

2021 in review: Exploration bounces back in the Territory

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Introduction

The Territory's exploration sector rebounded strongly in 2021 despite ongoing issues related to the Covid-19 pandemic. Mineral exploration expenditure figures suggest that expenditure on exploration during the 2021 dry season was substantially higher than the previous year, and at the highest levels for nearly a decade. There was also a dramatic upturn in applications for mineral exploration titles, with 444 new applications received, a 255% increase on 2020. This is the highest number of applications received since 2009. It reflects an apparent substantial increase in interest in uranium and lithium exploration, as well as ongoing uptake of tenure for copper, particularly sediment-hosted copper in the Territory's Proterozoic basins. Despite this uptake of greenfield exploration tenure, the percentage of exploration expenditure spent in greenfields areas remains at moderate levels, which is likely to be due at least in part to Covid-19-related access restrictions. Petroleum exploration activity was also stronger in 2021, with drilling or flow testing occurring at seven wells in the Beetaloo Sub-basin.

According to the Australian Bureau of Statistics (ABS), mineral exploration expenditure in the NT in 2021 was \$153.4 million, up 38% on the figure of \$110.8 million for 2020 (**Figure 1**). This represents the highest annual expenditure since 2011, and the third highest on record. The proportion of exploration expenditure in the NT that is in greenfields areas increased during the second half of 2021 to 34%, similar to the Australian average.

In addition to ABS exploration statistics, the NT Geological Survey collects statistics on the admissible exploration expenditure reported by industry under the *Mineral Titles Act*. This shows that expenditure reports submitted for exploration activities on both exploration licences (ELs) and mineral leases (MLs) during 2020 (which may relate to activity in 2020 and/or 2021) totalled \$112.4 million in admissible exploration expenditure. This was a decrease of 4% from the \$116.9 million reported in 2020. The proportion of total reported expenditure on MLs was 71%, up from 58% in 2020.

At the end of 2021, there were 925 granted non-extractive mineral exploration licences (compared with 773 at the end of 2020) and 739 outstanding exploration licence applications. Of these applications, 486 are on Aboriginal freehold land. During 2021, 444 new applications were received (up from 174 in 2020), 278 were granted (up from 71 in 2020) and 61 licences ceased (down from 146 in 2020). The area of the NT covered by granted exploration tenure has increased from 11 to 18%, with a further 26% of the Territory covered by applications. At the end of 2021, in the onshore NT and coastal waters, there were 38 granted petroleum exploration permits, 3 retention licences and 5 production licences.

Mineral exploration and production highlights

Figure 2 shows selected mineral exploration highlights for 2021. In the following summary of exploration and mining results for the Territory during 2021, all mineral resources are assumed to have been reported in accordance with the JORC or NI43-101 codes. Where resource categories are not listed, readers are directed to the original sources for this information. Most material cited here has been sourced from company websites, news releases and Stock Exchange announcements by companies. As a result, details of exploration by some private and other non-listed companies that do not report publicly could not be included.

Mineral production statistics for the NT for 2020/21 collected under the NT *Mineral Titles Act* are given in **Table 1**. This shows mineral production was \$4.28 billion in 2020/21, down slightly from last year's \$4.40 billion.

Gold – Tanami Region and Aileron Province

Newmont Corporation's *Tanami Operations*, located 550 km northwest of Alice Springs, remains the Territory's largest gold operation, reporting 485 000 oz of gold produced in 2021. Gold production was down 2% as the mine was temporarily placed into care and maintenance due to Covid-19 issues. During 2021, 2.65 Mt of ore was mined

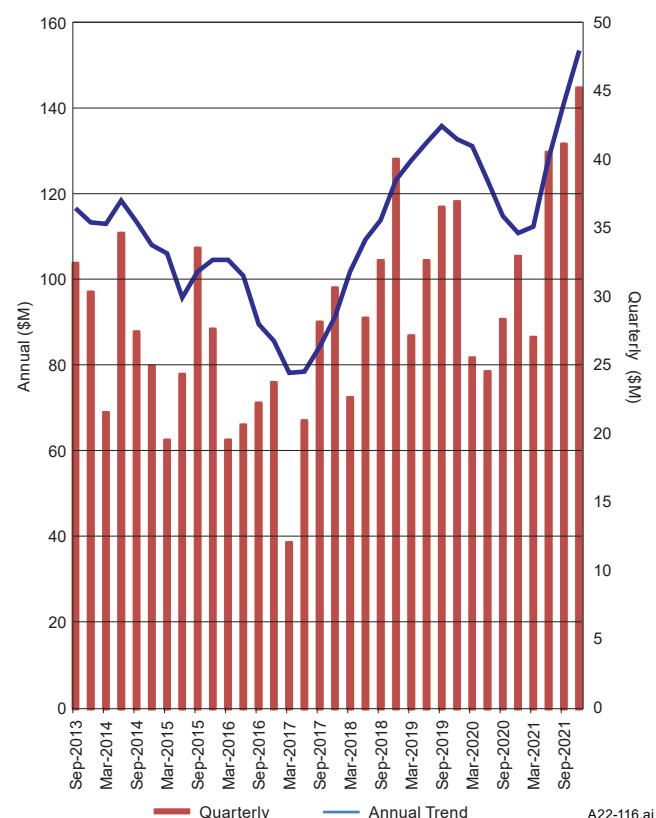


Figure 1. Annual and quarterly mineral exploration expenditure for the Northern Territory from 2013 to 2021 according to the Australian Bureau of Statistics.

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at an average grade of 5.83 g/t Au. Mineralisation consists of high-grade gold-quartz veins in folded carbonaceous siltstone in the lower part of the Dead Bullock Formation. The operations consist of a number of orebodies, including the flagship Callie deposit (>7.6 Moz), the Auron deposit (>5.83 Moz), the Federation South Limb, and the Liberator deposit. As of 31 December 2021, Proven and Probable Ore

Reserves were 34.8 Mt at 5.15 g/t Au containing 5.78 Moz of gold. Reserves increased by 0.8 Moz largely due to the first declaration of reserves at Liberator. Additional Measured and Indicated Mineral Resources total 33.1 Mt at 2.18 g/t Au for 2.32 Moz of gold; and Inferred Mineral Resources are 12.5 Mt at 4.53 g/t Au for 1.82 Moz of gold. The company reported that 0.3 Moz of Measured and Indicated Mineral

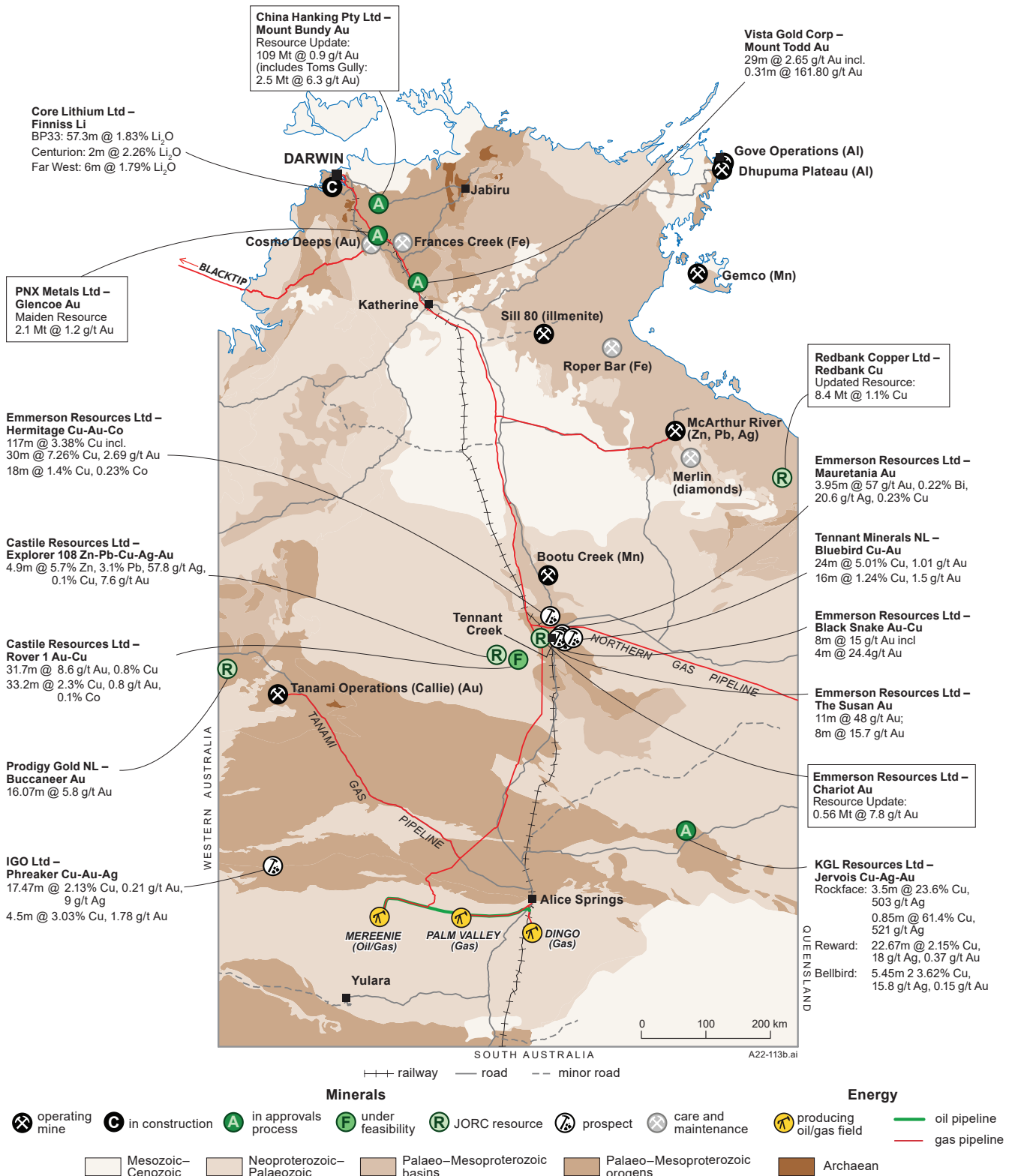


Figure 2. Map of the Northern Territory showing selected mineral exploration highlights for 2021.

