Initial findings and implications for the interpretation of 17GA-SN1 from the first pass exploration drilling of the Jessica and Carrara projects

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Encounter Resources (Encounter) controls a large portfolio of Australian exploration projects that are prospective for copper, zinc, rare earths, and lithium; this includes the Jessica and Carrara projects in the Northern Territory (NT). A subsidiary of South32 Ltd (South32), in partnership with Encounter, recently completed an initial drilling program at the Jessica and Carrara project areas targeting important structural positions and interpreted key stratigraphic horizons and geophysical anomalies over the 17GA-SN1 seismic line. The drilling program, which totalled eight drillholes for 7205.2 m, was completed in early December 2023, and will provide important information and data critical to the understanding of the evolution and mineral potential of the Proterozoic- and Cambrian-aged basins of the NT's Barkly region.

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Greenfields base metal exploration in the South Nicholson and Carrara basins

Background

In June 2022, Encounter and a subsidiary of South32 entered into farm-in and joint venture agreements (Encounter 2022) covering the Carrara Copper–Zinc Project and the Jessica Copper Project in the NT (**Figure 1**), which present as unique exploration opportunities within a true greenfields terrain. The South Nicholson Seismic Survey, acquired as part of the Geoscience Australia *Exploring for the Future (EFTF)* program, has provided a critical initial dataset for mineral exploration in this part of the NT, and in turn has armed explorers with a renewed confidence to tackle exploration in highly prospective but covered regions. Reprocessing of the EFTF seismic lines at Jessica and Carrara by HiSeis has allowed for sharper resolution and interpretation of discrete shallow crustal features and stratigraphic horizons; this interpretation was used as a major foundation for the 2023

