



America's Critical Strategic Vulnerability: Rare Earth Elements

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The People's Republic of China's (PRC) dominance over global critical mineral supply chains presents one of the largest strategic vulnerabilities to the United States and her allies since the Arab oil embargo-triggered energy security crisis of the 1970s. The embargo, which coincided with dwindling U.S. reserves and a devaluation of the dollar, brought devastating impacts: high inflation coupled with economic stagnation (stagflation), and a quadrupling of oil prices.

Today, the PRC holds a similar power to hobble the economic prosperity and military-industrial capabilities of adversaries around the globe. Rare earth elements (REEs) and critical minerals are crucial for production in high-tech manufacturing.

In 2018, the U.S. Department of Interior identified 35 critical minerals crucial for national and economic security, including 17 REEs from atomic numbers 57-71 such as cerium and promethium as well as chemically similar elements scandium and yttrium. Though these elements are considered "rare," there are misconceptions regarding their availability. REEs are, despite the name, commonly found in the Earth's crust. However, extracting economically mineable concentrations is difficult, thus their relatively low supply.

Chinese Strategic Dominance of Rare Earths Sector

China is the world's leading supplier of REEs: In 2019, it produced 62% of raw materials. In comparison, the United States produced 12.2%. The PRC also holds a majority share of REE and critical mineral reserves, owning 36.7% of global totals, whereas U.S. reserves are marked at 1.1%.

Refinement capacities in China are significantly stronger than those in the United States due to an abundance of domestic facilities that process locally sourced and foreign raw critical mineral materials. Regarding REE export, the PRC transported 408,000 metric tons of final product materials from 2008-2018, roughly 43.3% of all rare earth exports over that period. This placed China as the clear export leader, ahead of the next best U.S. total at just 9.3%. The United States also imported 98% of its processed REEs from China in 2018.

China's dominant REE refining capacity, buoyed by low labor costs and lax environmental regulations, makes it the world's top destination for REE processing. To address growing insecurity of its strategic mineral supply, the United States and her allies must evaluate the current Chinese domination of the critical mineral and REE supply chain and develop alternatives to this potentially dangerous dependence. Decreasing reliance on China for the supply of these vital resources will enhance strategic stability and ensure enduring self-reliance in the face of increasingly adversarial relations with Beijing.

U.S. Domestic Mineral Production

U.S. corporations are beginning to take steps in association with the federal government to enhance domestic supply lines. However, 14 of the 35 minerals identified to be critical by the Department of Interior are not currently extracted or refined in the continental United States.

Recognizing the long-term vulnerability of an over-reliance on Chinese REEs, then-President Donald Trump signed Executive Order 13817, identifying federal government priorities to increase domestic extraction of minerals, refinement processes, supply chain activity, and evaluating new material sources. Later in 2020, the Trump administration issued Executive Order 13953, declaring reliance on Chinese critical mineral export a national emergency. This also authorized the Defense Production Act to streamline the construction of domestic mines whilst prioritizing the expansion and protection of minerals in secured supply chains.

The Biden administration has signaled its intent to continue and expand upon efforts outlined during the previous administration, pledging investment in rare-earth separation processes in the recently passed \$2 trillion infrastructure plan. After a 100-day review of U.S. critical mineral supply chains as part of Executive Order 14017, President Biden announced the formation of a supply chain disruptions task force headed by the Secretaries of Commerce, Transportation, and Agriculture. The group will identify improvements in supply chain management that will strengthen U.S. critical mineral supply over time. Recommendations in the review also encourage the Department of Defense, Congress, and private businesses to work with allies to develop mineral extraction sites and refinement projects in the United States.

On the whole, the mandate to identify unreliable critical mineral supply chains and accompanying actions to develop reliable long-term supplies demonstrates that the Biden administration is taking critical mineral source diversification seriously. However, the United States is years away from providing a steady domestic supply of critical minerals, and rivaling Chinese production will require a massive policy commitment, deregulation, and investment.

U.S.-China Global Competition

The United States and China compete across multiple sectors and regions for critical mineral and REE supply. However, Chinese dominance of supplies, exports, and refining capacity remains. In 2020, China produced 140,000 tons of REEs, whereas the United States produced just 38,000 tons.

The Chinese government has previously used its mining prowess to undercut U.S. efforts to reduce reliance on their refinement power. In 2019, the PRC raised tariffs on imports from the U.S. from 10% to 25%, meaning that REEs exported to China would be significantly more expensive to process. The Trump administration considered implementing counter-tariffs but refrained from using them due to concerns of U.S. companies being left stranded without an alternative supplier. This situation highlights the need to have redundancies in the REE processing supply chain.