Table 1. 2020/21 mining production statistics for the Northern Territory

Commodity	Unit quantity	2020–2021 ^{1,4,5}		
		Quantity produced ²	Quantity sold	Quantity sold (\$) ³
Metallic minerals				
Bauxite	tonnes	12,021,675	12,079,243	\$468,093,841
Gold ⁶	grams	2,239	0	\$0
Gold dore ⁷	grams	14,983,771	14,902,807	\$1,189,201,272
Iron ore	tonnes	636,456	589,772	\$73,659,575
Manganese	tonnes	6,733,171	6,817,183	\$1,465,728,648
Mineral sands concentrate	tonnes	37,238	37,238	\$12,338,738
Lead concentrate	tonnes	23,787	32,715	\$41,974,453
Zinc concentrate	tonnes	203,173	188,862	\$266,180,938
Zinc lead concentrate	tonnes	406,438	415,131	\$599,169,447
Metallic minerals value				\$4,116,346,912
Gemstones				
Diamonds	carats	0	0	\$0
Gemstones	carats	0	0	\$0
Mineral specimens	kilograms	0	200	\$32,571
Gemstones value				\$32,571
Non-metallic minerals				
Crushed rock	tonnes	1,374,990	1,475,646	\$30,410,741
Dimension stone	tonnes	0	0	\$0
Gravel	tonnes	148,627	143,771	\$2,378,485
Sand	tonnes	202,475	189,423	\$4,672,687
Soil	tonnes	120,582	46,923	\$608,631
Garnet sands	tonnes	648	576	\$223,920
Limestone	tonnes	0	1,668	\$28,852
Quicklime ⁸	tonnes	7,779	8,224	\$2,246,815
Vermiculite	tonnes	0	0	\$0
Non-metallic minerals value				\$40,570,131
Energy minerals				
Uranium oxide	tonnes	810	1,023	\$123,685,290
Total minerals value				\$4,280,634,904

¹ Fiscal year is 1st July to 30th June.

² Data is from production returns lodged by operators under statutory obligations.

³ \$ amount for quantity sold is in AUD and is the gross amount paid to the operator

⁴ Data has been rounded and autosum applied.

⁵ Data is correct as at 13 Oct 2021 and may be subject to revision due to late lodgements and/or receipt of superior data.

⁶ Pure gold (100%); does not include gold reported as gold dore.

⁷ Gold dore is primarily comprised of gold with additional silver and accessory elements.

⁸ Quicklime is derived from limestone. Processing input and output data is deemed operator commercial-in-confidence.

Resources had been added through exploration programs. Some 1.67 Moz of the Mineral Resource is defined as ‘Open Pit’, which is assumed to include the **Oberon** orebody, 25 km north of Callie. Newmont are in the process of executing their Phase 2 Expansion, which includes construction of a 1460 m shaft, additional capacity in the processing plant, and supporting infrastructure to enable profitable recovery of ore at depth to 2140 m below surface. The expansion is expected to increase average annual gold production by ~150 000 to 200 000 oz from 2024 and reduce operating costs by around 10%.

In the Tobruk JV with Prodigy Gold NL, located immediately southwest of the Callie Mine, Newmont is sole funding up to \$12 million in exploration expenditure to earn up to a 70% interest. During 2021, it was reported that 137 deep sensing geochemical samples were collected, along with a passive seismic survey. In November 2021, Newmont signed an Exploration and Farm-in Joint Venture Agreement with Prodigy Gold to advance exploration at the Monza Project (including tenements that were formerly part of Prodigy Gold’s Euro joint venture with Newcrest Mining), covering exploration tenements and applications north and northeast of Callie and The Granites.

In September 2021, Tanami Gold NL and Northern Star Resources Ltd advised that a transaction had been completed to establish a 50/50 joint venture covering the Central Tanami Project that includes the Tanami mine corridor and Groundrush deposits. The two companies established a joint venture management company through which they will jointly fund all exploration and development activities on the Central Tanami Joint Venture. The only reported drilling program in 2021 was an aircore program at the Cave Hill prospect area, 20 km northwest of Callie, but only 15 out of a planned 53 holes were completed. A planned diamond drill program at **Jims** in late 2021 was deferred due to Covid-19 and rainfall-related issues. In Northern Star’s 100% owned Tanami Regional project, the focus was on completing reconnaissance aircore drilling across new anomalies defined in the Stubbins area.

In late 2021, Prodigy Gold completed an eight hole, 1419 m program of geotechnical and metallurgical diamond drilling at the **Buccaneer** deposit, 90 km west-northwest of Callie, which has an existing Mineral Resource of 10 Mt at 1.8 g/t Au. The drilling was designed to further evaluate potential low-cost, heap leach processing for the development of the Buccaneer resource. The results confirmed multiple stacked zones of mineralisation, with a best drill intersection of 16.07 m at 5.8 g/t Au from 140 m, including 5.5 m at 13.2 g/t Au from 151 m. Seventeen aircore holes for 1124 m were also completed at Buccaneer to test the potential for shallow oxide mineralisation south of the resource and south of the current pit design, with a best intersection of 6 m at 1.4 g/t Au from 12 m.

In September 2021, Prodigy Gold completed a 211 m diamond drillhole at the Tregony deposit in the Hyperion project area. The drilling was designed to provide insight into the structural context and stratigraphic controls of gold mineralisation at Tregony, and intersected a number of mineralised intervals, with a best result of 5.15 m at 2.5 g/t Au. The company have remodelled the Tregony deposit as a

stacked shear vein system in the hanging wall of the regional Suplejack Fault. At the **PHD** prospect, 30 km northwest of the Hyperion gold deposit, Prodigy Gold drilled a 241 m diamond drillhole co-funded by NTGS, which intersected quartz veining and sulfidic sediments. They also conducted an 80 hole aircore drilling program. No significant results were reported.

In the northern Aileron Province, Prodigy Gold undertook a 11 hole, 1549 m RC drilling program at the **Sabre** prospect, which forms part of their Reynolds Range project, 90 km north of Alice Springs. Drilling successfully extended the historically defined gold mineralisation trend at Sabre by over 450 m, with a best intersection of 23 m at 0.6g/t Au, including 7 m at 1.5 g/t Au.

In the Irindina Province northeast of the Harts Range, Shree Minerals Ltd continued reconnaissance exploration at the **Bruce** gold prospect, where historic sampling of ferruginous quartz veins by NTGS assayed up to 53 g/t Au. In November 2021, the company reported rock chip samples of up to 15.26 g/t Au from newly identified ferruginous and partly gossanous quartz veins. In January 2022, Shree Minerals announced it had divested its interest in the tenements to MetalsGrove Mining Ltd.

Gold – Pine Creek Orogen

Vista Gold Corporation's **Mount Todd** gold project, northwest of Katherine, has reported Measured and Indicated Mineral Resources of 299.1 Mt at 0.82 g/t Au containing 7.87 Moz of gold, and Inferred Mineral Resources of 65.3 Mt at 0.77 g/t Au containing 1.61 Moz of gold. Proven and Probable Ore Reserves at the end of 2021 are 280.4 Mt at 0.77 g/t Au containing 6.98 Moz of gold. The company undertook a substantial drilling campaign during 2021 designed to demonstrate district-scale mineralisation and structural continuity between the Batman and Quigleys deposits. Highlights included an intersection of 29 m at 2.65 g/t Au (including 0.31 m at 161.8 g/t Au) from 500 m north-northeast of Batman. An 18 hole, 6000 m program was undertaken in mid-2021 and successfully identified several gold-bearing structures that connect the Batman pit and the Golf-Tollis deposit (**Figure 3**). This included a 901 m hole



Figure 3. Diamond drill rig near Mount Todd, April 2021.

co-funded by NTGS through the Geophysics and Drilling Collaborations (GDC) program that intersected more than 100 m of mineralisation, including 22.7 m at 1.1 g/t Au. In June 2021, the company announced that they had received Mining Authorisation for the project. In February 2022, the company announced the results of a feasibility study on the project, based on a sixteen-year mine life with an average annual production of 395 000 oz of gold.

Kirkland Lake Gold Inc's operations in the Pine Creek region remained in care and maintenance through 2021, with an \$80 million rehabilitation program undertaken in the Cosmo Howley area. This included hauling more than 13 Mt of potential acid forming material from the Howley area into the Cosmo pit, and then filling the Cosmo pit with treated water to act as a wet cap. In late 2021, the company undertook an exploration drilling program at Pine Creek testing for new mineralised structures below existing pits, but no results have been publicly announced. Combined Mineral Resources for all of Kirkland Lake's Territory assets at the end of 2020 comprise Measured and Indicated Mineral Resources of 25.2 Mt at 2.3 g/t Au and an Inferred Mineral Resource of 19.2 Mt at 2.3 g/t Au, for a total contained 3.22 Moz of gold.