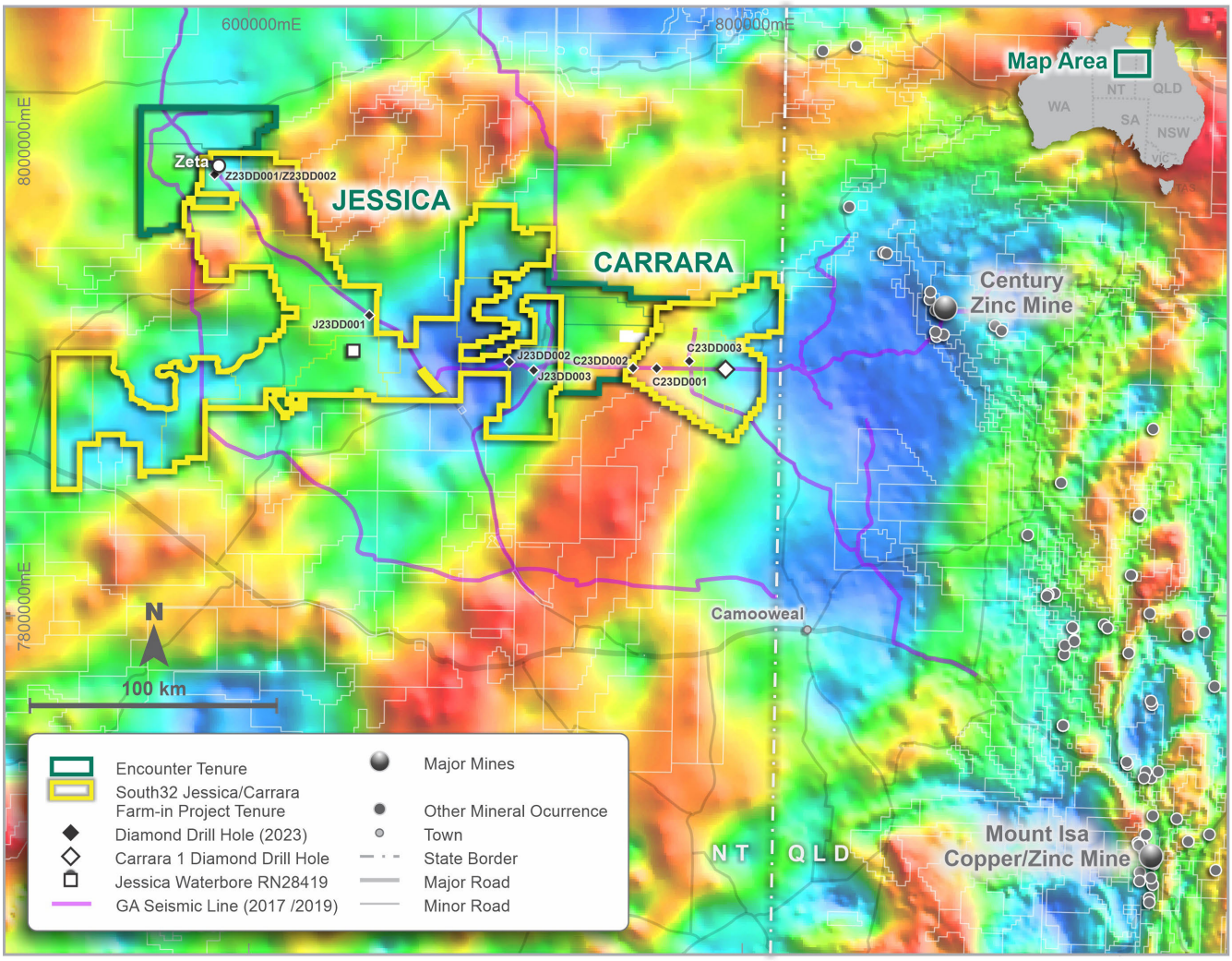


Figure 1. Jessica and Carrara projects – location plan over Bouguer gravity map.

maiden drilling program focusing on a suite of compelling structural and stratigraphic drill targets (**Figure 2**).

Jessica copper project

The Jessica project covers ~6300 km^2 along key structural corridors east of Tennant Creek, a region prospective for both sediment-hosted copper and iron oxide copper-gold (IOCG) style deposits (**Figure 1**). The project area includes compelling structural targets along the Brunette Downs Rift Corridor, which were identified by Geoscience Australia, and by magnetic/gravity geophysical anomalies noted in regional datasets. In addition, previous assessment of drill chips from water bores in the region, conducted by Encounter and previous explorers using handheld x-ray fluorescence (XRF) spectrometers, identified areas of copper anomalism, including a sample containing up to 1.5% Cu from 0–3 m in water bore RN28419 (James 2023).

In 2022, a 2 km-spaced gravity survey was completed at the project by the Northern Territory Geological Survey (NTGS) in collaboration with Geoscience Australia, which was later infilled at 1 km-spacing over selective areas coincident with magnetic targets. A significant and discrete gravity feature was identified coincident with a prominent magnetic feature on the margin of a large interpreted intrusive body (**Figure 3**), subsequently named the Zeta IOCG target (Zeta). In addition, seismic reprocessing highlighted discrete seismic reflectors at depth immediately underlying Zeta, and a zone of textureless (ie 'washed out') seismic character at depth, interpreted to represent a potential deep rooted alteration zone associated with a crustal-scale structure (James 2023). This confluence of geophysical anomalism (gravity, magnetics and seismic), together with the structural context and location on a fundamental north–northwest structure, makes Zeta an intriguing exploration target.

Carrara copper–zinc project

The Carrara project was secured following the release of the South Nicholson Seismic Survey, a foundational dataset acquired as part of the Geoscience Australia *Exploring for the Future* program. A key finding of this survey is the correlation of prospective stratigraphic units from the Isa Superbasin into the Carrara Sub-basin, and in turn, the potential extension of the highly prospective Mount Isa Province to the west (Carr *et al* 2020).

In 2020, a 1751 m deep stratigraphic drillhole (NDI Carrara-1), located within the Carrara project tenure, was completed as part of the National Drilling Initiative funded by the Minex CRC. This hole was designed to validate the interpretation of the South Nicholson Seismic Survey. The results of the NDI Carrara-1 stratigraphic drillhole support the interpretation that the equivalent

