Geophysical data in the Northern Territory: Insights from government and industry acquired data

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Two gravity surveys covering over 13% of the Northern Territory mainland (**Figure 1**) and almost 97 000 line km of magnetic and radiometric data were acquired under the *Creating Opportunities for Resource Exploration (CORE)* initiative in 2015 (**Figure 2**). These data were complemented by another 7045 gravity stations acquired through a Geophysical and Drilling Collaboration (GDC) co-funded survey and over 20 000 line km of magnetic and radiometric data reported via industry in 2015.

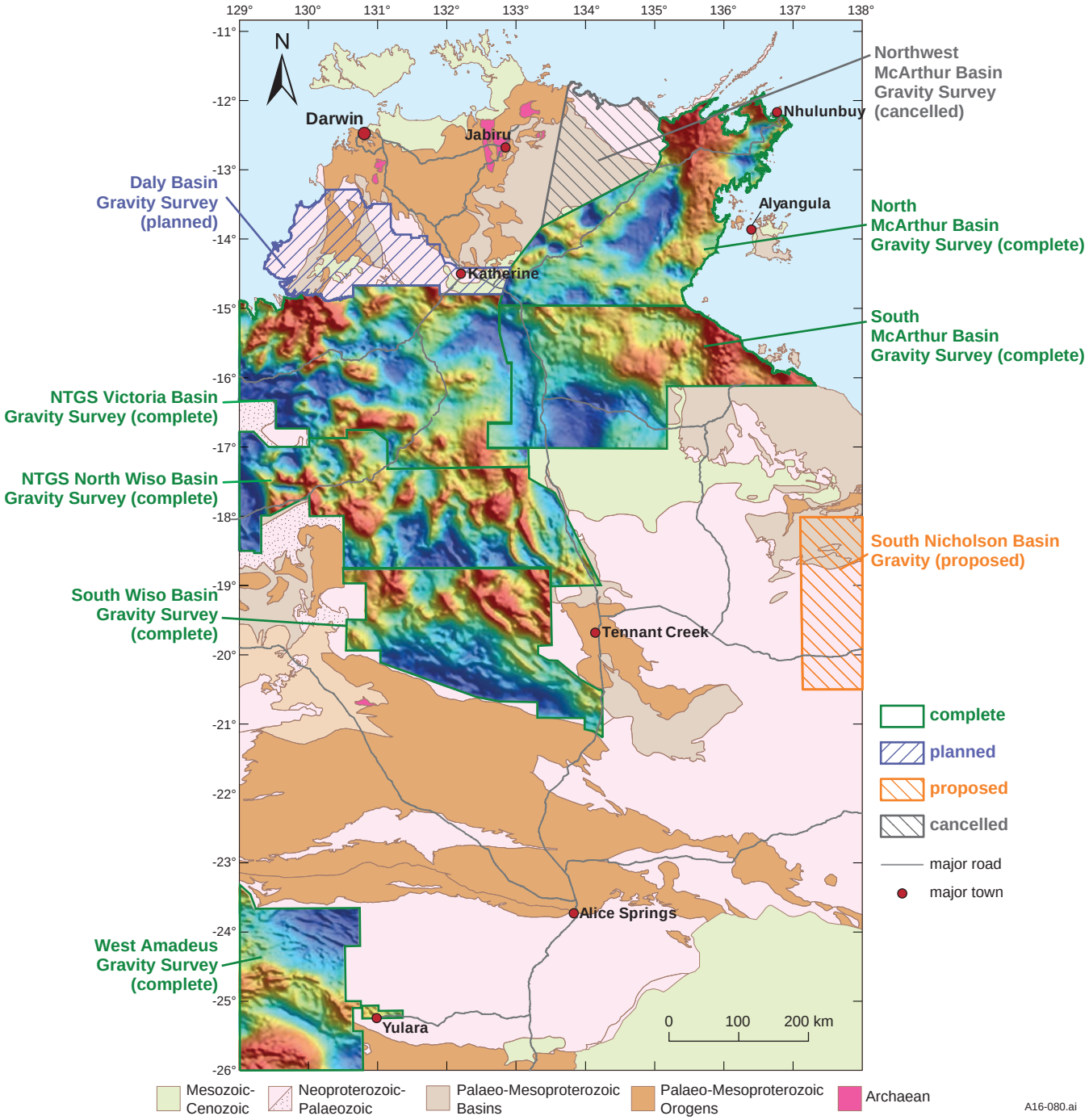

Figure 1. Location of ground gravity surveys: completed, planned or proposed under the *CORE* initiative. Completed surveys are outlined in green with the Bouguer anomaly survey images plotted on the map. Discontinuities at the boundary between adjacent Bouguer anomaly images are the result of colour stretches being applied to individual surveys rather than continuously across the Territory. Purple outlines are planned gravity surveys; orange outlines are proposed gravity surveys. The grey outline is the Northwest McArthur Basin Gravity Survey, originally proposed in 2015, but no longer being considered for acquisition under the *CORE* initiative.

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CORE Initiative Geophysical Acquisition Program

The *CORE* initiative geophysical acquisition program aims to improve gravity coverage to 4 km station spacing or better, and magnetic and radiometric coverage to 400 m line-spaced or better in the greater McArthur Basin. Gravity acquisition focused on the western part of the greater