Airborne Geophysical Survey

Ringarooma Bay, Tasmania

June 2007

Survey Operations and Logistics Report

For

Van Dieman Mines

Survey Flown by:

GPX Airborne

GPX Airborne

Job 2272

1 GENERAL SURVEY INFORMATION 4
1.1 INTRODUCTION..4
1.2 SURVEY BRIEF..4
1.3 SURVEY PERSONNEL...4
1.4 SURVEY EQUIPMENT..5
1.5 SURVEY AREA 5
1.6 SURVEY PARAMETERS...7
2 SURVEY EQUIPMENT SPECIFICATIONS..8
2.1 DATA ACQUISITION CONSOLE..8
2.1.1 Navigation / Flight Control 8
2.1.2 Data Recording 8
2.1.3 Display of real-time collected Data and status monitoring..........9
2.1.4 Data Retrieval...9
2.2 MAGNETOMETER PROCESSOR 9
2.3 MAGNETOMETER SENSOR 10
2.4 FLUXGATE MAGNETOMETER 10
2.5 TEMPERATURE AND HUMIDITY SENSORS..10
2.6 BAROMETRIC PRESSURE SENSOR 10
2.7 RADAR ALTIMETER..11
2.8 GPS RECEIVER...12
2.9 DGPS RECEIVER 12
2.10 BASE MAGNETOMETER...13
2.10.1 Gem GSM-19 13
2.10.2 Base Station Location...13
3 EQUIPMENT CALIBRATIONS AND DATA ACQUISITION CHECKS ..14
3.1 DYNAMIC MAGNETOMETER COMPENSATION 14
3.2 HEADING ERROR CHECK 14
3.3 SYSTEM PARALLAX TESTS...14
3.4 ALTIMETER CALIBRATIONS...15
3.5 DAILY TIME SYNCHRONIZATION 15
3.6 SURVEY LINE NUMBERING SYSTEM 15
4 DATA VERIFICATION AND FINAL PROCESSING 16
4.1 IN FIELD DATA PROCESSING 16
4.1.1 Altimeter Data...16
4.1.2 Flight Path Data..16
4.1.3 Magnetic Data 17
4.2 FINAL PROCESSING...18
4.2.1 Altimeter Data...18
4.2.2 Magnetic Data 18
5 IMAGES 20
5.1 TOTAL MAGNETIC INTENSITY IMAGE...20
5.2 REDUCED TO POLE IMAGE 21
6 CONTRACTOR INFORMATION..22
7 APPENDIX A: DATA PROCESSING READ ME FILE..........................23

7.1 LOCATED DATA FORMAT. 23

1 GENERAL SURVEY INFORMATION

1.1 INTRODUCTION

In March 2007, GPX Airborne commenced a fixed wing airborne magnetic survey for Van Dieman Mines in the Ringarooma Bay area in Tasmania to adjoin the survey being flown for Geoscience Australia in North East Tasmania. The survey was flown using a Cessna 210 owned and operated by Ozshore. This report summarizes the procedures, details and equipment used by GPX Airborne in the acquisition, verification and processing of the airborne geophysical data.

Client:	Van Dieman Mines
GPX Job Number:	2272.
Survey Area:	Ringarooma Bay, Tasmania.
Data Processing Base:	St Helens, Tasmania.
Production:	22nd March to 7th April 2007
Line km surveyed:	387.1 kms (extended to include all the data flown that is not part of the Geoscience Australia survey area)

1.2 SURVEY BRIEF

Aircraft equipment installation, test and calibration flights were carried out prior to departure from Perth, Western Australia. The crew arrived on the 17th March and commenced flying the Geoscience Australia survey area on the 21st March 2007. The crew stayed at St Helens, Tasmania, where all survey operations were run from and where the post flight data verification was performed. The base magnetometers were also set up locally. The final flight of the survey for the Van Dieman Mines area was on the 7th April 2007. Although radiometric data was collected as part of the Geoscience Australia project, none was supplied with the Van Dieman Mines survey as it was all over water.