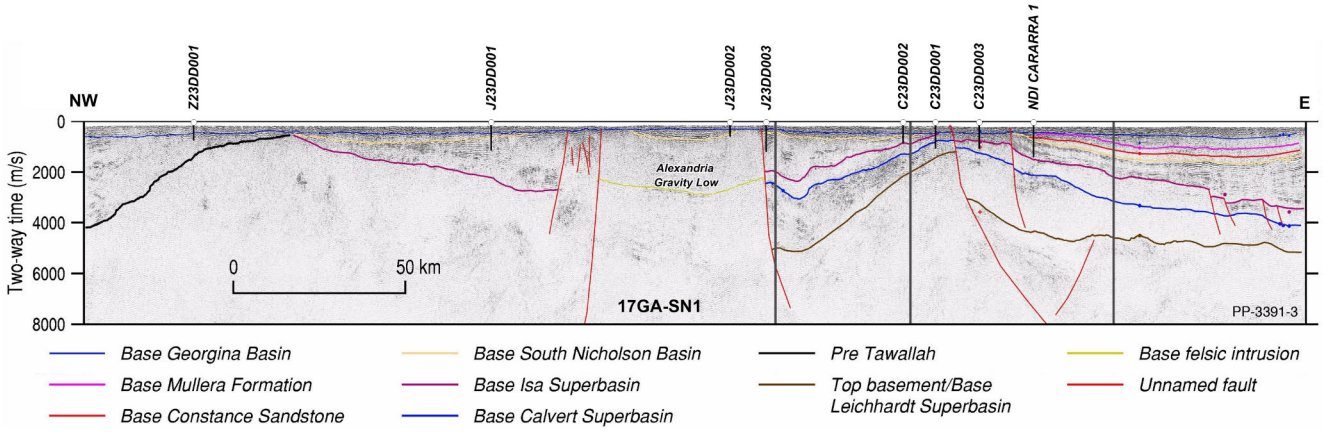


Figure 2. Approximate location and depth extents of the 2023 drillholes superimposed on the Geoscience Australia 17GA-SN1 Seismic interpretation (Carr *et al* 2020).

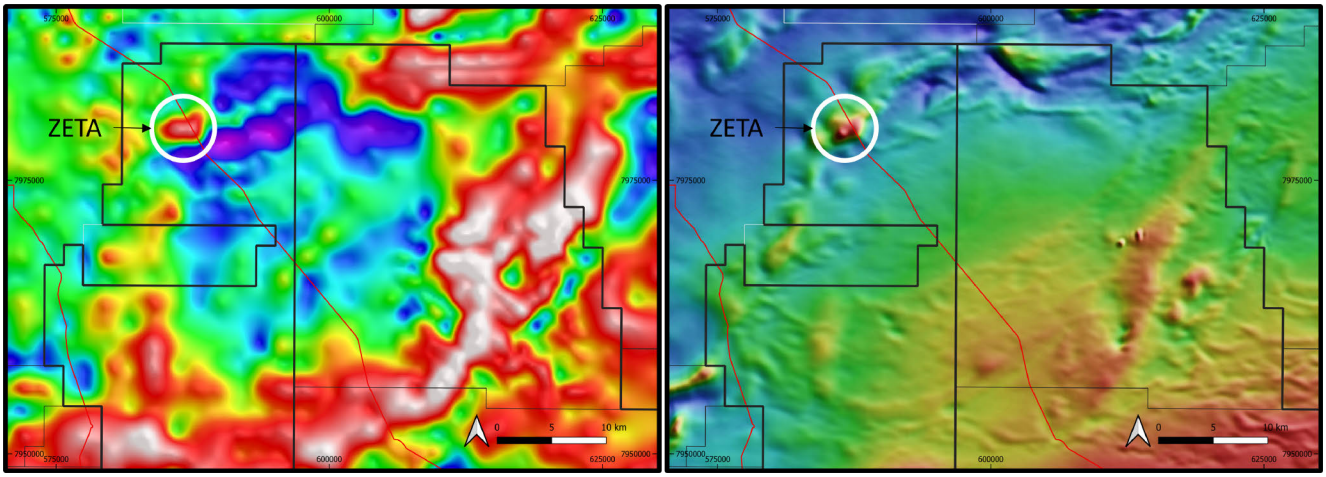


Figure 3. Jessica Project – Location of the Zeta IOCG target showing regional: (**a**) Gravity (1VD) and (**b**) Magnetic (RTP) responses. Location of Geoscience Australia seismic lines shown in red.

sequences of the Isa Superbasin extend throughout the Carrara Sub-basin, and thus increase the potential for sediment-hosted base metals in the region.

