CRITICAL MINERALS OUTLOOK

Strategic moves boost sector

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Huge investment needed to meet demand

High-profile action by the Biden administration in the US has highlighted the strategic need for certain minerals – those considered essential for modern technologies, economic prosperity and defence and with supply chain vulnerabilities.

Countries are increasingly seeking domestic or alternate supply chains to China, which currently controls most of the market for processing and refining for cobalt, lithium, rare earth elements (REEs) and other critical minerals.

Against this backdrop, analysts and industry groups agree billions of dollars in investment are needed to ramp up to meet demand and a picture is emerging of likely supply shortfalls across a range of critical minerals.

These developments have lit a fire under the share prices of mining companies exposed to a range of critical minerals and could help speed up supply, at a time the sector faces headwinds including increasing environmental, social and governance (ESG) considerations, supply-chain disruption and geopolitical tensions that have threatened imports.

It would be a Herculean task to provide in-depth coverage of every single mineral deemed critical, so – given recent developments and using *Mining Journal*'s editorial expertise – this report will focus on hot commodity lithium, the nascent REEs sector, plus nickel and zinc, given the latter two metals' recent inclusion on the US list.

"Billions of dollars in investment are needed to ramp up to meet demand"

Ngaire McDiarmid , Mining Journal

Contributors: Tim Treadgold, John Robertson and Andreas Walstad.

Incentives emerge to tackle demand shortfall

by Ngaire McDiarmid

The US has upped the ante in the race to secure critical minerals amid a forecast demand surge, and to reduce its heavy reliance on China for supply and processing.

Critical minerals play a key role in many of today's rapidly growing clean-energy technologies and some are more well-known for being part of the battery minerals suite, such as lithium and graphite.

Overall, mineral requirements for clean-energy technologies are expected to rise up to sixfold under a "net zero emissions by 2050" scenario, according to the International Energy Agency (IEA). As for which minerals are deemed critical, the US list has grown to 50, with additions including nickel and zinc, while REEs and platinum group minerals (PGMs) were split into individual entries.

Copper – central to electrification and predicted to have a massive supply shortfall within the decade – did not make the US list, due to its level of domestic production and therefore low disruption potential.

The red metal made Canada's list of 31 critical minerals but isn't on Australia's list, which included high-purity alumina and silicon, this year.

Armed with the country's updated list, US president Joe Biden invoked the Defense Production Act in March to support domestic production of critical materials on national security grounds. Fastmarkets head of battery and base metals research Will Adams said this measure could help address capacity and permitting challenges, noting it was a "drawn-out process" to get a new mine into production, especially in the US and Europe.

"Any move by the US to speed up the process could have a marked impact on speeding up the supply response, as well as helping ensure the US becomes more independent in its efforts to push forward with its green agenda," he said.

Biden then signed a US$40 billion bill in May to assist Ukraine and aid domestic production of strategic minerals produced in Russia or Ukraine, adding a further US$600 million provision for Defense Production Act-related purchases.

The US Department of Defense has also asked Congress to let it fund critical minerals processing facilities in allied countries, Australia and the UK, calling the proposal crucial to national defence.

This followed a US commitment in March to help finance critical minerals projects in Australia through the US' export financing arms. US investment provided "a seal of approval for companies and jurisdictions" and demonstrated the US was taking the issue of security of supply seriously, Edison Group energy and resources director Lord Ashbourne told *Mining Journal*.

Meanwhile, the Australian and Canadian governments have set aside billions of dollars to boost their critical minerals sectors. Canada is making up to C$3.8 billion available in the country's first Critical Minerals Strategy and plans to introduce a new 30% critical mineral exploration flow-through tax credit.

Australia has been bolstered by US attention and also updated its critical minerals strategy earlier this year, to

build on initiatives including a A$2 billion critical minerals facility to provide loans to the sector.

"The broader structural trend of decarbonisation (EVs, renewable energy) is a long-term phenomenon, and requires a significant increase in supply of a wide variety of minerals and mined products," Cannacord Genuity's head of mining research Australia Reg Spencer told *Mining Journal*.

Experts have outlined the investment dollars needed and likely supply shortfalls, which spells opportunity for the next generation of critical minerals companies.

The 2022 US list of critical minerals

Aluminum	used in almost all sectors of the economy	**Magnesium**	used as an alloy and for reducing metals
Antimony	used in lead-acid batteries and flame retardants	**Manganese**	used in steelmaking and batteries
Arsenic	used in semi-conductors	**Neodymium**	used in permanent magnets, rubber catalysts, and in medical and industrial lasers
Barite	used in hydrocarbon production	**Nickel**	used to make stainless steel, superalloys, and rechargeable batteries
Beryllium	used as an alloying agent in aerospace and defense industries	**Niobium**	used mostly in steel and superalloys
Bismuth	used in medical and atomic research	**Palladium**	used in catalytic converters and as a catalyst agent
Cerium	used in catalytic converters, ceramics, glass, metallurgy, and polishing compounds	**Platinum**	used in catalytic converters
Cesium	used in research and development	**Praseodymium**	used in permanent magnets, batteries, aerospace alloys, ceramics, and colorants
Chromium	used primarily in stainless steel and other alloys	**Rhodium**	used in catalytic converters, electrical components, and as a catalyst
Cobalt	used in rechargeable batteries and superalloys	**Rubidium**	used for research and development in electronics
Dysprosium	used in permanent magnets, data storage devices, and lasers	**Ruthenium**	used as catalysts, as well as electrical contacts and chip resistors in computers
Erbium	used in fiber optics, optical amplifiers, lasers, and glass colorants	**Samarium**	used in permanent magnets, as an absorber in nuclear reactors, and in cancer treatments
Europium	used in phosphors and nuclear control rods	**Scandium**	used for alloys, ceramics, and fuel cells
Fluorspar	used in the manufacture of aluminum, cement, steel, gasoline, and fluorine chemicals	**Tantalum**	used in electronic components, mostly capacitors and in superalloys
Gadolinium	used in medical imaging, permanent magnets, and steelmaking	**Tellurium**	used in solar cells, thermoelectric devices, and as alloying additive
Gallium	used for integrated circuits and optical devices like LEDs	**Terbium**	used in permanent magnets, fiber optics, lasers, and solid-state devices
Germanium	used for fiber optics and night vision applications	**Thulium**	used in various metal alloys and in lasers
Graphite	used for lubricants, batteries, and fuel cells	**Tin**	used as protective coatings and alloys for steel
Hafnium	used for nuclear control rods, alloys, and high-temperature ceramics	**Titanium**	used as a white pigment or metal alloys
Holmium	used in permanent magnets, nuclear control rods, and lasers	**Tungsten**	primarily used to make wear-resistant metals
Indium	used in liquid crystal display screens	**Vanadium**	primarily used as alloying agent for iron and steel
Iridium	used as coating of anodes for electrochemical processes and as a chemical catalyst	**Ytterbium**	used for catalysts, scintillometers, lasers, and metallurgy
Lanthanum	used to produce catalysts, ceramics, glass, polishing compounds, metallurgy, and batteries	**Yttrium**	used for ceramic, catalysts, lasers, metallurgy, and phosphors
Lithium	used for rechargeable batteries	**Zinc**	primarily used in metallurgy to produce galvanized steel
Lutetium	used in scintillators for medical imaging, electronics, and some cancer therapies	**Zirconium**	used in the high-temperature ceramics and corrosion-resistant alloys

Source: United States Geological Survey.

$42B for lithium

The lithium industry needs US$42 billion of investment to meet a forecast four-fold increase in demand by 2030, according to recent analysis by Benchmark Mineral Intelligence.

The price reporting and research agency forecast lithium demand would reach 2.4Mt lithium carbonate equivalent (LCE) in 2030, 1.8Mt more than the expected 2022 production of 600,000t.

"Let's be honest: investment in new lithium mines is going nowhere near the pace needed," Benchmark CEO Simon Moores tweeted after the report's release in May. The lithium sector has also been set back by Serbia withdrawing support in January for Rio Tinto's proposed, large-scale Jadar lithium-borates project.

Fastmarkets' Adams said this was an example of the "nimby-ism, social and environmental concerns, higher ESG standards and resource nationalism [that] are headwinds for the development of local battery raw materials production, which in many cases look set to delay, and possibly even prevent, some projects getting off the ground".

"As things stand, there is a high risk that the rollout of EVs and energy storage systems to support renewable energy projects will have to be scaled back because it is very unlikely lithium supply will be able to scale-up in a timely manner," he said in April.

Meanwhile, soaring lithium demand saw prices reach "insane levels", as Tesla CEO Elon Musk tweeted in April, with battery-grade lithium hydroxide and carbonate prices rising more than 500% over the past 12 months. Lithium prices have since softened as lockdowns in China, where the country has been pursuing a zero-COVID strategy, have impacted the market.

Australia is the top global lithium producer from hard rock deposits but the "lithium triangle" straddling Argentina, Chile and Bolivia holds the world's largest resources, making it an exploration and development hotspot.

Chile, where the country's copper production is dominated by state-run Codelco, is now looking to develop a national lithium company and the government assured reporters in June it was "not closed to tenders or any path" after two lithium contracts were voided by the supreme court due to opposition by indigenous communities.

Lithium projects in the pipeline

The top-ranked lithium project in *Mining Journal's* Project Pipeline database* is Goulamina in Mali, which scored 84 out of 100. Although it received a score below 5 in the Jurisdiction and Geology categories, it achieved a solid 10 out of 10 for Economics, Financeability and Engineering, along with a 9.4 for Confidence.

ASX-listed Firefinch owns Goulamina but is demerging its stake into Leo Lithium, which is developing the project in a 50:50 joint venture with leading lithium chemical producer Jiangxi Ganfeng Lithium Co.

Goulamina is expected to produce an average annual 726,000t of spodumene concentrate over 21 years, with

**The Intelligence Pipeline database is a store of more than 350 development projects around the world that have had their data normalised for comparison and been pushed through a unique ratings system for a score out of 100.*

initial capex of US$255 million.

It has a post-tax net present value using an 8% discount of US$2.9 billion and a robust internal rate of return (IRR) of 83%, according to an updated DFS in December.

Next cab off the rank in the Project Pipeline is another hard rock project, AIM-listed Atlantic Lithium's Ewoyaa pegmatite discovery in Ghana, with a score of 81.

A 2021 updated scoping study outlined an eye-popping post-tax IRR of 194%, a US$789 million NPV (8% discount) and initial capex of US$70 million for an 11-year operation producing an average 300,000tpa of 6% Li2O spodumene concentrate.

Ewoyaa is "on track to become West Africa's first lithium producing mine" and is fully funded through to production under a US$102 million deal with Piedmont Lithium, which acquired about 10% of Atlantic and can earn up to 50% of its Ghana projects.

Coming in third in *Mining Journal*'s database with a score of 73 was ASX-listed Galan Lithium's Candelas brine project in Argentina.

A preliminary economic assessment late in 2021 estimated initial capex of US$408 million and a 25-year operation producing an average 14,000tpa battery-grade lithium carbonate, with an after-tax NPV of US$660 million (8% discount) and IRR of 20.9%.

Meanwhile, AIM-listed Savannah Resources has a definitive feasibility study underway for its Barroso lithium project in Portugal, billed as "the most significant conventional lithium project in Europe".

Its 2018 scoping study estimated initial capex of US$109 million, average annual production of 175,000t of 6% spodumene concentrate and associated quartz and feldspar products, a post-tax NPV of $241 million (8% discount) and post-tax IRR of 48.6%.

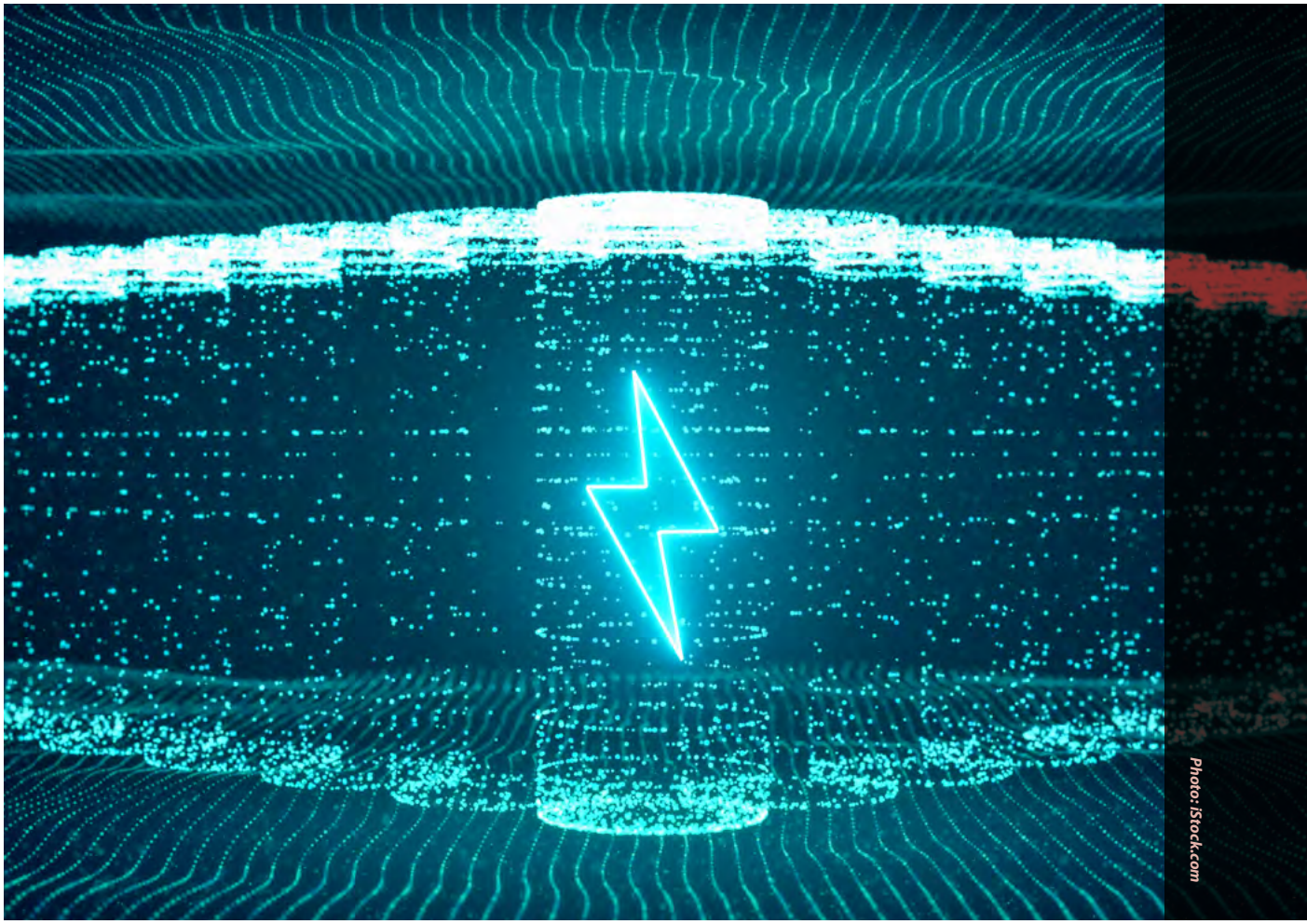

Photo: iStock.com

Savannah eyes major lithium production in Portugal

UK lithium company to become key player in Europe's new lithium value chain. State-of-the-art project targets net-zero footprint.

London-listed Savannah Resources (LSE AIM:SAV) is expected to become one of the first major producers of conventional lithium in Europe through the development of its 100%-owned Barroso lithium project, in northern Portugal.

The company acquired 75% of the project, now its sole focus, in 2017 "to become a key player in Europe's new lithium value chain". It has been fully-owned since 2019.

"We want the Barroso lithium project to be state-of-the-art, founded on responsible development and operation, and demonstrate best practice in our industry with a net-zero footprint," explained Savannah Resources' interim CEO Dale Ferguson.

Ferguson, previously Savannah's technical director, who has recently taken on the role following the stepping down of former CEO David Archer, went on to point out that the company is "committed to long term, responsible, lithium raw material production in Europe".

Lithium has been deemed critical by the USA, Australia and the EU during the last few years and its supply has become a real concern with a deficit anticipated in the industry in the short term.

"Lithium has become highly strategic," commented Ferguson. The forecast is for rocketing lithium demand and prices are being pushed up by the global shift to electric vehicles (EVs). Europe is eager to source its own raw materials to supply flourishing battery projects on the continent and reduce its dependency on China where most of the lithium chemicals are currently produced.

Barroso Lithium Project in Portugal

The Barroso Lithium project is located in northern Portugal, approximately 145km northeast of the City of Porto and the industrial port of Leixões.

"The project is now well established as Western Europe's most significant spodumene lithium project," the company declared.

Savannah Resources expects to start production in 2026. "We could probably operate at 1.5 million tonnes per annum to produce about 200,000tpa spodumene concentrate which contains enough lithium for approximately 500,000 vehicle battery packs per annum," reported Ferguson.