1.3 SURVEY PERSONNEL

The following personnel were involved on this project:

Project Leader and	Don Copley
Technical Support:	Bob Taylor
Pilot:	Noel Fuller
Operator:	Tim Cousin
Data Processing :	Cathy Carr

1.4 SURVEY EQUIPMENT

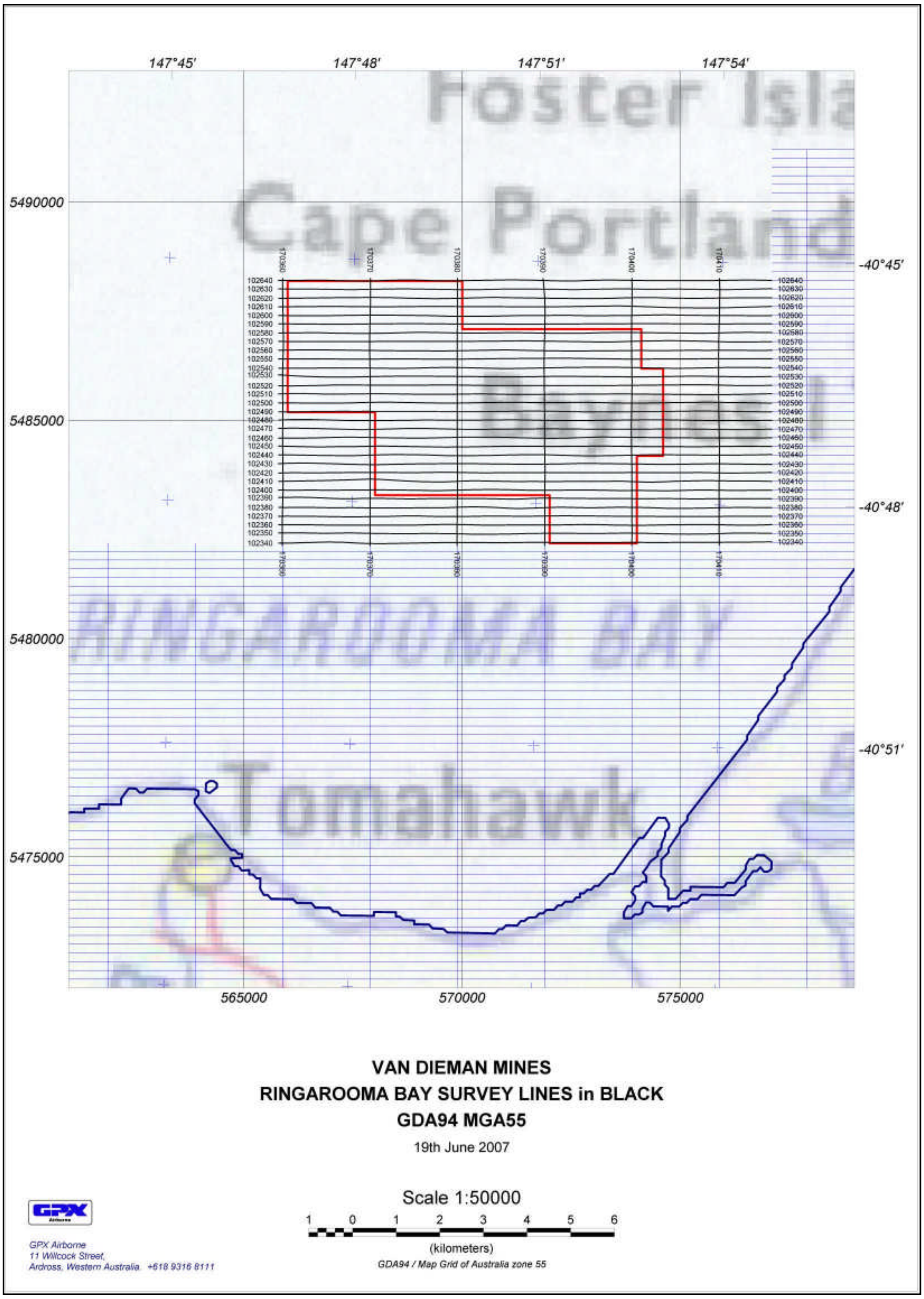
Survey Platform	Cessna 210 (VH-MNN).
Data Acquisition System	Pico Envirotec AGIS PC104 Console.
Magnetometer Processor	Pico Envirotec MMS4 Magnetometer Processor
Magnetometer	Geometrics G-822A Cesium Vapour
Spectrometer	Exploranium GR820 (32 Litre Crystal)
Fluxgate Magnetometer	Billingsley TFM100-G2
GPS Receiver	Novatel OEM3 Propak II
DGPS Receiver	CSI DGPSMax
Radar Altimeter	Collins ALT-50A
Magnetic Base Stations	Gem Systems GSM-19W
In-field Computer	Toshiba Notebook
In-field Software	Pico Envirotec PEIView, ChrisDBF

1.5 SURVEY AREA

The following coordinates are in GDA94 / Map Grid of Australia zone 55 and defines the survey area.