PNX Metals Ltd continued to progress their **Fountain Head** gold project, located 50 km northwest of Pine Creek. Combined Indicated and Inferred Mineral Resources for the Fountain Head and Tally Ho deposits total 2.94 Mt at 1.7 g/t Au for 156 000 oz of gold. The gold system extends ~1.6 km along the strike of the Fountain Head anticline. During 2021, the company continued to advance development studies for the Fountain Head project and submitted an Environmental Impact Statement in June 2021. PNX Metals also undertook an RC drilling program testing near-mine exploration targets, with a best intersection of 3 m at 4.13 g/t Au from the 'NW Breccia' target.

In April 2021, PNX Metals executed an agreement to acquire the **Glencoe** gold deposit, 3 km north of Fountain Head, from Ausgold Pty Ltd, and released an Inferred Mineral Resource estimate of 2.1 Mt at 1.2 g/t Au for the deposit. The company subsequently drilled 54 RC holes at Glencoe to test for near-surface extensions to gold mineralisation and to increase confidence in the current Mineral Resource. Drilling successfully identified immediate additions to near-surface gold mineralisation, extending the strike and demonstrating continuity more than 280 m to the southeast of the existing resource. Near-surface intersections included 9 m at 2.23 g/t Au, 6 m at 3.84 g/t Au, and 2 m at 8.58 g/t Au.

Privately-owned Bacchus Resources Pty Ltd continued gold exploration in the Pine Creek Orogen in 2021, including at their **Woolwonga** project. The company also commenced drilling programs at the **Brocks Creek** project area, which contains resources at the Zapopan (high-grade underground), Faded Lily, Raising Tide, Borgan and Alligator deposits.

Hanking Australia Pty Ltd's **Mount Bundy** project comprises the Toms Gully, Rustlers Roost and Quest 29 deposits, located 90 km east-southeast of Darwin. In December 2021, the company announced an increase in resources at the project based on recent drilling campaigns.

The Mineral Resource at the Toms Gully deposit increased by 63% to 2.5 Mt at 6.3 g/t Au for 514 000 oz of gold. At Quest 29, the Mineral Resource increased by 216% to 14.2 Mt at 1.0 g/t Au for 468 000 oz of gold. This followed a 48% increase in the Rustlers Roost Mineral Resources in July 2021 to 90.25 Mt at 0.68 g/t Au for 1.98 Moz of gold. Total combined Indicated and Inferred Mineral Resources for the entire project are 109 Mt at 0.9 g/t Au for 3.01 Moz of gold, with 75% in the Indicated category. The company continued to advance development plans and approvals processes for the Mount Bundy project; it was given Major Project Status by the NT Government in December 2021.

During 2021, Core Lithium Ltd undertook further gold exploration at its *Bynoe* gold project, which is in the same area as its Finnis lithium project, 20–60 km south of Darwin. The company undertook follow-up drilling at the Far East gold prospect, including three diamond drillholes co-funded by NTGS; assays are pending.

Private company PC Gold Pty Ltd undertook a drilling campaign and continued to progress approvals for the *Spring Hill* gold project, which has a Mineral Resource of 6.9 Mt at 1.74 g/t Au. Results of drilling have not been publicly announced.

Gold and copper-gold – Warramunga Province

There was strong exploration for copper and gold in Barkly region in 2021, with significant drilling programs in the Rover field and Tennant Creek mineral field, and the ramping up of exploration for copper-gold in undercover areas in the Barkly Tableland region east of Tennant Creek.

Rover field

At the **Rover 1** copper-gold project, 70 km southwest of Tennant Creek, Castile Resources Ltd undertook a substantial resource definition and extensional drilling program through 2021 in which 14 targets were drilled for a total of 11 616 m. The program included infill of wider spaced historic drilling to confirm the geometry and continuity of high tenor gold and copper mineralisation within the Jupiter Deeps magnetite body. Drilling confirmed and extended mineralised zones, with intersections of 31.7 m at 8.6g/t Au and 0.8% Cu from 571 m downhole, including 11.5 m at 17.2g/t Au and 1.1% Cu from 599 m; and 33.2 m at 2.3% Cu, 0.8g/t Au and 0.1% Co from 813.9 m. The results are being included in a resource update and pre-feasibility study due in the first half of 2022. Metallurgical testwork undertaken during the year concluded that Rover 1 can produce five minerals streams: gold, a gold-rich copper concentrate, a bismuth concentrate, a fine grained magnetite industrial mineral, and cobalt concentrate in resin. The company also announced they are investigating the potential to include mineralisation at the Rover 4 prospect, 2.5 km north of Rover 1, in the project development plans.

The *Explorer 142* deposit, 28 km west of Rover 1, has an existing Mineral Resource of 176 000 t at 5.3% Cu. During 2021, Castile Resources extended an existing drillhole at Explorer 142 to 982 m depth, with the additional hole length allowing for an increase in coverage by a new downhole EM

survey that should improve modelling of the conductor to allow drill testing in 2022

Exploration activity at the *Explorer 108* deposit, 36 km west-northwest of Rover 1, included re-entering, cleaning and casing an existing hole to allow for a downhole EM survey in 2022, as well as the drilling a daughter hole from drillhole NR108D049. Significant lead-zinc mineralisation was intersected in the daughter hole of 145 m at 1.6% Zn, 0.9% Pb, 9.3 g/t Ag and 0.6 g/t Au from 485 m downhole, including 4.9 m at 5.7% Zn, 3.1% Pb, 57.8 g/t Ag, 0.1% Cu and 7.6 g/t Au from 493.1 m.

Tennant Creek mineral field

Emmerson Resources Ltd continued to progress its exploration and development activities within the Tennant Creek mineral field. In June 2021, the company announced that had expanded its Strategic Alliance with Tennant Consolidated Mining Group (TCMG) to include both the Northern and Southern project areas, which consists of an exploration earn-in under which TCMG will fund \$10.5 million over five years to hold a 75% equity interest, and a 'small mines joint venture' for development of deposits of <250 000 oz gold equivalent. During 2021, TCMG undertook feasibility and planning for the establishment of a 700 000 tpa carbon-in-leach plant to be assembled at the Nobles Nob mine site. As part of the small mines joint venture, TCMG advanced mining studies at Mauretania, Chariot and Black Snake.

Emmerson Resources' exploration through much of 2021 focused on the high-grade *Mauretania* prospect, 16 km east-northeast of Tennant Creek. Following intersections of 8.8 m at 3.44 g/t Au and 12 m at 2.5% Cu, 0.26 g/t Au and 0.14% Co reported in February 2021, a follow-up drill program commenced in mid-May and resulted in a high-grade intersection in the primary gold zone of 3.95 m at 57 g/t Au, 0.22% Bi, 20.6 g/t Ag and 0.23% Cu. Further drilling at Mauretania focused on testing extensions to the shallow gold-bearing oxide zone outside the conceptual open pit boundary, with a best intersection of 25 m at 2.57 g/t Au and 0.24% Cu. During 2021, the company also announced high-grade drill intersections from *Black Snake* (including 8 m at 15 g/t Au) and *Susan* (11 m at 48 g/t Au).

In December 2021, Emmerson Resources announced results of drilling at their 100%-owned *Hermitage* prospect in the northern corridor of the Tennant Creek mineral field. Four RC holes were drilled in the program, with the best result from hole HERC003, which intersected 117 m at 3.38% copper from 75 m, including 30 m at 7.26% Cu and 2.69 g/t Au from 162 m. The hole was abandoned in mineralisation at 192 m depth and will be followed up by a diamond tail in 2022. The company reported that the hole intersected a zoned ironstone breccia comprising hematite–jasper near the surface and transitioning to magnetite–hematite–chlorite at depth; this was interpreted to be a subvertical, brecciated, high-grade metal-rich feeder zone. Hole HERC002 was drilled outside of the breccia zone and intersected 18 m at 1.40% Cu and 0.23% Co, and 24 m at 4.2 g/t Au. An RC drill program was also completed at the Edna Beryl project area, with assays pending.

In December 2021, Emmerson Resources announced an upgrade to the Mineral Resource at the Chariot gold project near Tennant Creek, with combined Indicated and Inferred Mineral Resources of 556 200 t at 7.8 g/t Au for 138 800 oz of gold. The Chariot project forms part of the joint venture with TCMG.

King River Resources Ltd undertook detailed ground magnetic and gravity surveys over the Lonestar-Gigantic-Blue Moon IOCG trend, immediately east of Mauretania, where prospective Warramunga Formation is under the thin veneer of Cambrian sediments.

In December 2021, Tennant Minerals Limited (formerly Blina Minerals) announced completion of a five hole, 1048 m drilling campaign at the **Bluebird** ironstone-hosted copper-gold prospect, 45 km east of Tennant Creek. The company announced that all diamond drillholes intersected significant intervals of haematite alteration with visible copper mineralisation, including malachite, chalcocite and native copper. The broadest intersection was in hole BBDD009, which intersected 50 m at 2.70% Cu and 0.52 g/t Au from 158 m, including 24 m at 5.01% Cu and 1.01 g/t Au, within an intense haematite-silica breccia with minor to abundant malachite with chalcocite.

In September 2021, CuFe Ltd (formerly Fe Ltd) announced it had entered a binding agreement to acquire a 60% interest in the exploration assets of the Gecko Mining Company, which includes the **Gecko**, Goanna and Orlando copper-gold deposits, 28 km northwest of Tennant Creek. The company announced in December that the transaction had been finalised.