China and the United States have begun competing for resources in other mineral-rich regions. Notably, Chinese corporations have increased business relations in South America to increase their hold on mineral supplies in the region. The primary example is Brazil, where China's Ningbo Zhoushan Port concluded a \$650 million deal with Brazilian mining company Vale to export iron ore to production facilities in mainland China. Though iron ore is not considered a critical mineral, the deal exemplifies the expansive nature of Chinese business. Brazil holds an estimated 22 million tons of REEs, roughly 18.3% of estimated global supply. Should Chinese companies pine for the expansion of critical mineral trade relations in Brazil, the precedent set by previous commercial deals will likely yield positive outcomes.

In Southeast Asia, China has capitalized on regional proximity by increasing trade relations with mineral rich nations such as Myanmar and Indonesia. Chinese companies reportedly relied on Myanmar for almost half of their REE concentrates in 2020, and thus the February 1 coup was of great concern to business officials. Though supply lines have not yet been disrupted as a result of the political instability, the coup brought in focus Myanmar's importance to Chinese REE manufacturing.

Current U.S.-China competition is taking place in Greenland, where snap elections in which the leftist environmental party, Inuit Ataqatgiit (IA), formed a majority and have placed mineral extraction projects in question. IA campaigned to block a joint Chinese-Australian mining venture, highlighting related practices considered to be harmful to local ecosystems. Greenland has rich REE reserves and the potential to become the largest supplier of critical minerals in the Western hemisphere. With renewed interests in diversifying its supply chain, the United States will likely look to Greenland for mine expansion. This will encourage the U.S. to keep China out of the Danish-controlled autonomy. After all, Denmark is a veteran and whole-hearted NATO member.

The trajectory of competition between the United States and China will see the PRC continue to use its leverage over the critical mineral market to improve its geostrategic position vis-à-vis allies and adversaries alike. Tensions over mineral resources acquisition are unlikely to lead to direct conflict at this point; however, supply chains will likely be used as tools to undermine respective strategic postures. Chinese leadership through their media have already signaled such actions could take place, suggesting supply cut-offs could be used in future conflicts. And should China do so, the U.S. is likely to increase its presence in Africa and Latin America to secure vital resources.

Joint U.S.-Ally Efforts to Bolster Critical Mineral Supply Security

After the U.S. and its fellow democracies recognized strategic vulnerabilities related to Chinese critical mineral production, U.S.-allied government and public-private sector cooperation increased, with U.S. allies acting to diversify their supply chains. This trend needs to be supported by the respective governments and further expanded, including in the Biden administration energy and infrastructure plan and through "buy American" policies enacted by the previous and current administrations. Yet, cooperation with the Five Eyes countries and key NATO and non-NATO allies is paramount.

In July 2020, the U.S. Department of Defense announced it would grant \$30 million dollars to the Australian rare earth corporation Lynas for the building of a heavy rare earth refinement facility in Texas. This was complemented by additional funding granted to Lynas in January 2021 to construct a light rare earth refinement center for those metals used in consumer goods. The projects, in cooperation with the U.S.-based Blue Line Corp, will establish the first domestic U.S. facilities capable of importing rare earths for processing.

U.S. corporations and government agencies have continually invested in critical mineral sources expansion in Mexico. The mining industry in Mexico is crucial to its economy, generating 2.5% of total national gross domestic product (GDP). Mexico is a major producer of 12 minerals, including three considered critical for U.S. demand: fluorspar, graphite, and strontium. Despite decreased investment related to economic downturn during COVID-19, several U.S.-affiliated mining projects are set for completion in the future, including those from Southern Copper and Asarco.

The U.S. government is looking to Canada for 13 of the 35 minerals deemed critical. In March 2021, the U.S. Commerce Department held a confidential meeting with Canadian miners to discuss ways to enhance production to counter Chinese competitors. Considering both nations are founding members of the Energy Resource Governance Initiative (ERGI), a multilateral partnership to foster mineral sector cooperation, U.S.-Canadian joint ventures in critical mineral sourcing will likely continue to endure in the long term.

Japan, an important strategic ally in the Asia-Pacific, has committed to reducing its reliance on PRC critical mineral and REE supply to less than 50% by 2025. In 2010, the PRC cut off mineral supply to Japan after the Japanese coast guard detained a Chinese fishing boat captain off the coast of the Senkaku Islands. Though having insignificant impacts on the Japanese economy initially, the crisis underscored PRC willingness to wager its critical mineral production as a cudgel to achieve political ends. This yielded investments in recycling technology, refinement facilities, and an increase in reserve stockpiles of critical minerals from 60 to 180 days of domestic consumption.