McArthur Basin (Close 2015) with the NTGS North Wiso Basin Gravity Survey and the NTGS Victoria Basin Gravity Survey completed (**Figure 1**). These surveys have increased the area of the NT mainland covered by modern, good resolution gravity from 62% to around 75%.

The NTGS Daly Basin Gravity Survey is planned to commence in June 2016; the survey area (**Figure 1**, purple outline) lies directly north of the NTGS Victoria Basin Gravity Survey. The survey design has been revised from that proposed in 2015 (Dhu 2015) and covers an area of over 35 000 km^2. The opportunity exists for industry to collaborate with NTGS to increase gravity resolution over specific areas of interest. The previously proposed Northwest McArthur Basin Gravity Survey is no longer be targeted in this initiative (**Figure 1**, grey outline). The 25 000 km^2 proposed South Nicholson Basin Gravity Survey (**Figure 1**, orange outline) is still under consideration and if acquired, will commence in 2017.

The NTGS Delamere and Spirit Hills Magnetic and Radiometric Survey cover two areas in the western greater McArthur Basin (**Figure 2**). The westernmost Spirit Hills area covers approximately 8500 km^2 while the more eastern Delamere area covers over 25 000 km^2. This completes the planned magnetic and radiometric acquisition for the *CORE* initiative.

NTGS North Wiso Basin and Victoria Basin gravity surveys

The NTGS North Wiso Basin and Victoria Basin gravity surveys were combined with gravity data from Tom Oates GDC Birrindudu and Victoria Petroleum surveys (Oates 2015) and Proto Resources' and Investment Ltd's Waterloo survey (Muir 2012). The North Wiso and Victoria Basin data consist of 4990 and 6172 stations respectively

