

Tasmanian MT Acquisition Report

Mineral Resources Tasmania



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1.0 PROJECT BRIEF

Tasmanian magnetotelluric (MT) surveys covered herein were acquired as part of the author's PhD project at the University of Tasmania, supervised by Prof. Anya Reading in collaboration with Prof. Graham Heinson of the University of Adelaide and Dr. Stephan Thiel of the Geological Survey of South Australia.

The project involved acquisition of three distinct datasets; a regionally spaced long-period MT dataset for deep 3-dimensional conductivity imaging acquired as part of the Australian Lithospheric Architecture Magnetotelluric Project ([AusLAMP](#)) supported by Geoscience Australia; and two 2-dimensional shallow imaging broadband MT transects across geologically diverse regions of economic interest in western and north-western Tasmania supported by Mineral Resources Tasmania (figure 1).

Data acquisition was completed in late November with current efforts focusing on modelling long period data as well as processing broadband data.

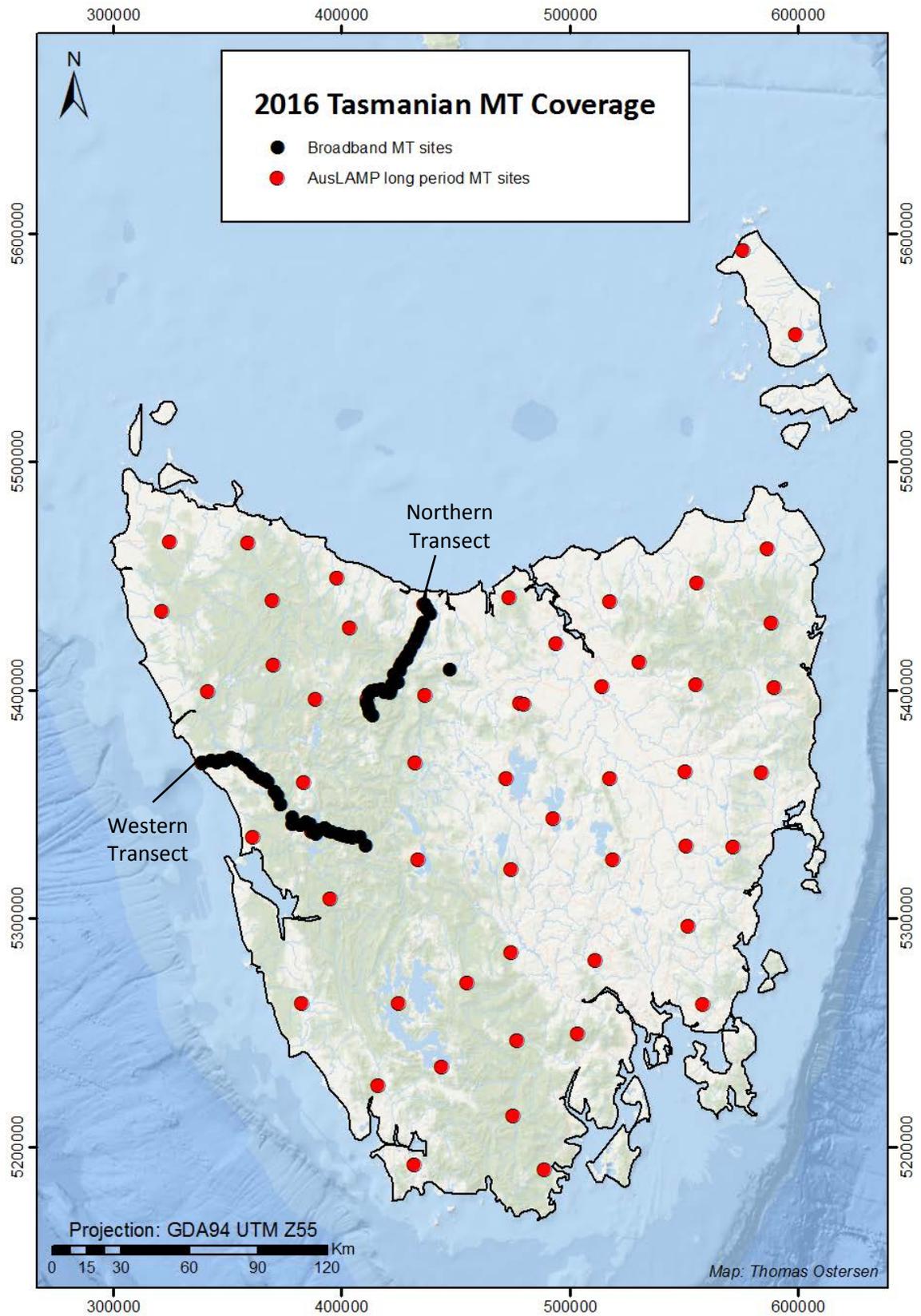


Figure 1: Tasmanian MT coverage overview map.

2.0 FIELDWORK TIMELINE

Initial work on negotiating land access for the survey began in early November 2015 and involved securing access agreements with Parks and Wildlife, Forestry Tasmania, Forico, Crown Land Services, West Coast Council, as well as several private land holders. A week-long reconnaissance trip in an MRT provided hire car was completed in the first week of January 2016 to finalise this process and pick up gate keys from the Burnie Forestry Tasmania and Queenstown Parks and Wildlife offices.

2.1 PHASE 1; JANUARY-MARCH 2016

The first round of fieldwork involved a 4-week intensive campaign starting on the 22nd of January. Two field crews based out of Queenstown deployed several AusLAMP long period sites and then completed the western broadband transect with remaining instruments. Following a crew change, acquisition teams moved onto the northern transect based out of Gowrie Park near Sheffield. A second crew change coincided with the completion of the northern transect and the deployment of all instruments at northern Tasmanian AusLAMP long period sites.