The Barroso deposit is believed to be the largest hard-rock spodumene lithium mineral resource in Western Europe. Based on this mineralogy and the shallow nature of the project's mineralisation, the company believes it "is the

closest European analogue to the successful Australian hard-rock lithium projects, which produce highly sought-after spodumene lithium concentrates for international markets."

Savannah Resources published the first ever resource estimate on the deposit soon after it acquired the initial 75% stake in the project in May 2017. The company has since then completed over 31,000m of resource-focused drilling and rapidly delineated a JORC-compliant resource of 27Mt containing 285,900t of lithium oxide (Li2O) at an average grade of 1.06% Li2O – 707,000t lithium carbonate equivalent (LCE) – across five orebodies as of May 2019.

The company believes its resources are "sufficient to supply a material proportion of Europe's lithium demand over the coming decades."

Since acquiring 100% ownership of the project in 2019, Savannah has expanded the footprint, adding the adjacent Aldeia lease (three blocks totalling 2.94km^2) later in 2019 to the original granted C-100 lease (5.42km^2), which underpins the Barroso lithium project. The mining lease is valid until 2036 and extendable for 20 years. Following a positive scoping study that outlined a conventional mine and concentrator operation, Savannah has been progressing with the development and licencing of the project.

At present the Portuguese authorities are making preparations for a new lithium exploration licence tendering process which Savannah believes will help to establish northern Portugal as a key lithium production hub for the EU-focused lithium battery supply chain.

Environmental approval still awaited

Following a positive Scoping Study which outlined a conventional mine and concentrator operation, Savannah has been progressing with the development and licencing of the project.

However, to develop the Project further and move ahead with the definitive feasibility study, Savannah needs Portugal's environmental regulator to approve its environmental impact assessment (EIA) study on the project.

The project's EIA was initially lodged in the summer of 2020 and underwent a public consultation process in the summer of 2021. Government processes were delayed by the calling of a snap election last November with the new government not in office and fully operating until May 2022.

In July this year, Savannah received feedback from the regulator and agreed to the EIA review process entering an additional 'Article 16' phase. Under this piece of legislation Savannah has up to six months to revise certain aspects of the Project and resubmit them for evaluation. The regulator then has up to 50 working days to conduct its review and issue its decision.

Historic development in resource and exploration potential at the Barroso Lithium Project in Portugal

"We are committed to delivering an environmentally responsible and socially optimised project," said Ferguson, who went on to add: "We remain confident that we can gain environmental approval for the Project."

Under the timetable set by the legislation, an EIA decision point would be reached no later than March 2023. Assuming this is positive, Savannah expects to conclude its DFS within one year thereof, and is targeting commissioning in early 2026. This would fit well with the likely start up schedules of merchant lithium conversion plants in Europe.

European markets

"We want to sell concentrate to European customers. We are really keen on keeping the material in Portugal through a local process of value add which will draw further potential to Portugal and increase the opportunities for the country," stated Ferguson. Savannah Resources' lithium will be used to produce lithium hydroxide which is necessary to make cathodes in lithium-ion batteries. The processing could potentially be done in Portugal as "at a national level, the discovery of lithium has already catalysed the announcement of two major lithium refining initiatives in the country – the Galp/Northvolt refinery at Setúbal and an alignment between Bondalti and Neometals", the company said.

The fact that the EU is keen to build energy independence with renewables is expected to boost interest in the project further. Last May, the European Commission launched the REPowerEU initiative: a plan to rapidly reduce Europe's dependence on Russian fossil fuels and fast-forward the green transition.

"Europe is already the second largest market for EVs. The plan is to cover its own requirements for cells and raw material as well. The latest proposal from the European Battery Alliance requires that up to 60% of European batteries are covered by raw material from the area. That's a massive challenge," reported Ferguson.

"Savannah can become a key, local, lithium raw material supplier to European customers. At the same time, the company offers investors direct exposure to the prices," said Ferguson.

Targets minimal carbon footprint

Savannah plans to ensure "its lithium product carries a minimal carbon footprint into the lithium battery supply chain".

Savannah announced the initiation of a decarbonisation strategy for the project in March 2022. "Working with leading consultants and service providers in the field, Savannah is committed to moving towards reducing the


Savannah Resources Interim CEO and Director Dale Ferguson

Scope 1 and 2 emissions at the Barroso lithium project to net zero once in production and, ultimately, to a position of net zero life-of-project, and targeting the reduction of its Scope 3 emissions in collaboration with its future customers," the company said.

Quarts & feldspar

The pegmatite which contains the spodumene lithium veins at the project also contain quartz and feldspar which will be recovered as co-products from the processing to produce lithium concentrate.

"Our co-products will be supplied to the local ceramic markets, Spain and Portugal being major producers. It will be an extra source of revenue," mentioned Ferguson.

Savannah Resources Plc – at a glance

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Market Capitalisation (at press time on 11th July- 2022)
£39 million

Quoted Shares on Issue
1.6 million

Major Shareholders
Aj Marjan Ltd (15.88%), Slipstream Resources Investments Pty Ltd (8.71%)

Eclipse Metals to explore rare earth potential of historic Greenland mine

With support from top academic geologists, the Australian junior will test for rare earths at the multi-commodity Ivittut mine and drill the nearby Grønnedal asset.

With support from top academic geologists, the Australian junior will test for rare earths at the multi-commodity Ivittut mine and drill the nearby Grønnedal asset

The Ivittuut mine in Greenland has long been a strategic asset. It is the world's only source of mined cryolite – a flux used in the aluminum refining process. During the Second World War, US forces occupied the site to secure their own supply of this mineral that was crucial to the production of military aircraft. Now the mine's new owners, Australian firm Eclipse Metals, believe it could become a new source of rare earth elements (REE) at a time when Western governments are looking to develop critical mineral projects in friendly nations.

"Greenland hosts up to a quarter of the world's rare earth mineralization," Eclipse Metals executive chairman Carl Popal said. "Our project is located in the south of the country, close to the sea in the warmest part [of Greenland], in an area with 130 years of mining history. For investors looking for strategic minerals opportunities in Tier One jurisdictions, I think our presence in Greenland places us at the top." Additionally, Eclipse recovered archived GEUS (Geological Survey of Denmark and Greenland) geological research documents on the Grønnedal area. "We realised there was a massive potential for REEs that had never been focused on," he said.

In 2021 Eclipse took control of the mining license covering Ivittuut. The previous owners had operated a small quartz extraction operation but Eclipse recognised that the project needed to be developed by a public company in order to secure the capital needed to realise its true potential. The mineral exploration license also covers the Grønnedal carbonatite prospect, 10km to the east of Ivittuut. When Popal arrived at on site during a recent visit, he noted evidence of the hilltop gun battlements, in the nearby town of Arsuk, that had defended the site from the Nazis. At the Grønnedal site there are magnetite outcrops with several hundreds of meters of historic drilling data.

"I saw the historical drill holes from the 1940s, when they were focusing on the outcrops and really only exploring for iron ore," Popal said. "They never assayed for REEs at the time. We split that core and assayed and found great potential for REE. As we do more surface sampling, we're finding that mineralisation is widespread."

Grønnedal has a complex geology with multiple fractures and faults giving rise to different rock types throughout the licensed area. At some points the REE Europium levels are up to five times higher than in other known REE projects around the world and strong levels of Dy, Pr and Nd have also been identified. At Ivittut the Eclipse Metals team has benefitted from the experience of REE expert and respected

Professor at St Andrews University (Scotland), Adrian Finch. Having visited the mine, Professor Finch will be leading a PhD research programme focusing on the impact of hydrothermal fluids on the movement of elements in and out of critical metal deposits. The program will help academics and company geologists alike gain a greater understanding of the deposit; initial results have indicated REE potential at Ivittuut.

"It's a completely different mineralisation to Grønnedal, which contains more heavy REE," Popal said. The REE mineralisation is also found mainly to the side of the current openpit as a result of the forces that created the cryolite formation. The geologists' best theory is that the cryolite was pumped upwards from the centre of the Earth through a cylinder of granitice greisen. The current open pit has focused on that greisen, but the heat and fluids at the edges of the greisen created the condition for the deposition of REE. Eclipse Metals intend to develop the Ivittut mine in two ways.

"At the sides of the pit we are looking at the potential of rare earths, but within the pit we're looking at the viability to extract the quartz," says Popal, "that's the low hanging fruit for us."

That quartz body is estimated at 5.8 million tonnes and lies under a layer of siderite and fluorite that formed the base of the cryolite deposit above. High silica grade quartz is used in photovoltaic products and semiconductors and demand is expected to grow at a CAGR of 6.9% between 2020 and 2030. The next step for the company, and the focus of the second half of 2022, is to move towards a mining license from the Greenland government and to begin work on an environmental impact assessment.

Greenland has forbidden the mining of uranium in its territory, but the huge territory is recognised by many foreign companies and the local government as having vast potential in other minerals. During the May 2022 Future Greenland Conference, Popal says he was pleased to see stakeholders from the government, military and civil society discussing mining. "We've had a very positive response from members of parliament," he says, "many of them have been very supportive of the Ivittuut project because it has no uranium content, it has a long history of mining and does not negatively impact and nearby towns or villages."

The project also has significant infrastructure. The roads that originally served the mine are still in good condition, Greenland benefits from cheap hydropower and the site contains a wharf, which could be used initially to export quartz products by sea.

Concurrently, the company will seek a better understanding of the Grønnedal deposit. Eclipse have engaged a drilling contractor, set to begin percussion drilling of the carbonatite and related structures in mid-July when the snow cover has receded. "We know that there is widespread REE mineralisation at and near surface level, now it's time for us to test below the surface and get an understanding of the chemistry and geology at depth," Popal said."

The Greenland license has quickly become a flagship project for Eclipse given a rising demand for critical minerals which can be soured outside Russia and China. Eclipse Metals also has projects in Australia, where it holds licenses with uranium in Northern Territory and a manganese project in Queensland.

"We've seen the US aggressively seeking potential avenues to secure strategic minerals recently, and both they and Canada understand the strategic importance of Greenland," he says. "We're still in the early stages, but with the help of St Andrews and Oslo Universities we should have a better understanding of the resource by the end of this season. It would be a huge leap for us to start negotiating with the big players in the US, but we are investigating the appropriate avenues."

Any experience – both in terms of geology and government relations – gained along the way will help Eclipse position itself in one of the world's frontier mining jurisdictions.

"Overall, I think Greenland has a huge potential; there are many deposits near surface that are now becoming visible due to the melting of the surface ice. It's heaven for geologists," Popal said.

"Moving forward, understanding the Greenlandic culture, working with the government and the people of Greenland, that's our priority. We want them to see that we are the right people to develop an important strategic asset for their country."

Eclipse Metals – at a glance

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A$51.87 million

Quoted Shares on Issue
1,914 million

Huge need for nickel

Nickel has made headlines in recent months, starting with its inclusion on the US list of critical minerals for meeting the "single point of failure" criteria – there was only one refinery in the US that produced crystalline nickel sulfate, the US Geological Survey (USGS) said.

This was followed by a short squeeze-induced price spike above US$100,000/t in March that prompted the London Metal Exchange to suspend nickel trading for eight days.

Price volatility is among the top-10 battery raw material risks for the EV market, according to Fastmarkets, with others including supply deficits, ESG concerns and geopolitical tensions.

Some two-thirds of current nickel output is used in stainless steel production but the demand for Class 1 nickel in EV batteries is surging.

"Demand for nickel in batteries is estimated to grow by over 500% over the next decade, in large part to support the world's rising demand for electric vehicles," BHP chief commercial officer Vandita Pant said in July 2021 as the world's biggest miner entered a nickel supply agreement with EV maker Tesla.

Nickel demand could exceed supply by between 700,000t and 1 million tonnes by 2030, according to a report by consulting firm McKinsey and Company released in January.

Its calculations were based on the supply change versus required growth between 2020-2030 in a 1.5 degree Celsius pathway, if the technology transition were to happen as expected today.

"For copper and nickel alone, we estimate that meeting demand growth … would require US$250 billion to US$350 billion cumulative capital expenditures by 2030, both to grow and replace depletion of existing capacity," McKinsey said.

"Despite a relatively large pipeline of projects to scale up supply in some of these commodities, and efforts to reduce the capital and operating costs associated with a number of them (such as direct lithium extraction), the task at hand is not trivial."

Nickel projects in the pipeline

The top-rated nickel project in *Mining Journal's* Project Pipeline database is ASX-listed Mincor Resources' Kambalda nickel operations, which returned to production in the June 2022 quarter.

The operations had been mothballed in 2016 due to depressed prices and were recently restarted, with the first ore processed at BHP Nickel West's refurbished Kambalda Nickel Concentrator in May.

Mincor's project in Western Australia scored 82 out of 100 in *Mining Journal's* database, thanks to a resounding 9.9 for the heavily weighted Economics category and 10 out of 10 for the Engineering component of the score.

Its 2020 definitive feasibility study had outlined low initial capex of US$44.3 million, a post-tax NPV (7% discount) of US$155 million and an IRR of 88%, forecasting peak annual production of 16,000t nickel in concentrate.

Second according to the Project Pipeline database was TSXV-listed FPX Nickel's Baptiste project in British Columbia.

> "Demand for nickel in batteries is estimated to grow by over 500% over the next decade."
> — Vandita Pant, BHP COO

Baptiste scored an overall 77, achieving 10 out of 10 in both the Financeability and Engineering categories.

The project is expected to produce 99 million pounds annually over a 35-year mine life, with initial capex of US$1.67 billion, a post-tax NPV (8% discount) of US$1.7 billion and IRR of 18.3%, according to a 2018 preliminary economic assessment. ASX-listed Ardea Resources' Kalgoorlie nickel project (KNP) came in third at 73 in the Project Pipeline database.

KNP was awarded "major project status" by the federal government in March.

Ardea has a feasibility study underway, to build on a 2018 PFS that looked at an initial base case of 1Mtpa throughput producing 41,500tpa nickel sulphate and 5,500tpa cobalt sulphate over 25 years, with initial capex of US$430 million and post-tax NPV (8% discount) of circa US$750 million and IRR of 25%.

Top nickel producing countries include Indonesia, the Philippines and Russia, where the world's biggest high-grade nickel producer Nornickel reiterated production guidance in April despite the "negative implications from the geopolitical situation" due to the war in Ukraine.

Photo: iStock.com

Zinc's time to shine

Zinc was added to the US critical minerals list due to the perceived supply risk and increasing concentration of mine and smelter production.

There'll be a global zinc production gap of 7.2Mt by 2040, according to the world's largest net zinc miner, Canada-based Teck Resources. The company produced 607t of zinc in concentrate in 2021.

"The market outlook for zinc is strong, due to declining production from existing primary zinc mines, underinvestment in global exploration for zinc, and long-term demand driven by decarbonisation, which is galvanized-steel intensive," president and chief executive Don Lindsay said.

Production from established zinc mines globally had only increased by 1.1% since 2014, while global zinc demand had risen by 4.1% in the same period, Teck said in a presentation for Bank of America Global Metals, Mining and Steel Conference in May.

Zinc projects in the pipeline

The top-ranked zinc project in *Mining Journal*'s Project Pipeline database is Kipushi, Ivanhoe Mines' 68%-owned zinc-copper-germanium-silver-lead mine in the Democratic Republic of Congo.

Kipushi received 80 out of 100, scoring 9 or above for Engineering, Financeability, Economics and Confidence, more than compensating for the low score of 2.8 for Jurisdiction. Ivanhoe is aiming to restart Kipushi and says it will be the world's highest-grade major zinc mine, producing an average grade of 36.4% zinc over the first five years of production.

A 2022 feasibility study put initial capex at US$382 million, the post-tax NPV (8% discount) at US$941 million and IRR at 41%, with the 14-year mine expected to produce an average 240,000tpa with a zinc grade of 32%. Next is TSX-listed NorZinc's delayed Prairie Creek project in Canada's Northwest Territories which scored 68, despite a middling 4.7 for the key Economics category.

NorZinc announced in December the project would be pushed back about a year due to regulatory delays for the all-season access road to Prairie Creek. It now expects to start construction on phase one of the road by year-end.

Prairie Creek is expected to produce an average annual 261Mlb zinc-equivalent over 20 years. Its 2021 preliminary economic assessment put initial capex at US$368 million, after-tax NPV (8% discount) at US$299 million and IRR at 17.7%. NorZinc plans to begin an enhanced feasibility study later this year. ASX-listed Ironbark Zinc's Citronen project in Greenland was a close third scoring 67 on the back of a strong performance in the Confidence category.

The project saw a 50% increase in mine life to 20 years in a 2021 bankable feasibility study, which put the capex at US$654 million, post-tax NPV (8% discount) at US$363 million and IRR at 15.2%.

