Exploring for the Future - Discovering the South Nicholson Basin region with new seismic data

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Introduction

Exploring for the Future (EFTF) is a four-year $100.5 million initiative by the Australian Government conducted by Geoscience Australia in partnership with state and Northern Territory government agencies, CSIRO and universities. This program aims to boost northern Australia's attractiveness for investment in resource exploration. As part of this program, Geoscience Australia will use innovative techniques to gather new pre-competitive data and information on an unprecedented scale about the energy, mineral and groundwater resource potential concealed beneath the surface.

A major EFTF output is a land seismic survey (the South Nicolson seismic survey) between the southern McArthur Basin and the western part of the Mount Isa Province, crossing the South Nicholson Basin and Murphy Province. Data acquisition was completed in early August 2017. Prior to this survey, the region contained no seismic data (**Figure 1**). Five seismic lines were oriented to best image geological features as indicated by outcrop and from

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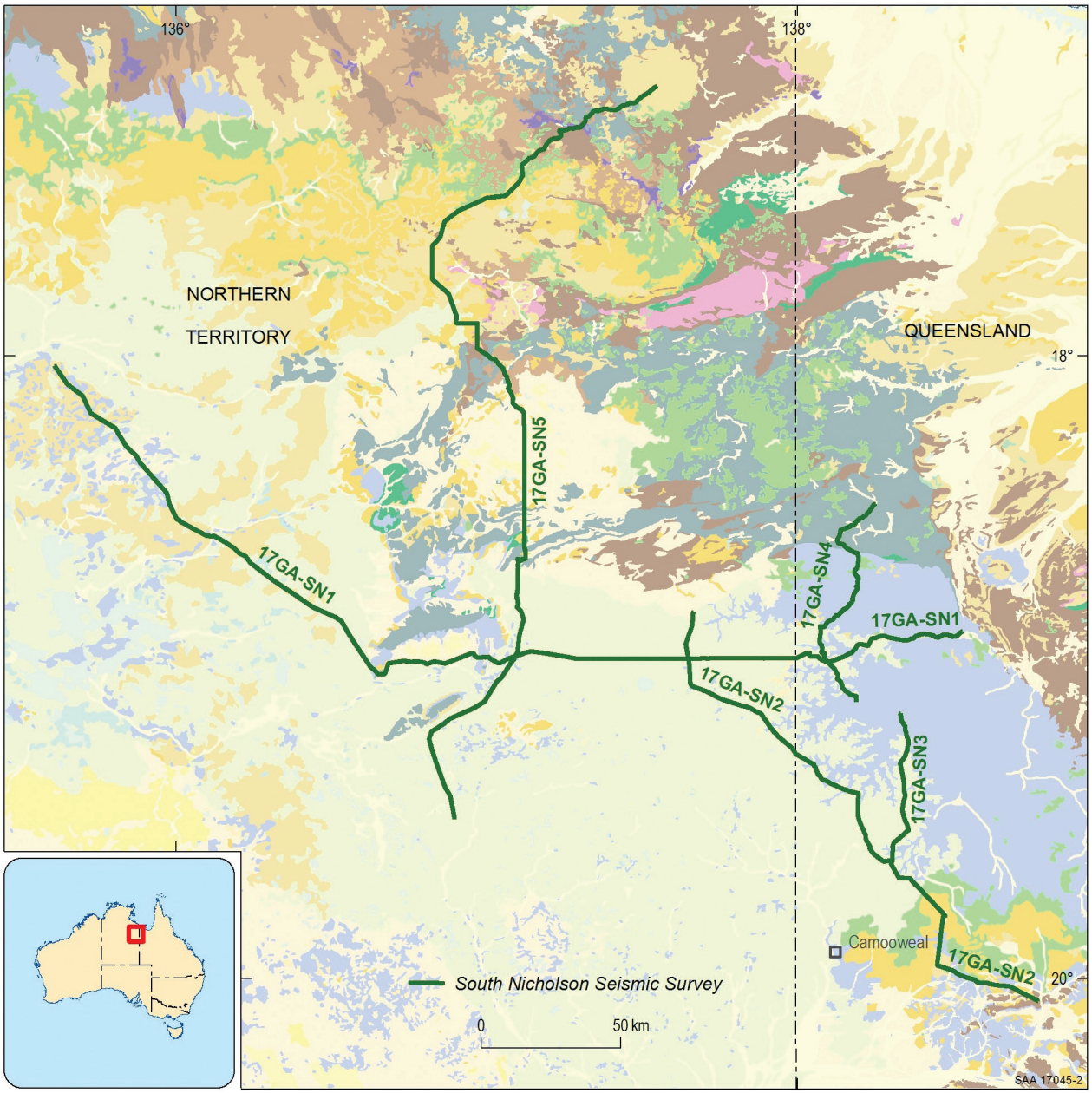

