Australian Critical Minerals

Rare Earth Producers & Advanced Projects

BUYS: LYC.AX, ILU.AX, ARU.AX, HAS.AX, ASM.AX

Global Thematic Research
Analyst: Dr Kingsley Jones, CFA
+61 467 555 612
kingsley.jones@jevonsglobal.com
Canberra, Australia: 1-August-2022

The Opportunity

The electric vehicle (EV) thematic is driving higher demand for rare earth metals for use in the magnets that feature in electric motors and generators.

In this research note, we survey the ASX listed rare earth prospectors, developers, and producers. There are around forty companies in total, of which many are early-stage prospectors. Our focus in this note is to form a **core basket** of active producers, advanced development projects, and exposure to promising downstream processing ventures. In coming up with this shortlist, we touch on several firms that are worth adding to any research watchlist. We also list those companies active in the current exploration rush for **Ion-Adsorption Clay (IAC) prospects**.

The recommended core basket of stocks is:

- Lynas Rare Earths LYC.AX (REE production)
- Iluka Resources ILU.AX (REE production)
- Arafura Resources ARU.AX (REE, pre-FID)
- Hastings HAS.AX (REE, pre-FID)
- ASM (Holdings) ASM.AX (REE, metals)

The selection criteria focus on current production status, the completion of major feasibility studies and proximity to a Final Investment Decision (FID), or a promising exposure to mining and processing options with modest capital expenditure.

The Rare Earths Thematic

The rare earths comprise seventeen metals that are vital to high-technology applications. The largest share of market value is in a group of **four metals** that are used in **high-performance magnets** for the manufacture of electric motors and generators. Demand has accelerated due to the rapid uptake of electric vehicles and the very large generators used in wind turbines to provide renewable energy.

The other key factor is the **geopolitics of strategic competition** between China and the USA. Until the 1990s, the USA dominated global rare earths with the production from one mine in California. Fast forward to today, and China produces over 60% of the unprocessed rare earth oxides, and 90 to 95% of finished magnets and precursor magnet materials.

The Rare Earths Complex

Rare earths have highly varied applications due to the unique physical and chemical properties of the seventeen component metals Exhibit 1. Economic deposits are rare since the host minerals are difficult to process and the rare earths are hard to separate. Nature provides us with a **group of rare earths**, and not the concentrated ores we associate with metals such as gold, silver, copper, zinc, lead, and iron.

Similarly, the commercial applications of any given rare earth metal can vary greatly according to the purity required, and the input form required. These facts make the analysis of the rare earth opportunity more complicated than is typical with base metals.

Nonetheless, we can simplify the analysis if we pay very close attention to a few key facts:

- Magnet Rare Earth Oxides (MREO) dominate
- Other rare earths are produced as by-products
- Few natural source minerals can be processed
- Processing and separation are capital intensive

Rare earths are not that rare but finding high grade mineral assemblages that can be mined, processed, and separated, is difficult. This principle can help streamline analysis to locate investible companies.

The Rare Earths Market

There has been extensive commentary on the key role played by **rare earths in defense applications**. This is true of a diverse array of technologies, from high power lasers, through nuclear reactor control rods, to guided missile fin actuators, and ultra-high power sonar transducers for submarine warfare.

However, from a commercial standpoint, that is the bath water. It comes with a bright bouncing baby, that is **permanent magnets** for high field strength and high efficiency electric motors and generators. It is the baby we are focused on, not the bathwater.

Estimates vary, but we think it is fair to say that 90% of market value is in the magnet materials. Of that, defense applications are minor. One F-35 fighter jet represents 500kg in a 75Mkg annual marketplace!

However, the national security question does figure prominently when we consider where rare earths are to be found and who controls the market for them The US Geological Survey maintains estimates of global resources across a host of commodities. The rare earth reserves are shown in Exhibit 2. China is the dominant player, with Australia in sixth place, but ranked as the leading reserve nation amongst developed world mining jurisdictions. Production is shown in Exhibit 3, with China clearly growing to its present dominant position since 1990. However, the geopolitical tension created by the 2010-2011 rare earth export embargo against Japan, has since led to accelerated efforts to secure independence from a China-dominated rare earth supply chain. This is a work in progress, but clearly to the benefit of mines operating in Australia, the USA, Canada, and other jurisdictions that remain open to non-aligned status for sourcing of critical minerals. Myanmar supply is tightly integrated with Chinese processing, but the emerging prospects in Africa are open for forming supply chain links into the wider global market.

Scarcity and Price Dynamics

Historically, the rare earths market was difficult to analyse because of the wide diversity of niche areas for application, with little visibility on the top-level demand trends that might cohere the market.

Examining Exhibit 3, global demand for rare earths accelerated around 2017. This period coincided with the breakout growth of electric vehicles, and rising demand for battery materials and the permanent magnet materials: Neodymium (Nd), Praseodymium (Pr), Dysprosium (Dy) and Terbium (Tb). Coincident with this rising demand, China began to face supply stresses due to the rapid depletion of their easy to extract resources of **Ion-Adsorption Clays (IAC)**.

The IAC had provided Chinese magnet makers with cheap and readily available sources of the so-called **Heavy Rare Earth Elements (HREE)**. In Exhibit 1, these comprise the elements of atomic number 63 (Europium) and higher (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y). These are scarce in hard rock deposits, except for those rich in the mineral **xenotime**.

The **Light Rare Earth Elements (LREE)** comprise Lanthanum through Samarium (La, Ce, Pr, Nd, Pm, Sm). The LREE tend to be more abundant, especially in **monazite** mineral deposits. China still has vast reserves of LREE in hard rock deposits but is facing rapid depletion for the IAC-based HREE elements.

The HREE in IAC and xenotime rich mineral sands, or hard rock deposits, are clearly key to the future development of the global rare earths industry.

However, magnets are not made from HREE alone, and the availability of the LREE magnet materials Nd and Pr is now constraining supply and driving the resulting price dynamics. The four key magnet materials, Nd, Pr, Dy, and Tb, are the **fab four** of the electric vehicles and wind turbine revolution. Their rise to dominance is marked by a significant change in pricing dynamics for global rare earths. Exhibit 4 shows the annualized compound growth rate in the price of a range of rare earth oxides and metals. The message of the market is clearest when products are ranked by the annualized price CAGR since recovery from the GFC slump in 2008-2013. Measuring the trend since Jun-2014 up until Jun-2022, we can see that the magnet materials, coloured in orange, have appreciated significantly more than the others. The other key point is that Rare Earth Carbonate (REC) pricing, which is a mixed intermediate containing unseparated rare earths is now pricing strongly with the sought-after magnet materials, while separated non-magnet materials are in price deflation.

