION APPLIED                                 0.0 s
COMM
COMM TEMPERATURE DATA
COMM PARALLAX CORRECTION APPLIED                                 0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NO PROCESSING APPLIED TO RAW 256 CHANNEL RADIOMETRIC DATA
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                  21.0
COMM POTASSIUM                                                     6.2
COMM URANIUM                                                       0.7
COMM THORIUM                                                       0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                 0.900
COMM POTASSIUM                                                   0.053
COMM URANIUM                                                     0.042
COMM THORIUM                                                     0.051
```

```
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                    0.2569
COMM BETA                                                     0.3736
COMM GAMMA                                                    0.7416
COMM a                                                        0.0591
COMM b                                                        0.0002
COMM c                                                       -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                   0.00049
COMM BETA                                                    0.00065
COMM GAMMA                                                   0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                              13.150
COMM POTASSIUM                                                 0.782
COMM THORIUM                                                   0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                1.875
COMM GROUND (C2)                                               0.677
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                             -0.0072
COMM POTASSIUM                                               -0.0099
COMM URANIUM                                                 -0.0086
COMM THORIUM                                                 -0.0067
COMM
COMM ---------------------------------------------------------------------
COMM DISCLAIMER
COMM ---------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
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COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
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COMM
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COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
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COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM ---------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                        UNITS          NULL                FORMAT
COMM Line Number                                 -99999              I7
COMM Flight Number                               -99                 I4
COMM Date (yyyymmdd)                             -9999999            I9
COMM Fiducial Number               s             -9999.9             F8.1
COMM Time (local)                  s             -9999.9             F8.1
COMM Easting                       m             -99999.99           F10.2
```

```
COMM Northing                      m            -999999.99          F11.2
COMM Longitude                     deg          -999.9999999        F13.7
COMM Latitude                      deg          -99.9999999         F12.7
COMM GPS Altitude                  m            -999.99             F8.2
COMM Radar Altitude                m            -999.99             F8.2
COMM Raw Cosmic                    cps          -99                 I4
COMM Barometric Pressure           hPa          -999.99             F8.2
COMM Temperature                   deg C        -9.9                F5.1
COMM Livetime                      s            -9.999              F7.3
COMM Raw 256 Channel Radiometrics  counts       -999                256I5
```

Yiyintyi West

Description File for 0.1 sec Magnetics Data

```
COMM JOB NUMBER:                                                    2251
COMM AREA NUMBER:                                                      3
COMM SURVEY COMPANY:                                 Fugro Airborne Surveys
COMM CLIENT:                                          Sandfire Resources NL
COMM SURVEY TYPE:                                 Magnetic and Radiometric
COMM AREA NAME:                                              Yiyintyi West
COMM STATE:                                               Western Australia
COMM COUNTRY:                                                    Australia
COMM SURVEY FLOWN:                          01 October - 03 October 2011
COMM LOCATED DATA CREATED:                            03 November 2011
COMM
COMM DATUM:                                                         GDA94
COMM PROJECTION:                                                      MGA
COMM ZONE:                                                             53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                         50 m
COMM TRAVERSE LINE DIRECTION:                                039 - 219 deg
COMM TIE LINE SPACING:                                             500 m
COMM TIE LINE DIRECTION:                                     300 - 120 deg
COMM NOMINAL TERRAIN CLEARANCE:                                     40 m
COMM FINAL LINE KILOMETRES (in the 10 Hz dataset):                599.07 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                              3000101 - 3013601
COMM TIE LINE NUMBERS:                                   3900101 - 3900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     559476    8312704
COMM     565423    8309318
COMM     563111    8306510
COMM     557577    8310226
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                              VH-FGZ Aerocommander AC500S
COMM
COMM MAGNETOMETER:                           Scintrex CS2 Cesium Vapour
COMM INSTALLATION:                                              Stinger
COMM
COMM RESOLUTION:                                              0.001 nT
COMM RECORDING INTERVAL:                                         0.1 s
COMM
COMM RADAR ALTIMETER:                                    Collins Alt-50
COMM RECORDING INTERVAL:                                         0.1 s
COMM
```

