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Eureka! AEM uncovers more than expected

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SUMMARY

Precompetitive AEM data and associated scientific analysis assists exploration under cover by reducing risk; stimulating investment and promoting exploration for commodities. In recent years, Geoscience Australia has flown three regional Airborne Electromagnetic (AEM) surveys covering three percent of Australia. Data and associated interpretations from regional surveys in the Paterson, Pine Creek and Lake Frome regions have led to tenement take up, stimulated exploration for a number of commodities and have given rise to many Eureka moments.

This presentation will outline significant results from the use of Geoscience Australia AEM data and interpretations, results that have been announced by government and industry via the Australian Stock exchange and other publications.

Key words: AEM, precompetitive data acquisition, exploration.

INTRODUCTION

Large parts of Australia remain relatively unexplored or under-explored. Encouraging exploration has been regarded by Geoscience Australia as a high priority for achieving future domestic energy security and for maintaining prosperity.

The recently completed Onshore Energy Security Program (OESP) Airborne Electromagnetic (AEM) program was primarily designed to provide new regional-scale data for greenfields to brownfields uranium provinces. Covering three percent of Australia, the regional AEM surveys, Paterson (W.A), Pine Creek (N.T.) and Lake Frome (S.A) regions have proven to be relevant in exploration for a variety of commodities. The precompetitive AEM data, integrated scientific analysis and interpretation reports have assisted exploration under cover, reducing economic risk and stimulating investment and promoting exploration. In addition the AEM program results have led to a positive change through increased tenement activity and tenement take up, stimulated exploration for a number of commodities, and have given rise to some unexpected Eureka moments.

This presentation highlights new results from the use of the regional AEM data and interpretations for commodities other than uranium; results that have been announced by industry via the Australian Stock exchange and other publications. A copper exploration company reported high-grade copper intercepts in target areas defined by data from the regional Paterson survey. A gold exploration company identified horizons associated with the gold-rich Cosmo-Howley corridor using the Pine Creek AEM data. The AEM data have also helped to identify Triassic coal measures at Leigh Creek.

PATERSON SURVEY

The first regional AEM survey was the Paterson Survey in Western Australia (Figure 1). The survey was flown by Fugro Airborne Surveys Pty. Ltd. (FAS), for Geoscience Australia (GA), using the Fugro TEMPEST™ time-domain AEM system (Costelloe et al., 2007). Conducted during 2007-2008, approximately 28 000 line km of new data were collected at various line spacings (200 m to 6000 m) and covered an area of approximately 47 600 km^2. Five companies contributed to the survey budget to fly tenement scale surveys within the area, the total survey cost was $2 725 000.

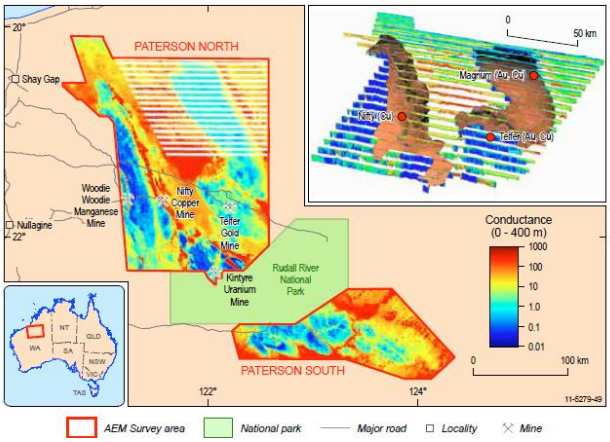

Figure 1. Paterson AEM survey location and 0-400 m conductance image. Inset: perspective view of Paterson North with a resistive basement model (McKay 2011).

The Paterson region is prospective for a range of minerals including gold, copper, silver, zinc, lead and manganese and is potentially prospective for other commodities. In the Paterson area most of the recognisable outcropping economic Archean or Proterozoic basement rocks have been visited and sampled by various exploration companies. A large proportion of the area, approximately 84%, is buried by Permian, Mesozoic and Quaternary cover, concealing mineralisation (Roach 2010).

