

POLICY BRIEF

China and the Rare Earth Supply Chain

February 23, 2021

Summary

- Rare earth elements are used in the production of high tech devices such as defense equipment (e.g. radar systems and guided missiles) and energy technologies (e.g. electric vehicles and wind turbines)
- China dominates the supply chain of rare earth elements, having 37 percent of proven reserves, producing 63 percent of global output, and housing about 85 percent of the processing capacity
- An Australian company operates the only non-Chinese separation plant, located in Malaysia
- The United States produced 12 percent of global rare earth supply in 2019 at its Mountain Pass mine, but the ore must be shipped to China to be upgraded into compounds and products which are then shipped back to the United States
- The Mountain Pass mine that produces the U.S.'s rare earths is partially owned by a Chinese company
- The United States imports about 80 percent of its rare earth requirements from China, compared to a high of 23 percent of imported oil from the Middle East¹ in 2001
- The United States is much, much more dependent upon China for the rare earth minerals necessary for renewable energy technologies than it ever was on the Middle East for oil imports
- The U.S. Department of Defense is funding two separation plants in the United States under a program initiated by President Trump

There are 17 rare earth elements that are used in the production of high tech devices such as smart phones and computers, defense equipment such as radar systems and guided missiles, and energy technologies such as electric cars and wind turbines. While these elements are common in the earth's crust, they are found in tiny concentrations and are mixed together, making them difficult to isolate. China has the most proven

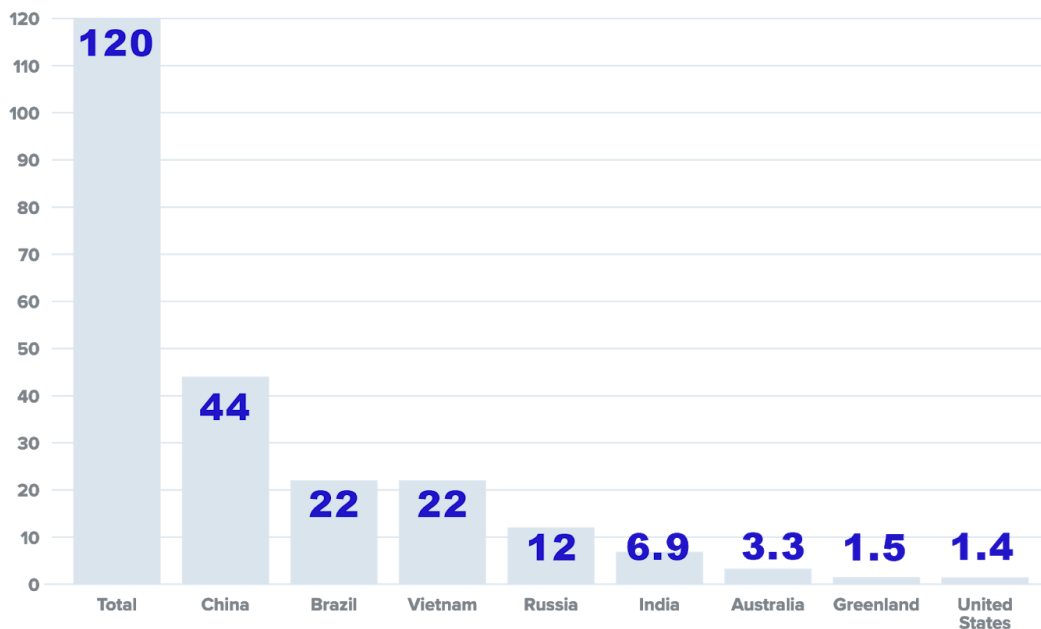
¹ Oil Price, How the United States has Reduced Its Dependence on Middle East Oil, January 15, 2020, <https://oilprice.com/Energy/Energy-General/How-The-US-Has-Reduced-Its-Dependence-On-Middle-East-Oil.html>

reserves of rare earth elements (37 percent²) and produces around 63 percent of global output³, which it uses to fuel its high-tech industries, exporting the remainder. Global consumption of rare earth elements in 2019 was about 210,000 metric tons—10.5 percent more than in 2018 and about 4.7 times greater than the 45,000 metric tons used 28 years ago.