Rio Tinto Exploration Pty Ltd has a number of granted exploration leases west and north of Tennant Creek, although results of exploration on these tenements has not been publicly released.

In August 2021, Elmore Ltd announced that it had executed shareholder and mining agreements with ICA Mining Pty Ltd under which it has been contracted to deliver and manage the **Peko Tailings** project near Tennant Creek in exchange for a management fee, royalty and 25% of the project profit. The project contains 3.75 Mt of historic tailings at the Peko mine site, containing magnetite, 138 000 oz of gold, 9567 t of copper and 3953 t of cobalt. The project is anticipated to produce 2–2.5 Mt of magnetite over 6 years. In December 2021, the company announced that it had completed the installation of all processing equipment on site to enable extraction of high-grade (65–67% Fe) magnetite. Stages 2 and 3 of the project are planned to remove gold from the tailings via flotation and leaching.

Barkly Tableland

The Barkly Tableland area east of Tennant Creek continued to be a focus of exploration interest in 2021 with the first drilling programs conducted by a number of companies. This followed a major uptake of exploration tenure across the region on the basis of encouraging results of collaborative pre-competitive geoscience in the area by Geoscience Australia, NTGS and the Minex Collaborative Research Centre (**Figure 4**). Exploration in the area is primarily targeting copper and gold mineralisation in Proterozoic

basement underlying the Cambrian cover of the Georgina Basin.

Greenvale Mining Ltd acquired further detailed airborne magnetic–radiometric and ground gravity surveys over their tenements in the East Tennant region, co-funded by NTGS through the GDC program. The company also drilled two holes for 1697 m into co-incident gravity and magnetic anomalies at their Twin Peaks prospect, located 90 km east of Tennant Creek. Both holes intersected basement rocks at around 600 m depth comprising hematite- and chlorite-altered metasedimentary rocks and breccias.

In January 2022, Middle Island Resources Ltd announced the results of an induced polarisation (IP) survey at their **Crosswinds** copper prospect, 13 km southeast of Barkly Homestead. The company interpreted the IP line as delineating a chargeable anomaly starting at ~500 m depth, representing a drill target for sulfide mineralisation. The company have interpreted the surface copper mineralisation at Crosswinds as reflecting the secondary migration of copper along growth faults that extend from primary mineralisation in Proterozoic basement rocks through the younger Georgina Basin cover.

In September 2021, Strategic Energy Resources Ltd drilled a single inclined 690 m diamond drillhole at their **Cottage** IOCG prospect, co-funded by NTGS (**Figure 5**). The Cottage prospect is located 105 km east-northeast of Tennant Creek, south of the Barkly Highway. The hole intersected basement at 200 m depth, comprising a metasedimentary package containing possible fine-grained mafic sills, with fine-grained pervasive hematite alteration, localised patchy hematite-carbonate-chlorite breccias, and common quartz and hematite veins and veinlets. However, the company reported that the drilling has not intersected a major mineralising system and that the geological source of the gravity and magnetic anomalies had not been identified.

During 2021, Inca Minerals Ltd undertook an airborne magnetic survey, co-funded by NTGS, at their Frewena East, Far East and Frontier project areas, covering 3500 km² and extending up to 110 km east of Barkly Homestead.

King River Resources Ltd undertook a detailed airborne magnetic survey, co-funded by NTGS, over part of their Barkly project area, 110 km east-southeast of Tennant Creek.

Newcrest Mining Ltd also has a substantial tenement holding in the East Tennant region. During 2021, the company undertook initial drill testing at the Lantern and Sabretooth target areas, although results have not been publicly released. Gravity surveys were completed over an initial six target areas and were followed with IP surveys. Newcrest are planning to scout drill the newly defined coincident gravity, magnetic and IP targets during 2022.

Polymetallic base metals - Aileron Province

KGL Resources Ltd continued to progress towards development at the **Jervois** copper project, located near the Plenty Highway, 380 km northeast of Alice Springs. Mineralisation at Jervois occurs in a series of stratabound, subvertical sulfide-rich deposits along a 12 km strike length of the Bonya Metamorphics in the Aileron Province. Following approval of the Mine Management Plan for the

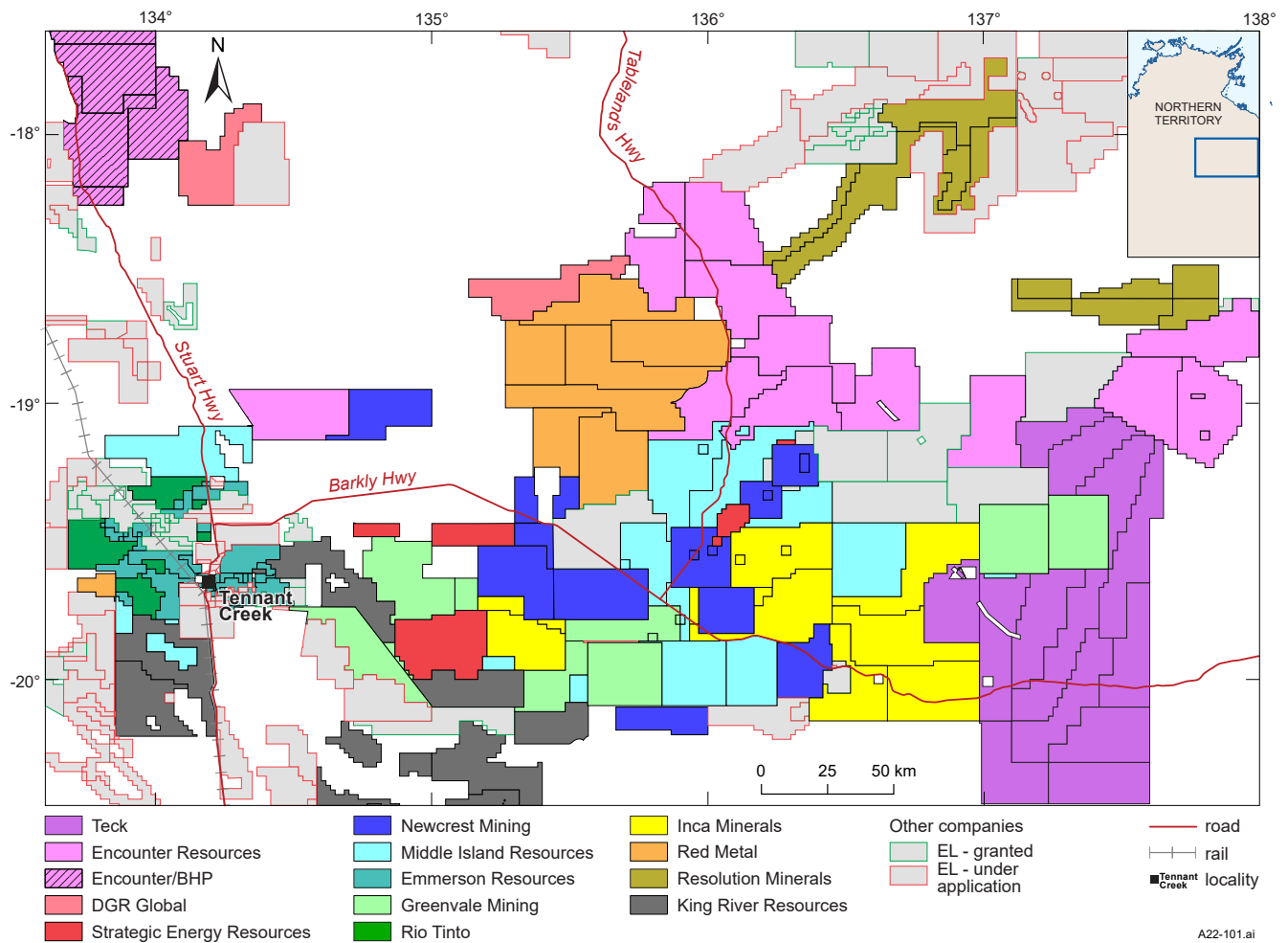


Figure 4. Map of exploration licences and applications in the Barkly Tableland in February 2022, showing the distribution of tenure for selected exploration companies.

project in January 2021, the company continued feasibility studies and substantial resource drilling through 2021 at the Reward, Bellbird and Rockface deposits. Notable intersections include 22.67 m at 2.14% Cu, 18.3 g/t Ag and 0.37 g/t Au at Reward; and 5.45 m at 3.62% Cu, 15.8 g/t Ag and 0.15 g/t Au (including 2.22 m at 8.08% Cu, 32.6 g/t Ag, 0.30 g/t Au) at Bellbird. Drilling at the Rockface deposit intersected a chalcopyrite- and bornite-rich massive sulfide shoot at Rockface North that has been intersected at least 160 m up and down plunge. Best intersections included 3.5 m at 23.6% Cu and 503 g/t Ag (including 1.51 m at 37.4% Cu and 1106 g/t Ag) and 4.21 m at 20.5% Cu and 302 g/t Ag (including 0.84 m at 61.4% Cu and 521 g/t Ag). In January 2022, KGL Resources announced resource updates for the Reward and Bellbird deposits, with Mineral Resources of 13.58 Mt at 1.80% Cu, 32.8 g/t Ag, and 0.31 g/t Au at Reward; and 5.76 Mt at 1.97% Cu, 12.1 g/t Ag, and 0.14 g/t Au at Bellbird. A resource upgrade at Rockface is pending. The company also announced a new brownfields discovery at Cox's Find, 1.5 km northeast of Rockface, based on drilling of a deep IP anomaly. Drilling returned a chalcopyrite- and bornite-bearing intersection of 2.53 m at 1.92% Cu and 14.7 g/t Ag. The company plans to finalise their Feasibility Study in mid-2022.

