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Rare Earth Elements:
A Critical Strategic Resource in Asia

by
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Rare Earth Elements:
A critical strategic resource in Asia
A Pacific Forum CSIS Monograph [1]

by
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Abstract

Rare Earth Elements (REE) are increasingly a critical strategic resource in Asia. These 17 elements are used in the production of most high-tech products from advanced military technology to mobile phones. China currently holds claim to over 90 percent of the world's production. Chinese export reductions in 2012 forced high-tech firms to relocate to China and forced other governments, particularly in the developed world, to pour money into their exploration and production.

In 2010, China temporarily halted shipments of REEs to Japan following a diplomatic crisis. In October 2012, after much instability in Sino-Japanese relations, India agreed to start exporting to Japan to support Tokyo's REE-intensive tech industry. Today, greater resource sharing and cooperation between India, South Korea and Japan aim to offset the production monopoly of China. However, with the bulk of production still centered in China, Beijing maintains a significant influence over high-tech manufacturing in Asia. Further diplomatic crises, such as that between China and Japan in 2010, cannot be ruled out.
This paper builds on research in the field of critical resources in Asia. It explores regional security vis-à-vis the use of natural resources as an instrument of foreign policy in Asia.

Background

Control over resources has long been a close companion to conflict. Since the late 1800s, hydrocarbon energy sources[2] have been cited as driving international disputes. Academic literature highlights such resource conflicts in detail, though little research has been conducted on rare earth elements (REE) and recent disputes (albeit not open conflict) in the Asia-Pacific region. This will be of increasing importance in coming years. The region was the largest consumer of rare earth elements in 2013, and a 12 percent growth in consumption is expected between 2014 and 2020.

Disputes over rare earth elements culminated in the submission to the World Trade Organization (WTO) of dispute settlement cases[3] filed by the US, Japan, and the

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[1] This working paper builds on work published by the author in *The Diplomat* and as Policy Briefs for the *Institute for Security and Development Policy*, Sweden.
[2] Daniel Yergin. *The Prize: the Epic Quest for Oil, Money, and Power*. New York: Simon & Schuster, 1991; Daniel Yergin, *The Quest: Energy Security and the Remaking of the Modern World*, New York: The Penguin Press, 2011.
[3] World Trade Organization, *Chronological list of disputes cases,* "DS431 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: United States);" "DS432 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: European Union);" "DS433 China — Measures Related to the Exportation of Rare Earths, Tungsten and

EU against China on March 13, 2012 – the first time the three parties have collaborated in such an international dispute. Canada later joined the WTO consultations.[4] On the March 26, 2014, the WTO ruled against Beijing's trade restrictions of rare earth elements.[5]

The WTO case is one indication of how rare earth elements are becoming a critical strategic resource in Asia and around the world. At the heart of the matter is the fact that extraction of REEs is capital- and skill- intensive and that the supply chain of REEs is heavily controlled by one country, China.

What are REEs?

The name, rare earth elements[6], is a misnomer; in fact, the elements are relatively abundant in the Earth's crust. Cerium, for example, is the 25th most abundant element (60 parts per million) in the Earth's crust of the 78 elements termed common elements; rare earths at the other end of the spectrum, thulium and lutetium, are found in 0.5 parts per million.[7] The name derives from the difficulty of finding economically viable deposits.
The elements are often divided into heavier (HREE) elements – gadolinium through lutetium, and yttrium – and the more abundant lighter (LREE) elements – lanthanum, cerium, praseodymium, and neodymium.[8] While the lighter elements are mined outside China, the lion's share of HREEs are mined solely in China. Unlike most other countries, Beijing has been able to bear the heavy negative environmental impact and make the mining of HREEs commercially viable. Alloys of LREEs and HREEs – where REEs are combined with other minerals – usually require importing rare earths from China.

In 2012, the US Geological Survey (USGS) updated its global reserve-estimate data of rare earth elements as it narrowed its definition of recoverable minerals. As a result, reserve estimates in China rose from 36 megatons (Mt) to 55Mt – approximately half of the world's current known reserves. US reserve estimates remain at 15Mt, the Commonwealth of Independent States (Russia and former Soviet republics) are reported to have reserves of 19Mt, and estimates of Australia's reserves have declined from 5.4 to

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Molybdenum (Complainant: Japan)," (13 March 2012) accessed May 29, 2013, http://www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm

[4] Ibid.

