Results from the MinEx CRC National Drilling Initiative campaign in East Tennant: What's there and why you should care

Andy Clark[1,2], Anthony Schofield[1], Angela O'Rourke[1], Michael Doublier[1], Ian Roach[1], Anthony Budd[1,3], Wenping Jian[1] and Andrew Cross[1]

New drill core from MinEx CRC's *National Drilling Initiative* (NDI) has increased our understanding of the geology and mineral potential of Palaeoproterozoic basement rocks in the East Tennant region of the Northern Territory (**Figure 1**). This region was selected as a NDI focus area following a multi-scale and multi-disciplinary area selection process during the first phase of Geoscience Australia's *Exploring for the Future* Program (EFTF; Schofield *et al* 2020). Reasons for the selection of this area include:

(1) large-scale structural architecture favourable for focusing transport of metals
(2) elevated electrical conductivity in the mantle and lower crust, with a trend broadly coincident with major structural features, potentially indicating fertile source regions for metals and fluids (Duan *et al* 2020)
(3) evidence for the distal footprints of mineral systems in the region, including observed Fe-oxide alteration in legacy boreholes (Schofield *et al* 2020)
(4) high modelled potential for IOCG mineral systems (Murr *et al* 2020)
(5) relatively thin (<200 m) cover thicknesses (Bonnardot *et al* 2020).

Basement in East Tennant is entirely covered by the Georgina Basin and, until now, has been intersected in only a handful of legacy drillholes and remains largely under-explored.

Ten drill cores were obtained in the East Tennant region to better constrain cover depths, determine the basement stratigraphic packages, characterise intrusive rocks, understand the structural and tectonic history of the region, and identify any mineral systems present. Drilling data is complemented by new geophysical data collected during EFTF, comprising gravity, magnetotellurics, airborne electromagnetics, and seismic (eg Jiang *et al* 2020; Schofield *et al* 2020). Based on new drilling results, legacy drill core analysis and regional geophysical data, Palaeoproterozoic bedrock geology was interpreted throughout the East Tennant region (**Figure 1**). This interpretation is designed to seamlessly integrate with Geoscience Australia's existing solid geology map of the North Australia Craton (Stewart *et al* 2020). New insights into the geology and mineral systems potential of the East Tennant region provided from this NDI campaign are outlined below. Further analysis as part of the MinEx CRC NDI and Geoscience Australia's EFTF program will provide additional constraints on the geological evolution and mineral potential of the region. Drilling data are available for download via the Borehole Completion Report tool in the GA portal[4].

Results

Most drillholes intersected basement at ~120–180 m, confirming that cover depths across much of the East Tennant region are relatively shallow. However, geophysical data indicate that cover thickness increases significantly to the north, south and east of the East Tennant region (Bonnardot *et al* 2020).

Drilling has confirmed that East Tennant is predominantly underlain by low-to-high grade, deformed metasedimentary rocks (eg **Figure 2a**), which bear lithological similarities to the Warramunga Formation – the ca 1860 Ma turbiditic sequence that hosts mineralisation at Tennant Creek (Donnellan 2013). These metasedimentary rocks are intersected in seven of the ten drillholes: NDIBK01–04, NDIBK06, NDIBK08, and NDIBK10. Detrital zircon spectra and maximum deposition ages obtained from legacy samples at East Tennant are also comparable to those obtained from the Warramunga Formation (Cross *et al* 2020). However, there are some lithologies in East Tennant, such as carbonates, that have no known correlatives in the Warramunga Formation (Donnellan 2013). We collectively refer to the deformed supracrustal rocks in the East Tennant region as the Alroy Formation. These rocks are grouped based on their shared deformation history (see below), predominantly metapelitic composition, and widespread nature, all of which suggests that they were deposited coevally within a shared tectono-stratigraphic setting.