This change in the market pricing dynamics began around the same time as the big uplift in production volumes in 2017, as shown in Exhibit 3. This signals that **Magnet Rare Earth Oxides (MREO)** demand is now mediating the entire market. The effect is to drive demand for concentrates that are rich in Nd and Pr, and sources of Gd, Tb and Dy. That is very good news for advanced projects that have competitive grades for Nd-Pr production, and/or a profile to deliver HREE-rich mixed concentrates.

Australian Development Opportunities

Geosciences Australia has been actively supporting exploration activities with a robust research and survey mapping effort across critical minerals.

Exhibit 5 shows a mineral resource map from 2018, at the beginning of the present exploration boom, with boxed areas added by the author to mark some of the more recent developments. Note that at the time this map was created there were only two operating mines, the Lynas Rare Earths Mt Weld operation, and the Northern Minerals Browns Range operation, which is a pilot-scale operation mining and beneficiating a Dysprosium rich concentrate. This is now joined by Iluka Resources, producing a monazite concentrate from the Eneabba stockpile.

Many geologically prospective rare earth resources are never likely to become mines due to the grade of material being too low (Olympic Dam). There is also the difficulty of developing an effective flow sheet to beneficiate, concentrate, and ultimately separate the sought-after rare-earth elements from the host mineralisation. There are far more large pink dots on the map than there are operating mines.

The simplified story is that there are essentially four major sources of mineralisation that are known to be capable of economic processing:

- **Monazite** (carbonatites and mineral sands)
- **Xenotime** (mineral sands and some hard rock)
- **Apatite** (now proven possible at Nolans, NT)
- **Ion-Adsorption Clay** (the frontier ex-China)

There are over 200 documented mineral types that may host significant Rare Earth Element grades, but most of these have so far resisted processing.

In addition to the above-mentioned minerals, there are so-called **polymetallic** deposits that contain several different metal bearing minerals. The largest rare earth mine in the world, at Bayan Obo in Inner Mongolia, China, is a complex polymetallic deposit with rare earth metals hosted in a niobium rich iron ore deposit. It is worth noting that Bayan Obo was discovered in the 1950s, after the announcement of the Mountain Pass discovery in California. However, it took thirty years for Chinese scientists to work out how to crack the code of processing the ore. Once that happened, in the mid-1980s, the Bayan Obo ferro-niobium deposit soon dominated supply.

ASX Listed Opportunities

A survey of all ASX Listed companies can surface the available investment opportunities, Exhibit 6. There are around thirty active companies, most of which are early-stage exploration plays. Within that list are five onshore firms with current market values greater than $200M AUD, the typical lower bound for institutional investment. Outside the list are two small producers: **Northern Minerals** with a pilot plant at Browns Range, NT, and **Vital Minerals**, which is producing around 1000 tonnes per annum into an offtake agreement with Schaeffler in Europe via processing facilities at REEtec, in Norway.

Peak Rare Earths is also well advanced with their long standing Ngualla Project in Tanzania, which is undergoing an updated Bankable Feasibility Study to account for improved project economics on the recent uplift in rare earth pricing since 2017.

The other offshore projects worthy of mention are **Ionic Rare Earths**, which is making rapid progress on infill drilling at their Ion-Adsorption Clay project at Makuutu in Uganda. The hope is that they may soon progress their scoping study and drill program to be able to record a maiden JORC resource. In addition, we mention **Greenland Minerals**, which has a large resource at Kvanefjeld, Greenland, but is now stymied in their pursuit of social license, due to the presence of high Uranium concentrations in the mineral assemblage, and the need to extract that to support project economics. The new government of Greenland has instituted a Uranium ban, which led Greenland Minerals to place their plans on review.

Current Exploration Trends

The survey at Exhibit 6 highlights that the rare earth opportunity set is dominated by two large firms and a half dozen or more contenders. Ahead of forming our core basket exposure, it is worth revisiting the boxed sections of the map at Exhibit 5, to relate the names regions to the firms we have listed.

The foregoing market commentary highlighted the key role played by HREE prospects now that China has plateaued on IAC-hosted REE production.

The search for IAC prospects began in earnest with the Ionic Rare Earths project in Uganda, which has shown the path forward in establishing continuous mining, with land rehabilitation, and heap leaching to reduce capital cost. This production model must be proven at scale but is an obvious solution to the problem of lowering the capital cost while securing social license with attractive project economics.

Onshore efforts to locate IAC-hosted REE deposits accelerated with finds by **Australian Rare Earths** at their **Koppamurra Project** in the Southern Murray Basin, where an early drill program over around 2% of their 4,000 square km tenement package has provided a maiden JORC resource of 39.9Mt grading at 725 ppm Total Rare Earth Oxide (TREO). These are excellent numbers for an IAC type deposit and have been met with other promising drill results at a slew of other early-stage exploration companies.

In this note, we cannot do justice to the strength of the present exploration boom but choose instead to list the companies according to their proximity to one another, or to existing projects. This approach seems warranted as the discoveries are new, and the exploration firms are learning from each other.

Some Rare Earth Nearology

Gold miners are fond of nearology, and the principle that any ground pegged adjacent to proven ground is worth a lunch where the investment banker pays.

In no special order, our rare earth nearology starts with the **Murray Basin Region** bridging between the northern mineral sands rich Wimmera, and the emerging IAC province in the Southern Murray basin, extending across into South Australia.

Here we find the privately held Avonbank project of WIM Resources Pty Ltd, the private Goschen Project of VHM Ltd and the WIM 100 project of **Iluka**. These are all heavy mineral sands-based projects that will receive a boost from the commissioning of Iluka's new mineral sands refinery operation at Eneabba. Although they are competing firms, the likelihood seems strong that there will arise toll-processing options to further develop this type of project.

Apart from these exciting prospects, the mentioned Koppamurra Project of **Australian Rare Earths** has been met with a rush of new exploration. In that neighbourhood **Resource Base** took up adjoining exploration licenses. **Taruga Minerals** made an IAC find at Mt Craig in the Adelaide Fold Belt, and the Eyre Peninsula has delivered IAC hosted REE for **Itech Minerals** across their four kaolin prospects.

Down in Tasmania, bauxite developer **ABx Group** hit some interesting IAC hosted REE at Deep Leads. The other emerging region of interest is **Esperance**, WA, where both **Meeka Metals** and **Mount Ridley Mines** have reported shows of IAC hosted REE. The action is likely to continue with **OD6 Metals** and **Mount Monger Resources** having joined the hunt.

Only time will tell whether the IAC hosted REE that is now reported will prove economic for extraction, but the early signs are encouraging, and the cadence of reported discoveries suggests we are in still in the early stages of uncovering the full IAC potential

The other exploration trend of note is the search for **polymetallic REE deposits**, as part of a wider trend involving the search for Ni-Cu-Co-PGE deposits.

