Resourcing Australia's Prosperity – Birrindudu Deep Dive Project

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The *Resourcing Australia's Prosperity* initiative (the Initiative) is a landmark investment to sustain and improve Australia's position as a global renewable energy leader, ensuring a pipeline of economic resources and enabling the responsible management of all resources. The Initiative will invest $3.4 billion over 35 years (2024–2059) to deliver accelerated and enhanced geoscience data acquisition, scientific analysis and decision support tools. Activities will support the transition to net zero by 2050, as well as the Australian Government's Future Made in Australia plan. The initial phase of the Initiative will have funding of $556.1 million over the first 10 years, with a subsequent phase investing further funding until 2059.

Australia aims to be the sustainable supplier of choice for critical minerals and strategic materials essential to the production of renewable energy technologies, such as solar panels, wind turbines and electric vehicle batteries, which will require a reliable pipeline of resource projects. The Initiative is specifically designed to support increased resource exploration and responsible management of all Australian resources to achieve net zero ambitions, underpinned by precompetitive geoscience from Geoscience Australia.

The Initiative (**Figure 1**) includes the collection of Australia-wide geoscience datasets, the building blocks used to see and understand what lies on and below the land surface and seabed. It will also assess the national potential for a broader range of resources, particularly those critical to a net zero transition; groundwater; and environmental, social and governance (ESG) risk factors for resource exploration and development. As part of the Initiative, 12 'deep dive' projects will provide a more detailed understanding of the resource prospectivity in selected onshore regions and collect more targeted datasets.

The increased rate of precompetitive geoscience data collection and analysis under the Initiative is essential to meet resource supply shortfalls, maintain international competitiveness and diversify critical mineral supply chains. New offshore precompetitive data will enable Australia to capitalise on its vast marine estate to develop offshore resources, including offshore wind zones and carbon capture and storage (CCS), and to meet net zero targets.

The Initiative is also designed to help identify where we could potentially co-locate mineral exploration with projects such as hydrogen production and geological CCS, which is required for the permanent removal of carbon dioxide from the atmosphere. Geoscience analysis and data acquisition can help identify decarbonisation pathways for carbon-intense industries such as our energy, mining and metal production sectors at the same time.

Geoscience Australia, in partnership with state and territory governments, will comprehensively map Australia's

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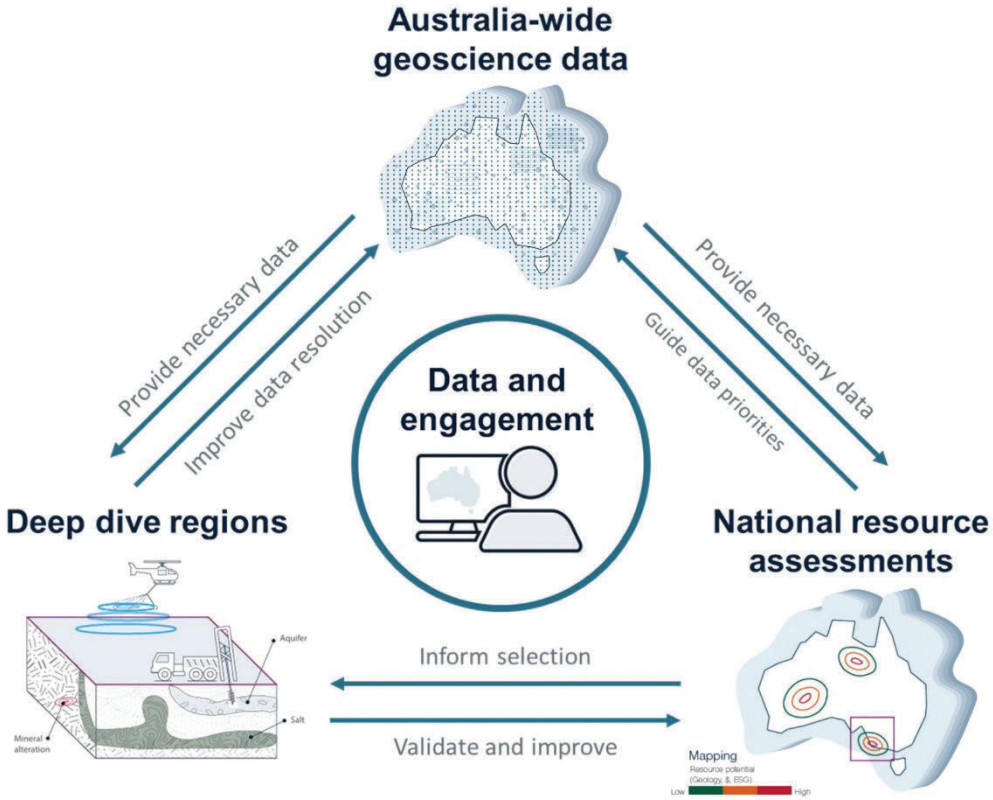