```
COMM NAVIGATION:                                  real-time differential GPS
COMM RECORDING INTERVAL:                                             1.0 s
COMM
COMM ACQUISITION SYSTEM:                                          Fugro DAS
COMM
COMM BASE MAGNETOMETER:                                  Scintrex Envi-Mag
COMM RECORDING INTERVAL:                                             5 s
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                     0.5 s
COMM
COMM MAGNETIC DATA
COMM DIURNAL CORRECTION APPLIED                        base value 48088 nT
COMM
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM IGRF CORRECTION APPLIED                           base value 47803 nT
COMM IGRF MODEL 2010 extrapolated to                            2011/09/24
COMM
COMM DATA HAVE BEEN HEIGHT CORRECTED (TAYLOR DRAPE) to 40m AGL
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                     0 s
COMM
COMM DIGITAL TERRAIN DATA
COMM DTM CALCULATED [DTM = GPS ALTITUDE - (RADAR ALT + SENSOR SEPARATION)]
COMM DATA CORRECTED TO AUSTRALIAN HEIGHT DATUM
COMM DATA HAVE BEEN TIE LINE LEVELLED
COMM DATA HAVE BEEN MICROLEVELLED
COMM
COMM ------------------------------------------------------------------------
COMM DISCLAIMER
COMM ------------------------------------------------------------------------
COMM It is Fugro Airborne Survey’s understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
COMM That purpose was a significant factor in determining the scope and
COMM level of the Services being offered to the Client. Should the purpose
COMM for which the data is used change, the data may no longer be valid or
COMM appropriate and any further use of, or reliance upon, the data in
COMM those circumstances by the Client without Fugro Airborne Survey's
COMM review and advice shall be at the Client's own or sole risk.
COMM
COMM The Services were performed by Fugro Airborne Survey exclusively for
COMM the purposes of the Client. Should the data be made available in whole
COMM or part to any third party, and such party relies thereon, that party
COMM does so wholly at its own and sole risk and Fugro Airborne Survey
COMM disclaims any liability to such party.
COMM
COMM Where the Services have involved Fugro Airborne Survey's use of any
COMM information provided by the Client or third parties, upon which
COMM Fugro Airborne Survey was reasonably entitled to rely, then the
COMM Services are limited by the accuracy of such information. Fugro
COMM Airborne Survey is not liable for any inaccuracies (including any
COMM incompleteness) in the said information, save as otherwise provided
COMM in the terms of the contract between the Client and Fugro Airborne
COMM Survey.
COMM
COMM With regard to DIGITAL TERRAIN DATA, the accuracy of the elevation
```

COMM calculation is directly dependent on the accuracy of the two input
COMM parameters, radar altitude and GPS altitude. The radar altitude value
COMM may be erroneous in areas of heavy tree cover, where the altimeter
COMM reflects the distance to the tree canopy rather than the ground. The
COMM GPS altitude value is primarily dependent on the number of available
COMM satellites. Although post-processing of GPS data will yield X and Y
COMM accuracies in the order of 1-2 metres, the accuracy of the altitude
COMM value is usually much less, sometimes in the ±5 metre range. Further
COMM inaccuracies may be introduced during the interpolation and gridding
COMM process. Because of the inherent inaccuracies of this method, no
COMM guarantee is made or implied that the information displayed is a true
COMM representation of the height above sea level. Although this product
COMM may be of some use as a general reference,
COMM THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.
COMM ----------
COMM
COMM LINE DATA FORMAT
COMM A space is left between fixed fields so that a field of, for example,
COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM

COMM FIELD	UNITS	NULL	FORMAT
COMM Line Number		-99999	I7
COMM Flight Number		-99	I4
COMM Date (yyyymmdd)		-9999999	I9
COMM Fiducial Number		-9999.9	F8.1
COMM Time (UTC seconds past midnight)	s	-9999.9	F8.1
COMM Easting	m	-99999.99	F10.2
COMM Northing	m	-999999.99	F11.2
COMM Longitude	deg	-999.9999999	F13.7
COMM Latitude	deg	-99.9999999	F12.7
COMM GPS Altitude	m	-999.99	F8.2
COMM Radar Altitude	m	-999.99	F8.2
COMM Compensated TMI	nT	-99999.999	F11.3
COMM Diurnal	nT	-9999.99	F9.2
COMM Final TMI	nT	-99999.999	F11.3
COMM Digital Terrain Model	m	-999.99	F8.2

Description File for 1.0 sec Windowed Radiometrics Data

COMM JOB NUMBER: 2251
COMM AREA NUMBER: 3
COMM SURVEY COMPANY: Fugro Airborne Surveys
COMM CLIENT: Sandfire Resources NL
COMM SURVEY TYPE: Magnetic and Radiometric
COMM AREA NAME: Yiyintyi West
COMM STATE: Western Australia
COMM COUNTRY: Australia
COMM SURVEY FLOWN: 01 October - 03 October 2011
COMM LOCATED DATA CREATED: 03 November 2011
COMM
COMM DATUM: GDA94
COMM PROJECTION: MGA
COMM ZONE: 53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING: 50 m
COMM TRAVERSE LINE DIRECTION: 039 - 219 deg
COMM TIE LINE SPACING: 500 m
COMM TIE LINE DIRECTION: 300 - 120 deg
COMM NOMINAL TERRAIN CLEARANCE: 40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset): 589.40 km
COMM

