



HALLGARTEN & COMPANY

Coverage Update

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American Rare Earths (ASX:ARR, OTCQB:ARRNF) Strategy: LONG

Key Metrics

Price (AUD)	\$	0.235
12-Month Target Price (AUD)	\$	0.46
Upside to Target		96%
12mth hi-low		\$0.155-\$0.585
Market Cap (AUD mn)	\$	104.92
Shares Outstanding (mns)		446.48
	Fully diluted	466.00

American Rare Earths

Proving Up Two Projects and Advancing on the Processing Technology Front

- + Exploration Target at Halleck Creek ranges between 1.01 and 1.27 billion tonnes of ore, with grade ranges indicating 2.8 to 3.56 million *in-situ* tonnes of TREO
 - + Expanding technology partnerships with universities and the National Laboratories with DOD and DOE funding , puts the company at the forefront of REE processing innovation
 - + Rare Earth prices have held firm at levels substantially above the average levels of the last ten years
 - + Over the past two years, focus in the US has swung towards the vulnerability of the country to China's dominance of specialty metals, in particular, Rare Earths
 - + There are few REE projects in the US and only a handful are in active consideration or credible
 - + The low level of radioactive contaminants is a major plus at both La Paz and Halleck Creek
 - + Raised AUD\$14mn in August that again included institutional investment by Fidelity International
 - + Prior to the recent capital raise, the company had AUD\$6.3mn in cash on hand at the end of the June quarter of 2022
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- ✘ The La Paz project is low-grade, but large in tonnage
 - ✘ China still has the whip hand in REE-pricing and can sink prices, suddenly, at will
 - ✘ The DoD strategy of picking "champions" is being muddled by companies lacking HREE resources being given consideration
 - ✘ The environment for funding REE project builds remains tough so capex to the low side is a virtue

Rare Earths Rising

In the last three years the Rare Earths space has gone from mild buzzing to a full furore. Despite this there has not been a massive burgeoning of projects, as in 2009-11, nor have there been many additions to the number of viable projects in the United States

The awakening in Rare Earths has been spurred by the invective related to the almost total dependence of the US economy (and its military) upon externally-sourced Rare Earths, primarily from China.

The renewed interest of politicians and investors coincides with the on-going slide in China's own internal production (particularly in Heavy Rare Earths). This changes the dynamic from the one which has reigned for the last eight years, where China definitively had the whiphand. With Chinese supplies under a cloud and the West having added no capacity in recent years, the scenario is one of shortages and rationing, particularly with regard to those REEs for magnets most used in EVs, offshore wind

turbines, high efficiency heat pumps, and 5G.

American Rare Earths is aiming to develop Rare Earth mineral processing facilities close to the planned mining sites in La Paz County, AZ and Albany/Platte Counties, WY. The La Paz deposit is relatively low-grade (300–700 ppm total REEs), being notable for its sheer volume, uncomplicated mineralogy, and low U/Th and high Scandium content. For details on this asset see our previous research notes.

The Halleck Creek project, in Wyoming, has a notably large Exploration Target and higher grades ranging from 2,245-2,807 ppm Total Rare Earth Oxides (TREO).

In this note we shall expand upon the progress at Halleck Creek, the expanding relationships with major universities and the Department of Energy's Lawrence Livermore National Laboratory on the development of processing technologies and the update of the La Paz resource. We also look at the state of the Rare Earth industry in the US over the last six months where there has been considerable excitement generated by the US pivot towards more self-reliance.

REE Champions Still Thin on the Ground

From over 300 claimants to be potential Rare Earth producers in 2011, at the end of the last Rare Earths boom, the number of developers had shrunk to less than twenty survivors by 2019. Of those only five had properties in the United States. These assets are the La Paz & Halleck Creek properties of ARR, the Bear Lodge property (Rare Earth Elements - OTCQB:REEMF & General Atomics), Mountain Pass in California (the sole producer, controlled by MP Materials, that sells practically all of its product to China's Shenghe group, Bokan in Alaska (owned by UCore – TSX-v:UCU) and the Round Top project of USA Rare Earths/Texas Mineral Resources (OTC:TMRC). We would note though that the number of prospective properties in the US has not shrunk to an appreciable extent since 2011, but rather the attrition has been in Canada, Africa, Australia and elsewhere.