Figure 1. Four core components of the *Resourcing Australia's Prosperity* initiative.

onshore resource potential for all 36 critical minerals and strategic materials, as well as Australia's groundwater systems. It will also assess options for geological storage of hydrogen and carbon dioxide. In offshore areas, it will assess suitable sites for renewable energy infrastructure and carbon dioxide storage.

Through this generational investment, Geoscience Australia will:

- **assess national resource potential**, mapping 'hot spots' for all of Australia's critical minerals and strategic materials, and other resources needed to support the net zero transition
- **map all of Australia's groundwater systems**, supporting climate resilience, agricultural output and water security for communities, industries and the environment
- **investigate 12 onshore 'deep dive' regions** with unrealised potential for the resources needed to support Australia's transition to net zero
- **complete Australia-wide geoscience datasets**, the building blocks used to see and understand what lies below the land surface and seabed.

Birrindudu Deep Dive Project

The Birrindudu Deep Dive (BDD) Project area in northwest Northern Territory extends into northeast Western Australia. The BDD covers a broad range of geological time periods that will be assessed for the long-term support of economically sustainable resources, the agriculture sectors, and social benefits for Australia's regional and remote communities.

The BDD region has some historic and current mining activities, and the region supports several remote communities and numerous agricultural activities. By acquiring, analysing and interpreting new and existing precompetitive geoscience data, we will build knowledge in the BDD region to assess its resource potential. The BDD is in a broadly frontier region except for some known resource areas (eg Halls Creek, Tanami Region).

Geology

The Palaeoproterozoic to Mesoproterozoic Birrindudu Basin represents the geographic centre of the BDD region and extends across the northwestern Northern Territory into northeastern Western Australia. Definition of the basin has evolved through increased data acquisition, improving understanding of the geology and stratigraphy (see Dunster and Ahmad 2013, Korsch 2024 for summary). The accepted basin definition is that proposed by Dunster and Ahmad (2013), where the Palaeoproterozoic to Mesoproterozoic Birrindudu Basin is distinguished from the overlying Neoproterozoic Victoria Basin (Dunster *et al* 2000) by a regional unconformity, interpreted based on a major shift in detrital zircon provenance between the Tijunna Group of the Birrindudu Basin and the Auvergne Group of the Victoria Basin. Under this definition, the Birrindudu Basin is considered to contain six stratigraphic groups; the basal, age-equivalent Birrindudu and Tolmer groups, which are unconformably overlaid by, in ascending order, the Limbunya, Wattie, Bullita and Tijunna groups (Dunster and Ahmad 2013, Munson 2014). This is in contrast with earlier definitions that place the top of the Birrindudu Basin at the top of the Limbunya Group (eg Sweet 1977, Cutovinos *et al* 2002). Rocks of the Birrindudu Basin unconformably overlie metamorphosed and deformed rocks of the Pine Creek Orogen in the north, Tanami Region in the south, the Inverway Metamorphics in the central part of the basin, and probably the Halls Creek Orogen in the west (Dunster and Ahmad 2013, Korsch 2024). The Birrindudu Basin sedimentary succession is in turn overlain by the Neoproterozoic Victoria, Wolfe and Murraba basins, the Cambrian Kalkarindji Province, the Palaeozoic Daly, Ord and Wiso basins and younger Mesozoic(?) sedimentary rocks (Korsch 2024). The latest provisional Birrindudu Basin boundary was proposed in Korsch (2024) and is defined by the outer limits of surface outcrops of the succession and based on the limits of units on the solid geology map of the North Australia Craton by Stewart (2020). This boundary should be regarded as a work in progress and will need revision. This provisional basin boundary has a total spatial extent of ~143 000 km^2, with Birrindudu Basin rocks reported to outcrop over ~35 000 km^2 (Dunster and Ahmad 2013). The provisional boundary of the Birrindudu Basin overlaps with the Osmond Basin in WA, a small, Mesoproterozoic basin (eg Hassan 2000). The relationship between the Birrindudu Basin and Osmond Basin is unclear.