[5] World Trade Organization, *Summary of Findings*, "DS431 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: United States);" "DS432 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: European Union);" "DS433 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: Japan)," (26 March, 2014) accessed 27 March 2014, http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm#bkmk431r

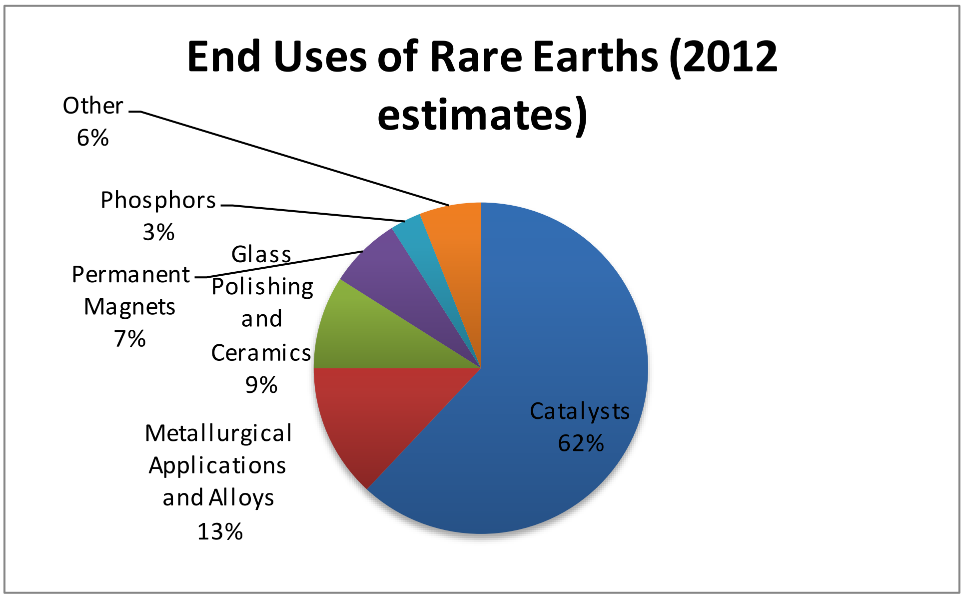
[6] Rare earths elements include: cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, terbium, thulium, ytterbium, yttrium, ferrocerium, monazite, bastnasite, and mischmetal.

[7] U.S. Geological Survey, *Rare Earths Statistics and Information*, accessed May 29, 2013, http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/#pubs

[8] Marc, Humphries, "Rare Earth Elements: The Global Supply Chain" in *Rare Earth Minerals: Policies and Issues,* ed. Steven M. Franks (New York: Nova Science Publishers Inc., 2011) 7.

1.6Mt.[9] In 2013, the two largest suppliers of rare earth elements were both Chinese; Inner Mongolia Baotou Steel Earth Hi-Tech Co and China Rare Earth Holdings accounted for 33 percent of total market revenue.[10]

The 17 individual rare earth elements are used in the production of high-technology products including advanced military technology, renewable energy technologies (such as wind turbines) and mobile phones. Their importance in high-tech products makes them increasingly likely to be characterized as a national security interest. This has been demonstrated by new policies of national stockpiling (explained in more detail later in this paper).



Source: "Rare Earths" in *U.S. Geological Survey, Mineral Commodity Summaries*, p. 128, January 2013, http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2013-raree.pdf (accessed May 15, 2013)

According to USGS data, US consumption of rare earth imports doubled in 2013 from 5,770 tons to 10,500 tons year-on-year.[11] This increase was largely due to lower prices and improved economic conditions as well as a desire in the US to stockpile greater quantities of the resource. The consumption increase highlighted concerns over China's control of the resource.

Concern surrounds China's near monopoly of REE production and what some states and commentators have seen as control over their export.[12] China is responsible for

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9 U.S. Geological Survey, *Mineral Commodity Summaries: Rare Earths* (January 2012), http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2012-raree.pdf

10 Grand View Research, *Rare Earth Elements Market Analysis And Segment Forecasts To 2020*, February 2014

11 U.S. Geological Survey, *Rare Earth Mineral Commodity Summary 2013*, February 2014, accessed March 2014 http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2014-raree.pdf

12 W. Morrison and R. Tang, *China's Rare Earth Industry and Export Regime: Economic and Trade Implications* (Congressional Research Service, 2012,) p. 31.