Nevertheless, Mountain Pass (in the guise of Molycorp) was advanced to production when the curtains came down in 2011 and all the rest have been marking time. None of the projects in long term development have secured the elusive Nuclear Regulatory Commission (NRC) permit that a Thorium producing US REE mine will require. It is notable that the NRC has not issued a new greenfield mine permit in over two decades. While La Paz existed back at the earlier time it was not really on the radar and has surfaced in the current revival as a somewhat "fresh face" on the landscape. Mountain Pass died (and has been reborn under MP Materials - NYSE:MP) and the others went through a long somnolence (from which Bokan and Bear Lodge have still not awoken).

Halleck Creek Project

Originally called the Laramie REE Project at the time ARE acquired it, the now renamed Halleck Creek project is an exploration project located in the southern Laramie Mountain range of south-eastern Wyoming about 70 km northeast of Laramie, Wyoming, and 30 km southwest of Wheatland, Wyoming.

The project is now comprised of 249 unpatented lode mining claims in Albany County, Wyoming totaling approximately 4,208 acres (1,703 ha). ARE also controls four (4) Wyoming State mineral leases covering approximately 1,844 acres (746 ha).



The Deal

In December of 2020, ARE announced the acquisition of the project from Zenith Minerals (ASX: ZNC). The total project purchase price was 2.5 million ARR ordinary shares (price A\$0.02 each) plus AUD\$50,000 cash. The deal closed in June of 2021. The purchase included American Rare Earths acquiring all data, including samples and maps, associated with the REE Project in Wyoming, and exploration permits.

In June of 2021, the Wyoming Office of State Lands, and Investments (SLI) provided the final approval of four state mineral leases to Wyoming Rare (USA), Inc. (WyR), now a 100% wholly owned subsidiary of American Rare Earths. The company regarded the unanimous decision for approval of the leases, handed down by the Board of Commissioners of the SLI, as an indicator of the mining friendly nature of the jurisdiction. The acquisition of the Zenith's company, WyR, that controls the project, its lode claims, and mineral leases are inclusive of the transaction.

With the State's approval, ARR moved to control the four Wyoming State Mining Leases totaling approximately 1,844 acres (746 ha) in Albany County and Platte County, Wyoming. In June 2021, WRE staked an additional 44 unpatented lode mining claims, significantly expanding the project area. Then more recently the company added the adjacent Bluegrass prospect taking its claim control to over 6000 acres.

