Northern Cobalt's Wollogorang Cobalt Project, Northern Territory: Geological setting and exploration

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The Wollogorang Cobalt Project lies on the eastern edge of the McArthur Basin, straddling the NT-QLD border in the Gulf of Carpentaria (**Figure 1**). Geologically, it comprises the uppermost Redbank package on the Wearyan Shelf where it is postulated that no Glyde Package (McArthur Group) was deposited as it was a stable margin to the Batten Fault Zone, which hosts the McArthur River Zn-Pb-Ag deposit (McArthur River Mine). This part of the stratigraphy is currently viewed as unprospective for world-class mineral deposits, unlike the younger packages that host McArthur River, Mount Isa, Century and Walford Creek. However, Northern Cobalt ("N27") is aiming to dispel this theory by progressing the Wollogorang Project from the current small high-grade 'boutique' base metal deposits into a significant mineral province in its own right – this is only possible if the broader mineral system is tested.

The upper Tawallah Group host-rocks for Wollogorang comprise interlayered basalt, sandstone, shale, dolostone and felsic volcanics (Gold Creek Volcanics and Pungalina Member; **Figure 2**). These are intruded by small shallow-level co-magmatic felsic intrusives (Rawlings 1996). This geology is laterally very continuous, recognised almost identically in Arnhem Land some 600 km to the northwest. The host-sequence is folded in a Jura-style – disharmonic low-amplitude folds. This contrasts with the underlying rigid Settlement Creek Dolerite and overlying Echo Sandstone, suggesting that this folding was synchronous with felsic plutonism and gravity slide of the more ductile basalt-sediment sequence. It is postulated that this folding and intrusive activity was responsible for the numerous breccia pipes in the district – Running Creek, Redbank and Selby pipe clusters being the only named and tested clusters (**Figure 3**). Others likely exist as subtle flexures and circular features, or under cover of the overlying Tawallah Group and thin Cenozoic coastal sediments.

The district has attracted the attention of the major exploration companies in the 1980s and 1990s: Rio Tinto, BHP, MIM and others were lured to the area by the regular occurrences of stratiform-style copper, and by the breccia pipes at Redbank (which were mined sporadically for 40 years until the mid-2000s). Redbank incorporates over 20 small pipes up to 150 m diameter with copper grades of 1.5%, as both primary sulphide and secondary oxide zones. Joe Fisher discovered the Running Creek pipe cluster (**Figure 3**) in the late 1980s and attracted CRAE into a joint venture in the early 1990s. It is likely that originally, CRAE were interested in chasing the stratiform copper model in the area until the cobalt grades at the newly discovered Stanton took their attention. With the upswing of the cobalt price, CRAE soon found themselves defining small Co-Cu-Ni breccia pipes, much to the amusement of many CRAE officianados who thought this did not pass the CRAE 'size test'. However, one suspects they still had their eye on the bigger picture, but faltering cobalt prices and new management in London soon had them exiting the project

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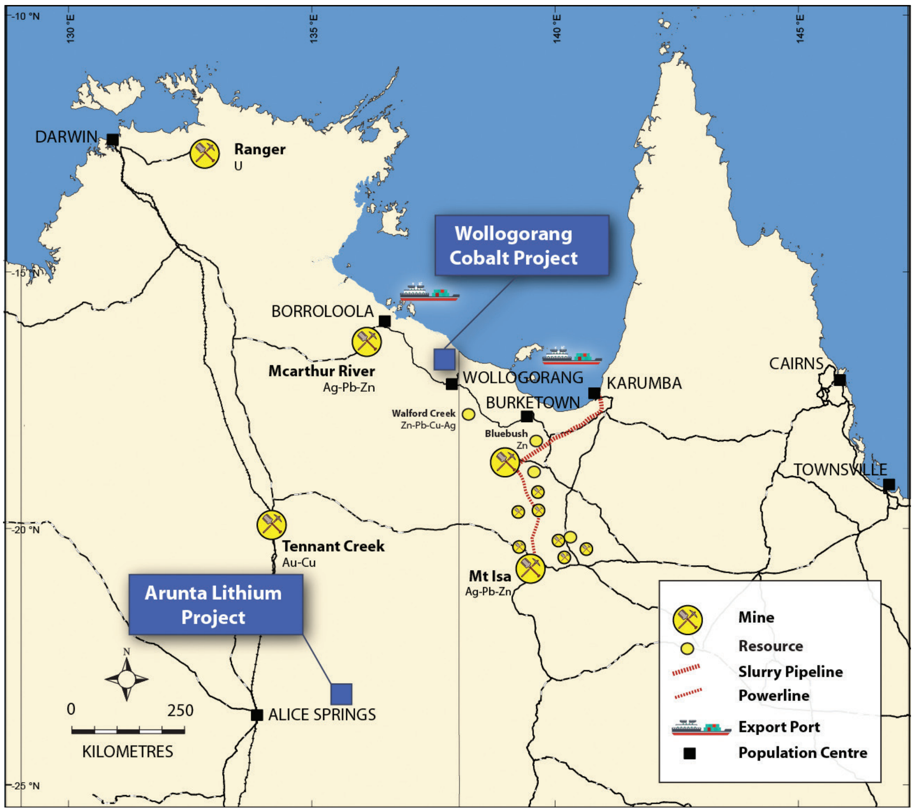