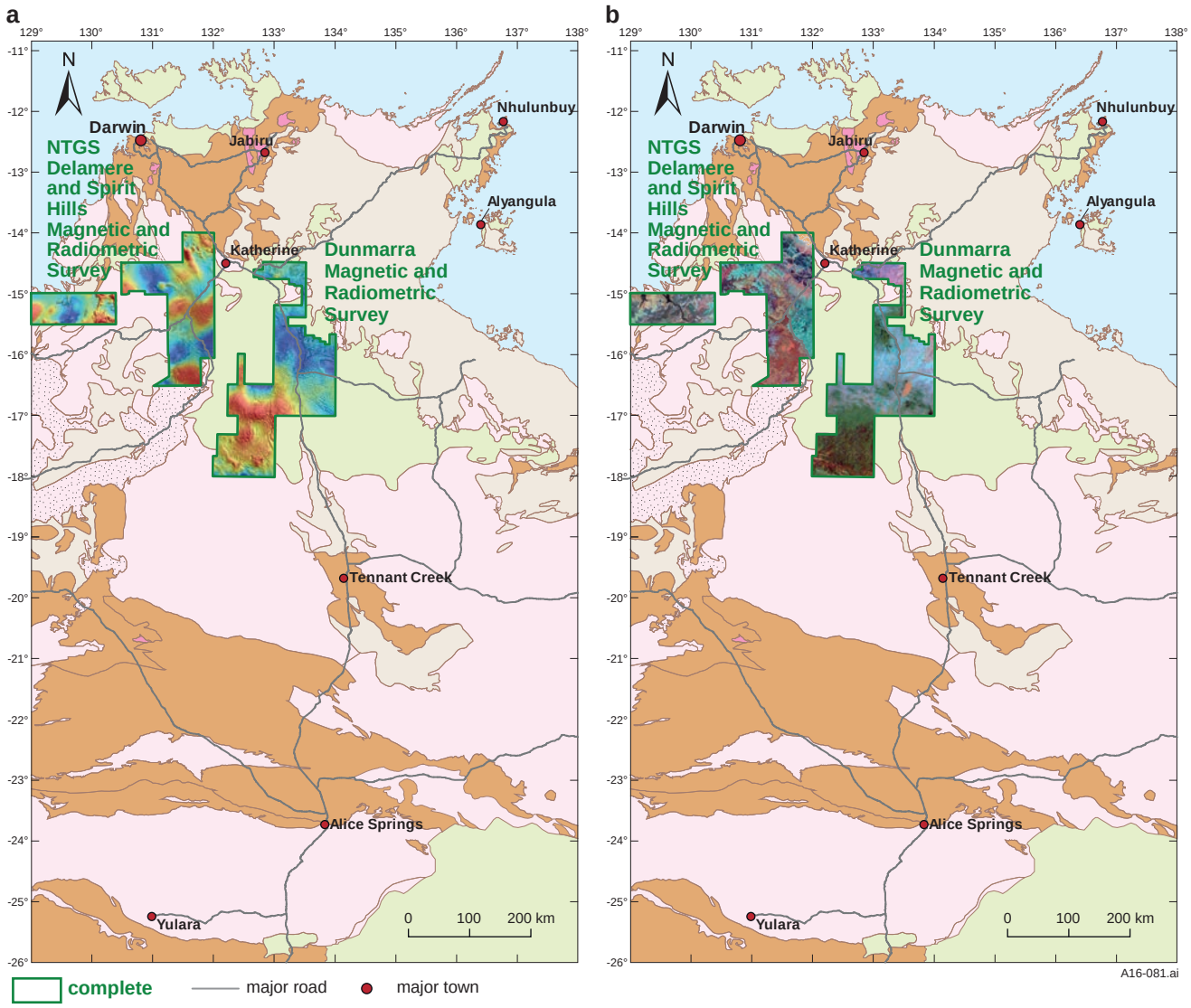

Figure 2. Location of magnetic/radiometric surveys completed under the *CORE* initiative. (**a**) magnetic: RTP TMI is plotted for individual magnetic surveys (**b**) radiometric: ternary radiometric image (red is potassium, green is thorium and blue is uranium) is plotted for individual radiometric surveys. No more magnetic and radiometric surveys are proposed for acquisition under the *CORE* initiative.

on a 4 km x 4 km grid while the Birrindudu and Victoria Petroleum surveys comprise 7045 stations nominally on a 1 km x 1 km grid with some 500 m x 500 m infill; the Waterloo survey is variably spaced with station spacing ranging from 100 m to 500 m (**Figure 3a**).