Geology

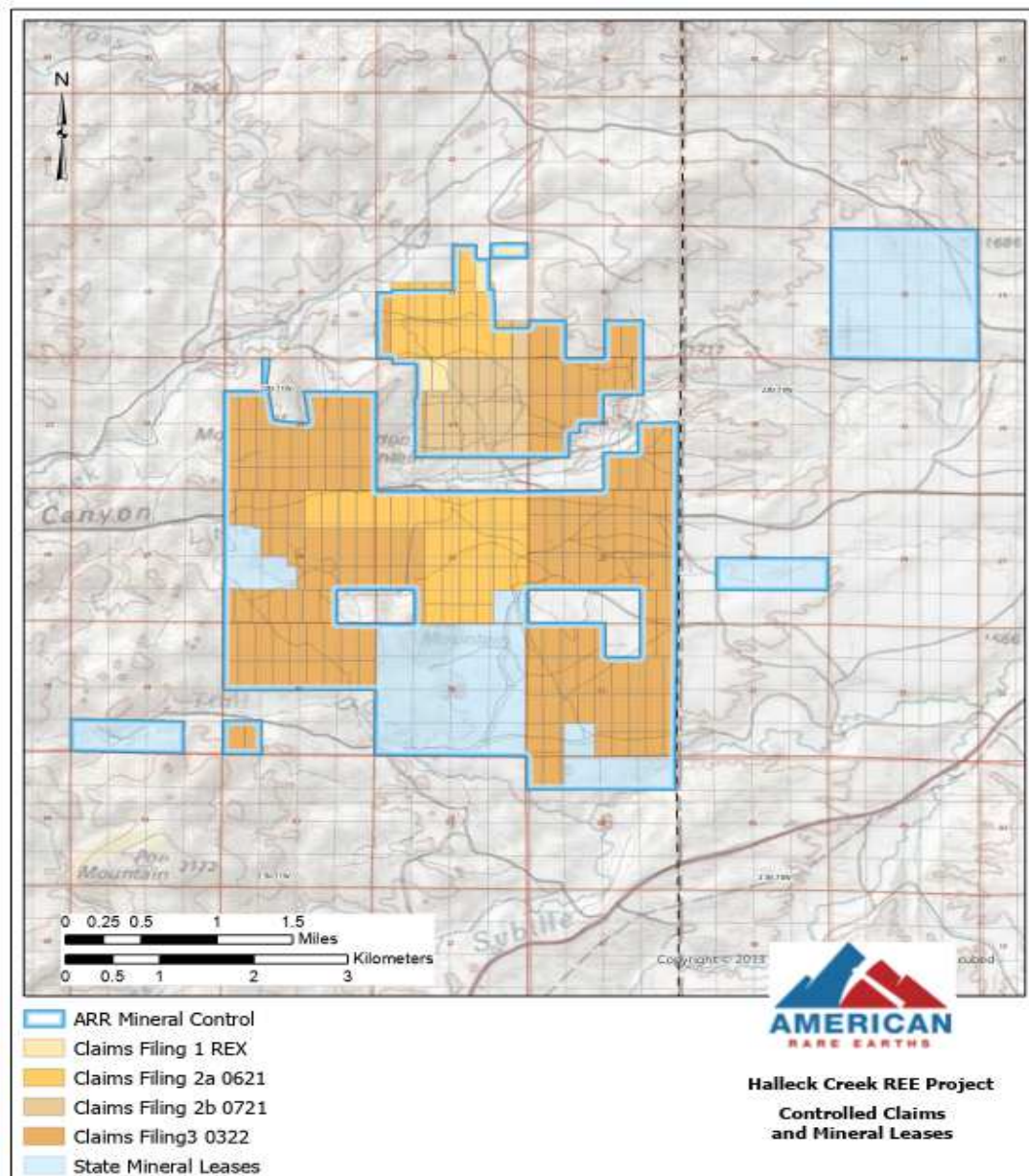
According to previous ZNC press releases, the primary rock types exposed on the Laramie REE property are the Red Mountain Pluton and the Sybille intrusive monzonites and syenites. These intrusive complexes have subsequently been intruded by younger granite dikes. The Red Mountain Pluton is composed of three intrusive units:

- Fayalite Monzonite (Olivine rich unit)

- Clinopyroxene Quartz Monzonite
- Biotite Hornblende Quartz Syenite

These rock types contain disseminated allanite of variable quantities up to 2% (by weight%) present throughout the Pluton. The younger granite dikes also contain variable quantities of allanite. Based on the petrographic work completed to date the allanite is the primary host of the REE's. In the older Sybille intrusive, allanite is only sparsely present and sampling to date indicated minimal REE mineralization. Therefore, the REE mineralization appears well focused throughout the Pluton which is exposed at surface over several square kilometres.

These leases had been under consideration by the State of Wyoming for more than two years without progress. ARR's USA based staff found a path to approval in just a few months.



Exploration

ZNC stated in a press release in November 2019, that total Rare Earth oxide grades of up to 0.6% were observed in rock samples collected in the project area.

In May of 2022 the company announced the completion of maiden drilling of 917 metres (3,008 feet) and that it had collected 822 samples from nine holes in the Red Mountain and Overton Mountain zones of the larger Red Mountain Pluton, with core recovery from most holes exceeding 99%.

In August of 2022 the company announced a major boost to the planned work at Halleck Creek

proposing 12,232 meters of drilling and an expanded exploration target.

- Permits approved on initial 55 drill holes to establish a maiden resource
- Expecting 5,400 samples over 8200 meters of drilling to begin September 2022

Additional exploration permits have been filed for an additional 27 RC drill holes for 4,032 meters in the Bluegrass area, a recent expansion of the project. Exploration drilling in the Bluegrass area may not occur until after the maiden resource has been calculated for Red Mountain and Overton Mountain. However, the exploration of the Bluegrass Creek area is designed to increase the anticipated in-place JORC compliant resource estimates to encompass the Overton Mountain and Bluegrass Creek areas.

The technical team expects the amended NOI (permit approvals) will be obtained in early 4Q22. Exploration drilling could commence in late 1Q23 or early 2Q23.



