TESLA AIRBORNE GEOSCIENCE

OPERATIONS REPORT

BAUHINIA

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY

NTGS Technical Note 2000-008

TESLA AIRBORNE GEOSCIENCE PTY LTD

NOVEMBER 2000

ISO 9002 SGS

CONTENTS

Click page No to go to section

1. INTRODUCTION

This report provides details of the Bauhinia airborne geophysical survey flown in the Northern Territory during 2000. The survey was commissioned by the Northern Territory Department of Mines and Energy and flown by Tesla Airborne Geoscience Pty Ltd.

2. SURVEY DETAILS

2.1 Project Identification

Area Name:	Bauhinia
Contractor:	Tesla Airborne Geoscience Pty Ltd
Tesla Job No.:	TA2690

2.2 Survey Location

The survey location is shown in Figure 1. Final flight path is provided in ERMapper format in the "Flight_Path" directory of this final report CDROM.

Survey boundary coordinates are:

-15° 30'	135° 00'	
-15° 30'	135° 19'	
-16° 00'	135° 19'	
-16° 00'	135° 30'	
-16° 30'	135° 30'	
-16° 30'	136° 10'	
-16° 00'	136° 10'	
-16° 00'	136° 30'	
-17° 00'	136° 30'	
-17° 00'	135° 00'	(WGS84)