Extended Block

EASTING	NORTHING
565764.48	5482143.56
577123.66	5482143.56
577123.66	5488255.29
565764.48	5488255.29


147°45'
147°48'
147°51'
147°54'
Foster Isla
Cape Portland
5490000
-40°45'
Baynes
5485000
-40°48'
RINGAROOMA BAY
5480000
-40°51'
Tomahawk
5475000
565000
570000
575000
VAN DIEMAN MINES
RINGAROOMA BAY SURVEY LINES in BLACK
GDA94 MGA55
19th June 2007
Scale 1:50000
1 0 1 2 3 4 5 6
(kilometers)
GDA94 / Map Grid of Australia zone 55
GPX Airborne
11 Willcock Street,
Ardross, Western Australia. +618 9316 8111

Flight plan

1.6 SURVEY PARAMETERS

Line spacing:	200 metres
Line direction:	90° and 270°
Tie line spacing:	2000 metres
Tie line direction:	0° and 180°
Minimum line length:	5000 metres
Sensor height:	60 metres
Magnetometer sample rate:	10 Hz
Altimeter sample rate:	1 Hz
Base magnetometer sample rate:	1 Hz

2 SURVEY EQUIPMENT SPECIFICATIONS

2.1 DATA ACQUISITION CONSOLE

The Data Acquisition console is a Pico Envirotec AGIS PC104. This is a versatile multi-function system that is capable of operation in many different configurations, depending on platform type, navigation and system requirements. The AGIS PC104 provides the following functions:

- Navigation / flight control
- Data recording
- Display of real-time collected data and status monitoring
- Data retrieval access

2.1.1 Navigation / Flight Control

The AGIS PC104 is used to guide the aircraft on a pre-defined flight plan that can be generated in UTM or Latitude/Longitude coordinates. The pre-defined flight plan can be designed to file prior to the start of the project, entered or altered in the AGIS system or delineated 'on-the-fly' e.g. while in the air flying the boundary and entering corner coordinates. Co-ordinates can only be entered in the WGS84 datum system, this has been implemented to avoid confusion and eliminate possible conversion errors. Normal survey altitude and ground speed, with pre-set tolerances are also entered.

The pilot display consisted of a 2-line strip display or more comprehensive Pilot Guidance Unit (PGU). The strip display is driven directly from the AGIS PC104 console; whereas the PGU is a self-contained computer system that is capable of more demanding navigation functions such as "drape" flying using a pre-programmed altitude grid.

The desired flight line is selected from the operator interface, which will either be a keyboard or touch-screen.

2.1.2 Data Recording

The AGIS PC104 relates all acquired data to the instant position from the GPS receiver and records the collected data to three separate data files. The data is recorded in compressed binary format, to a commercial solid-state hard disk.

The flight path file is recorded from AGIS program start-up to shutdown and cannot be turned off by the operator. It contains position, timing, altitude and basic data.

The data file is recorded whenever the acquisition system is "On-line". It contains all navigation data plus "enabled" data.

The raw data file, when enabled and supported by the GPS receiver in use, contains raw GPS data necessary for post-flight position correction. It is recorded from AGIS program start-up to shutdown.

2.1.3 Display of real-time collected Data and status monitoring

The AGIS displays flight path and geophysical data as it is acquired aiding the data quality control and real time navigation guidance. The user is presented with graphical representations of the survey area, flight lines, navigation status, and sensor data. The spectra data was also displayed.

Several other status indications are also provided which will either change state indicating a major system malfunction, such as a magnetometer or spectrometer failure, or will change state during normal operation, indicating data being written to a file etc

2.1.4 Data Retrieval

The AGIS PC104 provides facility to transfer the recorded data from the internal solid-state disk to compact flash media immediately following the completion of the survey flight. Recorded data is not deleted from the main disk until this "retrieved" data has been verified "error free".

2.2 MAGNETOMETER PROCESSOR

The Magnetometer Processor is a Pico Envirotec MMS4 Magnetometer Processor. This is an advanced frequency-measuring device that can support several continuous signal magnetometers (Cs, He, K). It is a hardware-software designed system, exhibiting simplicity, easy interfacing and substantial versatility. Magnetometer readings are synchronized with the PPS (Pulse Per Second) signal derived from the GPS for accurate timing.

The MMS4 contains 8 channels of analog differential inputs. The first 4 analog channels are sampled synchronously with MMS4 magnetometer at up to 50 samples per second. The remaining 4 analog channels are sampled at 10 samples per second. Analog data is integrated into the magnetometer data stream.

