

Integrated geoscience projects through the CORE initiative

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Introduction

Under the Northern Territory (NT) Government 2014-18 initiative *Creating Opportunities for Resource Exploration (CORE)*, the Regional Geoscience group of the Northern Territory Geological Survey (NTGS) has been tasked with acquiring, analysing and interpreting both new and existing geoscience data over four key geological areas in the NT. These areas are the greater McArthur Basin (as defined in Close 2014), the Amadeus Basin, the Arunta Region and the Arnhem Province. The Regional Geoscience programs under the CORE initiative are designed to improve the understanding of the framework geology and resource prospectivity of these areas (**Figure 1**). The following is an update on progress towards this objective for each of these key areas.

greater McArthur Basin

The CORE projects undertaken within the greater McArthur Basin are focussed on 1) improving the understanding of the regional scale of the stacked Meso-Palaeoproterozoic basin stratigraphy through the correlation between outcropping basins, tracking the subsurface continuity beneath younger basins, investigating the basins' architecture and evolution, interpreting the palaeogeography and depositional environment; and 2) providing resource information across black shale intervals through compilation of existing data and provision of a consistent suite of drill core source rock analysis.

A campaign geophysical acquisition program for the whole greater McArthur Basin has attained ground gravity coverage at a resolution of 4 km or better spacing plus airborne magnetics and radiometrics at 400 m line spacing. This increased resolution of these regional geophysical datasets will form the basis of an updated interpretation of the basin architecture. Gravity is proving to be an excellent tool in identifying potential sub-basins or depocentres where seismic coverage is poor.

The geophysical acquisition program is complimented by a project to collate rock property data published in company reports and to collect new rock property data on bulk density, apparent grain density, apparent porosity and magnetic susceptibility (Hallett 2015) from drill core housed at NTGS's core facilities.

A project to capture hyperspectral data and high resolution imagery of drill core intersections of significant stratigraphy in the greater McArthur Basin has been undertaken through this initiative. Systematic scanning of the drill core through the HyLoggerTM, combined with interpretation of the spectral response delivered in digital format, has provided ready access to view and investigate key drill core online through the NVCL portal. Interpretation of the spectral response of lithologies within stratigraphic

units has identified potential inconsistencies in formation identification during initial geological logging of the drill core (Smith 2016) thus validating the HyLogger as a useful tool for stratigraphic correlation.

An important component of NTGS work in the greater McArthur Basin has been creation of the a 3D model in SKUA-GOCADTM design to improve the understanding of the stacked basin architecture, the subsurface stratigraphic extents and the controlling fault network, including its shape and orientation at depth. The paucity of subsurface data across the extent of the greater McArthur Basin has provided significant challenges to the creation a 3D model at this scale. The approach has involved integrating available seismic data, drillhole formation picks, cross sections from published maps, surface structural measurements and interpretations from potential field modelling. Initial outputs from the 3D model construction have concentrated on the Mesoproterozoic Wilton package (as defined in Close 2014), particularly to enable an understanding of the extent and depth of major stratigraphic intervals that include the Velkerri and Kyalla formations, both of which are highly prospective for hydrocarbons. The second phase of the 3D model construction focussed on the Palaeoproterozoic Glyde package (as defined in Close (2014) to interpret the architecture of the sequences that include the McArthur Group and stratigraphic equivalents, host to world class Pb-Zn mineralisation and also highly prospective for hydrocarbons.

A project to provide evidence of stratigraphic correlation between the outcropping McArthur Basin, Birrindudu Basin and Tomkinson Province has commenced with the stratigraphic characterisation of the Mesoproterozoic sequences of the Wilton package. This investigation has targeted the type sections of the formations in the Wilton package to undertake a consistent analysis of sedimentology, geochemistry U-Pb zircon geochronology, Lu-Hf and Sm-Nd isotope geochemistry. This approach will provide information on maximum deposition ages, provenance, depositional environments and palaeogeography across the extent of the correlated Wilton package sediments (Munson in press).

The greater McArthur Basin is increasingly recognised for its potential for unconventional and conventional hydrocarbon resources. In this regard, the NTGS is undertaking a consistent suite of analysis of the black shale units within the greater McArthur Basin to improve the availability of key datasets and information to understand the scale and extent of these hydrocarbon resources. Analyses include total organic carbon, pyrolysis, biomarkers, X-ray diffraction, and triaxial compressive strength testing to assess if the black shale units in the greater McArthur Basin meet the desirable characteristics of a shale gas system. Initial analysis has focused on the Wilton package with early assessment highlighting the potential of the middle