The Birrindudu Basin succession correlates with basin sequences of the McArthur Basin and Tomkinson Province to the east. Interpretation of industry seismic data and stratigraphic drilling indicates that sequences in the Birrindudu Basin and western Beetaloo Sub-basin of the McArthur Basin are continuous in the subsurface. This is particularly evident in the long east–west seismic line PB13-20 in the 2013 Hidden Valley 2D Seismic Survey (Hoffman 2015, Pangaea Resources 2019, Williams 2019, Garrad 2023). The larger region incorporating the McArthur Basin, Birrindudu Basin and equivalent units in the Tomkinson Province has been referred to informally as the greater McArthur Basin (Close 2014). The continuity of the basins is also demonstrated by recent SEEBASE® studies showing depth-to-basement images (approximate base of Birrindudu and Tolmer groups) by Connors and Pryer (2018), Frogtech Geoscience (2018), Debacker *et al* (2021), Northern Territory Geological Survey and Geognostics Australia (2021) and Geognostics (2021). More broadly, the Birrindudu Basin likely correlates with age-equivalent units of the South Nicholson Basin, Lawn Hill Platform and the Mount Isa Province in the eastern Northern Territory and western Queensland (see Ahmad and Scrimgeour 2013 for discussion). Rocks of the Birrindudu Basin may also correlate, at least in part, with those of the Fitzmaurice Basin in the Northern Territory (Dunster and Ahmad 2013) and the Carr Boyd Basin (Munson 2014), Crowhurst Basin (Hassan 2000), Osmond Basin (Hassan 2000) and Kimberley Basin in Western Australia (Blake *et al* 2000). However, more work is required to determine the correlation and relationship between these basin sequences.

BDD – recent activities

As part of Geoscience Australia's *Exploring for the Future* program, it recently acquired the deep crustal Northwest Northern Territory Seismic Survey (NW NT Seismic Survey) over the Birrindudu Basin and adjacent regions. Co-funded by the Northern Territory Government, the NW NT Seismic Survey was designed to provide an improved understanding of the concealed geology and crustal architecture of the region (Anderson *et al* 2024). Importantly, the NW NT Seismic Survey connects to existing 2D seismic lines that extend into the western Beetaloo Sub-basin (2013 Hidden Valley 2D Seismic Survey by Pangaea Resources; Hoffman 2014, 2015; Pangaea Resources 2019) and the Tanami Region (2005 Tanami 2D Seismic Survey L171; Jones *et al* 2005, Goleby *et al* 2009). These previous seismic surveys were used to develop a wider regional geological interpretation.

The key science objectives of the NW NT Seismic Survey were to:

1. enhance understanding of the stratigraphy of the region and identify any previously undiscovered concealed basins, sub-basins or depocentres
2. evaluate geological and stratigraphic relationships between the Birrindudu Basin, the resource-rich McArthur Basin to the east, and the Tanami Region to the south
3. improve understanding of the major structures in the region, such as basin geometry, timing of tectonic events and their relationship to mineralisation and energy resources
4. determine possible relationships between basin architecture and resource potential.

The NW NT Seismic Survey has provided unique subsurface understanding of the Birrindudu Basin, which has enabled new perspectives to be gained regarding its geology and relationship to surrounding regions. The new seismic data has shown an increase in the extent of the Birrindudu Basin, revealing the presence of extensive concealed sedimentary sequences and major, well-preserved depocentres. A main depocentre of the basin, imaged in the northwestern Birrindudu Basin, was previously only inferred in the SEEBASE® model of Frogtech Geoscience (2018). In the central Birrindudu Basin and Tanami Region, shallow basement and deep-seated faults are encouraging for mineralisation, as these structures have the potential to focus mineralised fluids to the near surface. The clear presence of shallow Tanami Region rocks underlying the southern Birrindudu Basin sequences at the northern end of line 23GA-NT2 extends the mineral resource potential of the Tanami Region further north into the southern Birrindudu Basin. A new minimum age of 1822 ± 7 Ma (Kositcin and Carson 2024) for the deposition of metasedimentary rocks underlying the central Birrindudu Basin in drillhole LBD2, extends the age-equivalent mineral-rich basement rocks of the Tanami Region north into the central Birrindudu Basin – extending the mineral resource potential into a new region.