Figure 3b displays the spherical cap Bouguer anomaly for the combined surveys with an 800 m grid cell size. The western margin, located in the Victoria Basin, presents as a Bouguer anomaly low with increased gravity response in the northwest and central areas. There are a number of small linear trends in the west of the survey area, including a dominant east trending gravity trough in the southwest. A number of north-northwest trending gravity ridges are truncated by the southeastern margin of the survey.

A second Bouguer anomaly grid extending south of the NTGS North Wiso Basin Gravity Survey was generated from a combination of the NTGS North and South Wiso Basin and Tennant Creek gravity surveys plus over 30 000

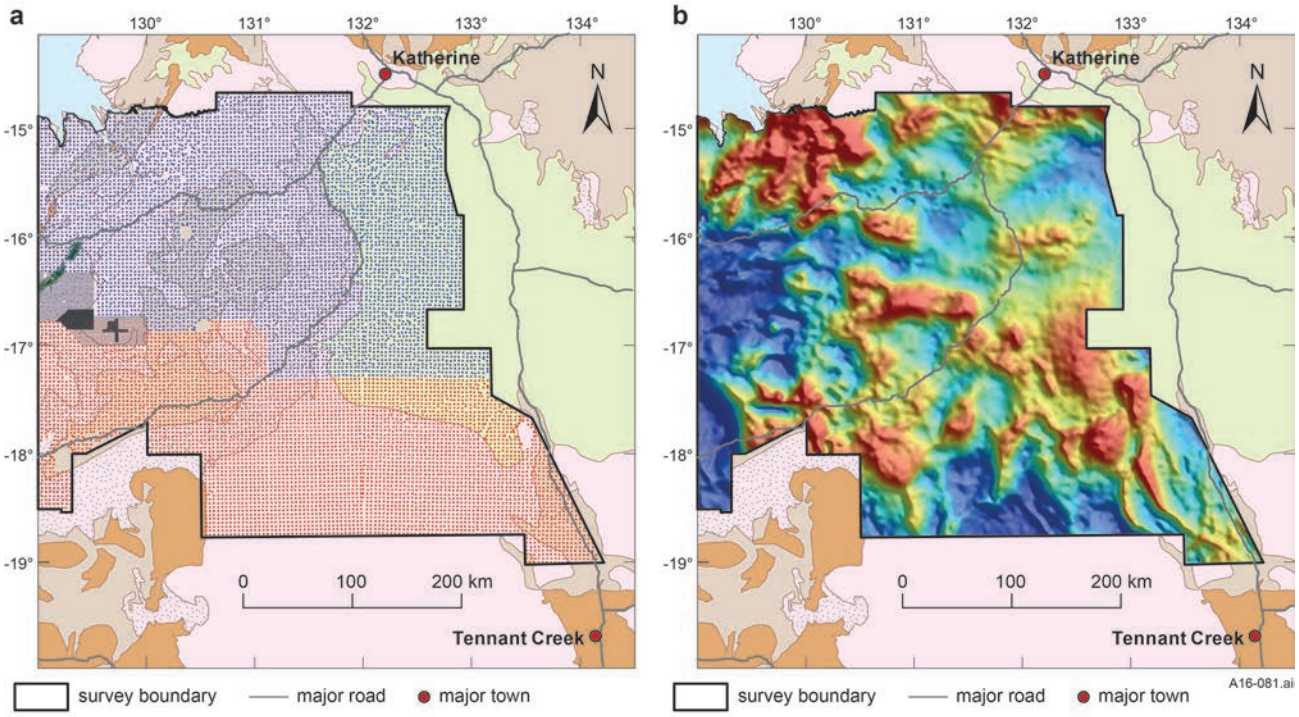

Figure 3. (**a**) Station locations from the NTGS North Wiso Basin Gravity Survey (red), NTGS Victoria Basin Gravity Survey (blue), *GDC* Birrindudu and Victoria Petroleum Project for Tom Oates (black) and CR2012-0455 Waterloo project Gravity Survey for Proto Resources and Investment Ltd (green) overlaying 1:2 500 000 Geological Regions of the Northern Territory. (**b**) Bouguer anomaly image gridded from the four surveys listed displayed with a histrogram stretched pseudocolour algorithm where red colours represent high values and blue colours represent low values.

