Rare Earths

14 October 2020

Mining

The Strategic Imperative Remains!

Summary

- **Rare-earths increasingly critical for advanced technologies**
- **~80% of US rare-earths imported from China**
- **~60% of EU, Japanese and South Korean REEs sourced from China**
- **~90% LREE supply controlled by China**
- **China to retain market control for foreseeable future**
- **Dearth of global economic LREEs discoveries over past decade**

Approximately half of advanced technologies are reliant on REEs in some form or another, from F35 jet fighters, catalytic converters, batteries, fibre optic cable, sensors, actuators to electric motors relying on permanent magnets. The presence (or absence) of light rare-earths (LREEs) is a critical determinant for any investment decision. LREEs are an indispensable component in the permanent magnet sector. Shortages already exist, although this may, in part, be the result of constrained Chinese allocation. However, if current growth in demand (e.g. electric vehicles, wind turbines) is maintained, we forecast that structural consumption will exceed primary supplies in less than a decade.

The vast majority (~90%) of LREE supply is monopolised by six key Chinese SOEs (State owned enterprises), which strategically have down-stream processing and are vertically integrated in the manufacture of REE based products, in particular, neodymium (Nd) based magnets. The strategic imperative is that the US (among others) is still completely reliant (~80%) upon China for its REE imports, declining only 10% from a decade earlier. Necessitates a strategic change in sourcing.

In summary, we forecast that the REE sector will be at the forefront of many Government policies to incentivise supply for the decades to come.

Analyst

Gaius L.L. King

gaius@fox-davies.com

Disclaimer

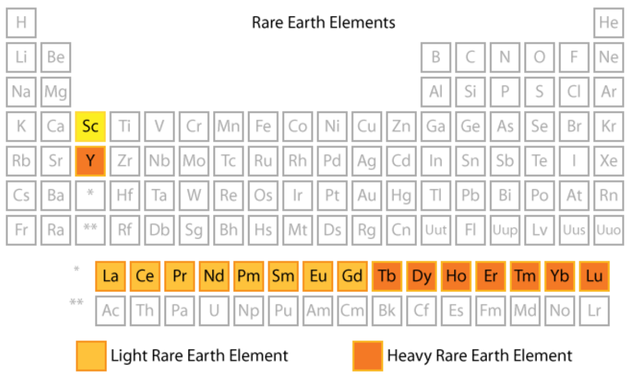
Table of Contents

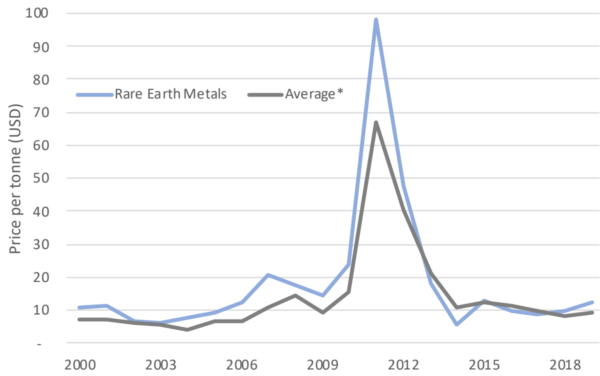
What are Rare Earths?

Rare-earths are indispensable for much of modern technology.

Although needed in small amounts, rare earths are referred to as the vitamins of chemistry, supporting approximately half the world's advanced technologies. Their impact on the various products and system outputs are often critical, and in the majority of cases, there is no other realistic substitution without substantial degradation in efficiency and/or output. Referred to as "rare" because they are not commonly found in commercially viable concentrations, REEs are divided into two main subgroups (i) light rare earths (LREE) and (ii) heavy rare earths (HREE). REE mineral deposits are usually rich in LREE or HREE, rarely containing both in any significant quantities.

Figures 1 & 2: Rare earth elements (REEs), consist of 15 elements that range in atomic number from 57 (lanthanum) to 71 (lutetium). Commonly referred to as the "lanthanides", Yittrium (atomic number 39) is also commonly regarded as a REE because it shares chemical and physical similarities and has affinities with lanthanides (Left); and rare-earth metal prices from 2000-2019. In 2010, when Japan detained a number of Chinese fishermen coming into it's territorial waters, the resultant Chinese REE embargo caused global prices to spike >10x within a relatively short time, leading to Japan accusing China of trying to undermine it's entire economy. Ever since, Japan has attempted to diversify its sources, mainly via Mt Weld, Australia, and finding technological alternatives (Right). Note that Fastmarkets have decided to discontinue quoting rare-earth prices from August this year, citing insufficient market liquidity and transparency.





Source: Sciencenotes.org (2019), USGS (2020), ChinaPower (2020), China General Administration of Customs (2020), FD

Are REEs Rare?

Commentators liken various REE elements such as Y, La, Nd to having similar crustal abundances as Cr, Ni, Zn and Mo, concluding that REEs are not, therefore, rare at all. We vehemently disagree, for example, LREEs used in permanent magnets are projected to increase at a point whereby in less than a decade, global supply will struggle to keep up.

REE substitutes are, in many instances, vastly inferior.

The correct context for discussing rare earths and their "rareness" revolves around their inherent necessity, the additional cost added if supply is suddenly constrained; but more importantly, what are the alternatives if no supply can be sourced, and what are the primary and secondary impacts? For example, the wind turbine industry would be uneconomic almost immediately, with costs and utilisation rates regressing to what they were more than a decade ago. The current EV and hybrid car revolution would also be severely curtailed.

