Nobles Gold project, Tennant Creek, Northern Territory, Australia: From concept to first gold in four years

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Background

Nobles Nob gold deposit, near Tennant Creek in the Northern Territory, was discovered by Bill Weaber and Jack Noble in the 1930s. Four leases were subsequently granted to them over what is now the Nobles Nob gold mine. Ownership changed to Australian Development NL and an underground mine developed. During the morning on 11 August 1967 the crown pillar of the mine collapsed with a vehicle, an office, main shaft-winder and mill all tumbling into the failure zone (Szwedzicki 2001).

The failure zone was excavated with over 1.2 million tonnes (Mt) of dilute ore, hanging wall and footwall lithologies stockpiled adjacent to the mine, forming the Crown Pillar Stockpile (CPS). In January 1968 milling resumed and the Nobles Nob mine continued as an open-pit operation until 1985 when it was closed. The Nobles Nob leases have had several owners since that time, including Excalibur Mining, and in 2021 were acquired by Tennant Consolidated Mining Group Pty Ltd (TCMG). TCMG intends to again consolidate the licences in the Tennant Creek Mineral Field (TCMF) and an exploration joint venture with Emmerson Resources Limited (ERM-JV) applies over 1700 km^2 of prospective TCMF tenements.

The CPS, to a large extent untreated, has remained on the surface to the present. Auger and sonic drilling of 79 holes from the top of the CPS into the subsoils was completed by TCMG in 2023 and 2024. Additionally, trenching, bulk sampling and screening of the material helped maximise confidence in a geological model and final Mineral Resource estimate. All factors combined yielded an Indicated Mineral Resource of 1.26 Mt at 1.48 g/t. The Indicated Mineral Resource was subsequently converted to a Probable Mineral Reserve following mining studies and the application of modifying factors. This already broken rock, stockpiled on surface and adjacent to a permitted tailings storage facility on an active Mining Licence, leapfrogged the now termed Nobles Gold project into execution.

A carbon-in-leach (CIL) gold processing plant, with a capacity of ~840 000 tonnes per annum, entered commissioning phase during quarter two of calendar year 2025; this plant is the largest ever to have been constructed in the TCMF. The CPS is the bulk ore feed for the initial two years of production with sufficient Probable Ore Reserves to ensure payback of the construction capital.

The terminology used here to describe the projects' gold Mineral Resource and Ore Reserves follows the definitions of the Joint Ore Reserves Committee (JORC) Code for reporting of Mineral Resources and Ore Reserves, 2012 (www.jorc.org).

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Geology of Nobles Nob mine

The Warramunga Group, hosting gold, copper and bismuth deposits, has undergone a major period of deformation forming east–west trending, sub-horizontal upright folds with an associated axial planar cleavage (Rattenbury 1992; Rattenbury 1994). Reverse faulting and thrusting occurred simultaneously with shearing and the major fold-forming event (Rattenbury 1994). Strike-slip movement along the northwest- and northeast-trending faults occurred in combination with the formation of small-scale kink folds. South-over-north (reverse) movement during low-temperature brittle-ductile deformation is evident (Rattenbury 1994).

Hematite-magnetite-quartz-chlorite ironstones are spatially related to 3 to 4 stratigraphically occurring hematite shale horizons above the locally stratiform porphyry sill (Rattenbury 1992) in the Black Eye Member of the Carraman Formation (Wedekind *et al* 1989). The hematite-magnetite bodies (or ironstones) have ellipsoidal to pipelike shapes and are commonly flattened in the direction of strike of the regional east–west cleavage (Large 1975). Chlorite-rich pipes extend vertically below the orebodies. Mineralising fluids have been channelled through the ironstones along the regional cleavage and local reverse faults. Rattenbury (1992) reported ironstone formation where the cleavage or fault-fluid conduits have intersected relatively oxidised shale, commonly in the fold hinge zones.

Large (1975) illustrated the precipitation of iron oxides during the replacement of sediments in formation of the lode to have been accompanied by a gradual and continual decline in $f(O_2)$ and an increase in pH of the mineralising fluids. This reaction is likely to have controlled gold, copper and bismuth deposition (Wedekind *et al* 1989).