Citronen has an 85Mt resource grading 4.7% zinc and 0.5% lead and the company has binding offtake agreements with major shareholders, with Trafigura for 35% LOM production, and with Glencore (35% for 10 years of zinc and life-of-mine lead). Ironbark expects to make "significant

"The market outlook for zinc is strong, due to declining production from existing primary zinc mines, underinvestment in global exploration for zinc, and long-term demand driven by decarbonisation, which is galvanized-steel intensive."

— Don Lindsay, Teck president and chief executive

progress towards funding" this year following preliminary approval from the US EXIM Bank for up to US$657 million in debt funding in December.

Elsewhere, the only major new zinc mine scheduled for completion in 2022 – Ozernoye in Russsia – was facing significant headwinds post-Ukraine invasion, Ironbark noted in April.

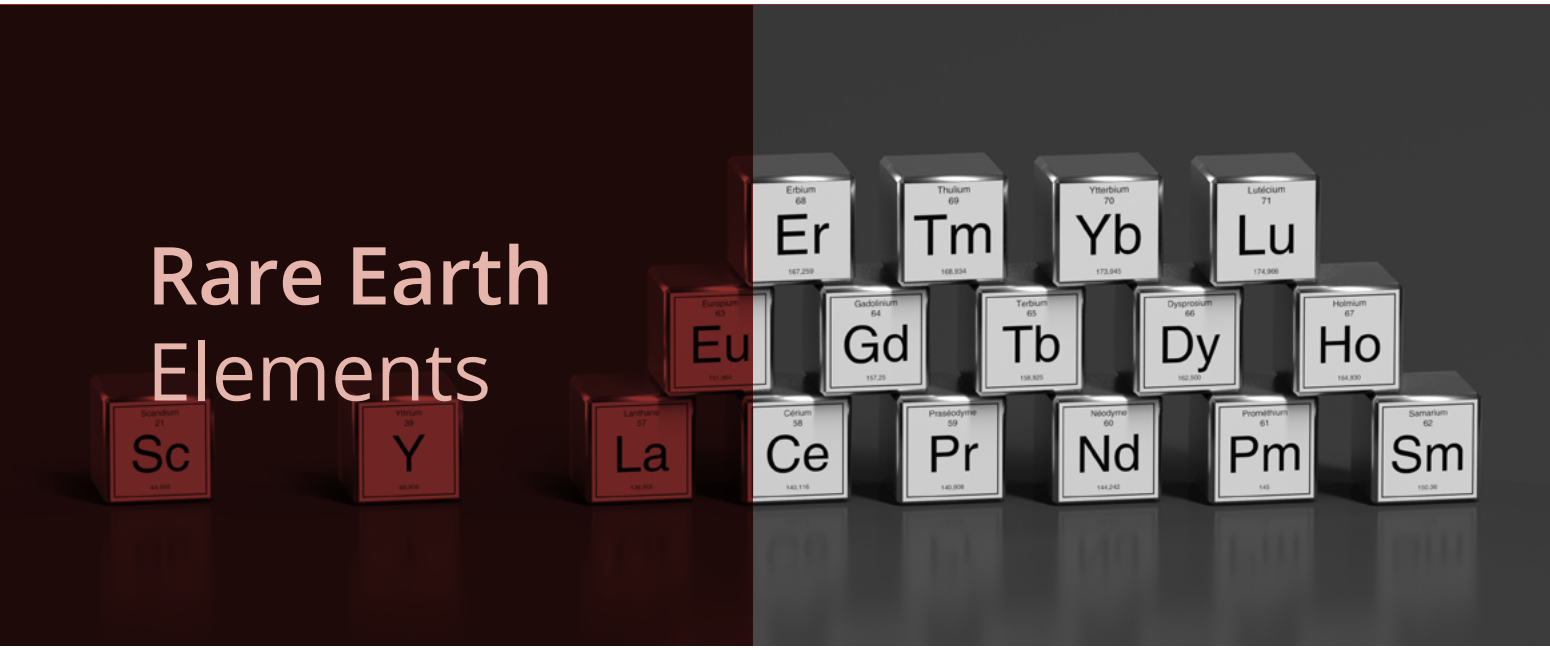
In Latin America, TSXV-listed Tinka Resources' flagship Ayawilca zinc-silver-tin project in central Peru received a boost towards development with a C$11 million strategic investment in May by zinc producer Nexa Resources and shareholder Compañia de Minas Buenaventura.

Ayawilca has the potential to be a top-10 global zinc producer, Tinka said in October after releasing a PEA that outlined initial capex of US$264 million, after-tax NPV (8% discount) of $433 million and IRR of 31%, with average annual production of 155,000t zinc in concentrate over 14.4 years.

At an earlier stage, ASX-listed Auking Mining recently upgraded the resource at its majority-owned Koongie Park project in Western Australia to 8.9Mt at 1.01% copper, 3.67% zinc, 0.16g/t gold, 32g/t silver and 0.77% lead, while in Fiji, TSXV-listed explorer Thunderstruck Resources is exploring zinc and copper prospects at its Korokayiu and Nakoro VMS projects.

Underground EV at Vale's Canadian operations

Rare Earth Elements



The updated US critical minerals list now includes 16 of what are considered the 17 REEs, which have uses from permanent magnets in EVs and wind turbines to medical apparatus and aerospace alloys.

The sharp growth in EVs and wind turbines will drive significant growth in demand for neodymium and praseodymium (NdPr), according to ASX-listed Lynas Rare Earths. Lynas is currently the only significant producer of separated REE outside China.

Electric car sales more than doubled in a year to 6.6 million in 2021, the IEA said, with government and corporate efforts to electrify transport providing a solid basis for further growth. Lynas said every 1 million EVs would require 600t NdPr, while the 235GW of new offshore wind capacity forecast to be installed by 2030 would require 70,000t of NDPr over 10 years.

"REEs provide excellent exposure to global megatrends that will shape economies and consumer behaviour over the next decade, such as sustainable mobility, electronics and industrial automation and renewable energy," Lynas managing director and CEO Amanda Lacaze told *Mining Journal*.

China accounted for about 60% or 168,000t of the estimated 280,000t of global rare earth oxide equivalent (REO) production in 2021, according to the USGS, and is responsible for the majority of processing.

China's reserves of 44Mt eclipse the next biggest reserve base of 22Mt in Vietnam, USGS data showed, followed by Brazil and Russia, each with 21Mt.

Lynas welcomed efforts by governments around the world to support the development of a diversified REE industry, including the US plans to support Australian critical minerals projects.

"We believe competitive markets are healthy markets and a flourishing market is essential to drive competition," Lacaze told *Mining Journal*.

Lynas has already received support from the US in two funding contracts related to constructing a heavy REEs (HREEs) separation facility and a commercial light REEs separation plant in the US.

Lynas has the Mt Weld mine and concentration plant in Western Australia, is developing an initial processing facility at Kalgoorlie and has an established plant in Malaysia.

The US has also awarded a US$35 million contract to California-based miner MP Materials to design and build a HREE processing facility at its Mountain Pass mine.

REE projects in the pipeline

ASX-listed Ionic Rare Earths' majority-owned Makuutu project in Uganda has the highest rating in *Mining Journal*'s Project Pipeline database for REEs contenders. Makuutu scored 79 out of 100, rated highly in terms of Financeability, Economics, Geology and Confidence.

A resource update is imminent for the ionic-adsorption clay deposit. A scoping study in 2021 based on 78.6Mt at 840ppm total REO estimated initial capex of US$89 million and average annual REO production over 11 years of 2,680t. It put the NPV (8% discount) at US$321 million and internal

rate of return IRR at 38%. TSXV-listed Defense Metals Corp's Wicheeda REEs project in British Columbia is next in *Mining Journal*'s database, achieving an overall 68 out of 100. It scored highly in terms of Financeability, Jurisdiction and Geology.

Wicheeda's late 2021 preliminary economic assessment outlined average annual production of 25,423t REO over 16 years, with initial capex of US$338 million, a post-tax NPV (8% discount) of US$397 million and internal rate of return of 18%.

Among other companies stepping up to meet demand, Hastings Technology Metals describes itself as "Australia's next REEs producer" after securing a federal A$140 loan for its Yangibana project.

Yangibana is expected to produce 15,000tpa mixed REEs carbonate (including 3,400tpa NdPr oxide) over 15 years, with total capex of A$582 million, an after-tax NPV (8% discount) of A$1 billion and IRR of 26%. The federal government has also lent its support to Iluka Resources in the form of a recently-announced A$1.25 billion low-interest loan for Australia's first integrated rare earths refinery at Eneabba.

Eneabba is expected to start producing neodymium, praseodymium, dysprosium and terbium from 2025.

Other REE projects include London-listed Pensana's plans to establish the world's first independent and sustainable magnet metal REE separation hub at the Saltend Chemicals Park in the UK, treating material from the Longonjo operation in Angola and third-party feedstock.

At an earlier stage, ASX-listed Kingfisher Mining made a REE discovery in the March quarter at its Mick Well project in Western Australia, and ASX-listed Eclipse Metals has applied for a drill permit to test the REE potential at its Ivittuut multi-commodity project in Greenland.

Lynas Rare Earths Samples

More critical minerals in the frame

PGMs

The picture of demand exceeding supply for critical minerals is also evident in platinum group metals (PGMs), though the war in Ukraine created significant uncertainty over PGM shipments from Russia, speciality chemicals and sustainable technologies company Johnson Matthey said in its May market report.

The firm expected the platinum market to move closer to balance in 2022 but said palladium and rhodium markets could move back into deficit, with downside risks to Russian shipments and lower South African supplies due to maintenance and operational challenges.

South Africa's Bushveld Complex hosts the world's largest PGM reserves, according to the USGS. However, the country scored poorly in *Intelligence*'s 2021 Investment Risk Index within the ***World Risk Report (feat. MineHutte ratings)****, with an overall CCC rating (moderate-to-high risk), given long-standing challenges including power shortages, infrastructure issues and permitting delays.

One of the bigger PGM developments is Ivanhoe Mines' Platreef discovery in South Africa, which is expected to be in production in 2024.

Ivanhoe said its 2022 feasibility study confirmed Platreef's potential to be the industry's largest and lowest-cost primary PGM producer, starting with estimated phase-one average annual production of 113,000 ounces of platinum, palladium, rhodium and gold, plus 5Mlb of nickel and 3Mlb of copper.

In the US, TSXV-listed Group Ten Metals has delineated five Platreef-style deposits and multiple targets at its Stillwater West project in Montana, adjacent to Sibanye-Stillwater's PGM mines.

Group Ten is drilling to expand its 2021 maiden resource which contains 2.4Moz palladium, platinum, rhodium and gold plus 1.1 billion pounds of nickel, copper and cobalt.

Safe-haven jurisdiction Western Australia has entered the spotlight as a PGM exploration hotspot thanks to Chalice Mining's recent Julimar discovery.

Julimar hosts a 330Mt resource containing 1.9Mt nickel-equivalent or 17Moz palladium-equivalent, and is described as the largest nickel sulphide discovery worldwide since 2000 and the largest PGM discovery in Australian history.

Chalice is also bringing its expertise to an exploration joint venture with ASX-listed Venture Minerals at its earlier-stage South West nickel-copper-PGM project.

To the north, focused explorer ASX-listed Future Metals is advancing its 2.4Moz Panton PGM project and nearing a resource update at the time of writing.

The 'forgotten' metal

Tin might be the 'forgotten EV metal' but its use in electronics and energy applications – such as solar cells – will also drive demand and a supply deficit is looming,

**The Intelligence World Risk Report (feat. MineHutte ratings) includes jurisdiction-by-jurisdiction ratings for 106 key mining addresses across the world using a unique formula covering legal, governance, social, finance and infrastructure aspects .*

according to the International Tin Association (ITA).

"We see tin demand growth growing from a long-term average of around 2% to something closer to 3-4% annually," ITA market analyst James Willoughby told *Mining Journal*.

"Projected over the next decade, this could see demand for the metal reach some 500,000 tonnes by 2030."

The outlook for supply was less optimistic, with output from existing mines generally declining and new supply only likely to add 65,000t over the next decade.

"Even with all proposed mines – even those that have seen little development so far – mine production would only reach some 360,000t," Willoughby said.

"There is some recycling of tin (currently around 80,000t) – and there is interest in increasing this number – but it still looks like the market will fall short."

He said the projected deficit could be manageable if investment improved in the next few years – "something that we are already seeing signs of".

However, reports of a proposed Indonesian ban on tin exports could see the market lose 60,000t – an amount "not rapidly replaced", Willoughby explained. Indonesia is the world's second-largest producer of refined tin, and is the world's largest exporter of the metal, the ITA said.

The forecast tin shortfall provides an opportunity for emerging developers.

London-listed First Tin has raised £20 million and is aiming to bring its two tin projects – Tellerhäuser in Germany and Taronga in Australia – into production in 2025.

Meanwhile Venture Minerals' flagship asset, the Mount Lindsay tin-tungsten project in Tasmania, is described as one of the largest undeveloped tin projects in the world and an underground feasibility study is underway.

Lesser-known minerals enter the spotlight

Existing and emerging technologies are generating unprecedented demand for lesser-known minerals, such as tellurium for solar panels.

Tungsten has also been deemed a critical mineral in several jurisdictions and is "indispensable to our lives", according to the International Tungsten Industry Association, which cites uses including in mobile phones, light sources and mining drills. TSX-listed Almonty Industries is aiming to become the largest tungsten producer outside China, as it moves to bring its 90-year Sangdong tungsten project in South Korea into production.

The company is already producing tungsten at its Panasqueira mine in Portugal and has two tungsten development projects in Spain.

Some may also be unaware that mineral sands such as zirconium and titanium are on critical minerals lists.

At the sector's big end of town is Rio Tinto-controlled Richards Bay Minerals in South Africa, which has been dogged by serious security issues in recent years.

Emerging players include ASX-listed Sheffield Resources – aiming to have its "globally significant" Thunderbird mineral sands joint venture with Yansteel in Western Australia in production in 2024.

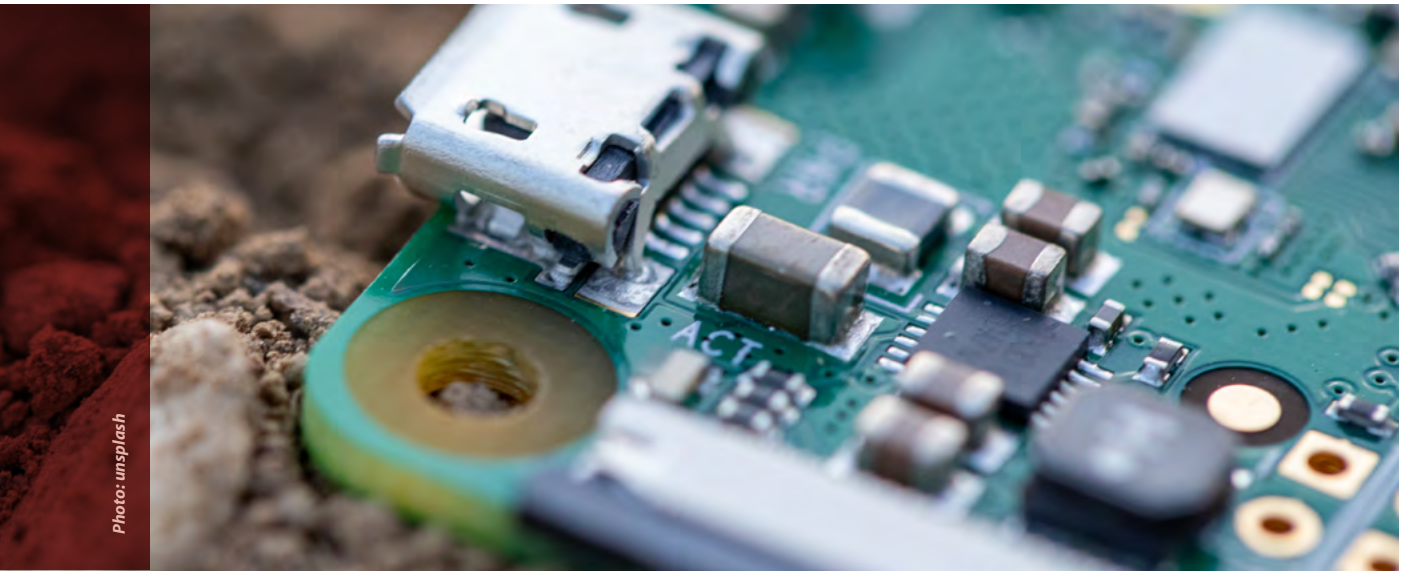


Photo: unsplash

Pensana Plc to build rare earth processing hub in the UK

Pensana wants to lead the way in tilting rare earth processing and production away from China, which has dominated the space for decades, to the UK.

Building a supply chain away from dependency on Chinese rare earth refineries is crucial for the global economy, Chairman of Pensana Paul Atherley said.

"We have been worried about the resilience of the supply chain," he said. "Supply chain resilience is at the top of the agenda for world leaders." "We can't have everything relying on China."