The East Tennant region contains abundant felsic intrusive rocks (**Figure 1**), similar to Tennant Creek and other Palaeoproterozoic inliers of the North Australian Craton (Ahmad 2000). Geophysical interpretation of widespread intrusive rocks was validated by intersections of intrusive rocks in the new drill core (eg **Figure 2b**), from drillholes NDIBK01, NDIBK05, NDIBK09, and NDIBK10. Although intrusive igneous rocks in the East Tennant region are dominantly felsic in composition, mafic intrusives dated at ca 1850 Ma have been recognised from previous drilling in the East Tennant region (Cross *et al* 2020). Most intrusives exhibit a weak to moderate foliation and are tentatively interpreted as correlatives of the ca 1855–1845 Ma Tennant Creek Supersuite (Donnellan 2013).

The East Tennant region has experienced significant deformation, locally accompanied by medium- to high-grade metamorphism. Aeromagnetic geophysical data image a strong, northeast-trending tectonic architecture, which is present throughout the Alroy Formation in drill core as a well-developed tectonic foliation (eg **Figure 2c**). Monazite

[1] Geoscience Australia, Cnr Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609, Australia
[2] Email: andrew.clark@ga.gov.au
[3] MinEx CRC, Australian Resources Research Centre (ARRC), 26 Dick Perry Avenue, Kensington WA 6151, Australia

[4] https://portal.ga.gov.au/

from deformed metapelitic rocks in legacy drill core from the East Tennant region were dated ca 1845 Ma (Cross *et al* 2020); this suggests that East Tennant experienced the same deformation event that drove mineralisation in Tennant Creek (eg Donnellan 2013).

Evidence for mineral systems in the East Tennant region

Alteration is variably developed but spatially widespread in drill core from the East Tennant region. Magnetite and hematite alteration, accompanied by minor copper-sulfides,