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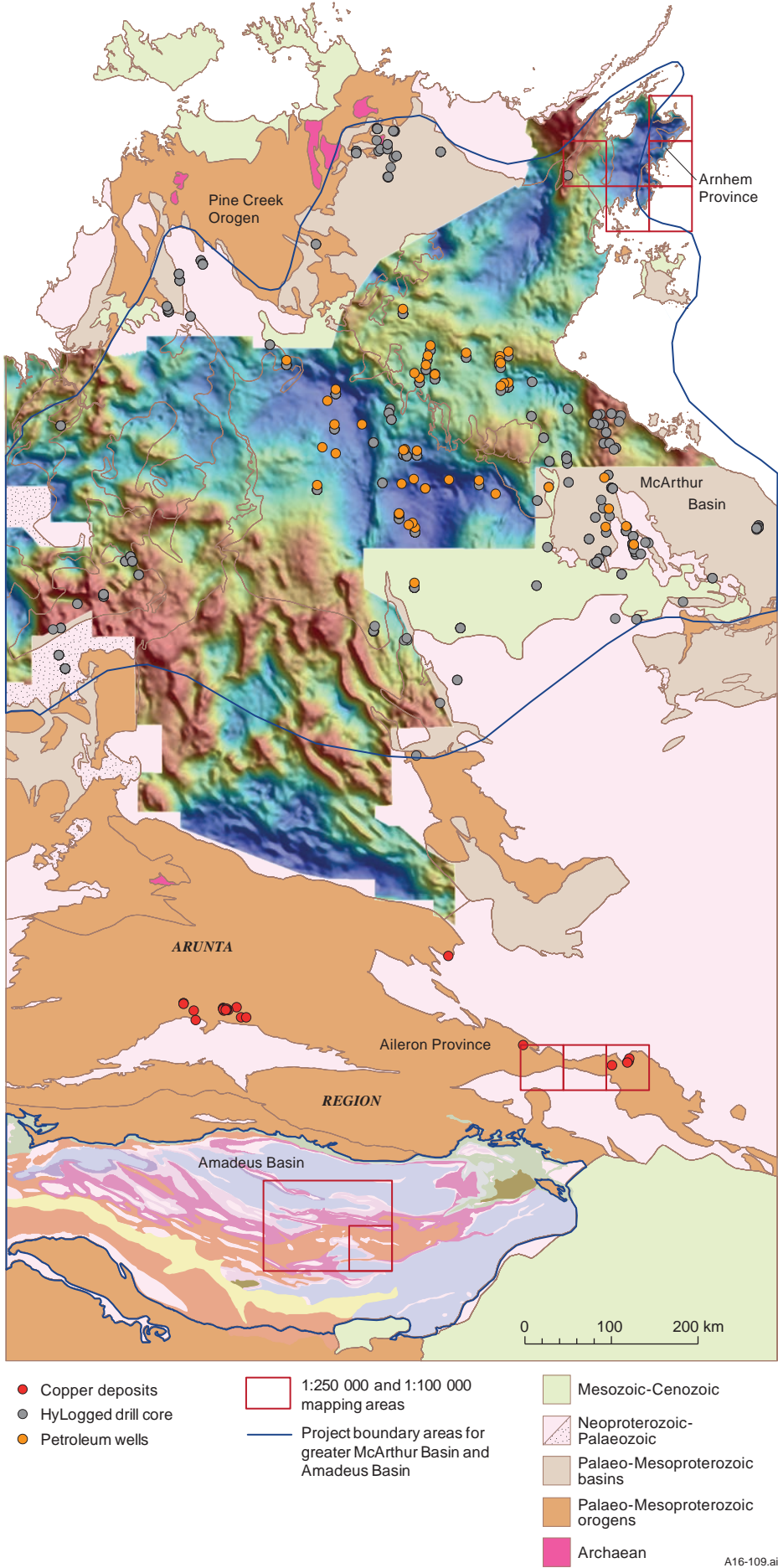


Figure 1. Geological regions map of the NT showing the location of NTGS regional geoscience projects carried out under *CORE* including the residual Bouguer anomaly derived from new gravity data.

Velkerri Formation and the Kyalla Formation (Revie 2016). The assessment will continue into the prospective units in the Glyde package.

Amadeus Basin

The West Amadeus Gravity Survey to acquire regional scale ground gravity at 4 km spacing or better across the entire Amadeus Basin was completed in 2014. This improved regional dataset was utilised in the CSIRO COBRA project to model the available potential field data to create a 3D model of the Amadeus Basin. This model provided a framework to investigate the mineral resource potential of the basin by incorporating a range of other studies in the COBRA project integrating ASTER, shallow magnetic interpretation, hydrogeochemistry, geochemistry and mineralogy (Schmid *et al* 2016).

A standardised approach to characterise the Neoproterozoic stratigraphy that is well exposed in the northeast of the Amadeus Basin (Normington *et al* 2015) has been utilised in the second edition mapping of the HENBURY³ 1:250 000 mapsheet. The first year of the field work has led to significant changes in the outcrop distribution of the Neoproterozoic stratigraphy in the mapsheet area.

Arnhem Province

The geology of the Arnhem Province, an isolated Palaeoproterozoic basement inlier in the far northeast of the NT, has never been fully documented. A 1:100 000 scale mapping project undertaken in this area under the CORE initiative will provide the first ever geological framework using modern analytical techniques. This study will improve the understanding of the relationship between the Arnhem Province and the polymetallic Pine Creek Orogen. It will also provide more insight into the basement that underlies the greater McArthur Basin.

Arunta Region

NTGS continues to focus on the Arunta Region to improve the understanding of the geological framework of this area through integrated field mapping and analysis of the magmatic, metamorphic, structural and depositional evolution of the area. Under the CORE initiative, the mineral-rich northeastern exposure of the Arunta Region was selected for detailed work to produce a series of first edition 1:100 000 maps (JERVOIS RANGE, JINKA and DNEIPER).

The improved understanding of regional geological framework in this area provides the context to a targeted study into characterising the Jervois mineral field and investigation of the mineral systems driving this polymetallic mineral field. This study has expanded to document and characterise other copper ± base metal deposits and prospects in the Aileron Province such as the

Bonya Hills area, Home of Bullion and Mount Hardy copper field (McGloin *et al* 2016).

Conclusion

The CORE initiative had enabled a range of regional geoscientific programs designed to provide an advanced understanding of the regional geoscience framework and resource prospectivity for the targeted areas of the greater McArthur Basin, Amadeus Basin, Arunta Region and Arnhem Province

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³ Names of 1:250 000 and 1:100 000 mapsheets are shown in large and small capital letters, respectively, eg HUCKITTA, JERVOIS RANGE