IGO Ltd continued greenfields exploration in the remote southwestern Aileron Province, 400 km west of Alice Springs, as part of their Lake Mackay exploration alliance with Prodigy Gold. Systematic exploration since 2014 has led to the discovery of polymetallic mineralisation at a number of new prospects. In March 2021, the company commenced



Figure 5. Co-funded drilling at the Cottage copper-gold prospect, Barkly Tableland, September 2021 (Source: Strategic Energy Resources, ASX Release 15 September 2021).

a three-hole diamond drilling program at the **Phreaker** prospect, located 14 km to the south of the Grapple and Bumblebee prospects. The holes targeted EM conductors that were believed to be associated with base metal mineralisation previously identified in shallow RC drilling in 2019. All holes intersected copper-gold mineralisation between 75 m and 430 m below previous RC drilling, with best intersections of 4.5 m at 3.03% Cu, 1.78 g/t Au and 14 g/t Ag from 562 m, and 17.5 m at 2.13% Cu, 0.21 g/t Au and 9 g/t Ag from 575.23 m. Drilling at Phreaker has now defined copper, gold and silver mineralisation over 650 m of strike length and 430 m vertically, with mineralisation open along strike and down dip. IGO have reported that they consider Phreaker to be the largest mineralised copper-gold prospect identified to date in the southwestern Aileron Province. Collaborative funded diamond drilling was also completed in 2021 at the Raw and Customisable EM targets, 20 km west-southwest of the Andrew Young Hills; the drilling intersected sulfide with low grades of copper and zinc.

During 2021, Prodigy Gold undertook exploration at their Reynolds Range exploration project area in the central Aileron Province, including at the **Reward** and **Scimitar** copper prospects. A 260 m diamond hole was drilled at Reward to test an EM conductor located 350 m southeast from the historic Reward mine that averaged 11% Cu. Narrow intersections of sulfidic sedimentary rocks were intersected in the target position. Three RC holes were drilled at Scimitar, testing the bedrock source of soil and rock-chip copper-gold anomalies. Narrow intersections of low-grade copper were intersected.

In August 2021, Eastern Metals Limited completed the acquisition of EL23186 near Barrow Creek from Wesfarmers Ltd (formerly owned by Kidman Resources Ltd). The tenement includes the **Home of Bullion** polymetallic deposit, which has a combined Indicated and Inferred Mineral Resource of 2.5 Mt at 1.8% Cu, 2.0% Zn, 1.2% Pb, 36 g/t Ag, and 0.14 g/t Au. The company has announced that they are planning resource expansion drilling in 2022.

In June 2021, Inca Minerals Ltd announced the results of reconnaissance exploration at the Jean Elson project area 40–60 km southeast of Jervois. Rock chip samples at the Ningaloo prospect at **Camel Creek** included one sample assaying 3.21 g/t Au and 1.89% Cu, and numerous copper-rich assays associated with quartz-hematite veins. The company reported that copper-dominant mineralisation was now observed over a 1.25 km-wide zone, which remains open in all directions. In late 2021, the company undertook a NTGS co-funded airborne magnetic–radiometric survey over the Jean Elson project area.

Sediment-hosted copper and/or zinc – greater McArthur Basin, Lawn Hill Platform and South Nicholson Basin

The **McArthur River** mine, situated 70 km southwest of Borroloola in the McArthur Basin, is operated by McArthur River Mining Pty Ltd (MRM), a subsidiary of Glencore plc. At 31 December 2021, the McArthur River mine had total Reserves and Resources of 152 Mt at 9.9% Zn, 4.5% Pb and 46 g/t Ag, including Ore Reserves of 91 Mt at 8.8% Zn, 4.1% Pb and 41 g/t Ag. During 2021, MRM produced 279 600 t of

zinc, 55 200 t of lead and 1.803 Moz of silver in concentrate. The company stated that as of the end of 2021, the expected mine life is about 19 years based on Ore Reserves, and up to an estimated 29 years based on the life of mine schedule inclusive of all available Mineral Resource categories.

A second major shale-hosted zinc resource occurs at Teck Resources Limited's **Teena** zinc deposit, 10 km west of the McArthur River mine, which was discovered in 2013. The 2016 Inferred Mineral Resource at Teena is 58 Mt at 11.1% Zn and 1.6% Pb for 6.5 Mt of zinc and 0.9 Mt of lead metal (at a 6% Zn+Pb cut-off). No exploration results have been publicly reported from Teena during 2021. The company also has an option and joint venture agreement with Sandfire Resources Ltd over Sandfire's North Batten tenements in the northern Batten Fault Zone area, under which they have the right to earn up to a 75% interest in the project by spending \$27 million on exploration over ten years.

In May 2021, following a successful program of validation of existing datasets, BHP Limited exercised its option to enter into a formal farm-in and joint venture agreement in Encounter Resources Limited's Elliott project, located near Elliott and Newcastle Waters. In October 2021, four additional tenements were added to the Agreement, increasing the area to 7200 km² and also increasing BHP's earn-in amount to \$25 million to earn a 75% interest. The project is targeting the undercover southwestern margin of the Beetaloo Sub-basin for sediment-hosted copper mineralisation.

Encounter Resources also have a large tenement holding across the Barkly Tableland, predominantly targeting sediment-hosted copper based on release of new datasets across the region by Geoscience Australia and NTGS. This includes the Carrara project, 110 km north of the Barkly Highway close to the Queensland border, which is targeting sediment-hosted copper and zinc in potential Isa Superbasin rocks identified through the 2017 GA-NTGS South Nicholson Seismic Survey and MinEx CRC Carrara-1 drillhole. Teck Resources have also taken a large tenement holding extending from this area south-southwest to the Barkly Highway (**Figure 4**). During 2021, Red Metal Ltd applied for seven tenements on the western end of the newly identified Brunette Downs rift corridor, targeting copper and zinc mineralisation in Isa Superbasin sediments.

During 2021, Redbank Copper Ltd ramped up exploration activity across its tenure holding in the southern McArthur Basin, including at the **Redbank** copper project. The company completed a 30 hole, 3500 m RC drilling program on IP targets east of the Bluff copper deposit at Redbank. A 700 m stratigraphic diamond hole was also drilled between the Azurite and Punchbowl deposits to test the geology beneath the breccia pipes at Redbank; this hole was co-funded by NTGS through the GDC program. The company also completed a regional VTEM survey, two lines of magnetotelluric surveys, and regional soil sampling. In June 2021, a revised Inferred Mineral Resource for seven breccia pipes at Redbank was announced, totalling 8.4 Mt at 1.1% Cu for 88 600 t of contained copper.

In August 2021, Resolution Minerals Ltd announced that OZ Minerals Limited had signed a farm-in and joint

venture agreement on the Wollgorang copper project, north of Redbank, under which OZ Minerals can earn a 51% interest in the project by spending \$4.9 million over 5 years. During the year, Resolution Minerals also completed a 2000 km VTEM survey over the Wollgorang project area that identified 40 conductors, 37 of which are untested by drilling.

Resolution Minerals also commenced exploration at their **Benmarra** project on the margin of the South Nicholson Basin and Lawn Hill Platform adjacent to the Murphy Province. Following a VTEM survey acquired during 2021, the company undertook a 15-hole RC drilling program that intersected thick, pyritic, carbonaceous and dolomitic siltstones and shales, which are associated with flat lying VTEM anomalies. The company also announced that geochemistry from the drilling indicated the presence of Fe-Mn alteration associated with the prospective units, and the presence of an anomalous thallium trend increasing from the west-northwest to east-southeast.

Nickel-copper-cobalt

Most reported exploration for nickel in the NT is undertaken by IGO Ltd, who have three large project areas in central Australia. IGO have identified new surficial nickel-cobalt prospects (Grimlock and Swoop) overlying weathered mafic and ultramafic rock at their Lake Mackay joint venture with Prodigy Gold, located in the southwestern Aileron Province. No further on-ground exploration was reported at these prospects in 2021. The company also has a large 100%-owned tenement package at their Raptor project area, along the 'Willowra Gravity Ridge' in the northern Aileron Province, over an east-west extent of more than 400 km. IGO have reported that historic exploration over the region in the 1990s included an intercept of 4 m grading 1.35% Ni and 0.21% Cu in a metagabbro at the Osprey target, and 28 m grading 0.32% Ni and 0.31% Cu in an amphibolite at the Kestrel target. The company has collected airborne geophysical data across the entire belt through collaborative funding programs with NTGS and are planning a co-funded airborne electromagnetic survey over the Kestrel target in 2022. During 2021, IGO applied for another province-scale tenement package over more than 11 000 km² in the Irindina Province, east of Alice Springs.

Lithium

2021 was a strong year for the Territory's lithium sector with the Territory's first lithium mine commencing construction and a number of new players entering the Territory to explore for lithium.