This trend started with the Dubbo Toongi Project decades ago, but is now firming in the **Gascoyne Region**, WA with encouraging exploration results from **Dreadnought Resources,** and new entrants pegging ground near **Hastings Yangibana Project**.

Advanced Australian Projects

While exploration is important, the main game in addressing global magnet demand is providing high tonnage rates in Nd-Pr concentrates. This will not go away, and so large and economic hard rock mines remain the core of the industry. This fact is reflected in the trade off between IAC hosted REE grades, that are exceptional at 1000 ppm, and traditional hard rock mineral deposits that become marginal at any grade below around 10,000 ppm, or 1% TREO.

To put this statement in context, the Mt Weld mine resource expansion, from their 2018 statement, has a 25-year mine life, at total resource grades of 5.0% TREO, of which nearly half was measured resource at 8.0% TREO. These grades deliver very substantial Nd-Pr tonnages over a total resource of 3Mt. The combination of grade, tonnage, beneficiation, and ore processing simplicity are key to reducing the capital cost of plant, and the operating costs of run of mine throughput, and the use of reagents.

Good mines make money most of the time, but great mines make margin in bad times and can well fund further expansion with minimal calls on capital.

Exhibit 7 shows a comparison of leading LREE rich Australian hard-rock projects according to Nd-Pr content as a percentage of the TREO. **Yangibana**, owned by **Hastings Technology Metals** offers a very high Nd-Pr ratio on modest capital expenditure of around $590M and a mine life of around 15 years. The **Nolans Project**, owned by **Arafura**, exhibits a strong profile also, with 25% Nd-Pr and a projected mine life of 38 years, for a capital cost of $1.06B.

Exhibit 8 repeats the exercise for hard-rock HREE rich projects. The **Brockman Project** looks good but has tricky metallurgy. The **Browns Range Project** has proven metallurgy but needs more tonnage, as does the **RareX Cummins Range Project**.

The new starter is likely the **Dubbo Toongi Project**, where metallurgy and other test work for processing and separation work has been completed. The key challenge for that project has been the projected $1.7B capital cost and securing offtake for Zircon, Hafnium, Niobium and Tantalum and REO. Since the project was spun out from Alkane, **Australian Strategic Materials** has pursued a new strategy of moving downstream first with a new metals refining technology that can produce high purity Titanium alongside the magnet metals Nd, Pr, Dy and Tb.

Core Basket Construction Principles

The ASX listed and Australian domiciled rare earths universe is narrow in terms of advanced projects, but rapidly broadening in exploration scope. These are exciting times for the industry as it stands on the cusp of **demand-driven expansion** and deepening.

Lynas Rare Earths and **Iluka Resources** enjoy very strong positions as **anchor firms** for an **integrated mines to metals strategy**. While the dominance of these two players may distract investor attention from worthy new entrants, we consider the health of the industry will depend on a portfolio approach to investment. The key step in supply chain security is to **upgrade Australian mined material through onshore refining and separation**. This strategic capability will open opportunities for downstream value-adding activities, in metals and magnets.

Therefore, it makes sense to construct a core basket that anchors our investment in the commodity, in major producers, and supports this with attention to firms that will soon need to raise further capital for mine and plant construction. Rare earths mining, separation and processing is a capital and expertise intensive business. We should remember that the original Mt Weld discovery occurred in 1989 as the result of an aeromagnetic survey but did not enter production until 2012. There were many hurdles to overcome, especially the need to secure finance. With strategic policy support from government, and widening investor engagement, there is scope to grow the entire Australian rare earth ecosystem.

Recommendations

Noting the present stage of industry development, it is important to recognize which firms are now closest to entering volume production. For now, it is the hard-rock miners which are closest to the Final Investment Decision (FID) stage of development. In time, the emerging Ionic-Adsorption Clays (IAC) sector will likely add a new dimension of low capex, and faster pace, heavy rare earths production.

The separation of rare earths into their individual oxides remains challenging and capital-intensive. If we only produce mixed concentrates, the material will simply be shipped to China for the **critically important separation step** in the value chain.

Holistic investment strategy demands a coordinated capital deployment at each pinch point in the supply chain from the mine through to finished magnets. This is especially true of the higher risk areas of mine construction, refining and separation, and downstream metals processing. The robust demand trends of electrification, and the energy transition, are providing the necessary rare earth price support in the magnet materials sector to de-risk projects.

However, we should remember that Australia ranks sixth in global rare earth reserve status. Our mining sector, and geosciences community, have taken a strong lead, among global peers, in pushing projects further towards production. To cement leadership will require substantial investment in new plant and the spirit to back innovation in exploration, mine optimisation, beneficiation, solvent extraction, the isolation, and sequestration, of Naturally Occurring Radioactive Materials (NORMS), rehabilitation, and the critically important downstream value-added areas of metals refining and magnet manufacture.

Alongside **Lynas Rare Earths** and **Iluka Resources**, our core basket can be diversified across project, mineral type, and development strategy, in three additional names: **Hastings Technology Metals**; **Arafura Ltd** and **Australian Strategic Materials**.

The last three will require significant capital to get up and running with their plant construction, but we think such a concerted push is essential if the Australian industry is to secure its position. This is a time of very rapid industry development when the long-term strategic relationships are forged. The global rare earths industry must now grow at the exponential pace required to support the energy transition. With a resurgent exploration sector, a proactive Critical Minerals Strategy, and resolute capital deployment, there is surely a bright future ahead for an integrated rare earths industry.

Australia and China share a symbiotic relationship in commodities trade, but our two nations do face a period of intense strategic competition. **It need not be construed as a war, but it is a race**. That race is for a **commercial prize**, the construction of a fully integrated and robust supply chain to support our transition to a cleaner world. This is a goal that we believe all Australians will support, and so we **commend investor attention** to the challenge of financing and completing the task before us.