Several bushfires burning across northern and western Tasmania complicated acquisition, with several AusLAMP sites rendered inaccessible due to road closures. Acquisition plans were modified daily with crews regularly checking the Tasmanian Fire Service map for fire activity updates.

Long period instruments were deployed for 3 weeks before being retrieved by a single crew and returned to the instrument pool in Adelaide. A total of 32 long period and 67 broadband sites were acquired over the course of phase 1.

2.2 PHASE 2, 3 & 4; JULY-NOVEMBER 2016

Phase 2 focussed on the acquisition of remaining long period sites in southern Tasmania, Flinders Island and sites in north western Tasmania that either failed early during deployment or were inaccessible during phase 1. Commencing on the 17th of July 2016, a two-man crew deployed 23 long period instruments in challenging winter conditions.

Phase 2 deployments had a high failure rate with 8 sites recording incomplete time series data because of limited daylight hours on charging solar panels. 2 of the failed sites also had compromised magnetic channels due to waterlogged magnetometers.

Two further deployment phases were carried out between September and November 2016 to redeploy failed sites from phase 2 as well as infill parts of the AusLAMP dataset in areas of interest.

3.0 PERSONNEL

3.1 PHASE 1

NAME	AFFILIATION
THOMAS OSTERSEN	University of Tasmania
GORAN BOREN	University of Adelaide
NICK SMITH	PassiveX Ltd
JINGMING DUAN	Geoscience Australia
EMAEIL ESHAGHI	University of Tasmania
YOHANNES DIDANA	University of Tasmania
TANYA FOMIN	Geoscience Australia
MATTHEW CAREY	Geoscience Australia
JOSEPH RUGARI	University of Adelaide
DENNIS CONWAY	University of Adelaide
MATTHEW FERGUSON	University of Tasmania

3.2 PHASE 2, 3 & 4

NAME	AFFILIATION
THOMAS OSTERSEN	University of Tasmania
BENJAMIN CAVE	University of Tasmania

4.0 INSTRUMENTATION AND ACQUISITION PROCEDURES

All MT data were acquired using instruments developed by AuScope and sourced through the [ANSIR National Facility for Earth Sounding](#). The instruments utilise Earth Data [PR6- Portable Field Recorders](#) to record time series electric and magnetic field data in ASCII format to an internal hard drive, either in broadband mode (for transect sites) or long period mode (for AusLAMP sites). Figure 2 depicts a schematic diagram of a typical long period MT deployment setup.