Pine Creek Orogen

On 30 September 2021, Core Lithium Ltd announced the final investment decision for the development of a lithium mine at the Grants deposit within their **Finniss** lithium project, with construction commencing by late October. The Finniss project forms part of the Bynoe pegmatite

field, 20–50 km south-southwest of Darwin. Lithium mineralisation in the Bynoe field occurs as spodumene in north-trending pegmatites up to 40 m in width, along a 30 km north-trending corridor. The combined Mineral Resource at Finniss is 14.72 Mt at 1.32% Li₂O for 208 600 t Li₂O. In July 2021, the Ore Reserve was increased to 7.4 Mt at 1.3% Li₂O, supporting a 8-year life of mine based on open pit mining methods at the Grant and Hang Gong deposits and underground mining methods at the Grants, BP33 and Carlton deposits. Core Lithium continued resource drilling programs during 2021, along with additional regional exploration drilling. At the BP33 deposit, two deep diamond drillholes produced intersections of 57.35 m at 1.83% Li₂O and 51.0 m at 1.63% Li₂O. A further 2 diamond holes and 7 RC holes were drilled to test southern extensions to the BP33 system and confirmed that a spodumene-bearing pegmatite extends to the south beyond the limits of the existing resource. Reported intersections from regional RC drilling include 14 m at 1.37% Li₂O from the Ah Hoy prospect, and 6 m at 1.79% Li₂O and 11 m at 1.23% Li₂O from the Far West prospect. The company also acquired six mining leases adjacent to the Finniss project, and drilled 29 RC holes to test ten separate targets. Of results reported to date, the Centurion prospect had the best results, including 2 m at 2.26% Li₂O and 22 m at 0.74% Li₂O. Other pegmatites also contained significant grades of tin, tantalum and niobium.

In August 2021, newly listed Charger Metals NL commenced exploration on their **Bynoe** lithium project on tenements formerly owned by Lithium Australia NL, located 10–20 km south-southwest of Core Lithium's Grants deposit. The project area includes numerous known pegmatites, many of which were historically worked for tin and tantalum. Exploration undertaken in 2021 included the collection of 3034 soil samples and an airborne magnetic survey.

Aileron Province

In the northern Aileron Province in central Australia, a number of companies commenced exploration for pegmatite-hosted lithium associated with the Barrow Creek and Mount Peake pegmatite fields, an area where Core Lithium also has a substantial tenement position. During 2021, Australasian Metals Ltd commenced reconnaissance at their **Mount Peake** project area, with rock chip samples up to 1.61% Li and 223 ppm Ta. Australasian Metals also acquired a 90% interest in five exploration tenements from Prodigy Gold east of Barrow Creek in the Barrow Creek pegmatite field.

In January 2022, Askari Metals Ltd commenced reconnaissance exploration at their **Barrow Creek** lithium project on exploration tenure acquired from Consolidate Lithium Pty Ltd. Eastern Metals announced plans to commence lithium exploration at their tenements east of Barrow Creek. Private company Lithium Plus Minerals Ltd also have tenements for lithium in the northern Aileron Province, but no exploration results have been publicly released.

Rare earth elements

Arafura Resources Ltd continued to progress the **Nolans** rare earth-phosphate project located in the Reynolds Range, 135 km northwest of Alice Springs. Measured, Indicated and Inferred Mineral Resources at Nolans total 56 Mt at 2.6% total rare earth oxides (TREO) and 11% P_2O_5 , containing 1.46 Mt REO. Twenty-six percent of the rare earths in the resource are neodymium and praseodymium (NdPr). Proven and Probable Reserves totalling 29.5 Mt at 2.9% TREO and 13% P_2O_5 , supporting a mine life of at least 33 years with nameplate production of 4400 tpa NdPr oxide from an on-site separation plant. During 2021, the company continued development studies, including Front-End Engineering Design (FEED), and progressed financing and offtake arrangements. Arafura Resources is targeting a final investment decision in the second half of 2022.

Canadian company Megawatt Lithium and Battery Metals Corp have exploration tenements in the Aileron province for rare earths, including the Arctic Fox project close to Nolans, and the Isbjorn project located north of the Charley Creek alluvial rare earth resource. No on-ground exploration was reported in 2021.

Energy Metals announced that they had undertaken reconnaissance rare earths exploration during 2021 at their Crystal Creek project area, 45 km west of Yuendumu. Anomalous rare earths values were identified, associated with ironstone dykes, quartz blows and vein systems; they also reported anomalous rare earths values (up to 0.33% TREO) in rock-chips over 3 km of strike length, and extensive REE-in-soil anomalies ($La + Ce > 140\text{ppm}$) that remain open in three directions.

Tungsten (-molybdenum)

In late 2021, Thor Mining PLC announced the results of drilling at their **Molyhil** tungsten-molybdenum project located near the Plenty Highway northeast of Alice Springs. The 3 hole, 995 m diamond drilling program tested a large magnetic target that was interpreted to be a potential extension to the known Molyhil tungsten-molybdenum-copper mineralisation. The second and third holes in the program intercepted over 45 m and 29 m respectively of disseminated scheelite-molybdenite-chalcopyrite mineralisation in a massive magnetite-rich skarn. The company announced that this extension of mineralisation directly south of the deposit has significant positive implications for the future of the project. Mineral Resources at Molyhil (as of October 2019) are 4.71 Mt at 0.28% WO_3 , 0.14% Mo, 0.05% Cu and 18.1% Fe, most of which are in the Indicated category.

Vanadium

TNG Limited's **Mount Peake** project contains a vanadium–titanium–iron deposit hosted in the Mount Peake Gabbro in the northern Aileron Province, 60 km west-southwest of Barrow Creek. It contains Measured, Indicated and Inferred Mineral Resources of 160 Mt at 0.28% V_2O_5 , 5.3% TiO_2 and

23.0% Fe; and a Probable Ore Reserve of 41.1 Mt at 0.42% V_2O_5 , 7.99% TiO_2 and 28.0% Fe (using a cut-off grade of 15% Fe). In September 2021, the company announced a strategic change for the project whereby the site of the proposed TIVAN processing facility will move from Middle Arm near Darwin to the Mount Peake mine site.

Diamonds

In May 2021, Lucapa Diamond Company Ltd announced that it had entered into a binding agreement to acquire the **Merlin** diamond project in the McArthur Basin from Merlin Diamonds Ltd (in liquidation). The acquisition was completed in December 2021. Merlin comprises 14 kimberlite pipes of which nine were subject to open cut mining between 1998 and 2003, producing 507 000 ct of diamonds. The Indicated and Inferred Mineral Resources are 27.8 Mt at 0.16 c/t for a total of 4.35 Mct of diamonds. In October 2021, the company commenced a geotechnical drilling program at Merlin; and in December 2021, released a scoping study is based on a processing capacity of 1.2 Mt per annum for an average annual diamond production of 153 000 ct over a 14 year mine life. They are targeting commercial production for 2024.

Bauxite

Rio Tinto Limited operates the **Gove** bauxite mine in northeastern Arnhem Land, which has been in production since 1971. Bauxite at Gove occurs in deeply lateritised, dissected plateau remnants overlying the Cretaceous Yirrkala Formation. At the end of 2020, the Gove operation had Proven and Probable Ore Reserves of 80 Mt at 50.4% Al_2O_3 , with additional Measured, Indicated and Inferred Mineral Resources of 34 Mt at 48.7% Al_2O_3 . During 2021, the Gove operation produced 11.76 Mt of bauxite, a 4% decrease on 2020. Bauxite production in the Gove region also includes a second mining operation on the **Dhupuma Plateau**, immediately south of the Gove mineral lease. This mine is operated by the Aboriginal-owned Gulkula Mining Company Pty Ltd and is associated with a Mining Training Centre for local Aboriginal people. The ore is sold to Rio Tinto's Gove operation.

Iron ore

In November 2021, Nathan River Resources Pty Ltd placed their **Roper Bar** iron ore mine into care and maintenance. The company had recommenced mining at Roper Bar, 55 km southeast of Ngukurr, in October 2020, with planned production of 1.5 Mtpa of ore exported through the port of Bing Bong.

In May 2021, Vietnamese steel maker Hoa Phat Group announced that it had acquired the **Roper Valley** project, located 150 km east of Mataranka, which is geologically similar to the Roper Bar project. The company announced that the project is expected to have a mining capacity of 4 Mtpa.

The **Frances Creek** iron ore deposit, north of Pine Creek in the Pine Creek Orogen, has been the Territory's largest

historical iron ore producer with production occurring from 1966–1974 and 2007–2014. In June 2021, NT Bullion Pty Ltd shipped 30 000 t of beneficiated ore from stockpiles at Frances Creek through the Darwin port.

CuFe Ltd (formerly Fe Ltd) holds a 50% share of, and operates, the **Yarram** iron project near Batchelor; they have announced an exploration target of 4–6 Mt at 60–62% Fe. No drilling was reported in 2021.

Manganese

Oolitic and pisolitic ore in Mesozoic sedimentary rocks on **Groote Eylandt** in the Gulf of Carpentaria forms one of the world's highest grade manganese deposits; it has remaining Mineral Resources as at 30 June 2021 totalling 147 Mt at 43.4% Mn, with Proven and Probable Ore Reserves of 44 Mt at 43.2% Mn (ROM) and 7.1 Mt at 40.0% Mn (Sands). The mineralisation is a stratiform sedimentary deposit in shallow marine Cretaceous sedimentary rocks and is commonly oolitic or pisolitic. It was discovered in 1960 and has been continuously mined by the Groote Eylandt Mining Company (GEMCO) since 1966. GEMCO is majority owned by South32 Limited. Production from Groote Eylandt in 2020/21 totalled 5.88 Mt of manganese ore, up 2% on the previous year.