approximately 90 percent of the world's production.[13] Between 2010 and 2012, Beijing's export reductions forced high-tech firms to relocate to China and led other governments – including India and Japan – to pour money into their exploration and production. Such strategic maneuvering and REE's importance in manufacturing reveal the resource to be as important as oil to some high-tech manufacturing-based economies.[14] Deng Xiaoping recognized the importance of rare earth elements two decades ago. "China's rare earth resources can be likened in importance to the Middle East's oil. They have immense strategic significance and we must certainly deal with rare earth issues with care, unleashing the advantages they bring," he said in 1992.[15] His comments marked the beginning of a new drive in rare earth production in China, a market once commanded by the US.

Since the 1990s, China has increased production of REEs and China's near monopoly on production has industry and government implementing new policies. In recent years, governments in the US, Australia, and Canada, have fast-tracked efforts to increase production. This has led to new mines coming online in Mount Weld, Australia, operated by Lynas, and Mountain Pass, USA, operated by Molycorp. In 2012, bastnäsite ore, a class of minerals that contains cerium, lanthanum, and yytrium, was mined in the US for the first time in over a decade.[16] However, both the Mt Weld mine and the Mountain Pass mine produce predominantly light rare earth elements[17] requiring continued dependence on China for heavy rare earth elements to produce refined alloys ready for manufacturing. Both mines are currently producing well under their potential annual capacities: Mt Weld last year produced 700 mt out of its 11,000 mt capacity and Mountain Pass produced 15,000 mt of its 19,050 mt capacity. Further constraining moves to reduce dependence on Chinese REEs is the fact that new REE greenfield mining projects take significant time to come online, easily taking a decade to reach production.[18]

Defense Industry & Stockpiling

In recent years, debates in several countries over whether to stockpile the strategic resource led to the recommendation in January 2013 by the US Department of Defense to stockpile $120.43 million of HREE currently only produced in China.[19] This followed the

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[13] Production of REEs in China occurs in Fujian, Guangdong, Guangxi, Hunan, Inner Mongolia, Jiangxi, Shangling, and Sichuan provinces.

[14] Elliot Brennan, "The Next Oil?: Rare Earth Metals," *The Diplomat* (January 10, 2013), accessed May 29, 2013, http://thediplomat.com/2013/01/10/the-new-prize-china-and-indias-rare-earth-scramble/

[15] Cindy Hurst, *China's Rare Earth Elements Industry: What Can the West Learn?* (Institute for Analysis of Global Security, March 2010,) p. 3.

[16] "Rare Earths" in *U.S. Geological Survey, Mineral Commodity Summaries*, p. 128, January 2013, http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2013-raree.pdf

[17] Marc Humphries, "Rare Earth Elements: The Global Supply Chain" in *Rare Earth Minerals: Policies and Issues*, ed. Steven M. Franks (New York: Nova Science Publishers Inc., 2011) p. 2.

[18] Marc Humphries, "Rare Earth Elements: The Global Supply Chain" in *Rare Earth Minerals: Policies and Issues*, 2011, Nova Science Publishers Inc. New York, p. 2.

[19] Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, *Strategic and Critical Materials 2013 Report on Stockpile Requirements* (Department of Defense USA, January 2013) p. 15, accessed May 29, 2013,

announcement by the US Department of Energy of the creation of the Critical Materials Institute, which was established to act as an "innovation hub for critical materials" for academics, industry partners and national laboratories.[20]

Examples of Defense Applications of REEs

Source: Humphries, Marc, "Rare Earth Elements: The Global Supply Chain" in *Rare Earth Minerals: Policies and Issues*, 2011, Nova Science Publishers Inc. New York, p. 6.

Jet fighter engines and other aircraft components, including samarium-cobalt magnets used in generators that produce electricity for aircraft electrical systems;
Missile guidance systems, including precision guidance munitions, lasers, and smart bombs;
Electronic countermeasures systems;
Underwater mine detection systems;
Antimissile defense systems;
Range finders, including lasers; and
Satellite power and communication systems, including traveling wave tubes (TWT) rare earth speakers, defense system control panels, radar systems, electronic counter measures, and optical equipment.