In addition, a drill core analytical program was undertaken to complement the acquisition of the NW NT Seismic Survey. A sampling program of legacy drillholes was carried out at the Northern Territory Geological Survey core repository in Darwin. Over 1200 core samples from 10 drillholes were collected for analytical work, including geochemistry, petrology, oil inclusion studies, rock properties and geochronology. These were published in 2024 (see Anderson *et al* 2024 for full list). The key objective of the sampling program was to provide new insights into the stratigraphy and resource potential of the Birrindudu Basin and surrounding regions.

Resource potential

The BDD project area has not been the focus of significant exploration outside the Halls Creek and Tamami regions, with only a small amount of seismic data available and limited exploration drillholes. Although the Birrindudu Basin region contains rocks of equivalent age to those that host world-class sediment-hosted lead–zinc deposits in the McArthur Basin and Mount Isa Province, it has not been subject to the same rigorous exploration activity. Previously, several major mining and exploration companies, such as CRA Exploration Pty Limited/Rio Tinto Exploration Pty Limited, Geopeko, BHP Minerals Pty Ltd and Western Mining Corporation Ltd have undertaken exploration activities for base metals. Within the basin, the Kalkarindji Province has been the focus of nickel and platinum group elements (PGE) exploration. During exploration for diamonds, De Beers Australia Exploration Limited discovered five kimberlite pipes on the DELAMERE 1:250 000 geological mapsheet (Hulton and Morris 1998), but they are currently considered subeconomic.

The BDD region is partially covered by mineral exploration licences, and outside the Halls Creek and Tamami regions is subject to only limited mineral exploration activity. For example, Ripple Resources Pty Ltd is currently exploring in the VICTORIA RIVER DOWNS 1:250 000 mapsheet area for lead–zinc (Bierling 2022), and Omnia Panton Pty Ltd (Omnia Metals Group Ltd 2022), is currently exploring around the Negri Fault in the LIMBUNYA 1:250 000 mapsheet area for copper, nickel and PGE. The Negri Fault is interpreted to be a mantle-tapping structure, potentially bringing deep metal-bearing fluids to the near- surface (Omnia Metals Group Ltd 2022).

Graphite resources (eg Leliyn graphite deposit, McIntosh Graphite Project) in the BDD region, along with graphite occurrences discovered during Geoscience Australia 2024 sampling in legacy drill cores (eg NTGS: LMDH8), demonstrate the potential for discovery in the region. Rare earth resources, including Cummins Range carbonatite-type deposit, heavy rare earth elements (HREE) resources at Brown Range Dome and the recently discovered carbonatite complex north of Lake MacKay in Western Australia (Encounter Resources 2023) highlight regional prospectivity. The potential for carbon capture and storage (CCS) in the BDD region is yet to be determined.

***Resourcing Australia's Prosperity* initiative – BDD AEM survey and sampling**

Building on this previous work and as part of the BDD, Geoscience Australia will acquire an airborne electromagnetic (AEM) survey. This large-scale survey will have three components:

1. acquire AEM data in areas with none
2. infill existing data to a minimum of 10 km spacing
3. acquire closely spaced AEM data in select areas.

The survey will cover a geographic area spanning the Western Australian and Northern Territory border. Data will provide insights into the geology of the region and accelerate the assessment of critical minerals, groundwater resources and energy systems.

In addition, during 2024 a new drill core sampling program of legacy drillholes was carried out within the broader BDD region in the Northern Territory. Over 1000 core samples from 23 drillholes were collected for analytical work to support the assessment of resources in the region. These samples are expected to improve the geological knowledge of the region, by shedding light on the wider stratigraphic relationships, geomechanics, geochemistry and associated energy and mineral systems of the BDD region.

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