Just as important as building a reliable supply chain is creating a supply chain that is sustainable, Atherley went further to say. "We are trying to establish independent and sustainable rare earth production in the UK with low embedded carbon,". Resilience in supply chains will be vital in meeting future demand, he continued. Demand for these rare earth materials is set to explode exponentially, according to figures from Adamas Intelligence.

"Every year the price for rare earth metals is higher. Rare earth mines are very difficult to bring into production," he said. "By the time 2035 comes, the deficit of rare earth metals will be 15 times Pensana's projected annual production."

The rare earths produced by Pensana will be used in permanent magnets which power electric vehicles and offshore wind turbines.

"What makes EVs go is not only the lithium-ion battery – the real power is in the permanent magnets," Atherley commented.

"Electric vehicles contain two kilos of permanent magnets in all sorts of motors," he said, whilst wind turbines are heavily reliant on permanent magnets to function.

Volkswagen's ID.3 range of EVs would "consume all of Pensana's production for a decade", he said.

Demand will be even greater once the growth of the robot industry is considered, he added.

"It is very clear that as China, the EU and the US industrialise and turn their factories towards robots, these robots will require permanent magnets," Atherley said.

"We [at Pensana] were blindsided by this information. Permanent magnet demands for robots will be bigger than electric vehicles."

Pensana is one of three major players on the global market that can bring these critical minerals to market – the others being Australia-based Lynas Rare Earths and US-based MP Materials, the chairman said.

The company benefits from a stellar board which has led Pensana to a "stellar listing" on the LSE, Atherley said. The board includes Steve Sharpe, an executive board member of

EIT Raw Materials; Dr Jeremy Beeton, director general of the London 2012 Olympic and Paralympic Games and non-executive director of John Laing; and Rt Hon Baroness Northover, formerly the prime minister's trade envoy to Angola and a minister in the Department for International Development.

From Angola to the UK

Pensana will extract the rare earth ore from its Longonjo mine in Angola. The mine has a projected 20-year life of mine, and contains one of the world's largest rare earth deposits.

"It's a really exciting mine, with the ore body right at surface," Atherley said. The surrounding area also contains about 7,500km of unexplored high potential grounds, with potentially even higher grades.

The mine complex includes a 1.5 million tonne per annum flotation concentrator, as well as a mineral sands type roaster. Together, this has the capacity to produce 45,000tpa of high-value mixed rare earths sulphate.

Commissioning of the Longonjo concentrator is targeted for late 2023, while commissioning for the Longonjo MRES is expected onwards from April 2024. Pensana is marking the stone laying at the Angola mine this month.

The mine will be powered by hydroelectric power.

> "What makes EVs go is not only the lithium-ion battery – the real power is in the permanent magnets"
> — Paul Atherley, Pensana chairman

"We have a 10-year contract with the local power company for hydropower at 2 cents per kilowatt hour," Atherley commented on. "It's a very low cost over a long period of time."

Longonjo also benefits from recently upgraded infrastructure in the form of a US$2 billion Benguela rail line connecting the mine to the Atlantic port of Lobito.

The port has also been refurbished, with all facilities upgraded, Atherley said.

Once loaded at the dock, the ore will be shipped to the UK, where it will be processed at the Saltend Chemical Park in the Humber Freeport.

The £150 million processing hub recently secured council approval. The facility will be built within Saltend Chemicals Park, which will provide many of the necessary utilities.

On the sustainability front, the Saltend processing hub will be using only green energy to power operations, Atherley commented.

"Just offshore of Yorkshire, Hitachi is building the world's biggest wind farm," he went on to say. "We'll be able to connect to the battery being built next to the Saltend facility. That way, we'll be able to connect to secure low-cost offshore wind, zero-carbon electricity."

Investing in the separation process is a way to make REE mining and production more profitable, Atherley said.

"We found in the REE business, the further downstream you go, the bigger the margin," he said. The Company found that the UK was an excellent location to set up REE processing, due to the availability of chemical parks and the country's chemical engineering expertise.

"Companies set up chemical-based opportunities a long time ago, which have now been privatised and are owned by private equity firms," Atherley commented. The US hedge fund which now owns the Saltend Chemicals Park provides a "plug-and-play" service.

"All we have to do is operate the separation plant," the Chairman said.

"There will be a ground-breaking ceremony in Saltend in July, and continue into a 12 month construction period following financing."

Commissioning of the Saltend facility is expected in late 2023, with production planned for 2024.

High demand from customers

Automobile manufacturers are also in talks with the British company, Atherley said.

"There are two things [auto manufacturers] worry about: transparency, and low embedded carbon," he said. "With hydropower in Angola and wind power in the UK, we're targeting a zero-carbon mine and low-carbon processing plant," the Chairman went on to say further.

Pensana is also in the process of finalising an offtake agreement with a large Asian group outside of China.

The Group will purchase 50% of Pensana's production. The Company expects to export primarily to Japan and Korea, with some exports heading to Europe and eventually to North America. "Separation [of rare earth oxides] is where we take China right on," Atherley said. "Every other country is supplying China in one way or the other," by sending them rare earth concentrates to process.


Pensana executive chairman, Paul Atherley

"We're producing a product to directly supply Japanese, Korean, European and USA customers."

Pensana – at a glance

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Market Capitalisation (at press time on 12th July)
£150.8 million

Quoted Shares on Issue
235.5 million

Major Shareholders
ASF Africa Mining LP (20.5%), Pershing Nominees Ltd (17.2%), Jim Nominees Ltd (14.2%), Vidacos Nominees Ltd (12.1%), State Street Nominees Ltd (5.3%), Selection Capital Ltd (3.8%)

Kingfisher Mining's breakthrough discovery opens up new rare earth district

The discovery of rare-earth bearing dykes structures 100km to the south of several major development projects is perfectly timed with federal government support for strategic metals development.

Over the last decade Australia has emerged as a leading contender to challenge China's dominance of the rare earth elements (REE) market. Thanks in no small part to the development of the Mount Weld mine in Western Australia, the country now accounts for nearly 8% of global production. Today, however, another highly prospective REE district is emerging in the Gascoyne region of Western Australia, 250km inland of the coastal town of Carnarvon. Following the decision by Hastings to develop Yangibana and the discovery of the Mangaroon REE deposits, junior mining firms are adjusting their exploration plans to focus on these strategic elements.

In mid-2021 ASX-listed Kingfisher Mining conducted an airborne geophysics study at its Gascoyne project, 100 kilometres to the south of Yangibana. "At that stage we were still exploring for copper however we had such an unusual response in terms of electromagnetics that we decided to drill the anomaly," says James Farrell, Kingfisher's CEO.

As they waited for the drill results to return from the laboratory, the geological team set to work mapping and sampling the area and identifying carbonatite rocks associated with rare earth elements. When the lab results came back in January, hole MWRC004 returned 12 metres at 1.12% total rare earth oxide (TREO). "That intersection was about the same width and grade as seen at Yangibana, with similar neodymium and praseodymium content" says Farrell. "This is a brand new discovery, with the same mineralisation style." Farrell and his team moved quickly to stake out the target structural corridor, which lies along a 54km strike. "We had the first mover advantage in the area and have taken up all the tenure we want. We're completely fenced in now," he says. Farrell, an exploration and resource development geologist, previously worked at Millennium Minerals with Warren Hallam, a former managing director of Metals X, re-developer and operator of the Renison tin mine in Tasmania and a growing force in Australian gold through the demerger of Westgold. Hallam invited Farrell to take up the reigns at Kingfisher Mining in September 2020 and he's since turned his exploration nous from copper and gold towards rare earths and critical minerals.

In March, as soon as the temperature had dropped enough – which still means day temperatures of 45°C in the Gascoyne region of Western Australia – the Kingfisher team returned to the project. In early May they completed an 18 hole, 2,400 metre drill program. Seven of the holes were drilled at the MW2 site, home of the company's first discovery in the Gascoyne, while the remainder were focused on other priority targets. One of those is Kingfisher, hitherto a copper project on the eastern extreme of the land

package, which had previously shown traces of barium and strontium, which are indicator elements associated with rare earth mineralisation. "Going forward, we're coming at the Gascoyne project from both directions," says Farrell. "That means working in from the tenement extents with regional scale airborne geophysics to define new target areas and working out from our existing discoveries with mapping and sampling. Additional drilling is planned for later in the year on the back of our increasing geological knowledge."

As such Kingfisher's geologists have been pacing the wider territory, with the goal of defining and mapping the outcropping mineralisation to develop additional drill targets. Further carbonatite intrusions have been discovered on the eastern section of the land package and Kingfisher will begin new airborne magnetic and radiometric surveys to cover the remaining half of the titled area not already covered by historical airborne surveys. Farrell describes the terrain as "cattle country," a vast and rocky terrain populated by a few cattle stations with access via station tracks. The geological team have been overlanding across the terrain, at times carrying 20kg of rock samples in their backpacks over several kilometres. There is a huge reward for the sweat and graft, however, with all major studies forecasting major growth in demand in the coming years. "We've known that these elements are critical for fundamental technologies from wind turbines to electronic vehicles for some time, but now we're in a position where the demand is so high that they will be needed regardless of what happens in the broader economy," Farrell said, "There's a real fizz in the market."

Crucially, the importance of these elements to national industry and security has been recognised by western governments. Even before the Russian invasion of Ukraine, the US, Australia and others had shown a commitment to developing security of supply for REEs, 60% of which are produced in China. In February Hastings Technology Metals announced it would receive a A$140 million loan from the state-run Northern Australia Infrastructure Facility (NAIF) towards its total $300-400 million funding requirement for building out Yangibana. In April, the Critical Minerals Facility, managed by Export Finance Australia, announced it would provide a A$1.2 billion loan to Iluka Resources to build a REE refinery in Western Australia. At present all rare earth finishing is done in Asia. The Eneabba refinery will serve to process elements from deposits across Australia, with the goal of lowering costs and reducing risks for projects to come to market. The strong demand for REE is not only attracting capital but also smoothing over some of the licensing and bureaucratic hurdles that have traditionally hindered projects. "It has taken some Australian rare earth projects more than 30 years to move from discovery to construction and onto production," Farrell said. "I don't think the landscape looks like that any longer. What we're seeing today is the result of a real effort from US and Australian governments to break the monopoly that China holds over rare earths." That strong government messaging bodes well for the development of projects such as Hastings Technology Minerals and Dreadnought Resources, owners of Mangaroon, but also for early stage exploration companies such as Kingfisher. But while Hastings and Dreadnought have market caps of A$480 million and A$114 million respectively, Kingfisher's remains under A$15 million. That value includes the company's other project, a copper gold project called Boolaloo in the Ashburton Mineral Field in Western Australia, originally considered Kingfisher's flagship project. With a total tenement package of over 700km2, the Green Hills prospect has been the target of RC drilling, following a major airborne electromagnetic survey completed in mid-2021. Amongst the RC drill results were 12m at 0.7% copper along with a diamond drill result of 10m containing 0.5% copper at Copper Strike.

"We took the same strategy at Boolaloo as we did at Gascoyne, taking up over 30km of strike length on the target structure," Farrell said. "That's a good size for a company of our scale, however that project has taken a back seat for now given the excitement over the potential in the Gascoyne." So far Kingfisher has remained very tightly held with a small market cap, but the success of the projects 100km north, combined with the upcoming drill results could soon see that change. "We're fully funded beyond the end of the first quarter 2023 and are focused on delivering value for our shareholders from exciting exploration results," Farrell said. "At the moment from everything we've seen at the project, the potential is amazing."

Kingfisher Mining – at a glance

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Market Capitalisation (at press time on 22nd June 2022)
A$14.36 million

Quoted Shares on Issue
42.25 million

Major Shareholders
Board and Management (14.9%), Top 20 Investors (33.1%)

Future Metals primed to lead Australia's charge into PGM supply

Future Metals is in the vanguard of Australia's push into the platinum-group metals, or PGMs, market and is tracking to become the country's first producer of the commodities—which comes at a time when the world is growing increasingly eager for supply from a stable jurisdiction.

The company's flagship project is Panton, located in Western Australia's East Kimberley region—just 1km from the Great Northern Highway, which provides direct access to the Port of Wyndham. "I think there has probably been no better time in recent history to be pushing a project like this forward," the company's managing director and CEO Jardee Kininmonth said. "We're one of the nearest term prospects to production within Australia, progressing the project at a time when supply from Russia is being sanctioned and the existing issues for producers in South Africa show no signs of abating," he added.The company recently updated its Mineral Resource Estimate which now puts the Panton project as comparable to Chalice's Gonneville in size and grade, with a total resource of 129million tonnes @ 1.20g/t PGM3E and 0.19% nickel (1.66g/t PdEq) for 5 million ounces PGM3E and 239,000t nickel for 6.9Moz palladium equivalent. The resource comprises of a discrete high-grade reef and the surrounding bulk mineralisation. The high-grade portion has a resource of 25Mt @ 3.57g/t PGM3E and 0.25% nickel for 2.9Moz PGM3E and 60,000t nickel, while the bulk mineralization contains a further 2.1Moz PGM3E and 180,000t nickel.

Kininmonth said the new mineral resources was pivotal moment for the company in demonstrating a resource of "global scale" and allowed it to assess the optimal project development scenarios as part of its scoping study, which was slated to be completed in December quarter.

"We've taken the highest grade PGM resource in Australia and proven up the bulk mineralisation which envelopes the high-grade portion, providing significant scale potential to the project as well as significant optionality in how we progress the project, be it underground, open pit or a combination of both," he said. Former Panton owner Platinum Australia conducted a mineral resource for the deposit in 2003, which was re-reported in 2015, that showed a 14Mt resource containing 2.4Moz PGM and gold; and 38,000 nickel, plus rhodium and iridium. This relates solely to the high-grade chromite reefs. The high-grade portion of the resource has been remodelled as part of the new mineral resource to be more suitable for underground mine planning.The new MRE also incorporated the previously overlooked shallow, bulk mineable sections of

the deposit. Assays from the nine most recent historical cores paint a picture of broad mineralised widths through the footwall of the reefs, along 3.5km of 12km strike of the Panton Sill. Notable recent results include 37.1m at 0.95g/t PGM3E and 0.16% nickel from 8m using a 0.5g/t cut-off. Another hole returned 32.88m at 1.33g/t PGM3E and 0.19% nickel from 28m using the same cut-off, but when unconstrained returned 150.8m at 1.18g/t palladium equivalent. These results were all fed into developing the new resource.

The strong and strengthening tailwinds that Future Metals is riding with Panton – are coming from both the supply and demand fronts. One of those tailwinds is accommodated by the powerhouse mining jurisdiction that is Western Australia. It provides a stark contrast to issues faced in, by far, the two largest sources of PGMs currently: Russia and South Africa.

"Russian supply is essentially out of circulation for Western consumers. A lot of European refiners are not accepting products from Russia anymore and a lot of end users of palladium are looking to disintegrate Russian supply from their value chains," Jardee noted. Johnson Matthey said in its 2022 PGM Market Report released in May that given the "unusually large uncertainties" surrounding Russian PGM supplies, it's difficult to anticipate just how big the impact could be. "That means South Africa is kind of the mantle holder in supply of PGMs to the world and it's had perennial power availability issues, labour relations issues, and the mines there are getting deeper and deeper as they chase the Bushveld reefs which is driving up capital and operating costs," Kininmonth said. Supplies from South Africa are likely to fall this year, the Johnson Matthey report said, on the back of plant maintenance and operational challenges. Many mines have seen higher than usual levels of disruption with causes ranging from safety stoppages, inconsistent power, social unrest, Covid, illegal labour stoppages, and heavy rains, it said.

In 2021, South Africa was responsible for 74% of global platinum supply, and 39% of palladium, according to Johnson Matthey

Russia's platinum supply in 2021 made up 10% of the global mix, while for palladium it contributed 40%, it said. "So, Australia really has a strong opportunity to slot in there," Kininmonth said. "Western Australia particularly is the eminent mining jurisdiction globally. So, in terms of skilled workforce, ease of permitting, infrastructure, power availability, and all those things other jurisdictions can have trouble with—Western Australia really has a tailwind behind it," he said. Along with the historic drill results, Future Metals is also hitting the ground running with Panton, with granted mining leases and prior environmental and heritage surveys not demonstrating any red flags. In-place infrastructure includes sealed roads, a port, airport, and hydropower. The CEO notes that it's also all happening at a time when state and federal governments are getting behind critical minerals, such as PGMs, and lending their support to build up industry. "There are a lot of funding initiatives becoming available to aid development of critical minerals projects such as Panton," he said. "Governments are also particularly interested in projects that are looking to integrate downstream and create integrated businesses around these mines," he said.

Future Metals' Panton is well future proofed for the global shift towards cleaner energies with a fairly even split between platinum and palladium grades—along with the nickel, rhodium and iridium. For the near-term, the company can support the demand for palladium in catalytic convertors for internal combustion engines and hybrids, while medium- and long-term demand should see an uptick in the need for platinum in hydrogen electrolyzes and fuel cells.