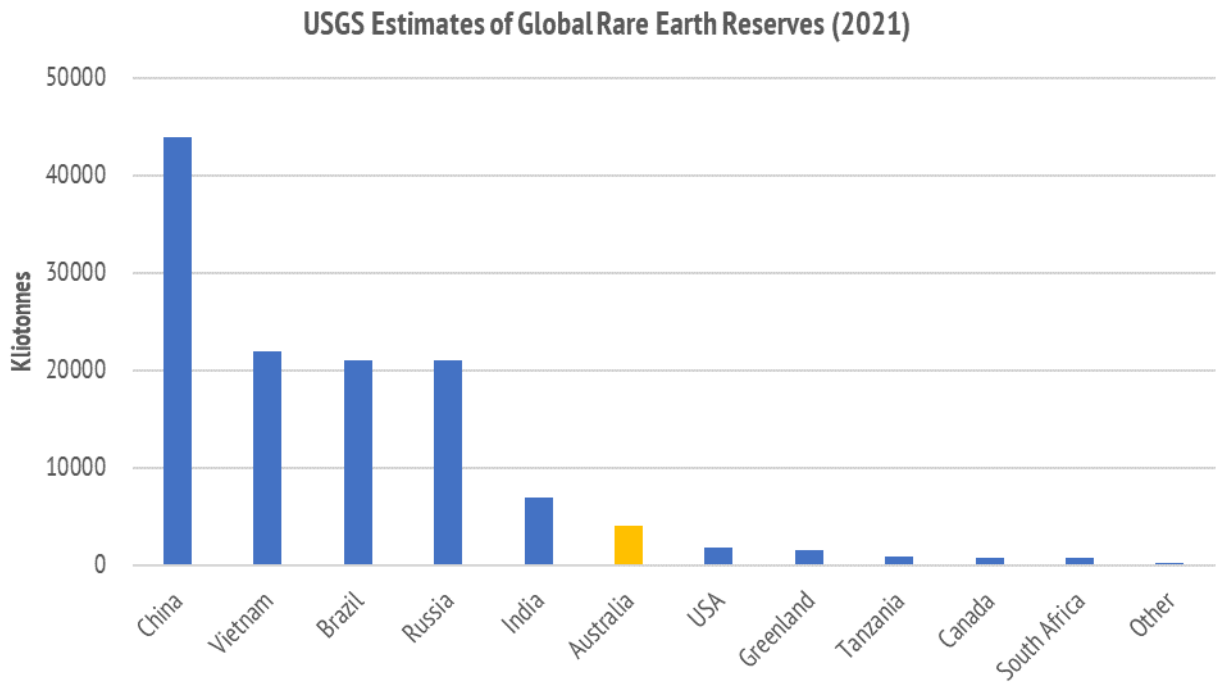
This bear market may just give birth to a sustainable Australian critical minerals industry.

Exhibit 1 Rare Earth Elements and their oxide formula, metal to oxide weight conversion multipliers, and primary economic uses.

Rare Earth Element	Atomic Number	Chemical Symbol	Oxide Formula	Atomic Weight	Metal to Oxide Multiplier (M)	Primary Uses
Scandium	21	Sc	Sc_2O_3	44.956	1.5338	alloys, ceramics & fuel cells
Yttrium	39	Y	Y_2O_3	88.906	1.2699	ceramics, catalysts & lasers
Lanthanum	57	La	La_2O_3	138.906	1.1728	catalysts, ceramics & batteries
Cerium	58	Ce	Ce_2O_3	140.116	1.1713	catalysts, ceramics, glass & polishing
Praseodymium	59	Pr	Pr_6O_{11}	140.908	1.2082	permanent magnets, batteries & alloys
Neodymium	60	Nd	Nd_2O_3	144.242	1.1664	permanent magnets, catalysts & lasers
Promethium ☢	61	Pm	Pm_2O_3	145	1.1656	radioactive with no stable isotopes
Samarium	62	Sm	Sm_2O_3	150.36	1.1596	permanent magnets & nuclear absorber
Europium	63	Eu	Eu_2O_3	151.964	1.1579	nuclear control rods & phosphors
Gadolinium	64	Gd	Gd_2O_3	157.25	1.1526	permanent magnets & medical imaging
Terbium	65	Tb	Tb_4O_7	158.925	1.1762	permanent magnets, lasers & sonar devices
Dysprosium	66	Dy	Dy_2O_3	162.5	1.1477	permanent magnets, data storage & lasers
Holmium	67	Ho	Ho_2O_3	164.93	1.1455	magnets, nuclear control rods & lasers
Erbium	68	Er	Er_2O_3	167.259	1.1435	fibre optics, optical amplifiers & lasers
Thulium	69	Tm	Tm_2O_3	168.934	1.1421	metal alloys & lasers
Ytterbium	70	Yb	Yb_2O_3	173.04	1.1387	scintillometers, catalysts & lasers
Lutetium	71	Lu	Lu_2O_3	174.967	1.1371	scintillators for medical imaging

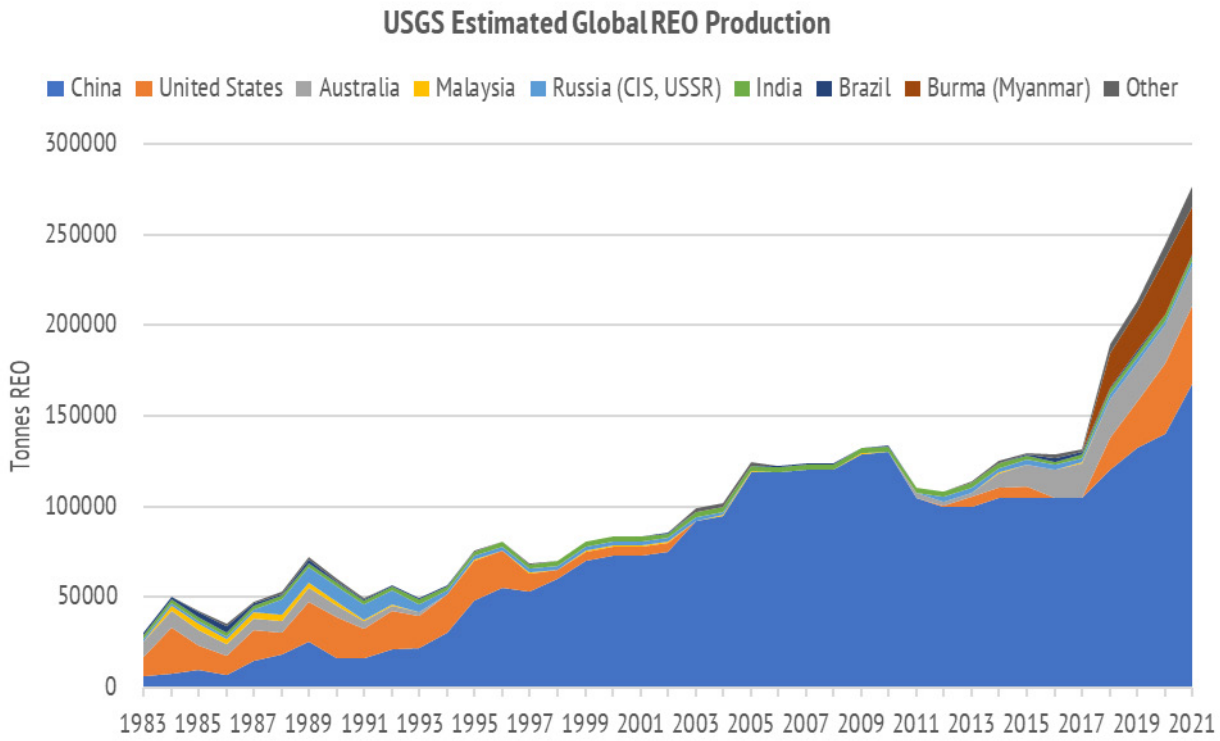
Source: US Geological Survey (2022).

