Australian Government

Geoscience Australia

Georgina - Arunta Magnetotelluric Survey Report

June 2011

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1. Introduction

In May-June 2009, as part of the Australian Government's Onshore Energy Security Program (2006-2011), Geoscience Australia in collaboration with Northern Territory Geological Survey has acquired magnetotelluric (MT) data along the deep crustal seismic reflection transect in the Georgina - Arunta region, Northern Territory.

The aim of the MT survey was to produce a two-dimensional image of electrical resistivity structure of the crust and upper mantle. This information is complementary to that obtained from deep seismic reflection, gravity, magnetic and geological data, which together provide new knowledge of the crustal architecture and geodynamics of the region, important for helping to determine the potential for both mineral and energy resources.

2. Survey Details

2.1 Project Name: Georgina magnetotelluric survey (09GA_GA1 L192 seismic reflection line)

2.2 Acquisition Period: 22st May – 22th June 2009

2.3 Survey Type: two dimensional MT survey

2.4 Survey Map: see Appendix A and Appendix B for survey location and MT sites.

2.5 Data Acquisition

The Georgina MT data were acquired along an ~376 km profile at the 39 broadband and 18 long period sites with station spacing 5 - 20 km, offset by 100 m from the seismic line. See Appendix C for detail of site location.

3. Acquisition Specifications

3.1 Acquisition Equipment

AuScope MT equipment (broadband and long period) was used for data acquisition through ANSIR (National Research Facility in the Earth Sciences) agreement. Data were recorded on high precision, high dynamic range Earth Data Loggers with GPS timing synchronization. The instrumentation used for sensing magnetic data included two induction coils for the higher frequencies (broadband) and three component fluxgate magnetometers for the lower frequencies (long period). Electric field measurements were using three non-polarising copper/copper sulphate electrodes with wires. Data QA/QC was conducted during the acquisition.