According to the Energy Information Administration, reserves are “estimated quantities of energy sources that analysis of geologic and engineering data demonstrates with reasonable certainty are recoverable under existing economic and operating conditions. The location, quantity, and grade of the energy source are usually considered to be well established in such reserves”. Thus, reserves are not the entire resource base since more sources are bound to be found with additional exploration.

Rare Earth Reserves, 2019 (Million Metric Tons)

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Source: [Statista](#)

² Statista, Rare earth reserves worldwide as of 2019, by country, February 13, 2020, <https://www.statista.com/statistics/277268/rare-earth-reserves-by-country/>

³ Investing News, 10 Top Countries for Rare Earth Metal Production, May 26, 2020, <https://investingnews.com/daily/resource-investing/critical-metals-investing/rare-earth-investing/rare-earth-producing-countries/>

Light and Heavy Rare Earth Metals

Rare earth metals are often broken up into two categories according to their atomic weight⁴: light and heavy. All rare earth metals are part of a chemical group called lanthanides; light rare earths represent the lanthanides with the lowest atomic numbers. Light rare earths include: cerium, lanthanum, praseodymium, neodymium, samarium and scandium. Of those, neodymium is considered one of the most critical. The metal is used in everything from mobile phones and electric cars to medical equipment. Neodymium is also the main light rare earth used in the creation of permanent magnets. These magnets are versatile and are heavily used in data storage systems and wind turbines. Praseodymium is also a significant light rare earth metal that is used in alloys with magnesium to form aircraft engines and in creating permanent magnets.

Heavy rare earth metals are defined by their higher atomic weights relative to light rare earths. They are less common, and some elements within the group are facing shortages as demand outpaces supply. That typically makes them more valuable than light rare earths, though they also have smaller markets.

Dysprosium, yttrium and terbium are considered critical elements in the

heavy rare earth metals group as they face low supply and increasing importance in the development of renewable energy technologies. Like the light rare earths, heavy rare earths also play a critical role in other technology, including hybrid cars, fiber optics and medical devices. Dysprosium is used in tandem with neodymium in magnets that are vital to modern technology and renewable energy. In addition, dysprosium oxide is used in nuclear reactors to help cool fuel rods to keep reactions under control.

Top Countries Producing Rare Earth Elements

China

China has dominated rare earths production for a number of years. In 2019, its domestic output of 132,000 metric tons was an increase from 120,000 metric tons the previous year—an increase of 10 percent. Chinese producers must adhere to a quota system for rare earths production. The full-year quota⁵ for mining in 2019 was set at a record high at 132,000 metric tons, and the quota for smelting and separation was 127,000 metric tons. The quota system is a response to China's problems with illegal rare earths mining⁶. Currently, six state-owned

⁴ Investing News, Rare Earth Metals: Heavy vs. Light, August 17, 2017, https://investingnews.com/daily/resource-investing/critical-metals-investing/rare-earth-investing/investing-in-rare-earth-heavy-vs-light/?as=1&nameplate_category=Rare+Earth+Investing

⁵ Reuters, UPDATE 2-China raises annual rare earth output quotas to record high, November 8, 2019, <https://www.reuters.com/article/china-rareearths/update-2-china-raises-annual-rare-earth-output-quotas-to-record-high-idUSL3N270341>

⁶ China Daily, China to crack down on illegal rare earth mining, August 9, 2016,

miners are in charge of China's rare earths mining industry and operate at the behest of the government.

Mining is only one portion of the supply chain. China also dominates rare earth processing with at least 85 percent of global rare earth processing capacity. The only exception⁷ is Australia's Lynas Corp which operates a separation plant in Malaysia.

In late May 2019, China raised the prospect of using its control of rare earths in its trade war with the United States but did not announce formal restrictions, which it has done previously. In 2010, China cut its rare earth exports by 40 percent and cut off supplies to Japan over a territorial dispute⁸, causing prices to soar. These actions were challenged by the United States, the European Union, and Japan, resulting in a ruling against the country's export quotas by the World Trade Organization (WTO). The WTO ruled that the export quotas represented an unfair restriction that allowed China to control global rare earth prices. Because China does not impose the regulations on mining rare earths that other countries do, "toxic wastes from

http://www.chinadaily.com.cn/business/2016-08/09/content_26399298.htm

⁷ Reuters, Column: U.S. finds its Chinese rare earth dependency hard to break, July 28, 2020.