Russia is another major player in global REE supply chain management due to its massive mineral resources and a centuries-long tradition of mining and metal processing, particularly

for military-industrial applications. Russia accounts for some 10% of global untapped supplies at around 12 million tons. Some cooperation with the U.S. is still ongoing, including titanium supply to Boeing by the state-owned VSMPO-Avisma. However, expanding U.S. reliance on Russia in a strategic area of REE is not currently viable because of the history of adversarial and competitive relations dating back to the Cold War. Moscow is considering increased investment in critical mineral infrastructure, and Russian corporations may be able to produce around 7,000 tons of REE concentrate by 2024, greatly enhancing leverage over supply chains and diminishing the country's dependence on China.

Areas of opportunity for U.S. cooperation with the United Kingdom are ample, as British companies are well versed in mineral extraction due to centuries of overseas and colonial trade relations and domestic mining industries. There are currently 16 UK mineral corporations exploring rare earths and refined metals expansion, including larger corporations like Glencore, Rio Tinto, and Broken Hill Propriety (BHP). Mining revival in the UK has become a hot issue of policy, with parliamentary debates highlighting the significance of REEs to the economy. Mineral corporation Pensana recently won a bid to build mineral extraction plants in Angola, the first British-affiliated REE facility scheduled for operation in a decade. The establishment of this facility aligns well with U.S. foreign policy, and Africa has quickly become a priority destination for critical mineral extraction.

Mining in Africa: A Coming Boom?

Several African nations hold significant reserves of critical minerals and REEs, as foreign interest in them is growing. From 2006-2017, Chinese mineral investments in Sub-Saharan Africa were estimated at \$33 billion, dwarfing the West. However, Western nations have begun to invest in African mining out of necessity.

With considerable foreign investment from China and other nations, Africa has become the most desirable and competitive global mining destination. Africa's rich mineral reserves constitute major shares of the known global supply. The Democratic Republic of Congo (DRC) produces 70% of world's cobalt and holds 50% of total reserves. Ghana, Côte d'Ivoire, Gabon, and South Africa were responsible for 51.8% of manganese supplies in 2020, while South Africa held 40% of manganese reserves. Other nations with untapped REE resources include Tanzania, Burundi, Madagascar, Zimbabwe, and Malawi. These nations will likely see project expansions in 2021 and beyond.

Current U.S. mineral extraction ventures in Africa are limited. In 2019, the U.S. Department of Defense held talks with Canadian Mkango Resources, regarding their rare earth mining projects in Malawi. These mines have not yet commenced operations, but the talks signaled U.S. intent to consider diversification into Africa.

China has enjoyed amicable trade relations with African nations for decades, starting with Beijing's support of anti-colonial movements during the Cold War. These relationships evolved into trade ties, foreign direct investment (FDI), and infrastructure projects. Mineral exports to Chinese processing facilities came as a logical next step. Surveys conducted from 18 African nations in 2019 revealed a healthy 59% public approval rating of Chinese economic investment. Considering Beijing plans to increase domination of the critical mineral sector, Africa will remain crucial to Chinese rare earth supply chains.

Mining in Central Asia & Mongolia

After the fall of the Soviet Union, Kazakhstan, Tajikistan, and Kyrgyzstan embarked on enhanced mining production and almost exclusively exported minerals to China and Russia. In particular, Kazakhstan has bolstered its mineral extraction, as it is home to plentiful resources of uranium, chromite, and magnesium. The U.S. Geological Survey (USGS) has estimated that over 40% of global uranium production originates in Kazakhstan. The country is planning to prioritize the REE mining sector as it diversifies its economy away from the oil sector.

The U.S. Department of Trade suggested that domestic corporations should consider investing in Kazakhstani rare earth business in 2020. However, Western companies need to assess political risks of such investments carefully. To date, Kazakh mineral corporations have stronger ties with Chinese and Russian conglomerates than with the U.S. and European Union. Kazakhstan and other Central Asian nations were targeted as critical to China's Belt and Road Initiative (BRI), with Chinese companies investing an estimated \$1.2 to 1.3 trillion across the region since Xi Jinping has announced BRI in the Kazakh capital in 2013. Yet, both Kazakhstan and Uzbekistan are interested in balancing their foreign policy in a "multi-vector" fashion, maneuvering between Beijing, Moscow, Brussels, and Washington. Smaller countries, including Kyrgyzstan and Tajikistan, recently appear to be more in synch with Moscow and Beijing.

The landlocked Mongolia has experienced a mining boom since the collapse of communism, as foreign investment poured in, bringing much-needed tax and tariff revenue. According to USGS, Mongolia is home to 16.8% of global critical mineral reserves. Increases in mining productivity yielded over \$3 billion in profits from its primary export partners, Russia and China.

