

GS93/06



AIRBORNE GEOPHYSICAL SURVEY

ROPER RIVER
NORTHERN TERRITORY

SURVEY DETAILS, TECHNICAL SPECIFICATIONS
AND
SURVEY LOGISTICS REPORT

PREPARED BY
WORLD GEOSCIENCE CORPORATION LIMITED
FOR

NORTHERN TERRITORY
DEPARTMENT OF MINES AND ENERGY

GS93/6

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1. SURVEY AREA

1.1 SURVEY AREA COORDINATES

	AGD-84	ZONE 53	
EASTING			NORTHING
499000			8453100
598890			8453100
599880			8449200
596110			8434000
598260			8431380
597535			8429715
592670			8429715
587755			8425655
584725			8425680
572280			8407455
572940			8405050
566400			8403705
564240			8399165
568370			8399160
568410			8393935
561755			8393935
558430			8378870
547615			8372840
543155			8365950
546110			8355080
555670			8340700
499000			8340700

1.2 GENERAL SURVEY DESCRIPTION

The survey area lies west of Groote Eylandt on the eastern side of the Northern Territory. The eastern side of the area is the actual coast line, this boundary follows the coastal trends. The Roper River runs through the southern portion of the area, with some ranges in the central and north western parts. The terrain is densely vegetated inland, with numerous river systems, water holes and natural wetlands throughout the area. Tidal flats abound along the coast line making radiometric data invalid in these moisture saturated regions.

A total of 18,248 kms, including overfly, was flight planned and flown on this project. 453

1.3 AREA MAP



2. SUMMARY OF TECHNICAL SPECIFICATIONS

2.1 SURVEY PARAMETERS

2.1.1 LINE SPACING & HEADING

<i>Traverse line spacing</i>	:500m
<i>Traverse line direction</i>	:90° - 270°
<i>Tie line spacing</i>	:5,000m
<i>Tie line direction</i>	:0° - 180°
<i>Navigation</i>	:Autonomous GPS for aircraft, :navigation and Differentially :Post Processed GPS, :(DGPS) for final positions.
<i>Navigation Tolerances</i>	:Flight lines NOT to exceed :150% of spacing for > 5kms. :Tie lines NOT to exceed :150% of spacing for > 5kms.

2.1.2 MAGNETIC SENSOR HEIGHT

<i>Sensor Height</i>	:100m (nominal)
<i>Height Tolerance</i>	:+/- 20m :NOT to exceed +/- 20m :for > 5kms

2.1.3 DATA CYCLE / SAMPLE INTERVALS

<i>Magnetometer</i>	:10Hz (0.1sec.) / less than 7m
<i>Radar altimeter</i>	:10Hz (0.1sec.) / less than 7m
<i>GPS</i>	:1. Hz (1.0sec.) / less than 70m
<i>Spectrometer</i>	:1. Hz (1.0sec.) / less than 70m
<i>Magnetic base station</i>	:5 sec. / 0.1nT sensitivity.

3. SURVEY EQUIPMENT & SPECIFICATIONS

3.1 AIRBORNE MAGNETOMETER

The aircraft uses a Scintrex VIW 2321 H8 optically pumped caesium vapour magnetometer.

This sensor consists of the sensor optics and the sensor electronics which are connected by a cable assembly. The caesium sensor is an oscillator which produces a frequency that is directly proportional to the total field intensity. The proportional constant is 3.4986 Hz per gamma. Over the specified operating range of the instrument, the output frequency will vary from 69,972 Hz (20,000 nT.= nano Teslas) to 349,860 Hz (100,000 nT).

SPECIFICATIONS

Model	:VIW 2321 H8
Working Range	:20,000-100,000 nT
Output "Larmor" Frequency	:69,972 Hz @ 20,000 :nT, 349,860 Hz @ :100,000 nT
Sensor orientation	:Optimum angle 45deg :between sensor head :axis and magnetic field :vector.
Sensitivity	:0.005 nT
Resolution	:<0.02 nT @ 0.1sec :cycle rate.

3.2 RADAR ALTIMETER

The aircraft recorded both radar and barometric altimeters. The Radar Altimeter is a commercially available unit (Sperry RT-100), which works on the send / receive principle. The voltage output is proportional to flying height and measured for any given height. The altimeter is calibrated prior to project commencement using W.G.C.'s software to determine the relationship between the analog output and the true altitude in ft./metres. The raw output in millivolts is also recorded. The calibration software outputs a set of coefficients to compensate for any slope change in the analog output. These coefficients are then used to digitally record the aircraft height each 0.1 of a second.

