Logistics
Report

for a

DETAILED AIRBORNE GEOPHYSICAL SURVEY

for the

DEAF ADDER PROJECT

carried out on behalf of

CAMECO AUSTRALIA PTY LTD

by

UTS GEOPHYSICS
(UTS Job #A267)

VALENTINE ROAD, PERTH AIRPORT
PO BOX 126, BELMONT WA 6104
Telephone +61 8 9479 4232 Facsimile +61 8 9479 7361
A.C.N. 058 054 603

TABLE OF CONTENTS

1 GENERAL SURVEY INFORMATION

In June 1998, UTS Geophysics conducted a low level airborne geophysical survey in the Jabiru area of Northern Territory for Cameco Australia Pty Ltd. This report summarises the logistics, survey parameters and processing details of the survey.

The survey commenced on the 25th June 1998 and was completed on the 15th July 1998.

UTS Geophysics provided the described survey for the following company:

Cameco Australia Pty Ltd
66 Winnellie Road
WINNELLIE N.T 0820

2 SURVEY LOCATION

The area surveyed was located in the Jabiru area of the Northern Territory. A survey location map is provided in Appendix C of this report.

The survey was flown using the AMG84 coordinate system (a Universal Transverse Mercator projection) derived from the AGD66 geodetic datum and was contained within zone 53 with a central meridian of 135 degrees. Details of the datum and project system are provided in Appendix B of this report.

3 AIRCRAFT AND SURVEY EQUIPMENT

The UTS navigation flight control computer, data acquisition system and geophysical sensors were installed into a specialised geophysical survey aircraft.

The list of geophysical and navigation equipment used for the survey is as follows:

General Survey Equipment

- FU24-954 fixed wing survey aircraft.
- UTS proprietory flight planning and survey navigation system.
- UTS proprietory high speed digital data acquisition system.
- Novatel 3951R, 12 channel precision navigation GPS.
- Satellite transmitted differential GPS correction receiver.
- UTS LCD pilot navigation display and external track guidance display.
- UTS post mission data verification and processing system.
- Bendix King KRA-405 radar altimeter.

Magnetic Data Acquisition Equipment

- UTS tail stinger magnetometer installation.
- Scintrex Cesium Vapour CS-2 total field magnetometer.
- Develco three component vector magnetometer.
- RMS Aeromagnetic Automatic Digital Compensator (AADC II).
- Diurnal monitoring magnetometer 1 (Geometrics G-856).
- Diurnal monitoring magnetometer 2 (Scintrex Envimag).

Radiometric Data Acquisition Equipment

- Exploranium GR-820 gamma ray spectrometer.
- Exploranium gamma ray detectors (2 x 16 litres).
- Barometric altimeter (height and pressure measurements).
- Temperature and humidity sensor.

3.1 Survey Aircraft

The aircraft used was a FU24-954 fixed wing survey aircraft owned by UTS Geophysics, registration VH-CYU.

Power Plant

- Engine Type Single engine, Lycoming, IO-720
- Brake Horse Power400 bhp
- Fuel Type AV-GAS

Performance

- Cruise speed 105 Kn
- Survey speed 100 Kn
- Stall speed 45 Kn
- Range 970 Km
- Endurance (no reserves) 5 hours
- Fuel tank capacity 400 litres

3.2 Data Positioning and Flight Navigation

Survey data positioning and flight line navigation was derived using real-time differential GPS (Global Positioning System).

Navigation was provided through a UTS designed and built electronic pilot navigation system providing computer controlled digital navigation instrumentation mounted in the cockpit as well as an externally mounted track guidance system.

GPS derived positions were used to provide both aircraft navigation and survey data location information.

The GPS systems used for the survey were:

- Aircraft GPS Model Novatel 3951R
- GPS satellite tracking channels 12 parallel
- Typical differentially corrected accuracy 2-3 metres (horizontal)
- Real-time differential service RACAL Landstar

3.3 UTS Data Acquisition System and Digital Recording

All geophysical sensor data and positional information measured during the survey was recorded using a UTS developed, high speed, precision data acquisition system. Survey data was downloaded onto magnetic tape on completion of each survey day.

Instrument synchronisation times were measured and removed in real-time by the UTS data acquisition system.

3.4 Altitude Readings

Accurate survey heights above the terrain were measured using a King radar altimeter installed in the aircraft. The height of each survey data point was measured by the radar altimeter and stored by the UTS data acquisition system.