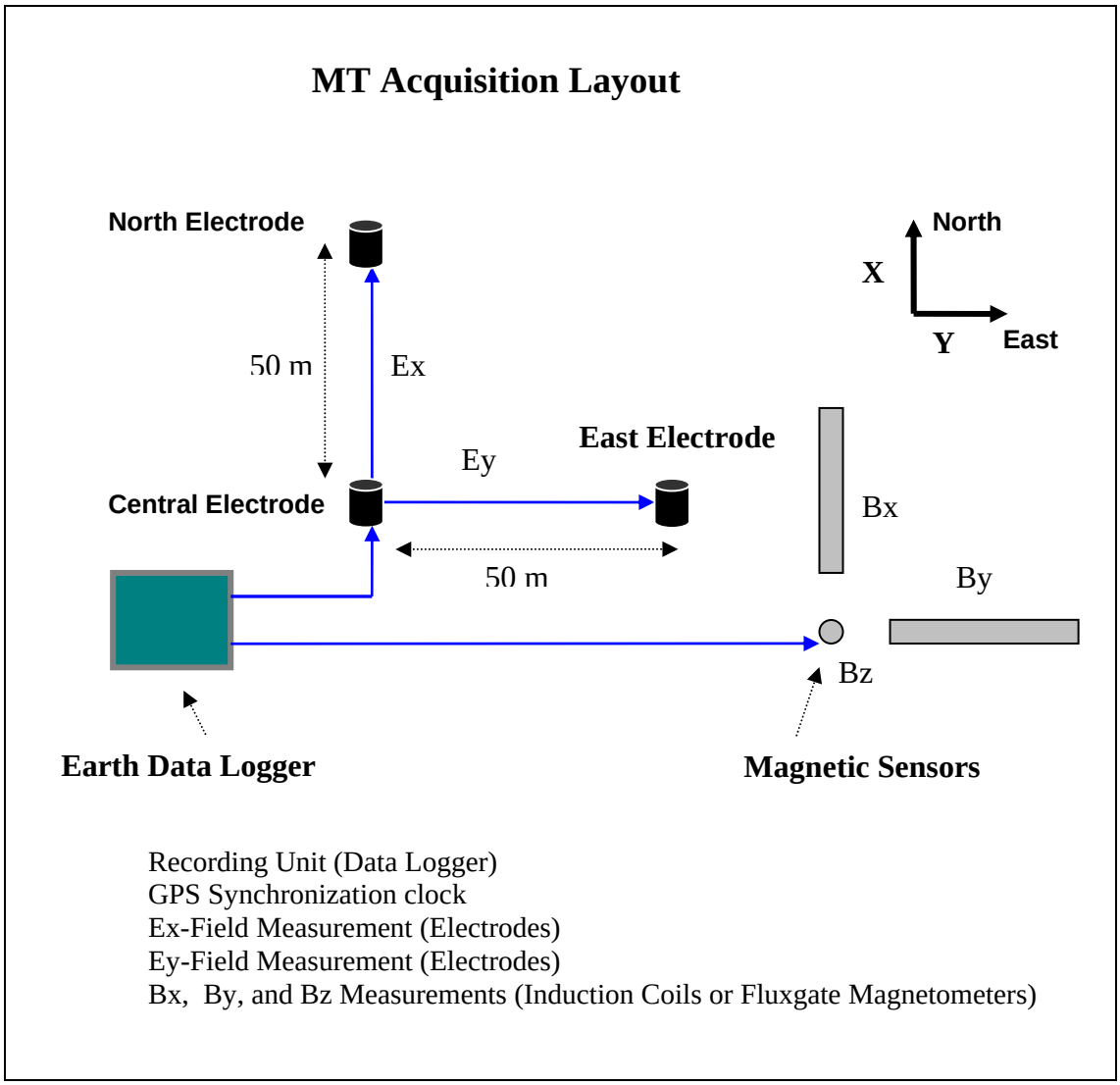
3.2 Acquisition Layout

The equipment was deployed at each site as depicted in the acquisition layout, with directions referenced to magnetic north by using a compass. This is adjusted in later processing by rotation of the data to true geographic directions by knowledge of the declination at each site.

At each broadband site two orthogonal induction coils were deployed to measure magnetic field variations in two orthogonal directions (NS and WE). The induction coils were buried in shallow trenches for stability.

At each long-period site the three-component Fluxgate magnetometer was deployed for measurement of magnetic field variations in three orthogonal directions (NS, WE and vertical directions). The magnetometer was buried for both stability and to minimise temperature variations.

The two orthogonal horizontal electric fields were measured at both long-period and broadband sites by using two orthogonal dipoles (NS and WE directions) having average a length of 50 m each, and grounded with the three electrodes in an L-shaped configuration.



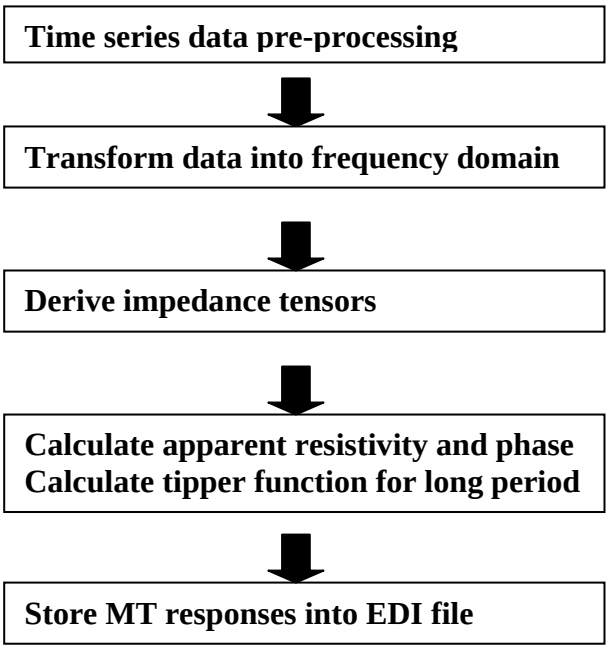
3.3 Acquisition Parameters

Table1 1:

	Broadband	**Long period**
Type of data recorder	Earth Data Recorder PR 6-24 with 30Gb removable hard disk	Earth Data Recorder PR 6-24 with 30Gb removable hard disk
Data format	MiniSeed	MiniSeed
Sampling rate	1000 Hz	10 Hz
Record time	30 - 60 hours	5 – 7 days
Site spacing	5 - 10 km	15 – 20 km
Remote-Base Synchronization	GPS clock (10µsec accuracy), 10 min correction in every hour	GPS clock (10µsec accuracy), 10 min correction in every hour
Sensor type	LEMI-120 Induction Coil	Bartington Mag-03MS Fluxgate magnetometer
Effective frequency Bandwidth	200 – 0.01 Hz	0.2 – 0.0001 Hz

4. Data Processing

The MT data were collected in time series measurements with reasonable quality. Data were processed using the robust algorithm BIRRP (Chave and Thomson, 1987 and 2004) with remote reference data when available. The aim of the process was to remove outliers in the time series measurements (e.g., from a passing train) and produced a robust estimation of the transfer function to obtain a series of power spectral estimates between the electric and magnetic fields for each MT site. Then, the apparent resistivity and phase as a function of frequency were calculated. The spectral estimates and other fundamental quantities are stored in a standard Electrical Data Interchange (EDI) file.

