AusAEM; acquisition of AEM at an unprecedented scale

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SUMMARY

Exploring for the Future is a four-year programme of the Commonwealth Government that aims to boost Australia's attractiveness as a destination for investment in resource exploration. A significant component of the data acquisition component of the programme is the AusAEM Airborne Electromagnetic (AEM) Survey. This survey will focus on wide line-spaced acquisition as a regional mapping tool to gather new pre-competitive data and information, on extents never previously attempted. The objectives are to map, at a reconnaissance scale:

- trends in regolith thickness, character, and variability
- variations in bedrock conductivity
- the continuity of key conductive bedrock (lithology-related) conductive units under cover
- the groundwater resource potential of the region.

The first AEM survey of this programme, when completed, will cover an area of over one million square kilometres (more than the areas of France and Spain together), at a nominal line spacing of 20 km with infill surveys in selected areas for subscription companies.

In order to have the greatest impact the survey targets greenfield areas where the resource potential is unknown. The AEM data will contribute to estimating features and character of the cover material. To maximize industry collaboration on the project GA sought, and received, expressions of interest from industry subscribers for infill flying on the regional survey for lines spaced at 200 or 400 meters.

Regional AEM surveys improve geological understanding in areas with little or no outcrop. The processed data enables informed interpolations of conductivity between sparse drill-holes and estimates on the depth of the basement-cover interface from geophysical modelling. The modelling results are used to inform follow-up exploration activities thereby reducing exploration risk. The new data will be released to the public domain at regular intervals to promote future activity by the government, exploration and research sectors.

Key words: TEMPEST®, Exploring for the Future (EFTF), airborne electromagnetics (AEM), exploring undercover

INTRODUCTION

Australia's economic prosperity has historically been significantly dependant on the mineral resources sector, but over the last decade no Tier 1 (i.e. world class) deposit discoveries have been made in Australia. Most of the currently producing mines were discovered decades ago in regions where the mineralization is hosted in rocks exposed at the surface or under very shallow cover. Recognizing the importance of exploration as a precursor to resource development and extraction is essential as it can take over 10 years to convert a discovery into a mine.

Pre-competitively funded exploration is needed in order to sustain a resource-dependant economic future as a way of mitigating the inherent uncertainty linked to discovery of new resources. Acquisition of new geoscientific data will reduce risk for private sector mineral exploration and help identify potential new gas, mineral, and ground water resources. *Exploring for the Future* is a Commonwealth Government funded programme that is expected to lead to new exploration investment, increased tenement uptake and an improved effectiveness of exploration drilling campaigns. The programme encourages and promotes new and novel ways of exploration, which we think is the way to ensure that new deposits continue to be found, and for a healthy pipeline of resource projects to be secured.

As part of the *Exploring for the Future* programme, Geoscience Australia is conducting a regional TEMPEST® airborne electromagnetic (AEM) survey in the Tennant Creek–Mount Isa (TISA) region (approximately 1,117,000 km^2) of northern Australia. The regional survey consists of 20 km spaced reconnaissance lines over the onshore parts of the Newcastle Waters, Alice Springs, Normanton and Cloncurry 1:1,000,000 standard map sheets. The planned flight paths, their orientation and distribution are shown in Figure 1.

The AEM data collected will contribute to mapping regional features of the regolith, the geology and the hydrogeology and to the understanding of mineral and groundwater resource potential of the survey area. As part of the acquisition program we have invited exploration companies holding tenements in the survey area to subscribe to the survey and fly higher resolution infill over their

tenements. This will increase the understanding of their prospects at both the tenement and regional scales and complement the objectives of the regional survey.