SPECIFICATIONS

Model (type)	:Sperry RT-100
Accuracy	:40 to 200 ft: +/- 6 ft :200 to 500 ft: +/- 3% :500 to 2000 ft: +/- 3.5% :2000 to 2500 ft: +/- 4.5%

3.3 BAROMETRIC ALTIMETER

The Barometric Altimeter is a pressure transducer type, which measures the varying altitude pressure while on survey.

The barometric height of the airport, (QNH) is input by the operator prior to survey commencement to compensate for changes in daily air density pressure.

SPECIFICATIONS

Model (Baro)	:Sensyn Transducer :LX1501A
Range	:0 to 30,000ft
Accuracy	:+/- 2.75% of Full Scale
Resolution	:0.1 foot

3.4 MAGNETIC BASE STATION

Two Geometrics G-856 memory magnetometer were used for this survey. One unit was located some distance off the road to the airport from the field office / accommodation base at Alyangula, on Groote Eylandt, and the other positioned on the airport grounds. A small area surrounding these locations were "mini surveyed" to determine a magnetically quiet position. The units were time checked prior to each survey flight commencement against the GPS receiver time, which is the time base for all acquired data.

SPECIFICATIONS

Model	:G-856 memory magnetometer
Displays	:Six digit display of :Magnetic field to resolution :of 0.1 nT or time to :nearest second. :Additional three digit display :of station, day of year, and :record number.
Resolution	:Typically 0.1 nT in :average conditions.
Absolute accuracy	:One nT, limited by :remnant magnetism in :sensor and :crystal oscillator accuracy.
Clock	:Julian clock with stability :of ~2 seconds per day.
Memory	:Approx. 12,500 readings.
Output	:Plays data out in :standard :RS-232 format :at selected baud rates.

3.5 TRACKING CAMERA

A video camera is located in the under-side of the aircraft pointing directly down with a wide angle lens to record any cultural anomalies on land and the ocean surface, for example, townships, buildings, ships, oil production platforms, mining activity ect.

SPECIFICATIONS

<i>Model</i>	:Sony wide view CL-352
<i>Lens</i>	:Auto iris wide angle

3.6 VIDEO RECORDER

The camera is coupled to a commercially available standard video cassette recorder unit. Video tapes are long play with 180 minutes per tape. The recorder has a digital counter to measure remaining tape. The line attempt number, heading, position and fiducial number are superimposed upon the tape at the top and bottom of the display. The operator has the facility to input an event marker with comments upon the video image to manually mark any features of interest, such as the above mentioned cultural anomalies.

The operator has a small format CRT monitor displaying the image immediately below the aircraft in real time.

SPECIFICATIONS

<i>Model</i>	:National Panasonic
<i>Format</i>	:VHS

3.7 NAVIGATION

Aircraft navigation was performed using GPS autonomous positioning. Differential corrections were applied in post processing. The GPS base station was located in the field office at Alyangula. This GPS base station was initially positioned using commercially available Ashtech "RANGER" software. This entails logging the receiver for a period of approximately 4 hours, then averaging the reference site, this was done on several occasions during the survey to satisfy position repeatability. The GPS base station antenna was located on the roof of the field crews operations and accommodation base.

SPECIFICATIONS

<i>Receiver(s)</i>	:Ashtech XII, auto all in :view, 12 channel C/A :code tracking
<i>Position accuracy</i>	:Differential mode = 1-10m : (PDOP<6) : Spherical Error Probability :(SEP)
<i>Receiver(s) update rate</i>	:2 per second
<i>Velocity</i>	:>1200m / sec.
<i>Antenna</i>	:Kinematic

3.8 DIGITAL RECORDING

The survey was conducted using a PICODAS digital recording system, This system comprises of a PC based computer with internal hard disk, 3 1/2" micro disk and a 40Mb DC 2000 tape drive. The software used has been developed by W.G.C. and is proprietary software. All data recorded is in binary format and stored onto hard disk then copied to DC 2000 thetamat media, then down loaded onto a field personal computer, verified and checked before being shipped to W.G.C.s processing Dept.