Specifications:

Input:	Coaxial - Larmour signal over DC Power Supply
Resolution:	0.0002 nT (Gamma) = 0.2 picoTesla
Sampling rates:	10, 20, 50 samples per second
Dynamic range:	15000 to 100000nT
Synchronization:	GPS – PPS (Pulse Per Second)
Data Storage:	Removable Compact Flash Memory

2.3 MAGNETOMETER SENSOR

The Magnetometer Sensor is a Geometrics G-822A, which employs an optically pumped cesium-vapour atomic magnetic resonance system that function as the frequency control element in an oscillator circuit.

Specifications:

Model:	Geometrics G-822A
Operating Range:	20,000 – 100,000 nT
Sensitivity:	Typically 0.002 nT P-P at a 10Hz sample rate
Heading Error:	< 0.15 nT over entire 360º
Output:	Larmour frequency, 3.498572 Hz/nT

2.4 FLUXGATE MAGNETOMETER

The Fluxgate Magnetometer is a Billingsley Ultra Miniature TFM 100G2. This unit is a low noise, high sensitivity unit, packaged into a compact housing. An analog DC output voltage is produced for each of the measured X, Y and Z orthogonal components of the current magnetic field.

Specifications:

Model:	Billingsley TFM 100G2
Axial Alignment:	Orthogonality better than ±1º
Sensitivity:	100uV / nT
Noise:	20pT RMS / Hz @ 1Hz
Output:	± 100uT = ± 10V

2.5 TEMPERATURE AND HUMIDITY SENSORS

The Temperature and Humidity transmitter is a Vaisala HMP233. The unit provides both a digital RS232 output and Analogue voltage or current output directly proportional to the measured Temperature and Humidity. The unit is a commercial grade device housed in a rugged aluminium enclosure.

Specifications:

Model:	HMP233
Humidity Range:	0 – 100% RH
Humidity Accuracy:	±1 %RH (0...90 %RH)
	±2 %RH (90...100 %RH)
Temperature Range:	-40 to +80°C
Temperature Accuracy:	± 0.1°C
Analog Output Accuracy:	±0.05 % full scale

2.6 BAROMETRIC PRESSURE SENSOR

The Barometric Pressure transmitter is a Vaisala PTB220. The unit provides both a digital RS232 output and Analogue voltage or current output directly proportional to the measured Barometric Pressure. The unit is a Class "A" commercial grade device housed in a rugged aluminium enclosure.

Specifications:

Model:	PTB220
Range:	500 – 1100 hPa
Resolution:	0.01 hPa
Accuracy at +20ºC:	± 0.1 hPa

2.7 RADAR ALTIMETER

The Radar Altimeter is a Rockwell Collins ALT-50 two-antenna unit operating at a centre frequency of 4300MHz. The voltage output to the data system is directly proportional to the aircraft flying height with an output characteristic of 20mV/ft up to 500ft, then 10.4V + 3mV/ft above 500ft.

Specifications:

Model:	Collins ALT-50A Radio Altimeter System
Accuracy:	± 3ft - 0 to 150ft range ± 2% of indicated altitude – 150 to 500ft range ± 3.5% of indicated altitude – 500 to 200ft range
Measurement Rate:	Same rate as magnetometer, 10Hz minimum.

2.8 GPS RECEIVER

The GPS receiver is a Novatel OEM3 GPS Receiver housed in a Propak II enclosure. The antenna is a Rojone wideband unit, which has it's output split to provide signal for both the GPS and DGPS receivers.

Specifications:

Receiver:	CSI DGPS MAX
Position update rate:	5Hz
Raw data update rate:	1Hz
Input frequency:	L1
Antenna:	Fugro Wideband – Stinger Mounted

2.9 DGPS RECEIVER

The DGPS receiver is a CSI DGPS MAX, which is a 12-channel combined GPS/DGPS unit. The DGPS MAX is able to use differential corrections received through an internal WAAS demodulator, VLF beacon receiver, or the OmniSTAR DGPS Service.

Specifications:

Receiver:	CSI DGPS MAX
GPS Position update rate:	5Hz
GPS Input frequency:	L1
Antenna:	Fugro Wideband – Stinger Mounted
DGPS Update rate:	Typically every 6 seconds
DGPS Solution Used:	OmniSTAR VBS

2.10 BASE MAGNETOMETER

Monitoring of the Earths diurnal activity.