- Radar altimeter model — King KRA-405, twin antenna altimeter
- Accuracy — 0.3 metres
- Resolution — 0.1 metres
- Range — 0 - 500 metres
- Sample rate — 0.1 Seconds (10Hz)

3.5 UTS Stinger Mounted Magnetometer System

The installation platform used for the acquisition of magnetic data was a tail mounted stinger. This proprietory stinger system was constructed of carbon fibre and designed for maximum rigidity and stability.

Both the total field magnetometer and three component vector magnetometer were located within the tail stinger.

3.6 Total Field Magnetometer

Total field magnetic data readings for the survey were made using a Scintrex Cesium Vapour CS-2 Magnetometer. This precision sensor has the following specifications:

- Model — Scintrex Cesium Vapour CS-2 Magnetometer
- Sample Rate — 0.1 seconds (10Hz)
- Sensitivity — 0.001nT
- Operating Range — 15,000nT to 100,000nT
- Temperature Range — -20^{o}C to +50^{o}C

3.7 Aircraft Magnetic Compensation

At the start of the survey, the system was calibrated for reduction of magnetic heading error. The heading and maneuver effects of the aircraft on the magnetic data was removed using an RMS Automatic Airborne Digital Compensator (AADC II).

Calibration of the aircraft heading effects were measured by flying a series of pitch, roll and yaw maneuvers at high altitude while monitoring changes in the three axis magnetometer and the effect on total field readings. A 26 term model of the aircraft magnetic noise covering permanent, induced and eddy current fields was determined. These coefficients were then applied to the data collected during the survey in real-time.

UTS static compensation techniques were also employed to reduce the initial magnetic effects of the aircraft upon the survey data.

3.8 Diurnal Monitoring Magnetometer

Two base station magnetometers were located in a low gradient area beyond the region of influence by any man made interference to monitor diurnal variations during the survey.

The specifications for the magnetometers used are as follows:

- Model Scintrex Envimag
- Resolution 0.1 nT
- Sample interval 5 seconds (0.2Hz)
- Operating range 20,000nT to 90,000nT
- Temperature -20^{o}C to +50^{o}C

- Model Geometrics G-856
- Resolution 0.1 nT
- Sample interval 10 seconds (0.1Hz)
- Operating range 20,000nT to 90,000nT
- Temperature -20^{o}C to +50^{o}C

3.9 Barometric Altitude

An Air DB barometric altimeter was installed in the aircraft so as to record and monitor barometric height and pressure. The data was recorded at 0.33 second intervals and is used for the reduction of the radiometric data.

- Model Air DB barometric altimeter
- Accuracy 2 metres
- Height resolution 0.1 metres
- Height range 0 - 3500 metres
- Maximum operating pressure: 1,300 mb
- Pressure resolution: 0.01 mb
- Sample rate 3 Hz

3.10 Temperature and Humidity

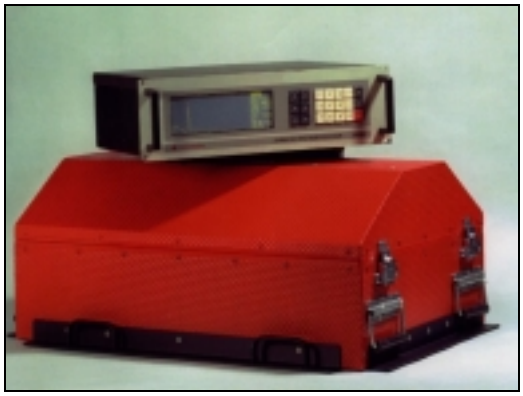
Temperature and humidity measurements were made during the survey at a sample rate of 10Hz.

3.11 Radiometric Data Acquisition

The gamma ray spectrometer used for the survey was capable of recording 256 channels and was self stabilising in order to minimise spectral drift. The detectors used were thallium activated sodium iodide crystals.

Thorium and cesium source measurements were made each survey day to monitor system resolution and sensitivity. A calibration line was also flown at the start and end of each survey day to monitor ground moisture levels and system performance.

- Spectrometer model Exploranium, GR820
- Detector volume 32 litres



4 PERSONNEL

4.1 Field Operations

UTS Geophysics operator	Steve Whelan
UTS Geophysics data processor	Steve Whelan
UTS Survey Pilot # 1	Mike Officer
UTS Survey Pilot # 2	Alan Price

4.2 Project Management

Cameco Australia Contact	Geoff Beckitt
UTS Geophysics Perth Office	Matthew Wall

5 SURVEY PARAMETERS

The survey data acquisition specifications for each area flown are specified in the following table:

PROJECT NAME	LINE SPACING	LINE DIRECTION	TIE LINE SPACING	TIE LINE DIRECTION	SENSOR HEIGHT	TOTAL LINE KM
Deaf Adder North	50m	090-270	500m	000-180	25m	1838
Deaf Adder South	50m	090-270	500m	000-180	25m	2193
TOTAL						**4031**

The total number of line kilometres of survey data collected over the survey areas specified in the above table was 4,031.