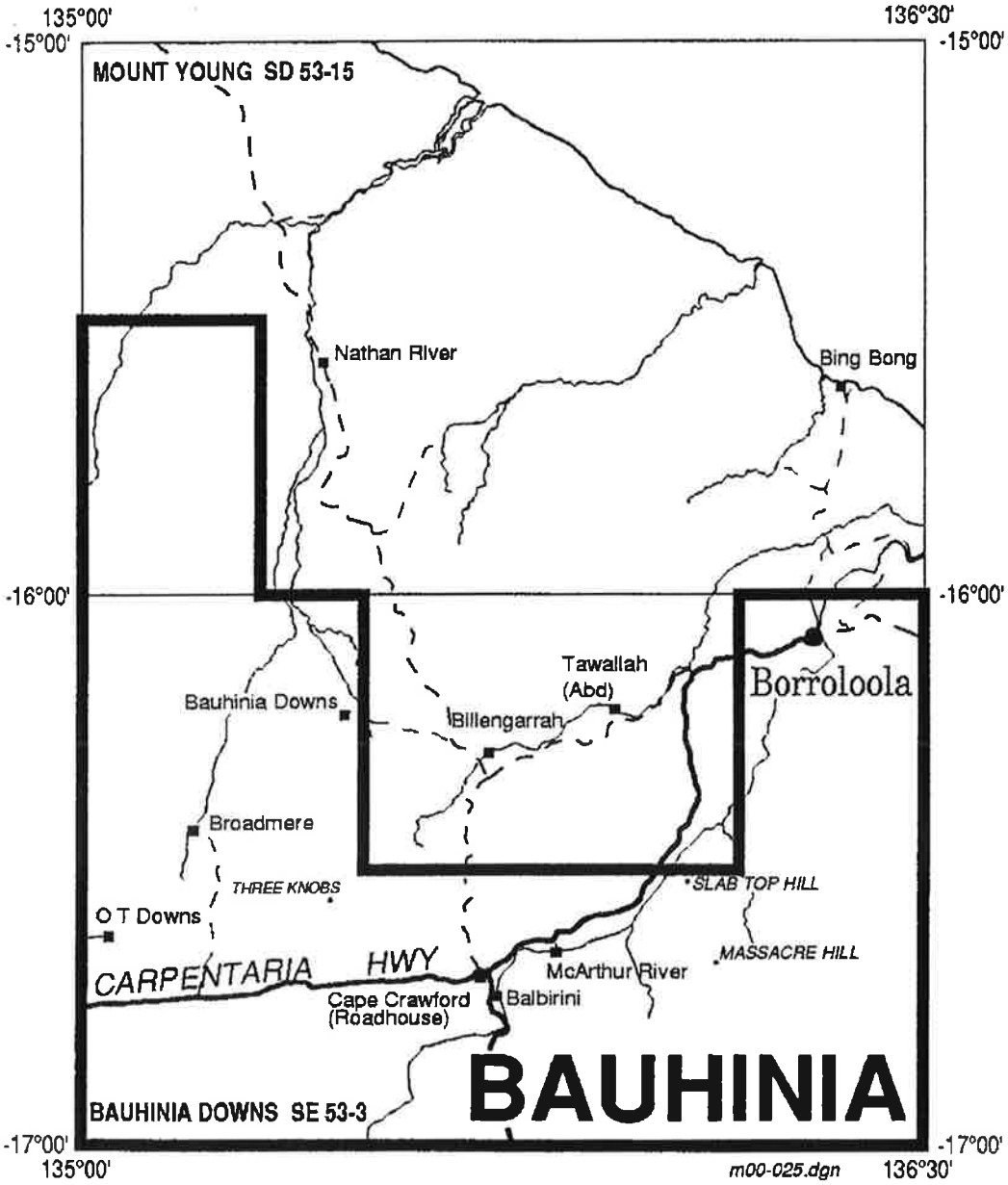

FIGURE 1 – SURVEY LOCATION

2.3 Specifications

Traverse kilometres	41,400
Traverse direction	090-270
Traverse spacing	400 m
Number of traverses	560
Tie-line kilometres	4,200
Tie-line direction	000-180
Tie-line spacing	4,000 m
Number of tie lines	41
Survey height	80m
Sample Intervals:	
Magnetics (aircraft)	10Hz (approx. 7m)
Radiometrics	1Hz (approx. 70m)
GPS positions	1Hz
Radar altimeter	10Hz
Temperature, pressure & humidity	1Hz
Magnetics (base stations)	0.5Hz
Crystal size	33.6Lt

3. PROJECT PERSONNEL

PROJECT SUPERVISION	Rod Pullin – data acquisition Brett Merritt – data processing
SURVEY PILOTS	James Horwood Darien Sherman
SURVEY OPERATORS	Rob Sharp Paul McCarron
DATA PROCESSING	Michelle Kounnas
NTDME CONTACT	Andrew Johnstone

4. ACQUISITION

4.1 Aircraft and Equipment

4.1.1 VH-BNZ

Model	Cessna 210N
Acquisition System	
Model	Tesla TAG3
Software Version	6.145_8
Total Field Magnetometer	
Sensor	Scintrex CS-2
Mounting	Tail Stinger
Sensitivity	0.001 nT
Vector Magnetometer	
Model	Billingsley TFM100-1E
Compensator	
Model	RMS Instruments Automatic Aeromagnetic Digital Compensator (AADCII)
Gamma-ray Spectrometer	
Model	Exploranium GR820
Crystals	
Detectors	Eight all-viewing NaI crystals Total volume: 33.6 litres
Radar Altimeter	
Model	Collins Alt-55B
Humidity and Temperature Transmitter	
Model	Vaisala HMD 50Y
Barometer	
Model	Vaisala PTB 200A
GPS Receiver	
Model	Novatel 951R
Real-time Corrections	Fugro Surveys OmniSTAR link

4.1.2 Base Stations

GPS Receiver

Model Marconi Allstar OEM CMT-1200

BASE GPS RECORD:

Borroloola

Job No:	TA2690	Crew Leader:	R. Sharp
Client:	N.T.D.M.E.	Date:	July 19, 2000
Area:	Bauhinia	Julian:	201
Aircraft:	VH-BNZ	Completed by:	R. Sharp

Calculated Base Station Co-ordinates	*Latitude*	16° 04' 18.45166" S
	Longitude	136° 18' 26.30997" E
	Height	75.916 metres
Ellipsoid		WGS84
Method of Position Determination:		Differentially processed against averaged, real-time corrected aircraft position
Duration of Sample		3.5 hours
Sample Interval:		1 second
Differential Correction Method:		Real-time: Fugro OmniSTAR Post-flight: Waypoint Consulting Inc. Grafnav V6.01
Location of GPS Antenna:		Fixed to roof outside corner of room B4

Magnetometers

Models Scintrex Envimag

BASE MAGNETOMETER RECORDS

Borroloola

Job No:	TA2690	Aircraft:	VH-BNZ
Client:	N.T D.M.E	Date:	July 19, 2000
Area:	Bauhinia	Julian:	201
Crew Leader:	R. Sharp	Completed by:	R. Sharp

Magnetometer A		**Magnetometer B**	
Magnetometer Type:	Scintrex Envi-mag	Magnetometer Type:	Scintrex Envi-mag
Serial Number:	9602266	Serial Number:	9403058
Location:	Near quarry, Borroloola	Location:	Near quarry, Borroloola
Cycle Rate:	2.0 seconds	Cycle Rate:	2.0 seconds
Sensor Height:	1.5 metres	Sensor Height:	1.5 metres
Area Gradient		Area Gradient	
2m North	48334.1	2m North	48331.1
2m South	48336.3	2m South	48328.6
2m East	48335.7	2m East	48328.6
2m West	48335.3	2m West	48330.3
Central	48335.4	Central	48330.9

4.2 Survey Operations

Base	Borroloola, NT
Acquisition Commencement	July 19, 2000
Acquisition Completion	August 26, 2000
Average Production	1,170 km/day

A full daily operations report is provided as a Microsoft Excel spreadsheet under the "Operations" directory of this final report CDROM. Survey flight logs are also provided as an Excel spreadsheet in this directory.