<https://www.reuters.com/article/us-usa-rareearths-ahome/column-u-s-finds-its-chinese-rare-earth-dependency-hard-to-break-idUKKCN24T20I?edition-redirect=uk>

⁸ Institute for Energy Research, Rare Earth Elements: What Are They? Who Has Them?, July 27, 2016,

<https://www.instituteforenergyresearch.org/renewable/rare-earth-elements/>

rare-earth facilities have poisoned water, ruined farmlands, and made people sick"⁹.

United States

From 1940 to 1990, the United States produced and mined its own rare earth minerals at the Mountain Pass mine in California. Until the 1980s the United States was one of the world's largest producers, but was usurped by China, whose production increased by more than 500 percent since 1990 due to its substantial deposits and cheap labor. The cost of developing a rare earth mine can cost up to a half billion dollars.¹⁰ Generating profits from rare earths has proved elusive for non-Chinese companies and low prices make the funding of new projects difficult to justify.

Rare earths supply in the United States currently comes *only* from the Mountain Pass mine in California, which went back into production in the first quarter of 2018 after closing in the fourth quarter of 2015 due to China's competitive prices, opposition from environmentalists, and U.S. environmental regulations escalating the cost of production. It was run by Molycorp before it went bankrupt and then was bought¹¹ by MP Materials in 2017. In 2019, the United States

⁹ Foreign Policy, Rare Earth Market, July 12, 2016,

<https://foreignpolicy.com/2016/07/12/decoder-rare-earth-market-tech-defense-clean-energy-china-trade/>

¹⁰ Wyoming Mining Association,

<https://www.wyomingmining.org/minerals/rare-earths/#:~:text=Origins,mined%20in%20Sweden%20and%20Norway.&text=From%201940%20to%201990%2C%20the,its%20own%20rare%20earth%20minerals.>

¹¹ Investing News, The Only US Rare Earths Mine Could be Nationalized if this CEO Gets His Way, July 19, 2017,

<https://investingnews.com/daily/resource-investing/critical-metal-s-investing/rare-earth-investing/us-rare-earths-mine-nationalized/>

produced 26,000 metric tons of rare earths, up from 18,000 metric tons the previous year—a 44 percent increase, accounting for 12 percent of global production.

The rare earth ore that the United States mines at Mountain Pass gets shipped to China to be upgraded into compounds and products which are then shipped back to the United States. MP Materials, who mines Mountain Pass, is one of the three companies chosen by the Trump Administration's Department of Defense to receive direct government funding for one of two separation plants in the United States¹². However, that will happen only after a review by its Chinese shareholder, Shenghe Resources, is completed. Australia's Lynas is teaming with Texas-based Blue Line on a heavy rare earths separation plant. But, once the oxide is generated at the separation plants, it may still have to go to China for further processing.

The United States is a major importer of rare earth materials, with demand for compounds and metals worth \$170 million in 2019¹³--up from \$160 million in 2018. The country has classified rare earths as critical minerals, a distinction that has come to the fore due to trade issues between the United States and China. According to the United States Geological Survey, the United States

gets around 80 percent¹⁴ of its rare earth imports from China.

The United States currently has virtually no capacity to produce neodymium-iron-boron magnets—the most common end-use application for rare earths and one that is set for major growth as electric vehicles increase their market share. Rare earth magnets are also key inputs to many other applications from wind turbines to the F-35 fighter jets. General Motors had one of the two original patents for the magnets but sold the rights to China. Japan's Sumitomo sold the other patent to Hitachi, which is now the primary supplier outside of China.