According to Campbell *et al* (1998), $^{40}Ar/^{39}Ar$ dating of the Tennant Creek gold mineralisation places the age of this event at 1825 million years (Ma). This age is towards the end of the major phase of felsic volcanism associated with the Barramundi Orogeny (Campbell *et al* 1998). Campbell *et al* (1998) therefore suggests the gold was derived from felsic magmas or from supracrustal rocks buried deep in the crust during peak metamorphism associated with the Barramundi Orogenic event.

Nobles Nob mineralisation is contained within the iron oxide lode with gradual decrease in economic mineralisation into the chloritized hanging wall and footwall lithologies. Gold, bismuth and copper mineralisation form a late-stage overprint on the hematite-magnetite lodes; gold is typically concentrated towards the footwall of the ironstone or where the ironstone is in contact with chlorite and muscovite (Wedekind *et al* 1989). Economic enrichments of gold and copper are less evenly distributed compared to the ironstone, suggesting factors other than structure and stratigraphy are involved (Rattenbury 1992).

The crown pillar failure

During the morning on 11th August 1967 the then crown pillar of the Nobles Nob mine collapsed (Szwedzicki 2001). Crown pillar failures typically occur due to changes in the strength of the rock mass, rock stress, the geometry of mine openings and/or the thickness of the surface crown pillar (Szwedzicki 2001). These failures tend to show visible and measurable signs of deterioration – such as ground condition changes or ground movement at the periphery of the collapse usually in hanging wall rocks – months, or even years before eventual failure occurs (Szwedzicki 1999 and Szwedzicki 2001). Moreover, typically weeks before the collapse visible signs of high stress would be noted in underground excavations in proximity to the collapse, crumbling of underground pillar support and/or the opening of failure zones.

The Nobles Nob mineralised iron oxide crown pillar collapsed over a mining void which had been stoped to within 25 m of the surface (Szwedzicki 2001). The sink-hole above the collapse formed in the early morning and grew to 45–50 m in diameter. The main shaft winder, a vehicle, the mill and an office building collapsed in the failure zone. Australian Development NL excavated the failed material and stockpiled it adjacent to the plant before continuing the Nobles Nob mine as an open pit. This stockpile, termed the Crown Pillar Stockpile, is therefore composed of diluted mineralised iron oxide lode deposit rocks as well as moderately-altered, chloritized hanging wall and footwall lithologies.

Quantifying the mineral resource of the CPS

Determining the grade or mineral content of stockpiled rock is much more difficult than determining the volume of the material. In recent years drone-based technology, has provided a mechanism for assessing volume, both accurately and in a time-efficient way (Raeva *et al* 2016).

Grade or content determination needs to consider the method of deposition of the material and how the material can be sampled. Sampling strategies are typically either one dimensional (in a stream) or three dimensional (grab sampling). From this a sampling process can be designed to limit the sampling error according to Gy's sampling theory (Minkkinen 2004).

At Nobles the CPS comprises fractions of material ranging from –10 mm to +150 mm. This variable particle size, as well as the differences in rock types, means sampling conditions are challenging. Initial sampling of the CPS was conducted through auger drilling and later by sonic drilling. Barrow (1994) explains that the sonic drilling technique offers unique capability to drill through rock, clay, sand, boulders, permafrost or glacial till. Sonic drilling also requires no mud, air, water or other circulating medium. In total, 79 drillholes penetrated the CPS and were used to estimate the average grade through Ordinary Kriging processes (TCMG 2024).

To further supplement drilling and to satisfy Gy's sampling theory (while at the same time limiting fundamental sampling error) a bulk sampling project was undertaken. In this project, approximately 6 kt of CPS material was excavated, screened and stockpiled according to size fractions. The material excavated allowed: (1) bulk sampling; (2) particle size distribution measurements; (3) assay of the different size fractions; and (4) metallurgical recovery test work. The result is an Indicated Mineral Resource of 1.26 Mt at 1.48 g/t which, together with a metallurgical recovery value of 94%, enabled the conversion of this material to a Probable Ore Reserve.

Brownfields exploration

Due to the rich history of mining in the TCMF, various geological mapping, sampling, drilling, geophysical survey results and processing information are available. TCMG collated and digitised the relevant information from these legacy datasets for use in geological modelling, the estimation of Mineral Resource and in feasibility studies.