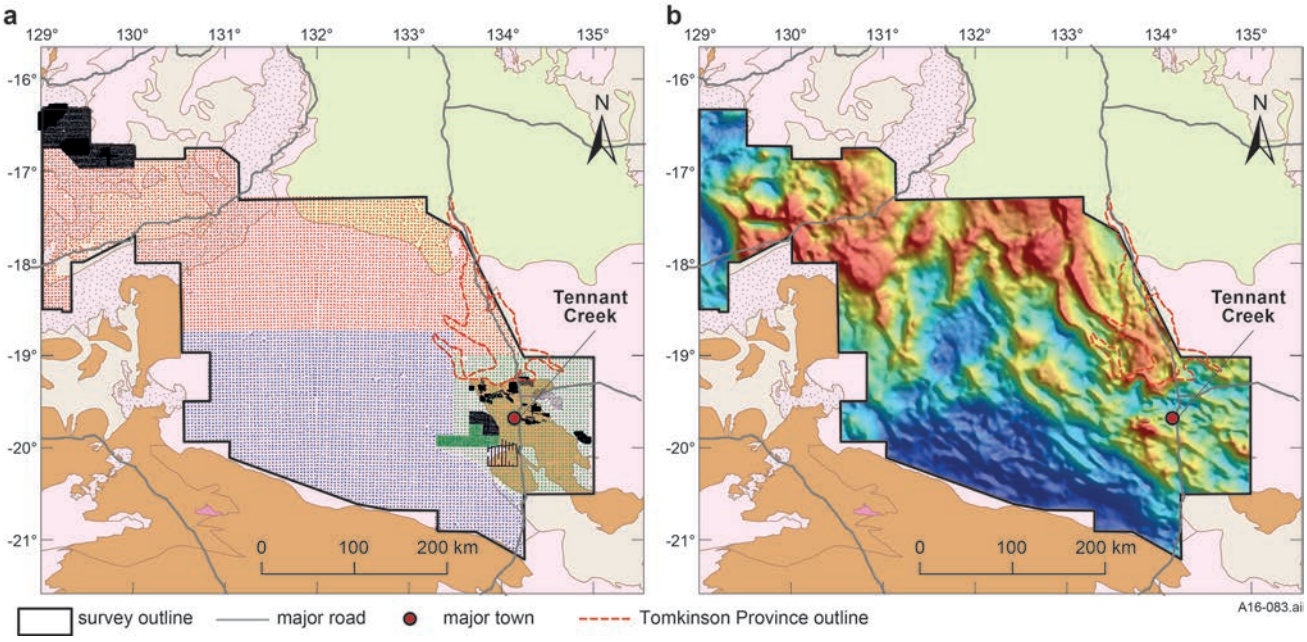

Figure 4. (**a**) Station locations from the NTGS North Wiso Basin Gravity Survey (red), the South Wiso Basin Gravity Survey (blue), the Tennant Creek Gravity Survey (green) and a number of industry gravity surveys (black). (**b**) Bouguer anomaly image gridded from the listed surveys displayed with a histogram stretched, pseudocolour algorithm with northeast sunshade where red colours represent high values and blue colours represent low values, overlain by the Tomkinson Province boundary.

industry-reported gravity stations (**Figure 4a**). The north-northwest trending gravity ridges appear to extend from the Tomkinson Province on the eastern boundary of the survey (**Figure 4b**). The image is dominated by northwest trending structures in the south that rotate more northerly towards the centre of the image.