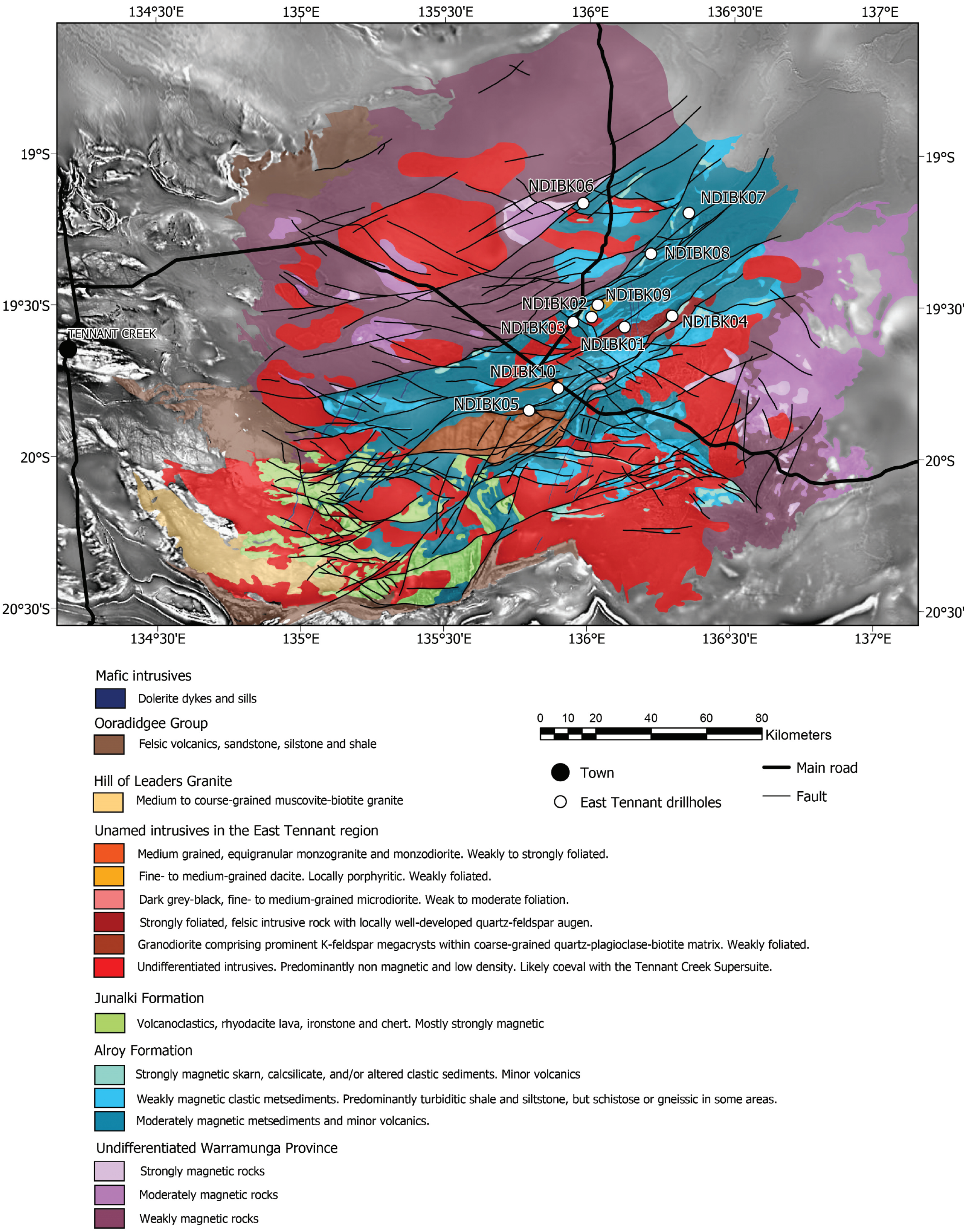

Figure 1. Map showing new interpreted Palaeoproterozoic bedrock geology and the location of NDI drillholes in the East Tennant region, overlain onto an image of the first vertical derivative of total magnetic intensity. Note that the lack of a straight boundary around the interpreted area is to enable seamless integration with existing solid geology datasets (Stewart *et al* 2020).

is present in legacy drill core from East Tennant (Schofield *et al* 2020). NDIBK04 was targeted to test modelled hematite and magnetite alteration in a magnetic, conductive zone adjacent to a major shear zone. This drillhole intersected anomalous copper, lead and zinc mineralisation, skarn-like alteration in carbonates, and pyrrhotite, pyrite and arsenopyrite veins. The mineralised veins are locally deformed and strung out along shear zones associated with deformation described above (eg **Figure 2d**). Drill cores containing alteration and mineralisation are generally coincident with conductors in modelled airborne electromagnetic and magnetotelluric data. Furthermore, broadband magnetotelluric data and seismic imagery show multiple, widespread near-surface conductors adjacent major fault zones that continue and merge at depth in the deep crust and upper mantle (Jiang *et al* 2020). We suggest that the above data indicate that the East Tennant region was affected by a widespread hydrothermal event associated with regional tectono-magmatism at ca 1850 Ma. This event, at least locally, appears to have resulted in copper, lead and zinc mineralisation. However, the precise age, extent and intensity of mineralisation, and its relationship with the geological evolution of East Tennant, remains to be determined. This is the focus of ongoing work as part of Geoscience Australia's EFTF Program and the MinEx CRC NDI.