Table 1: Substantial differentiation between the uses and importance of LREEs and HREEs. Nd and Dy have greater saturation magnetisation than any other elemental-peer, allowing the fabrication of smaller/stronger magnets, with some able to withstand high temperatures. Essential within wind turbines and performance in electric motors. La is a hydrogen absorber in rechargeable batteries, with each Prius estimated to contain ~4.5kg. La and Ce are stabilisers as a cracking catalyst for oil refineries; Ce makes up to 30wt% in petrol vehicle catalytic converters. HREEs are presently strategically less important, with a number of elements not yet having any economic application. Eu, Y, and Tb produce energy-efficient phosphors utilised in computer displays and phones, as well as compact fluorescent lamps. Er is utilised in the making of fibre optic cable and laser repeaters.

Forecast that the greatest future shortages will be in the field of LREEs. Outside of Chinese supply channels, they are found primarily as the result of in-situ weathering of carbonatites.

LIGHT RARE EARTHS	Applications
Lanthanum (La)	Catalytic converters, refining, rechargeable batteries, hybrids - a Toyota Prius requires 10 to 15kg
Cerium (Ce)	Polishing compound, particularly in chemical-mechanical planarisation
Praseodymium (Pr)	Used in combination with Nd to create high-power magnets, notable for strength and durability
Neodymium (Nd)	Nd2Fe14B the strongest permanent magnet known, able to lift >1,000x its own weight
Samarium (Sm)	Sm-Co magnets have a higher resistance to demagnetisation, stable at temp. >700 °C
HEAVY RARE EARTHS	**Applications**
Europium (Eu)	Used as a red and blue phosphor in TVs and fluorescent lamps
Gadolinium (Gd)	No large-scale application, some specialised uses
Terbium (Tb)	Solid-state devices and as a crystal stabiliser of fuel cells. Ceates the green colour in modern TVs.
Dysprosium (Dy)	Laser materials, commercial lighting, neutron absorbing nuclear rods, coercivity for EVs and wind turbines
Holmium (Ho)	Highest magnetic strength of any element
Erbium (Er)	No large-scale application, specialised uses
Thulium (Tm)	No large-scale application, specialised uses
Ytterbium (Yb)	Un-utilised
Lutetium (Lu)	Un-utilised, production difficult, costly, uneconomic
Yttrium (Y)	Red component of colour television cathode ray tubes

Source: MIT (2019), Geol. Soc. Lond. (2011), Various commodity reports, FD

Our world view is that REEs are, geologically, rare within certain economic parameters. For example, when estimating Reserves for a gold mine, the extraction economics are based around a long-term gold price assumption. If the prevailing price is $1,400/oz Au, and a company's Reserves assume $1,200/oz, the chances are that the resultant operation will be profitable, and gold supply would ensue. However, if the operation requires $2,000/oz to break-even, and the price remains at $1,400/oz, then losses will result, and in the longer-term supply will be zero.

The unpalatable truth is, in particular for LREEs, there is no geological, economic, or realistic quantum of supply, other than what China produces within a certain price range. Or to put it more bluntly, there is no other Bayan Obo[1] globally, simply because we would have found it by now. We would go as far as to say that most investors completely misunderstand the potential predicament surrounding a REE embargo; the myriad causation effects it would inevitably have on modern life, and the calamitous impact on certain industries, such as non-Chinese made EV's and wind turbines.

[1] The world's largest and unique REE deposit at Bayan Obo, northern China. Geologically complex, its genesis is still debated. Originally formed ca. 1.3 Ga from carbonatitic magmatism, it has undergone a number of subsequent thermal perturbations.

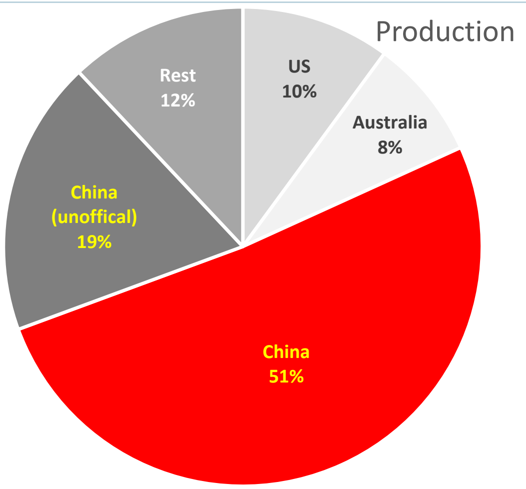
Why are Rare Earths so Important?

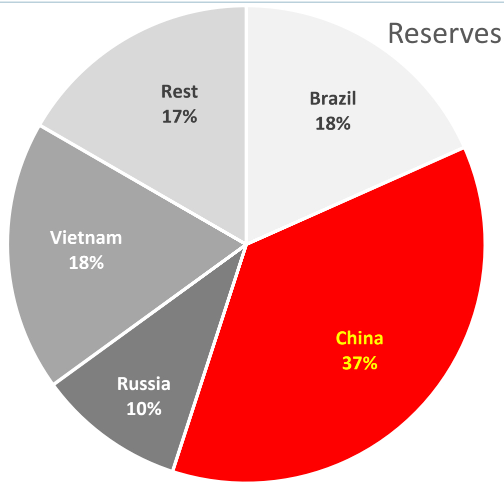
REE Resources are primarily found in four geologic environments: carbonatites (leading sources of production of LREEs, *e.g*. Bayan Obo, Mt Weld, and potentially Longonjo), alkaline igneous systems, ion-absorption clay deposits, and monazite-xenotime-bearing placer deposits. Ironically, the expertise to process REEs is largely lost globally, with production even from Mountain Pass, in the US, once the world's largest REE producer and refiner, now exporting all its concentrate to China.

The Chinese REE Industry is vertically integrated.