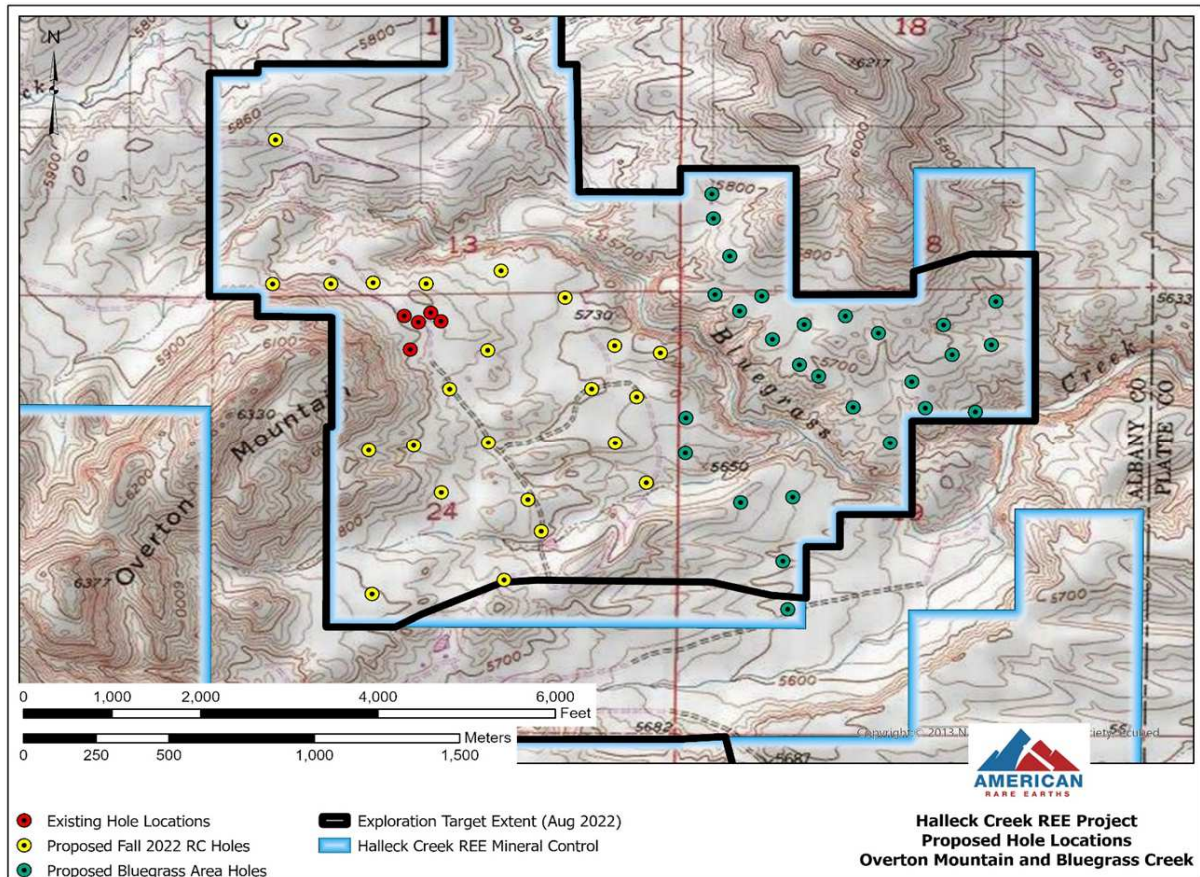
Bluegrass Creek

The newly claimed Bluegrass area consists of 32 unpatented federal land claims covering approximately 633 acres (256 ha). The Bluegrass area is one of three areas that form the Halleck Creek Project alongside existing claims for the Red Mountain and Overton Mountain areas. It is located approximately two miles Northeast of the Red Mountain area and one mile East of the Overton Mountain area. Surface samples collected in the Bluegrass area exhibit an average TREO value of 3051 ppm.

The highest observed Total Rare Earth Oxides (TREO) from the 71 new surface samples was 5,065 ppm. Average TREO were 3051 ppm and average Magnet Rare Earth Oxides (MREO) were 812 ppm, with the high value MREO 27% of TREO. Additionally, the results showed very low levels of penalty elements thorium and uranium. All samples were collected from the same lithology, clinopyroxene quartz monzonite (CQM) within the Red Mountain Pluton (RMP). This is the same lithotype that occurs within the Overton Mountain and Red Mountain Areas.

In the company's opinion the latest assays from Bluegrass demonstrate that REE mineralisation is likely to expand significantly beyond the current resource target and that the REE mineralisation may be prevalent throughout the majority of the Red Mountain Pluton (RMP).