SPECIFICATIONS

<i>Model</i>	:*PDAS-1000 (Digital Acquisition System)
<i>Processor</i>	:*IBM/PC/AT compatible :*80386 (with maths co-processor)
<i>Speed</i>	:25 MHz
<i>Operating System</i>	:*MS DOS 5.0
<i>Analog to Digital channels</i>	:12 channels with 16 bit resolution (expandable)
<i>Display</i>	:Electro-luminescent :640 x 400 :pixel resolution
<i>Recording Media</i>	:80Mb Hard Disk / 40Mb :*1/4" streaming tape :*3 1/2" Floppy Disk

* registered trade marks

3.9 ANALOG RECORDING

World Geoscience uses RMS Instruments GR-33A Graphic Recorders (thermal print). This instrument is a microcomputer based 32 channel chart recorder with alphanumeric annotation. The analog output is as follows from left to right across the full 12 inches of chart;

<i>TRACE ID</i>	<i>DESCRIPTION</i>	<i>Position / Value / Span</i>
FDD1	Fourth Digital Difference (MAG)	centred = 50pT per 1"
MAG1	RAW MAG Coarse Scale	base = 2nT per 1"
CMA1	COMPENSATED MAG Fine	base = 20nT per 1"
FGAT	Total of three axisfluxgate MAG	centred = 5mV per 1"
BARO	Barometric Altimeter	base = 500ft / 1"
RAD	Radar Altimeter	base = 500ft / 1"
TC	Total Counts per sec.	base = 2000 cps / 1"
Kst	Potassium (stripped)	base = 200 cps / 1"
Ust	Uranium (stripped)	base = 200 cps / 1"
Th	Thorium	base = 200 cps / 1"

(These values are NOT absolute and may have been modified at times during the survey period. This was dependant on the activity of the traces in a particular part of the survey area, OR, the client may have requested changes to the scales for readability purposes.)

The values of full scale deflection are operator selectable and these were found to give the most comprehensible displays and enabled the operator to visually interpret the incoming data in real time. Acquisition time is displayed along the left side (top) and fiducials (events in seconds) are displayed along the right side (bottom).

When the acquisition system is initialised, a print out of year, month, day, type of magnetometer, software version and aircraft identifier are displayed. Then followed by, flight number., job number., client, aircraft, operators name, pilot, magnetometer type, survey altitude, RMS chart recorder speed and a remarks line, which the operator can input any relevant information. At the start of any recorded acquisition, the full scale deflection values are displayed for each channel, following this is the line No., direction, start fid, video number. date, and start time. After a line has been recorded and terminated, the operator has the option of making any relevant notes in the remarks; this is then followed by the binary file name, actual line number., heading, end time, end fiducial and lastly a list of last values for each trace is output.

SPECIFICATIONS

Model	:RMS GR-33A Graphic Recorder
Type	:Fully programmable 32 :channel microprocessor non- :mechanical, thermal printing :system.
Size	:315mm (12.4 ") record on :321mm (12.625 ") paper
Resolution	:100 X 100 dots / inch :(approx. 4 X 4 dots)
Recording Method	:Fixed position monolithic :thermal print-head
Speed	:~ 2mm per second. :Alphanumeric - 3 lines per sec.

3.10 GENERAL DESCRIPTION of DATA ACQUISITION SYSTEM

The main body of this system is the PICODAS (PDAS) computer referenced above in section 3.8. This is coupled to the Ashtech GPS receiver for timing. This GPS receiver is connected to a PICODAS navigation console (PNAV) which displays to the pilot a graphical representation of the line being flown, this PNAV has a flight plan of the area boundaries and start and end of the line coordinates loaded into memory via a pre recorded flight plan. The PNAV outputs to the acquisition computer the position coordinates and other relevant GPS information. The magnetometer, fluxgate magnetometer, barometric altimeter and other analog channels are powered by a PICODAS 1000A interface console. The acquisition computer also outputs line numbers, direction, current position and fiducials, to a VHS video recorder which records each line. The acquisition PDAS also converts the digital data into analog form and outputs this information to the RMS chart recorder to graphically display each channel in the form of a labelled trace onto a paper hard copy in real time.

3.11 TIME BASE

The time base for this survey was the ATOMIC clock output of the GPS satellites in all aspects of data acquisition. The aircraft acquisition system software is set to GPS time, then adjusted to the LOCAL area time each time the system is initialised. The system utilises the "PULSE PER SECOND" output from the Ashtech Ranger XII GPS receiver(s), which is Chronologically Synchronised to the ATOMIC clock output of the satellites. The G-856 base station magnetometers are also synchronised to GPS time, setting each unit manually prior to survey commencement.