Paterson Survey results have greatly improved understanding of the basement-cover relationships in the area, particularly between Proterozoic rocks of the Yeneena Basin and Rudall Complex and the overlying Paleozoic-Mesozoic rocks of the Canning Basin (Roach 2010). The AEM data and the drill hole data base have also allowed the 3D stratigraphy of the Canning Basin to be interpreted over a broad area, revealing a number of large-scale sedimentary structures that were previously unknown. The data also reveal new information regarding the 3D structure of Permian palaeovalley systems around the Rudall Complex (Costelloe et al., 2010).

PINE CREEK SURVEY

Flown during 2008-2009 the Pine Creek survey collected approximately 29 900 line-kilometres of new data at various line spacings (200 m to 5000 m) and covered an area of approximately 74 000 km^2 (Costelloe et al. 2009). The Pine Creek survey comprised three sub areas (Figure 2). Woolner Granite and Rum Jungle sub-survey areas were flown by Fugro Airborne Surveys Pty. Ltd. (FAS) using the TEMPEST^{TM} time-domain AEM system. The Kombolgie sub-survey area was flown by Geotech Airborne Pty. Ltd using the VTEM^{TM} time-domain AEM system. Industry partners contributed over $1 000 000 to the total cost of approximately $3 745 000.

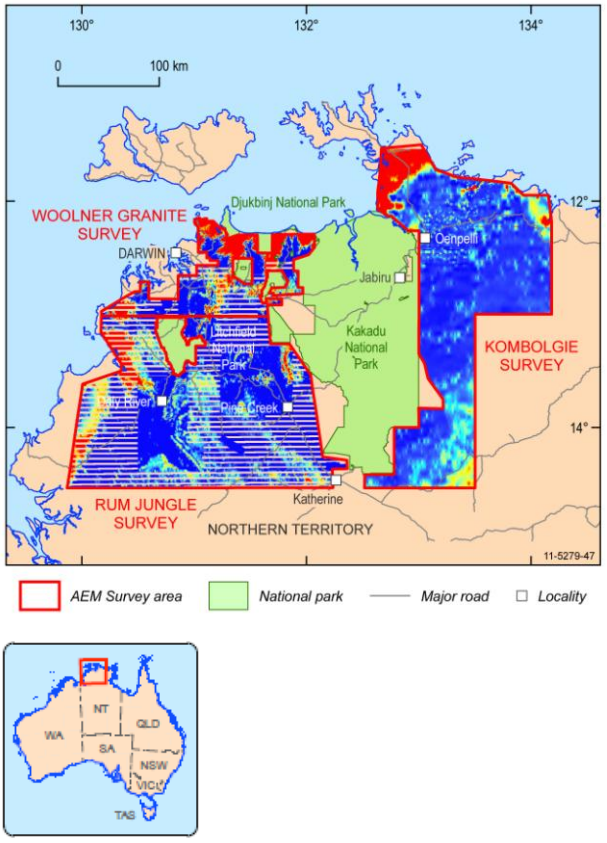

Figure 2. Pine Creek AEM survey location with Woolner Rum Jungle conductance image to 400 m and Kombolgie conductance image to 2 000 m.

The Pine Creek Orogen (PCO) is one of Australia's most endowed Proterozoic provinces hosting several mineral occurrences, prospects, and deposits of gold, tin-tantalum, tungsten, copper and lead-zinc (Ahmad 1998, Ahmad et al. 2006). The regional geology of the PCO is commonly referred to in three main geological domains Nimbuwah, Central and Litchfield (NTGS 2010*)*. The Nimbuwah Domain hosts world class unconformity-related uranium deposits. The Central Domain hosts an abundance of gold deposits which are associated with a thick package of turbiditic sediments; lower-greenschist facies of metamorphism and widespread felsic magmatism (Craig 2011). The Litchfield Domain is dominated by tin-tantalum mineral systems associated with felsic magmatism (Frater 2005).

FROME SURVEY

Covering approximately 10% of South Australia, or 95 450 km^2 the Frome AEM Survey was flown by FAS in 2010 using the TEMPEST^{TM} AEM system (Costelloe and Roach 2012 and Roach 2012). The joint survey between Geoscience Australia, the Geological Survey of South Australia (DMITRE) and industry partners collected approximately 32 317 line km of new data on lines spaced 2500 m and 5000 m apart and cost approximately $2 500 000. The survey area extends from the South Australia-New South Wales border at Cameron Corner across to the Marree and Leigh Creek areas, skirts the highland of the northern Flinders Ranges, and includes the entire Lake Frome area, the Olary Spur between the towns of Yunta and Cockburn and the north western Murray-Darling Basin (Figure 3).