Winchelsea Mining Pty Ltd continued to progress their **Winchelsea Island** manganese project, located off the northwest coast of Groote Eylandt. The company is a joint venture between the Anindilyakwa Advancement Aboriginal Corporation (representing the two Traditional Owner clans of Winchelsea Island) and AUS China International Mining. Exploration has delineated two zones of manganese mineralisation that display significant geological and grade continuity, with combined near-surface mineralised intervals that are generally 2 m in thickness and locally up to 5 m. In May 2021, the company submitted a revised referral document to the NT Environment Protection Authority (NT EPA) for a staged open cut mine plan that targets an annual production rate of ~600 000–700 000 t with a potential mine life of 12 years; the NT EPA subsequently issued Terms of Reference for an Environmental Impact Statement in November 2021. The company applied for a mining lease over the mineralisation in April 2021. The JORC Resource for the project has not been publicly announced.

In December 2021, mining was completed at the **Bootu Creek** manganese mine, 110 km north of Tennant Creek. OM Manganese Ltd began mining operations at Bootu Creek in November 2005. During 2021, the company mined 1.13 Mt of ore at 20.85% Mn, and produced lumps and fines totalling 738 019 t at 28.42% Mn, a 16% increase on 2020. At the end of 2021, OM Manganese announced that mining of Shekuma 8, the final remaining viable pit, was completed on 13 December 2021 and that processing of the remaining feedstock would continue until January 2022. With the completion of mining and the cessation of operation of the main processing plant, the company plans to enter into standalone processing of tailings and rejects through the ultra-fines plant (UFP). At January 2022, bulk processing trials were being conducted along with a re-assessment of

the UFP project's financial viability. The remainder of the operation will be under care and maintenance.

Mineral sands

In 2020–21, Australian Ilmenite Resources Pty Ltd produced 37 200t of ilmenite concentrate from the **Sill 80** ilmenite mine in the Roper region (**Figure 2**). Ilmenite at Sill 80 occurs in surficial cover overlying sills of Derim Derim Dolerite intruding the Roper Group.

Phosphate

Verdant Minerals Ltd's **Ammaroo** phosphate project is located in the southern Georgina Basin, 80 km east of Barrow Creek. The project has Indicated Mineral Resources of 165 Mt at 15.5% P_2O_5 , and total Measured, Indicated and Inferred Mineral Resources of 1.141 Bt at 14% P_2O_5 (using a 10% P_2O_5 cut-off). During 2021, the company commenced a definitive feasibility study based on the proposed development of ammonium phosphate fertiliser production, with the study due to be completed in the second half of 2022.

A second major phosphate project in the Georgina Basin is Avenira Limited's **Wonarah** project, which has a Measured Resource of 64.9 Mt at 22.4% P_2O_5 , an Indicated Mineral Resource of 133 Mt at 21.1% P_2O_5 and Inferred Mineral Resource of 353 Mt at 21% P_2O_5 (using a 15% P_2O_5 cut-off). During 2021, the company progressed a scoping study for phosphoric acid production, with a view to supplying the lithium ferro-phosphate cathode market as well as the fertiliser market.

Uranium

The past year saw a significant uptake in exploration tenure applications for uranium, particularly in the Aileron Province, Ngalia Basin, and Amadeus Basin in central Australia. New entrants into uranium exploration included URO Corporation Pty Ltd, which applied for tenements for uranium and other minerals; and Core Uranium Pty Ltd, which applied for a large area of ground in the southern Amadeus Basin. Despite this, on-ground exploration for uranium was subdued in 2021, in part due to Covid-related access restrictions.

In January 2021, **Ranger**, the Territory's only operating uranium mine, ceased production after 40 years of continuous operation during which ~132 000 t of uranium oxide was produced. Energy Resources of Australia Ltd produced 34 t of uranium oxide from the Ranger mine in 2021 prior to the end of processing on 8 January. The company no longer reports any Mineral Reserves or Resources for the Ranger project area but still reports a Mineral Resource of 25.1 Mt at 0.55% U_3O_8 for the Jabiluka deposit, which remains in care and maintenance.

Vimy Resources Ltd continued to explore the King River–Wellington Range project in western Arnhem Land and assumed 100% of the project after acquiring Rio Tinto's share of the joint venture in early 2021. The project contains the **Angularli** prospect that was discovered by Cameco Corporation and which has a 2018 Inferred

Mineral Resource of 0.91 Mt at 1.3% U_3O_8 for 11 558 t of U_3O_8 . The field program for 2021 was substantially impacted by Covid-19, with the only reported fieldwork comprising a soil sampling program at the Angularli North, Bandooge, Such Wow North and Southern Flank prospects. Covid-related access issues also impacted other explorers in western Arnhem Land, with substantially no on-ground work reported by DevEx Resources Ltd and Alligator Energy Ltd, although both companies announced plans for drilling programs in 2022.

In central Australia, significant sandstone-hosted uranium deposits occur in the Ngalia and Amadeus Basin. These include the **Bigirlyi** uranium deposit, which is subject to a joint venture operated by Energy Metals Limited and has a Mineral Resources of 7.5 Mt at 0.13% U_3O_8 and 0.12% V_2O_5 ; and the Angela uranium deposit near Alice Springs (10.7 Mt at 0.13 U_3O_8), owned by Elevate Uranium Limited (formerly Marenica Energy Ltd). Neither company reported on-ground exploration in 2021.

In November 2021, Eclipse Metals Ltd announced that it had executed a Heads of Agreement with Oz Yellow Uranium Limited in which it conditionally agreed to sell its interests in its Ngalia Basin uranium projects as well as the Liverpool uranium project in western Arnhem Land.

Onshore petroleum exploration and production highlights

Petroleum exploration activity in the onshore basins of the Northern Territory accelerated in 2021, with most activity focused on the Beetaloo Sub-basin and the Amadeus Basin. The year also saw an increase in activity for helium and hydrogen exploration. **Figure 6** shows granted petroleum tenure and basins in the Territory, and the location of wells and fields mentioned in the text.

McArthur Basin

The **Beetaloo Sub-basin** is a significant depocentre of Mesoproterozoic Roper Group sedimentary rocks that underlies the Mesozoic Carpentaria Basin in the vicinity of Dunmarra and Daly Waters, and which is the Territory's most advanced shale gas play. The most prospective shale units in the Roper Group occur within the Velkerri and Kyalla formations. Drilling of the middle Velkerri Formation has demonstrated the consistent presence of gas-saturated, quartz-rich shale source rocks that are mature for gas over extensive areas, and which appear to meet all of the physical and chemical parameters for a successful shale gas play. Wells drilled to date by industry, and associated discovery reports, indicate a P50 Gas-In-Place Resource for the Velkerri B-shale alone of at least 500 Tcf, with the additional potential for liquids across the basin.

Exploration in the central part of the Beetaloo Sub-basin is operated by Origin Energy Limited in joint venture with Falcon Oil & Gas Ltd. In August 2021, the company performed extended production testing at **Amungee NW-1H**, a 3808 m well 60 km east of Daly Waters that includes an 1100 m horizontal section. The well was originally drilled and production tested in 2015–16, with

production averaging 1.1 MMscf/d (million standard cubic feet per day). The results of a production log test in 2021 indicated that most production was sourced from only four of the 11 hydraulic stimulation stages, and on this basis, normalised gas flow rates are now estimated to be 5.2–5.8 MMscf/d per 1000 m of horizontal section.

During 2021, Origin Energy undertook flow testing at the **Kyalla 117 N2-1** well, which was spudded in October 2019, targeting the liquids-rich shale gas play in the Kyalla Formation. The well was drilled to a vertical depth of 1895 m, and hydraulic stimulation of a 1579 m lateral section occurred in September 2020. In January 2021, the well flowed unassisted for 17 hours with initial gas composition data indicating liquids-rich gas with 65% methane, 18.8% ethane and a C3+ gas component of 14.4%, with low CO_2 (0.9%). Extended production testing at Kyalla 117 during 2021 demonstrated liquids-rich gas flows for intermittent periods although production was not sustained.

In August 2021, Origin Energy spudded a well to test the Velkerri wet gas play (**Velkerri 76 S2-1**), which was successfully drilled to a vertical depth of 2129 m; the well demonstrated the stratigraphic continuity of the prospective Amungee Member of the Velkerri Formation towards the eastern flank of the sub-basin within the wet gas window. Preliminary petrophysical interpretation of the well confirmed the reservoir quality of the B-shale, with 4.3% total organic carbon over a gross thickness of 54.9 m. Further testing of Velkerri 76 is planned.

Santos Limited also have exploration tenure in the eastern Beetaloo Sub-basin in joint venture with Tamboran Resources Limited. In August 2021, Santos completed drilling the **Tanumbirini-2H** horizontal well in EP161 to a total depth of 4598 m, including a horizontal section of over 1000 m in the B-shale of the Amungee Member. A second horizontal well (**Tanumbirini-3H**) was spudded in August and was drilled to a total depth of 4857 m. In late December 2021, Santos completed fracture stimulation of both horizontal wells and commenced flow testing. Following a weather-related event in January 2022, flow rates from the Tanumbirini-2H peaked at 4.0 MMscf/d and subsequently stabilised at a 14-day average of 1.7 MMscf/d over a 660-metre, unoptimised fracture stimulated horizontal section (normalised at 2.6 MMscf/d over 1000 m). Flow rates in the Tanumbirini-3H well peaked at 10.0 MMscf/d following shut-ins for the same weather-related event and planned maintenance. The well subsequently stabilised at a 10-day average of 1.5 MMscf/d over a 600-metre, unoptimised fracture stimulated horizontal section (normalised at 2.5 MMscf/d over 1000 m). Tamboran Resources reported that modelling indicates the Mid-Velkerri shale is capable of flowing gas in excess of 5 MMscf/d per 1000-metres. In February 2022, the company reported that the Unrisked 2C Contingent Gas Resource for EP161 is 610 billion cubic feet (Bcf).