Figure 1. Regional location and projects.

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before they could test the broader geology. No further work has taken place until Northern Cobalt listed on the ASX in August 2017.

The currently defined breccia pipes at Wollogorang (**Figure 3**) are cone-shaped features up to 100 m in vertical extent and 100 m in diameter. They appear to terminate downwards within the Wollogorang Formation, and upwards at a subtle disconformity below the Pungalina Member (**Figure 4**). The pipes are filled with *in situ* breccia of mixed clasts of the host stratigraphy comprising oxidised and reduced basalt, sandstone, siltstone, organic shale, and dolostone in a matrix of the retextured sediments (**Figure 5**). The material has not been milled but is a disaggregation of partially lithified materials.

Each breccia pipe is interpreted to be the conduit for the ascent of relatively hot (but still <150°C) reduced hydrocarbon-bearing fluids from the Wollogorang Formation. These mixed with the ambient, oxidised, saline metalliferous brines in the Gold Creek Volcanics wherever there was sufficient permeability. The mixing zone was a transient redox interface, delicately balanced by the competing fluid fluxes and thermodynamic regime so as to discourage pyrite precipitation, which is almost absent at Wollogorang, but prolific at the Cu-dominant Redbank. This has also led to the development of some complex redox phenomena preserved in the breccia (**Figure 6**).

Timing of fluid movement is contentious but the euhedral shape of siegenite ($(Ni,Co)_3S_4$), low temperature (implied by fluid inclusions and alteration assemblages) and the presence of pyrobitumen and live oil, all point to being contemporaneous with sedimentation in the overlying Echo Sandstone. It appears likely that the mineral system would not have been confined to the breccia pipes and would have propagated outwards where permeability allows. Leakage of metals above the breccia pipes is likely to be manifest as the uranium-base metal occurrences at Karns and Selby (**Figure 3**), about 200 m higher in the stratigraphy to the west. The hydrothermal plume is likely to have a vertical zonation, as seen in the Arizona Strip breccia pipes.

N27 contends that the permeable conglomeratic sediments of the lower Pungalina Member represent an ideal medium to transport the reduced fluid laterally away from the pipes. There is local evidence to support this, such as reduction of originally oxic siltstones in the subjacent stratigraphy (**Figure 7**). This model forms part of N27's exploration going forward as it begins to test for more breccia pipes and potential stratiform-style (large) Co-Cu mineralisation in the district. N27 believes the district is an analogue of the Dzhezkazgan copper deposits in Kazakhstan that host billion tonne stratiform Cu-Ag deposits (7th biggest copper producer in the 1990s; Box *et al* 2012). It appears likely that the mineral system has the capacity to generate significant volumes of reduced fluid, which then migrate to various trap sites vertically and laterally from the conduit pipes. The oxidised fluids are likely to be in hydrologic continuum with the brines that formed the sedex deposits in the overlying stratigraphy (McArthur River etc). However, the Wollogorang Formation otherwise acted as an aquiclude,

