Introduction

Todd River Resources Ltd (TTR) is an Australian-based resources company that holds a large, highly prospective base metals exploration portfolio entirely within the Northern Territory (Figure 1). The company was created in 2017 as the base metals spin out of Australian strategic metals developer TNG Ltd (TNG). TTR is currently expanding the EM1 mineralisation at its Mount Hardy Project, a copper and zinc-rich polymetallic discovery identified in mid-2018 to the northwest of Alice Springs. In addition to Mount Hardy, TTR holds 12 other projects (Figure 1) including Manbarrum, a MVT-style Zn-Pb-Ag project with a JORC (2012) compliant mineral resource estimate of 22.5 Mt at 2.3% Zn+Pb; McArthur River, a Zn-Pb-Cu-Ag prospect located within the same structural corridor as the McArthur River Mine; Tomkinson, an early stage project in a known manganese province; and Rover, Petermanns Range and Stokes Yard, three early stage Cu-Au/base metals projects. TTR is also looking to advance several of its current tenement applications towards grant and is working closely with the relevant stakeholders to fast track this.

The Mount Hardy Project was initially acquired by TNG in 2012. It is located on the Tanami Highway, 300 km northwest of Alice Springs and 20 km west of the town of Yuendumu (Figure 2), and lies entirely on the pastoral land of Mount Doreen Station owned by M Braitling. The project comprises several high-grade structurally-controlled precious and base metal oxide and sulfide targets, including the advanced EM1 prospect, generated from geochemical and geophysical surveys.

Geological setting

The Mount Hardy Project is located in the centre of the Arunta Region’s Aileron Province, wholly within the area of the Mount Doreen 1:250 000-scale map sheet (Figure 3). The dominant host rock for the known mineralisation is a unit of the Palaeoproterozoic Lander Rock Formation (LRF) consisting of lower amphibolite facies biotite–muscovite–andalusite–quartz gneiss, schist, metapsammite, metapelite, and quartzite. Other local LRF units (mostly to the south of the mineralised unit) include greenschist facies muscovite–chlorite–quartz schist, gneiss, quartzite, and local conglomerate; and transitional granulite facies migmatitic cordierite–garnet–sillimanite–biotite gneiss. The LRF is interpreted to be stratigraphically equivalent to the Killi Killi Formation of the Tanami Group, which hosts the significant discoveries at The Granites, Dead Bullock Soak and Coyote. To the west and north of the target LRF unit, intrudes the Mesoproterozoic Southwark Suite, consisting of megacrystic and minor even grained biotite and biotite–muscovite granite; leucogranite, pegmatite and aplite.

To the south, intrudes the Palaeoproterozoic Carrington Suite, consisting of weakly foliated to gneissic and locally migmatitic xenolithic biotite granodiorite, biotite tonalite and muscovite–biotite granite (Young et al 1995).

The Palaeoproterozoic Aileron Province hosts many different examples of copper-related mineralisation (eg Jervois, Home of Bullion, Mount Hardy, Perenti, and Lake McKay). The geologic processes and controls on the location and genesis of this broad spectrum of mineralisation styles are poorly understood; the temporal and genetic links between each system, as well as the larger regional tectonic processes and geologic events, are not well constrained (McGloin et al 2016). Artisanal miners targeted areas containing secondary mineralisation above the water table, ie oxidised to highly visible malachite, azurite, chalcocite, chrysocolla, and cerussite (Kiek 1941). In the vicinity of the open cut at Mount Hardy, the copper carbonates persist for at least 15 m below the present floor level, they also extend up to 5 m from the veins into the host metasediments. At depth, primary mineralisation consists of predominantly chalcopyrite and pyrite with variable proportions of sphalerite, pyrrhotite, minor galena, and scarce native copper. Mineralisation forms thin stringers and blebs within quartz veins and spatially associated pegmatite, and more rarely, in the country rock. Recent drilling has identified a thick, continuous zone of brecciated massive sulfides in varying mineral ratios from surface to ~600 m down plunge, with the total extent of the mineralisation still unknown.

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Figure 2. Mount Hardy Project location and site layout.
Figure 3. Regional geology of the Mount Hardy area from the Mount Doreen mapsheet (Goldberg et al. 2008, L symbols indicate Lander Rock Formation, and Pg symbols indicate Proterozoic granites).
Historical mining and exploration

The Mount Hardy Copper Field was discovered in 1935, and there have been two published reports on the geology and mineralisation of the field, Kiek (1941) and Grainger (1968). The field has had small-scale prospecting work sporadically from the 1930s discovery through to the late 1960s, consisting of surface workings, small pits less than 5 m deep and limited drilling to depths of less than 50 m. There has been no large scale mining carried out. The largest historical working is the small open pit at the Mount Hardy Copper Mine, a 20 m × 6 m × 5 m cut into the low hill. There is also a 57 m long shallow costean dug by hand by aboriginal prospectors from Yuendumu in 1967 (Grainger 1968). There is no evidence of processing of any ore from the old workings on site; however, ~750 t of handpicked secondary copper ore was stockpiled and remains in place. Water access was a problem in the vicinity and hindered any artisan processing.