Early insights and results from the 2023 drilling program

Zeta IOCG target

Zeta is a coincident gravity and magnetic anomaly associated with a discrete seismic reflector. Encouragingly, the Zeta drilling intersected a number of key IOCG indicators: chalcopyrite/bornite in thin quartz-chlorite-carbonate veins; intense and pervasive red rock hematite alteration; and interpreted bimodal felsic and mafic volcanic sequences (**Figure 4**). Z23DD001 (EOH 700.1 m) was designed to test a 2.4 mGal gravity anomaly and intersected basement (at 413.7 m) consisting of intermediate volcanics with hematite alteration associated with late quartz carbonate veins, with minor chalcopyrite and bornite observed (Encounter 2023).

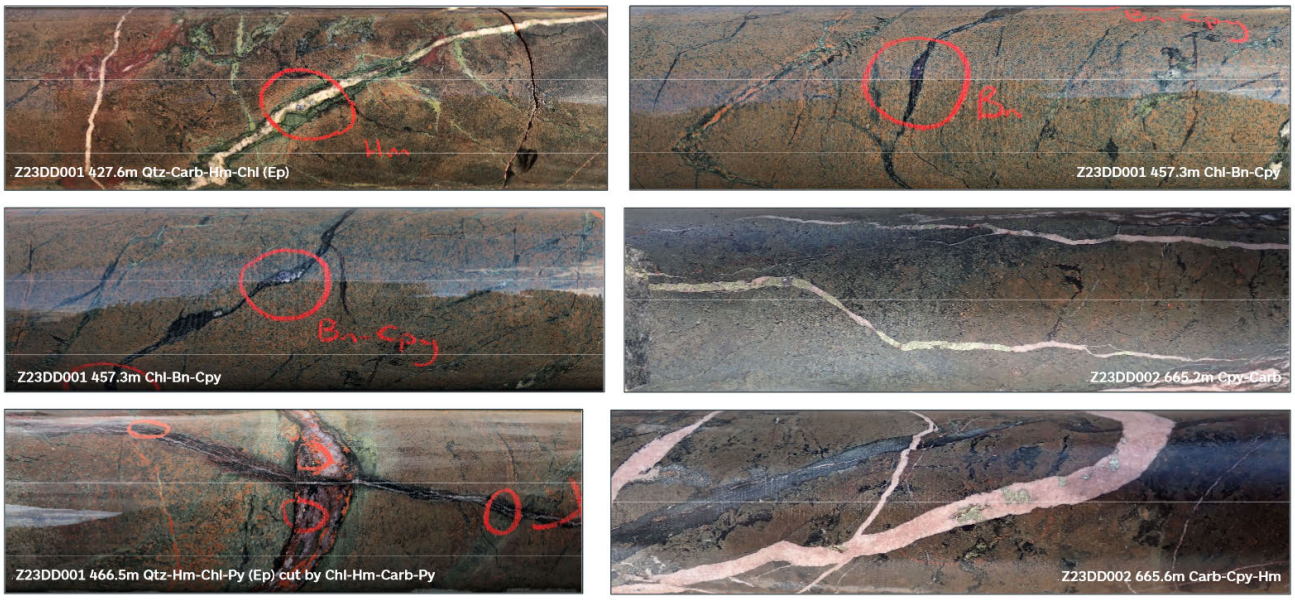
Z23DD002 (EOH 796 m) was designed to test the shallowest modelled basement magnetic response and intersected basement lithologies (at 448.2 m) consisting of a strongly red rock- (hematite dusted K-feldspar) altered felsic volcanics down to 578 m. Red rock alteration becomes more variable beyond this depth until a similar intermediate volcanic unit to that seen in Z23DD001 was intersected at 662.75 m depth. Quartz carbonate veining containing chalcopyrite was intersected from 664.55 m to ~667.75 m depth, with mineralisation characterised by fine- to medium-grained sulfides occurring as isolated grains within thin (2–7 mm) carbonate veins. Trace chalcopyrite was observed in veins beyond this interval until ~750 m depth (Encounter 2023). Initial mineralisation observations from the drilling support an IOCG-exploration model for the Zeta target.