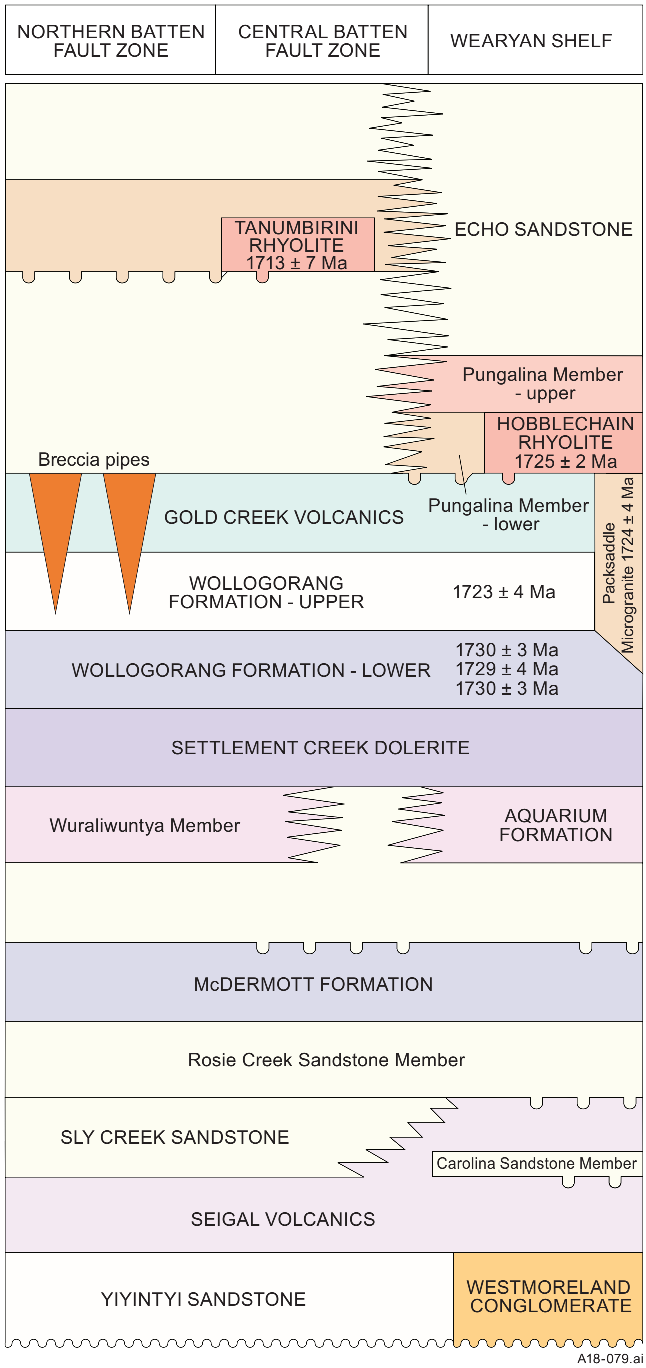

Figure 2. Stratigraphic column for the Redbank Package (Rawlings 2006).

compartmentalising the Westmoreland-Alligator Rivers uranium system below.

Cenozoic weathering has affected the breccia pipes at the Wollogorang Project, leading to the development of a 10–20 m thick oxidised zone where Co grades can reach percent levels. Cobalt is hosted by asbolane, a hydrated oxide of manganese. Asbolane is the cobalt mineral dug out by artisanal miners in the DRC. Weathering, together with the natural rock-property differences created by the pipes, should logically be manifest in high resolution datasets like magnetics (**Figure 8**), which N27 has already begun investigating.

From October to December 2017, N27 drilled 70 reverse circulation (RC) and 10 diamond core holes on the Stanton