A timeline of historical activity carried out in the Mount Doreen 1:250 000-scale mapsheet in the Mount Hardy area is as follows:

- Mount Hardy Copper Field was discovered by WW Braitling in 1935.
- Sporadic small scale mining by aboriginal prospectors from Yuendumu took place until the 1970s.
- Uranium Development and Prospecting NL carried out diamond drilling in the area in 1956.
- Bureau of Mineral Resources (BMR) conducted aeromagnetic, radiometric and gravity surveys in 1967.
- Central Pacific Minerals held AP1722 in the Mount Doreen area from 1967–69.
- Northern Territory Geological Survey (NTGS) assessed historical working is the small open pit at the Mount Hardy Copper Mine.
- NTGS and BMR completed 2nd edition mapping of Mount Doreen 1:250 000-scale mapsheet in the 1990s.
- White Industries conducted exploration on EL 5688 from 1988–90. Rock chip and stream sediment sampling was carried out from Wolfram Hill through to Mount Hardy.
- Bruce and Mules’ explored the Silver King area for gold and base metals from 1988–91.
- MIM/ Roebuck Resources Joint Venture targeted mineral highs in the early 1990s and explored the Silver King deposit.
- Yuendumu Mining Company/Posgold explored the western parts of the Mount Doreen mapsheet from 1992 to 1996, particularly Terry’s Find, ‘Buger’, and ‘Grasshopper’.
- BMR completed airborne magnetic and radiometric surveys in 1993.
- Aberfoyle Resources were granted EL8913 and EL8608 in late 1994 and undertook ground magnetics surveys and substantial RAB drilling. Exploration failed to locate significantly anomalous gold mineralisation and the tenements were surrendered.
- BHP tested the northern Mount Doreen and southern Mount Theo 1:250 000-scale map sheets for Cu-Au in the late 1990s but concluded that no major deposits were likely.
- Tanami Gold NL explored for Tanami-style gold mineralisation and Tennant Creek-style copper mineralisation in the Mount Doreen mapsheet from 2001 to 2005. The main target areas were the Terry’s Find, Mount Hardy, and Pyramid Hill prospects. Of 42 rock chip samples collected from the Mount Hardy Project area, 14 returned copper assays between 5 and 19%.
- Deep Yellow conducted exploration for uranium in the Mount Hardy area in 2009 and 2010. No other commodities were investigated.

TNG and TRT exploration

In June 2012, TNG purchased the exploration licence from Walla Mines Ltd (who had held the ground for a period of time without work) after noting the tenement’s potential for base metal mineralisation. TNG subsequently commenced exploration in July 2012 with a helicopter electromagnetic survey (HELITEM) to outline any conductors that may represent sulfide accumulations of base and precious metals. The survey was completed by Fugro Airborne Surveys and comprised 930 line km of 200 m spaced lines. Five anomalous areas within EL 27892 were field checked and mapped. Niton readings were taken from rock and soil samples; additional grab samples were collected for analysis. TNG was able to quickly define several large anomalous target zones requiring drill testing.

Initial exploration drilling occurred in October 2012 with seven RC holes testing four strong surface electromagnetic (EM) targets identified from the HELITEM survey. Results showed that the large geophysical anomalies represented mineralised systems at depths of ~100–200 m. Further work including core drilling for metallurgical test work was planned.

Induced polarisation (IP) and gravity surveys were completed in 2013, defining 17 priority EM targets. Based on the indications from the 2012 drilling and the geophysical work, a 15-hole diamond drill program totalling 2757 m was completed from March to April 2013. Drilling tested the Mount Hardy and Browns prospects, as well as the mapped mineralisation and surface IP anomality at targets EM1, EM2 and EM4. The drilling confirmed broad zones of polymetallic mineralisation from surface to approximately 200 m depth, coinciding with the surface geophysical anomalies. Significant zones were intersected, including the following highlights:

- EM1: 21.0 m at 4.4% Zn, 1.9% Pb, 0.5% Cu and 36 g/t Ag from 211 m (MHDD0010)
- EM2: 3.8 m at 2.0% Zn, 1.8% Cu, 0.5% Pb and 18 g/t Ag from 177 m (MHDD0012)

In 2014, down-hole electromagnetic (DHEM) surveys were conducted for four core holes drilled during 2013. IP surveys were also completed at the Browns prospect, EM6,
and EM7. No on-ground exploration was undertaken at Mount Hardy during 2015 and 2016.