The planned holes are shown on the map below.



The Exploration Target at Halleck Creek

In recent weeks the company has updated the JORC Exploration Target estimate based on the latest surface sampling, and 2022 maiden drilling results. The updated exploration targets outline between 1.01 and 1.27 billion tonnes of rare earth mineralized rocks with TREO grades ranging between 2,245 ppm and 2,807 ppm. However, it should be noted that the potential quantity and grade of the Halleck Creek resource are still conceptual in nature, and there has been insufficient exploration to estimate a Mineral Resource. The TREO metal oxide is estimated between 2.849 to 3.561 million tonnes. Very few resource estimates globally exceed 2 million tonnes of oxide content. Halleck Creek assays also indicate notable levels of Zirconium and Hafnium, also on the US Government’s list of Critical Minerals.

Halleck Creek Exploration Target Ranges

TREO Range (ppm)	TREO Metal Oxide (million kg)	MREO* Metal Oxide (million kg)	Nd ₂ O ₃ Metal Oxide (million kg)	Pr ₆ O ₁₁ Metal Oxide (million kg)
Overton Mountain				
1,500 - 2,500	170 -212	47 - 59	34 -43	9 -11
>2,500	905 -1132	217-271	160 -199	44 - 55
OM Total	1075 -1343	264 -330	194 -242	53 -66
Red Mountain				
1,500 - 2,500	538 -673	157 - 196	114 - 142	30 - 38
>2,500	1235 -1544	271 -338	196 -245	54 -67
RM Total	1774 -2217	428 - 534	310 -387	84 - 105
Grand Total	2849 -3561	691 - 864	503 - 629	137 -171

Technology – Various Irons in the Fire

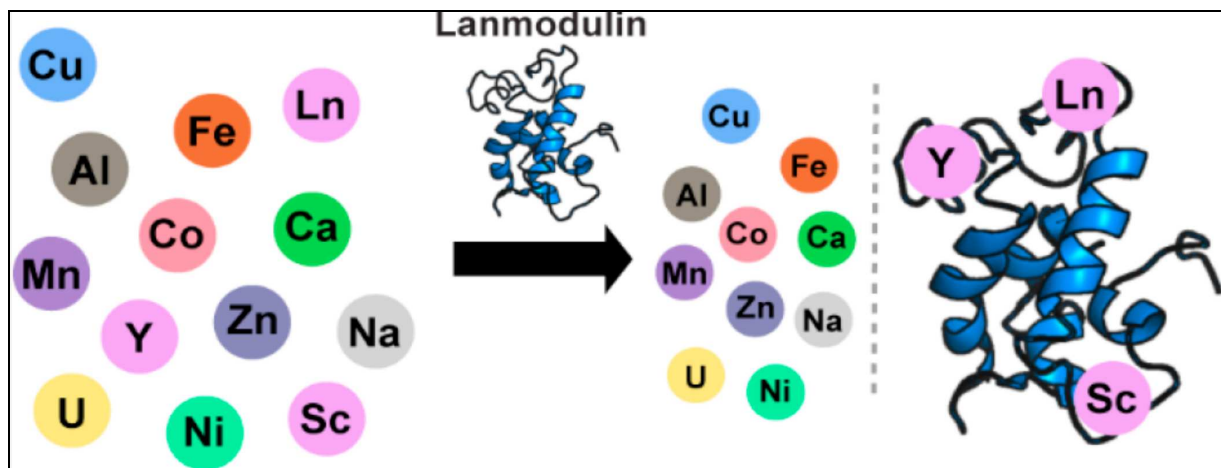
One thing that became clear in the wake of the first REE Boom was that the rewarmed conventional processing methods for REE oxides (many of which were unchanged from the 1960s and 1970s) were the downfall of some of the PEAs and PFSs that many players dished up during the feeding frenzy. Many of these “tried & true” also came with eye-watering price tags that ranged from \$500mn through to over one billion dollars.

This go around, if anything, it is entirely the opposite with most players seeking out new technologies to lower costs and differentiate themselves from the other players on the field. In particular, companies have been looking for systems that can bypass having to process out at great cost (of money and time) the essentially unwanted Lanthanum and Cerium. Few though are talking about the radioactive component in their deposits. We note in particular that one company claims to have a plant in the suburbs of Denver and yet does not mention the uranium-tainted nature of their ore and concentrates.