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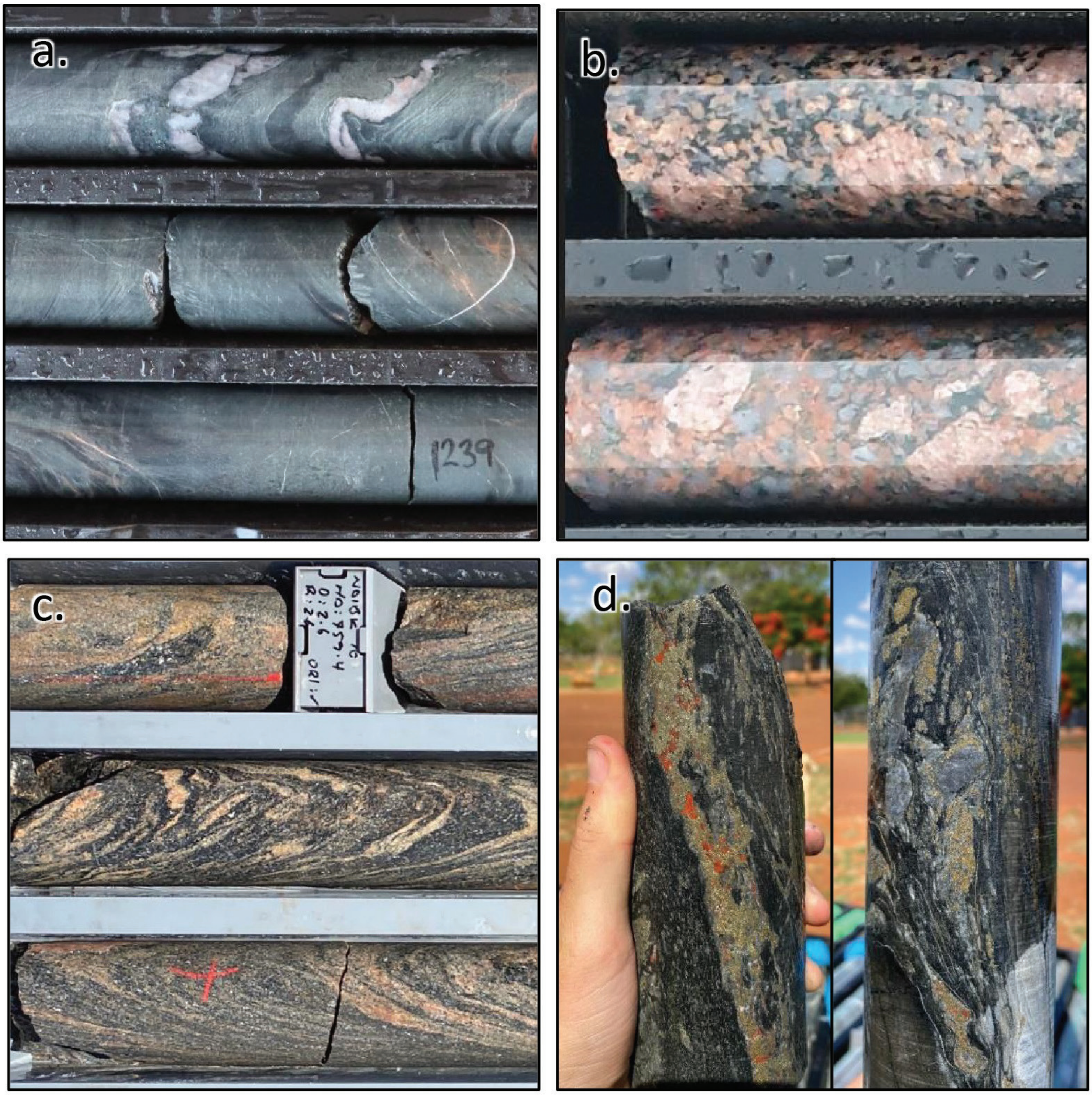

Figure 2. (a) Folded metasedimentary rocks in NDIBK02. **(b)** Megacrystic granodiorite in NDIBK05. **(c)** Paragneiss in NDIBK10. **(d)** Pyrite, chalcopyrite and arsenopyrite veins in NDIBK04.

also thank landholders for their assistance in facilitating MinEx CRC's access to the project area for drilling. We also acknowledge and thank the Traditional Owners and Custodians of the region for their support and consent, we recognise their enduring connection to the lands on which this work was undertaken.

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