The vast majority of processed REE concentrate globally, is monopolised by six major Chinese SOEs (state-owned enterprises). Moreover, the Chinese have strategically moved down-stream, becoming vertically integrated in the manufacture/application of REE products, namely: permanent magnets, catalytic converter materials, luminescence, polishing, sensors and instrument panels.

Figures 3 & 4: China dominates global supply of rare earth raw materials, but also most rare earth functional materials, including rare earth permanent magnets. Officially, China supplies 51% of global REE's primary supply. China's official production was estimated ~ 132kt, but unofficially, 19% (our estimate, based on 2018 back-calculating magnet material production tonnages by Chinese customs) and 40%[2] of Chinese REE production is via illegal miners/smugglers, which has become an essential source of Western supply of HREE. Historical illegal REE exports was controlled by Chinese Triads, typically contained within and exported within steel billet to their Japanese equivalent, (Yakuzza), for processing (left); USGS (2019) estimate that there are 120Mt of proven reserves worldwide; China has 44Mt, Russia has 12Mt, Brazil and Vietnam 22Mt each. In the past 20 years China has become the largest supplier of REE with ~80% of the market, but only has 37% of proven worldwide reserves (right).





Source: USGS (2020), USGS (2019), Shen *et al*. (2020), FD

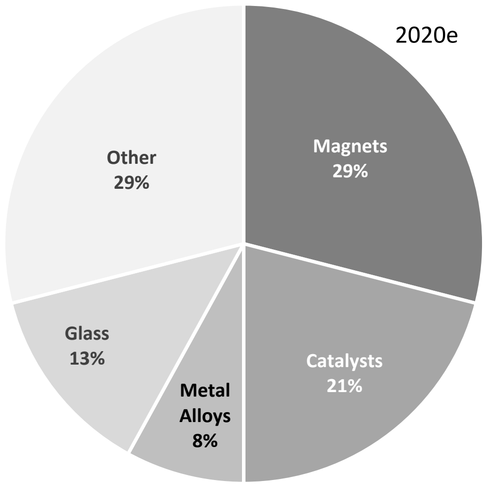
The largest (29%), most important REE market is magnets (see Figure 5). Although Nd may not make a significant part of that product by weight, value, or volume, it is often essential for a high-tech device to function effectively. For example, the functioning of a modern vehicle, typically require more than 200 magnets (Neodymium and Samarium Cobalt), collectively ~0.5kg REEs, of which, ~70% are Nd based.

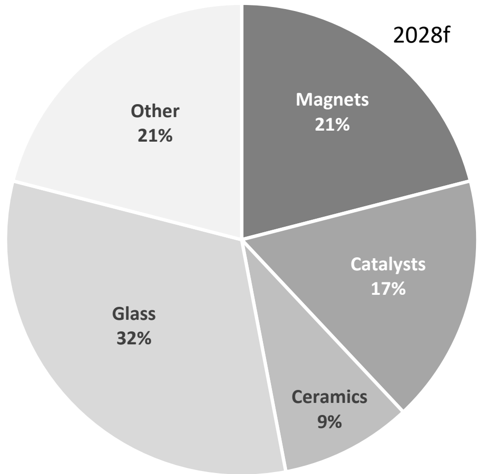
[2] Shen, Y., Moomy, R. & Eggert, R. (2020) "China's public policies toward rare earths, 1975–2018". *Mineral Economics*, v. 33, p. 127–151 (https://link.springer.com/article/10.1007/s13563-019-00214-2)

Applications of which, can be divided into three main areas, namely;

- *Actuators*, operating cruise control, fuel injectors, fans, power steering, suspension;
- *Motors*, involved in moving seats, speakers, alternators, wind screen wipers, door-locks, sunrooves, regenerative braking; and
- *Sensors*, ABS, airbags, seatbelts, etc.

Figures 5 & 6: Estimated volume distribution of rare earths worldwide for 2020 (left); and forecast distribution of rare earths for 2028 (right). The volumetric distribution is deceptive, although magnets are predicted to only make up 21% of tonnages in 2028, they are expected to account for >68% of the end value.