4. EQUIPMENT CALIBRATIONS AND DATA ACQUISITION CHECKS

Prior to commencement of the survey, a series of calibrations were performed by the following;

4.1 HEADING ERROR

HELMHOLTZ coil adjustments to compensate for heading error were performed prior to project commencement and upon completion. This comprises of a series of flying runs over the same visually prominent feature in a clover-leaf pattern in a magnetically quiet location while adjusting the current (mAmps) for each axis (X,Y,Z) of a spherical set of copper coils surrounding the sensor, thereby creating an induced magnetic field around the sensor and removing the magnetic influence of the aircraft. The magnetic base station, is also recorded while these calibrations are being performed and the diurnal effect is taken into consideration. This heading error was within 1 nT. on traverse line headings as follows;

North	=47,112.8nT.
South	=47,112.7nT.
East	=47,105.6nT.
West	=47,105.6nT.

4.2 SYSTEM PARALLAX

The aircraft parallax is also checked when heading checks are done. This parallax error is simply the delay caused by the physical distance from the magnetic sensor, at the tail of the aircraft, to the centre of the video image.

The heading error and parallax error are recorded and therefore are known. Any error is removed during processing.

4.3 MAGNETIC, REAL TIME COMPENSATION COEFFICIENTS

Also performed are a series of aircraft compensation tests flown on survey line heading and also 5° to 20° either side to accommodate cross wind flying conditions. The data for each heading consists of a series of aircraft manoeuvres, pitches, rolls and yaws. This is done to artificially create the worst possible attitude the aircraft may encounter whilst on survey and compensate for any magnetic noise caused by the aircraft's attitude in the naturally occurring magnetic field. This data is processed to obtain the best possible magnetic *REAL TIME COMPENSATION* coefficients from 32 mathematical terms. These coefficients may be applied in real time, or post processing. The compensated magnetic data was demonstrated to be less than 0.5nT. peak to peak.

4.4 RADIOMETRIC CALIBRATIONS and QUALITY CONTROL

Prior to project commencement and upon completion, resolution checks of the spectrometer were performed to ensure accuracy to contract specifications. Aircraft background and height attenuation tests were performed prior to commencement of this project.

Uranium and Thorium hand sample calibrations were carried out each production flight (pre and post flight). These were within 10% of initial calibrations. A low and high level test line were recorded each production flight (pre and post flight) as per contract specifications.

The low level test line Coordinates are as follows;

AGD-84		ZONE 53
EASTING		NORTHING
655900	START	8466700
655800	END	8460000

4.5 RADIOMETRIC CORRECTION PROCEDURES

Radiometric correction procedures are as follows;

Parallax Correction	Coefficient;	0.3
Radon Corrected		
Background Corrected		
Height Attenuation Correction		
“ “ Total Counts	Coefficient;	0.006382
“ “ K	“ “ ;	0.008370
“ “ Ur	“ “ ;	0.005138
“ “ Th	“ “ ;	0.006440
Stripped Th into Ur	Coefficient;	0.3047
“ Th into K	“	0.3314
“ Ur into K	“	0.6343
“ Ur into Th	“	0.0242
Tie Line Leveled		
Micro Leveled		

4.6 DIGITAL DATA FORMATS

Descriptive digital data formats as follows;

"F6"	:line No.
"F3"	:flight No.
"F7"	:date
"F8-2"	:time
"F9-2"	:fiducial No.
"F2"	:recovery flag
"F10-1"	:easting
"F10-1"	:northing
"F1"	:final mag flag
"F9-2"	:raw magnetic intensity
"F9-2"	:corrected magnetic intensity
"F9-2"	:diurnal
"F9-2"	:igrf
"F6"	:total count
"F6"	:potassium
"F4"	:uranium
"F4"	:thorium
"F4"	:cosmic
"F1"	:data flag
"F8-1"	:total count corrected
"F8-1"	:potassium corrected
"F6-1"	:uranium corrected
"F6-1"	:thorium corrected
"F6-1"	:radar altitude