Figure 1. Gravity image of the South Nicholson region. New seismic survey: thick white lines. Older seismic surveys: thin white lines. Petroleum wells: black dots.

other geophysical data (**Figure 2**). The acquisition was designed to determine the undercover extent of exposed sedimentary basins, to better understand the location and scale of potential oil, gas and mineral resources, and to image the crustal architecture.

South Nicholson seismic survey

Acquisition of the new seismic data was led by Geoscience Australia in collaboration with the Northern Territory Geological Survey and the Geological Survey of Queensland. It was acquired largely on minor roads and tracks by Terrex Seismic using an array of three Inova AHV-IV PLS364 (62 000 lb) units configured to image the whole of crust. Five seismic lines were acquired totalling 1100 line km (**Figure 2**), with the new seismic array directly linking with existing Mount Isa Province seismic lines (06GA-M1 and 06GA-M2) in the Century Mine area, and linked along strike with the 06GA-M3 seismic line (**Figure 1**). This data will support exploration activities by providing an improved understanding of the architecture and structural evolution of the region and assist in identifying geological terranes with greater resource potential.

The high-quality seismic data collected has revealed numerous features; some of the most significant are described below. One of the aims was to investigate the prominent gravity lows in the region and to determine whether they represented thickened underlying basin sequences in a similar way to the coincident gravity low of the Beetaloo Sub-basin. The gravity low that straddles the Northern Territory Queensland border to the north of Camooweal (**Figure 2**) was a primary target and is entirely under the Georgina Basin. At the location of this gravity low, the new seismic data has imaged a 5–7 km thick, relatively undeformed basin; major semi-continuous seismic horizons can be tracked across the intersecting lines 17GA-SN1, 17GA-SN2, 17GA, SN3 and 17GA-SN4 (**Figure 2**). Although the sequences within this basin are currently unknown due to the lack of well data, interpretation of seismic data in the Century mine area (ie lines 06GA-M1 and 06GA-M2) and correlations with the existing data suggest that the McNamara Group units and overlying Mesoproterozoic units (which have proven gas discoveries and host major Cu, Pb, Zn, resources elsewhere) may extend undercover to the west of their current outcropping locations and into this basin. Understanding the lateral extent of these units is critical to developing our knowledge of high potential exploration areas within this new basin. Additional geochronology work is also being undertaken to test and establish stratigraphic correlations between the southern