4.3 Recorded Parameters

All acquired data are recorded digitally.

The following parameters are recorded at 10 Hz:

Parameter	*Resolution*	*units*
Local time	0.1	s
Fiducial number (time after midnight, local)	1.0	unit
Terrain clearance (radar altimeter)	0.01	m
Uncompensated Total Magnetic Intensity (TMI)	0.001	nT
Fluxgates X, Y & Z	0.01	nT
Fluxgate Total Field	0.01	nT
Uncompensated TMI 4th difference	0.001	nT
Compensated TMI	0.001	nT

The following parameters are recorded at 1 Hz:

Parameter	*Resolution*	*units*
GPS time	1.0	s
Latitude	0.0000001	°
Longitude	0.0000001	°
GPS height	0.01	m
Outside air temperature	1.0	°C
Barometric pressure	0.01	hPa
Barometric altitude	0.01	m
Relative humidity	0.001	%
Full 256-channel gamma-ray spectrum	1.0	cps
Spectrometer livetime	0.001	s
Resolution	0.1	%
Number of satellites	1.0	
Position dilution of precision (PDOP)	0.1	
HDOP	0.1	

4.4 Calibrations and System Checks

4.4.1 Radiometric Calibrations

Pre-survey radiometric calibrations for the aircraft were completed. Results are summarised in Table 1.

		VH-BNZ
Aircraft Background	TC	91.90
	K	23.80
	U	1.69
	Th	0.72
Cosmic Background	TC	0.871
	K	0.053
	U	0.040
	Th	0.045
Height Attenuation	TC	0.0074
	K	0.0087
	U	0.0081
	Th	0.0072
Stripping	α	0.2619
	β	0.4084
	γ	0.7940
	a	0.0624
	b	0.0000
	c	0.0060
Air/Ground	Dose	26.2
	K	93.8
	U	9.9
	Th	5.2

TABLE 1 – COEFFICIENTS SUMMARY

4.4.2 Magnetic Compensation

Magnetic compensation sequences were flown at 10,000 feet above sea level. Resulting coefficients were used for real-time magnetic compensation.

4.4.3 Low-level Test Lines

A low-level test line was flown twice per day at survey height with the aircraft in the same flight configuration as on survey. Average radiometric counts were compared to assess system repeatability, soil moisture effects, etc.

The start and end point coordinates are:

Start	(WGS84)	16° 03.386817' S	136° 18.889415' E
End	(WGS84)	15° 59.134831' S	136° 17.266958' E

Resulting statistics and Th graph are given in the "Calibrations" directory of this CDROM.

4.4.4 Radiometric Button Checks

Crystal stabilisation using Thorium was undertaken prior to each day's acquisition. Radiometric counts were recorded with Thorium samples beneath the aircraft and also with samples removed to determine background radiation.

Calibration statistics and Th graph for these calibrations are given in the "Calibrations" directory of this CDROM.

5. PROCESSING

5.1 Hardware and Software

All data processing was carried out by Tesla10 Pty Ltd in its Kariong, NSW office.

Hardware	UNIX workstations PCs HP Designjet 650C Plotter HP Designjet 2500CP Plotter Exabyte 8mm tape drive Compact Disc writer Iomega ZIP drives
Software	Tesla10 Pty Ltd in-house software ERMapper 6.2

5.2 GPS Positioning

5.2.1 Spheroids, Datums and Zones

The acquired GPS positions (latitude, longitude and altitude) were differentially post-processed in the field. These coordinates were then converted to easting and northing grid positions referencing GDA94 in MGA zone 53.

The 1 Hz position data was linearly interpolated to coordinate all 0.1 Hz data.

5.2.2 Quality Control

In addition to Tesla's 'normal' quality control, "100-hourly" reports were produced. These are in the form of ERMapper vector files (.erv) and are provided in the "Quality_Control" directory of this final report CDROM.