In September 2020, Empire Energy Group Ltd spudded the **Carpentaria-1** well near the eastern margin of the Beetaloo Sub-basin; it was drilled to a depth of 1916 m and intersected extensive intervals of liquids-rich gas within shales of the Velkerri Formation. In October 2021, the company announced the result of hydraulic stimulation and

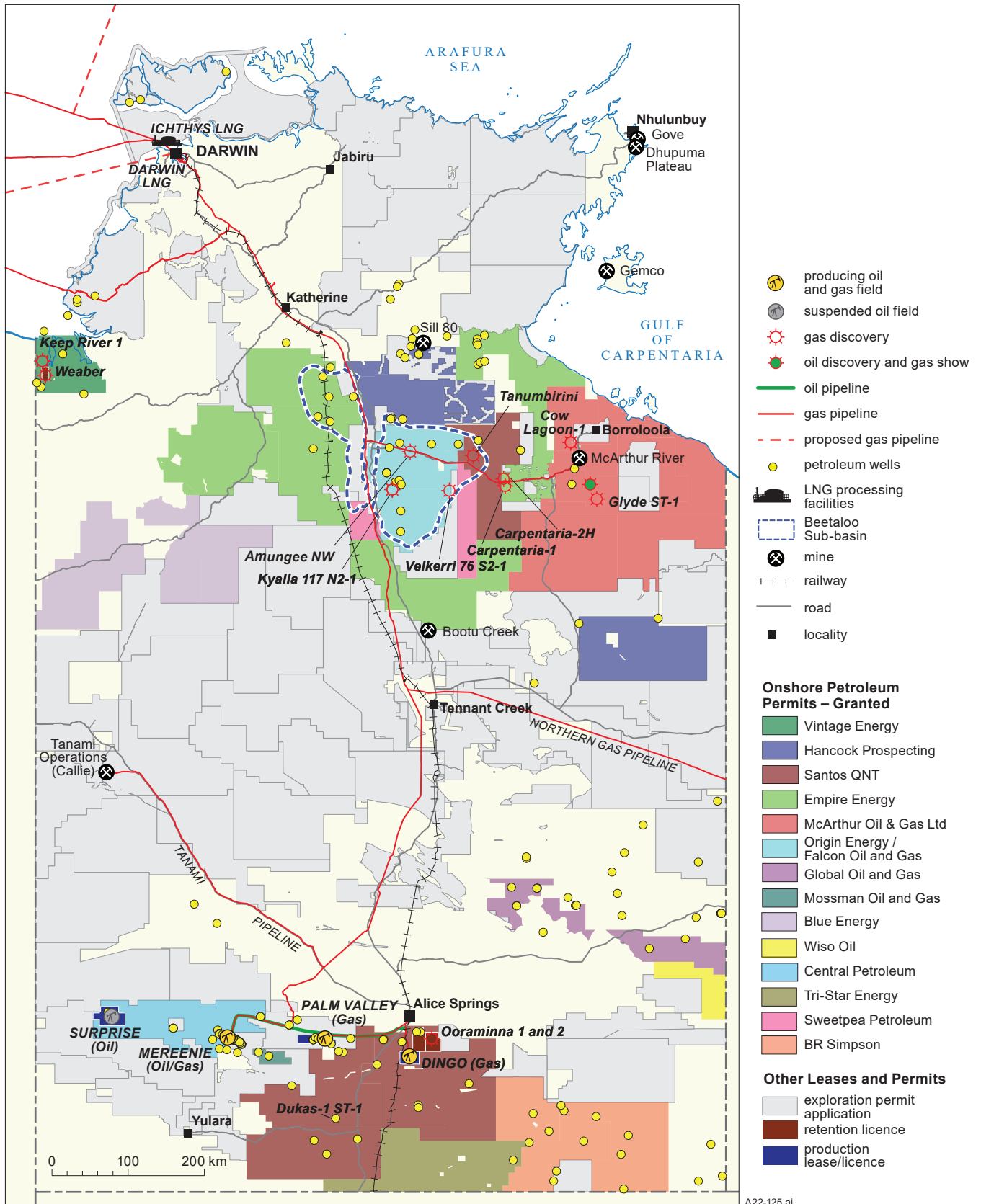


Figure 6. Map of granted petroleum exploration permits in the onshore Northern Territory as of March 2022, coloured by operator, along with names of wells and fields mentioned in the text.

flow testing of the vertical well, with an average flow rate of 0.364 MMscf/d over 10 days. In November 2021, Empire Energy spudded the **Carpentaria-2H** horizontal appraisal well, 11 km north of Carpentaria-1. The vertical section

of the well intersected 192 m of liquids-rich shale gas net pay across the four middle Velkerri pay zones (Velkerri A, B, Intra A/B and C). The well was drilled to a total measured depth of 3150 m with the horizontal section of

1345 m wholly placed within the Velkerri B Shale target window. Fracture stimulation and flow testing of the well is scheduled for 2022. The company also acquired a seven-line, 164 km seismic survey in same area as the Carpentaria wells. Following the 2021 work program, Empire Energy announced a 2C Contingent Resource of 396 Bcf gas and a 2U Prospective Resource of 4.25 trillion cubic feet (Tcf) gas.

In April 2021, Empire Energy announced that it had acquired Pangaea (NT) Pty Ltd's tenements in the western Beetaloo Sub-basin, which contain a 2C Contingent Resource of 129.9 Bcf gas and a 2U Unrisked Prospective Resource of 22.78 Tcf gas and 630 MMbbl liquids.

During 2021, Armour Energy Limited continued to progress the proposed demerger of their assets in the Northern Territory into a new entity named McArthur Oil and Gas Limited. In July 2021, the company announced that they had completed a large airborne survey over their McArthur Basin prospects, aimed at detecting anomalies in areas of upward fluid flow of migrating hydrocarbons above fluid pathways and/or hydrocarbon accumulations

South Nicholson Basin/Lawn Hill Platform

In early 2021, Armour Energy announced the completion of the sale and purchase agreement to sell their remaining shares in several South Nicholson Basin permits in Queensland and the Northern Territory to Santos, including EPA172 and 177.

Amadeus Basin

The Territory's current onshore gas production is entirely sourced from fields in the Amadeus Basin operated by Central Petroleum Limited. In 2021, 14.456 billion standard cubic feet (Bscf) of gas was produced in the onshore NT, a 6% increase on 2020. This comprised 10.633 Bscf from Mereenie, 2.486 Bscf from Palm Valley and 1.337 Bscf from Dingo. Onshore oil production in the Territory in 2021 was sourced entirely from the Mereenie Field, with 0.159 million barrels (MMbbl) of oil produced. Proven and Probable (2P) gas reserves (at July 2020) are 91.8 PJ gas and 0.97 MMbbl oil at Mereenie, 27.7 PJ gas at Palm Valley, and 36.1 PJ gas at Dingo.

During 2021, Central Petroleum drilled and brought into production two new wells at Mereenie. Sustained gas flows were recorded from the shallower Stairway Sandstone

interval above the primary production target (Pacoota Sandstone), increasing the potential for additional reserves to be added with future appraisal. A two well exploration program is scheduled to commence in March 2022, with the first well (Palm Valley Deep) targeting the Arumbera Sandstone below the producing Pacoota Sandstone at Palm Valley, and the second well (Dingo Deep) targeting the Pioneer Sandstone and Areyonga Formation at Dingo.

Central Petroleum also have a farm-in agreement with Santos targeting sub-salt and intra-salt plays of the Neoproterozoic lower Gillen-Heavitree System in the southeastern part of the basin, which have potential for large gas, helium and hydrogen accumulations. In October 2021, Santos farmed down its interest to 30% and introduced a new joint venture partner, Peak Helium Pty Ltd, to progress the re-drilling of the Dukas-1 well, which was drilled by Santos in 2019 to 3704 m before being suspended after encountering an over-pressured zone above the target reservoir formation. Santos will remain operator of the joint venture, with the re-drilling of Dukas currently scheduled for early 2023.

In February 2022, Central Petroleum farmed out interests in a number of its southeastern Amadeus Basin exploration tenements to Peak Helium Pty Ltd. Under the farm out, Central Petroleum will be free carried by Peak Helium for two new sub-salt exploration wells, one at Mt Kitty and the other at either Magee or the nearby Mahler prospect. Peak Helium also has a 100%-owned exploration permit on the southeastern margin of the basin.

Mosman Oil and Gas Limited continued to explore for multiple plays for hydrocarbons, helium and hydrogen in EP145, located east-southeast of Mereenie. During 2021, the company acquired an airborne gravity gradiometry survey that enabled high resolution basement modelling, highlighting a basement high that Mosman consider is analogous to gas and helium sub-salt prospects elsewhere in the basin.

Georgina Basin

In late 2021, Global Oil and Gas Pty Ltd commenced exploration for helium and hydrogen on EP127 on the southern margin of the Georgina Basin. The company undertook a near-surface, helium soil gas sampling program across 49 sites and identified an area of elevated helium gas values that the company reported was an indication of an active helium system in the area.