Geophysical data in the Northern Territory: recently acquired government and industry data

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The Northern Territory's geophysical data is generated from a range of sources including government regional-scale geophysical surveys, Geophysical and Drilling Collaboration (GDC) co-funded surveys, and data acquired through industry mineral and petroleum exploration projects. In addition to these geophysical datasets, a range of derived geophysical products (such as Territory wide grids and images) suitable for geophysical interpretation have been created. Geophysical interpretation and modelling of these data and products incorporates constraints determined by rock property data. Rock property data has been collected and collated by the Northern Territory Geological Survey (NTGS) since 2014 and is published annually in Digital Information Package (DIP) 013 (Hallett 2017). The integration of new geophysical data, derived products and constrained geophysical interpretation and modelling is providing insight into the geological framework of the Northern Territory.

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NTGS regional geophysical acquisition

Under the *Creating Opportunities for Resource Exploration (CORE)* initiative, a range of regional geophysical surveys have been completed. These surveys have been undertaken to improve the resolution of ground gravity and airborne magnetic and radiometric data across the Amadeus and greater McArthur basins. Two airborne magnetic and radiometric surveys have been completed (**Figure 1**): the 2014 Dunmarra survey (Dhu 2015) and the 2016 NTGS Delamere and Spirit Hills survey (Dhu 2016); both basins