"The real growth upside for PGMs, for both platinum and palladium, relates to the hydrogen industry," Kininmonth said. Platinum plays a central role in that industry. It basically fulfills a role that no other mental or element can at the moment.

"The events in Russia and Ukraine have probably put a rocket under the development plans for the hydrogen industry because it can help to reduce dependency of oil and gas from Russia. Hydrogen is the likely solution there. The increased impetus to make green hydrogen cost competitive with other fuels means it will attract a lot more capital and a lot more brainpower, accelerating the industry's development and leading to broader adoption of fuel cells too." he said.

Future Metals – at a glance

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Market Capitalisation (at press time on 27th June 2022)
A$60 million

Quoted Shares on Issue
353.8 million

Hot spots

With such an array of commodities and jurisdictions in play in the critical minerals space, naming hot jurisdictions is a challenge.

Australia and parts of Africa were among the top picks by analysts canvassed by *Mining Journal*.

"But, such is the anticipated demand for these metals that almost any jurisdiction may prove viable if it can show the appropriate mineral potential," Edison Group energy and resources director Lord Ashbourne told *Mining Journal*.

Photo: iStock.com

He said traditional areas of production would have a headstart, such as South America and Australia for lithium, because investors would be more confident of mineral endowment.

Lord Ashbourne said it was probably easier to rule out jurisdictions that had eliminated themselves as potential future centres of investment by creating a hostile investment environment, citing Russia as a possible example.

"Interestingly, one area of the world that seems to be benefitting in a general sense is Africa and, in particular, sub-Saharan Africa, where the perception seems to be that it is a good jurisdiction for mineral potential and a known quantity when it comes to the regulatory environment," he said.

"Areas where there isn't perceived to be a serious environmental impediment – for example, deserts – also appear to be particularly favoured.

"However, such is the level of interest from investors that even areas of the world that, in other respects, are considered almost off-limits for mining – Europe comes to mind – are nevertheless attracting interest."

Given the West's attempt to reduce reliance on China for supply, Cannacord Genuity's Reg Spencer sees regions proximal to emerging battery/EV hubs (ex.China) as important.

"In our view, these include Canada [to feed the US], Australia [to feed Asia] and certain parts of Africa [to feed Europe]," he told *Mining Journal*.

Opportunities for investors

Demand for critical minerals is clearly presenting an opportunity for investment and car manufacturers have stepped up, not only inking offtake deals but also investing in mining companies to shore up supplies of critical minerals for their growing EV products.

It began with China's Great Wall Motors taking a stake in Pilbara Minerals in 2017 as the ASX-listed company developed its flagship lithium operations in Western Australia.

Toyota Tsusho then took a 15% stake in ASX-listed lithium producer Orocobre the following year. Others, including Tesla, have since made investments.

A case of timing

For individual investors, the issue is proximity to production in a chronological sense, Edison's Lord Ashbourne said.

"Initially, it has been the existing producers of these [critical] metals that have benefitted as they have reaped the most immediate benefits of moves in metals' prices," he told *Mining Journal*.

"Once their share prices have risen as much as they can, however, it will be the turn of those with advanced-stage projects, after which it will be those with more distant prospects for production.

"At any time, however, a discovery in either an established jurisdiction – best – or a new one will have the potential to accelerate a junior up the value curve."

As existing deposits in 'friendly' jurisdictions are depleted and grades fall, the need for new sources of these critical minerals will only grow.

This puts explorers and developers at the forefront of the challenge to ensure leading economies can build new and more diverse supply chains of these critical minerals, as a greener future beckons.

Photo: Unsplash.com

Venture Minerals aims to develop a multi-generational tin and tungsten mine in Tasmania

Now redesigned as an underground mine, the developers of the Mount Lindsay project believe rising demand for critical minerals and focus on ESG compliance can bring a new scale to the project

Across the globe the energy transition is boosting future demand projects for those metals crucial to the production of electric vehicles (EVs), wind turbines, solar cells and many other green technologies. Much focus has been placed on copper – the main element in wiring and other electronic components – but there is also a huge role to be played by the metal that serves as the glue that holds these components together: tin. With current tin prices sitting around $35,000 per tonne – almost double their pre-pandemic value and four times that of copper – the search is on for new projects that source tin without sacrificing the ESG principles that underpin the energy transition. Venture Minerals' Mount Lindsay project in Tasmania fits the bill.

"The time for tin is now," Venture Minerals managing director Andrew Radonjic said. "Our project is located in a tier one ESG jurisdiction that has reached net zero emissions through access to renewable hydropower at a time when tin prices are near record highs."

Tasmania has been a producer of tin since the 1890s with Mount Lindsay discovered in 1909 and then later subject to modern day exploration by owners of the nearby Renison Bell tin mine. However, the low prices of the mid 1980s meant that little work was done at the site until Venture Minerals took up the challenge in 2007. The company's geologists discovered evidence of tunnels and previous operations overgrown with vegetation and had the chance to pore over 17,000m of historical drilling data from the previous owners. The company then set out on an aggressive exploration campaign, drilling over 830,000m in the property before producing a JORC compliant resource estimate in 2012 which identified more than 80,000 tonnes of tin and 3.2 million metric tonne units of tungsten trioxide. A feasibility study for an openpit mine was released the same year.

"The ore body has been well drilled out, we did a fair bit of detail," Radonjic said. "When we did the feasibility for the openpit mine, the economics were okay but it was tough to raise funding for a tin and tungsten project at the time and permitting an openpit in Tasmania would also have been more difficult." The Venture Minerals team reconsidered its options and chose to re-plan the project as an underground mine, with sufficiently reduced start-up costs, strong economic and ESG metrics and a smaller final footprint of 33 hectares compared to the original 200 hectares. A pre-feasibility study is set to be released later in 2022.

"We decided the best way to develop the asset was to build a smaller underground operation, firstly to help the permitting process and secondly to get the capital costs

down," Radonjic said. "We're focusing on the underground design. We have an extremely high grade core and a low-grade halo around it, so the mine will be a reasonable size."

Drill results from Mount Lindsay's MacDonald shoot – the main skarn deposit – include 26m of 2.7% tin and 8m at 1.4% tungsten trioxide. The original plan for the underground mine in 2018 envisioned a 4Mt project, but with the higher tin price more of the halo material can be processed meaning it could easily turn out to be twice the size, according to Radonjic. Many of the environmental and hydrological studies were prepared already for the openpit mine and would only need minor updates. The project was also aided by breakthroughs in metallurgical testing. Using a technique called electrostatic separation the team were able to extract the 3% tungsten content from its tin concentrate to produce a 75% tin product. That would allow the firm to achieve higher prices for the tin as well as boost the overall production of tungsten, an incredibly durable metal with a high melting point used extensively in armaments and aerospace industries. Revenues from the current project are estimated at 40% tin, 40% tungsten and 20% magnetite with a mine life of 10 years.

"We have a great opportunity to build a new generation tin and tungsten mine at Mount Lindsay," Radonjic said. "We will focus on battery-driven underground mining equipment, we have hydropower running through our tenement and a much reduced footprint. Mining has also built up a social license in North-Western Tasmania through a history of over 130 years of mining activity. Permitting in Australia can be stringent but we're ticking a lot of the ESG boxes." That's important at a time when most of the world's tin is sourced from environmentally disastrous dredging operations – which churn up rivers with no rehabilitation commitments – or from countries with extremely dubious track records in human-rights and corruption issues. This creates a market for hard rock projects, such as Mount Lindsay, that would abide by global standards of responsible sourcing of critical materials.

There are also economic and geopolitical winds favoring projects such as Mount Lindsay. Despite its mining pedigree there have been no major new projects in Tasmania in recent years at a time when the island has one of the highest unemployment rates in Australia. With both tin and tungsten included on the US government's 2022 list of critical minerals, the time is ripe for Australia to develop its resources. "For many years Australian messaging around mining has focused on exporting raw materials and given away a lot of value in downstream work," Radonjic said. "We're seeing a process now where the UK and the US is returning to Australia to secure strategic supply in exchange for support with developing technologies here." This emphasis on security of supply for critical minerals is a boon to Venture Minerals in the permitting process for Mount Lindsay, the first part of the company's two-pronged strategy for 2022 to 2025. The firm began the process, which takes around two years, in late 2021. The construction period is estimated at 18 months meaning Radonjic is earmarking 2025 for production from the mine. The fact that the company successfully permitted an openpit mine – the nearby Riley iron ore mine – is another source of confidence. In recent years, the Riley mine has been developed for production from a gravel washing plant to take advantage of high iron ore spot prices.

Venture Minerals also has a joint venture with Chalice Mining in Western Australia, which Chalice believes bears strong geological similarities with its province-defining Julimar deposit, a globally significant source of battery and hydrogen green metals.

The second part of Venture Minerals' dual-strategy is to explore new sources of ore around the site. "We want to build a multi-decade mine. We want to provide multi-generational employment to Tasmania," Radonjic said. "It's very rare that you discover a whopper resource. At the moment we have a ten-year mine, but we're looking to find other ten-year deposits in the region around the plant that we can work and then rehabilitate." The company has identified over 40 anomalies on its land package though electromagnetic studies. When combined with the region's history of alluvial tin mining, and the fact that Mount Lindsay sits on the same tin-rich source rock that has sustained the Renison Bell mine for over a century, Radonjic believes that "it's not a question of if we'll hit new tin deposits, it's when".

Venture Minerals – at a glance

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Market Capitalisation (at press time on 23rd June 2022)
A$ 73.6 million

Quoted Shares on Issue
1.67 million

Major Shareholders
Elphinstone Holdings (3.15%), Republic Investment Management (2.88%), WGS Pty (2.51%)

First Tin leverages conflict-free tin to match global demand

First Tin assets in Germany and Australia to take conflict-free tin to the market by 2023.

LSE-listed firm, First Tin (LSE:1SN.L) developing its mining projects in Germany and Australia to support the global clean energy transition and technological revolutions whilst creating value for investors.

Due to the volatile history of its exploration, tin is unlike any other mineral commodity in the market today. And with two very advanced mining projects in Germany and Australia, First Tin is looking to capitalise on the promising global demand projections to produce high-quality tin from first-tier jurisdictions. The company's two mining assets, are about to join a market crowded by output from conflict, high political risk areas. For First Tin CEO Thomas Buenger, investors and customers will notice the difference.

Following a crash in the price of tin in the 1980s, exploration for new tin deposits was severely curtailed. For over 30 years, barely any mining companies looked for new tin ore deposits. "For most other commodities, we know where all the ore bodies are," Buenger said. "They are better or worse explored, but the challenge is to develop these resources. For tin, we lack this knowledge about where ore bodies are, because most of our information comes from exploration in the 1970s and 1980's", he added.

Luckily for First Tin, two of the 11 mining projects that the International Tin Association – a sector body – considers mature enough to enter into production up until 2030, are part of the company's portfolio.

Leveraging that portfolio, First Tin aims to match the high demand expected from the energy and environmental transition. Solar energy generation, automated and electrical cars, energy storage, and most computing and robotics require tin. These areas are expected to create a demand shock in the market.

From an annual 360,000-380,000 tonnes, global tin production will have to rise by an additional 100,000t per year to accommodate market needs. At the moment, global output includes 300,000t of primary tin production and about 80,000t of recycled tin. "If you take the primary production and add 100,000t, that means nothing else than adding an extra 30% of demand," Buenger said. "And that is a very good forecast for a producer".

Based on that forecast, First Tin hopes to start production by 2025. This will involve bringing to market two mining assets situated on opposite points of the globe. In Germany, First Tin is moving forward with its Tellerhäuser project, in Saxony. The region has seen tin mining since the Middle Ages, and activity eventually stopped, not because of insufficient mineralization, but for lack of adequate technology. First Tin owns roughly 140km of drill course, in a very high-grade ore body with extensive exploration. The company is looking at a capex of US$49 million to bring Tellerhäuser into production, and counting on a JORC resource estimate of 53,000t of tin. "We expect to have

around 3.000t of tin produced out of the Tellerhäuser mine per year", Buenger said.

At Tellerhäuser First Tin is aiming to build a zero-waste mine. This brings its own challenges. "I would call it sustainable mining, as sustainable as mining can be. We will mine around 500,000t of ore annually and turn about 45% to 50% of the mine volume into product," Buenger said.

Aggregates for construction materials, a magnetite concentrate for the steel and iron industry, or a zinc, copper and indium concentrate, First Tin is aiming to maximize all the economic benefits it can produce from its underground mine, and looking to power its operations with hydroelectric power from the region. At its Australian mine concession in Taronga, New South Wales, First Tin will develop an openpit mine with tin resources at 57,000t, in what is considered to be the fifth largest undeveloped tin reserve in the world. To advance its mining ambitions Down Under, First Tin is looking at a capex of US$76 million.

At the moment, the firm has no doubts regarding the strength of its value offer. "At US$30,000/t of tin price, still a very conservative approach, we talk about a four-fold increase in value relative to our capex, which is US$125 million combined for Germany and Australia," Buenger said. "With the price at US$40,000/t, it is a seven-fold increase in our valuation. So, excellent business cases, and mature enough to stay even profitable at the long-term tin prices we've seen in recent few years", he added.

With that goal in mind, First Tin listed on the main market of the London Stock Exchange in April 2022. The Initial Public Offering raised £20 million. "We feel this is all we need to take our two assets to the investment-ready stage," Buenger said. This will include an estimated £13 million to complete permitting processes and bankable visibility studies, which are expected to be finalised by the second half of 2023.

Another part of the financing, roughly £6 million, will allow for additional exploration in both Germany and Australia. At Tellerhäuser, the firm expects to do some deep-drilling, reaching as far as 800m. But the broader exploration area in is also being looked at more closely, with the company recently finishing some exploration drilling at Gottesberg, less than 30km from Tellerhäuser, part of First Tin's concession area that hosts potential to expand mining operations in the future. In Taronga, Australia, the firm is studying the historical drilling data before moving forward with more exploration. These efforts aim to add further to indicated resources. "If one of our exploration targets shows promising resources, US$6 million is not enough to move that into a resource-ready programme, so if it promising, we will need to raise more money. We will need to go over the data if we reach that point," Buenger said.


First Tin CEO, Thomas Buenger

By aligning with the future demands of both investors and the firms using tin in their manufacturing, First Tin is promising to redirect the market towards a cleaner growth path. Today, over 80% of global tin comes from countries with lax regulations on child labour and areas embroiled in conflict. According to the International Tin Association just three countries - China, Indonesia and Myanmar – accounted for 66% of tin output as of 2020.

"There are number of institutional investors which can't invest if you are not conflict free and ESG compliant," Buenger said. "Downstream, too, large tin consumers need to declare their product conflict-free to sell in some of markets. I can't see how they can do that at the moment."

First Tin's offer of conflict-free tin adds a layer of long-term value to its mining assets in Germany and Australia. And a revolutionary path for the future of tin mining.

First Tin – at a glance

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Market Capitalisation (at press time on 13th June 2022)
51.78 million

Quoted Shares on Issue
266 million

Major Shareholders
AusTin Mining Limited (22.6%), Baker Steel Resources Trust Limited (15.36%), Arlington Partners Fund (7.51%), Lau Sheung Man (4.75%), Sparta AG (4.39%)

Thunderbird set to soar over mineral sands market

Investment spurs project progress at worlds largest Zircon reserve.

Sheffield Resources (ASZ:SFX) owns 50% of the large, long life and high grade Thunderbird mineral sands project, which is on the cusp of taking flight to bring on a major new supply of zircon with a multi-decade life in mining-friendly Western Australia.

"By volume, it's an ilmenite mine – the prominent product by volume is the titanium product. But by value, it's really the zircon," Sheffield executive chair Bruce Griffin said. "It's the world's largest zircon reserve. And it's high grade. It'll be one of the key sources of zircon in the world over a three-to-four-decade life, particularly since a number of the existing large sources of zircon are nearing the ends of their lives.

"We'll be about 10% of the world's market for zircon when stage 2 is executed. So, it's very large and it's going to be there a long time. It's in a good jurisdiction with some real advantages, including proximity to Asia," Griffin said.

The company's progress has been spurred by a cash injection from the Northern Australia Infrastructure Facility, or NAIF, and Chinese manufacturing giant Tangshan Yanshan subsidiary Yansteel's investment of A$130 million to acquire 50% of the Thunderbird and offtake agreement for 100% of the magnetic concentrate.

The NAIF investment, which came in April 2022, is to the tune of A$160 million and roughly covers half-or-more of the A$300 million to A$320 million of required project financing.

And its benefits extend further than a regular investment investment – and not only because it's cheaper money. "I think sometimes there's a bit of a misunderstanding about how NAIF really helps a project like ours," Griffin said

"While our project is very robust, there's very good economics—it generates a lot of cash and can service a lot of debt - the challenge for greenfield mining projects is that typical commercial debt generally has a five to seven year term. And often there's about a two-year period where you're not generating any cash, which is between the initial drawdown and the end of the build period.

"That means you can have as little as three years to repay it. It doesn't matter how good your project is. Repaying 100% of the debt in three years is pretty challenging," he said.