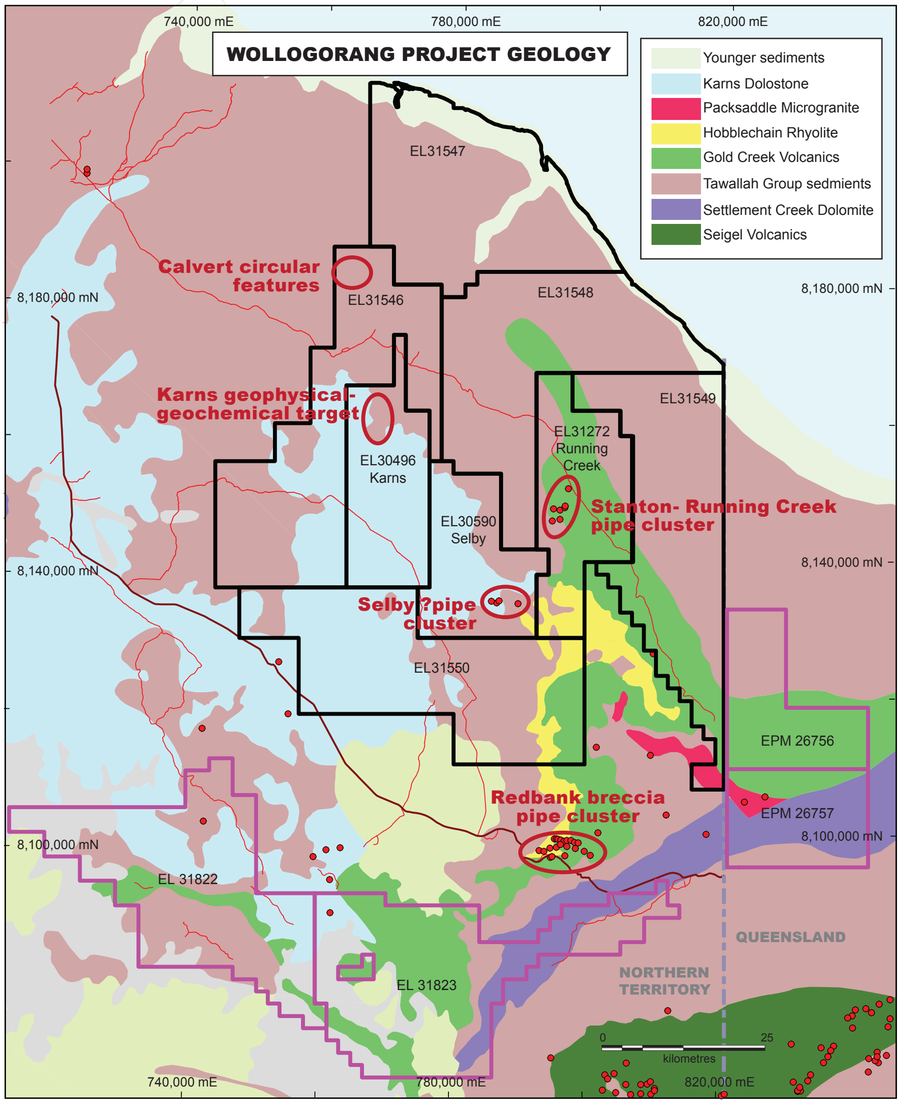

Figure 3. Wollogorang Project area showing the known pipe clusters.

cobalt resource, aiming to upgrade the existing inferred Mineral Resource of 500 000 t of 0.17% Co, 0.09% Ni, and 0.11% Cu, as well as to obtain material for metallurgy studies and use in scoping studies. A further 57 RC holes were drilling on existing regional prospects previously defined by CRA, for a combined total of 11 856 m drilled in 2017.

Figure 9 depicts a schematic cross-section with drillholes through the middle of the Stanton resource, showing the relatively flat-lying interlayered basalts/sandstones/siltstone peripheral to the main central zone of brecciation. Cobalt mineralisation comprises both asbolane in the oxidised zone and siegenite in the sulphide zone below (**Figure 10**). Significant intervals of cobalt mineralisation from the Stanton resource include:

17RC003	37 m @ 0.28% Co (from 25 to 62 m)
17RC005	18 m @ 0.33% Co (from 32 to 50 m)
17RC021	20 m @ 0.31% Co (from 27 to 47 m)
17RC126	19 m @ 0.29% Co (from 11 to 30 m)

A helicopter airborne magnetic and radiometric survey was flown during the 2017 field season (**Figure 8**). Flight lines were 25 m spaced with a sensor height of 30 m. The surveyed area overlapped historic surface soil and lag geochemistry grids. The results have provided a new foundation in the understanding of the geophysical characteristics of the basement geology and will complement surface exploration techniques.