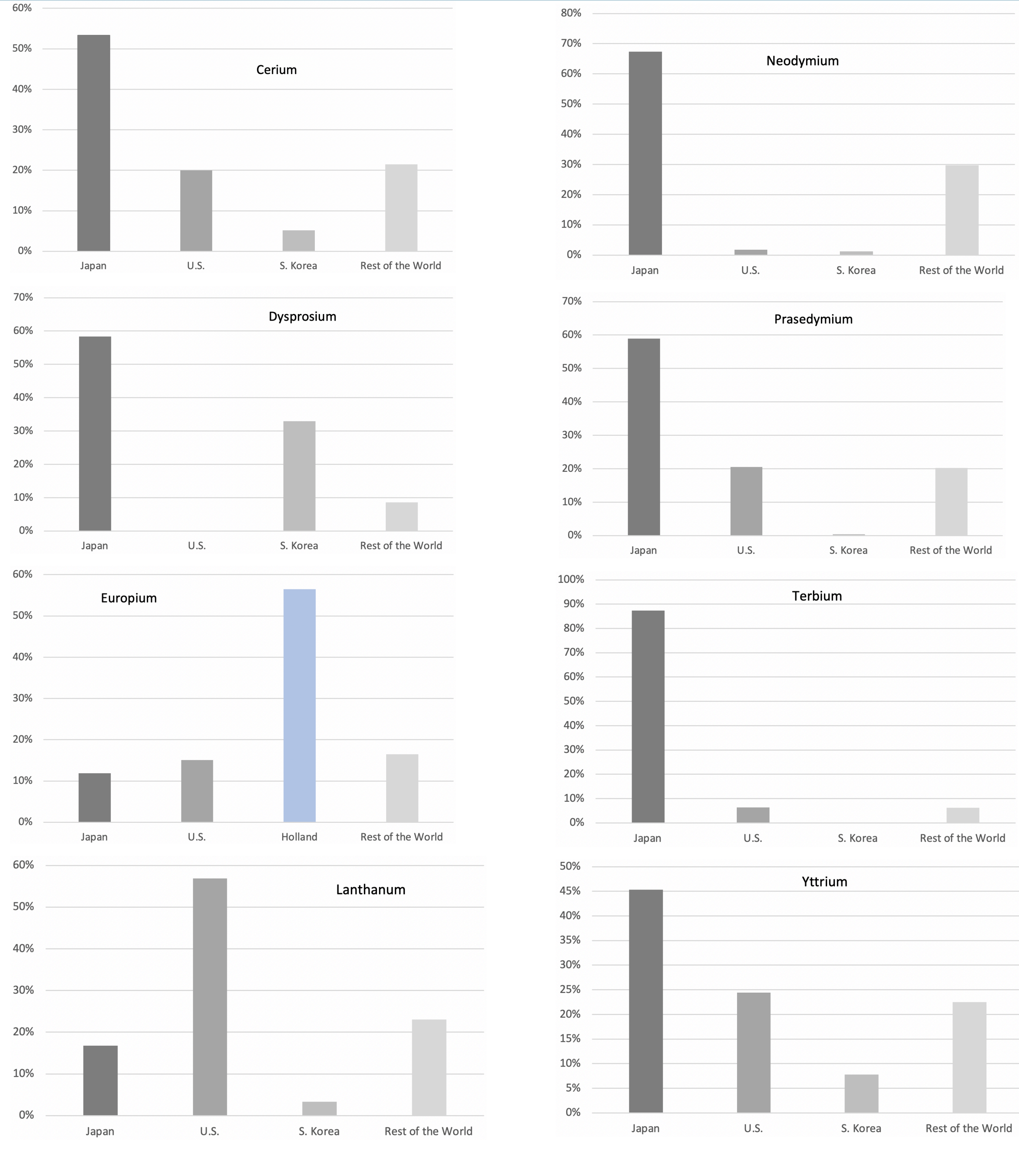
Source: Roskill (2020), Statista (2020), FD

When examining electric vehicles, REE's demand becomes even more acute, for example, a typical Prius hybrid vehicle motor contains ~1kg Nd, and >15kg of La within the batteries. A standard drive motor of an EV consumes between ~5kg of Nd-Fe-B magnetic materials, Tesla's consume substantially greater amounts of REE again (the amount dependent on the model). A modern 5MW wind turbine uses a permanent magnet generator system containing approximately three tonnes of permanent magnets, eliminating gearboxes, allowing them to become substantially more cost-efficient, reliable, thereby lowering maintenance requirements. It would be, therefore, hard to imagine the continuation of a global wind turbine industry (outside of China) surviving a REE embargo. Strategically, a single US F-35 fighter contains 400kg of REE's; an Arleigh Burke class destroyer uses two and a half tonnes, whilst a single Virginia class submarine requires four and a half tonnes of REE per unit.

Global LREE supply is predominately sourced from carbonatite intrusions.

In geological terms, the key sources of light rare earths (LREEs), so critical for a wide range of technical applications, have a very limited geographical imprint. China supplies approximately 80% of the world's rare earths, but importantly, supply ~90% of global LREEs. There are two other deposits which can partially make up some additional primary supply outside of Chinese direct sources, namely Mount Weld in Western Australia owned by Lynas Corporation, and the undeveloped Longonjo deposit owned by Pensana in Angola. Both of these deposits are based around weathered remnants of carbonatite intrusions, with mineralisation enriched from in-situ weathering.

Figures 7, 8, 9, 10, 11, 12, 13 & 14: REE elemental dependence on Chinese supply, per region. As a result of its high-tech manufacturing base, Japan is most at risk from a Chinese product embargo, closely followed by the US. Unsurprisingly then, they are the two key countries undertaking research to mitigate their REE dependence, or attempting to source alternate sources.



Source: ChinaPower (2020), China General Administration of Customs (2020), FD

Not all REEs are Created Equal – Permanent Magnets require LREEs

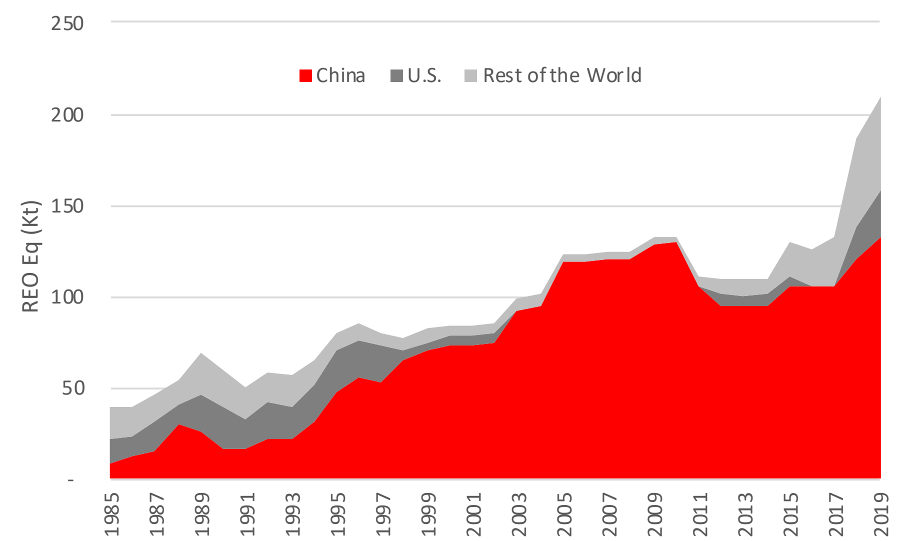
Historically, China established a rare-earth quota system of supply. Soon after the induced price spike in 2010 (see Figure 2), the US[3], Japan[4] and the EU[5] lodged a complaint with the World Trade Organisation (WTO) over monopolistic behaviour by China. After several years of investigation and deliberation, the WTO in 2014 concluded that China was violating its free trade commitments. The Middle Kingdom countered that export quotas were the direct result of environmental protection, one of the few exceptions legalising trade restrictions under WTO rules. This argument was dismissed as it was noted that China has done little to limit rare earth consumption within its borders; the judges' finding that tonnages were designed to achieve industrial policy goals. As a result, in early 2015, China officially scrapped the quota system.