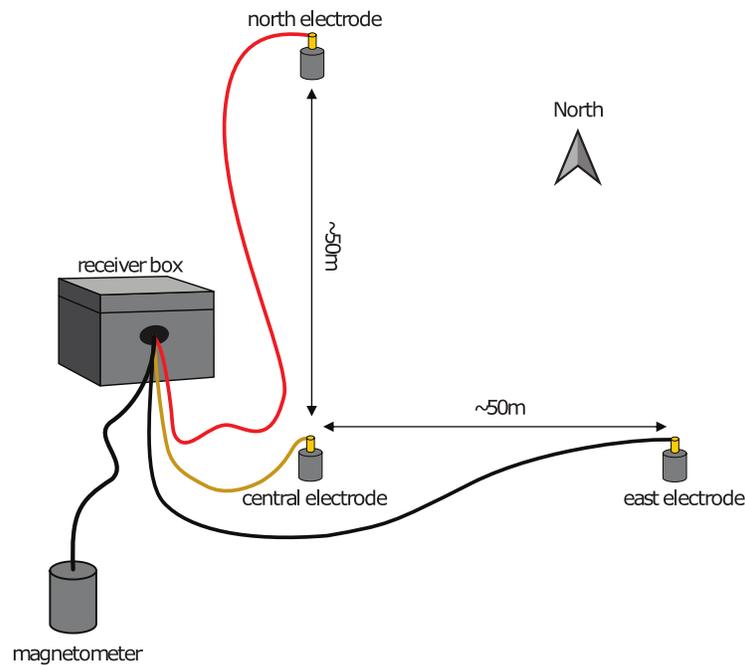


Figure 2: Deployed MT instrument diagram.

For both broadband and long period modes, the horizontal component of the Earth's electric field is measured between a three non-polarisable electrodes (manufactured by [SDEC](#)) buried $\sim 0.3\text{m}$ in the ground and separated by $\sim 50\text{m}$ north and east of a central electrode. Contact resistances between electrodes were measured once electrodes were in place and kept below $10\Omega\text{m}$ at time of deployment to minimise electrical noise.

Deployment information sheets detailing instrument ID numbers, setup orientations, potential sources of electrical and magnetic noise, as well as a detailed description of the instrument location were filled out for each site. These sheets were later used for data processing purposes.

4.1 BROADBAND

Broadband transect MT sites were deployed for 36-48 hours and sampled the Earth's magnetic and electric fields at 1000hz. Typical data volume for a single broadband deployment is in the order of 4.5-5GB.

The horizontal component of the magnetic field was recorded using two [LEMI-120](#) induction coils buried $\sim 0.3\text{m}$ in the ground for stability, one oriented N-S and another E-W. Figure 3 illustrates a typical induction coil setup for a broadband deployment.



Figure 3: Burying induction coil aligned with magnetic north near Cradle Mountain, Northern Transect.

4.2 LONG PERIOD

Long period MT sites were deployed for 3-4 weeks and sampled the Earth's magnetic and electric fields at 10Hz. The long deployment time for long period sites necessitated the use of a 1x1.5m solar panel to maintain battery charge. Typical data volume for a single long period deployment is in the order 0.8-1.5GB.

Earth's magnetic field was recorded using [Bartington Mag-03](#) three-component fluxgate magnetometers encased in a waterproofed PVC covering and buried $\sim 0.5\text{m}$ in the ground for stability. Figure 4 illustrates a typical magnetometer coil setup for a long period deployment.



Figure 4: Burying fluxgate magnetometer for long period deployment.