The Stanton cobalt deposit is characterised by a prominent magnetic low in the TMI_RTP (**Figure 11**) and TMI_RTP_1VD, as well as a semi-coincident VRMI (vector residual magnetic intensity) high. Detailed GIS synthesis has revealed 32 new priority anomalies in the dataset with identical geophysical characteristics to Stanton, as well as over 80 secondary anomalies. Further review of data indicates a correlation between existing surface geochemistry anomalies and the K-channel in the radiometric data, broadly picking out areas of outcropping and subcropping basement geology. N27 believe that significant areas of prospectivity remain untested below thin transported sedimentary cover.

During the 2018 exploration season, N27 will test for extensions to the Stanton cobalt deposit (which remains open to the southeast and northwest), as well as following up anomalous geochemistry results from the 2017 regional drillholes. Concurrently, N27 will implement a larger drilling program using rapid shallow drilling techniques to test newly defined anomalies in the magnetic data for mineralisation below transported sedimentary cover. The

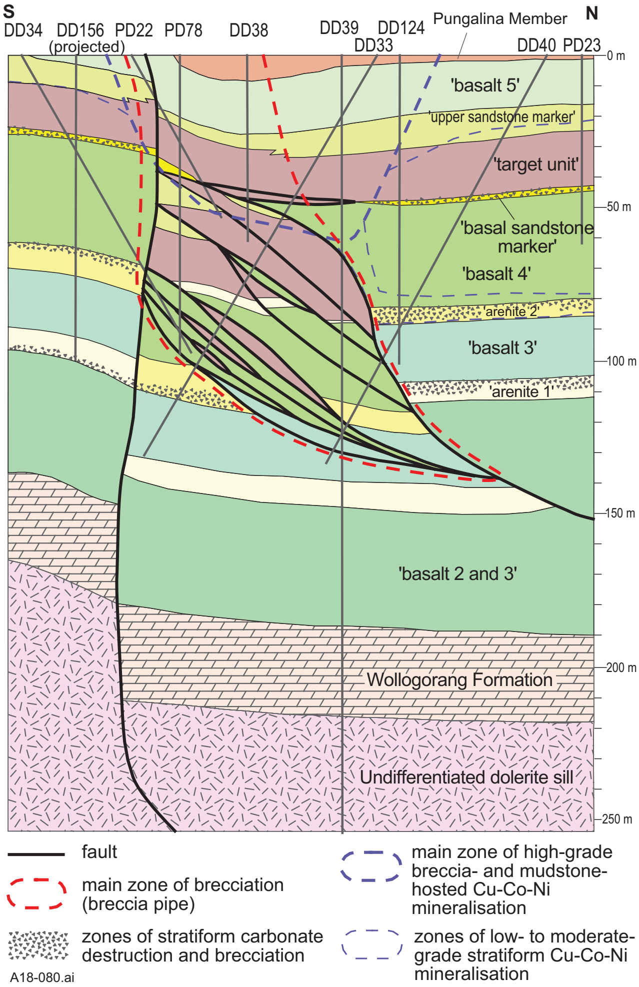

Figure 4. Breccia pipe morphology schematic (Rawlings 2006).

company will utilise a portable XRF (pending successful validation against existing drill samples) for rapid geochemical analysis as drilling progresses, providing focused decision making for more detailed target drilling.

N27 also plans to increase the airborne magnetic survey coverage over the broader tenement package to assist in discovery of further mineralised deposits. Geological mapping and structural interpretation of new anomalies identified from planned geophysical surveys will enhance the potential for the discovery of new mineralised systems in the quest to establish a significant mineral province.

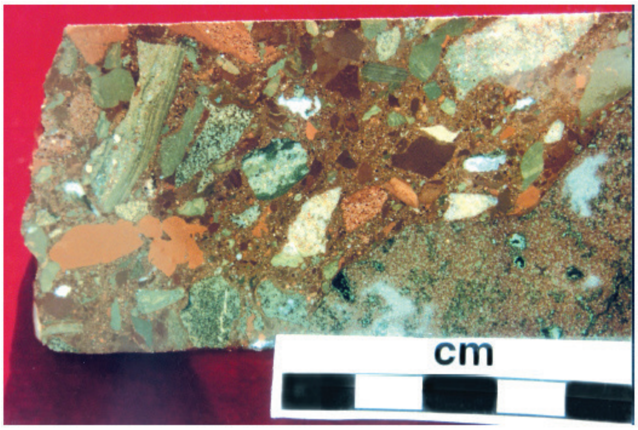

Figure 5. Breccia texture in drill core (Rawlings 2006).