China has long had a similar hub for its rare earth industry through the Chinese Society of Rare Earths, founded in 1980, which boasts a network of some 10,000 professionals in the REE industry. REEs are also of increasing importance for Beijing, as demonstrated by the release of a 2012 White Paper[21] on rare earth elements, the first of its kind. The reorganization of the rare earth mining industry has led to significant decreases in exports. The reorganization aims to clean up the mining industry in China, which is fragmented and relatively unregulated,[22]and allows for greater monitoring and greater government control. China's domestic demand is led by its growing middle class demand for high-tech devices, increases in resource dependent energy infrastructure, as well as a high-tech defense modernization program, amongst other factors. More specifically, new projects such as Beijing's long planned increase of wind energy – from 2009 base rates of 12 gigawatts to 100 gigawatts by 2020[23] – and solar energy will require REEs. In July 2012 the *China Security Journal* reported that China had also

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http://www.mineralsmakelife.org/assets/images/content/resources/Strategic%20and%20Critical%20Materials%202013%20Report%20on%20Stockpile%20Requirements.pdf

[20] Ames Lab News Centre, "US to build $120m rare earth research institute," https://www.ameslab.gov/news/in-the-news/bbc-news-us-build-120m-rare-earth-research-institute (accessed 31 May, 2013)

[21] Information Office of the State Council The People's Republic of China, "Situation and Policies of China's Rare Earth Industry," June 2012, http://www.miit.gov.cn/n11293472/n11293832/n12771663/n14676956.files/n14675980.pdf (accessed 20 May, 2013)

[22] Ibid.

[23] Cindy Hurst, China's Rare Earth Elements Industry: What Can the West Learn? Institute for the Analysis of Global Security, March 2010

started stockpiling REEs, likely following the advice from China's first White Paper on rare earths elements.[24]

While alternatives for some REEs exist and others are being explored, there remains no efficient substitute for the resource. Furthermore, existing applications of these elements in defense technology will necessitate their continued use during routine maintenance and replacement of parts through the life-cycle of the equipment, life-cycles that for some defense products can last for several decades.[25]

The Invisible Hand: Pricing of REE

Prices of REEs have dropped significantly. Some reports argue that low prices could force the closure of companies operating in the industry. According to a KPMG report, low REE prices could force the closure of 75 percent of companies between 2012 and 2014.[26] If such a trend were to continue and a collapse was to occur in 2014 or 2015, this would further consolidate the REE industry into just a few operators, notably state backed companies in China, Japan, and India.

Despite a renewed emphasis on REE production outside China, some analysts argue that profit-making enterprises cannot viably sustain REE extraction and production given high labor costs and the cost of environmentally sound extraction. State-funding or support may be necessary, an advantage for China, but also for government-run Indian Rare Earths Ltd and other such state firms. Jack Lifton, founder of Technology Metals Research, told Reuters in 2011 that he estimated only 4 percent of ventures outside of China would prove profitable.[27]

Coerce, Coopt and Cooperate

In 2010, China temporarily halted shipments of REEs to Japan following a diplomatic crisis. The crisis occurred following the detention of a Chinese fishing boat captain found in disputed waters by Japanese authorities. Yet the following year, with little choice, Japan purchased the majority share of China's rare earth exports, some 56 percent in 2011.[28] In May 2012, China expanded the definition of REEs to include iron alloys containing more than 10 percent of REEs. These were subsequently subject to the same export quota. The quota was officially expanded to curb the unregulated export of

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[24] Xinhua, "Full Text: Situation and Policies of China's Rare Earth Industry," accessed 31 May 2013, http://news.xinhuanet.com/english/business/2012-06/20/c_131665123_4.htm

[25] United States Government Accountability Office, "Rare Earth Materials in the Defense Supply Chain" in *Rare Earth Minerals: Policies and Issues,* ed. Steven M. Franks (New York: Nova Science Publishers Inc., 2011) p. 35.

[26] Javier Piedra, *Quarterly Commodity Insights Bulletin: Q3-2012 & Q2-2012*, (KPMG, October 2012), accessed May 29, 2013, http://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/commodity-insights-bulletin/Documents/commodity-insights-bulletin-rare-earth-elements-2012-q2-q3.pdf

[27] Andrew Topf, "96% of non-Chinese rare earth projects will fail, says Jack Lifton," *Mining.com*, November 1, 2011, accessed May 29, 2013, http://www.mining.com/96-of-non-chinese-rare-earth-projects-will-fail/