Mining in the TCMF ceased from 1985 to the early 2000s during which time the prevailing gold price was in the range US$250–500/oz (www.goldprice.org). These prices are very different from the current price of ~US$2900/oz (on 13 February 2025, www.goldprice.org). The current gold value creates the opportunity for previously uneconomical mineralised blocks to be re-assessed. The digitisation of historical data and the application of detailed quality assurance and quality control (QAQC) methods (such as by sample twinning and the consideration of historic QAQC methods) both serve to maximise the precision and accuracy of data used (Abzalov 2008). This historical information, combined with new drilling allowed TCMG to fast-track to a Mineral Resource base (**Table 1**).

Table 1. TCMG's Mineral Resources and Ore Reserves at 30 June 2024.

			Contained Gold		
		Million tonnes	Grade (g/t)	Tonnage (mt)	Million ounces
Mineral Resources	Measured	0.0	0.00	0.0	0.00
	Indicated	10.6	3.06	32.5	1.04
	Inferred	3.5	2.14	7.5	0.24
	Total	**14.1**	**2.83**	**40.02**	**1.29**
Mineral Reserves	Proved	0.0	0.00	0.0	0.00
	Probable	2.9	3.10	12.1	0.39
	Total	**3.9**	**3.10**	**12.1**	**0.39**

Subjecting these Mineral Resources to mining studies such as pit optimisations, underground stope optimisers, detailed designs and contractor quotes allowed Ore Reserves to be estimated (**Table 1**). The Mineral Resources and Ore Reserves, through a feasibility study, are reported within three years of initial licence acquisition, a commendable timeframe which was expedited through using all available historic and current data.

Project construction

The timely report of a Mineral Resource and Ore Reserve leap-frogged the Nobles Gold project closer to execution. TCMG acquired a second-hand, mothballed CIL gold plant – complete with milling, gravity, CIL, elution and carbon regeneration circuits as well as a functional gold room – from the Great Australian Mine (GAM) in Cloncurry, Queensland. This acquisition ensured that the Nobles Gold project could be operational by May 2025, 12 months after relocation of the CIL plant from Cloncurry began.

The relocated facility is the largest capacity CIL plant ever to have been constructed in the TCMF and unlocks additional possibilities for TCMG to review previously discarded or uneconomical deposits.

Future work

The TCMF has the potential for future greenfield mineral discoveries, as evidenced by the Tennant Minerals Limited's Bluebird discovery (https://tennantminerals.com/) and Emmerson Resource Limited's Mauretania deposit (https://www.emmersonresources.com.au/). Moreover, over the 20 years since mining operations ceased in the region, exploration technologies have advanced tremendously.

More cost-effective, accurate, precise and rapid data collection techniques – such as drone-based magnetotelluric surveys as described by Ogawa (2002) – create potential in previously overlooked areas. Additionally, ultrafine soil sampling (<2 µm) and spectral mineralogy and physiochemical property proxies improve targeting of gold and base-metal exploration (Noble *et al* 2019). These are two exploration methods TCMG is employing over its tenements in the TCMF during 2025.

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Conclusions

Pole-dipole IP successfully mapped the known mineralisation as a discrete chargeability and low resistivity anomalies. The 2D chargeability inversion clearly defines the main and southern lodes as separate and distinct anomalies, while the resistivity inversion shows only a broad diffuse zone of lowered resistivity.

Overall, the variation in amplitudes across the survey is small, even across the main mineralisation. This is not a problem for target detection because mineralisation appears to be the only chargeable unit. Conversely, the trial line of GAIP showed that although Home of Bullion was detectable, the weak signal would be unlikely to be resolved in areas of significant cover.

Other than the main mineralisation, the most interesting anomalies are on the lines directly along strike from the mine. The most compelling target is a moderate-chargeability, low-resistivity anomaly ~600 m east of the Home of Bullion mine. This anomaly has a similar shape and signature to Home of Bullion but is weaker, indicating lower-grade or deeper mineralisation. Another strong but deep anomaly is present 400–800 m east of Home of Bullion and coincides with the same magnetic trend as the main lode.

The results from this recently completed IP survey have outlined three new geophysical anomalies along strike to the north-west and south-east of the Home of Bullion deposit, adding significant value to this project. Given that only 14 of the original 26 planned lines of IP were acquired there is significant potential for future data acquisition to further improve exploration targeting.

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