Thunderbird's debt tenure with NAIF is expected to extend beyond 10 years.

A 2022 bankable feasibility study on the project views a post-tax net present value (8%) of A$1.28 billion, a post-tax internal rate of return of 27.5%, and mine life of 36 years in the base case.

The project's development pathway sees the initial stage 1 mining and processing feed rate forecast at 1,085 dry tonnes per hour, with stage 2 doubling the feed rate to

2,170tph— which is targeted during the fifth year operations.

Stage 1 and 2 are estimated to produce 1.4 million tonnes per annum of zircon and ilmenite concentrates over the mine life.

First production is targeted for the first quarter of 2024 and the company is scheduling to make a financial investment decision in the middle of this year. Despite the market impact of the war in Ukraine and central bank interest rate increases in response to inflation, Thunderbird intends to lock in the remainder of its financing this month or next.

Griffin— previously CEO of mineral sands consultancy TZ Minerals International – said he expected Thunderbird's production to come online amid high demand for the commodities.

"At the moment, we're in a very strong market for zircon, for ilmenite, for rutile, for all the mineral sands—we're at near record prices for them all. And because of some of the supply challenges, there's the view that those prices have a few years to run.

So, for us, it's quite a favourable environment—we still expect strong prices when we're starting up. And all of our debts are structured assuming a low-price environment," he added.

Another aspect that saw Thunderbird fit the NAIF profile is its environmental, social, and governance aspects.

The Kimberley is sparsely populated. Indigenous Australians make up approximately 40% of the population and the region is comparatively underdeveloped.

Thunderbird intends for its employment to mirror those community demographics and wants to offer stable benefits that feed through generations.

"Our focus is on operational roles and operational contracts. Construction is boom/bust, it'll only last about 18-months" Griffin said. He explained that the company is mindful of navigating employment for the construction period as to not disrupt the needs of the communities.

"For example, if we do our construction electrical work purely with local sparkies, no one is going to get electrical work done for 18 months because we'd be using every electrician in the west Kimberley.

But we can offer a long-term contract to someone to provide electrical services during operations and they can staff up for that. We have a long-life project that's multi-generational. So, we have an expectation that we can employ people and potentially employ their kids as well. That has much more of a lasting impact," he said.

While the Kimberley itself is not historically known for a great amount of mining, it is within the mining powerhouse state of Western Australia—and subject to the benefits that brings.

"I think the jurisdiction thing does sometimes get overlooked," Griffin said.

"Even within Australia we see the difference. Western Australia is a traditional mining state. It brings a greater level of comfort in knowing that mining is integral to the State. I don't think you see that knee-jerk hostility. That reduces the approval risk. As an investor, there's a confidence.

"If you look at something like mineral sands, a lot of the other large greenfield projects are in more complicated environments. You can still do business in them, but they don't have quite that same security.

"Approval processes are very rigorous in WA, but they have a proper cadence to them—and don't seem to get stuck.

He noted that the very nature of sand mining also means the company can easily navigate elevated areas and outcrops of rocks—which are more typically regarded as significant by traditional owners.

"We've got decent sized buffer zones around all of that. We've got the right agreements in place and are making sure to treat the heritage properly"

Sheffield Resources – at a glance

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Market Capitalisation (at press time on 24th June 2022)
A$ 180 million

Quoted Shares on Issue
346 million

Major Shareholders
YGH Australia Investment Pty Ltd (9.9%), Mr Walter Mick George Yovich & Mrs Jeanette Julia Yovich (8.7%), Blackrock Group (6.3%)

EU carbon reforms to test critical mineral supply

by Andreas Walstad

The EU is currently in the process of revamping the Emissions Trading System (ETS) and introducing a new carbon border tax for imports of foreign goods.

These regulatory developments are expected to increase costs for miners both in the EU and globally, at least over time.

Under the ETS, emitters including mining companies must surrender one carbon allowance for each tonne of CO2 they emit. The system has been subject to some radical reforms over the years and more changes are coming.

After prices for carbon allowances once again hit rock bottom in 2016, when they were trading below EUR 5/tonne due to a huge surplus of allowances, the system was reformed amid political backing from Germany and France.

In short, allowances were taken out of the market in a move to boost prices. It worked; prices started to increase steadily due to buying interest from emitters and speculators. At the time of writing, it costs more than EUR 80/t to buy one carbon allowance in the open market, according to ICE data.

Not all emitters are treated equally. Steel and aluminum producers, for example, receive many allowances for free, in some cases all their allowances, while miners must purchase all the allowances they need in auctions or in the open market.

The main reason why metals producers and other carbon intensive industries receive free allowances is down to concerns over carbon leakage; the risk that they may relocate overseas if carbon costs are too high.

Of course, mining is a lot less energy intensive than metals production. In Europe, energy accounts for around 10-20% of miners' production costs compared with 80% for steel and aluminum producers. Most of the CO2 emissions from mining operations are from electricity generation, typically on-site gas or coal-fired plants.

But higher carbon costs have begun to eat into the profits of European miners. And with the ETS reforms currently being negotiated by the EU institutions, there is a real possibility that carbon prices will increase significantly also in the near future.

The proposed changes include phasing out free allowances by the early 2030s and introducing a steeper annual reduction rate of the annual supply of allowances to the market, the latter known as the Linear Reduction Factor (LRF).

This means metal producers and other heavy industries would have to buy more allowances to cover their emissions while, at the same time, there would be fewer allowances available. This adds to a bullish outlook for prices.

"Potential changes include lowering the overall emissions cap and increasing the annual rate of reduction of emission allowances, which will further incentivize emissions reductions. These changes could result in higher costs for the EU mining industry," says David E. Bond, a partner with law firm White & Case.

The EU ETS reform is currently in the hands of the European Parliament which has yet to find a common position on the

dossier, but which may do so in a plenary vote on 22 June. Once the reforms are endorsed by the EP, negotiations with the representatives from member states in the Council of the EU will begin. What the mining sector wants is predictability that would help them to manage the increasing costs related to carbon abatement.

"The ETS is the best instrument around because it is market based. But the reforms currently on the table would lead to a lot of uncertainty and volatility in the carbon market which will drive energy prices in general and electricity prices in particular even higher," says Florian Anderhuber, director of energy and climate at euromines, the European Association of Mining Industries, Metal Ores and Industrial Minerals.

In our opinion it is better to increase the Linear Reduction Factor so that the supply of allowances is gradually reduced faster on an annual basis instead of a one-off rebasing exercise. This would be more predictable, but at the same time achieve the same results as phasing out free allowances."

CBAM adds to concerns

The EU ETS reforms are not being negotiated in isolation. The dossier is inextricably linked with a proposal for a carbon border tax, known as the Carbon Border Adjustment Mechanism (CBAM) which could be phased in from next year.

The CBAM would impose a levy on certain goods imported from non-EU countries that do not have a nationwide carbon pricing system similar to the ETS in place.

> "Potential changes include lowering the overall emissions cap and increasing the annual rate of reduction of emission allowances, which will further incentivize emissions reductions. These changes could result in higher costs for the EU mining industry."
> — David E. Bond, White & Case partner

The idea is to increase climate ambition while at the same time avoid carbon leakage; polluters in Europe stop receiving allowances for free while importers of foreign goods must pay a levy equal to the ETS price.

Photo: Unsplash.com

"The European Parliament has debated whether to add polymers, organic chemicals, and hydrogen to the CBAM's scope from the early stage of the instrument's application."
— David E. Bond, White & Case partner

According to the European Commission's original proposal, imports of cement, iron and steel, aluminium, fertilisers and electricity will be subject to the CBAM. Many MEPs also support adding aluminum, hydrogen, polymers and organic chemicals to that list. Indirect emissions may also be included, which is emissions deriving from the electricity used by manufacturers.

Photo: iStock.com

The EC's proposed scope excludes raw materials used in the production of goods, Bond notes, for example bauxite for aluminum production, iron ore for steel production, and phosphorous for fertilizer production.

It also excludes critical minerals, such as nickel, lithium, and cobalt.

Yet raw materials may be included in the CBAM at a later stage as it is already included within the scope of the EU ETS.

"The European Parliament has debated whether to add polymers, organic chemicals, and hydrogen to the CBAM's scope from the early stage of the instrument's application and then - by 2030 - to have full product coverage, which would bring raw materials of minerals and metals within the CBAM's scope," says Bond

"Thus, while the CBAM's impact on the global mining sector and the supply of critical minerals to Europe might be limited initially, the impact could be more significant after a few years of operation," he says.

"The application of the CBAM to critical minerals, such as nickel and lithium, could significantly increase the cost of importing these materials into the EU, as the process for extracting these materials can be carbon-intensive depending on the methods used."

Unsurprisingly, countries outside the EU are observing the CBAM negotiations with a great deal of concern. To this end, Brussels has insisted the CBAM is carefully designed to be compatible with WTO rules.

However, many are unconvinced that this is really the case.

The CBAM will in any case face intense scrutiny from EU trading partners. For example, the European Business Association has calculated that the CBAM may cost Ukrainian exporters to EU countries EUR 1 billion per year in levies. The Minerals Council of Australia is also among those who have voiced concern.

"The European Commission has emphasized its view that the CBAM is WTO consistent, stating that the measure is designed to apply to imports the same carbon costs that EU producers incur under the ETS," says Bond.

"However, some trading partners are likely to question whether the CBAM impermissibly discriminates between otherwise "like" products based solely on their emissions profiles, resulting in more favorable treatment for domestic goods than imports, or for certain imports over others."

Cobalt content adds strategic edge to AuKing Mining's Koongie Park project

The discovery of the cobalt content in core samples from the Sandiego deposit in Western Australia gives further impetus to a copper-zinc project looking to grow its resource in 2022.

As governments around the world set out strategies to ensure security of supply for critical minerals, it can pay for mining firms to reassess old core samples. When the team at AuKing Mining reprocessed historic samples held in storage at its Koongie Park copper-zinc project in northeast Western Australia, it was met with a pleasant surprise: significant anomalies of cobalt, a crucial element in electric-vehicle batteries.

"Koongie Park will always be a headline copper and zinc project," AuKing Mining CEO Paul Williams said. "But with cobalt prices ranging from US$70,000-80,000 per tonne, you don't need a lot of the mineral to make it economically viable to include it in the copper concentrate to refineries which will give you credit for it."

While cobalt production is dominated by major mines in the Democratic Republic of Congo, the US Department of Energy considers the material the highest short-to-medium term supply chain risk for the electric vehicles industry. Williams hopes the element can act as a sweetener to a copper-zinc project that is already starting to draw attention thanks to its growing resource and improved metallurgical results.

Koongie Park is situated in the Halls Creek region in the northeastern corner of Western Australia, once the epicenter of the 1880s gold rush. In the 1970s and 1980s it was well explored by major mining firms including Kennecott Copper and BHP Billiton and then by ASX-listed junior Anglo Australian Resources (now called Astral Resources). In total over 50,000m of drilling was completed at the project. In February 2022 AuKing Mining secured a 75% interest in Koongie Park following an initial earn-in exploration campaign in late 2021.

That work allowed AuKing to boost the JORC resource estimate at the project by 30% to 8.9 million tonnes including 1.1% copper and 3.67% zinc with 0.16g/t gold and 32g/t silver. Almost all resources were shifted from the inferred to the indicated categories. Highlights from the 2021 drill campaign included 124m @ 1.03% Cu, 1.08% Zn, 1.59% Pb and 105m @ 1.94% Cu, 0.76% Zn, 55g/t Ag including 16m @ 10.2% Cu, 1.03% Zn and 316g/t Ag.

"Last year's drilling enabled our geologists to have a greater confidence in the resource estimate," Williams said. "The resource looks very much like a VMS style deposit where

there are clusters of mineralized shoots. We're confident there are quite a few others in the area."

So far, most drilling has focused on the near-surface Onedin target, which could be the established as an open-pit operation, and at the Sandiego deposit, which is deeper and where the cobalt content was discovered.

While copper and zinc are not specifically included in government critical minerals lists, the production of minerals such as cobalt, germanium and indium usually occur as a by-product of primary copper or zinc mining operations. In addition, due to its vital role in the electrification of energy transition technologies from electric vehicles to wind-turbines means that long term demand for the red metal is expected to rise for the foreseeable future. The price surpassed $10,000/t in early 2022 while zinc – also used in batteries and electrical systems – reached over $4000/t.

"We're seeing a price cycle in copper and zinc that we haven't really seen before," Williams said. "Koongie Park's previous owners, such as Kennecott and BHP, were looking for elephant-sized deposits, but this new price structure makes these kind of deposits more attractive from a development perspective." The focus then for 2022 will be to boost the resource number through a 7,500m drill programme.

"Before we can get into a serious feasibility study programme we need to increase the tonnes and identify additional mineralised zones," he says. "We're sitting on

"Before we can get into a serious feasibility study program we need to increase the tonnes and identify additional mineralized zones"
— Paul Williams, CEO

8.9Mt, but that's on the low side for putting out a study. We really want to get to around 15Mt for a deposit like this. That's when we'll be in a position to significantly accelerate development." The campaign will be overseen by new exploration manager Chris Bittar who previously supervised resource expansion activities at Pantoro's Norseman project, also in Western Australia. One particular target is the Emull prospect in the western area of AuKing's tenure portfolio, into which the firm plans to drill around a dozen holes to a maximum of 250 m.

But while drill programs and core samples are typically the sort of news flow that piques investor interest, in AuKing's case one of the most important breakthroughs has come in the metallurgical testing labs.

Previously Anglo-Australian had faced challenges

separating the heavily oxidized material near the surface of the deposit, running to about 90m in depth, using traditional flotation and acid-leaching processes. However, with the help of Perth based Accudo Metals' patented ammonia leaching technology, the company announced preliminary metal recovery rates of 75% at Onedin in May 2022.

"In the carbonate areas we're having excellent recovery rates using this process," Williams said. "Ammonia is a lot easier to handle, so the environmental footprint for the mine would be reduced. If we can put something together with this process it would not only benefit Koongie Park, it could have wider applications elsewhere."

The research and development investment put into the technology also benefits from significant rebates from the Commonwealth government. That's typical of a government that understands the importance of the mining industry to the local economy.

"Western Australia is a strong and stable jurisdiction, you won't find a significant change in mining laws any time soon and the local government and regulators are familiar with the industry," Williams said. "Our big focus is building a strong relationship with the traditional owners (TOs), the aboriginal population that make up a substantial part of the population in the Halls Creek region. We want to provide training and employment opportunities for the local TOs wherever possible."

With a population of 1,500 and a small tourism industry Halls Creek is linked up to local infrastructure including a major highway, a commercial airstrip and potential for gas-fired and other renewable power sources. With hot stormy summers pushing the temperatures up to the 40-45 degree Celsius range, sourcing water is a challenge that can be overcome by developing water bores and storage projects to take advantage of the heavy rainfall that accompanies the wet season from late November to March.

In late May 2022 AuKing tied up more than $4 million through a capital placement and rights issue, enough to fund the current exploration push.

Williams, an experienced Brisbane lawyer who worked in-house for a spell with Mitsui's coal operations, is joined in leadership of the firm by non-executive chairman Dr Mark Elliott, a 40-year geologist with previous management positions at several ASX-listed mining firms and another 40-year geologist, non-executive director Ian Hodkinson.


Auking CEO, Paul Williams

"We've got the commercial and technical expertise to build up the story to support the exploration results," Williams said.

"We're in a Tier One mining jurisdiction, we're attracting attention in the critical minerals space and as we progress our metallurgical test work I expect us to produce a standout Australian resource project."

AuKing Mining – at a glance

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Market Capitalisation (at press time on 22nd June 2022)
A$ 8 million

Quoted Shares on Issue
102.5 million

Quoted Options
32 million

Substantial Shareholders
Bienitial International Industrial Co (8.9%)

Stars align for Tinka at Ayawilca

TSX junior hits the drills as it gears up to release a PFS for a potential top 10 zinc deposit.

A strong demand/supply set-up has lifted zinc prices to record highs in recent months, giving a boost to Toronto-listed junior Tinka Resources (TSX-V:TK) in its bid to progress the promising Ayawilca project in central Peru.

Hype has been building around Ayawilca since October 2021 when a PEA showed the deposit had the potential to become one of the world's top 10 zinc producers. It outlined an after-tax NPV8% of US$433 million – up 19% from a previous PEA released in 2019 – and IRR of 32% at US$1.20/lb zinc, with an initial capex of US$264 million. Annual production was slated at approximately 155,000 tonnes based on 43.5 million tonnes mined over 14.4 years.

"It's a globally significant zinc deposit in anyone's language," says Tinka's CEO Graham Carman. "It's got the size and grade that majors want; the zinc is all sulphide, there's no oxidation, it floats beautifully. The technical risk is really quite low, and there is significantly more exploration upside."