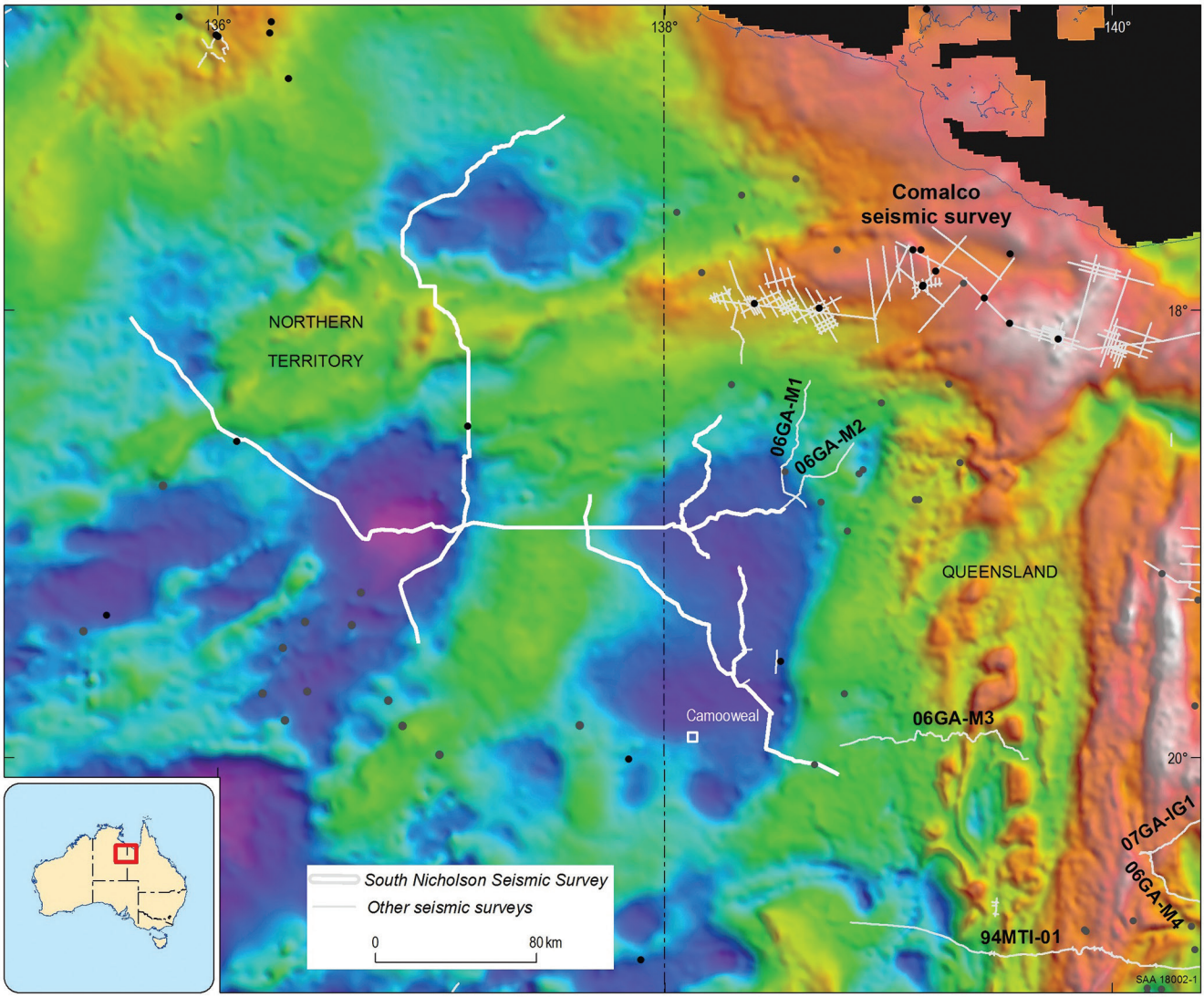

Figure 2. Geology image of the South Nicholson region, showing named seismic lines.

McArthur Basin, South Nicholson Basin and Mount Isa Province.

The north-south 17GA-SN5 seismic line (**Figure 2**) is oriented broadly orthogonal to the southern outcropping boundary of the South Nicholson Basin, which is roughly defined by the Little Range Fault. A series of parallel east-west structures are clearly defined in geological map patterns in this area and display significant displacement across faults. The new seismic has imaged structures in the area consistent with a structural architecture of thin-skinned north over south, low angle thrusting; the timing of this deformation is still to be determined. These structures are in contrast to the relatively undeformed new basin to the south indicating that there is a sharp transition in structural character to the south of the Little Range Fault. The northern boundary of the outcropping South Nicholson Basin is bounded by the Paleoproterozoic Murphy Province. Seismic reflectivity at this boundary does not allow clear interpretation of the contact and further work is required to determine the nature of this boundary.

To the north of the Murphy Province, the northern extent of the 17GA-SN5 seismic line traverses a large gravity low over an area of outcropping McArthur Basin units. From the northern boundary of the Murphy Province where lower Tawallah Group units outcrop, to the northern extent of the seismic line where the McArthur Group units outcrop, the new seismic data images a deep basin sequence of semi-continuous reflectors dipping to the north and reaching a total depth of ~13 km. This basin sequence is host to the Redbank copper mine; these new findings will have implications for understanding the genesis of this mineral system.

Conclusions

The new South Nicholson seismic survey represents a foundation dataset from the *Exploring for the Future* program that links the highly prospective resource-rich areas of the McArthur Basin and Mount Isa Province via a continuous seismic traverse. Decades of scientific research undertaken in both regions will act as a framework to interpret the new data in the South Nicholson Basin region and act as a catalyst to enable transfer of scientific knowledge across the border. This output will be combined with additional EFTF data collected over the region (including drilling, magnetotelluric surveys, airborne electromagnetic surveys and passive seismic surveys) to greatly improve resource evaluations in northern Australia. The *Exploring for the Future* program will de-risk greenfield regions and position Australia for the next wave of exploration investment.