Alexandria gravity low

Previous work by Geoscience Australia has identified a prominent but also stratigraphically unconstrained gravity low imaged on both the 17GA-SN1 and 17GA-SN5 seismic lines (Carr *et al* 2020; Carson *et al* 2022), termed herein as the 'Alexandria gravity low' (AGL). The preliminary interpretation of the AGL identified in 17GA-SN1 (Carr *et al* 2020) as a Mesoproterozoic-aged sag basin overlying a felsic igneous complex was tested by drillhole J23DD002 (EOH 524.9 m). The initial lithological summary from J23DD002 identified nodular mudstones interbedded with thin sandy layers (0–100.9 m) and a significant accumulation of ferruginous (red-brown) sandstones with sporadic thin interbedded siltstone layers (100.9–524.9 m) with an average specific gravity of 2.55.

Of note was the absence of the Cambrian-aged Helen Springs Volcanics (HSV) and carbonate platforms of the Narpa Group, which were identified in both the J23DD001 hole, ~59 km to the west (HSV thickness ~54.9 m), and J23DD003, positioned ~10 km east (HSV thickness ~82.3 m). The absence of the HSV in the cover sequence of J23DD002 can be explained by two scenarios: the presence of a large paleo-mesa or topographic high composed of Mesoproterozoic sediments, which impeded and diverted the Cambrian-aged basic volcanics; or alternatively, the area represents a post-Cambrian basin and ensuing subsidence of the Helen Springs horizon beyond 525 m.

A possible paleo-topographic rise setting would need to be compatible with the following: the linear magnetic margins (interpreted HSV) coincident with the gravity low (indicating linear and steep flanks impeding the HSV); subsequent erosion and integration with the present-day topography; the sag geometry of the upper (youngest) sedimentary layers as seen in 17GA-SN1; and the similar but subdued magnetic character of the AGL compared to the surrounding Georgina Basin (paleochannels?). Alternatively, a post-Cambrian basin could explain the sharp magnetic margins and geometry, is also compatible with other examples of post-Cambrian sedimentation (eg Toko Group or Dulcie Sandstone), would preserve any magnetic stratigraphy related to the HSV at depth, and has interpreted rhombic geometry compatible with late strike-slip faulting (**Figure 5**). Based on the above



Figures 4. Jessica project – Zeta IOCG target – Mineralisation and alteration examples from the Z23DD001 and Z23DD002 drillholes (Encounter 2023).

