

Resourcing the Territory program: Unlocking brownfield and greenfield opportunities in the NT

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The \$9.5 million annual ongoing *Resourcing the Territory* program is largest program ever funded by the Northern Territory Government to support resources exploration in the Territory. The program provides pre-competitive geoscience, investment attraction and exploration stimulus programs designed to increase exploration activity, drive success rates, and open up new areas of the Territory for exploration. It aims to make the Territory a preferred destination for exploration investment, with the added benefit of supporting local businesses and communities that rely on the exploration and mining sector.

Key program themes under *Resourcing the Territory* are briefly described below.

Providing competitive grants to stimulate exploration success

To support the discovery and development of resources in the Territory, \$3 million of the *Resourcing the Territory* program funding is available annually through a competitive grants scheme. The Geophysics and Drilling Collaborations (GDC) program co-funds selected industry projects that address geoscientific knowledge gaps and advance exploration activity, with two thirds of the grant allocation dedicated to projects targeting critical minerals as defined in the report ‘Critical Minerals in the Northern Territory 2024’.

At its 17th year of delivery, the GDC program has been expanded to include a new eligibility criteria of ‘Advancing critical minerals’, and a new activity for co-funding under the ‘Innovative targeting’ criteria.

The program provides co-funding assistance up to 50% of direct claimable project costs inclusive of GST, capped at specific co-funding amounts under each eligibility criteria. Information gained from the successful projects will become open file six months after project fieldwork completion or on 1 August 2025 (whichever is earlier).

The projects and eligibility criteria for co-funding are:

- **Greenfields drilling:** Aimed to increase density of geoscientific data, improve geological knowledge, and de-risk exploration in underexplored areas of the Northern Territory. Capped amounts for co-funding contribution are \$200 000 for a single deep diamond drillhole; \$150 000 for a multi-hole diamond drilling program; and \$100 000 for a non-diamond drilling program (such as RC, aircore, sonic, RAB).
- **Brownfields drilling:** Aimed to help bring forward resource development in areas of known resource endowment. Capped amount for co-funding is \$150 000 for diamond drilling programs testing new concepts below or adjacent to a known deposit.

- **Regional-scale geophysics:** Aimed to significantly improve the resolution and quality of geophysical data in underexplored areas. Capped amounts for co-funding are \$100 000 for regional-scale geophysical acquisition resulting in a significant improvement in the resolution and quality of existing data; and \$150 000 for reflection seismic surveys.
- **Innovative targeting:** Aimed to promote innovation in the testing of methods and techniques for exploration targeting. Capped amounts for co-funding are \$100 000 for camp- or prospect-scale acquisition of geophysics and/or geochemistry where technique and/or approach is innovative in the area of interest; and \$100 000 for seismic re-processing to assist in visualizing sub-surface geology and undercover targeting.
- **Advancing critical minerals:** Aimed to support assessment of critical minerals endowment or recoverability using new or existing sample sets. Capped amounts for co-funding are \$50 000 for re-analysis of existing sample sets and/or mine waste to include previously untested critical minerals; and \$50 000 for early-stage metallurgical test work and/or ore characterisation to assess potential recoverability of critical minerals from mineralised material.

Applications for Round 17 of the GDC program opened 26 February 2024 and will close on 29 April 2024. Information on the program can be found at <https://resourcingtheterritory.nt.gov.au/gdc>.

Underpinning exploration success through enhanced geophysics

As geophysical data is a primary tool for area/target selection in resources exploration, improvement of the quality, accuracy, resolution, and accessibility of government-acquired and industry-submitted geophysics will be a focus under the *Resourcing the Territory* program.

Improve the quality and resolution of regional-scale geophysical datasets

A review and audit of existing regional-scale government-acquired aeromagnetic and radiometric data across the Northern Territory in 2022 identified quality inadequacies in some legacy surveys (Dhu 2023, 2024). The findings from this review will be used to determine a multiyear program of quality improvement, including the design and prioritisation of future airborne magnetic and radiometric acquisition programs.

Areas selected for improved regional-scale ground gravity resolution in 2023 (‘Pedirka Ground Gravity Survey’; Dhu 2023) and 2024/25 (Pine Creek and West Arnhem ground gravity surveys; Dhu 2024) complement pre-competitive geoscience programs under the *Resourcing the Territory* program.