```
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                          3000101 - 3013601
COMM TIE LINE NUMBERS:                               3900101 - 3900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     559476    8312704
COMM     565423    8309318
COMM     563111    8306510
COMM     557577    8310226
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                             VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                        256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                          33.56 l
COMM RECORDING INTERVAL:                                        1.0 s
COMM
COMM RADAR ALTIMETER:                                    Collins Alt-50
COMM RECORDING INTERVAL:                                        0.1 s
COMM
COMM NAVIGATION:                        real-time differential GPS
COMM RECORDING INTERVAL:                                        1.0 s
COMM
COMM ACQUISITION SYSTEM:                                     Fugro DAS
COMM
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NASVD FILTERING APPLIED TO 256 CHANNEL DATA
COMM WINDOW DATA EXTRACTED USING IAEA STANDARD WINDOWS
COMM PARALLAX CORRECTION APPLIED                                0.0 s
COMM COSMIC, AIRCRAFT AND RADON BACKGROUNDS REMOVED
COMM STRIPPING CORRECTIONS APPLIED
COMM HEIGHT CORRECTED TO                                     40 m AGL
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                21.0
COMM POTASSIUM                                                   6.2
COMM URANIUM                                                     0.7
COMM THORIUM                                                     0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                0.900
COMM POTASSIUM                                                  0.053
COMM URANIUM                                                    0.042
COMM THORIUM                                                    0.051
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                     0.2569
COMM BETA                                                      0.3736
COMM GAMMA                                                     0.7416
COMM a                                                         0.0591
COMM b                                                         0.0002
```