In the context of the PRC's geopolitical expansion, Central Asia and Mongolia will play a significant role in providing mineral resources for Chinese supply chains despite the lingering anti-Chinese sentiments in the latter. The BRI will undoubtedly shape relations between these nations, increasing reliance on China for the capital to pursue expansion in the mineral and infrastructural sectors and utilizing access to Chinese ports. Theoretically, increased U.S. business presence in the region would further develop REE mining opportunities in Central Asia and is welcomed by the governments of Kazakhstan, Uzbekistan, and Mongolia. However, due to its geographic location between Russia and China, Mongolia has a heightened political risk in case the international environment deteriorates sufficiently to endanger the Western-owned mining operations there. Such risk assessments must be considered in developing U.S. and allied globally focused policies to ameliorate the strategic vulnerabilities arising from the lopsided REE supply chain.

Policy Recommendations: U.S. Must Lead in Building the Western Supply Chain

As it stands, Chinese domination of the critical mineral supply chains dwarves the U.S. by all conceivable metrics: China commands 85% of the REE export market, producing 62% of global raw mineral materials and importing \$2 billion worth of critical minerals and REEs. In the event of an acute international crisis, the PRC would likely use its leverage to further geostrategic aims by imposing critical mineral embargos. Considering the United States derives roughly 80% of its REEs from China, these would likely be catastrophic for the economy, including the high tech, computers, electronics, electric mobility, aerospace, and military-industrial complex.

Given China's track record and threats in this space, the potential for future embargos is realistic. Like the Strategic Petroleum Reserve (SPR), the stockpiling of rare earths and critical minerals would provide sustainability in the face of international crisis. Supply delays during the COVID-19 pandemic exposed the U.S. lack of preparedness and supply chain bottlenecks, which is beginning to have short-term ramifications for U.S. semiconductors, appliances, autos, and other industries. Current semiconductor shortages in car and appliances factories are threatening to interrupt production and are leading to wait periods of up to six-month delivery times.

In the event of a critical minerals embargo, U.S. companies would be left stranded with limited REE stockpile capabilities. To counter the strategic vulnerabilities associated with reliance on Chinese critical mineral and REE supply chains, the United States must immediately establish a reserve of critical minerals like that of the SPR for oil imports. The capacity of such a reserve is open to discussion, but one third-to-half of annual REE demand seems appropriate at the first stage, later expanding the reserve to a whole year of supply.

Developing domestic capacities to mine and refine critical minerals across the United States should be a priority for the U.S. government agencies, yet the private sector should be the primary driver behind REE exploration and production, like other mineral mining and processing. The sole Mountain Pass mine in California will not be sufficient for long-term aims of decoupling from Chinese critical mineral supply. Plans made by Lynas and Blue Line Corp to build domestic REE refinement facilities in the United States should be the pioneering projects, leading to bigger and better ones throughout North America. The Biden administration should also reauthorize the Defense Production Act to speed up the planning, construction, and operation of these facilities, as expanding domestic mineral projects addresses a key strategic vulnerability.

U.S. corporations should be encouraged to expand rare earths extraction operations in Africa, Asia, and Latin America. The construction of mining infrastructure in African nations would be relatively inexpensive, given lower labor costs and less stringent environmental regulations. Africa's rich mineral reserves make it an ideal destination for supply chain diversification. However, the security challenges, from Al Shabaab to Boko Haram will require U.S. and its allies to project power in order to protect the supply chain. Importantly, the African governments and audiences should be aware of U.S. efforts to address developmental needs of host countries, regions, and communities—in competition with China. Roads, schools, medical facilities, and environmental protection should be front and center for U.S. REE operations in Africa.

Finally, U.S. policymakers must set specific targets to decrease reliance on Chinese REEs and critical minerals. Targeting specific non-China reliance goals will increase intergovernmental and business sector cooperation and signal clear intent to international partners to build robust levels of Western REE self-reliance.

The United States and its allies should pursue policies that guarantee dependable access to these critical resources at affordable prices, like those in response to the 1970s Arab embargo-triggered energy crisis. President Richard Nixon launched Project Independence after the 1973 oil embargo, attempting to ensure that the U.S. would increase its capacity to refine and extract oil domestically while promoting a union of consumer countries to study the industry and influence oil pricing. The International Energy Agency arose from such cooperative efforts of oil-consuming democracies. Similarly, the U.S. must now explore critical mineral supply expansion while gathering allies into an REE "consumer club" to develop policies and build strategic cooperation and partnerships in the diversification of extraction and refinement facilities.

Critical minerals are the lifeblood of the 21st century, fueling high-tech manufacturing and renewable energy transition. These resources are the keystones of economic progress and industrial leadership in building 21st century defenses. The U.S. and her allies must diversify their critical mineral supply chains. Governments who underestimate their importance do so at their own risk.

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