China is still actively controlling supply globally.

In reality, Chinese REE supply is still pre-ordained with tonnages consistent with perceived demand. According to S&P Global, Chinese exports in recent months have been declining inline with global demand, exporting 1.6Kt tonnes of REEs in August, down 62.3% over the pcp; following a 69.1% plunge in July. With year-date (January to August) exports down 25.7% to 24.4kt, is almost identical to the percentage drop in global car sales, which we have written extensively about whilst looking at global PGM demand. We do not believe in coincidences.

Although Chinese REE output appears impressive, it is its possession of critical constituents (especially those requiring permanent magnets) and the lack of alternative supplies, which will only exacerbate in time – belying its real power.

Figure 15: Global REE production from 1985 to 2019. China dominates primary product, with a slew of new product entering markets primarily via Mt Weld and Mountain Pass.



Source: USGS (1986-2020), FD

The danger for many manufacturers, especially Japan and the US, is the absence of alternate supply. In 2019, following the US decision to blacklist Chinese telecoms

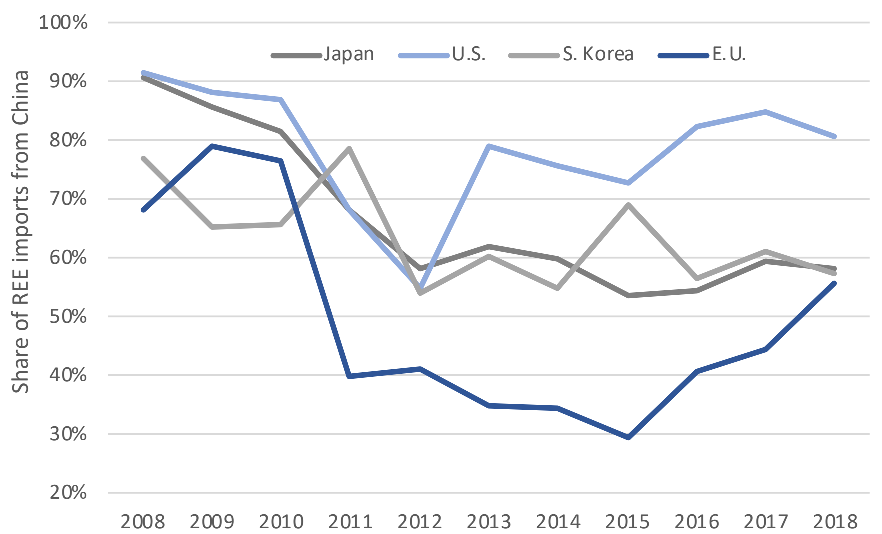
[3] https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm
[4] https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds433_e.htm
[5] https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds432_e.htm

company Huawei, the Chinese President Xi in 2009 undertook a none too subtle visit to JL MAG Rare-Earth Co, a significant producer of magnets, used in power steering, brakes and windmills, with most of its export market directed into Europe. The upcoming trade-war between the United States and China will probably be the defining macro-economic event over the next decade, with various national participants forced to take sides. From a Chinese perspective, several notable policy hawks have expressed the view that the time has arrived for the inevitable rise of the Middle Kingdom to supplant the US, and establish its own regional hegemony.

The more recent mercantile policies of China are not dissimilar to those of Great Britain in the 19th Century; allowing a small wind-swept island located in the north-west of the Atlantic, to account for 50% of global manufacturing and become the global superpower (i.e. it's a strategy that works).

The argument that China would not disrupt the international trade framework and implement an embargo does not fit with recent history. In the past 18 months, China has placed bans on Canadian canola oil, pork, including hostage diplomacy over the arrest of a Huawei executive; the closure of Lotte's entire China operation as a result of a South Korean decision to purchase an American missile system; withdrawal of investment and downgrade of the English Premier League after the banning of Huawei by the UK; and hundreds of millions in lost revenue incurred by the NBA over players' criticism regarding Hong Kong; import restrictions (in varying measures) on Australian coal (thermal and metallurgical), wheat, barley, beef and wine (and potentially in the near future, iron ore).

Figure 16: Share of REE imports from China (2008-2018). What is evident over that period is that Japan, South Korea and the EU have marginally reduced their dependence on Chinese by 10-20% over the past decade; but underlies the point that global consumers rely on China for between 55% (EU) and 80% (US) of their REE supply.