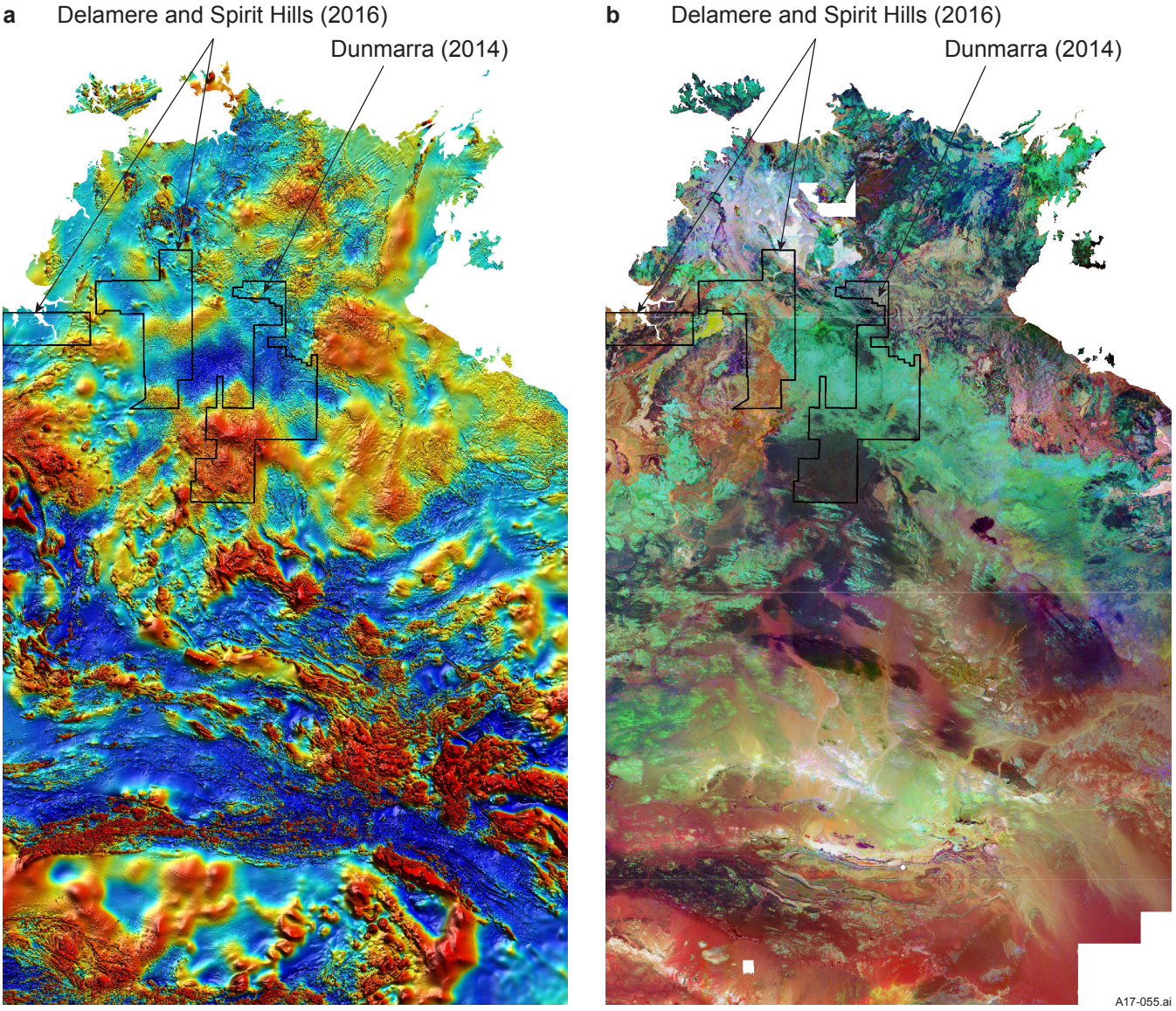

Figure 1. Location of the Dunmarra (2014) and NTGS Delamere and Spirit Hills (2016) magnetic and radiometric surveys overlain on the Northern Territory-wide total magnetic intensity image (**a**) and ternary radiometric image (**b**).

are now covered by airborne magnetic and radiometric data at a line spacing of 500 m or less.

Gravity surveys are designed to increase resolution of ground gravity across the basins to 4 km station spacing or less. Five ground gravity surveys have been completed covering almost a quarter of the Northern Territory mainland. These surveys consist of approximately 20 000 stations acquired by NTGS on 4 km grid spacing and another 8500 infill stations at various spacing acquired through collaboration with industry. The North McArthur Basin and West Amadeus surveys were released in 2014 (Dhu 2015), the NTGS North Wiso Basin and NTGS Victoria Basin surveys in 2015 (Dhu 2016), and the NTGS Daly Basin survey in 2016 (**Figure 2a**). The NTGS Daly Basin survey is located directly north of the Fitzmaurice River on the northwestern coastline of the Northern Territory. Approximately 2500 ground gravity stations at 4 km grid spacing were acquired during the survey along with one infill survey of 350 stations at 1 and 2 km spacing. This survey covers the southern extent of the Pine Creek Orogen and the Daly, Bonaparte and Birrindudu basins (**Figure 2b, c**).

Geophysical and drilling collaboration geophysical surveys

The NTGS has provided co-funding for geophysical surveys under the GDC program since 2008. To be eligible for co-funding, surveys need to be in greenfields areas where there is a paucity of geological information or the surveys need to use innovative approaches. Since inception, 24 geophysical projects have been completed and released with another three underway as of February 2017 (**Figure 3**). Completed projects have acquired over 50 000 ground gravity stations and 24 000 line km of airborne magnetic and radiometric data. In addition, approximately 30 000 line km of airborne electromagnetic (AEM) data using TEMPEST, SKYTEM, VTEM and XTEM systems have been acquired. Innovative, prospect scale surveys include audio-magnetotelluric (AMT) surveys in the Batten Fault Zone and at the Carrara project in the Barkly Tablelands, a helicopter-borne sub-audio magnetic survey at Tin Camp Creek, and two seismic lines over the Emu Fault at the Yalco project. A number of these projects have led to follow-up GDC co-funded drilling programs.

Rock properties

The rock properties project is building a dataset of rock properties from across the Northern Territory to aid in the interpretation and modelling of geophysical data. The dataset contains both rock property measurements (magnetic susceptibility and density) collected by NTGS and a compilation of measurements from other sources including exploration reports (minerals and petroleum statutory reporting), core sampling reports, government reports (Geoscience Australia, CSIRO and previously