Tinka is currently progressing Ayawilca towards a pre-feasibility study, which Carman said should be delivered in around 18 months. "It's going to be a really exciting time for us. The last 12 months has been pretty quiet – we haven't really done much work other than putting together the PEA and we've kind of been getting ready for this next phase. Now we're fully cashed up, with all the necessary permits and ready to go," he said.

Tinka is poised to kick off a 10,000-metre drill programme, with exploration drilling set to start mid-June. This will be followed by infill drilling to target high grade zinc zones, with a view to boosting measured and indicated resources. Results are expected to filter through from the end of July to the end of the year at least. The deposit is divided into four different areas – west, south, central and east, and Tinka will focus on the higher-grade west and south areas, where Carman said there's still about 15Mt of inferred resources.

"Those two areas not only feature the highest grade but also represent the thickest parts of the deposit," said Carman.

"We've got around 20Mt indicated and 45Mt inferred at the moment, and we want to get that 20Mt up at least another 50% to about 30-35Mt, so that's what we're going to be targeting and that will then feed into a PFS towards the back end of 2023," said the CEO. Carman is also hoping to add a tin component to the resource, having unearthed a separate zone of the metal beneath the zinc that it chose not to include in the PEA. The Company is working on metallurgical test work at a laboratory in Australia at this time.

Cashed-up

Tinka is well positioned from a financial standpoint after announcing a strategic financing with Nexa Resources –

Latin America's largest zinc producer – and with Buenaventura an existing insider of the company, towards the end of May 2022. The deal saw Tinka raise C$11 million at a 50% premium to the closing share price. It means Tinka is now fully funded through to PFS, with C$20 million in the bank. Nexa's investment gave the company a 19% stake in Tinka, putting them just behind the other large strategic investor, Peruvian miner Buenaventura.

Given Tinka's size and experience, it would be unsurprising should one of the strategic partners come in to build the mine.

"I would imagine that one of those companies ultimately will end up developing this. But we do have some competitive tension so I think that's a good thing," said Carman. However, Carman cautioned against complacency.

"We've got to be prepared to develop it ourselves to get the best outcome for our shareholders" he said.

Nexa owns three mines in Peru and also owns the country's only zinc smelter, located about 200km from the project, and connected by a direct train line. Tinka itself began life a decade ago with a silver project on the northern side of the Ayawilca property. The company then discovered Ayawilca somewhat fortuitously in 2014 as it explored for more silver.

"They drilled through the overlying sandstone unit where the silver was hosted. The drill hole busted through the limestone and all this zinc came out of the ground, which was a surprise for our geological team at the time" said Carman.

"That drill hole caused a change of focus for the company."

In addition to its flagship project, Tinka also holds a large exploration portfolio in central Peru, half of which it bought in 2021 from BHP. That ground features an outcropping copper-gold skarn, known as Silvia, which Carman said BHP "didn't really recognise" as having potential. Tinka's geologists have been sampling and mapping the skarn outcrops and the size of the potential discovery has grown.

Carman said Tinka was working hard to get a drill permit for Silvia, having announced a trench of 45 metres at 0.8% copper and 1.6g/t gold in an outcrop earlier in 2022.

"It's obviously early days but we think there's a lot of potential on that Silvia property to hide a very large copper-gold discovery, so we're planning to drill that prospect some time in the next 12-18 months," said Carman.

Political risk

While many miners feared a marked increase in political risk under Peru's President Pedro Castillo, who was elected mid-2021, Carman said he was more focused on the dynamic between the company and local communities. "I think at the end of the day, what's important for the Ayawilca project is our relationship with our local communities, not what happens in Lima. We work very closely with our local communities; we have excellent relationships with our stakeholders and have had for the 10 years or more since Tinka first worked in the area.

We provide ongoing social programmes for our communities including assistance with infrastructure projects, with school and sporting equipment, educational programs and so on. We also employ dozens of community workers during our drilling programmes, which is a win-win for our stakeholders and for the company " said Carman, who believes successful development of Ayawilca depends on getting community relations right.

"I think that one of the most important parts of putting this project into development is to continue to work with the communities and acquiring long term surface rights – not just the three- or four of five-year access agreements that we've worked on in the past."

As for zinc itself, which the US Geological Survey added to its list of critical minerals in early 2022, a shortage of promising new projects bodes well for Tinka.

"A lot of the zinc mines that are currently producing are old; they've been around for many years, so the grades are dropping and the production is dropping. So I think the supply/demand story is fantastic for zinc," said Carman.

Tinka Resources – at a glance

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Market Capitalisation
C$70 million

Quoted Shares on Issue
391 million

Major Shareholders
Buenaventura (19%), Nexa (18%), Sentient (19%)

Almonty plans top tungsten production outside China

Canadian tungsten operator develops world-class South Korean tungsten mine using Iberian historical knowledge. Secure funds for further growth.

Almonty Industries Inc. (TSX:ALL.TO, ASX:ALL.AX, OTC:ALMTF, FRA:ALI.F) is progressing steadily to become a major tungsten producer outside of China in the next few years. The Canada-based company is rebuilding the Sangdong tungsten mine, a South Korean world-class tier-one deposit acquired in 2015, and developing tungsten projects in the Iberian Peninsula. Tungsten is among the list of minerals and metals deemed critical by the USA and the UE over the last few years. More than 80% of its production is controlled by China.

"Tungsten is called an enabling metal because it is in absolutely everything that is in your life. From a car, to plane, to defence, to medical, to semi-conductors, to batteries. You only have a little tiny piece of it but, without it, none of it works," explained Lewis Black, Almonty Industries' Director, President, and CEO. During the last few months, Almonty raised significant funds to finance its various tungsten projects that include assets in South Korea, Portugal and Spain. The company announced on 7th June that it had issued the closing of a private placement of up to 2,5m Chess Depository Interests (CDIs) at A$0.85 per CDI with its third largest shareholder Deutsche Rohstoff AG, raising A$2.12 million (US$1.52m). The fund will be used in part "to accelerate ongoing growth strategies now being pursued". Last month, Almonty also raised US$3.3m in a private placement to company directors and existing shareholders.

Tier-one Sangdong tungsten in South Korea

Almonty's focus is on developing the Sangdong tungsten mine in South Korea, expected to become one of the largest tungsten mines in the world. The company owns a 100% interest in its Almonty Korea Tungsten project (AKT) through its wholly-owned subsidiary, Woulfe Mining Corp.

The deposit, located at 2,5-hour drive from Seoul, hosts one of the largest tungsten resources in the world according to the company. "It has a grade of 3,5 times the average of a tungsten mine and an estimated 90+ years resources so far according to historical data produced by the Korean government and Korea Tungsten," explained Black, describing Sangdong as "a very unique deposit". The company reports indicated resources totalling 8.33m tonnes and grading at 0.49% WO3."It was the one project that we coveted because everybody wanted it," he said. "We did not think we could get it. But we got an opportunity and we took it. We are a tier-three mining company and we acquired the tier-one mining project in tungsten," he added.

Sangdong used to be in production between 1912 and 1992. The vast mine, initially ran by a three-star general for a governmental body, accounted for 30% of GDP after the

Korean war in the 1950s. But the mine fell victim to China's rival into the market in the 1980s and was closed in 1992.

Almonty spent 4,5 years redesigning the project. Construction started in 2021 and the company, which expects to start production end of Q2 2023, hopes to "achieve carbon neutrality as all energy comes from renewable source at site". Initially, 45% of the output is covered by a hard floor offtake around 640,000 tonnes per year and will be shipped to a plant in the USA. "During the next 12 months, we will put together a programme to ensure that we can expand it to operate at 1.2m tonnes / year," said Black. The other 55% is planned to remain in the country and be down streamed for local consumption. As Lewis pointed out, South Korea remains the largest consumer of tungsten per capita in the world through the semiconductor and battery sectors and the hard metals sector. Those are the three main end markets for Sangdong tungsten as the government is keen to see Almonty working on it. "It is the Korean government that is encouraging us to downstream to supply the local market as they are entirely dependent on China with 94.7% of their tungsten oxide coming from there," revealed Black. In March, Almonty announced that it was investigating the construction of a vertically integrated nano tungsten oxide downstream processing plant to supply the South Korean battery anode manufacturing industry.

Recycling

The company also eyes tungsten recycling. At present, all the tungsten that is recycled is exported to Taiwan, then processed and shipped to China. "We intend, with our downstream plant, to be able to consume that scrap. Therefore, 25% of our output in South Korea will be scraped sourced. And that is important for the carbon credit of our customers," explained Black.

Molybdenum in South Korea

The Sangdong tungsten mine also came with a vast high-grade molybdenum deposit that sits 150 meters under the existing infrastructure. The Almonty Korea Moly (AKM) project is an entirely separate deposit from the Sangdong mine. South Korea being the fourth largest importer of the product in the world, it shows a keen interest in any potential domestic production. "We are already in discussion with the government as they will look for that to be downstream for a product that they can use in country," Black revealed.

Tungsten historical knowledge in Iberian Peninsula

Almonty owns a 100% interest in the Panasqueira old tin and tungsten mine in Portugal, through its wholly-owned subsidiary Beralt Tin and Wolfram (Portugal) SA. Located near Covilha, between Porto and Lisbon, Panasqueira has 20+ years mine life with indicated resources of about 8m tonnes grading at an average 0.24% WO3. The mine produces about 1,000 tonnes tungsten / year. Portugal used to be a massive tungsten producer for over a hundred years and the mine has been around for 126 years, making Panasqueira a valuable asset for Almonty Industries.

"The most important is that it gives us access to the knowledge to be able to produce tungsten anywhere in the world. Producing tungsten is very complicated and it is where this knowledge was preserved," explained Black.

Tin-tungsten assets in Spain

Almonty Industries fully owns two assets in Spain. The Los Santos Mine is an open pit Scheelite skarn deposit that is currently producing tungsten concentrate. Acquired in September 2011, it is located about 50 km from Salamanca in western Spain. According to figures from 2015, indicated resources totalled 2.2m tonnes grading at 0.29% WO3. About 250 km from Los Santos in north-western Spain, Almonty develops the Valtreixal tin-tungsten project. The company acquired the project from SIEMCALSA, the same group that was involved in the historical development of the Los Santos Mine.

Valtreixal's indicated resources are 2.8m tonnes grading at 0.34% WO3. "We will now push the permitting more aggressively because we have a customer who is very keen to develop as because they can drive to it," declared Black.

Almonty Industries Inc. – at a glance

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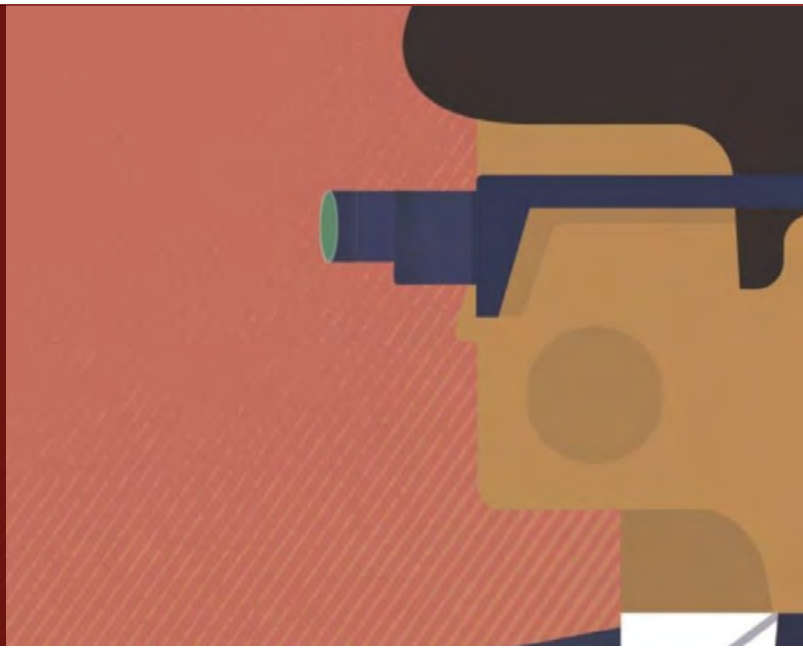
Market Capitalisation (at press time on 9th June 2022)
C$ 215.9 million

Quoted Shares on Issue
215.9 million

Major Shareholders
Lewis Black & Almonty Partners LLC (11.5%), GTP Plansee Group (17.7%), Deutsche Rohstoff (14.2%)

Australia has critical minerals lessons for US



*by John Robertson**

Australia is streets ahead of the USA in framing a critical minerals supply policy as Congress dithers over comprehensive supply chain legislation.

Supply chain logistics, once the preserve of specialised business consultants, has become an everyday conversation topic and a political hot potato for US policymakers.

The COVID-19 pandemic provided the most potent insight into the extent of US economic and security vulnerabilities as the country's dependence on foreign protective equipment became quickly evident.

Since then, shortages of everything from Barbie dolls to semiconductors and infant formula have reinforced the seriousness of the country's supply predicament. Meanwhile, the impact of Russia's invasion of Ukraine on energy and food supplies has exacerbated US anxiety about supply insecurity.

In moving production offshore, US businesses and their consumers had followed some basic economic instincts. As long as trade remained unfettered, sophisticated business planning models could deliver cheaper, and higher margin, goods when they were needed. The mining industry had been a lonesome voice warning for many years that it would be unable to meet the needs of its end users, jeopardising government decarbonisation policy targets.

Suddenly, mining is just one of a large number of industries, now including makers of pharmaceutical products and semiconductors, admitting that the old economic model was no longer fit for purpose.

In February 2021, President Biden signed an extensive executive order giving officials 100 days to review national supply chain vulnerabilities and demanding a panoply of reports from government agencies about how they intended to respond.

Mining is a potential beneficiary of the intensified supply chain awareness. The resulting reports include recommendations for an expansion of domestic critical minerals production.

The newly supportive policy stance has cheered the industry but legislation has not been passed and competing interests are jostling to mould policy in their favour.

While the White House is pushing for higher critical mineral production rates, it has also ordered "a laser focus on boosting strong labor, environmental and environmental justice, community engagement, and Tribal consultation standards" in pursuing higher output targets.

The laser focus, it turns out, is not on the objective as much as it is on appeasing hostility to new mining. Recommended courses of action are overwhelmingly concerned with how to impose US regulatory standards on production in the rest of the world, as a means of fostering higher US output.

A year down the track from the 2021 executive order, the White House announced "major investments to expand domestic minerals supply chain". The statement referred to several initiatives by companies and government agencies but only announced a single government project investment.

MP Materials was to receive US$35 million, diverted from

Defense Department funds, toward constructing its integrated magnet supply operation in California. But that was only a minor part of the US$700 million total project bill. Otherwise, the policy emphasis was on where US government agencies are conducting or supporting research and development.

Direct official investment in the critical minerals production space remains conspicuously absent.

The US remains at the mercy of timely responses by private sector investors to emerging supply bottlenecks for the bulk of the needed funding.

Despite heated political arguments about the COVID-19 pandemic response, Operation Warp Speed - the Trump administration's program to research, manufacture and distribute COVID-19 vaccines at an unprecedentedly fast pace - illustrated how government and private enterprise can co-operate to address a pressing national supply need.

The equivalent response in the case of critical minerals would involve the government committing short term funds to get development underway quickly while agreeing to guarantee purchases of early production.

The Operation Warp Speed model would also require the government to clear away regulatory impediments that might restrict fast track development approvals.

There is no sign of the US government approaching critical minerals supplies with a determination similar to the commitments under Warp Speed.

Speaking in Washington last week, Secretary of State Antony Blinken was almost begging congressional leaders to pass authorising supply chain legislation for the president's signature. Without it, investors have little more than unfunded thought bubbles.

The Building Resilient Supply Chains Act currently before the House of Representatives pays lip service to partnerships and collaboration with other governments but requires a new overseeing bureaucracy to "promote the health of the economy of the United States and the competitiveness of manufacturing in the United States".

The legislation, if passed in this form, would also require the government to "encourage manufacturing growth and opportunities in economically distressed areas and communities of color".

While the proposed legislation envisages "grants, loans and loan guarantees" to secure supply chains, "eligible entities"

Photo: iStock.com

must be operating within the borders of the USA to qualify.

While intergovernmental discussions will no doubt touch on international opportunities for co-operation in reducing China's market influence, US domestic political reality will most likely prevent any meaningful direct contribution to offshore mining developments from the US government.

Companies with Australian based development opportunities will get little advantage from US policies, as they currently stand. A West Perth entrepreneur should consider staking ground in the USA for any chance of getting direct US official development assistance.

That is the unambiguous direction of the emerging economic incentives.

Future Australian projects could face heightened competition for funding as the US government favours re-establishing a domestic mining base over contributing to the industry's prosperity in other countries.

Perhaps representatives of the Australian industry should be lobbying US legislators to treat "good friend" Australia as a jurisdiction in which participants may be eligible for official funding.

Less directly, Australian companies will benefit from decisions to replenish strategic stockpiles of critical metals.

The US Defense Department has sought congressional authority to spend US$253.5 million to procure minerals for the National Defense Stockpile after decades of selling titanium, tungsten, tantalum, cobalt and aluminium worth billions of dollars.