2.10.1 Gem GSM-19

Specifications:

Type:	Overhauser Magnetometer
Resolution:	0.01nT
Absolute Accuracy:	0.1nT
Dynamic Range:	10000 to 120000 nT
Sampling Rate:	1 second or greater
Data Storage:	Internal memory
Data Retrieval:	Up to 115200bps serial transfer

2.10.2 Base Station Location

The base station was established in bush land away from the township of St Helens at the following co-ordinates

Longitude: 148.2503235 E
Latitude: 41.3587822 S

3 EQUIPMENT CALIBRATIONS AND DATA ACQUISITION CHECKS

3.1 DYNAMIC MAGNETOMETER COMPENSATION

Aircraft compensation tests were flown at high altitude on the 4 survey line headings and also at +/-15° 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 is 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. This data is processed to obtain the REAL TIME COMPENSATION terms of which the aircraft used the standard 17-term model. These terms include permanent, induced and eddy values. These coefficients may be applied in real time or during post processing. Note that this form of compensation will only remove those noise effects modelled in the manoeuvres test flight. External noise sources and random motions of the stinger with respect to the aircraft airframe generally establish the noise floor for this type of installation. The surveyor's goal is to achieve a 4th difference noise level on the order of 0.01nT RMS during normal surveying conditions. In general, this noise level was routinely achieved or bettered as a matter of course.

3.2 HEADING ERROR CHECK

Historically, heading error checks have been an essential part of the aeromagnetic data acquisition procedure but their importance now has diminished. GPX Airborne now corrects for these effects using the dynamic aircraft magnetic compensation system and specially developed software. In the past, repeatable heading errors of less than one nanotesla (1.0nT) were considered good. Dynamic compensation typically yields heading errors in the order of 0.1 to 0.3 nT, which are effectively eliminated by modern data levelling techniques.

3.3 SYSTEM PARALLAX TESTS

One of the processing parameters required to process digital data was the parallax or offset time, between the time the digital reading was taken by the instrument and the time the position fix for the fiducial of the reading was obtained. Each instrument - magnetometer, altimeter - may have a different parallax, so the parallax must be computed for each instrument.

The parallax correction derived is the correction to be applied to each survey line. A positive parallax indicates the instrument reading is ahead of the position of the fiducial. Each integer fiducial represents one second so the parallax can be expressed in either fiducial or seconds.

The correct fiducial is computed by:

Fc = Fr - Ip

where

Fc = Parallax corrected fiducial

Fr = Fiducial for recorded reading
Ip = Instrument Parallax

3.4 ALTIMETER CALIBRATIONS

The height of the aircraft above ground is recorded by a radar altimeter as a voltage every 0.1 second. The voltage data is converted to height via a lookup table determined by calibration with the GPS altitude.

3.5 DAILY TIME SYNCHRONIZATION

Before each days survey the magnetic base station is automatically synchronized with the GPS receiver time in the aircraft. Prior to the commencement of survey, the temporal drift of this base station was determined. The unit is automatically updated by the GPS so there is no time drift in the system.

3.6 SURVEY LINE NUMBERING SYSTEM

The first digit in any line number represents the area number, i.e. 100050 is area no. 1.

The next four numbers are the line number it self, i.e. 101030 is line number 103.

All Tie lines begin with the digit 7, i.e. 170020.

The sixth digits of any line number represent the attempt number, i.e. 100010 is the first attempt.

4 DATA VERIFICATION AND FINAL PROCESSING

4.1 IN FIELD DATA PROCESSING

All data verification and preliminary processing and map production was conducted at the field office. The survey processing and office equipment listed below was transported to and set up on location.

- Toshiba Notebook computer with internal CD/DVD drive.

At the conclusion of each days survey all magnetic, radiometric, altimeter, flight path and diurnal data was transferred via compact flash memory onto the office computer for preliminary data verification. No radiometric data was supplied for this data set as it was over water.

4.1.1 Altimeter Data

Radar Altimeter Data

The radar altimeter is verified to check that a reasonably constant height above the terrain specified in section 1.6 was flown; readings during the course of the survey did not exceed the specified tolerances. The radar altimeter data is used in the production of digital terrain maps.

GPS Height Data

The aircraft's height above mean sea level each second was determined by data from the post-processed GPS. The GPS height of the aircraft is verified to check for data masking and for equipment reliability. The GPS height data is used in the production of digital terrain maps.

Digital Terrain Data

After verification the radar altimeter height was subtracted from the GPS height to give the elevation of the terrain above mean sea level.

Gridding and Inspection

The digital terrain data was gridded and grid image enhancements were computed and displayed on screen. These were viewed also with the aid of crossline sun angles and inspected for inconsistencies and errors and appropriate corrections were made if required.

4.1.2 Flight Path Data

The flight path is plotted daily to ensure it was within survey specifications. Any data not within specification was re-flown. The aircraft GPS recorded the data in the WGS84 datum.

4.1.3 Magnetic Data

The raw un-edited magnetic data was checked to identify noise and spikes. Single reading spikes were manually edited and if the noise exceeded the contract specifications, the line was re-flown.