Delamere and Spirit Hills Magnetic and Radiometric Survey

The Delamere portion of the Delamere and Spirit Hills magnetic and radiometric survey covers parts of the Daly and Victoria basins and the Kalkarindji Province (**Figure 5a**). While some shallow folding is evident at the southern boundary of the image, the speckled response of the early Cambrian Antrim Plateau Volcanics dominates the image (**Figure 5b**). **Figure 5c** shows the reduced to pole (RTP) total magnetic intensity image (TMI) upward continued 1000 m. The upward continuation filter dampens the high-frequency response minimising the impact of the Antrim Plateau Volcanics. In this image, a number of northwest trending structures are visible and anomalies from deeper bodies are more evident. **Figure 5d** shows the radiometric response for the survey.

The more westerly Spirit Hills area of the survey covers the Victoria, Bonaparte and Fitzmaurice Basins (**Figure 6a**). The survey is less affected by the speckled response present in the Delamere area. There are low amplitude, high frequency anomalies indicative of shallow structures coincident with the Keep River and surrounding plains. A low response, relatively smooth texture is apparent over the central Fitzmaurice Basin with higher amplitude

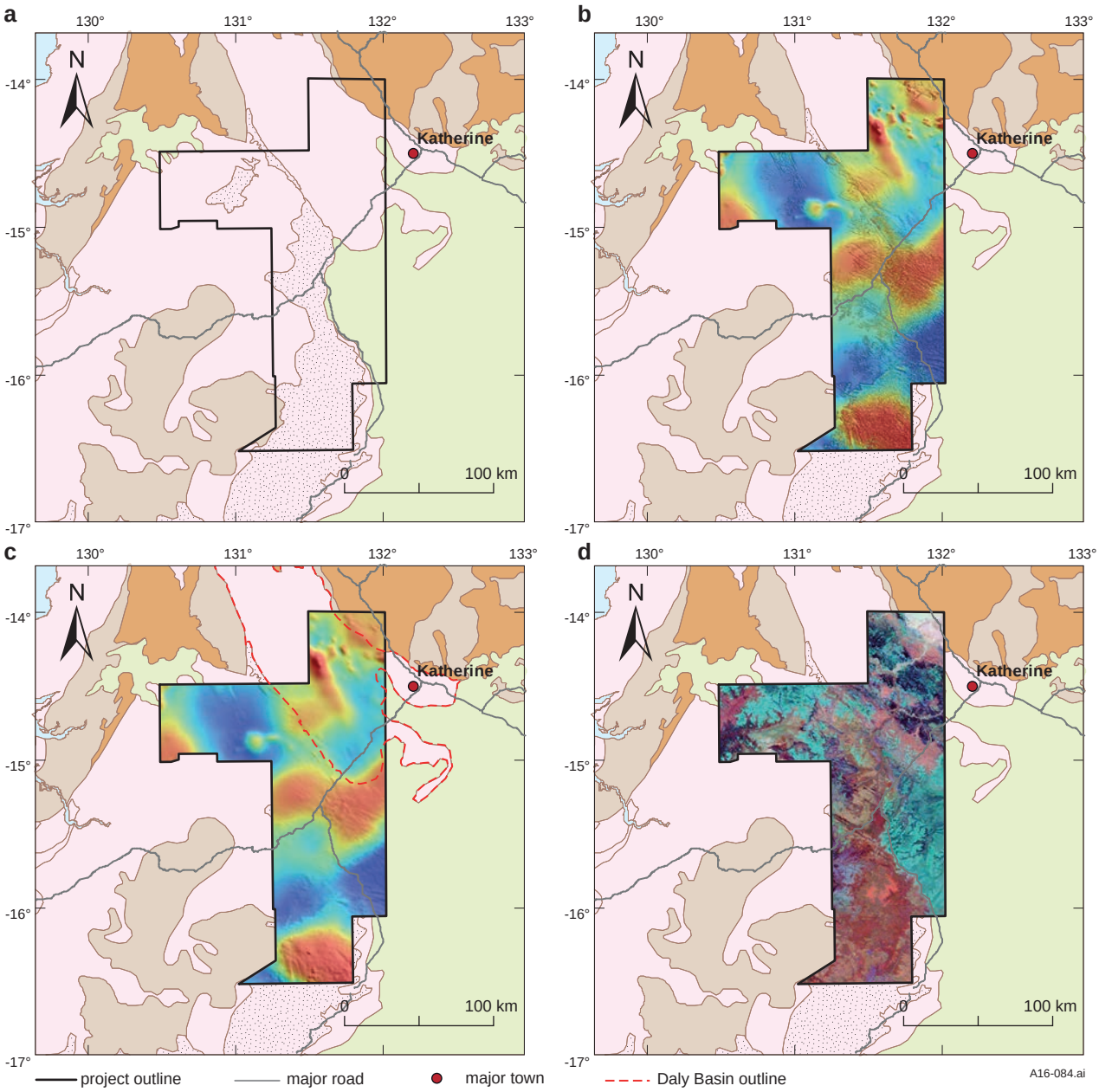

Figure 5. (**a**) Delamere area of the NTGS Delamere and Spirit Hills Magnetic and Radiometric Survey outline overlain on the 1:2 500 000 Geological Regions of Northern Territory. (**b**) Delamere RTP TMI image displayed with a histogram stretched, pseudocolour algorithm with northeast sunshade overlain by fold trends in the south. (**c**) Delamere RTP TMI upward continued 1000 m image displayed as per (b) overlain by the Daly Basin boundary in the northeast. (**d**) Delamere ternary radiometric image (red is potassium, green is thorium and blue is uranium).