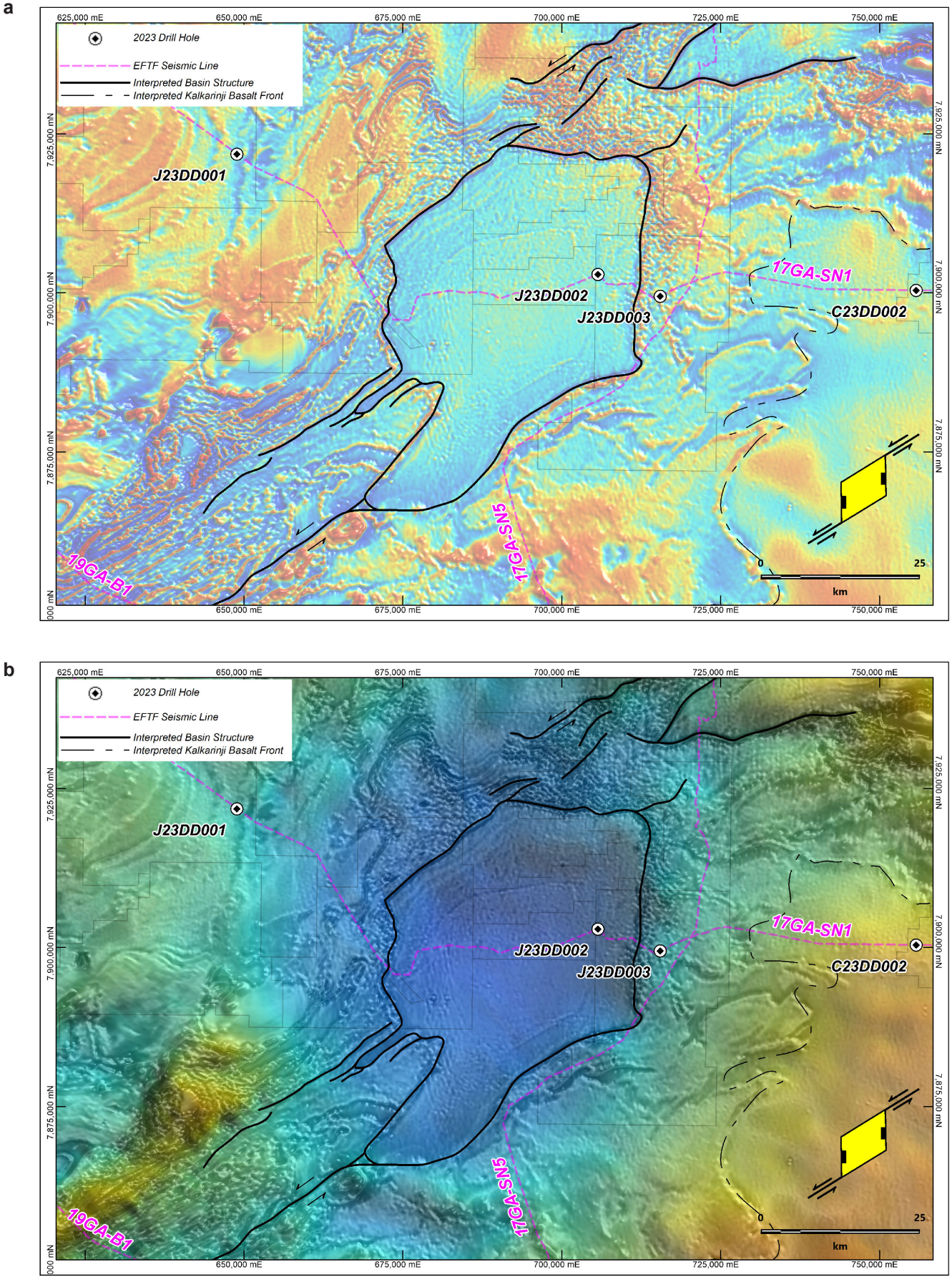


Figure 5. Jessica Project – Alexandria Gravity Low – Summary map of the interpreted pull-apart basin geometry and sinistral fault kinematics associated with the AGL, showing GA seismic lines and 2023 drillholes overlain on: (**a**) TMI RTP 1VD magnetics, and (**b**) Composite gravity and 1VD RTP magnetic response.

constraints on the HSV from the recent drilling, a scenario involving the formation of a late sag basin is considered more likely, and that deposition of uppermost sequences intersected in J23DD002 post-dated the Helen Springs event. Either of the above proposed scenarios associated with the formation of the AGL have implications for the interpretation of the regional basement horst (Carr *et al* 2020, Gibson and Edwards 2020) located between CMP 18000 to CMP 23000 along 17GA-SN1 (**Figure 2**).

The presence of a possible felsic igneous complex (Carson *et al* 2022) associated with the AGL is still compatible in either setting; however, recent drilling in conjunction with the 17GA-SN1 seismic line indicates that if present, it would be positioned much deeper than the current interpretation. More work is required to resolve this issue and we await the results from geochronology to help answer these questions, although the potential for of a Devonian- or younger-aged sub-basin may indicate a long-lived basement linking structure.

Implications for resource prospectivity

Based on the positions of recent drillholes J23DD002 and J23DD003 within the AGL, in conjunction with the interpreted structural architecture within GA17-SN1, the original interpreted bounding structures constraining the previous igneous volcanic zone (Carson *et al* 2022) appear to control the late subsidence at least towards the upper section of the survey. This is important as the current seismic section of 17GA-SN1 shows strong evidence for ramping and inversion of Palaeoproterozoic sedimentary rocks abutting an interpreted large-scale (growth?) fault on the eastern side of the AGL, termed Old Man's Fault (Gibson and Edwards 2020).

Deformation during the Isan Orogeny resulted in ramping, inversion features, and complex architectures of the Palaeoproterozoic basins, particularly proximal to faults, with strong evidence of inversion seen in 17GA-SN1 associated with Old Man's Fault. More work is required to determine the importance of this structure, although based on the current interpretation of GA17-SN1, it appears significant in enabling inversion during the Proterozoic period of sediment-hosted Pb–Zn mineralisation in some genetic models (Gibson *et al* 2017).