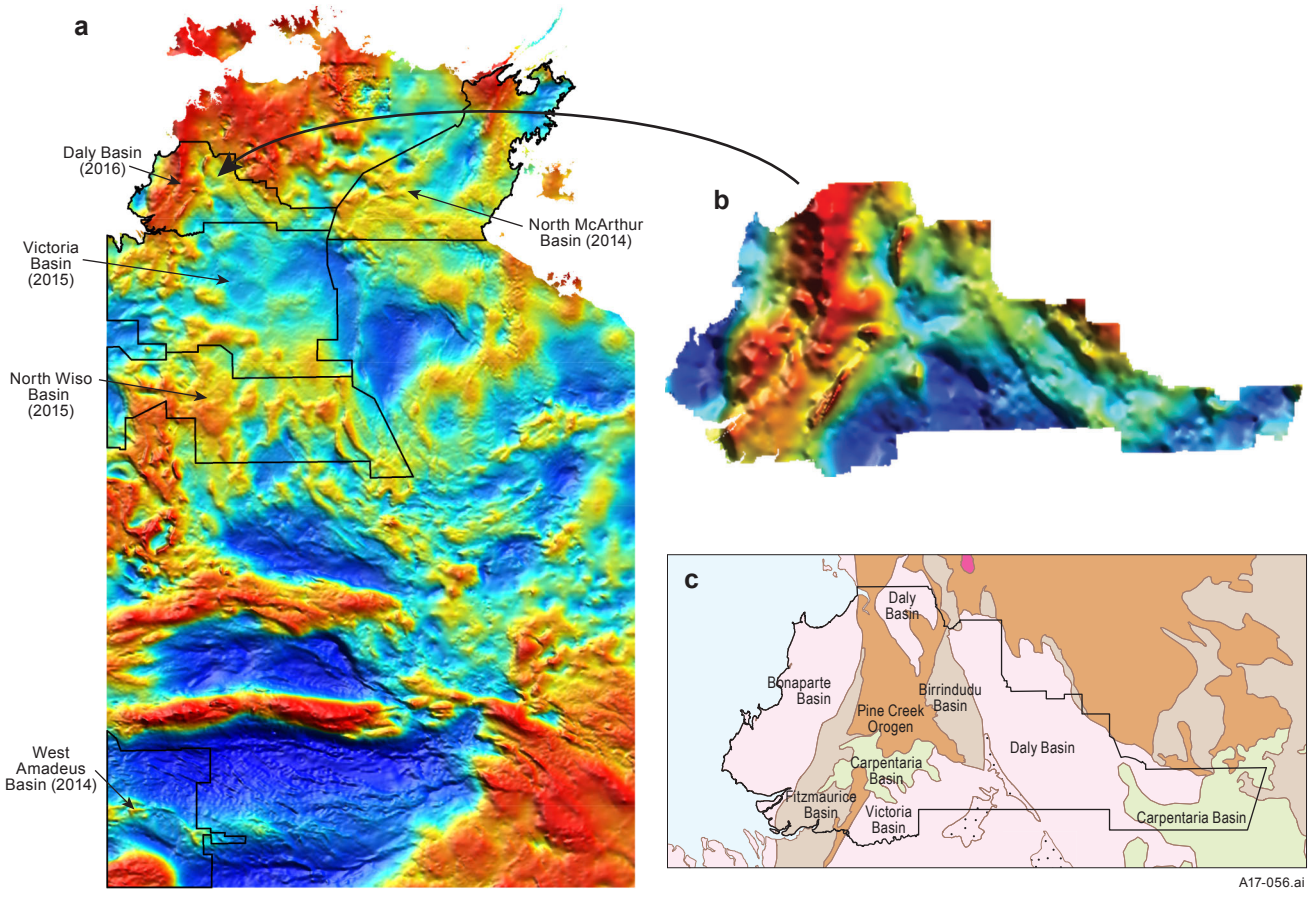

Figure 2. (**a**) Location of West Amadeus (2014), North McArthur Basin (2014), NTGS North Wiso Basin (2015), NTGS Victoria Basin (2015) and NTGS Daly Basin (2016) gravity surveys overlain on the Northern Territory-wide Bouguer gravity anomaly. (**b**) Image of the NTGS Daly Basin Bouguer gravity anomaly. (**c**) Location of the Daly Basin gravity survey overlain on the geological regions map of the Northern Territory.

published NTGS data) and academic publications. These data aid in understanding the geophysical signature of different lithologies; they are applied to constrain forward modelling and inversion of geophysical data. For example, current work by Blaikie and Kunzmann (2017) uses differences in geophysical signature to map the distribution of depositional packages within the greater McArthur Basin (Close 2014) and to model the packages extent in 3D. Understanding the variation of density and magnetic susceptibility extracted from the rock property dataset within the greater McArthur Basin stratigraphy is providing a key constraint for this work.