responses in the west and east (**Figure 6b**). **Figure 6c** is the first vertical derivative (1VD) of the RTP TMI; it emphasises the high frequency content highlighting shallow anomalies within the subdued central region. **Figure 6d** shows the radiometric response for the survey.

Industry geophysical acquisition

Geophysical data acquired and submitted by the minerals and petroleum industry is a key resource. In 2015 the minerals industry reported over 25 000 line km of airborne magnetic data, almost 24 000 line km of airborne radiometric data and nearly 3000 line km of airborne electromagnetic data from a number of surveys acquired between late 2013 to early 2015. It is important that these data are available to users for re-evaluation as geophysical processing and interpretation techniques, and geoscientific understanding advance.

To ensure that geophysical data can be fully accessed at a later stage, it is important that a logistics report is submitted with the data outlining processing and acquisition parameters; this requirement should be discussed with geophysical acquisition companies before committing to a survey. Final located data products should be requested in ASEG GDFII format in addition to any standard products. Any inverted data, for example conductivity depth images, should also be supplied in located format. If geophysical data is processed by a different company to the acquisition company, both acquisition and processed data should be supplied. For example, if gravity data is acquired by a contractor and reduction and Bouguer anomaly calculation are undertaken by a different contractor, both datasets should be received and submitted to Government.

When submitting data to the Government, submit all products as listed in the logistics report; complete surveys should be submitted rather than survey subsets.