Indirectly, too, Australian miners will get a boost from increased government investment spending. That said, the size of the impact could easily be overstated.

In 2021, all levels of US government spent US$605.9 billion on non-defence investment, according to the government's Bureau of Economic Analysis.

The Bipartisan Infrastructure Law, signed by President Biden in November 2021, authorised new spending over 10 years of US$550 billion. While relatively metal intensive, the incremental amount is less than one year's spending spread over a decade.

US critical minerals policy remains an ambiguous mix of political anxiety and wishful thinking without the authority to make up for critical capital shortages. Perversely, the strongest commitment is to a new US regulatory regime the Biden administration wants to impose on the global mining industry.

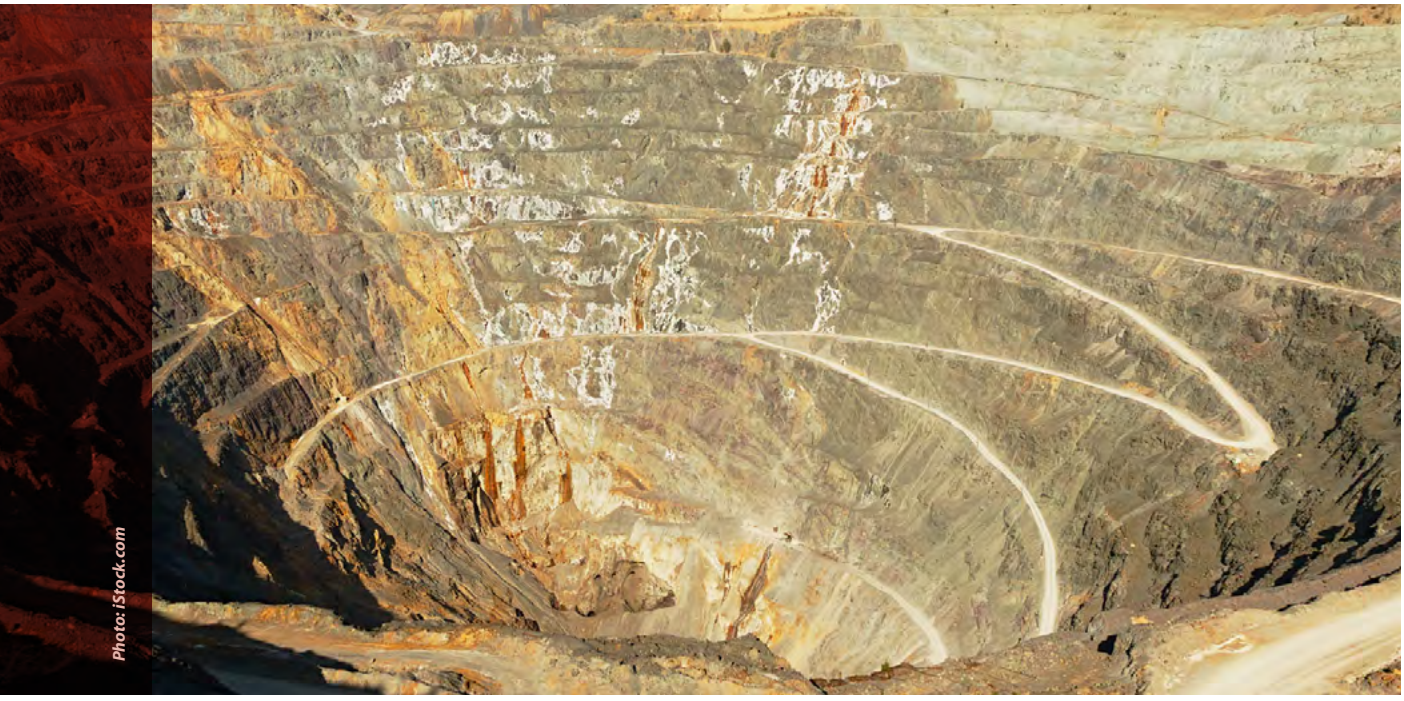


Photo: iStock.com

*John Robertson is the chief investment strategist for PortfolioDirect, an Australia-based equity research and resource stock rating group. He has worked as a policy economist, business strategist and investment professional for nearly 30 years, after starting his career as a federal treasury economist in Canberra, Australia .

Homegrown and future-focused: a battery and critical metals discovery in the USA

Stillwater Critical Minerals leverages Bushveld parallels and a consolidated approach at its new Montana resource.

Stillwater Critical Minerals (TSX. V: PGE | OTCQB: PGEZF) formerly Group Ten Metals, has just undergone a complete rebranding, adopting a fresh image that showcases its enviable position in the market.

The company's flagship project is the district-scale, 100%-owned Stillwater West PGE-Ni-Cu-Co-Au property in Montana, where Stillwater Critical Minerals (SWCM) is the second-largest landholder in the iconic, yet under-explored, Stillwater Complex. The Complex is a layered igneous intrusion with remarkable similarities to South Africa's prolific Bushveld Complex, and Sibanye-Stillwater currently operates three mines on one deposit on the neighbouring property, where it extracts palladium, platinum and other metals. Its deposit is the highest-grade PGE deposit in the world, and the largest outside southern Africa and Russia.

Mining in this historic district dates back much further than the current operations, which started in 1986. High-grade nickel and copper have been extracted since the 1880s, and the complex also provided vital chromium during WWII. In October 2021, its next chapter began when SWCM announced its maiden NI 43-101 Mineral Resource Estimate, reporting 1.1 billion pounds of battery metals (Ni, Cu, Co) and 2.4 million ounces of PGEs+Au.

Subsequent expansion drilling has demonstrated that there is plenty of room to grow those numbers, with the company's most recent results including an impressive 13.2m of 3.33% NiEq within 401m of continuous near-surface mineralisation. "That interval has got people buzzing," SWCM CEO Michael Rowley said. Mineralisation remains open along trend and at depth in all five of the deposits included in the resource estimate, which are set in very large-scale geophysical targets across the 12km-long area modelled to date. Significant expansion potential is confirmed by correlating signatures in soil geochemistry across a wider 25km area.

Stillwater West is superbly positioned to help address two modern challenges: climate change and resource security. No fewer than eight metals from the project appear on the 2022 US critical minerals list: five PGEs, nickel, cobalt and chromium.

"It means a great deal to the company that these metals are included on the critical minerals list," Rowley said. "This is a famously productive, metal-rich district, and our work is focused on securing large-scale domestic US supply chains."

SWCM knows that a low-carbon future will rely on battery

technologies, and this project is one of very few in the USA with the potential to produce a secure supply of nickel and cobalt for the industry. Stillwater West could also add significantly to the global inventory of platinum and palladium, both designated critical metals that are crucial for reducing emissions from internal combustion engines and producing green hydrogen.

Additionally, with electric vehicles demanding five times more copper than traditional automobiles, the estimated resource of 347Mlb of copper could help drive the development of green transport. Finally, in addition to this plethora of green and critical metals, the property also hosts gold at both high-grade and co-product levels.

To top off the project's climate credentials, its ultramafic lithology may make it suitable for carbon sequestration, reducing its net emissions and making its products even more marketable. "That's meaningful to SWCM," said Rowley. "Mining can do more than provide essential commodities, it can play a direct role in reducing atmospheric carbon."

Rowley has attracted an impressive team of seasoned mining industry to advance the vision of domestic production of low-carbon metals, including executive chairman and director Greg Johnson, one of the founders of NovaGold, as well as technical know-how from SWCM's new vice president exploration, Dr Danie Grobler, a 25-year veteran of the Bushveld who was heavily involved in the advancement of Ivanhoe's Platreef mine.

SWCM's rebranding also draws welcome attention to its flagship project's location. As part of the Metallic Group, a resource-sharing collaboration between three publicly listed resource-stage companies, it aims to replicate the NovaGold strategy of consolidating district-scale brownfields projects during bear markets and then systematically progressing them to produce de-risked assets in better times. This approach requires a mining-friendly jurisdiction in a region with proven production capacity, and the Stillwater Complex in Montana fits the bill.

SWCM's new image also spotlights the immense value of the Stillwater Complex itself. The similarities between Stillwater and the northern Bushveld are profound; Bushveld geology has closely guided exploration at Stillwater West and led directly to the company's most significant discoveries.

The operating mines at Stillwater exploit the Johns-Manville (J-M) Reef: a narrow, ultra-high-grade deposit analogous to the Bushveld's famous Merensky and UG2 Reefs. Stillwater West also hosts this style of mineralisation, however this system of mineralization has not been SWCM's focus to date.

Reef horizons can be more challenging to mine as they are narrow, requiring high-cost manual mining methods at smaller scale. The lower Bushveld stratigraphy suggested an alternative: Platreef-style mineralisation, which consists of large-scale nickel and copper sulphide deposits with PGEs and gold, is amenable to low-cost bulk-tonnage mining methods, while also bringing brings battery metals to the

table. Their economic potential is clear from highly profitable South African mines including AngloAmerican's operating Mogalakwena Mine, and projections from Ivanhoe's upcoming Platreef Mine.

Despite the known parallels between the Stillwater and Bushveld Complexes and abundant historical exploration at Stillwater West, SWCM was the first operator to systematically target Platreef-style deposits. The company consolidated previously disjointed licenses and compiled an immense database of historical results. This, alongside a high-quality induced polarisation (IP) survey in 2020, enabled SWCM to create a reliable 3D model.

"The IP survey lit the project up," Rowley said. "We saw kilometre-scale targets and could identify high-grade areas. Those results guided two very successful drill campaigns, with significant geophysical anomalies co-incident with high-grade core assays."

In 2021, the company extended the IP survey by 30%, producing some of the highest chargeability readings to date. Working with machine-learning experts at GoldSpot, SWCM developed its in-house predictive exploration model for the "Platreef-in-Montana" by drawing on both local data and the expertise of Bushveld specialists. "The investment we made in creating that predictive geologic model is already paying substantial dividends in terms of our high success rate, and our low discovery costs" Rowley said."

To date, a total of 230 holes have been drilled on the property. The project's promise really became clear during the 2020 drill campaign, which provided data for the resource estimate and produced results including 1.74% NiEq over over 8.5m, within 455 of continuous mineralisation above cut-off grade. Expansion drilling in 2021 returned 13.2m of 3.33% NiEq in a possible continuation 125m to the west. Results from 2021 and the upcoming 2022 season will contribute to an updated resource estimate planned for later this year.

In addition to Stillwater West, SWCM also holds the Kluane PGE-Ni-Cu property in the Yukon and the Duke Island Cu-Ni-PGE property in Alaska. In November, SWCM optioned its long-held Black Lake – Drayton gold property in Ontario, and it is keen to find similar partners to develop Kluane and Duke Island so that it can maintain shareholder exposure to these highly prospective properties while focussing on Stillwater West.

The market prospects for Stillwater West's resources are

SWCM CEO, Michael Rowley

certainly bright. Equally important, however, is SWCM's technical proficiency, demonstrated by the advancement Platreef-style mineralisation at Stillwater West. This systematic approach is guided by an experienced and substantially invested management team and board, and the company has methodically executed its well-conceived business and exploration strategies to create an important opportunity for US critical metals supply.

Stillwater Critical Minerals – at a glance

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Directors
Michael Rowley, Greg Johnson, Gregor Hamilton, Gordon Toll

Market Capitalisation (at press time on 28th June 2022)
C$ 57 million

Quoted Shares on Issue
170 million

Major Shareholders
Institutional (33%), High Net Worth (29%), Management/ Insiders (22%), Retail (16%) (Institutional holders include Sprott Asset Management, Goldspot Discoveries, Palisades Goldcorp, Regal Funds)

Goldman Sachs cottons on to lithium glut

by Tim Treadgold

Gluts come and gluts go, so when leading investment bank Goldman Sachs warned last month of a looming oversupply of lithium it was right – just six months late.

It was towards the end of last year that a similar warning about an oversupply of the critical battery metals was made in ("Beware the return of the lithium glut" MJ, November 21, 2021).

What Goldman Sachs has just done is identify the same issue as MJ, the impact on a still relatively small market of new projects (and restarts of mothballed projects) and how a surge of metal can overpower a still relatively small market.

What the bank might have added is that all commodities enjoying a growth spurt invariably overshoot before veering back the other way into a phase of undersupply and rising prices.

The sharp swings from shortage to glut was the essence of last year's MJ article which looked at why lithium crashed from US$20,000 a tonne in 2017 to $5000/t in 2020 before surging again, a pattern which is as repeatable as it is predictable.

The significance of the latest warning about lithium from Goldman Sachs is that it has sparked investor awareness of the cyclical nature of all commodities and the sometimes-violent price moves by material exposed to the fast-developing market for lithium-ion battery demand in electric vehicles (EVs).

Other critical metals will pass through the same over/under supply issues as demand picks up with the challenge for miners and investors being to time the development of fresh supply to match manufacturing requirements - and that's not easy.

What Goldman Sachs also did with its glut warning was start a debate in the financial community about lithium with investment banks firing off competing views. Credit Suisse, for example, largely agreed that the lithium price was close to a peak. Macquarie disagreed, saying that the "lithium investment case remains intact."

UBS took a different tack with a research note which played down the importance of lithium extracted from lepidolite ore (a technically complex mica-like material) in China which was one of the negative points raised by Goldman Sachs.

With multiple and competing views circulating it's worth examining how this latest over/under supply debate started and if you disregard MJ's November warning the latest exchange of views began on May 23 when Citi kicked the ball into play by saying that the price of the metal was "moderating" but was expected to "remain higher for longer" which meant it "remained bullish on the EV theme"."

"EV output curtailments in China alongside weakness in some non-EV related demand globally drove the (recent) price decline," Citi said, adding that prices remained extremely high relative to miners' production costs of $5000-to-$10,000 per tonne.

"Our base case is for prices to moderate further from extreme levels (of more than $70,000/t) but remain higher

for longer, averaging $35,000 through 2025, supported by solid growth in EV sales on the back of improving economies of scale and scope in battery and vehicles production."

Six days later Goldman Sachs unleashed its pot-stirring report which declared that the "battery metal bull market is over for now" with the family of critical metals fundamentally mispriced by a surge of investor capital into new supply.

"We see prices on a downward trajectory over the course of the next two years with a sharp correction in lithium (down to $16,372/t)," Goldman Sachs said, adding that cobalt would fall from a recent spot price of $87,100/t to $59,500/t next year.

Supply growth, courtesy of the capital flood, could see the amount of lithium hitting the market grow by 33% year-on-year over the period 2022-25.

Cobalt supply would grow by 14% y-o-y and nickel by 8% y-o-y.

"We see scope for the market to become oversupplied from 2025, so prices may slide to deter potential oversupply."
— Credit Suisse

Interestingly, last month's controversial Goldman Sachs battery metals report was not as negative as implied in some media reports which focused on the provocative headline: "Battery metals watch; the end of the beginning", when the body of the report was less alarmist, pointing out that shortages which drove prices higher were simply swinging towards a period balance, and possible

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Photo: istockphoto.com

over supply. Benchmark Mineral Intelligence mounted the strongest criticism of the bank's report with a multi-point rebuttal that started by saying too much emphasis had been placed on the potential impact of Chinese lithium supply from lepidolite ore and included observations that "capacity does not equal supply", and that new supply would come at a higher cost as orebodies with complex mineralogy and lower grades ore were developed.

UBS took up the issue of lepidolite in its response to the Goldman Sachs report saying that while the ore being mined in China could get to market quicker and would be strategically appealing to Chinese lithium converters it would be high on the cost curve given the low grades of contained lithium.

According to UBS lepidolite, which contains an average of 0.2% lithium oxide (a fraction of Australian hard rock spodumene ore) and concentrated up to an equally low 2% lithium versus 6.5% for spodumene.

The Credit Suisse view that prices may peak in the next few months included an observation that the sharpest falls could occur in the March quarter next year because that's when Chinese EV subsidies are due to expire.

Everything in the comments on lithium by the banks is based on assumptions about key factors such as total EV sales and the willingness of governments to continue subsidising motorists to make the switch from petrol and diesel power to battery electric.

"We see scope for the market to become oversupplied from 2025, so prices may slide to deter potential oversupply," Credit Suisse said.

"Of course, much depends on the demand outlook. A 10% higher EV penetration would see 30,000-to-60,000t supply deficits remain in 2023-24 sustaining price strength longer than our base case."

Macquarie's view is that investors have little to worry about from a fall in the price of lithium because most producers remain handsomely profitable.

Using the Australia miner Pilbara Minerals as a guide, Macquarie said that it was currently trading at a share price which reflects a Chinese lithium carbonate price of $13,000/t, roughly 80% below the spot market price for the metal, or 85% below the latest spot market sales of spodumene concentrate.

The key to future demand for lithium is the pace of EV sales and while there have been production interruptions associated with supply chain blockages the outlook is for EV demand is strong and growing, with EVs taking lithium for the ride - complete with the occasional bump in the road.