The drawbacks of most conventional REE extraction technologies is their reliance on energy- and chemical-intensive metallurgical techniques that can be expensive and environmentally harmful. In addition, these technologies (dating back half a century) are unable to effectively extract both Scandium (Sc) and those elements in the Lanthanide series at high efficiency. Many of these technologies co-extract Uranium and Thorium, leading to challenging volumes of radioactive wastes. This would also trigger the need of the elusive permit from the US Nuclear Regulatory Commission (NRC), last seen in 1998 for a new greenfield mine. The company’s mineral locations on Bureau of Land Management areas carry no mineral royalty burden and some of the lowest permitting friction. Its leases with the States of Wyoming and Arizona are especially mining friendly jurisdictions.

The Livermore Partnership

The team from American Rare Earths has been working with Lawrence Livermore National Laboratory (LLNL) and Pennsylvania State University (PSU) to enable clean extraction of both Scandium and lanthanides from REE-bearing feedstocks. The researchers have completed a proof-of-concept demonstration of a novel biosorption technology that uses the biological ligand, lanmodulin (LanM), for selective Scandium and Lanthanide recovery without enriching U/Th.



The schematic above seeks to show how the lanmodulin-based Rare Earth biosorption technology extracts the Lanthanides, Yttrium and Scandium. With this process high-purity Scandium and Lanthanides (Ln) can be produced from a single biosorption and desorption cycle, enabling selective Sc/Ln separation from other non-REE contaminants. The performance of lanmodulin (LanM) is enabled by its three EF-hand motifs that complex with REEs with high binding affinity and selectivity.

The researchers are now moving on to technical performance testing and economic analysis of an integrated process. This exercise will address the commercial feasibility this novel extraction technology with feedstocks from La Paz and Halleck Creek. By using the two different low-grade feedstocks (AZ and WY), the aim is to understand the minimum economically viable composition of rare earth feedstocks, and the optimal phases for the extraction process.

This approach could be helpful as ARR is aiming to develop Rare Earth mineral processing facility close to the planned mining sites.

ARR's strategy is to leverage the LLNL/PSU biosorption technology and to evaluate the economics of the LLNL/PSU technology to the complete REE supply chain. These activities will hopefully address questions required in order to license and incorporate the technology into its mineral processing platform. If this can be accomplished with high efficiency co-recovery of Scandium and the magnet REEs, while avoiding the need of a permit from the US Nuclear Regulatory Commission, it could be disruptive to the Rare

Earths supply-chain norms. The US Department of Defense, through the DARPA EMBER program, is funding up to US\$13mn for proving and scaling the concept.

The DOE Projects

In late August, the company's subsidiary, Western Rare Earths (WRE) joined as the industrial partner in a research consortium that includes the technology company, Phinix, LLC and Virginia Tech University. WRE's role will be to provide Rare Earths-bearing ores as feedstock for extraction and separation focused processing technology studies.

The partnership's goal is to produce light, medium, and heavy rare earth oxide products of greater than 95% purity. A Neodymium oxide product of greater than 95% purity will also be produced. An innovative extractor technology, based on gas-assisted micro-flow extraction (GAME) theory, will be employed with an efficient task-specific ionic liquid (TSIL) for REE extraction and separation. If this proves successful, it could reduce capex and opex expenditures for producing REEs while improving recovery efficiencies, thus reducing the loss of valuable REE to tailings.

The team was awarded R&D funding by DOE's Office of Energy Efficiency and Renewable Energy (EERE) Advanced Manufacturing Office (AMO) in an AMO program known as Critical Materials: Next-Generation Technologies and Field Validation. The consortium will receive up to US\$500,000 to fund the work. This makes three government funded R&D partnerships for the company in 2022. Their first one was announced in January, a DOE funded project through the Critical Materials Institute, a DOE Innovation Hub that activates the US' national laboratories on those scientific challenges of greatest import to the national interest.

La Paz Project – Resource Uplift

For historical details on this asset see our previous research notes. La Paz is a low-grade (300–700 ppm total REEs), bulk tonnage deposit with its chief attractions being that the deposit is near surface, low radioactivity, in a good mining jurisdiction, near high voltage transmission lines, gas supply and rail, in an easily accessible location and with a robust volume of high-value Scandium. Scandium is another technology metal on which we have written extensively.