Exhibit 2 US Geological Survey Estimates of Global Rare Earth Mining Reserves.



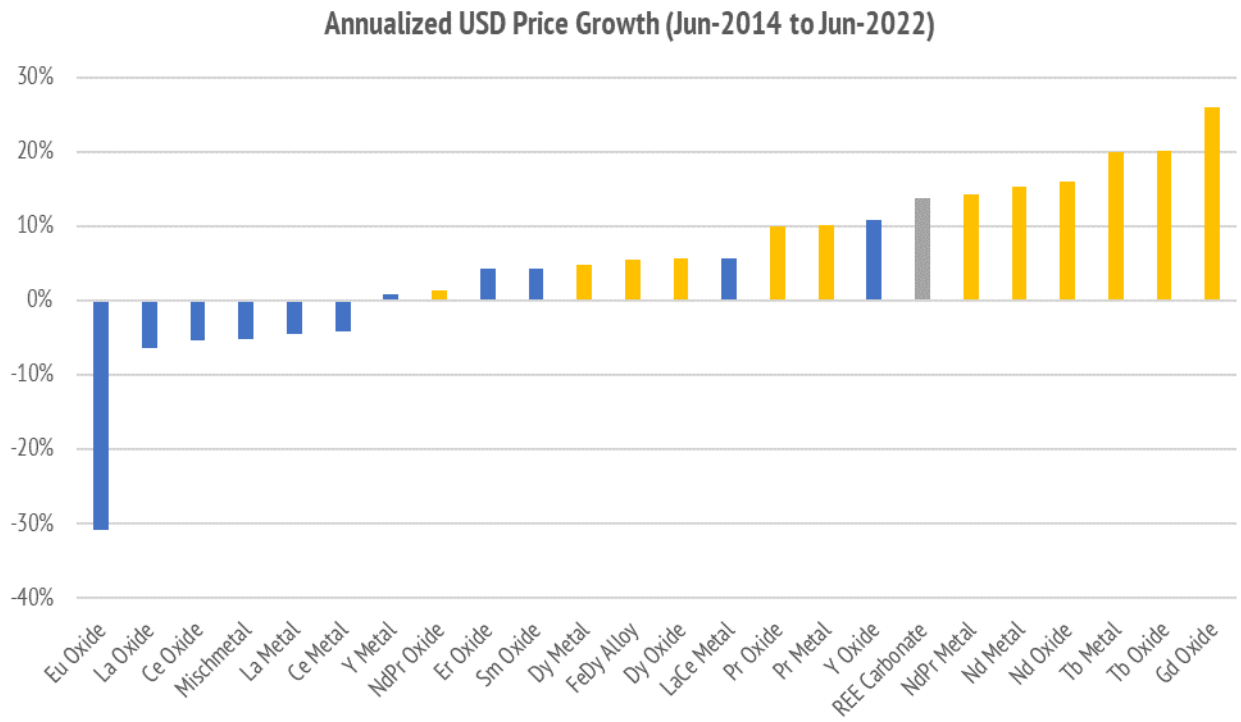
Source: US Geological Survey (2022). See: Mineral Commodity Summaries 2022

Exhibit 3 US Geological Survey Estimates of Global Rare Earth Oxide (REO) equivalent Rare Earth mine production.



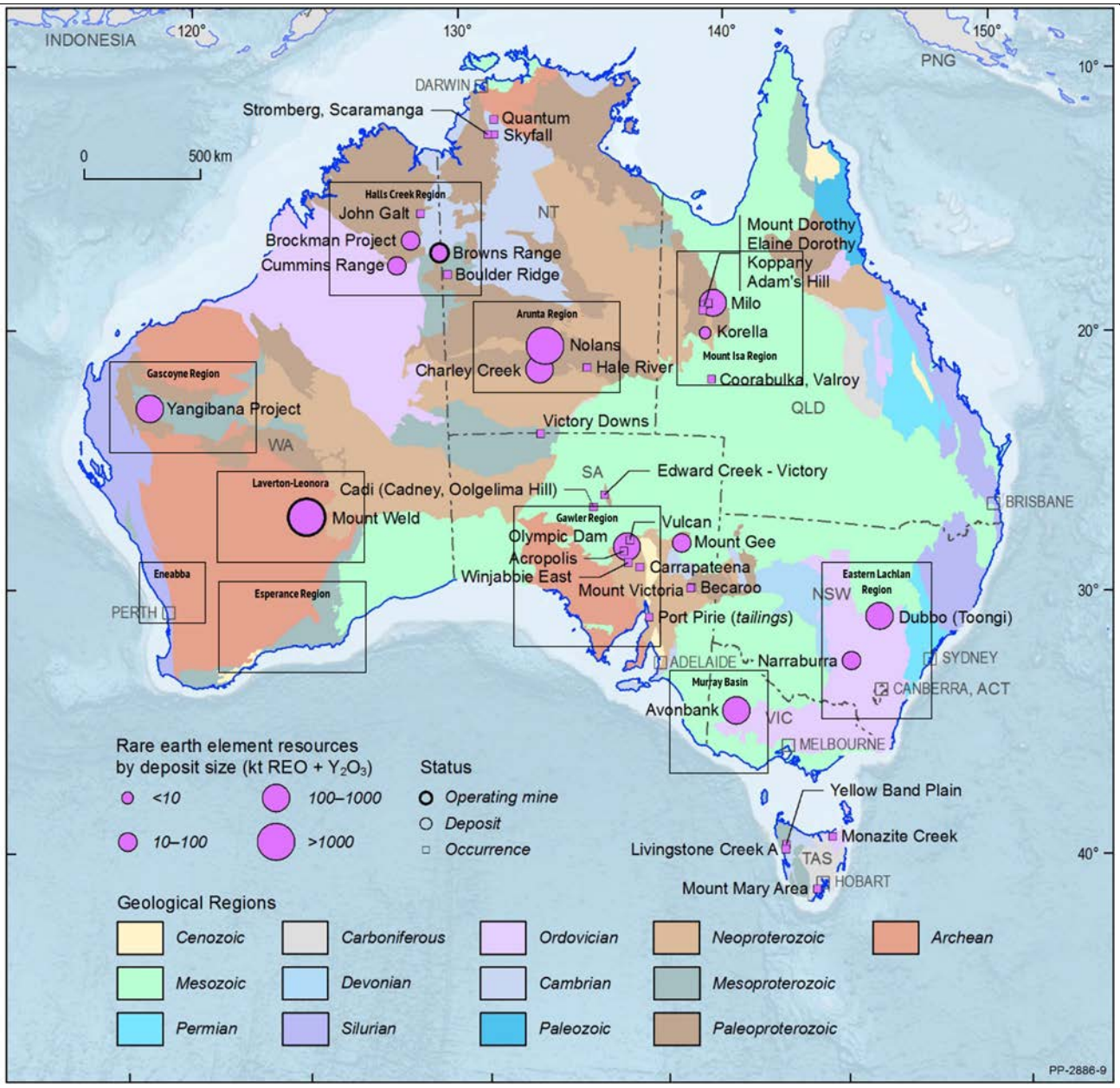
Source: US Geological Survey (2022). See: Mineral Commodity Summaries 2022

Exhibit 4 Pricing pressure dispersion across key Rare Earth Oxides (REO) and Rare Earth Metals (REM) with magnet materials in orange.