The NTGS systematically collects rock property measurements on drill core as part of its HyLogger™ program. Measurements are made at semi-regular intervals using a standard method to ensure data quality (Hallett in prep). To date, over 12 000 of these measurements have been made. In addition to this program, specific stratigraphic units and intervals are targeted to provide more complete coverage of rock properties in areas of focus: for example,

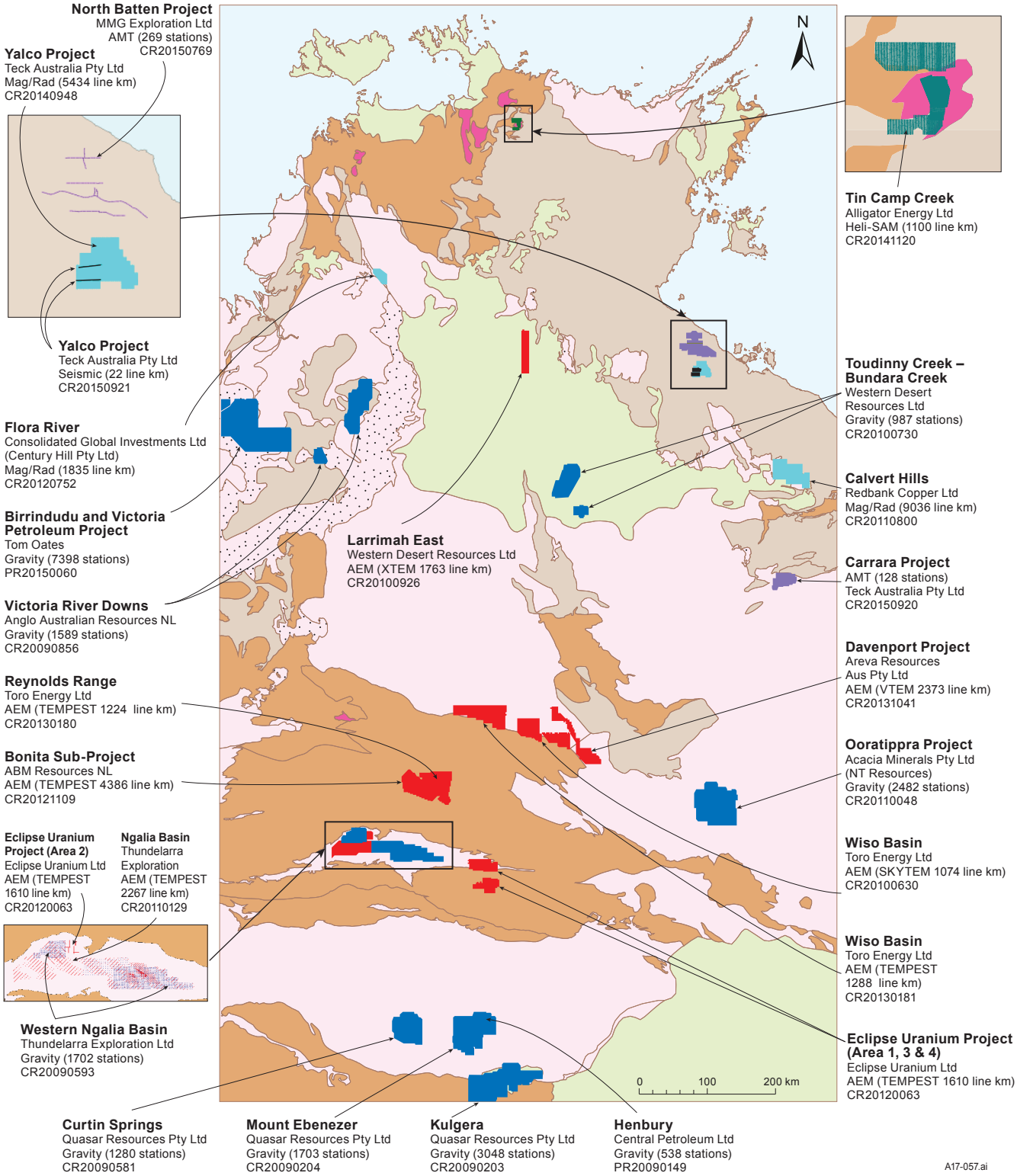

Figure 3. Location of GDC geophysical surveys overlain on the geological regions map of the Northern Territory.