```
COMM c                                                          -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                      0.00049
COMM BETA                                                       0.00065
COMM GAMMA                                                      0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                                 13.150
COMM POTASSIUM                                                    0.782
COMM THORIUM                                                      0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                   1.875
COMM GROUND (C2)                                                  0.701
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                                -0.0072
COMM POTASSIUM                                                  -0.0099
COMM URANIUM                                                    -0.0086
COMM THORIUM                                                    -0.0067
COMM
COMM ---------------------------------------------------------------------
COMM DISCLAIMER
COMM ---------------------------------------------------------------------
COMM It is Fugro Airborne Survey's understanding that the data provided to
COMM the client is to be used for the purpose agreed between the parties.
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COMM ---------------------------------------------------------------------
COMM
COMM LINE DATA FORMAT
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COMM A8 should only ever have a maximum of 7 characters in it, even when it
COMM is a null, thus:
COMM
COMM FIELD                      UNITS           NULL              FORMAT
COMM Line Number                                -99999            I7
COMM Flight Number                              -99               I4
COMM Date (yyyymmdd)                            -9999999          I9
COMM Fiducial Number             s              -9999.9           F8.1
COMM Time (local)                s              -9999.9           F8.1
COMM Easting                     m              -99999.99         F10.2
COMM Northing                    m              -999999.99        F11.2
COMM Longitude                   deg            -999.9999999      F13.7
COMM Latitude                    deg            -99.9999999       F12.7
COMM GPS Altitude                m              -999.99           F8.2
COMM Radar Altitude              m              -999.99           F8.2
COMM Uncorrected Total Count     cps            -9999.9           F8.1
```

```
COMM Uncorrected Potassium      cps            -999.9            F7.1
COMM Uncorrected Uranium        cps            -999.9            F7.1
COMM Uncorrected Thorium        cps            -999.9            F7.1
COMM Raw Cosmic                 cps            -99               I4
COMM Final Total Count          cps            -9999.9           F8.1
COMM Final Potassium            cps            -999.9            F7.1
COMM Final Uranium              cps            -999.9            F7.1
COMM Final Thorium              cps            -999.9            F7.1
```

Description File for 1.0 sec Raw 256 Channel Radiometrics Data

```
COMM JOB NUMBER:                                                    2251
COMM AREA NUMBER:                                                      3
COMM SURVEY COMPANY:                                  Fugro Airborne Surveys
COMM CLIENT:                                           Sandfire Resources NL
COMM SURVEY TYPE:                                  Magnetic and Radiometric
COMM AREA NAME:                                                Yiyintyi West
COMM STATE:                                                Western Australia
COMM COUNTRY:                                                      Australia
COMM SURVEY FLOWN:                              01 October - 03 October 2011
COMM LOCATED DATA CREATED:                                  03 November 2011
COMM
COMM DATUM:                                                          GDA94
COMM PROJECTION:                                                       MGA
COMM ZONE:                                                              53
COMM
COMM SURVEY SPECIFICATIONS
COMM
COMM TRAVERSE LINE SPACING:                                           50 m
COMM TRAVERSE LINE DIRECTION:                                039 - 219 deg
COMM TIE LINE SPACING:                                               500 m
COMM TIE LINE DIRECTION:                                     300 - 120 deg
COMM NOMINAL TERRAIN CLEARANCE:                                       40 m
COMM FINAL LINE KILOMETRES (in the 1 Hz dataset):                 589.40 km
COMM
COMM LINE NUMBERING
COMM
COMM TRAVERSE LINE NUMBERS:                                 3000101 - 3013601
COMM TIE LINE NUMBERS:                                      3900101 - 3900801
COMM
COMM AREA BOUNDARY
COMM
COMM    EASTING    NORTHING
COMM     559476    8312704
COMM     565423    8309318
COMM     563111    8306510
COMM     557577    8310226
COMM
COMM SURVEY EQUIPMENT
COMM
COMM AIRCRAFT:                                  VH-FGZ Aerocommander AC500S
COMM
COMM SPECTROMETER:                             256 Channel Exploranium GR820
COMM CRYSTAL VOLUME:                                                33.56 l
COMM RECORDING INTERVAL:                                             1.0 s
COMM
COMM RADAR ALTIMETER:                                        Collins Alt-50
COMM RECORDING INTERVAL:                                             0.1 s
COMM
COMM NAVIGATION:                                real-time differential GPS
COMM RECORDING INTERVAL:                                             1.0 s
COMM
COMM ACQUISITION SYSTEM:                                         Fugro DAS
COMM
```