5.0 DATA FORMATS AND PROCESSING

Raw ASCII format time series data for all sites, including AusLAMP and broadband transects, amounts to 520GB and is currently stored on the UTAS internal network as well as on several portable hard drives for data redundancy purposes. Figure 5 depicts a time series plot of electric and magnetic field variation from a typical long period deployment.

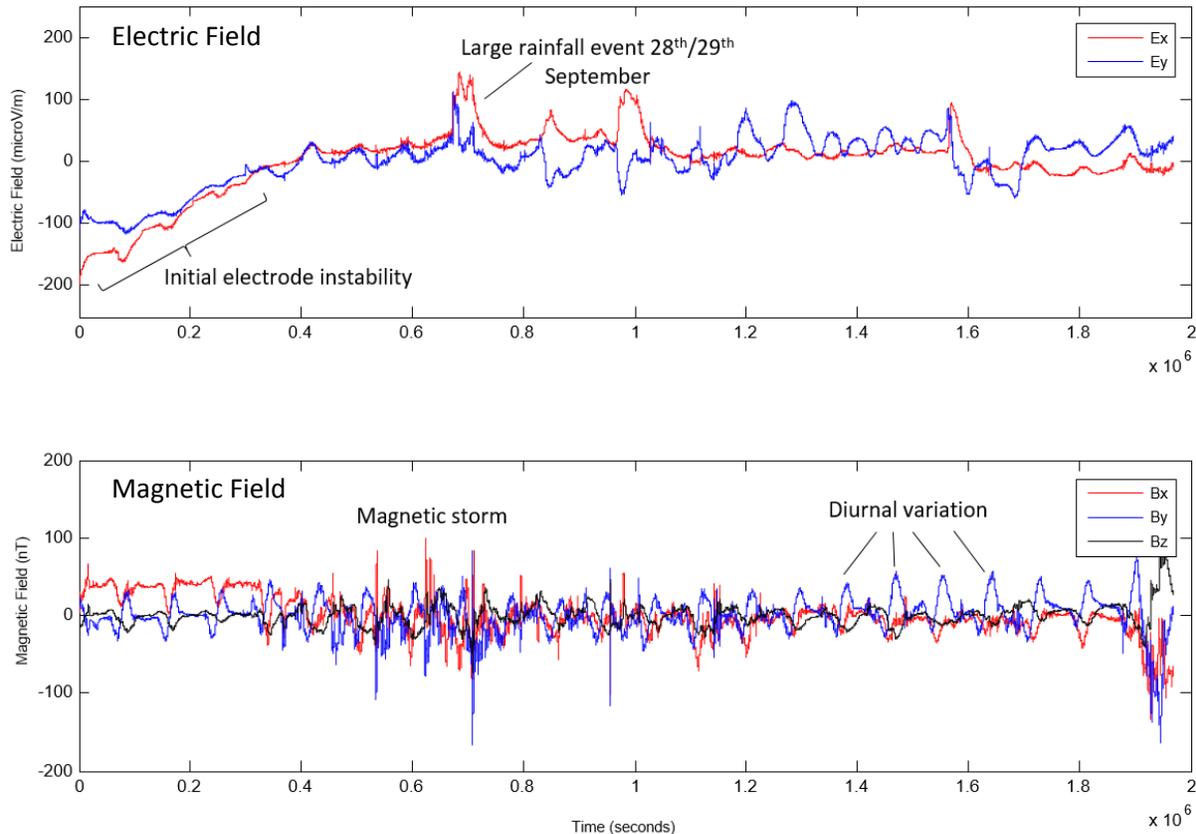


Figure 5: Time series data plot from long period deployment showing ~23 days' worth of data between 21st September and 13th October 2016.

Processing time series data involves selection of 'clean' sections of data with minimal electrical and magnetic noise for processing using the Bounded Influence Remote Reference Processing (BIRRP5) code of Chave and Thomson (2004). BIRRP5 proceeds by first converting electrical and magnetic field data to the frequency domain, rotates the data to geographic coordinates, removes uncorrelated magnetic noise by remote referencing to other sites, then solves the impedance tensor for several frequency windows to output Electrical Data Interchange (EDI) files containing apparent resistivity, phase and position information for each site. From EDI files, apparent resistivity and phase can be plotted as an MT sounding (figure 6).