Source: ChinaPower (2020), China General Administration of Customs (2020), FD

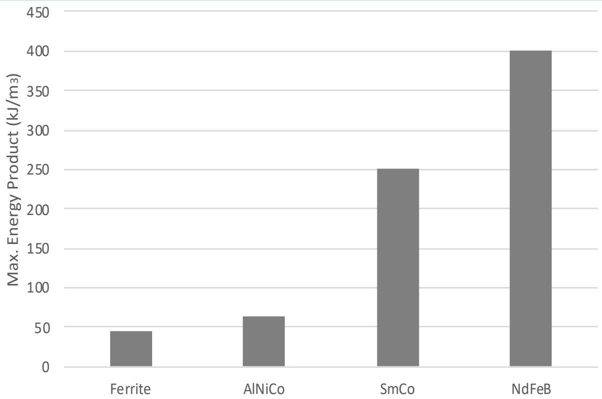
Geologically speaking, China indirectly controls REE prices. If alternate supplies are to emerge, they will have to be massively subsidised or production nationalised for the "greater good".

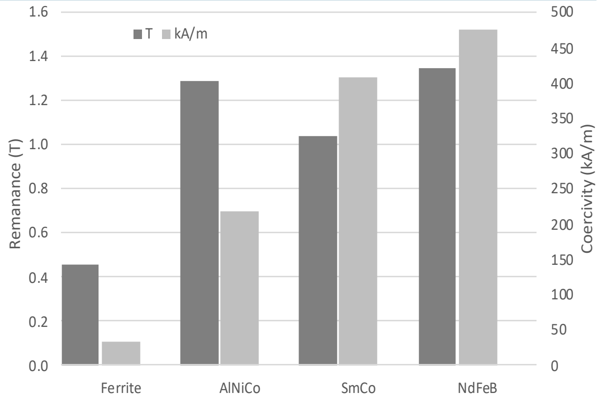
According to the *WSJ*, in early October, President Trump signed an executive order (declaring a national emergency) authorising the use of the Defence Production Act to speed the development of REE mines globally. The most obvious beneficiary will be LYC, however, its primary LREE production is almost exclusively allocated toward Japan, with the proposed project in Texas targeting HREE. Which comes back to our original argument, given global production, processing and prices[6] are largely (~90%) controlled by the Chinese State, there is no real geological alternative of supply, even if we fast forward a decade. "Rare Earths" are rare because they are rare in economic concentrations. The vast majority of proposed new supply is, and will remain, either desperately uneconomic, and/or, do not contain the critical REE constituents.

Known Unknowns - Enter Samarium

The long-term strategic danger for China by withholding the supply of key LREEs, with no real alternatives for the rest of the world is the inevitable research for replacements. It is generally accepted in many instances there is no realistic substitute to permanent magnet demand, and if, geologically speaking, REE carbonatite intrusions with associated economic concentrations are almost non-existent; then the only other alternative is research either into a method to create a permanent magnet without relying on REEs extensively, or attempting to mitigate supply bottlenecks.

Figures 17 & 18: Maximum Energy Product is the maximum amount of magnetic energy stored in a magnet, per unit volume, and is an indicator of magnet strength. Allowing the user to determine whether a small magnet with a higher energy product or a large magnet with a lower product can be used for the same application (left); Remanence or remanent/residual magnetism is the magnetisation left behind in a ferromagnetic material (such as iron) after an external magnetic field is removed. Coercivity is the measurement of an external magnetic field required to reduce the material's magnetic field to zero; important, because it allows testing of magnetic hardness in its normal working environment. Collectively, NdFeB magnets have significantly superior performance than their magnetic peers[7] (right). Samarium-cobalt magnets are essentially the more-expensive predecessor to modern neodymium magnets.





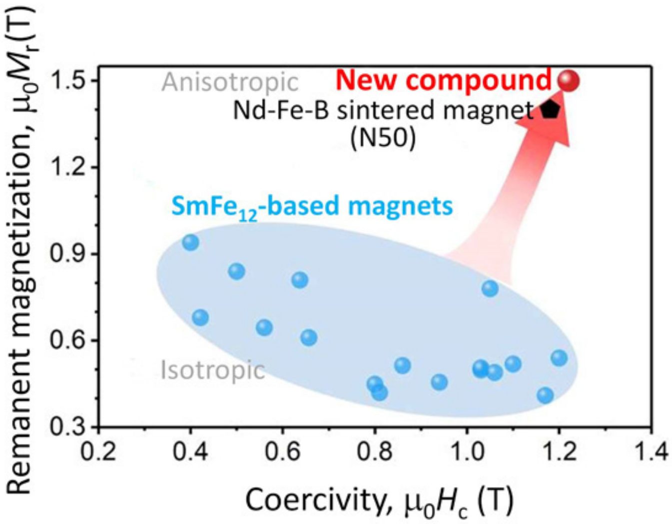
Source: Widmer *et al.* (2015), FD

[6] China still retains the ability to manipulate prices; in 2019 it announced it would increase global supply by 10%, depressing prices making several prospective projects uneconomic, in particular, in order to stall LYC's/Blue line HREE project, Texas. Underlies the fact that the vast majority of alternate global REE projects are competing in an era of ultra-low prices. Most, we believe, need prices greater than double those presently to be economic.

[7] Widmer, J. D., Martin, R. & Kimiabeigi, M. (2015) "Electric vehicle traction motors without rare earth magnets". *Sustainable Materials and Technologies*, v.3, p. 7-13 (https://www.sciencedirect.com/science/article/pii/S2214993715000032)

Unsurprisingly, given its history, the Japanese have been on the forefront of research in alternatives. Toyota[8] has developed a magnet that eschews the use of terbium (Tb) or dysprosium (Dy), necessary for highly heat-resistant neodymium (Nd) magnets[9]. In addition, they replaced a portion of Nd content with lanthanum (La) and cerium (Ce), these low-cost REEs are approximately 5% of the Nd price. How widespread will this new magnet rollout is unknown? Toyota only confirming that this new generation will be first applied in vehicle electric power steering by the first half of the 2020s; which seems very modest in scope, given its purported breakthrough status?