- flight path
- ground speed

5.3 Magnetics

5.3.1 Quality Control

In addition to Tesla's 'normal' quality control, "100-hourly" reports were produced. These are in the form of ERMapper vector files (.erv) and are provided in the "Quality_Control" directory of this final report CDROM.

- high-pass magnetic noise
- diurnal variation
- radar altimeter

This visual aspect of quality control was aided by the determination of statistics (max., min., mean and s.d.) for all parameters for every line.

System spikes were removed from the magnetic data but cultural responses were retained.

5.3.2 Parallax Correction

System parallax adjustments were performed by interpolating the position data to fit the magnetic data. An adjustment of four fiducials was applied.

5.3.3 Diurnal Correction

The magnetic data were corrected for diurnal variations. The correction formula was:

diurnal corrected TMI = compensated TMI *minus* diurnal *plus* mean diurnal value

5.3.4 IGRF Correction

The International Geophysical Reference Field (IGRF) was removed from the data using the 2000 model extrapolated to the survey date. The correction formula was:

final corrected TMI = diurnal corrected TMI *minus* local IGRF *plus* Base_Value

5.3.5 Levelling

Tie line levelling and further micro-levelling produced the final levelled magnetics data.

5.3.6 Gridding

A bi-cubic spline algorithm was used to produce gridded data of 100 metre cell size.

5.3.7 Enhancements

First vertical derivative profiles were calculated on the TMI line data.

The TMI gridded data was reduced to the pole. A first vertical derivative grid was produced from the gridded TMI data. This FVD grid was then enhanced by an Automatic Gain Control process.

5.4 Radiometrics

5.4.1 Quality Control

256 channel spectral plots for all flights and source tests were produced. All data were checked for peak stability and count variation.

Statistics for all channels were calculated and checked. Profiles were produced where required. The data were subsequently checked (images, profiles and statistics) after each stage of processing to ensure continued data integrity.

5.4.2 Calibrations and Coefficients

See Section 4.4.

5.4.3 256-Channel Pre-processing

The raw spectra were firstly smoothed using Tesla10's MAXNF technique. This is based on MNF theory. The 256 channel data were then pre-processed to obtain data for Radon gas background removal.

Raw count rates used for final processing were extracted by summing the 256 channel data over the IAEA windows centred on the peak locations, to the nearest channel. The IAEA windows are:

Total Count	0.40 to 2.81 MeV
Potassium	1.37 to 1.57 MeV
Uranium (Bi^{214})	1.66 to 1.86 MeV
Thorium (Tl^{208})	2.41 to 2.81 MeV
Cosmic	>3.0 MeV

5.4.4 Final Processing

Filters were applied to height, temperature, pressure, altitude and the cosmic count.

Cosmic, aircraft and Radon backgrounds were removed.

The Potassium, Uranium and Thorium count rates were corrected for Compton scattering (stripped). The coefficients themselves were corrected to the STP corrected height using theoretical linear corrections for the three primary stripping coefficients.

Corrections to the terrain clearance were made using STP corrected heights and the absorption factors appropriate to the exponentially decreasing count rates with height.

The airborne gamma-ray counts were converted to the equivalent ground radioelement concentrations and the data were then tie line levelled and micro-levelled where required. A minimum curvature algorithm was used to produce gridded data of 100 metre cell size.

5.5 Digital Elevation Model

5.5.1 Processing

The form of the calculation used was:

Digital Terrain = GPS altitude – Radar Altimeter

where,

GPS Altitude is flying height above ellipsoid (WGS84)

Radar Altimeter is flying height above ground

Tie line levelling and further micro-levelling produced the final levelled terrain model.

5.5.2 Australian Height Datum

The terrain surface was subsequently referenced to the AUSLIG 1998 N-values to produce a DTM corrected to the Australian Height Datum.

6. FINAL PRODUCTS

6.1 Final Located Data

Final located data was produced in ASEG GDF2 format. Three products were produced:

- 0.1 second magnetics & digital terrain
- 1.0 second radiometrics (ROI windows)
- 1.0 second 256-channel radiometrics

6.2 Final Gridded Data

Final gridded data was produced in ERMapper format. The grids supplied are:

- Total Magnetic Intensity (TMI)
- TMI Reduced to the Pole (RTP)
- 1st Vertical Derivative of TMI (1VD)
- Automatic Gain Control of 1VD TMI (AGC 1VD)
- Total Count (provided as Doserate, nGy/h) (TC)
- Potassium (%) (K)
- Uranium (ppm) (U)
- Thorium (ppm) (Th)
- Digital Elevation Model (DTM)