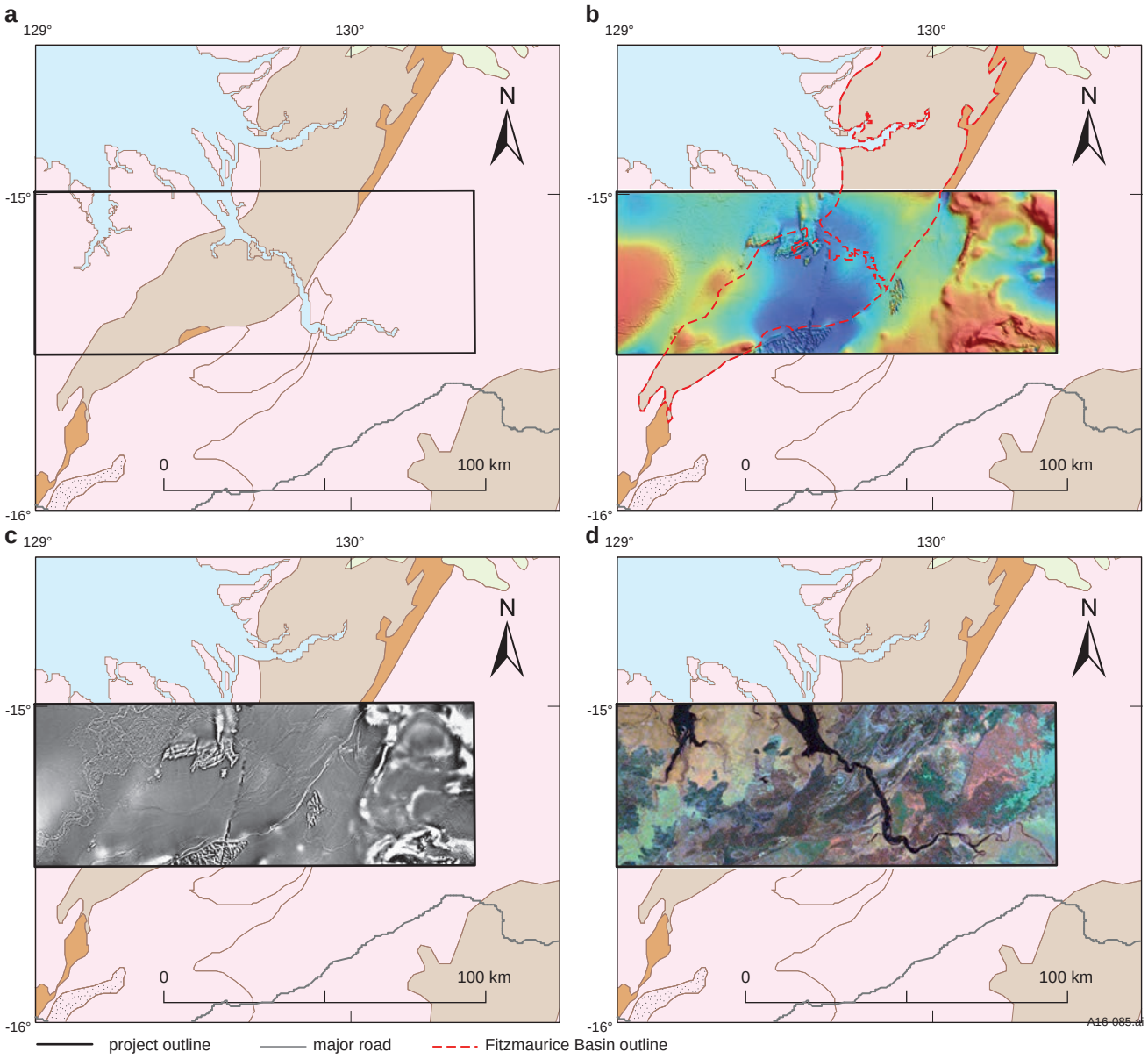

Figure 6. (**a**) Spirit Hills area of the NTGS Delamere and Spirit Hills Magnetic and Radiometric Survey outline overlain on the 1:2 500 000 Geological Regions of Northern Territory. (**b**) Spirit Hills RTP TMI image displayed with a histogram stretched, pseudocolour algorithm with northeast sunshade overlain by the Fitzmaurice Basin boundary. (**c**) Spirit Hills image of the 1VD of the RTP TMI displayed with a histogram stretched, greyscale algorithm. (**d**) Spirit Hills ternary radiometric image (red is potassium, green is thorium and blue is uranium).

The complete survey will be held as a closed file until all tenements are released or the sunset clause is enacted. Surveys only need to be submitted once; subsequent reports can simply refer to that first submission. Simplifying geophysical data reporting will improve both the integrity and discoverability of geophysical data in the Northern Territory for all future users.

References

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