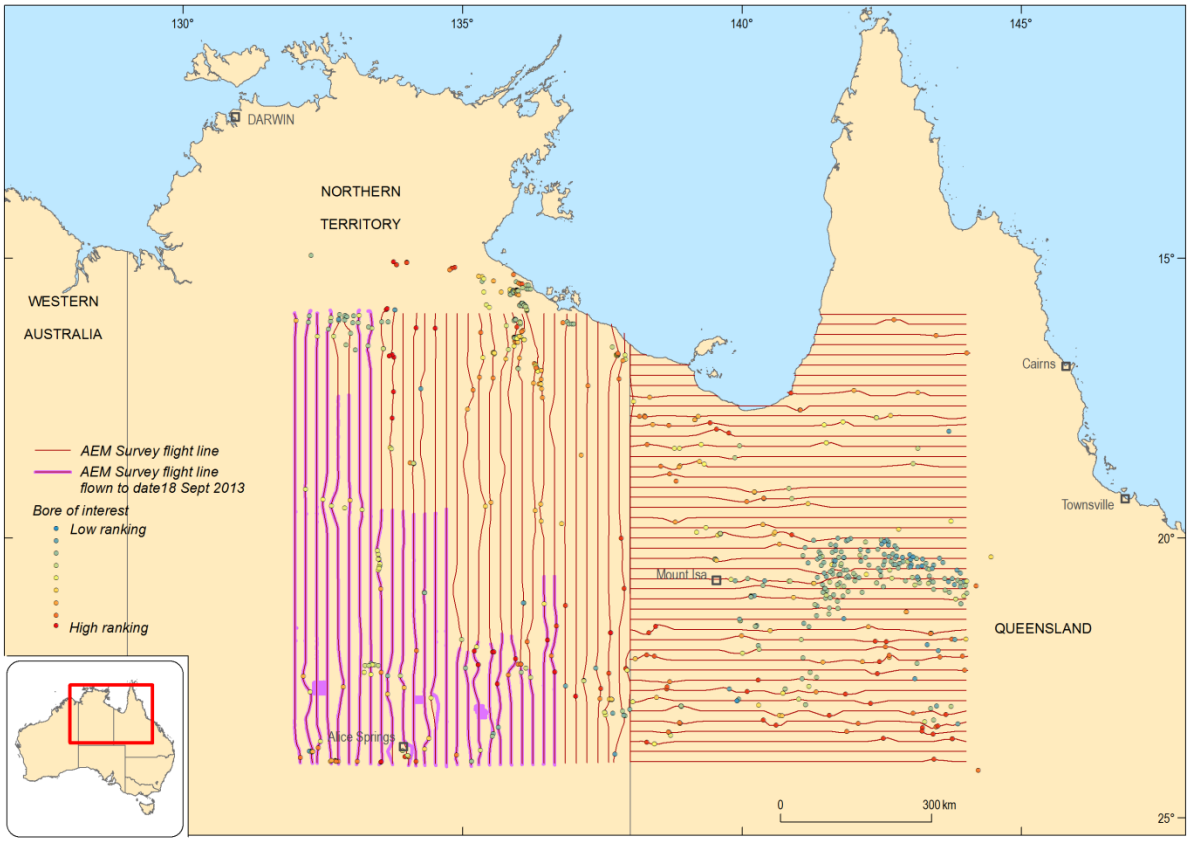

Figure 1: Planned flight paths diverted to intersect meteorite impacts, kimberlite deposits, geological features of interest and selected petroleum, mineral-exploration and groundwater boreholes, which have been ranked based on their potential usefulness and the availability of attributes such as; stratigraphy, depth, lithological description and down-hole electrical conductivity data.

DATA ACQUISITION, PROCESSING AND PRELIMINARY INTERPRETATION

The AusAEM Tennant Creek and Mount Isa region is located between two well-known mineral-endowed provinces. This area was chosen as current geological understanding is generally poorly understood, particularly the distribution and extent of the rocks under cover. The region has relatively unexplored energy potential, and the potential for commodities like Cu, Pb, Zn, U and Au, as historical exploration activities have revealed in areas of little or no surficial cover. The survey data will also contribute to our understanding of the water resources as there are high groundwater demands from the agricultural activities in the area.

Airborne electromagnetic surveys have successfully been used for large-scale mapping in programs like the Onshore Energy Security Programme (GA, 2011) that acquired regional AEM datasets in the Paterson, Pine Creek and Frome Regions (Roach 2012), and the Capricorn Region (Ley-Cooper *et al.*, 2015). The impact of the results of these surveys informed the design of the AEM component of the *Exploring for the Future* Programme (GA, 2016). These recent Australian initiatives were aimed at boosting resource exploration and gathering robust datasets to assist governments and the exploration community with geological mapping at a regional scale.