[28] "China issues white paper on rare earth," *Xinhua*, 2012-06-20 http://news.xinhuanet.com/english/china/2012-06/20/c_131665087.htm (accessed 13th May, 2013)

the elements under different guises such as in alloys – a practice that had become common to avoid the quota. In Beijing's defense to the World Trade Organization dispute settlement case, it argued that the curbing of exports was justified as they related to the conservation of an exhaustible natural resource.[29] As global demand continued to increase, between 2005 and 2012 China's REE export quotas decreased from 65.58 metric kilotons to 31.13 metric kilotons.[30] It is these quantitative limits that the World Trade Organization deemed, on March 26 2014, an attempt by Beijing to secure domestic "industrial policy goals" and inconsistent with the GATT 1994.[31]

In October 2012, after much instability in Sino-Japanese relations, India agreed to start exporting REEs to Japan to support Tokyo's REE-intensive technology industry. India has significant deposits of rare earth elements and has begun to boost production and exploration to meet domestic demand. A new 10,000 ton REE processing plant is being set up by Indian Rare Earth Limited.[32] The $25 million plant is expected to process 4 percent of global production of monazite ore, a mineral class containing REEs.[33] Much of this will be used to meet domestic demand.

Greater resource sharing and cooperation in exploration and refining is taking place between Asian states – notably between Australia and Malaysia but also between India, South Korea, and Japan. In Asia, where many economies are heavily dependent on high-tech manufacturing, new agreements and dialogues have emerged on the topic of REEs. Perhaps the most unlikely came in November 2011 when Seoul opened discussions with Pyongyang over the exploitation of North Korea's rare earth elements, estimated in 2012 to be worth $6 trillion.[34]

In December 2013, UK-based SRE Minerals announced a rare earth deposit in North Korea believed to contain over 216 million tons of rare earth oxides, including heavy REEs. The company signed a joint venture agreement with Korea Natural Resources Trading and will begin core drilling this year. While this discovery has, by its sheer size, the potential to change the market, production is still years off. If the deposit is confirmed, it would treble known resources of REEs and in the mid-to long-term,

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[29] This was in reference to Article XX(g) of the GATT 1994

[30] W. Morrison, and R. Tang, "China's Rare Earth Industry and Export Regime: Economic and Trade Implications for the United States", *Congressional Research Service*, 2011.

[31] World Trade Organization, *Summary of Findings*, "DS431 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: United States);" "DS432 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: European Union);" "DS433 China — Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum (Complainant: Japan)," (26 March, 2014) accessed 27 March 2014, http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm#bkmk431r

[32] Esther Tanquitic-Misa, "India Ventures Into Rare Earths, To Launch Soon Monazite Plant," *International Business Times*, September 11, 2012, accessed May 29, 2013, http://au.ibtimes.com/articles/382811/20120911/india-rare-earths-monazite-neodymium-manufacturing.htm#.UFIDtVQ79ZI

[33] Aditya Kaul, "India revs up rare earth production to join big league," *DNA*, accessed May 15, 2013 http://www.dnaindia.com/india/report_india-revs-up-rare-earth-production-to-join-big-league_1738207

[34] Scott Thomas Bruce, "North Korea's Six Trillion Dollar Question," *The Diplomat* (August 30, 2012), accessed May 29, 2013, http://thediplomat.com/2012/08/30/north-koreas-six-trillion-dollar-question/

significantly changing the geopolitics of the resource. While Pyongyang's thorny relations with Japan and South Korea may mean that they do not benefit from the find, it could also become a tool for cooperation, in terms of the rare earth supply chain, for East Asia.

The "New Frontier": Deep Seabed Mining

Deep-sea mining is also emerging as a possible "new frontier" in the Pacific Island countries.[35] Recent discoveries by the Japan Oil, Gas and Metals National Corporation (JOGMEC) and the licensing of deep seabed mineral deposits 1500m below sea level in Papua New Guinea, offer new opportunities for REE exploitation. While the exact amount of deep-sea REEs is unknown, it is believed such discoveries could significantly alter current distribution figures if their extraction is deemed viable. Private companies and state-owned entities from Canada, Japan, China, South Korea, and France are involved in such exploration.[36]

In the Indian Ocean, India and China have begun offshore exploration for REEs. China initiated such efforts by winning a bid for exploration rights from the International Seabed Authority (ISA)[37] to a 10,000 sq. km. block in the south-west Indian Ocean. Shortly after, New Delhi made similar bids and is currently investing $135 million to purchase an exploration vessel that could complement its small onshore deposits with offshore mining. A cross-disciplinary team, including space and nuclear energy engineers, will develop India's offshore mining capacity. According to India's Minister for Earth Sciences Ashwani Kumar, the program will address the country's "critical and strategic needs." Kumar noted that "Countries like China have taken to deep-sea mining with a strategic purpose."[38] It would thus appear that India has also taken to deep-sea mining with a similar goal.