Magnetic Diurnal Data

Diurnal data recorded every 1 second from the primary base station was down loaded from the magnetometer's memory onto the field processing computer via compact flash. The diurnal data was then checked and corrected for spikes. Single reading spikes were manually edited and multiple erroneous readings flagged as invalid. 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 survey lines were re-flown. The diurnal data was merged with the aircraft data and used in the verification of the magnetic data.

Diurnal Correction

The synchronized 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.

Parallax Correction

The aircraft system parallax is also checked prior to project commencement. A parallax error correction of 0.0 second was used for in field verification.

Gridding and Inspection

The magnetic data was gridded and grid image enhancements were computed and displayed on screen. These were also viewed with the aid of crossline sun angles and inspected for inconsistencies and errors and appropriate corrections were made if required.

4.2 FINAL PROCESSING

All final data processing of the data was performed in the offices of GPX Airborne. Raw field data was transferred to the offices and processed to produce the final data. No field-processed data was used in the making of the final data. The final processing of the data follows the same quality control checks that are made in the field, however the final data has additional processes performed.

4.2.1 Altimeter Data

Radar Altimeter Data

The radar altimeter is verified to check that a reasonably constant height above the terrain specified in section 1.6 was flown; readings during the course of the survey did not exceed the specified tolerances. The radar altimeter data is used in the production of digital terrain maps.

GPS Height Data

The aircraft's height above mean sea level each second was determined by data from the post-processed GPS. The GPS height of the aircraft is verified to check for data masking and for equipment reliability. The GPS height data is used in the production of digital terrain maps.

Parallax Correction

A parallax error correction as described in section 7.3.1 was applied to the coordinate data.

Digital Terrain Data

After verification the radar altimeter height was subtracted from the GPS height to give the elevation of the terrain above mean sea level.

Gridding and Inspection

The digital terrain data was gridded and grid image enhancements were computed and displayed on screen. These were viewed also with the aid of crossline sun angles and inspected for inconsistencies and errors and appropriate corrections were made if required.

4.2.2 Magnetic Data

The raw un-edited magnetic data was checked to identify noise and spikes. Single reading spikes were manually edited.

Magnetic Diurnal Data

The diurnal data was then checked and corrected for spikes. Single reading spikes were manually edited and multiple erroneous readings flagged as invalid.

Diurnal Correction

The synchronized 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.

Parallax Correction

A system parallax of 0.6 fiducial was removed from the data.

IGRF correction

The magnetics data has been corrected for the regional gradient by subtracting the calculated IGRF (2005 model) computed continuously over the whole area. The calculation of these corrections used the GPS flying height.

Tie Line Levelling

A crossover program was used to compute the magnetic difference between each tie line and the traverse line intersection. These differences were then applied to level the traverse lines to the tie lines.

Micro Levelling

Micro levelling was used to remove residual differences with a long wavelength along line and short wavelength across line. Application of the micro levelling process removed the streaks that were sometimes visible when using various grid enhancements.