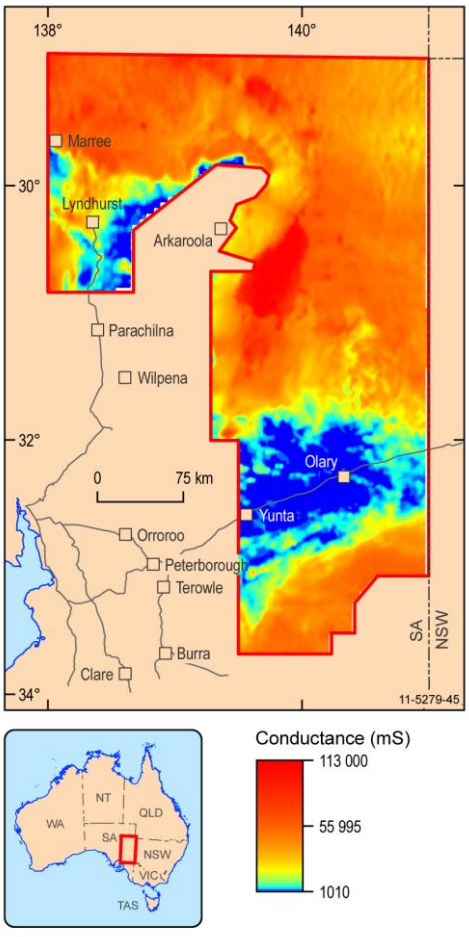

Figure 3. Frome AEM survey location and conductance image to 400 m.

The Frome AEM Survey maps geological environments and broad scale features such as the depth and electrical conductivity of cover over a large area, the extent and morphology of palaeovalley and basin systems, and major geological structures. The survey was designed to use a wide line spacing to uncover new geological features and to possibly expand the area perceived to be prospective in the Lake Frome area. A range of features are revealed including the extent of the resistive basement in the Benagerie Ridge, Neoproterozoic rocks under cover in the Flinders and Willouran ranges, the under-cover extent of resistive basement in the Olary Spur (at that depth) and regional-scale fault structures in the Nackara Arc under cover of the Murray-Darling Basin.

Airborne electromagnetic data from the three regional surveys were subjected to quality assurance and quality control procedures (Costelloe 2012) before being inverted using sample-by-sample GA layered earth inversion (GA-LEI) software (Brodie and Sambridge 2009, Brodie 2010). Data products released to the public include the contractor-supplied data, ASCII format GA-LEI data, PDF-format multiplots of GA-LEI line data and georeferenced raster images of the GA-LEI conductivity sections, GA-LEI conductance grids, GA-LEI conductivity depth slices and GA-LEI conductivity elevation slices. The GA-LEI data were validated using drill hole conductivity data, collected during field trips to the regions, and public-domain drill hole lithological data. The AEM data, together with surface geology, regional magnetics, radiometrics, gravity, SRTM, regolith maps and solid geology, were used to aid interpretation. The Paterson, Pine Creek and Frome AEM interpretations were released in separate Geoscience Australia Records and are free to download from the Geoscience Australia website.

CONCLUSIONS

The OESP AEM Surveys were designed to deliver reliable, low noise, calibrated, fit-for-purpose, precompetitive AEM data to aid research into the energy potential within the Paterson, Pine Creek and Frome areas. The survey data and interpretations have been used in uranium exploration in line with their intended purpose, however, the impacts of the OESP AEM surveys have extended into regional mapping, mapping under cover and mapping for a variety of commodities with results much greater than anticipated.

Companies have reported in Australian Stock Exchange announcements, quarterly and annual reports their successful use of the pre-competitive AEM data. Exciting impacts include the Yeneena copper discovery in the Paterson survey area; defining gold ore bodies in the Pine Creek Orogen, and imaging copper mineralisation in the Lyndhurst, area in South Australia.

Geoscience Australia's pre-competitive AEM program data and interpretation records enabled companies to call out *"Eureka, we found it!"*

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