The specified sensor height for the magnetic samples is as stated in the above table. This sensor height may be varied where topographic relief or laws pertaining to built up areas do not allow this altitude to be maintained, or where the safety of the aircraft and equipment is endangered.

The coordinate boundaries for the survey areas flown is detailed in Appendix C.

6 SURVEY LOGISTICS

The base location used for operating the aircraft and in-field processing of the survey data was the Frontier Lodge Hotel in Jabiru Northern Territory.

6.1 Survey Flight Summary

The following table summarises the flight logs for the survey areas flown:

Flight Date	Area No	Flight No	Area Name	Lines Flown	Line Km Flown
25/6/98	2	1	Deaf Adder South	36	397
25/6/98	2	2	Deaf Adder South	9	84
26/6/98	2	3	Deaf Adder South	46	513
08/7/98	2	4	Deaf Adder South	1	11
09/7/98	2	5	Deaf Adder South	30	308
12/7/98	2	6	Deaf Adder South	5	58
12/7/98	2	7	Deaf Adder South	45	460
13/7/98	2	8	Deaf Adder South	31	339
13/7/98	2	T1	Deaf Adder South	201	23
13/7/98	1	1	Deaf Adder North	26	236
13/7/98	1	2	Deaf Adder North	31	281
14/7/98	1	3	Deaf Adder North	64	581
14/7/98	1	4	Deaf Adder North	44	400
15/7/98	1	5	Deaf Adder North	19	175
15/7/98	1	T1	Deaf Adder North	18	165
TOTAL					**4,031**

6.2 Diurnal Magnetometer Locations

The following table contains the approximate locations where the diurnal base station magnetometer was located for each survey area.

Area Name	Period	Base Station ID	Location
Deaf Adder	25/6/98 – 26/6/98	01	Jabiru Airfield
Deaf Adder	08/7/98 - 15/7/98	01	Pine Creek Airfield

6.3 Spectrometer Calibration Results

The following table summarises the results for the spectrometer resolution and sensitivity tests performed during the survey.

7 DATA PROCESSING PROCEDURES

7.1 Magnetic Data Processing

The raw magnetic survey data was loaded from the field tapes and the recorded data trimmed to the correct survey boundary extents. Any reflight lines were removed from the data.

The diurnal base station data was loaded, checked and suitably filtered for application to the aircraft magnetic data. The diurnal measurements were then subtracted from a diurnal base field value and the corrections removed from the survey data by synchronising the diurnal data time and the aircraft survey time.

The regional magnetic gradient was subtracted from the data by application of the IGRF model calculated at the date of the survey and interpolated on position and time.

The data was then corrected to remove any residual parallax errors. Tie line levelling was applied to the data by measuring tie line crossover points with the survey traverse line data.

Final microlevelling techniques were then applied to the data to remove minor residual variations in profile intensities.

Located and gridded data were generated for the final processed magnetic data.

7.2 Radiometric Data Processing

The raw radiometric survey data was loaded from the field tapes and the recorded data trimmed to the correct survey boundary extents. Any reflight lines were removed from the data.

Statistical noise reduction of the 256 channel data was performed. The energy spectrum between the potassium and thorium peaks was recalibrated from the 256 channel measurements. The 256 channel data was then reduced to the 5 primary channels of total count, potassium, uranium, thorium and low-uranium. Dead time corrections were then applied to the data.

Cosmic and aircraft background corrections were applied. Radon background removal was performed using the Minty Spectral Ratio method (1992). Spectral stripping was then applied to the windowed data.

The altimeter data was corrected and converted to standard temperature and pressure altitude. Height corrections for the srtipped windows was performed to remove any altitude variation effects from the data.

The corrected count rate data was then converted to ground concentrations for total count, potassium, uranium and thorium.

Final microlevelling of the total count, potassium, uranium and thorium data was then applied to remove minor residual variations in profile intensities.