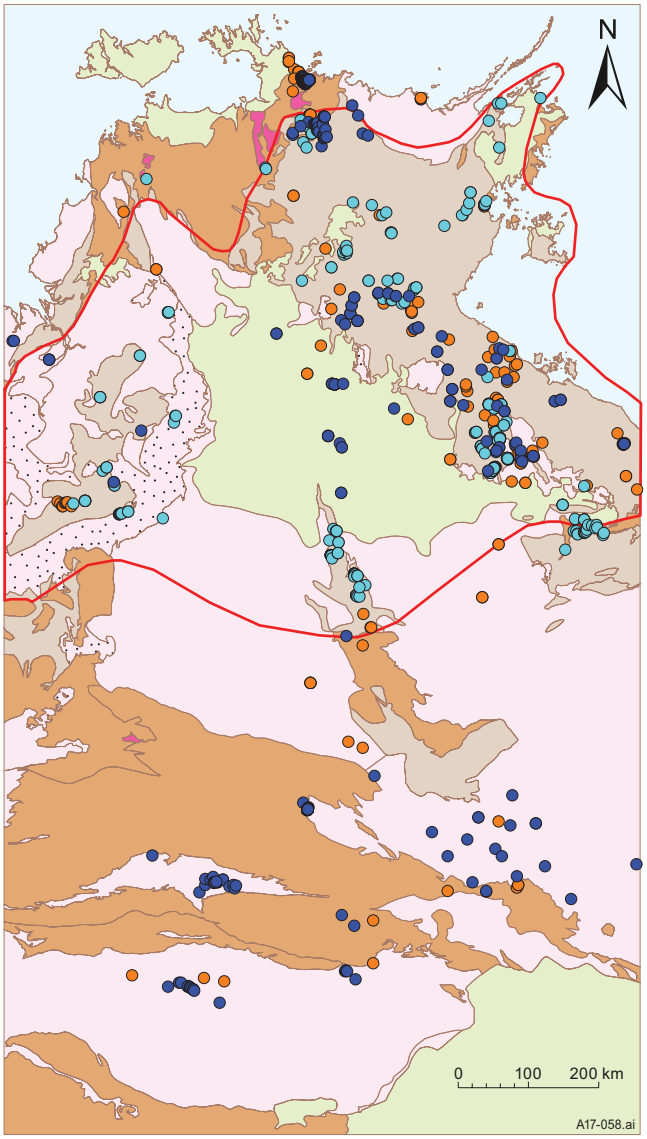

Figure 4. Location of rock property measurements published in DIP013. Orange dots represent the location of measurements conducted by the NTGS in conjunction with its HyLogger™ program. Light blue dots represent the location of targeted measurements conducted by the NTGS on drill core and hand samples. Dark blue dots represent the location of rock property values collated from archival reports. Red outline indicates boundary of greater McArthur Basin.

over 3500 targeted measurements have been completed on stratigraphic units of the greater McArthur Basin. Rock property data is now available on approximately 80% of the stratigraphic units within the greater McArthur Basin.

The rock property dataset is released annually in DIP013. As of March 2017, DIP013 contains over 60 000 rock property values from across the Northern Territory (**Figure 4**). The dataset contains measurements of:

- magnetic susceptibility
- bulk density
- apparent grain density
- apparent porosity
- permeability.

In addition to these rock properties, DIP013 records sample locations, published stratigraphy, drillhole names and measurement methods (where known).

Product availability

All products including geophysical datasets and DIP013 are available through GEMIS (http://geoscience.nt.gov.au/gemis) or can be requested from the Minerals and Energy InfoCentre.

References

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