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³ <https://geoscience.nt.gov.au/gemis/ntgjsjpu/handle/1/92851>

Accelerating resource development in known mineral provinces

Pre-competitive geoscience projects in areas of known endowment developed under this theme will improve the quality and consistency of foundational geoscience datasets, including regional-scale geophysics; stratigraphic, igneous and metamorphic frameworks; and mineral/energy systems studies where appropriate. Targeted collaboration with industry, federal agencies and research institutions, plus data and information acquired through the GDC program, will expand and enhance these projects. Areas of focus under this theme include Pine Creek Orogen and Warramunga Province (Tennant Creek area).

Pine Creek Orogen

The Pine Creek Orogen, a polymetallic province with historical gold and iron ore production, is prospective for a wide range of commodities, including critical minerals as listed on the Critical Minerals of the Northern Territory.

Projects will deliver an improved knowledge of the geological framework of the Pine Creek Orogen and provide context to the diverse mineral systems and commodity potential. These projects will redefine stratigraphy and tectonic evolution, and develop understanding of the variable mineral systems of the province, plus assess the potential for secondary prospectivity at historic mines across the Pine Creek region.

Key projects include:

- Reanalysis to the full suite of 72 major and trace elements for 736 legacy Geoscience Australia igneous geochemical pulps from across the Central Domain of the Pine Creek Orogen. The ‘Compilation of pre-competitive Northern Territory Geological Survey geochemistry’ is published as DIP 041⁴.
- Construction of 3D geological model to reinterpret the main mineralised area of Central Domain through integration of open-source geophysical and geological data. The project is being undertaken by the Sustainable Minerals Institute, University of Queensland⁵
- Assessment of secondary prospectivity of mine waste at selected sites across the Central Domain as a potential source for critical minerals, including mine waste at the gold and polymetallic gold deposits of Mount Bonnie and Iron Blow, Brocks Creek and Mount Todd. The project is being undertaken by the MIWATCH group⁶ at the Sustainable Minerals Institute. Assessment reports for Brocks Creek (Gomes *et al* 2023a), and Mount Bonnie and Iron Blow (Gomes *et al* 2023b) are already published.
- Compilation of industry-submitted geophysics datasets across the Central Domain into a digital information package (DIP), including regional, camp and prospect

surveys such as MT, ANT, IP and AEM; and correlation of survey techniques to exploration aims.

- Acquisition of regional-scale ground gravity across the Pine Creek Orogen to deliver a generational improvement in gravity data. The Pine Creek Ground Gravity Survey 2024 (cf **Improve the quality and resolution of regional-scale geophysical datasets**) will increase the current resolution of 11 km spacing to predominantly 2 km spacing, with potentially even closer spacing through industry collaboration infill.

Warramunga Province

The Tennant Creek area was once the third largest gold producing region in Australia through its endowment of high-grade copper–gold bearing ironstones. The area continues to deliver new discoveries of high-grade gold deposits and copper systems, as well as indications of potential cobalt, magnetite and bismuth resources through reprocessing of existing mine waste. The prospective geology of the Tennant Creek mineral field extends under cover to the west, incorporating the copper–gold and lead–zinc potential of the Rover Field. To the east of the Tennant Creek mineral field, recent pre-competitive geoscience data from drilling funded under Geoscience Australia’s *Exploring for the Future* program and the Territory’s *Resourcing the Territory* program (2018–2022) has seen an increase in exploration in the IOCG targets concealed beneath the younger Georgina Basin.

Key projects/outcomes include:

- An improved understanding of the geological framework and the diverse mineral potential (orthomagmatic copper–nickel, ironstone-hosted copper–gold–cobalt–bismuth and sediment-hosted lead–zinc) of the Rover field to the west (Farias 2023).
- Production of a series of Mineral Deposit Atlases including a 3D compilation of available data by the Sustainable Minerals Institute for the major deposits in the Tennant Creek mineral field and Rover field. DIP 023 contains a regional compilation and geological interpretation of the Rover field. Mineral Deposit Atlases completed to date comprise DIP 024–027, covering the Rover 1, Explorer 108, Curiosity and White Devil deposits respectively; and DIP 037–040, covering Juno, Northern Star, Geko Corridor and Nobles Nob deposits respectively.
- Compilation of industry submitted geophysics datasets across the Tennant Creek mineral field and Rover field (DIP 032), including airborne magnetic (\pm radiometric), ground gravity, airborne electromagnetic, ground magnetic, ground electromagnetic, resistivity/induced polarisation, downhole and other geophysical surveys.
- Assessment of secondary prospectivity of mine waste is being undertaken at selected sites within the Tennant Creek mineral field, including Peko and TC8 as a potential source for critical minerals such as cobalt and bismuth. The project is being undertaken by the MIWATCH group at the Sustainable Minerals Institute in partnership with Geoscience Australia.

⁴ <https://geoscience.nt.gov.au/gemis/ntgsjspsui/handle/1/92838>

⁵ <https://smi.uq.edu.au/>

⁶ <https://smi.uq.edu.au/miwatch-mine-waste-transformation-through-characterisation>

Future collaborative projects in the Tennant Creek mineral field with the University of Tasmania will fingerprint mineral chemistry of fertile gold and copper systems and apply this technique to the prospective undercover East Tennant region.

Attracting and supporting resource development in frontier areas

Much of the Northern Territory remains underexplored due to the paucity of modern geoscience data. Under the *Resourcing the Territory* program, key areas have been targeted to generate new datasets and improve resolution, quality and consistency of surface and subsurface datasets in order to de-risk and attract exploration into these largely greenfield areas.

greater McArthur Basin

The informally named greater McArthur Basin includes Palaeo- to Mesoproterozoic successions of the McArthur and Birrindudu basins, and the Tomkinson Province. These depositional areas are interpreted to have been contiguous at time of deposition and to be interconnected at depth beneath younger cover of Neoproterozoic to Phanerozoic rocks. Under the *Resourcing the Territory* program, NTGS continues to improve understanding of the architecture of the stacked basin sequences, depositional history, and environment in the greater McArthur Basin, including its minerals and energy prospectivity.

Correlating and defining stratigraphy

To allow improved stratigraphic correlation across the greater McArthur Basin, a systematic stratigraphic study of the late Palaeoproterozoic (1660–1600 Ma) Glyde package has been published (Munson 2023a). The Glyde package includes the prospective McArthur Group, host to the Pb–Zn McArthur River mine and Teena deposit, as well as conventional hydrocarbons. This publication complements an equivalent study on the overlying Mesoproterozoic (ca 1500–1320 Ma) Wilton package (Munson 2016) that includes the Kyalla and Velkerri formations, host to unconventional hydrocarbons.

Formal definition of younger sequences (post Wilton package) in the Beetaloo Sub-basin of the McArthur Basin has allowed correlation to the Neoproterozoic stratigraphy (Kiana Group) of the overlying Georgina Basin (Munson 2023b).

New geoscience in the frontier Birrindudu Basin

The Birrindudu Basin remains the least explored extent of the greater McArthur Basin. A range of geoscience projects under *Resourcing the Territory* will assist in extending the better-known stratigraphic correlations, basin architecture, depositional history and environment, and related resource potential, from the eastern section of the greater McArthur Basin into the Birrindudu Basin.

Basin architecture, correlations and depositional environment

Geoscience Australia, through their *Exploring for the Future* program and NTGS, under the *Resourcing the Territory* program, have co-funded the ‘Northwest Northern Territory

Seismic Survey’ (Henson *et al* 2023), comprising over 700 km of seismic data across the Birrindudu Basin and linked to existing seismic lines from the Beetaloo Sub-basin to the Tanami Region. This is the first seismic data acquired in the Birrindudu Basin and will provide insight to the concealed relationship with the greater McArthur Basin and Tanami Region, including fault controls within the Basin.

Extensive investigations by NTGS, CSIRO, Geoscience Australia and University of Adelaide on drill core from the Birrindudu Basin, housed at NTGS’s Core Facility in Darwin, has provided a consistent suite of information on the subsurface geology to assist in interpreting the ‘Northwest Northern Territory Seismic Survey’. These investigations include a systematic characterisation of the sedimentary facies and petrophysical signature of the Birrindudu Basin succession (Crombez *et al* 2023); fluid inclusion petrography and microthermometry for selected drillholes; stratigraphic reconstructions of bulk volatile chemistry from fluid inclusions; plus geochronology of targeted formations. This data will allow construction of 3D surfaces (Foley 2024), incorporating downhole interpretation with results from the new seismic data to improve understanding of the Birrindudu Basin architecture.