Source: Jevons Global analysis of pricing from the Shanghai Metals Market (2022).

Exhibit 5 Geosciences Australia Rare Earth Element Resources (2018) with current regions of interest overlayed by the author (2022).



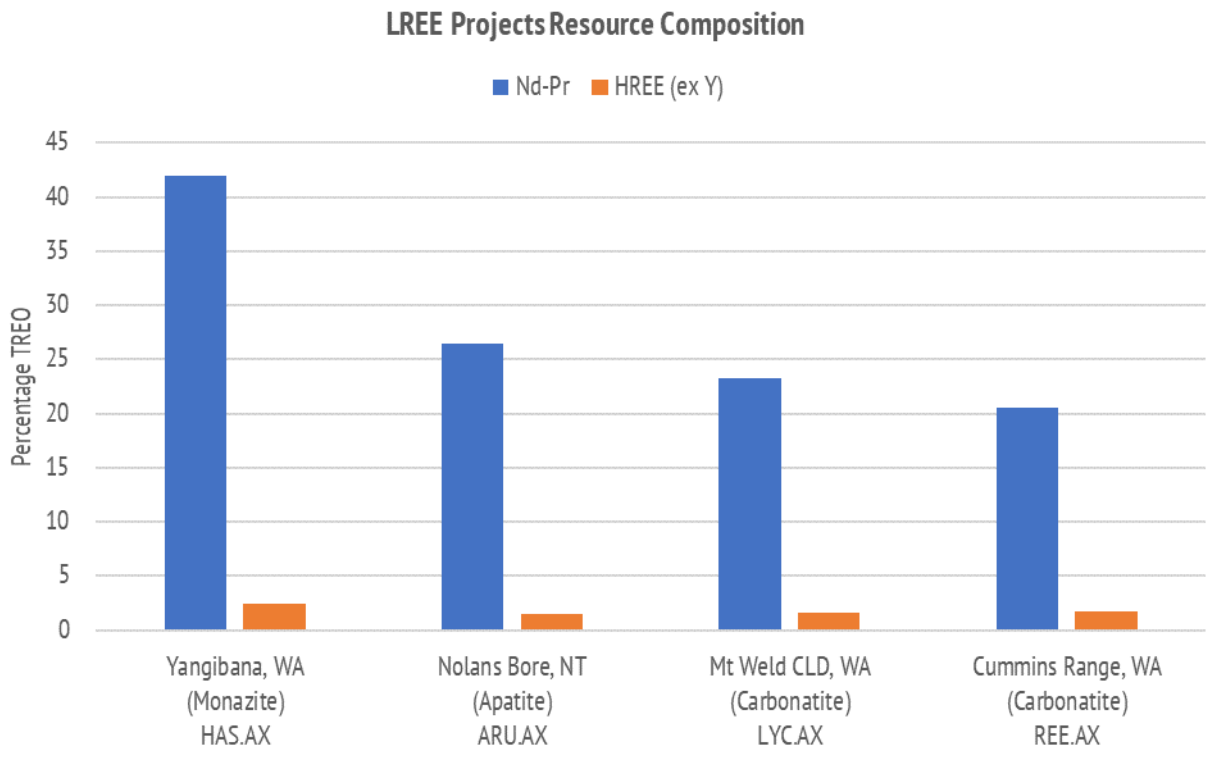
Source: Geosciences Australia (2018). See: Australian Rare Earths Deposits. Boxed additions are current areas of project development mentioned in this research report.

Exhibit 6 ASX listed companies with rare earths projects or prospective exploration leases granted (Cap >$200M AUD in green).