By April 2013, 17 new contracts for exploration of the deep seabed had been issued by the ISA in the Indian, Pacific, and Atlantic oceans. [39] This new frontier in mining for deep seabed minerals, including REEs, will pressure maritime border claims in Asia and may raise the stakes in disputes such as those in the South China Sea. It will further pressure the legal frameworks of Pacific Island countries.[40]

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[35] Cristelle Maurin, "Deep Seabed Minerals: A New Frontier in the Pacific Region," Policy Brief, No. 121, April 10 2013. Institute for Security and Development Policy, Sweden. http://www.isdp.eu/images/stories/isdp-main-pdf/2013-maurin-deep-seabed-minerals.pdf
[36] Ibid.
[37] The ISA is an intergovernmental body established in 1994. The Authority, as explained in its mandate, *"is the organization through which States Parties to the Convention [*United Nations Convention on the Law of the Sea] *shall, in accordance with the regime for the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction (the Area) established in Part XI and the Agreement, organize and control activities in the Area, particularly with a view to administering the resources of the Area."*
[38] "Deep-sea exploration to mine rare earth minerals on the cards: Minister," *The Hindu Business Line*, accessed May 29, 2013, http://www.thehindubusinessline.com/industry-and-economy/article3602876.ece
[39] Cristelle Maurin, "Deep Seabed Minerals: A New Frontier in the Pacific Region," Policy Brief, No. 121, April 10 2013. Institute for Security and Development Policy. http://www.isdp.eu/images/stories/isdp-main-pdf/2013-maurin-deep-seabed-minerals.pdf
[40] Ibid.

Key Rare Earth Companies by Country

US	Canada	China	Japan	India	Russia	Australia	UK
- Molycorp - Alkane Resources - Rare Element Resources - Quest Rare Minerals	- Avalon Rare Metals - Focus Metals - Midland Exploration -Tasman Metals - Tsodilo Resources -Matamec Explorations - Frontier Rare Earths - GeoMega - Wealth Minerals	- Baotou Steel Rare Earth Hi-Tech - China Rare Earth Holdings - China Minmetal Rare Earth - Jiangxi Copper - Aluminium Corporation of China - Maanshan Dingtai	- Hitachi Metals - Showa Denko -Sumitomo -Nippon Light Metal Holdings - JOGMEC	- Indian Rare Earth - Kerala Minerals & Metals	- Solikamsk Magnesium Works - Irtysh Rare Earths - TriArkMining - Rostec	- Arafura Resources - Greenland Minerals & Energy - Astron Ltd - Iluka Resources Ltd. - Lynas Corporation	- International Ferro Metals Ltd. - SRE Minerals

Source: Author 2014 *based on current activities and stockmarket prices

Environmental Issues

One of the key hurdles to increasing extraction and production of REEs is the environmental impact of such mining. Indeed the environmental costs of rare earth mining have proved significant. Given the positioning of most REE deposits within radioactive elements, the mining process results in radioactive by-products. Since 1992 Mitsubishi has spent $100 million cleaning up its rare earth refineries in Malaysia after reported rates of leukemia soared in local townships. Lynas Corp, the Australian company that operates a processing plant in Malaysia, has been under pressure by environmental groups to close the plant. Similar concerns forced the closure of the Mountain Pass mine in California in 2002. Yet, in the current hunger for the resource, the mine reopened in 2012 after millions of dollars worth of environmental assessments were conducted and safeguards installed. China has faced its own environmental problems, detailed in its White Paper on REEs.[41] Under a section titled "Severe damage to the ecological environment" the White Paper highlighted a range of environmental concerns caused by its rare earth mining industry. These included surface and ground water pollution, excessive exploitation leading to landslides, clogged rivers, and environmental emergencies.[42] In August 2012, Beijing announced that production would decrease by 20

[41] Information Office of the State Council The People's Republic of China, "Situation and Policies of China's Rare Earth Industry," June 2012, (accessed 20 May, 2013) http://www.miit.gov.cn/n11293472/n11293832/n12771663/n14676956.files/n14675980.pdf

[42] Information Office of the State Council The People's Republic of China, "Situation and Policies of China's Rare Earth Industry," June 2012, (accessed 16 April, 2014,) p. 7, http://www.miit.gov.cn/n11293472/n11293832/n12771663/n14676956.files/n14675980.pdf.

percent to accommodate improved environmental regulations that would result in the closure of a third of China's mines, most of which were small and unregulated.