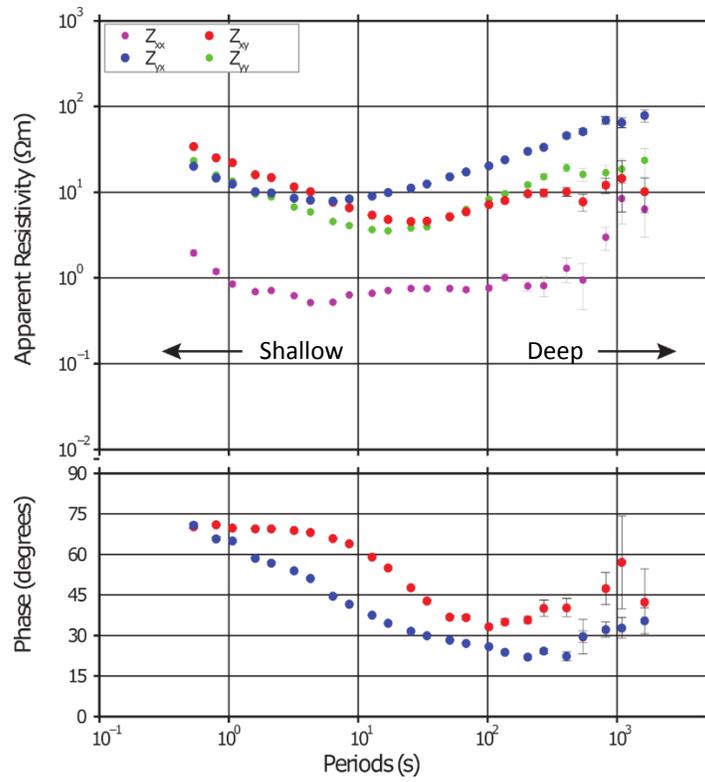


Figure 6: Resistivity and phase MT sounding plot from processed EDI file for AusLAMP site 108, near Strahan. Shorter periods represent MT response from mid-crustal depths while longer periods represent deeper, lithospheric mantle responses.

6.0 ONGOING WORK

6.1 LONG PERIOD MT

Long period data processing is complete and has progressed to an inversion and interpretation stage. ModEM code developed by Egbert and Kelbert (2012) has been compiled on a high performance cluster at the Tasmanian Partnership for Advanced Computing (TPAC) and is being used to invert 3D conductivity models from EDI files. It is expected a final 3D inverse model will be generated by early 2017.

6.2 BROADBAND MT

Initial broadband MT processing is complete and indicates data is of good quality. Some noise in electric and magnetic fields at ~50Hz from powerlines along the parts of both the northern and western transect is presenting a challenge however, and ongoing work is focussed on applying notch filters to time series data to try and remove this effect.

Figure 7 presents a phase tensor ellipse pseudosection from initial western transect processed data coloured by skew angle. The effect of powerline noise is visible at periods of ~50Hz, where ellipses are highly irregular.