Figure 19: Comparison of $Sm(Fe_{0.8}Co_{0.2})_{12}B_{0.5}$ coercivity (µ0Hc) and remanent magnetization (µ0Mr) with that of reported $SmFe_{12}$-based magnets, including magnetic properties of N50 commercial Nd-Fe-B sintered magnets[10].



Source: Sepehri-Amina H. *et al.* (2020), CMSM (2020)[11], Janus Analysis

Of more interest is the recent development whereby NIMS and Tohoku Gakuin University have developed a boron-doped anisotropic $Sm(Fe_{0.8}Co_{0.2})_{12}$ thin film containing only a small amount of rare earth elements. The compound exhibited 1.2 tesla coercivity (see Figure 19) sufficient for use in automotive electric motors, with superior magnetic properties to that of NdFeB based magnets. Prior research from NIMS (2017) confirmed that samarium-iron-cobalt compounds ($Sm(Fe_{0.8}Co_{0.2})_{12}$) were superior to Nd-based magnets in terms of magnetisation, magnetocrystalline

[8] Toyota Europe Newsroom (2020) *Toyota develops new magnet for electric motors aiming to reduce use of critical rare-earth element by up to 50%* (https://newsroom.toyota.eu/toyota-develops-new-magnet-for-electric-motors-aiming-to-reduce-use-of-critical-rare-earth-element-by-up-to-50/)
[9] Once the operating temperature of a NdFeB magnet reaches >80 degrees Celsius, irreversible de-magnetisation occurs. To offset this, NdFeB magnets are typically infused with HREEs to increase operating temperatures, the downside is a loss of strength/remanence (see Figure 18).
[10] Sepehri-Amina H. *et al*. (2020) "Achievement of high coercivity in $Sm(Fe_{0.8}Co_{0.2})_{12}$ anisotropic magnetic thin film by boron doping". *Acta Materialia*, v. 194, p. 337-342 (https://www.sciencedirect.com/science/article/pii/S1359645420303736?via%3Dihub)
[11] *CMSM* (2020) "News" (https://www.nims.go.jp/mmu/2020/20200706e.html)

anisotropy and Curie temperature, however its greatest shortcoming was coercivity (see Figure 18) which was determined to be inadequate for widespread industrial applications[12].

The key development with this particular $Sm(Fe_{0.8}Co_{0.2})_{12}$ compound is that it has proven to have very high coercivity, even when processed into a thin film, combined with a large remanent magnetisation of 1.5MT, much larger than the previously developed $SmFe_{12}$-based magnetic compounds. Potentially creating a novel platform capable of outperforming neodymium magnets, whilst being amenable to bulk production purposes.

Critically, utilising alternate magnet forms in the construction allows for the design of very high operating temperature motors, unlike those that currently rely on neo-magnets that define upper functional limits. Permanent loss of magnetic performance suffers when a magnet is heated above its Curie temperature, at which point, the structure of the magnetic domain changes and become self-keepering[13]; which cannot be repaired by remagnetisation.

---

[12] NIMS (2020) "$Sm(Fe_{0.8}Co_{0.2})_{12}$ with a Lean Rare Earth Content Exhibits Superb Magnetism" (https://www.nims.go.jp/eng/news/press/2020/06/202006100.html).

[13] Heating up Nd beyond 80C changes the flux density allowing atoms that were once aligned to become misaligned, creating numerous sub-domains that begin to cancel each other out. According to Magnet Expert (https://www.magnetexpert.com/technical-advice-i685/temperature-effects-on-magnets-i683) up to 150C neodymium magnets have the best performance of all permanent magnetic materials; after which, their strength is reduced to that below a magnet of the same size made from samarium (Sm_2Co_{17}), which does not suffer any irrecoverable losses until >350C.

Research Disclosures

Gaius L.L. King

Gaius L.L King has 25 years' experience in mining, exploration, corporate finance, mineral economics and as a resource analyst. As a geologist, he worked five years in various underground operations, and was involved in discovering and delineating ~2.6 Mt @ 3.5% Ni from a variety of ore bodies. Gaius has analysed fundamental supply and demand of iron ore, nickel, PGE, uranium, gold, REE, borate and lithium, among others. As an analyst, he has specialised in the mid-tier/junior sectors, covering mining stocks on the ASX and AIM.

Investment analyst certification

All research is issued under the regulatory oversight of Fox-Davies Capital. Each Investment Analyst of Fox-Davies Capital whose name appears as the Author of this Investment Research hereby certifies that the recommendations and opinions expressed in the Investment Research accurately reflect the Investment Analyst's personal, independent and objective views about any and all of the Designated Investments or Relevant Issuers discussed herein that are within such Investment Analyst's coverage universe.

Disclaimer - Important Information

This document is not independent and should not be relied on as an impartial or objective assessment of its subject matter. Given the foregoing, this document is deemed to be a marketing communication for the purpose of the European Markets in Financial Instruments Directive (MiFID), the Financial Conduct Authority's Rules and Dubai Financial Services Authority's Conduct of Business Rules and as such has not been prepared in accordance with legal requirements designed to promote the independence of investment research and Fox-Davies Capital is not subject to any prohibition on dealing ahead of dissemination of this document as it would be if it were independent investment research.