The potential reactivation of large-scale Proterozoic structures (as recently as the Devonian as interpreted from the current drilling) may have facilitated upward fluid migration and interaction of deep-seated low temperature brines (sourced from as low as the basement) with carbonate platforms and/or hydrocarbon-rich horizons of the Georgina Basin. This would increase the potential for Mississippi Valley Type (MVT) lead–zinc mineralisation associated with the AGL (**Figure 6**). The regional potential for MVT mineralisation within the Georgina Basin has long been recognised throughout both Queensland and the NT, with numerous base metal anomalies associated with Thorntonia Limestone and stratigraphic equivalents. The best-known MVT occurrences hosted within the Georgina Basin are the Box Hole and Trackrider prospects (Dunster *et al* 2007); however, they are considered sub-economic due to the lack of basement linking structures and the hydrological architecture required to transport and circulate basinal brines over vast areas.

As presented herein, opportunities to interpret new structures and regional geodynamics capable of transporting and focusing fluids from a variety of crustal sources have been made possible by Geoscience Australia's *Exploring for the Future* program and by subsequent research and results from the CSIRO and NTGS. This work has allowed industry to test exploration models and concepts with more confidence in the covered regions of the Barkly Tablelands.

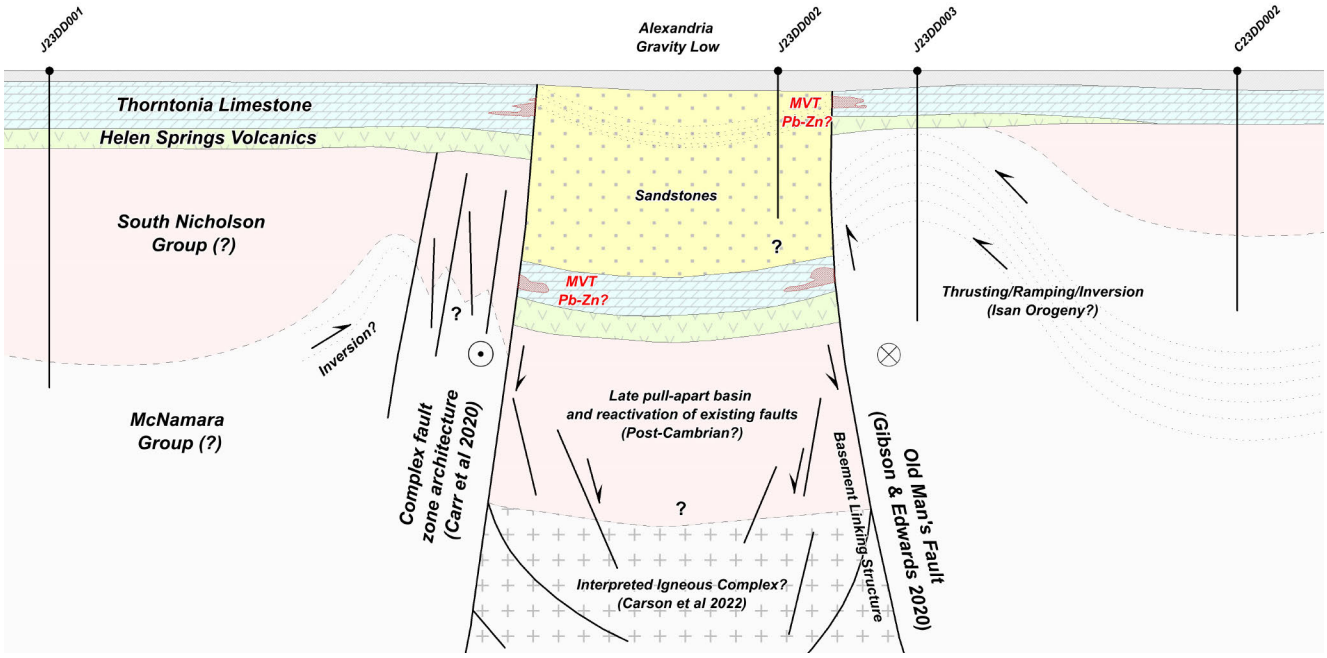


Figure 6. Jessica Project – Alexandria Gravity Low – Schematic sectional view of major stratigraphic groups and shallow crustal fault architecture related to an interpreted pull-apart basin (looking north).

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