Detailed and systematic facies analysis of selected drillholes in the Birrindudu Basin (Crombez *et al* 2023) provides a next stage analysis of potential sediment-hosted copper minerals systems (Schmid and Baumgartner 2024) in this frontier area.

Amadeus Basin

Whilst the Amadeus Basin has produced oil and gas for over 30 years, it remains underexplored for sediment-hosted mineral systems. In addition, with the move to a low emission’s future, indications of the Amadeus Basin’s naturally occurring hydrogen and critical resource helium, plus potential geological storage opportunities presented by the extensive salt bearing formations, has renewed exploration focus on this basin.

Seamless geology

Much of the Amadeus Basin has not been systemically mapped since the first edition BMR geological series maps from the 1960s. NTGS is undertaking an update of the 1:250 000 geological series outcrop maps to revise the stratigraphy seamlessly across the basin. The HENBURY⁷ 1:250 000 second edition geological series map was released in 2023 (Donnellan *et al* 2023), with LAKE AMADEUS and BLOODS RANGE 1:250 000 maps due this year. Second edition geological mapping of the RODINGA 1:250 000 will continue this seamless updating of stratigraphy and structure into the eastern Amadeus Basin in 2024 (Hansman and Verdel 2024).

Utilising the updated surface geological mapping, the NTGS released a 1:500 000 seamless interpreted geology (pre-Mesozoic) map of the western Amadeus Basin and accompanying explanatory notes (Weisheit 2021).

⁷ Names of 1:250 000 mapsheets are shown in large capital letters eg DARWIN.

Through collaboration with University of Adelaide, novel isotopic dating techniques will provide improved accuracy in constraining depositional age of formations within the eastern Amadeus Basin and assist with correlating stratigraphy across the basin.

Warburton/Pedirka/Eromanga basins

The stacked Palaeozoic basins in the southeast corner of the Northern Territory are mostly concealed beneath Quaternary sediments and hence, are underexplored. In collaboration with Geoscience Australia, through the ‘Australia’s Future Energy Resources’⁸ project (Bernecker *et al* 2022) under the *Exploring for the Future* program, and with the South Australia Department of Energy and Mines, NTGS has undertaken new data acquisition and targeted studies to improve knowledge of the framework and resource potential of these stacked basins.

New geochronology has indicated correlation between the Cambrian–Ordovician strata of the Amadeus Basin, Warburton Basin and Thomson Orogen in Queensland (Verdel *et al* 2023).

Petroleum geoscience data compiled from 1537 samples within the stacked west Warburton, Pedirka and Eromanga basins is published as DIP 034 (Doig and Jarrett 2023).

The lithostratigraphy of the Pedirka Basin has been significantly updated (Doig *et al* 2023), and an assessment of the petroleum systems in the Pedirka Basin within the Northern Territory has identified good to excellent source rocks, excellent reservoirs and fair to good seals (Jarrett *et al* 2023).

To complement the reprocessed 2D seismic over the Pedirka–Simpson Basin across the Northern Territory and Queensland border undertaken by Geoscience Australia (2022) through the *Exploring for the Future* program, NTGS has acquired 2 to 4 km-spaced ground gravity through the ‘Pedirka Ground Gravity Survey’ (Dhu 2024).

Applying geoscience to support a low emissions future

NTGS is commissioning a series of products to assess the Northern Territory’s potential for geothermal energy through Hot Dry Rocks Pty Ltd, and to assess the capacity for geological storage of carbon, hydrogen and compressed air in selected Northern Territory onshore basins through CSIRO.

Collaborative research projects are proposed with the University of Adelaide and University of Western Australia to improve our knowledge of key critical minerals, including understanding of lithium–caesium–tantalum pegmatites in the Pine Creek Orogen, Aileron and Irindina provinces; cobalt- and bismuth-rich systems in the Tennant region; and potentially rare earth elements within phosphorites in the Georgina Basin.

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