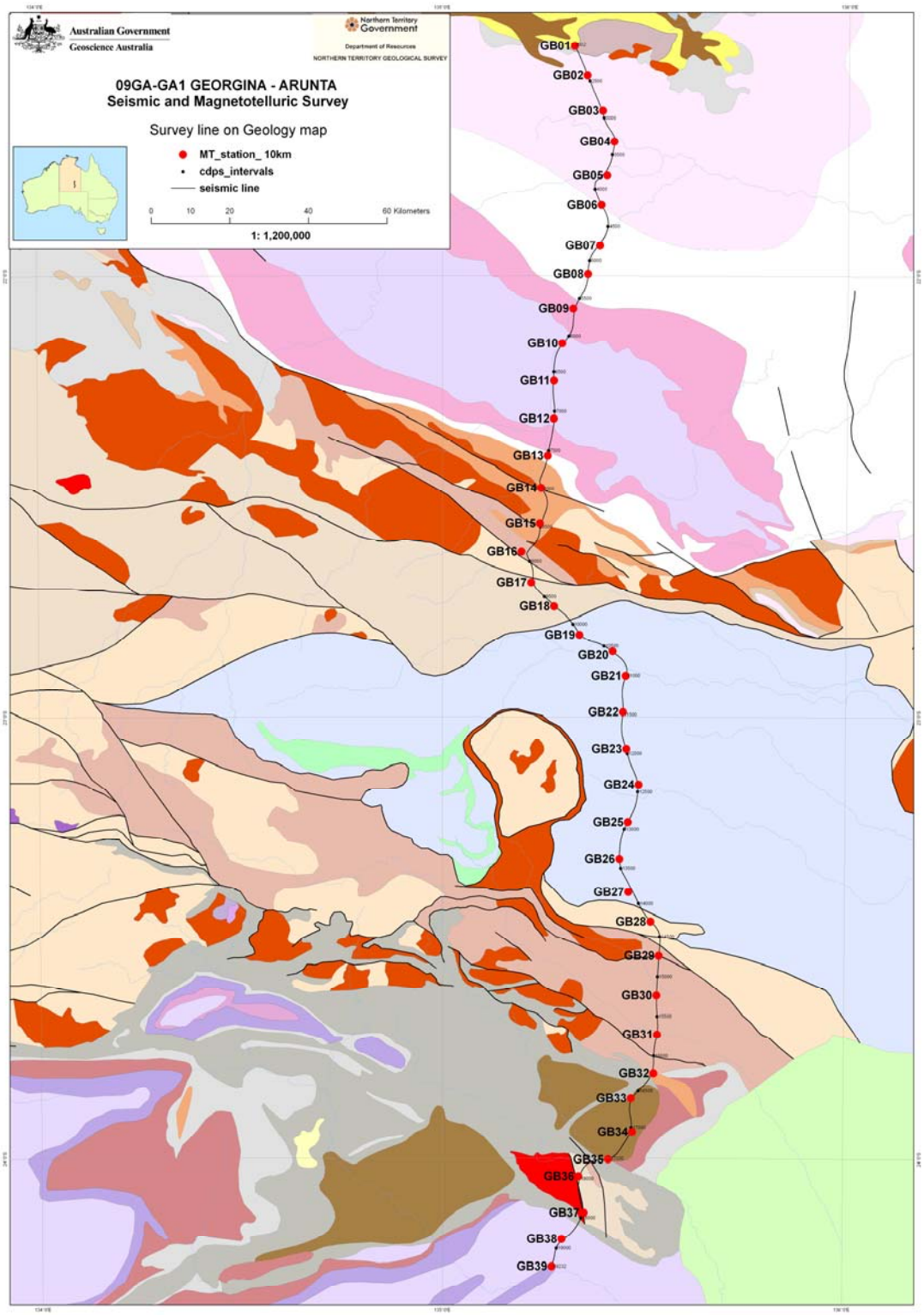


Appendix A: Survey location map

MT survey map with geological regions and the seismic reflection transect (black line).

Appendix B: Survey location map with MT sites

MT survey sites plotted on solid geology map. Black line – deep reflection seismic traverse; red points – sites of broadband MT data acquired by Geoscience Australia.



Appendix C: MT sites location

MT survey sites information, the broadband sites denoted with prefix GB* and long period sites denoted with prefix GL*.

Site Name	East	North	Elevation (m)	Declination
	(GDA94 – UTM Zone 53)			
GB01	533762	7624617	415	5.182
GB02	537003	7617358	415	5.197
GB03 (GL01)	541091	7607296	377	5.218
GB04	543852	7600615	381	5.232
GB05 (GL02)	542094	7592252	382	5.236
GB06	540395	7584980	390	5.240
GB07 (GL03)	540308	7574656	391	5.248
GB08	537104	7567593	395	5.251
GB09 (GL04)	533730	7559176	406	5.252
GB10	530470	7550037	422	5.250
GB11 (GL05)	528273	7540710	432	5.258
GB12	528301	7531102	437	5.269
GB13 (GL06)	526754	7521828	451	5.275
GB14	525410	7513548	466	5.280
GB15 (GL07)	524976	7504961	473	5.288
GB16	520912	749809	486	5.286
GB17 (GL08)	522530	7489768	512	5.298
GB18	528257	7484279	489	5.319
GB19 (GL09)	534802	7476896	450	5.343
GB20	543441	7472566	437	5.370
GB21 (GL10)	546693	7466663	440	5.384
GB22	545815	7457570	430	5.392
GB23 (GL11)	546709	7448262	424	5.404
GB24	549726	7439461	406	5.422
GB25 (GL12)	547336	7430210	423	5.426
GB26	545134	7420802	452	5.430
GB27 (GL13)	548336	7412485	419	5.448
GB28	552951	7405218	389	5.467
GB29 (GL14)	554939	7396640	369	5.482
GB30	554291	7386668	351	5.491
GB31 (GL15)	554705	7376682	354	5.503
GB32	553737	7367279	330	5.511
GB33 (GL16)	548074	7360765	304	5.500
GB34	548139	7352301	308	5.513
GB35 (GL17)	542260	7345386	308	5.505
GB36	534658	7341306	319	5.490
GB37 (GL18)	536074	7332087	297	5.504
GB38	530472	7325301	275	5.496
GB39	527971	7318633	266	5.497

Appendix D: References

Chave, A.D., Thompson, D.J. and Ander, M.E., 1987. On the robust estimation of power spectra, coherences and transfer functions. Journal of Geophysical Research-Solid Earth, **92**, 633-648.

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