CGG Australia Pty Ltd, using their TEMPEST® AEM system, was selected as the contractor to conduct the regional survey. TEMPEST® is a fixed-wing time-domain system with the transmitter strung around the aircraft and the receiver coils towed in a bird behind and below the aircraft as described by Lane *et al.* (2000). With this configuration the acquisition speed makes the mapping of very large and remote areas feasible.

Preliminary field data from the TISA AusAEM survey have been inverted using the GA Layered Earth Inversion-Sample By Sample (GALEISBS; Brodie 2015) and the GA Layered Earth Inversion - All at Once (GALEIAAO; Brodie and Ley-Cooper 2018) algorithms, as a means of assessing the quality of the data. The new AEM data will also be integrated with ancillary data for future geological interpretations to help in unveiling sub-surface geological features. Figure 2 shows a conductivity-depth section derived from the GALEISBS inversion for a 300 km segment of the western-most flight line shown in Figure 1. The section clearly differentiates the following features: 1) areas of thick conductive cover (at an approximate distance 150 km from the start of the line); and, 2) resistive areas where rocks outcrop at surface, accentuated by the vertical exaggeration used to produce the image.

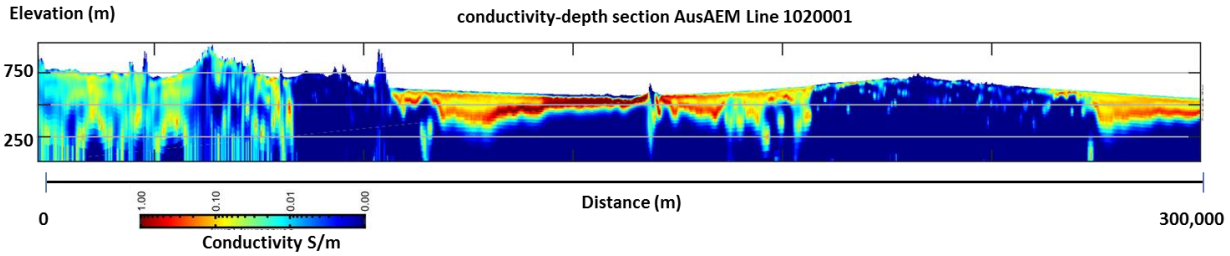

Figure 2: Representative conductivity-depth section of a segment of TEMPEST® data from the western-most flight line of the AusAEM TISA survey in Figure 1 Error! Reference source not found.**, derived using Geoscience Australia's TDEM GALEISBS inversion algorithm.**

From Figure a quantitative assessment on the thickness, character and variability of the cover can be drawn. The flat lying conductors in the middle and right-hand side of the section, we associate to potentially water-bound sediments, which in some areas extend over several hundreds of kilometres and vary in thickness from hundreds to a few meters.

At this early stage of the programme, interesting conductive units undercover have also been unveiled. These features will be of interest to explorers and will be further investigated when the other data acquisition programs in the TISA area are available for integration with the AEM data for detailed interpretation.

These sections also reveal the location, like that on the middle of the section in Figure , where structures such as faults and shear zones have affected the landscape and are associated with the position of sub-surface conductors.

CONCLUSIONS

The EFTF AusAEM program is acquiring data over extents never previously attempted. It comes from a long lasting tradition at GA of delivering precompetitive data to stimulate exploration and acquiring AEM data in areas with a paucity of data as a way of promoting exploration in new frontiers. At its current stage of acquisition the TISA AEM survey preliminary data have already proven useful in mapping the cover and basement interface. The new AEM data will provide explorers with insights to areas of thick cover and areas with potential targets for further investigation.

Conductivity-depth sections derived from the flight lines acquired at 20 km spacing have shown they provide enough detail to map cover thickness and basement topography. Some of the smaller confined basement conductors, identified in some of these regional lines, need follow up work with additional data collection in order to help delineate their extent and composition.

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