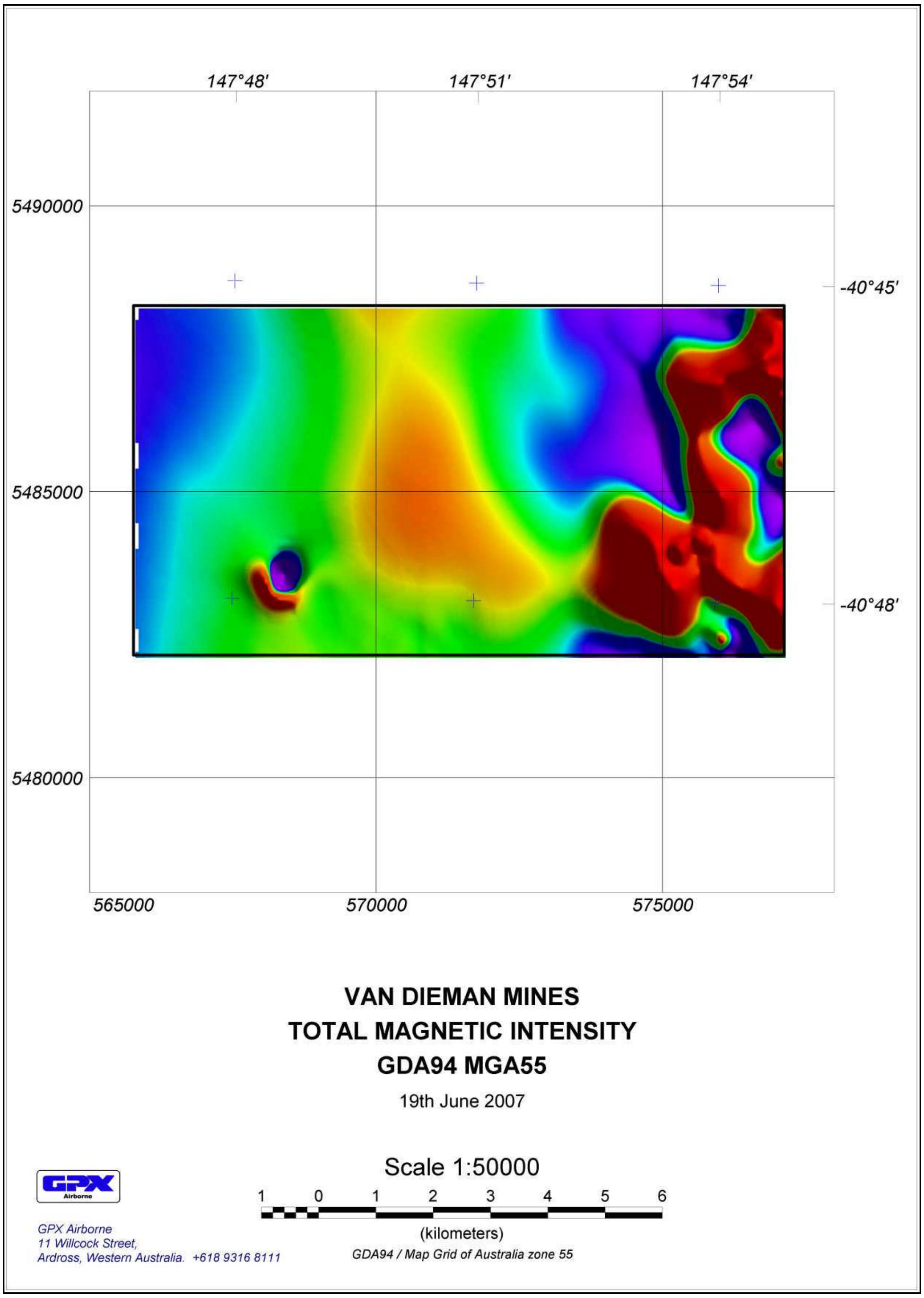
Gridding and Inspection

The magnetic data was gridded and grid image enhancements were computed and displayed on screen. These were also viewed with the aid of crossline sun angles and inspected for inconsistencies and errors and appropriate corrections were made if required.

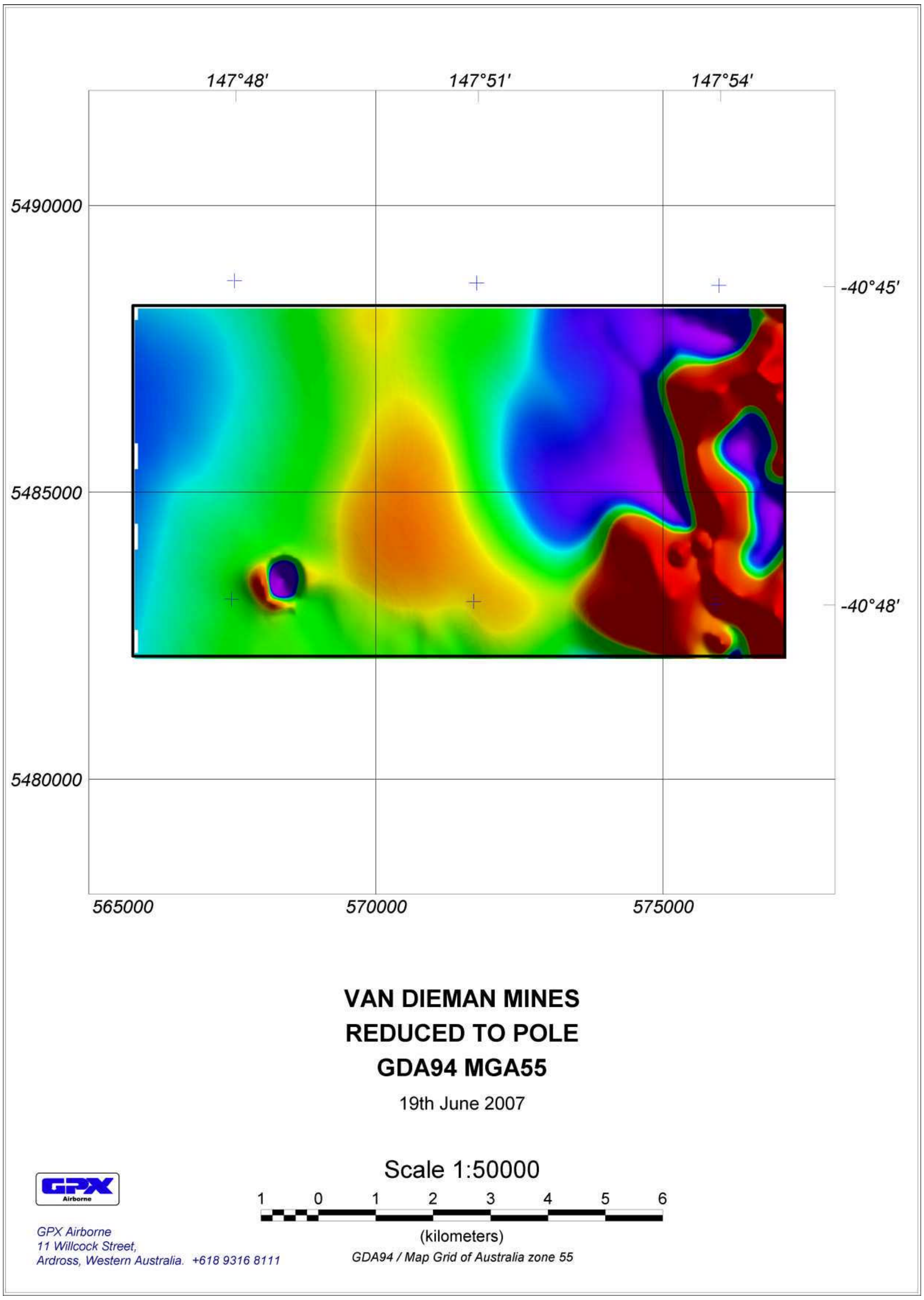
Note: No radiometric data was supplied as the survey was over the water.