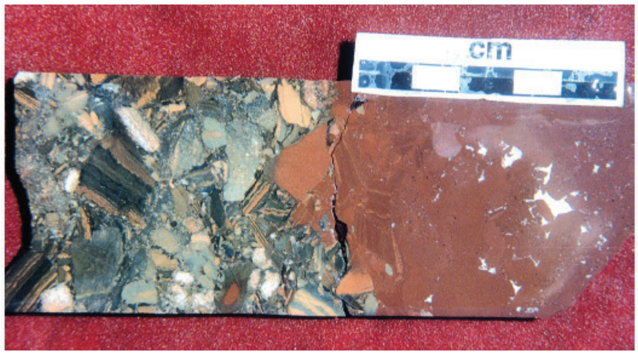

Figure 6. Breccia showing the contrasting redox state of clasts and matrix (Rawlings 2006).

Figure 7. Secondary reduction of originally oxic “redbed” siltstone (Rawlings 2006).

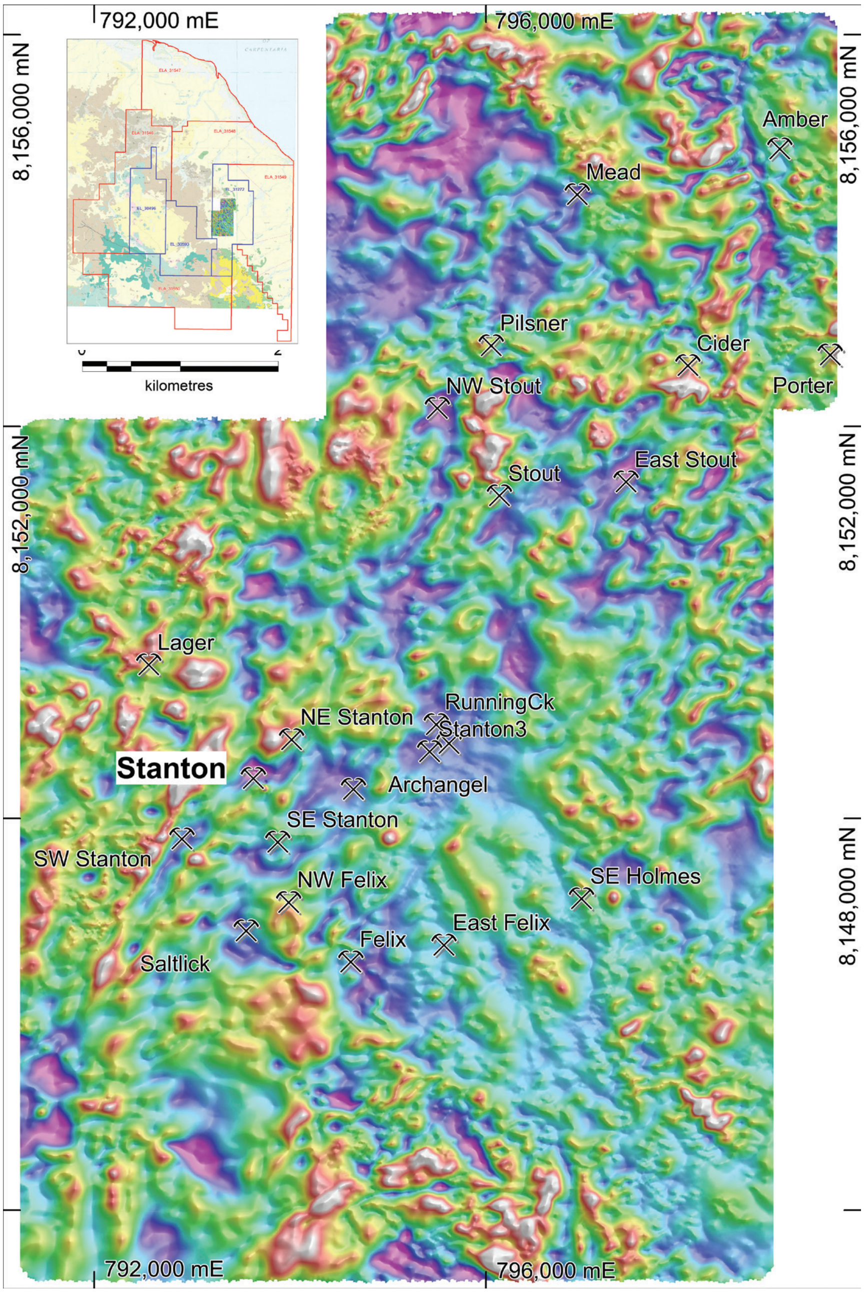