At the end of 2020, Congress passed a critical minerals research and development program managed by DOE's Office of Fossil Energy and authorized at funding levels between \$23 million and \$25 million annually through 2025 to develop advanced separation technologies for the extraction and recovery of rare earth elements and other critical materials from coal and coal byproducts.¹⁵

Myanmar

Myanmar mined 22,000 metric tons of rare earths in 2019¹⁶, up from 19,000 metric tons the previous year—a 16

¹² Reuters, Column: U.S. finds its Chinese rare earth dependency hard to break, July 28, 2020, <https://www.reuters.com/article/us-usa-rareearths-ahome/column-n-u-s-finds-its-chinese-rare-earth-dependency-hard-to-break-idUKKCN24T20I?edition-redirect=uk>

¹³ Investing News, 10 Top Countries for Rare Earth Metal Production, May 26, 2020, <https://investingnews.com/daily/resource-investing/critical-metal-s-investing/rare-earth-investing/rare-earth-producing-countries/>

¹⁴ Reuters, Column: U.S. finds its Chinese rare earth dependency hard to break, July 28, 2020, <https://www.reuters.com/article/us-usa-rareearths-ahome/column-n-u-s-finds-its-chinese-rare-earth-dependency-hard-to-break-idUKKCN24T20I?edition-redirect=uk>

¹⁵ Holland and Knight, <https://www.hklaw.com/en/insights/publications/2021/01/energy-policy-act-signals-inclusive-innovation-focused-future-for-doe>

¹⁶ Investing News, 10 Top Countries for Rare Earth Metal Production, May 26, 2020, <https://investingnews.com/daily/resource-investing/critical-metal-s-investing/rare-earth-investing/rare-earth-producing-countries/>

percent increase. Little information is available about the country's rare earth mineral deposits and mining projects, but the nation had a close relationship with China — in 2018, Myanmar provided 50 percent¹⁷ of China's medium to heavy rare earths feedstock. However, at the end of 2019, Myanmar closed its borders¹⁸ to China, driven by a stated aim of environmental protection and remediation. The recent coup there calls into question its reliability as a supplier to the world.

Australia

Rare earths production in Australia has been rising steadily for the last few years. In 2019, its output was 21,000 metric tons¹⁹, the same level as in 2018. The country holds the sixth largest-known rare earth reserves in the world, and is poised to increase its output. Australia-based Lynas Corp, the only non-Chinese rare earths producer, operates the Mount Weld mine and concentration plant in the country, and it recently announced plans to boost production to 10,500 metric tons per year of neodymium-praseodymium products by 2025. Lynas' Mount Weld project was supported by the Japanese

¹⁷ Thomson Reuters, China rare earth prices surge on Myanmar crackdown, May 23, 2019, http://share.thomsonreuters.com/assets/newsletters/Inside_Metals/JIM_STORIES_05232019.pdf

¹⁸ Roskill, Rare earths: Myanmar's border to China recloses, December 23, 2019, <https://roskill.com/news/rare-earths-myanmars-border-to-china-recloses/>

¹⁹ Investing News, 10 Top Countries for Rare Earth Metal Production, May 26, 2020, <https://investingnews.com/daily/resource-investing/critical-metals-investing/rare-earth-investing/rare-earth-producing-countries/>

government²⁰, which extended loans and lowered interest rates during the start-up phase. Northern Minerals opened Australia's first heavy rare earths mine in 2018. Its main products are terbium and dysprosium, the latter of which is used in technology such as permanent magnets.

In November 2019, Australia signed an agreement with the United States²¹, which mandated both nations' geological agencies work together to assess the potential for new supply. Australia identified 15 rare earth and critical minerals projects hoping to attract commercial funding and is offering state-backed loans to help develop them.

India

In 2019 rare earths production in India was 3,000 metric tons. In the fall of 2014, Indian Rare Earths and Toyota Tsusho Exploration entered into an agreement²² regarding the exploration and production of rare earths via deep-sea mining. Despite this deal, India's current rare earths production industry is far below its potential²³. The

²⁰ Reuters, Column: U.S. finds its Chinese rare earth dependency hard to break, July 28, 2020, <https://www.reuters.com/article/us-usa-rareearths-ahome/column-u-s-finds-its-chinese-rare-earth-dependency-hard-to-break-idUKKCN24T20I?edition-redirect=uk>

²¹ Ibid.