For further information concerning the survey flown, please contact the following office:

Head Office Address:

UTS Geophysics
Valentine Road
Perth Airport
REDCLIFFE WA 6104

Tel: +61 8 9479 4232
Fax: +61 8 9479 7361

Postal Address:

UTS Geophysics
P.O. Box 126
BELMONT WA 6104

APPENDIX A - LOCATED DATA FORMATS

MAGNETIC LOCATED DATA

FIELD	FORMAT	DESCRIPTION	UNITS
1	I6	LINE NUMBER	
2	I5	FLIGHT/AREA NUMBER	AAFF (Area/Flight)
3	I8	DATE	YYMMDD
4	F11.1	TIME	sec
5	I8	FIDUCIAL NUMBER	
6	I3	UTM/AMG ZONE	
7	F10.2	EASTING (AMG84)	metres
8	F11.2	NORTHING (AMG84)	metres
9	F13.7	LATITUDE (WGS84)	degrees
10	F13.7	LONGITUDE (WGS84)	degrees
11	F7.1	RADAR ALTIMETER HEIGHT	metres
12	F7.1	GPS HEIGHT (WGS84)	metres
13	F7.1	TERRAIN HEIGHT (CORRECTED)	metres
14	F10.2	RAW MAGNETIC INTENSITY	nT
15	F10.2	DIURNAL CORRECTION	nT
16	F10.2	LEVELLED MAGNETIC INTENSITY	nT
17	F10.2	IGRF CORRECTION	nT
18	F10.2	LEVELLED, IGRF CORRECTED	nT

RADIOMETRIC LOCATED DATA

FIELD	FORMAT	DESCRIPTION	UNITS
1	I6	LINE NUMBER	
2	I5	FLIGHT/AREA NUMBER	AAFF (Area/Flight)
3	I7	DATE	YYMMDD
4	F11.1	TIME	sec
5	I8	FIDUCIAL NUMBER	
6	I3	UTM/AMG ZONE	
7	F10.2	EASTING (AMG84)	metres
8	F11.2	NORTHING (AMG84)	metres
9	F13.7	LATITUDE (WGS84)	degrees
10	F13.7	LONGITUDE (WGS84)	degrees
11	F7.1	RADAR ALTIMETER	metres
12	F7.1	GPS HEIGHT (WGS84)	metres
13	I5	LIVE TIME	milli sec
14	F7.1	PRESSURE	hPa
15	F5.1	TEMPERATURE	Degrees Celcius
16	F8.1	TOTAL COUNT (RAW)	Counts/sec
17	F7.1	POTASSIUM (RAW)	Counts/sec
18	F7.1	URANIUM (RAW)	Counts/sec
19	F7.1	THORIUM (RAW)	Counts/sec
20	F7.1	COSMIC (RAW)	Counts/sec
21	F7.1	URANIUM LOW (RAW)	Counts/sec
22	F7.1	URANIUM UP (RAW)	Counts/sec
23	F8.2	TOTAL COUNT (CORRECTED)	Counts/sec
24	F8.2	POTASSIUM (CORRECTED)	Counts/sec
25	F8.2	URANIUM (CORRECTED)	Counts/sec
26	F8.2	THORIUM (CORRECTED)	Counts/sec

GRIDDED DATASET FORMATS

Gridding was performed using a bicubic spline algorithm.

The following grid formats have been provided:

- ER-Mapper format
- Geosoft 2 byte integer format

LINE NUMBER FORMATS

Line numbers are identified with a six digit composite line number and have the following format - ALLLLB, where:

A	Survey area number
LLLL	Survey line number 0001-8999 reserved for traverse lines 9001-9999 reserved for tie lines
B	Line attempt number, 0 is attempt 1, 1 is attempt 2 etc..

UTS FILE NAMING FORMATS

Located and gridded data provided by UTS Geophysics uses the following 8 character file naming convention to be compatible with PC DOS based systems.

File names have the following general format - JJJJAABB.EEE, where:

JJJJ	UTS Job number	
AA	Area number if the survey is broken into blocks	
BB	M	Magnetic data
	R	Radiometric data
	TC	Radiometric total count data
	K	Radiometric potassium data
	U	Radiometric uranium data
	Th	Radometric thorium data
	DT	Digital terrain data
EEE	File name extensions	
	LDT	Located digital data file
	FMT	Located data format definition file
	ERS	ER-Mapper gridded data file
	GRD	Geosoft gridded data file