Figure 8. Total Magnetic Intensity (TMI_RTP) data over the Stanton Cobalt deposit and surrounding area showing existing prospects.

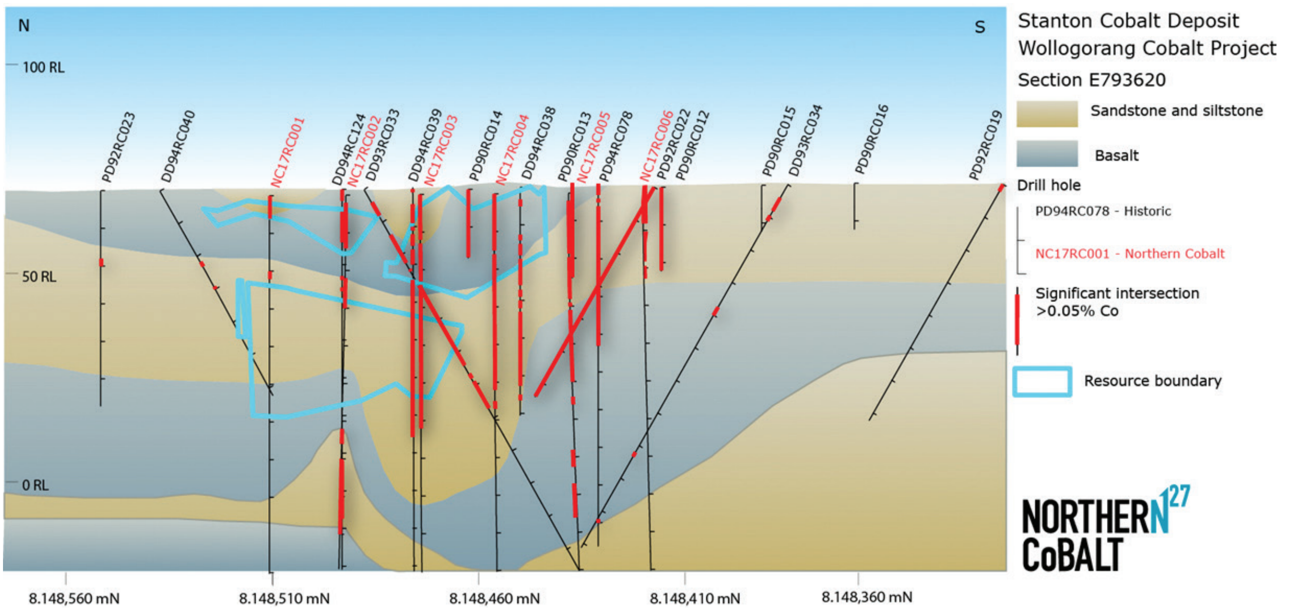

Figure 9. Cross-section through the Stanton Resource with N27 drillholes, historic CRA drillholes and intersections >0.05% cobalt.