In the time since our previous research note, completion of the confirmation core drilling in March/April 2021 the REE resource was updated with the new core data. The results delivered a total resource tonnage increase of 33.1% to 170.6mn tonnes. Indicated resource estimates increased to 35.2mn tonnes from 16.2mn tonnes, an increase of 117%. Additionally, the historic drill data was combined with the new core information to calculate a maiden Scandium resource of 4.4 million kgs of Scandium Oxide.

A new round of exploration permit applications have been filed with the BLM and the company is

waiting for final approval. The technical team plans to perform resource exploration drilling at La Paz SW in 1H23 to expand resource estimates at La Paz beyond the current 170mn tonnes JORC Resource estimate.

La Paz - Resource Estimate					
Classification	Tonnage (tonnes)	TREE (ppm)	TREE (kg)	TREO (ppm)	TREO (kg)
Indicated	35,161,600	382	13,448,019	459	16,144,347
Inferred	135,433,800	393	53,198,803	472	63,865,163
Total	170,595,400	391	66,646,822	469	80,009,510

The Changing Scandium Dynamic

We have long noted the chicken-&-egg dilemma in the Scandium market. End-users would not tool up to use the metal (particularly in aerospace applications) until they were guaranteed supply. Meanwhile potential producers could not get funded as end-users would not commit to the small amounts that the producers were likely to (initially) produce. In 2021 a seminal event occurred which came from a most unexpected quarter. In a surprise announcement the mining major RTZ, which had never mused publicly about its Scandium potential, suddenly revealed in 2021 that it would become a significant producer of Scandium by reprocessing waste materials at its Sorel-Tracy complex. These residues were a by-product of Titanium mining over many decades.

Suddenly the Scandium space went from being a niche activity amounting to a few tens of tonnes in total production per annum to one in which a global major miner committed to ensuring a supply. None of the smaller wannabes in the Scandium space had been able to persuade the aerospace giants (such as Boeing) that a reliable flow might exist to make viable them retooling their production lines. The attraction for aerospace companies is the potential for aluminium-scandium alloys in making a quantum leap in light-weighting of components.

For the existing major Scandium user, Bloom Energy, any diversification of sourcing would also be welcome. Meanwhile Eutectix, sited in Arizona, is the only industrial facility in the USA with capability to convert high-purity scandium oxide into Scandium metal tape that could be used for fuel cells and other applications. In the 1990s, Eutectix's facility reportedly had 300+ employees processing Scandium.

The RTZ development was a game-changer in unconfounding the chicken & egg nature of the Scandium supply/usage quandary. Instead of being bad news for juniors this meant that a significant opportunity has arisen for Scandium juniors (amongst which we would count ARR) to coattail on RTZ's initiative and further boost confidence of Scandium's future availability for adopters of aluminium/scandium alloys, in

particular.

All this signifies a better marketplace in which ARR can proffer and secure potential offtakes.

Searchlight Prospect

We might also mention in passing the Searchlight Heavy Rare Earths Project in Nevada. This is an exploration project located in a precious metal mining district in the eastern Mojave Desert Region about 119km south of Las Vegas.

The old mining district in which the project is located was variously explored and mined for precious metals and turquoise in the early 1900s, and some exploration was done in modern times for porphyry copper and detachment-related gold. During the 1950s uranium prospecting rush, a significant number of REE-Thorium occurrences were discovered in the district and adjacent areas, but none were mined. The district has received little attention since.

The eastern Mojave Desert Region is extensively underlain by Precambrian age rocks that also host the storied Mountain Pass mine located 30km west of the Searchlight Project area. The area is readily accessible by road, with climate and terrain favoring year-around exploration activities.

This project is not as immediate a priority as the company's other REE projects.

Cobalt Blue

While Cobalt might seem extraneous to the subject of Rare Earths, in the case of American Rare Earths it has proven to be somewhat of a cash-cow in recent years due to the sale of the company's former Thackaringa Cobalt asset to Cobalt Blue Holdings Limited (ASX: COB). This has proven to be a "gift that keeps giving" and a key to the company's ability in the short term to eschew other financing methods.