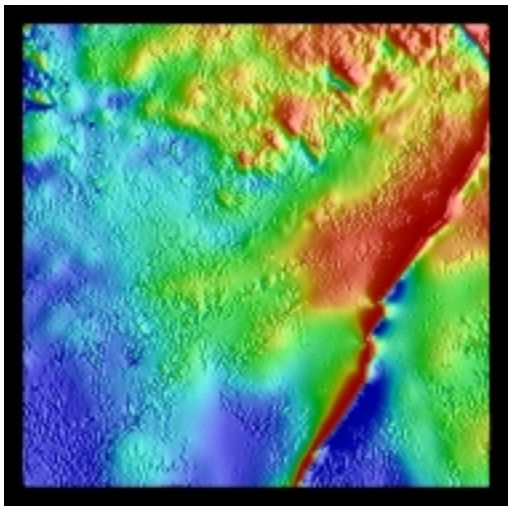
APPENDIX B - COORDINATE SYSTEM DETAILS

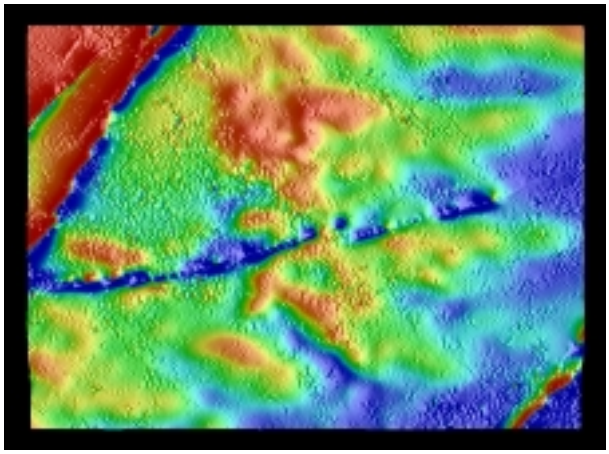
Locations for the survey data are provided in both geographical latitude and longitude coordinated as well as a Universal Transverse Mercator metric projection coordinate system.

WGS84	World Geodetic System 1984
Coordinate Type	Geographical
Semi Major Axis	6378137
Flattening	1/298.257223563
AMG84	Australian Map Grid 1984
Coordinate Type	Universal Transverse Mercator Projection Derived from the AGD66 spheroid
Semi Major Axis	6378160
Flattening	1/298.25

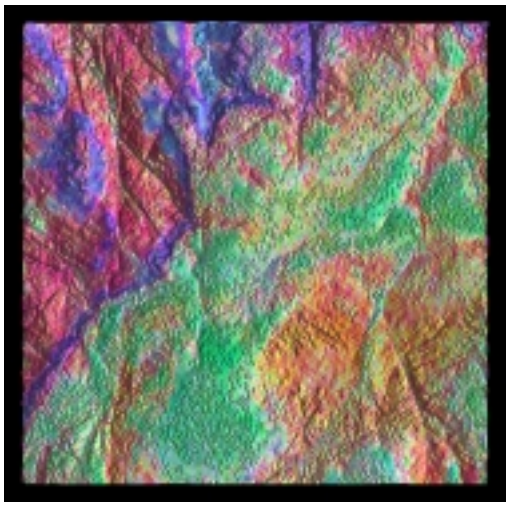
APPENDIX C - SURVEY BOUNDARY DETAILS

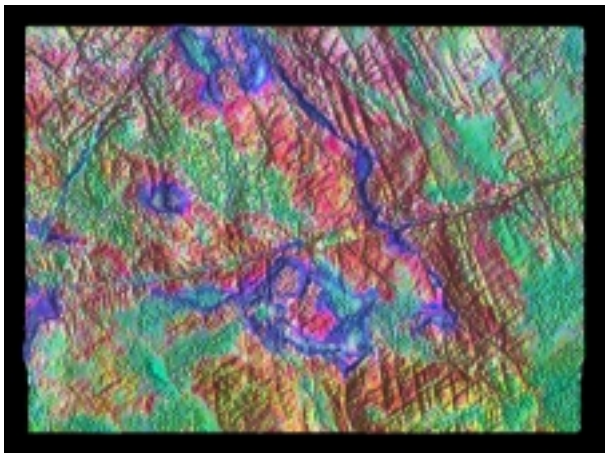
APPENDIX D - PROJECT DATA OVERVIEW





Total Magnetic Intensity





Radiometric Total Count

APPENDIX E – RADIOMETRIC EQUATIONS

Stripping Ratios

alpha	0.224
beta	0.395
gamma	0.722
a	0.047
b	0.000
c	0.000

Height Attenuation Coefficients

Total Count	-0.0060
Potassium	-0.0075
Uranium	-0.0039
Thorium	-0.0062

Height Datum

All data reduced to STP height datum 20m

Stripping Equations

alpha	=	alpha + STPHeight * 0.00049
beta	=	beta + STPHeight * 0.00065
gamma	=	gamma + STPHeight * 0.00069
tho`	=	(tho – (a * ura)) / (1 – (a * alpha)
ura`	=	(ura – (alpha * tho)) / 1 – (a * alpha)
pot`	=	pot – (beta * tho`) – (gamma * ura`)