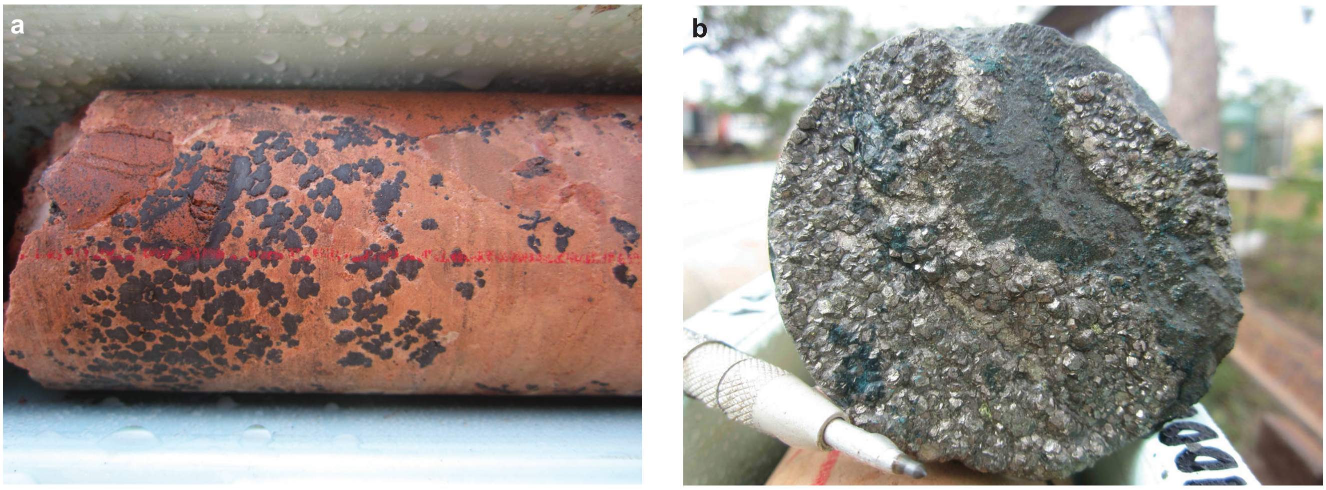

Figure 10. (**a**) Asbolane (17DD003 @ 47 m depth). (**b**) Siegenite (17DD006 @ 85.9 m depth) mineralisation in HQ diamond drill core at Stanton.

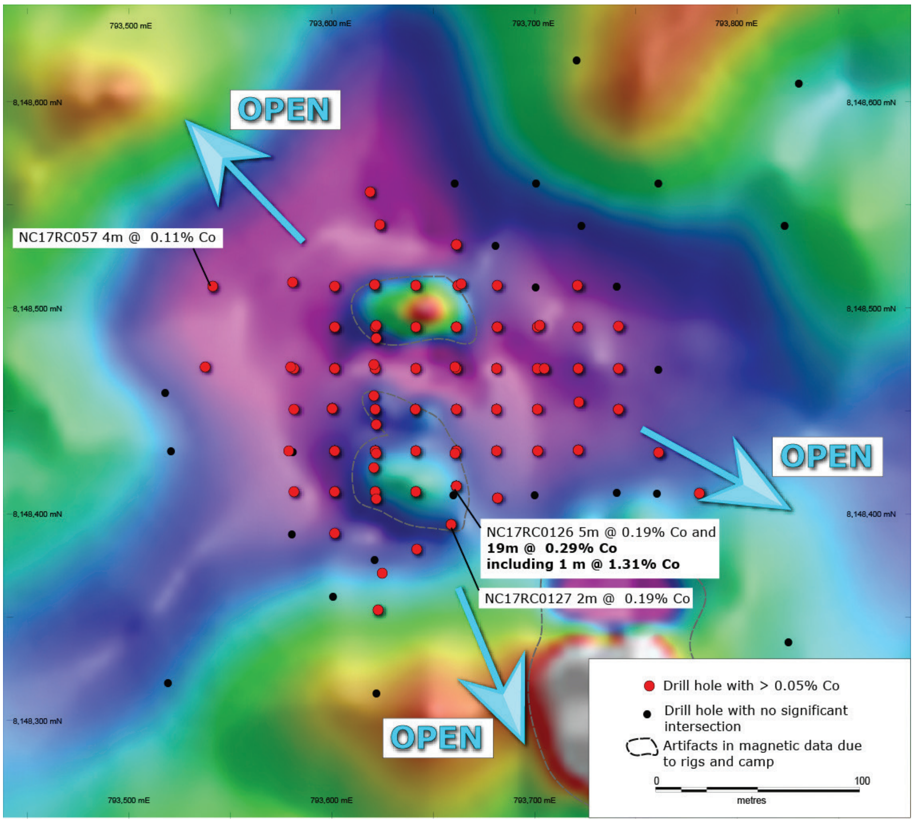

Figure 11. Total Magnetic Intensity (reduced to pole) over the Stanton Cobalt deposit showing completed drill collars.

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