²² Daily Mail, Rare earth diplomacy: India and Japan makes strategic partnership to explore stakes in deep-sea mining, November 12, 2015, <https://www.dailymail.co.uk/indiahome/indianews/article-3316143/Rare-earth-diplomacy-India-Japan-makes-strategic-partnership-explore-stakes-deep-sea-mining.html>

²³ Economic Times, 'India not realising potential of rare earth industry', October 19, 2016,

country holds almost 35 percent of the world's total beach sand mineral deposits, which are significant sources of rare earths.

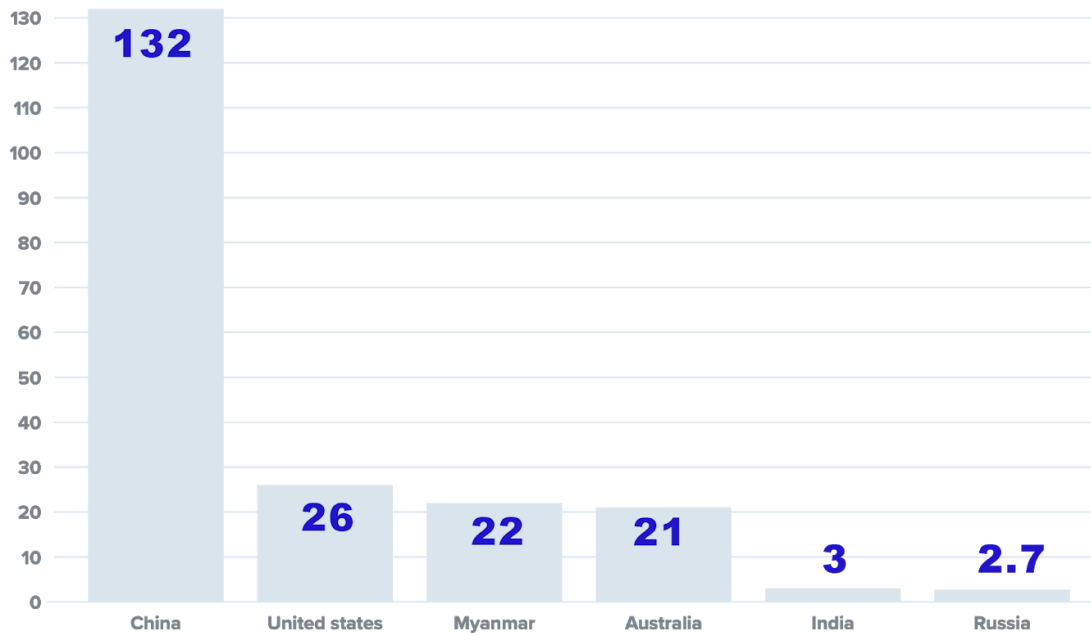
Russia

Russia produced 2,700 metric tons of rare earths in 2019²⁴, same as in 2018. The country's government is allegedly

“unhappy” with its supply of rare earths, and the companies IST Group and Rostec made a \$1 billion investment into production a few years ago. It is expected that production in Russia will increase over time through the development of pre-existing rare earths fields. The country now accounts for roughly 1 percent of global production.

Top Rare Earth-Producers, 2019 (Thousand Metric Tons)

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Source: [Investing News](#)

<https://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/india-not-realising-potential-of-rare-earth-industry/articleshow/54940321.cms>

²⁴ Investing News, 10 Top Countries for Rare Earth Metal Production, May 26, 2020,

<https://investingnews.com/daily/resource-investing/critical-metal-s-investing/rare-earth-investing/rare-earth-producing-countries/>

Conclusion

China has a virtual monopoly on the processing of rare earth elements that are needed for high tech (smartphones and laptops), defense equipment, and so-call “green” energy technologies. It not only produces the majority of rare earth elements, but it has the most rare earth reserves. China’s market dominance enables it to control prices and put pressure on challengers that threaten its ‘Made in China 2025’²⁵ strategy to create a vertically integrated supply chain encompassing mining, magnets, and high-tech manufacturing. The West needs to move rapidly to regain control of its industrial future; “green” energy policies that foster an overwhelming dependence on China threaten it.

²⁵ Institute for Energy Research, China Dominates the Rare Earths Supply Chain, August 4, 2020, <https://www.instituteforenergyresearch.org/international-issues/china-dominates-the-rare-earths-supply-chain/>