5. AIRCRAFT AND EQUIPMENT

Type	:Shrike Aerocommander AC-500S
Registration	:VH-MEH
Ownership	:W.G.C. Corporation Ltd :Aerodata Holdings Ltd.
Serial No.	:3258
Date of Manufacture	:1975
Engines	:Twin, IO540-E185 Lycoming :Piston type
Propellers	:Twin, 3 blade variable pitch :Hartzell HC-C3YR-2F
Dimensions	:Wingspan 49ft. :Length 36ft. :Height 14ft. 6"
Fuel	:AVGAS 100
Fuel Capacity	:Main Tanks 156 US gals - 593Lts :Boot Tank 50 US gals - 190Lts
Endurance	:at 24 US gals/Hr = 8.5Hrs
Total Airframe Time	:~15300Hrs at 30 June 1993
Total Survey Time	:~13000Hrs at 30 June 1993
Seating	:Survey Configuration - 3 Pax.
Flight Instruments	:Century III auto pilot
Radio Equipment	:Codan HF multi-channel radio :Collins 331-3S HSI :Sperry RT-100 Radar Altimeter :DigiQuartz 223-AS-002 :pressure transducer :King KMA 20-04 marker beacon :King K x 175B/KN72 Nav/Com VHF : " " " " " " :King KN75 Glideslope :King KR87 ADF :King KR85 ADF :AWA Domestic Van 10 DME :King KN65A International DME :King KT76A ATC-SSR

6. SURVEY OPERATIONS AND LOGISTICS

6.1 SURVEY BASE

The operating base used for this project was Alyangula on the western side of Groote Eylandt. The accommodation and office facilities were supplied by GEMCO (BHP Minerals). This base was also used for the preceding Northern Territory Department of Mines and Energy survey because of its close proximity and the logistical problems of re-locating / re-mobilising the base of operations to another site. This decision was made in consultation with client and it was determined the magnetic and GPS base stations were within tolerable distances to this particular survey area.

Because the base of operations was the same as the previous Northern Territory Department of Mines and Energy survey, flight numbers remain consecutive.

Airport details as follows;

<i>Airport</i>	:Alyangula
<i>Runway Length</i>	:1901m
<i>No. of runways</i>	:1
<i>Airport facilities</i>	:PA Lighting 125.1
	:NDB 407
	:DME 10
	:MTAF 126.0
<i>Aviation Fuel</i>	:Mobil

6.2 SURVEY FIELD CREW

The following personnel were employed on this project;

Project Co-ordinator - Sydney	:Dick Butler
Logistics & Operations - Perth	:Tony McCambridge
Project Manager(s) - On Site	:Bill Churchward
	:Ray Skeet
Pilot(s)	:Capt. Jeff Ibbotson
	:Capt. Dominic Walsh
Electronics Engineer / Data Tech	:Geoff Wells
Electronics Tech / Data Tech / Operator	:Ben Trevenen
Geophysicist / Data Processing - Sydney	:Alan Willmore
Geophysicist / Programmer - Sydney	:Ian Cambell
Data Quality Control - Perth	:Kevin Harrinton

6.3 FLYING SUMMARY

Date	FLT. No.	FLT. Hrs	Kms	Progressive Total	Comments
05/10/93	11	9.3	1536	1536	
06/10/93	12	9.5	1825	3361	
07/10/93	00	0.0	0000		A/C 100hrly
08/10/93	00	0.0	0000		A/C 100hrly
09/10/93	13	4.5	299	3660	Mag. storms half day STBY
10/10/93	00	0.0	0000		Mag. storms full day STBY
11/10/93	00	0.0	0000		Mag. storms full day STBY
12/10/93	14	4.5	804	4464	Survey Equip. U/S half day down
13/10/93	00	0.0	0000		A/C Fuel system U/S full day down
14/10/93	15	4.1	608	5072	Delay, waiting on parts half day down
15/10/93	16	10.4	1716	6788	
16/10/93	17	10.6	1862	8650	
17/10/93	18	8.6	1133	9783	
18/10/93	19	9.4	1508	11291	
19/10/93	20	3.9	283	11574	Survey Equip. problem half day down
20/10/93	21	10.0	1515	13089	
21/10/93	22	9.1	1202	14289	
22/10/93	23	9.5	1381	15672	Active diurnal
23/10/93	24	10.1	734	16406	
24/10/93	25	6.0	230	16636	Active diurnal half day STBY
25/10/93	26	6.0	879	17515	Active diurnal
26/10/93	27	4.5	524	18039	
27/10/93	28	5.0	204	18248	Area complete + Re-flts
28/10/93	29	5.8	0000		Re-flts, clean up

TOTAL

Actual survey days	= 17 days
Scheduled aircraft maintenance	= 02 days
Un-scheduled aircraft maintenance	= 03 days
Stand-by days due weather/diurnal	= 03 days
Total survey duration	= <u>25 days</u>