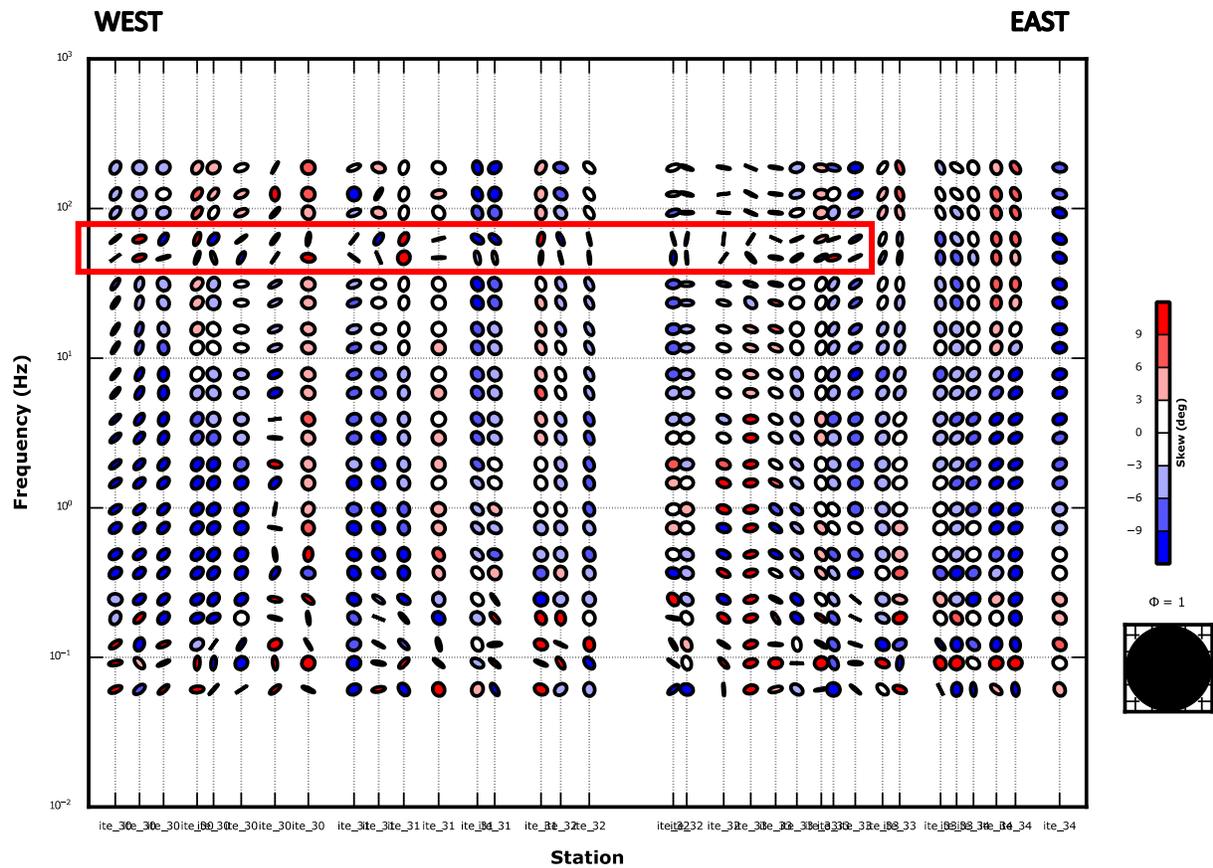


Figure 7: Western transect phase tensor ellipse pseudosection coloured by skew angle. Ellipses highlighted are affected by 50Hz cultural noise.

Final processed EDI files for western and northern transect broadband MT data will be completed by the beginning of 2017, and will be used to generate 2D inverse conductivity models using OCCAM 2DMT code by deGroot-Hedlin & Constable (1990). Issues with 3-dimensionality of the data indicated by non-zero skew angles may complicate this 2D inversion, and it may be necessary to model transect data using 3D ModEM code to properly account for this complex MT response.

7.0 PROJECT SAFETY

In accordance with University of Tasmania health and safety policy, a comprehensive risk assessment was carried out and signed off by all field personnel prior to commencement of field work. All crews carried with them a personal locator beacon and a check-in message was sent to responsible person in Hobart at the end of each day.

No incidents were reported during the survey.

8.0 REFERENCES

Chave, A. D., and D. J. Thomson (2004), Bounded influence magnetotelluric response function estimation, *Geophys. J. Int.*, 157(3), 988–1006.

DeGroot-Hedlin, C., and S. Constable (1990), Occam's inversion to generate smooth, two-dimensional models from magnetotelluric data, *GEOPHYSICS*, 55(12), 1613–1624.

Egbert, G. D., and A. Kelbert (2012), Computational recipes for electromagnetic inverse problems, *Geophys. J. Int.*, 189(1), 251–267.