Ticker	Company Name	Cap. ($M)	Project	Mineralisation	Development Stage	Internet Address
LYC.AX	Lynas Rare Earths Ltd	7860	Mt Weld, WA	Carbonatite	Production & Refinery	www.lynasrareearths.com
ILU.AX	Iluka Resources Ltd	4064	Eneabba, WA	Monazite HMS	Production & Refinery FID	www.iluka.com
ARU.AX	Arafura Resources Ltd	549	Nolans, NT	Apatite	Definitive Feasibility Study	www.arultd.com
ASM.AX	Australian Strategic Mat. Ltd	509	Dubbo, NSW	Polymetallic	Construction Ready	www.asm-au.com
HAS.AX	Hastings Technology Metals Ltd	414	Yangibana, WA	Monazite	Definitive Feasibility Study	www.hastingstechmetals.com
NTU.AX	Northern Minerals Ltd	194	Browns Range, NT	Xenotime	Pilot Production	www.northernminerals.com.au
DRE.AX	Dreadnought Resources Ltd	185	Mangaroon, WA	Polymetallic	Exploration Drilling	www.dreadnoughtresources.com.au
VML.AX	Vital Metals Ltd	179	Nechalacho, Canada	Polymetallic	Production	www.vitalmetals.com.au
IXR.AX	Ionic Rare Earths Ltd	174	Makuutu, Uganda	IAC Hosted REE	Scoping Study	www.ionicre.com.au
ARR.AX	American Rare Earths Ltd	101	La Paz, USA	Allanite	NI 43-101 Resource	www.americanrareearths.com.au
PEK.AX	Peak Rare Earths Ltd	94	Ngualla, Tanzania	Carbonatite	Bankable Feasibility Study	www.peakrareearths.com
GGG.AX	Greenland Minerals Ltd	75	Kvanefjeld, GL	Steenstrupine	Strategic Review	www.ggg.gl
MEK.AX	Meeka Metals Ltd	48	Circle Valley, WA	IAC Hosted REE	Exploration Drilling	www.meekametals.com.au
AR3.AX	Australian Rare Earths Ltd	42	Koppamurra, Vic	IAC Hosted REE	Resource Expansion	www.ar3.com.au
REE.AX	RareX Limited	38	Cummins Range, NT	Carbonatite	Scoping Study	www.rarex.com.au
ITM.AX	Itech Minerals Ltd	36	Eyre Peninsula, SA	IAC Hosted REE	Exploration Drilling	www.itechminerals.com.au
ABX.AX	ABx Group Ltd	35	Deep Leads, Tas	IAC Hosted REE	Exploration Drilling	www.abxgroup.com.au
ASR.AX	Asra Minerals Ltd	26	Mt Stirling, WA	REE Prospective	Exploration Drilling	www.asraminerals.com.au
CLE.AX	Cyclone Metals Ltd	24	Carnarvon Basin, WA	REE Prospective	Exploration Licenses	www.cyclonemetals.com
MRD.AX	Mount Ridley Mines Ltd	23	Mt Ridley, WA	IAC Hosted REE	Exploration Drilling	www.mtridleymines.com.au
KTA.AX	Krakatoa Resources Ltd	17	Mt Clere, WA	IAC Prospective	Exploration Drilling	www.ktaresources.com
TAR.AX	Taruga Minerals Ltd	14	Mt Craig, SA	IAC Hosted REE	Exploration Drilling	www.tarugaminerals.com.au
LNR.AX	Lanthanein Resources Ltd	13	Gascoyne, WA	REE Prospective	Exploration Sampling	www.lanthanein.com
RMX.AX	Red Mountain Mining Ltd	11	Mt Mansbridge, NT	REE Prospective	Exploration Licenses	www.redmountainmining.com.au
OD6.AX	OD6 Metals Ltd	8	Esperance, WA	IAC Prospective	Exploration Licenses	www.od6metals.com.au
RR1.AX	Reach Resources Ltd	6	Skyline, WA	REE Prospective	Exploration Licenses	www.reachresources.com.au
ENV.AX	Enova Mining Ltd	6	Charley Creek, NT	Monazite	Scoping Study	www.enovamining.com
RBX.AX	Resource Base Ltd	5	Murray Basin, Vic	IAC Prospective	Exploration Licenses	www.resourcebase.com.au
MGA.AX	Metalsgrove Mining Ltd	5	Arunta Region, NT	REE Prospective	Exploration Drilling	www.metalsgrove.com.au
MTM.AX	Mt Monger Resources Ltd	4	Ravensthorpe, WA	IAC Prospective	Exploration Drilling	www.mtmongerresources.com.au
MMC.AX	Mitre Mining Corporation Ltd	3	Mitre Project, NSW	IAC Prospective	Exploration Survey	www.mitremining.com.au

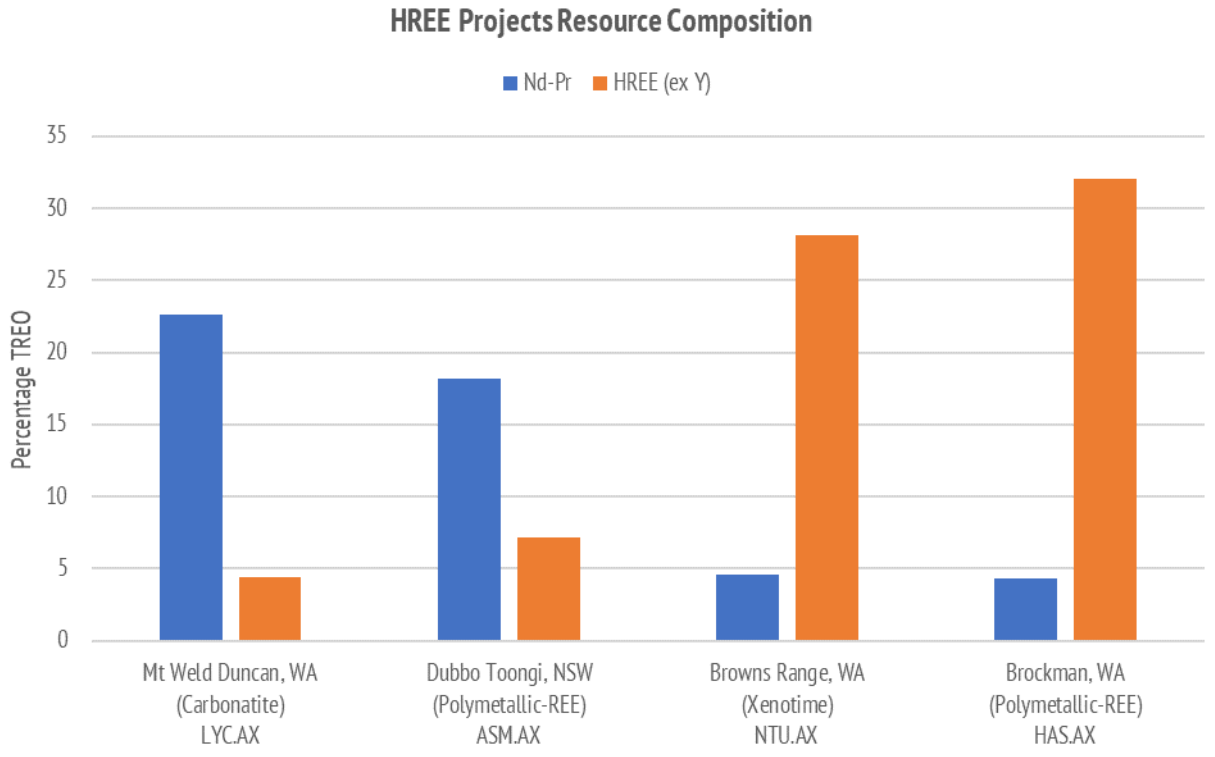
Source: Jevons Global (2022) and company reports.

Exhibit 7 Advanced Australian hard-rock Light REE Projects Nd-Pr and Heavy REE (HREE) resource composition.



Source: Jevons Global analysis and company releases (2022)

Exhibit 8 Advanced Australian hard-rock Heavy REE Projects Nd-Pr and Heavy REE (HREE) resource composition.



Source: Jevons Global analysis and company releases (2022)

Exhibit 9 ASX Rare Earth Universe with pricing and summary financials ranked by market capitalization.

