

Exploring for the Future opportunities beneath the Tennant Creek–Mount Isa (TISA) region

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Exploring for the Future is a four-year \$100.5 million program to unveil new resource opportunities in Northern Australia and parts of South Australia. It is being conducted by Geoscience Australia in partnership with state and Northern Territory government agencies, CSIRO, and universities. This initiative, which is due for completion in 2020–2021, has started to deliver a suite of new products to help unveil new resource opportunities in Northern Australia.

The program has three inter-related elements: minerals, energy and groundwater, which collectively aims to:

- provide baseline pre-competitive geoscience data to inform and encourage government, industry and community decision making about sustainable resources management to improve Northern Australia's economic development

- attract investment in resource exploration to Northern Australia
- deliver an assessment of groundwater resources for irrigated agriculture and community water supplies as well as for mineral and energy development; and an assessment of the potential impacts of those developments.

The minerals-focused projects have been designed with a three-fold program logic (**Figure 1**): 1) Northern Australia-wide projects, 2) focussed integrated studies, and 3) generic innovation and method development. The minerals-focused project activities address a number of the highest and high priority themes identified by the mineral exploration industry in the UNCOVER Roadmap.

1) Northern Australia-wide projects

This work program will develop and use innovative tools and techniques to collect semi-continental

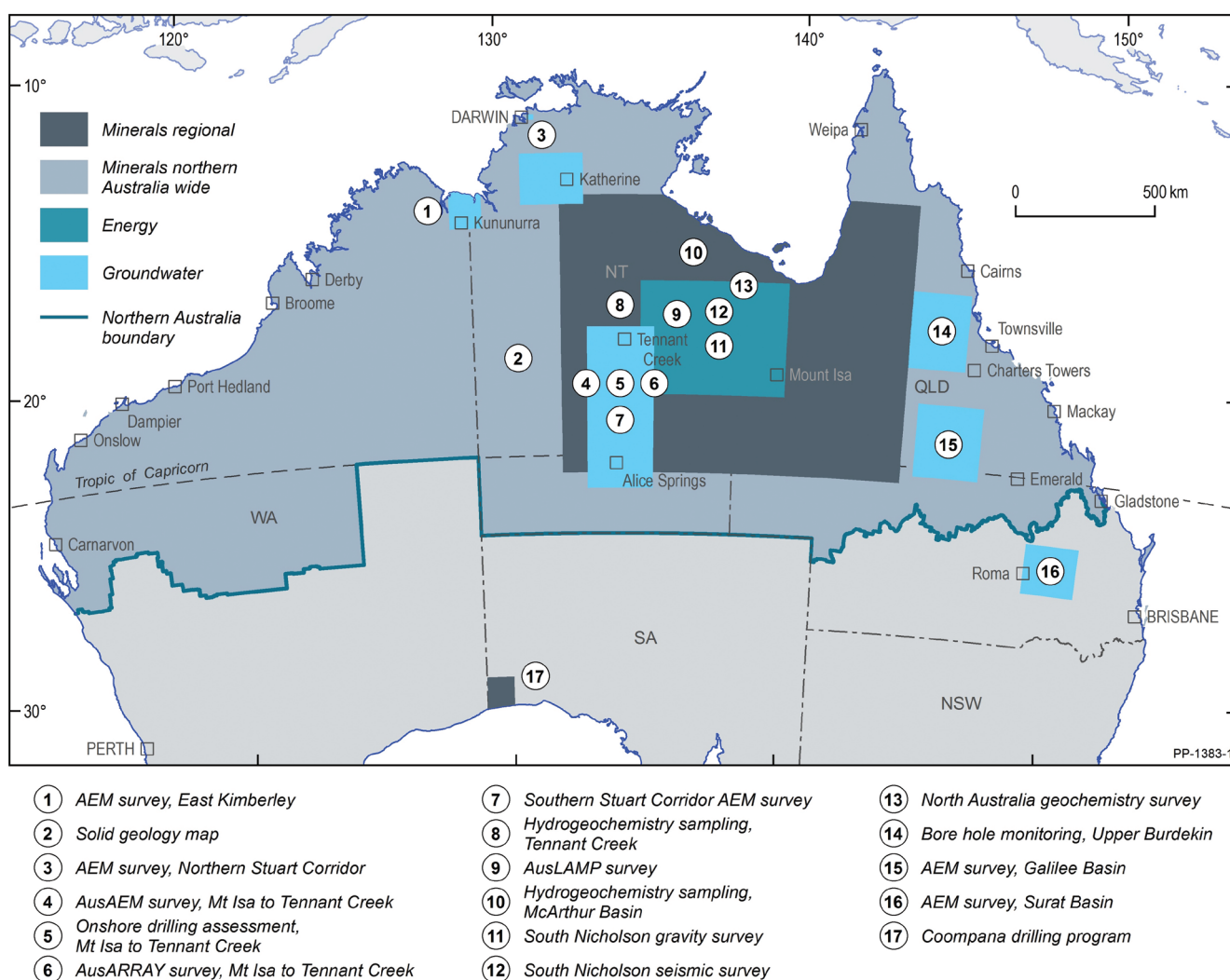


Figure 1: *Exploring for the Future* project activity map as of 2017. Note the focus of numerous projects in the Tennant Creek to Mount Isa region.

a) geological, b) geochemical, and c) geophysical data on an unprecedented scale. The commencement of these projects is focussed on the region between Tennant Creek and Mount Isa (TISA).

a) Geological projects

Because one person's cover is another person's basement, a Northern Australia-wide series of time-based geological maps are being prepared. Building from the national 1:1 M scale Surface Geology Map of Australia, the Cenozoic, Mesozoic, Palaeozoic and Neoproterozoic layers will be successively removed to reveal a series of 'solid geology' maps at 1:1M scale. These maps will form the basis for subsequent 3D models and resource assessments.