5 IMAGES

5.1 TOTAL MAGNETIC INTENSITY IMAGE



5.2 REDUCED TO POLE IMAGE



6 CONTRACTOR INFORMATION

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Fax: +618 9316 8033

Web: http://www.gpxair.com.au/

7 APPENDIX A: DATA PROCESSING READ ME FILE.

7.1 LOCATED DATA FORMAT.

GENERAL

Project	Van Diemen
Survey area	NE Tasmania VanDiemen
Located data type	0.1 Second Final Data
Surveyed by	GPX AIRBORNE PTY LTD.
Job number	2272
Processed by	GPX AIRBORNE PTY LTD.
Creation date	June 2007

SURVEY SPECIFICATIONS

Survey flown	March - April 2007
Traverse line spacing	200 metres
Traverse line direction	090-270 degrees
Tie line spacing	2000 metres
Tie line direction	000-180 degrees
Survey height	90 metres

LOCATED DATA FORMAT

Variable	Units	Undefined	From	To	Format
Line number		9999999	1	8	I8
Easting (MGA55)	metres	9999999.99	9	19	F11.2
Northing (MGA55)	metres	9999999.99	20	30	F11.2
Fiducial		99999.99	31	39	F9.2
Flight number		999	40	43	I4
Direction (1=E, 2=N, 3=W, 4=S)		9	44	45	I2
Date (YYYYMMDD)		99999999	46	54	I9
Time (GPS)	seconds	99999.99	55	63	F9.2
Longitude (GDA94)	degrees	999.999999	64	74	F11.6

Latitude (GDA94)	degrees	999.999999	75	85	F11.6
Radar altimeter	metres	9999.9	86	92	F7.1
GPS altitude	metres	9999.9	93	99	F7.1
Raw magnetics	nT	99999.999	100	109	F10.3
Post compensated magnetics	nT	99999.999	110	119	F10.3
Diurnal	nT	99999.999	120	129	F10.3
Final magnetics	nT	99999.999	130	139	F10.3

DATA PROCESSING

COORDINATE DATA
All lines are scissored to the following rules:
1) A 'smooth' edge outside the area boundary.
2) Maximum line overlap of 0 fiducials within the area boundary.

The local projection is a UTM projection based on the GDA94 spheroid with a central meridian of 147 East degrees.
System parallax of 0.6 fiducial has been removed.

MAGNETIC DATA
The magnetic data has been corrected for regional gradient by subtraction of IGRF model 2005 computed continuously over the whole area based on the GPS height.
Diurnal magnetic variations have been removed.
System parallax of 1.6 fiducial has been removed.
Tie-line levelling has been applied.
Microlevelling has been applied.
A base value of 61320 nT has been added to the data.