```
COMM DATA PROCESSING
COMM
COMM CO-ORDINATES
COMM PARALLAX CORRECTION APPLIED                                    0.5 s
COMM
COMM RADAR ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM GPS ALTITUDE DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM BAROMETRIC DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM TEMPERATURE DATA
COMM PARALLAX CORRECTION APPLIED                                    0.0 s
COMM
COMM RADIOMETRIC DATA
COMM NO PROCESSING APPLIED TO RAW 256 CHANNEL RADIOMETRIC DATA
COMM
COMM AIRCRAFT BACKGROUND COEFFICIENTS
COMM TOTAL COUNT                                                     21.0
COMM POTASSIUM                                                        6.2
COMM URANIUM                                                          0.7
COMM THORIUM                                                          0.9
COMM COSMIC COEFFICIENTS
COMM TOTAL COUNT                                                    0.900
COMM POTASSIUM                                                      0.053
COMM URANIUM                                                        0.042
COMM THORIUM                                                        0.051
COMM STRIPPING COEFFICIENTS
COMM ALPHA                                                         0.2569
COMM BETA                                                          0.3736
COMM GAMMA                                                         0.7416
COMM a                                                             0.0591
COMM b                                                             0.0002
COMM c                                                            -0.0169
COMM STRIPPING HEIGHT ATTENUATION COEFFICIENTS
COMM ALPHA                                                        0.00049
COMM BETA                                                         0.00065
COMM GAMMA                                                        0.00069
COMM RADON STRIPPING COEFFICIENTS
COMM TOTAL COUNT                                                   13.150
COMM POTASSIUM                                                      0.782
COMM THORIUM                                                        0.061
COMM SPECTRAL RATIOS
COMM RADON (C1)                                                     1.875
COMM GROUND (C2)                                                    0.701
COMM ALTITUDE COEFFICIENTS
COMM TOTAL COUNT                                                  -0.0072
COMM POTASSIUM                                                    -0.0099
COMM URANIUM                                                      -0.0086
COMM THORIUM                                                      -0.0067
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COMM

COMM FIELD	UNITS	NULL	FORMAT
COMM Line Number		-99999	I7
COMM Flight Number		-99	I4
COMM Date (yyyymmdd)		-9999999	I9
COMM Fiducial Number	s	-9999.9	F8.1
COMM Time (local)	s	-9999.9	F8.1
COMM Easting	m	-99999.99	F10.2
COMM Northing	m	-999999.99	F11.2
COMM Longitude	deg	-999.9999999	F13.7
COMM Latitude	deg	-99.9999999	F12.7
COMM GPS Altitude	m	-999.99	F8.2
COMM Radar Altitude	m	-999.99	F8.2
COMM Raw Cosmic	cps	-99	I4
COMM Barometric Pressure	hPa	-999.99	F8.2
COMM Temperature	deg C	-9.9	F5.1
COMM Livetime	s	-9.999	F7.3
COMM Raw 256 Channel Radiometrics	counts	-999	256I5

APPENDIX IV – List Of All Supplied Data

Final Located Data

- 0.1 second magnetics and digital terrain data
- 1.0 second windowed radiometrics data
- 1.0 second raw 256 channel radiometric data

Final located data is in ASCII format. Contents of each are shown in Appendix IV.

Raw Initial Products

Raw initial grids were produced in Geo-referenced TIFF format

- Raw Total magnetic intensity (nT)
- Raw Total count (cps)
- Raw Potassium count (cps)
- Raw Uranium count (cps)
- Raw Thorium count (cps)

Preliminary Gridded Data

Preliminary gridded data was produced in ERMapper format

- Total magnetic intensity (nT)
- Total count (cps)
- Potassium count (cps)
- Uranium count (cps)
- Thorium count (cps)
- Digital terrain model (m AHD)

Final Gridded Data

Final gridded data was produced in ERMapper format

- Total magnetic intensity (nT)
- 1VD of TMI (nT/m
- Total count (cps)
- Potassium count (cps)
- Uranium count (cps)
- Thorium count (cps)
- Digital terrain model (m AHD)

Additional Products
A logistics and processing report