The Mount Hardy tenements were transferred to the new licence holder and operator Todd River Metals Pty Ltd in March 2017 as part of the spin out of TRT from TNG. A total of 14 RC and diamond holes for 2839 m were drilled across the Mount Hardy prospect areas in April to June 2017, targeting the 2014 combined surface and DHEM results. Results produced a series of new DHEM target plates. Significant polymetallic zones were again intersected, including the following highlights:

- Browns: 7 m at 1.8% Cu, 0.4% Zn, 0.2% Pb and 18 g/t Ag from 67 m (MHRC0017)
- EM1: 14.1 m at 0.34% Zn, 0.29% Cu and 0.17% Pb from 174.5 m, including 7.45 m at 0.47% Cu, 0.45% Zn and 0.11% Pb from 177.7 m (MHDD0021)
- EM2: 10.5 m at 4.15% Zn, 1.10% Cu and 0.65% Pb from 178 m (MHDD0029).

2018 exploration activities

Two main phases of drilling were completed at Mount Hardy during 2018. Five drillholes (MHDD0030–0034) and the diamond extension of a sixth drillhole (MHDDH0021A) were completed in June 2018. The breakthrough intercept came in drillhole MHDD0031A with 25.15 m at 4.0% Zn, 3.1% Pb and 2.4% Cu from 184 m, including 9.15 m at 8.8% Zn, 7.6% Pb and 4.5% Cu from 200 m (Todd River Resources 2018a). Further success came with the diamond extension of MHDD0021A returning 13.45 m at 15.9% Zn, 5.75% Pb, 0.9% Cu and 89 g/t Ag from 358.55 m (Todd River Resources 2018b).

Based on these results, an additional six drillholes (MHDD0035–0040) were approved for drilling at short notice in July 2018 over EM1, and then 12 additional drillholes (MHDD0041–0052) were completed in September 2018. The most outstanding intercept to end 2018 was intersected in MHDD0043, which returned a significant width of brecciated mineralisation with a length weighted average grade of 35.54 m at 14.7% Zn, 2.92% Pb, 0.91% Cu and 59 g/t Ag from 431.54 m, including 11.29 m at 22.9% Zn, 3.35% Pb, 1% Cu and 58 g/t Ag from 443.61 m (Todd River Resources 2018c).

MHDD0042, the deepest drillhole at EM1 to end 2018, intersected mineralisation more than 600 m below surface and 180 m below and down-dip of the nearest drillhole, MHDD0043 (Figure 4). MHDD0042 returned a significant width of brecciated mineralisation with a length weighted average grade of 24.54 m at 4.86% Zn, 0.68% Cu and 0.29% Pb from 619 m, including 12.68 m at 8.21% Zn, 1.19% Cu and 0.47% Pb from 629.62 m (Todd River Resources 2019). This intersection is open in all directions; geophysical modelling of the DHEM results indicates a strong response to the north.

DHEM surveying of key drillholes was completed during the December 2018 drilling. The results have been combined with data acquired in all previous drillholes to produce 29 modelled plates, confirming the complexity of the area.

Further work is underway to build a 3D geological model to be integrated with the interpreted EM plates in order to better define constraints on mineralisation and to identify new targets. Preliminary results of this work indicate that the deep mineralisation is not closed off in any direction. There are two significant deep plates modelled from the data (represented on long section in Figure 4) that encourage further drilling, particularly above and to the north of MHDD0042.

Future

In 2019, an initial 12-hole campaign has been planned at EM1 (Figure 4). Drillholes will be started with an RC collar and completed with a diamond tail to a depth of up to 800 m; a few shallower drillholes will be completed by RC alone. Drillhole locations have been planned on a grid using the DHEM to target the most likely mineralised areas, as well as extensions to known mineralisation.

Figure 4. Mount Hardy Project, EM1 prospect area oblique long projection showing planned drillholes for the initial campaign of 2019.
An initial moving loop electromagnetic (MLEM) survey was completed in mid-December 2018, focusing on a four km$^2$ area centred on EM1 (Figure 5, Todd River Resources 2019). The data generated in this survey is currently being interpreted. Following modelling and target generation, drillholes will be planned to test targets north and south of EM1 in mid-2019. The MLEM survey area will also be expanded in early 2019 (Figure 5) to allow better targeting for drill testing at the Browns prospect and to open up the surrounding areas, particularly those with poor surface expression. Previous drilling intersections at both Browns and EM2 are yet to be followed-up. There remains multiple untested EM anomalies along strike from the EM1 prospect signifying outstanding potential to extend the known area of mineralisation at Mount Hardy.

References


Todd River Resources, 2018a. Outstanding thick high grade copper and zinc intercept confirms significant discovery at Mount Hardy, NT. Australian Stock Exchange media release, 20 June.


Todd River Resources, 2018c. Exceptional high-grade intercept from deepest hole to date at Mt Hardy. Australian Stock Exchange media release, 7 November.