This document has been issued by Fox-Davies Capital Limited and Fox-Davies Capital (DIFC) Limited (collectively "Fox-Davies Capital") for information purposes only and should not be construed in any circumstances as an offer to sell or solicitation of any offer to buy any security or other financial instrument, nor shall it, or the fact of its distribution, form the basis of, or be relied upon in connection with, any contract relating to such action. This document is not based upon detailed analysis by Fox-Davies Capital of any market; issuer or security named herein and does not constitute a formal research recommendation, either expressly or otherwise. This document has no regard for the specific investment objectives, financial situation or needs of any specific entity. Fox-Davies Capital and/or connected persons may, from time to time, have positions in, make a market in and/or effect transactions in any investment or related investment mentioned herein and may provide financial services to the issuers of such investments. The information contained herein is based on materials and sources that we believe to be reliable, however, Fox-Davies Capital makes no representation or warranty, either express or implied, in relation to the accuracy, completeness or reliability of the information contained herein. Opinions expressed are our current opinions as of the date appearing on this material only. Any opinions expressed are subject to change without notice and Fox-Davies Capital is under no obligation to update the information contained herein. None of Fox-Davies Capital, its affiliates or employees shall have any liability whatsoever for any indirect or consequential loss or damage arising from any use of this document.

This report has been approved in the UK by Fox-Davies Capital Limited solely for the purposes of section 21 of the Financial Services and Markets Act 2000. In the UK, this report is directed at and is for distribution only to persons who (i) fall within Article 19(1) (persons who have professional experience in matters relating to investments) or Article 49(2) (a) to (d) (high net worth companies, unincorporated associations, etc.) of the Financial Services and Markets Act 2000 (Financial Promotions) Order 2005 (as amended) or (ii) are professional clients or eligible counterparties of Fox-Davies Capital (all such persons together being referred to as "relevant persons"). This report must not be acted on or relied up on by persons in the UK who are not relevant persons. In accordance with the Dubai Financial Services Authority's Conduct of Business Rules, this marketing material is intended only for professional clients and market counterparties, and no other person should act upon it

Neither the information nor the opinions expressed herein constitutes, or is to be construed as, an offer or invitation or other solicitation or recommendation to buy or sell investments.

Neither this report nor any copy of part thereof may be distributed in any other jurisdictions where its distribution may be restricted by law and persons into whose possession this report comes should inform themselves about, and observe any such restrictions. Distribution of this report in any such other jurisdictions may constitute a violation of UK or US securities law, or the law of any such other jurisdictions.

Investments in general involve some degree of risk, including the risk of capital loss. The value of investments contained herein may go up or down. Where investment is made in currencies other than the base currency of the investment, movements in exchange rates will have an effect on the value, either favourable or unfavourable. Securities issued in emerging markets are typically subject to greater volatility and risk of loss. The services, securities and investments discussed in this document may not be available to nor suitable for all investors. Investors should make their own investment decisions based upon their own financial objectives and financial resources and, if in any doubt, should seek advice from an investment advisor. Past performance is not necessarily a guide to future performance and an investor may not get back the amount originally invested. Where investment is made in currencies other than the investor's base currency, movements in exchange rates will have an effect on the value, either favourable or unfavourable. Levels and bases for taxation may change. When we comment on AIM or OFEX shares you should be aware that because the rules for those markets are less demanding than the Official List of London Stock Exchange plc, the risks are higher. Furthermore, the marketability of these shares is often restricted.

Fox-Davies Capital and/or its associated companies may from time-to-time provide investment advice or other services to, or solicit such business from, any of the companies referred to in this document. Accordingly, information may be available to Fox-Davies that is not reflected in this material and Fox-Davies Capital may have acted upon or used the information prior to or immediately following its publication. In addition, Fox-Davies Capital, the directors and employees thereof and/or any connected persons may have an interest in the securities, warrants, futures, options, derivatives or other financial instrument of any of the companies referred to in this document and may from time-to-time add or dispose of such interests. Neither the whole nor any part of this material may be duplicated in any form or by any means. Neither should any of this material be redistributed or disclosed to anyone without the prior consent of Fox-Davies Capital. Fox-Davies Capital Limited is authorised and regulated by the Financial Services Authority and is a member of the London Stock Exchange. Fox-Davies Capital (DIFC) Limited is authorised and regulated by the Dubai Financial Services Authority.

Fox-Davies Capital Limited may distribute research in reliance on rule 15a-6(a)(2) of the Securities and Exchange Act 1934 to persons that are major US Institutional investors, however, transactions in any securities must be effected through a US registered broker-dealer. Any failure to comply with this restriction may constitute a violation of the relevant country's laws for which Fox-Davies Capital does not accept any responsibility. By accepting this document you agree that you have read the above disclaimer and to be bound by the foregoing limitations/restrictions.

Please note that unless otherwise stated, the share price used in this publication is taken at the close of business for the previous day. This document has been prepared on the basis of economic data, trading patterns, actual market news and events, and is only valid on the date of publication. Fox-Davies Capital does not make any guarantee, representation or warranty, (either expressly or implied), as to the factual accuracy, completeness, or sufficiency of information contained herein. This document has been prepared by the author based upon information sources believed to be reliable and prepared in good faith.

This note is confidential and is being supplied to you solely for your information and may not be reproduced, redistributed or passed on, directly or indirectly, to any other person or published in whole or in part, for any purpose.

Fox-Davies Capital Ltd

12 Hay Hill, Mayfair

London W1J 6DQ

United Kingdom

Member of the London Stock Exchange.

Authorised and Regulated by the Financial Conduct Authority.

Registered in England and Wales with company number 10165213 and registered address 5 Technology Park, Colindeep Lane, Colindale, London, United Kingdom NW9 6BX

Fox-Davies Capital (DIFC) Ltd.

Level 1, Gate Village Building 3

Dubai International Financial Centre

P.O. Box 507268, Dubai

United Arab Emirates

Authorised and Regulated by the Dubai Financial Services Authority.

Registered in the Dubai International Financial Centre with commercial license number CL2950

REEs – State of Play