Extensive use is being made of national-scale potential field geophysical data and existing drillhole data. This has the combined effect of calibrating the geological interpretation of the geophysics with known rocks and attributing the interfaces with their actual depth (from drilling or geophysical estimates). Resultant 3D data are being stored in a new database called *Estimates of Geological and Geophysical Surfaces* (EGGS); this is a national repository for depth-determined geological information from any method (drilling or geophysical estimate). The EGGS' database will form the depth-control points from which new 3D surfaces will be constructed and imported into a 3D geological model along with uncertainty.

A new peak metamorphic map of Australia is also in production, with a subset available for Northern Australia in the first phase. This map is a compilation of quantitative and qualitative estimates of metamorphic conditions across Australia. The maps will provide important constraints on the crustal exhumation and (mineral) preservation history, as well as thermo-barometric evolution of Australia.

b) Geochemical projects

An atlas of the surface of Northern Australia, as a subset of the national atlas, is in preparation. Geoscience Australia has time-series LANDSAT data from NASA extending back into the 1980s. Each pixel from each scene has been organised in *Digital Earth Australia (DEA)* so the archive can be 'data-mined' to extract pixels with the least vegetation and cloud-cover effects. Products of this work will be a new national Bare Earth image along with iron oxide, silica and clay mineral maps of the surface at 25 m resolution. The European Space Agency's Sentinel 2 satellite system provides global coverage of multispectral earth-observation data at 10 m resolution from these data. A new cloud-free seamless Sentinel 2 national map will be produced at 10 m resolution.

A suite of new machine learning codes has been produced in collaboration with DATA61. These codes are being deployed on the national whole rock and surface geochemical datasets to produce national surface maps of the major elements.

An isotopic atlas for northern Australia is being prepared, consisting of a suite of map layers including

Sm–Nd, Lu–Hf, U–Pb, Ar–Ar and Pb–Pb; it will be delivered in GIS form, and draped on the aforementioned 3D surfaces. In addition, selected age dating of geological units through U–Pb SHRIMP geochronology and various other dating techniques for direct dating of key mineral deposits are being undertaken.

c) Geophysical projects

The world's largest airborne electromagnetic (AusAEM) survey and the most extensive long-period magnetotelluric (AusLAMP) survey are well underway. At the time of writing (February 2018), 20 600 line-km of the 60 000 planned AusAEM data have been flown and 155 new AusLAMP stations have been acquired. In addition, a new seismic tomographic velocity model will be constructed from historical earthquake data; these data form the basis of the Australia-wide AusARRAY project. Gravity data are being infilled at higher resolutions in areas where station spacing is >4 km using a mix of ground and airborne gravity and airborne gravity gradiometry.

2) Focused integrated studies (TISA)

The region between Tennant Creek and Mount Isa (TISA) is the initial focus of all the above-mentioned activities plus a series of additional projects. This vast under cover region lies between the great mining centres of Tennant Creek (Cu, Au) and Mount Isa (Cu, Pb, Zn, Ag). The thickness of cover is variable and the underlying 'basement' geology is poorly known. The region lies at a key junction in Australian geology, with north-south striking domains in the east joining east-west and northwest-southeast striking domains in the west. The region showed unexplained base metal anomalism in the National Geochemical Survey of Australia (NGSA) and at depth, it has variable seismic velocity and Moho depths.

The program has collected 782 surface geochemical and 118 groundwater samples to augment the broad-spaced NGSA dataset; laboratory results are being modelled with the first products due for release in March 2018. The AusARRAY project deployed 120 passive seismic recorders that will remain in the TISA region until later this year. Two more deployments are expected in the life of the program at locations to be confirmed. A total of 2724 ground gravity stations were collected; the data was released in 2017. A total of 1100 km of deep seismic reflection data have been acquired and processed (see Henson this volume), with processed data to be released in March 2018, and interpretation products to follow.

The aim of focusing the activities into one region is to provide the best possible suite of data that will be integrated into an assessment of the undercover mineral potential of the TISA region. This assessment and the geological and mineral systems interpretations of the above data will be tested by a stratigraphic drilling program in 2019. Assessments are underway for basin-hosted base metals (Cu, Pb, Zn) and for iron-oxide-copper-gold mineral systems. The basin assessment will draw on well-established petroleum systems approaches and apply them to these mineral systems.

When the program is complete, the TISA region will arguably be the best imaged and understood piece of lithosphere on the planet.

3) Innovation and method development

To complement data acquisition, new big data management and data analytical methods, tools and platforms are being developed to maximise data value. Strategic collaborations have been established with world-leading experts at Australian universities and DATA61 to develop a suite of new geoscience-relevant computer codes and products that will be released in open source repositories (GitHub) and be incorporated into the Australian National Virtual Geophysical Laboratory (ANVGL).

Given the vast range of activities being conducted, many of which are novel, effort is being made to share the generic lessons. This includes publishing software codes and standard operating procedures as well as developing an

Explorer's Guide for the TISA region that will have generic applicability elsewhere. Particular effort is being made to transfer knowledge and receive feedback from industry through a series of workshops that commenced in 2017.

Conclusions

Exploring for the Future, an exciting initiative in collaboration with state and NT partners, will:

- Assist in securing an ongoing pipeline of new discoveries and help maintain Australia's position as a major global mineral and energy exporter.
- Determine the location, quantity and quality of groundwater resources to inform water management options, including infrastructure development and water banking.
- Benefit the Mining Equipment, Technology and Services (METS) sector by drawing on private sector expertise in undertaking data acquisition and analysis.