Policy Recommendations

- Further funding is required in the US, EU, and Australia for greater assessment of new markets and programs to promote stronger platforms for public-private information sharing and networking domestically, regionally, and internationally.

- Further research is needed to explore alternatives in the short-term supply and also overall efficiency of REE use. This should include the expansion of government and industry-supported recycling schemes. Some such schemes and dialogue already exist, notably in Europe through the European Association of Electrical and Electronic Waste Take Back Systems (or WEEE Forum). However, these schemes require greater support to serve as hubs across industry and government to provide for dialogue and joint policy-making for strategic partners including in Europe, the US, Japan, South Korea, and Australia. Further research should also be conducted into the pairing of REE exploitation as a by-product of other mining operations, such as in thorium-monazite deposits.

- While stockpiling has occurred in recent years, the overall supply chain has not changed significantly. Further reviews should be conducted by concerned governments to ascertain whether defense stockpiles should be acquired or increased. Price volatility may make significant stockpiling more viable at low points in the market. It should also be emphasized that only some of the REEs may be deemed critical for stockpiling purposes, namely HREEs.[43]

- Greater dialogue and international support should be offered in supporting China's REE sector. This support could include improving best practice extraction of resources and may also include the sharing of technologies that aid in the more environmentally friendly extraction of REEs. Such a move could allow China to increase its extraction by reducing negative environmental factors – a key defense in the WTO case proceedings.

Barriers to implementation

- Some Chinese actors may baulk at greater competition in the REE sector and respond negatively. This response could include a flooding of the market with cheap REEs which would make the development of REE industry in new markets and the position of REE-related companies financially untenable. This would likely lead to private firms folding or requiring capital injections from States to remain afloat. State-owned companies, such as Indian Rare Earth Limited, would

[43] According to a US department of Defense report seven of the elements meet the critical resource criteria set in a National Defense Authorization Act for FY2011 (Section 843 PL111-383) as cited in March Humphries, "Rare Earth Elements: The Global Supply Chain," December 16, 2013, *Congressional Research Service* p23 http://www.fas.org/sgp/crs/natsec/R41347.pdf

be more insulated from such price crashes. If such a crash were to occur, government should seize on the opportunity to stockpile resources and consider support in cash or kind for vulnerable private firms. Domestic and international efforts should thus include greater interaction with Chinese policy makers to convey the domestic and strategic importance of improved REE supply.

- The price volatility of REEs makes forecasting difficult. While this will be a problem for domestic policy, such as stockpiling, this is in fact the reason for doing so. Margins for loss should reflect this issue accordingly.

- Public displeasure with greater REE mining will remain one of the largest barriers to obtaining domestic supplies of REEs. Campaigns similar to that against hydraulic fracturing for shale gas or "fracking" – another strategic resource – should be expected at a local/community level and could increase. Supporting dialogue and holding proactive community engagement is important. Similarly, ensuring the industry's adherence to strict environmental regulations, as well as regular environmental assessment, should be enforced and the results of such environmental audits made public.

Conclusion

In the short-term, rare earth elements will remain a critical strategic resource in Asia and globally. The continued applications of REEs in technologies mean that even with the discovery of REE-alternatives, high-tech products, defense equipment and renewable energy infrastructure will remain reliant on them. Pricing fluctuations and accidents that lead to environmental degradation and production shortages could increase competition for REEs. Likely also, if prices increase accordingly, is greater recycling of used elements from high-tech products. The consolidation and centralization of China's rare earth industry will give Beijing the ability to more closely monitor and control exports as well as regulate production. This will concern many Asian states. In the immediate future it appears unlikely that China's monopoly over the resource will diminish but a decrease in its share of production, as other mines come online, appears the most likely scenario. In the meantime, as a matter of national interest, governments in Asia and around the world will continue to establish stockpiles of this critical strategic resource. In a world increasingly driven by high-tech industry, rare earth elements will remain a critical strategic resource for decades to come.