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

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Introduction

• Geophysical data has a wide range of applications from geological mapping to direct detection of anomalies
  – Different scale data is required for different purposes

• Currently there are 3 main sources of new geophysical data in the NT
  – Regional scale gravity, magnetic and radiometric surveys acquired under the CORE initiative
  – Semi-regional scale and innovative geophysical surveys acquired through Geophysics and Drilling Collaborations (GDC)
  – Prospect to semi-regional scale geophysical surveys acquired through mineral and petroleum exploration programs

• Overview of some of the new gravity, magnetic and radiometric data in the NT
CORE Gravity

- Improve resolution of ground gravity to 4 km or better in the greater McArthur and Amadeus basins

- Prior to CORE ~43% of NT mainland completed

- 2013-2015 four surveys acquired bringing coverage to ~62%

- 2015/2016 two surveys acquired bringing coverage to ~75%
CORE Gravity

- Planned Daly Basin Gravity Survey in 2016
  - 35,000 km$^2$
  - 2100 gravity stations

- Proposed South Nicholson Basin Gravity Survey in 2017
  - 2500 km$^2$
  - 1600 gravity stations

- Postponed Northwest McArthur Basin Gravity Survey
NTGS North Wiso Basin Gravity Survey

- Survey design
  - Almost 5000 stations
  - 4 x 4 km spaced grid
  - 80,300 square km
- Survey includes parts of the Birrindudu Basin and Tomkinson Province

- Prominent NNW trending ridges in the SE
NTGS North Wiso Basin Gravity Survey

- Survey design
  - Over 6000 stations
  - 4 x 4 km grid
  - 90,170 square km

- Survey includes parts of the Birrindudu Basin and Beetaloo Sub-basin

Bouguer anomaly image
Individual stations from different surveys are combined and interpolated to create a single grid

- **NTGS North Wiso Basin and Victoria Basin surveys:**
  - 11062 stations
  - 4 x 4 km grid

- **Geophysics and Drilling Collaborations (GDC) Tom Oates survey**
  - 7045 stations
  - 1 x 1 km grid with 500 x 500 m infill

- **Industry reporting Proto Resources and Investment Ltd**
  - 1129 stations
  - Variable spacing from 100 to 500 m
Victoria and North Wiso Basins

- Almost 20,000 gravity stations integrated seamlessly
- Grid cell size 800 m
- GDC and industry data under sampled

Bouguer anomaly image
NNW trending gravity ridges

Over 40,000 gravity stations
- NTGS: ~10,500 stations
- GDC: ~7,000 stations
- Industry: ~26,500 stations

- NNW trending gravity ridges extending from the exposed Tomkinson Province
- Series of NW trending ridges in the south becoming NNW trending towards the centre of the image

Bouguer anomaly image

630 km

μm/s²

80

-812
NNW trending gravity ridges

- Comparison of Total Magnetic Intensity (TMI) and Bouguer anomaly
  - Central NNW trending ridges not apparent in magnetics
  - Curvilinear gravity high on western boundary and adjacent EW trending trough have magnetic expression
  - Complementary geophysical datasets but represent different physical property
NT Wide Gravity

- Over 27,000 gravity stations through CORE initiative surveys

- Almost 10,000 gravity stations through industry infill

- Over 7,000 gravity stations through GDC funded surveys

- Integrated with historical Bureau of Mineral Resources (now Geoscience Australia), previous initiative NTGS and GDC surveys and petroleum and mineral industry statutory reported data
NT Wide Gravity

- Gravity surveys collected prior to 1995 were removed in areas where more modern data exists.
- Historical data often has poor horizontal and vertical positional accuracy:
  - Barometric levelling may lead to metre errors.
  - Height estimation from topographic maps may lead to tens of metre errors.
- Three metre elevation error can introduce 90 µm/s² gravity error:
  - About 3.5% of the total range of the NT wide Bouguer anomaly.

2015 Bouguer anomaly subset

2016 Bouguer anomaly subset

270 km
NT Wide Gravity

Regional trend of increasing amplitude from SW to NE

Linear polynomial regional field

Residual = Total - Original

Total Bouguer anomaly

Regional Bouguer anomaly
NT Wide Gravity

- Increased contrast between features, especially in areas of regionally high and low response
NT Wide Gravity

- Residual Bouguer anomaly interpolated from ~186,500 gravity stations

- Just under 54,000 stations added
  - NTGS~11,000
  - GDC ~7,000
  - Industry reporting ~ 35,900

- Just over 54,000 stations removed

\[711 \mu m/s^2 - 1199 \mu m/s^2\]
CORE Mag/Rad

- Improve resolution of airborne magnetics and radiometrics to 500 m or better in the greater McArthur and Amadeus basins

- Prior to CORE ~90% of NT completed

- 2014/15 Dunmarra survey acquired increasing coverage by 2.5%

- 2015/16 Delamere and Spirit Hills completed bringing coverage to ~98%
Delamere & Spirit Hills Magnetic and Radiometric Survey

• Survey design
  – Approximately 104,000 line km
  – North-south orientated lines
  – 400 m line spacing
  – Two separate blocks
    • Eastern Delamere block (blue outline)
    • Western Spirit Hills block (red outline)
Delamere & Spirit Hills Magnetic and Radiometric Survey

Delamere Block
- Over 70,000 line km
- ~25,130 km²

TMI Reduced to Pole (RTP) image

Dominated by the speckled response of the early Cambrian Antrim Plateau Volcanics

Kalkarindji Province

165 km

-213 nT

210 nT

165 km

AGES2016

AUSTRALIA'S NORTHERN TERRITORY
Delamere & Spirit Hills Magnetic and Radiometric Survey

- Upward continuation dampens the high-frequency response
- NW and NNW trending anomalies
Delamere & Spirit Hills Magnetic and Radiometric Survey

Spirit Hills Block
- Almost 25,000 line km
- ~8,500 km²
NT Wide Magnetics and Radiometrics

- Surveys gridded separately and then merged together with better resolution surveys “stitched” on top of existing data or gaps
NT Wide Magnetics

- 2016 NT wide magnetic image incorporating Delamere and Spirit Hills magnetic grid

2016 NT TMI RTP

2016 NT TMI RTP 1VD
NT Wide Magnetics

• Resolves the speckled response of the Antrim Plateau Volcanics
NT Wide Magnetics

• Resolves the speckled response of the Antrim Plateau Volcanics
NT Wide Radiometrics

- 2016 NT wide radiometric image incorporating Delamere and Spirit Hills radiometric grid
Industry statutory reporting of geophysics

- Industry reported surveys in 2015:
  - ~25,000 line km of airborne magnetic data
  - ~24,000 line km of airborne radiometric data
  - ~3,000 line km of airborne EM

- Request and submit a logistics report outlining acquisition and processing parameters

- Submit all data products as received from geophysics contractor
  - Located data, in native and ASEG GDFII format
  - Gridded data
  - Interpretative products such as inversions

- Submit complete surveys rather than sub-setting
- Submit surveys once and refer to that submission in subsequent reports
Data Delivery

- NT Mineral and Energy Infocentre
- STRIKE
- GIWS
- Geophysical Archive Data Delivery System (GADDS)