In July the company announced that it:

- Holds 4.8mn shares in COB valued at AUD\$2.48mn based on the closing price of AUD\$0.62 on 30 June
- Continues to hold an AUD\$3mn five-year Promissory Note, interest free for years 1, 2 and 3, with interest of 6% per annum for years 4 and 5 payable in arrears. The note, which is now in year 2, is secured over the title to the tenements. At 30 June 2022, this note has a financial asset value of A\$2.8mn
- Continues to hold exploration, base and precious metal rights on an agreed sub tenement as defined in the agreement with a 2% Net Smelter Royalty on all Cobalt from the Broken Hill (Thackaringa) Cobalt Project

While Cobalt has little relevance to ARR going forward it does provide a useful financing stream to fund other activities.

Financing

In mid-August the company announced a placement of ordinary shares at \$0.29 per share. Shares allocated under the placement settled on the 24th of August 2022 and rank equally with existing shares on issue. Subject to shareholder approval 6,000,000 options are to be issued at an exercise price of \$0.435, expiring three-years after date of issue will be issued to the lead manager, Canaccord.

Risks

The whole Rare Earth industry finds itself in a different world, with some constants from the previous “boom”, but also quite a few things have changed. However, it is worth enumerating some of the risks that may be faced:

- A return to weak Rare Earth prices
- The REE market is still controlled largely by China
- Financing difficulties for mine build
- Failure of demand to match rising production (i.e. build it and no-one comes)
- Excessive number of competing projects could crowd the scene and investors’ attention in the event that REE prices remain robust

Rare Earth prices are not likely to go lower than the levels they have been at in recent years, even the Chinese are not running a charity anymore. Prices have been ebullient for the last two years but there is no rationale for them to even vaguely test the highs of 2011-12. The Chinese have learnt their lesson from last boom and that lesson is that the best way to maintain control and discipline market players is by aggressive predatory pricing. Even now there is talk swirling of the Chinese pondering ramping down (!) LREE prices.

Despite all the hullabaloo, there is not a lot of money for major REE capex pipedreams out there, especially those without access to the Government push and market pull that comes with being in the USA or those needing to wrangle an NRC permit or its equivalent in other developed countries. The MP Materials SPAC came with \$500mn embedded, which got the company off to the races. Energy Fuels (TSX:EFR) entered the Rare Earth space on an experimental basis and have operated that silo on the smell of an oily rag. The rest of the fakers and wannabes are promoting the hell out of the concept but not actually spending anything.

With the EV “revolution” finally gaining traction outside of China the potential for greater demand for REE magnets from that quarter is enhanced. We see no reason for REE demand to slacken and indeed there is the potential for it to finally start to meet some of the bullish projections of 10 years ago.

Finally, there is the issue of competing projects. The Canadian projects have a few contenders to be real,

but most of the promoters there remind us of Mark Twain's definition of miners, except that most don't even have a hole to stand at the top of. Projects farther away (and we don't mean Greenland or Angola) stand some prospect (particularly if located on the territory of US allies, i.e. Australia, see Lynas) of being seen as being "as good as onshore".

Conclusion

The Rare Earth "crisis" has not gone away with the passing of the years, and indeed has intensified. The main targeted (new) usage of wind turbines in the previous REE boom has now been surpassed by the almost frenzied hunt for magnet REEs for the EV revolution. The *rigor mortis*-like grip of China on the REE supply chain has scarcely been loosened despite all the gum-flapping in the Western halls of power.

MP Materials, the lone US producer, has an open-pit that has been mined since the 1950s. They are to be applauded for optimizing throughput to 4x the best-ever achieved by their predecessor Molycorp. Yet, an ore body is a finite asset. At MP's new blistering pace, the end of Mountain Pass is approaching faster than ever before.

With such a small number of names to conjure with inside US borders, the few surviving Rare Earth players have scarcity value. Inevitably promoters will attempt to create new "stories" in the space but the embedded advantage lies with those projects, like La Paz, that have historic exploration work done and resource estimates to hand. If then one applies a filter that excludes projects that are radioactive (literally or metaphorically) then the universe is less than a handful.

With two projects now on the go, the challenge for American Rare Earths is to prove up the metallurgy and create a cogent plan to, economically, mine and upgrade to a REO product for the North American market. The strategic alliances, on the technology side, help towards the goal of differentiating the company from those others in the REE space that are trapped in a timewarp employing the 1950s technology aired in their 2009-2012 PEAs and PFSSs.

Thus, we reiterate our **LONG** rating on American Rare Earths and have raised our 12-month target price to 46 cts.



Important disclosures

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