Ticker	Company Name	Mkt Cap ($B AUD)	Last Price ($AUD)	% Below 52Wk. Hi	% Above 52Wk. Lo	Trailing P/E	Forecast P/E	Dividend Yield	Model Rank	Price/DCF Value
LYC.AX	Lynas Rare Earths Ltd	7.860	8.71	-25%	40%	28.90	13.10		80	0.92
ILU.AX	Iluka Resources Ltd	4.064	9.58	-25%	19%	11.07	8.44	4.4%	98	0.75
ARU.AX	Arafura Resources Ltd	0.549	0.35	-30%	192%				42	
ASM.AX	Australian Strategic Materials Ltd	0.509	3.56	-75%	24%				2	
HAS.AX	Hastings Technology Metals Ltd	0.414	4.08	-36%	18%				45	
NTU.AX	Northern Minerals Ltd	0.194	0.04	-44%	14%				34	
DRE.AX	Dreadnought Resources Ltd	0.185	0.07	-12%	103%				45	
VML.AX	Vital Metals Ltd	0.179	0.04	-43%	13%				26	
IXR.AX	Ionic Rare Earths Ltd	0.174	0.05	-54%	67%					
ARR.AX	American Rare Earths Ltd	0.101	0.26	-56%	207%				52	
PEK.AX	Peak Rare Earths Ltd	0.094	0.46	-64%	57%				19	
GGG.AX	Greenland Minerals Ltd	0.075	0.06	-64%	30%				15	
MEK.AX	Meeka Metals Ltd	0.048	0.05	-32%	49%					
AR3.AX	Australian Rare Earths Ltd	0.042	0.44	-67%	47%				4	
REE.AX	RareX Limited	0.038	0.07	-53%	25%				13	
ITM.AX	Itech Minerals Ltd	0.036	0.40	-44%	116%					
ABX.AX	ABx Group Ltd	0.035	0.16	-26%	60%				64	
ASR.AX	Asra Minerals Ltd	0.026	0.02	-57%	0%				50	
CLE.AX	Cyclone Metals Ltd	0.024	0.00	-60%	60%	2.88			54	
MRD.AX	Mount Ridley Mines Ltd	0.023	0.00	-64%	33%				55	
KTA.AX	Krakatoa Resources Ltd	0.017	0.05	-66%	20%				54	
TAR.AX	Taruga Minerals Ltd	0.014	0.03	-59%	56%				4	
LNR.AX	Lanthanein Resources Ltd	0.013	0.02	-64%	14%				54	
RMX.AX	Red Mountain Mining Ltd	0.011	0.01	-52%	44%				21	
OD6.AX	OD6 Metals Ltd	0.008	0.16	-16%	7%					
ENV.AX	Enova Mining Ltd	0.006	0.02	-47%	7%					
RR1.AX	Reach Resources Ltd	0.006	0.00	-77%	0%				28	
RBX.AX	Resource Base Ltd	0.005	0.13	-58%	24%	11.40			45	
MGA.AX	Metalsgrove Mining Ltd	0.005	0.13	-21%	8%					
MTM.AX	Mt Monger Resources Ltd	0.004	0.11	-59%	6%				39	
MMC.AX	Mitre Mining Corporation Ltd	0.003	0.12	-58%	0%					

Source: Jevons Global (2022), and Refinitiv (Pricing: 29-Jul-2022).

TRADING POSITION DISCLOSURE

The Jevons Global Opportunities portfolio holds these trading positions of relevance to this research note:

There are no active positions held in those stocks mentioned in this research report.

The analyst Dr Kingsley Jones, CFA has a beneficial interest in any profit or loss derived from these trading positions.

The author has taken due care in the preparation of this research report but is not a competent person according to the JORC code.

GENERAL ADVICE WARNING

Please note that any advice given by Jevons Global Pty Ltd (JG), an authorized representative of BR Securities Australia Pty Ltd (BR) is GENERAL advice, as the information or advice given does not consider your objectives, financial situation or needs. You should, before acting on the advice, consider the appropriateness of the advice, having regard to your objectives, financial situation, and needs. If our advice relates to the acquisition, or possible acquisition, of a particular financial product you should read any relevant Product Disclosure Statement or like instrument.

DISCLAIMERS

JG does not warrant the accuracy of any information it sources from others. JG provides this report as an opinion held at a point in time about an investment or sector. JG has no obligation to update the opinion unless you are a client of JG. Assessment of risk can be subjective. Historical information may not translate into future performance. Portfolios of investments need to be well diversified and the risk appropriate for the investor. JG does not stand behind the capital value or performance of any investment. To the fullest extent permitted by the law, JG disclaim any liability for any loss or damage arising from the use of, or the reliance on, any information within the report whether caused by any negligent act or omission of JG. Overseas investors acknowledge that JG has not solicited their business and that they have accessed this report while searching for information on Australian companies. JG is regulated to do business in Australia by the Australian Securities and Investments Commission (ASIC).

DISCLOSURES

Kingsley Jones, an authorized representative (AFS Representative Number 001250728) of BR Securities Australia Pty Ltd (BR), certifies that the advice provided is their honest opinion at a point in time. The analyst provides general advice on security selection and portfolio construction in accordance with the Jevons Global System. This classifies the global universe of securities into eight thematic sectors: Resources and Energy (RE); Food and Agriculture (FA); Physical Infrastructure (PI); Financial Infrastructure (FI); Digital Technology (DT); Analog Technology (AT); Consumer Needs (CN); and Consumer Wants (CW).

The investment process considers portfolio construction regarding the assessed risk and reward characteristics of each thematic sector regarding the targeted level of diversification and portfolio risk. Security selection within each thematic sector combines an assessment of relative value and strategic positioning of the targeted securities within the relevant thematic opportunity set. This process blends original industry research of Jevons Global with third-party quantitative screening models provided by StarMine, a service of Thomson Reuters. To the extent possible, portfolio construction is guided by the historical risk-return characteristics of thematic sectors and risk factors known to influence investment outcomes. These include but are not limited to profitability; balance sheet quality; revenue trends; management and cyclical factors. Model risks for individual positions are managed through attention to position limits and a disciplined approach to portfolio diversification across security, country, and industry exposures. Recommendations are given in the form of thematic sector positions along with a list of preferred security exposures.

Analysts are compensated through a share of fees generated from contract research and consulting services and may share in brokerage or origination fees where research services are provided to other parties. Analysts may own securities in companies recommended but will buy and sell in accordance with the BR Personal Dealing Policy, the BR Insider Trading Policy, the BR Conflict of Interest Policy, and the law. Jevons Global operates reference portfolios for the purpose of personal dealing and compliance. These are the Jevons Global Core portfolio and the Jevons Global Opportunities portfolio. Analysts are required to hold the bulk of their personally managed investments in a combination of these strategies, to properly ensure an alignment of financial interests with clients. The composition of the reference strategies is fully disclosed, where appropriate, as are individual security interests germane to any research note.

Analysts must disclose a beneficial trading interest wherever present.

CONFIDENTIALITY NOTICE

Jevons Global Pty Ltd (ABN 96 152 556 833) is a Corporate Authorized Representative (CAR 1250727) of BR Securities Australia Pty Ltd (ABN 92 168 734 530) which holds an Australian Financial Services License (AFSL 456663).

This research note was written in the beautiful urban-rural city of Canberra, Australia