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INDUSTRY ANALYSIS

Chinese Rare Earth Elements (REE) & Metals Dominance Analysis

REPORT PRODUCED BY THE INTEROS INC.
BUSINESS ANALYST TEAM

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Executive Summary

Research Purpose Statement

Western economic reliance on China is a subject of growing concern, thanks to a host of geopolitical issues that have raised doubts over the continued possibility of free and easy trade. China supplies materials, manufacturing, and other economic services that the world has come to rely on, including rare-earth elements (RRE). As this report shows, the world relies heavily on China for both the mining and refinement of these elements that are essential in the creation of virtually all advanced technology ranging from weapons system critical national defense to electric vehicles. As the political climate continues to intensify, global businesses must understand the concentration risk of the RRE industry in China and how political actions may disrupt this already fragile system.

This research document is intended to provide an overarching analysis on the circumstances surrounding China's Rare Earth Elements (REEs) dominance. Outlined in the following body of text is a pointed inquiry into the mineral and metals supply chain life cycle; Chinese import/export operations; legal vehicles and historical precedent surrounding industry-related tariffs and sanctions; and personalized SCRM analysis.

Key Findings

- With an HHI score of 7,219, the REE industry can be classified a highly concentrated marketplace at risk of monopolization. China dominates the industry in terms of the production of REEs and maintains 84% of the overall market share.
- China's REE dominance is the result of massive policy shifts within the IAEA's regulations; the voluntary transfer of expertise and intellectual property; and an absence of proactive industrial policy.
- REE/REO recycling is a highly specified and materially intensive process that yields small returns on investment both environmentally and financially driving a low recycling rate of 1-5% globally. Although Chinese dominance has sparked a growing interest in REE/REO recycling, limited technological advancements, low REE/REO concentration, and a lack of recyclable devices have limited widespread adoption of recycling practices.
- The Chinese consolidation of overseas REE resources creates further implications for organizations looking to stymie the flow of Chinese rare earths into their supply chains as the country has become staunchly integrated within the international REE material mining process.
- China today extracts 60% of all rare earth elements that are consumed by the global market. The country also refines 87% of the world's REE supply.

1.0
Rare Earth & Raw Materials Overview

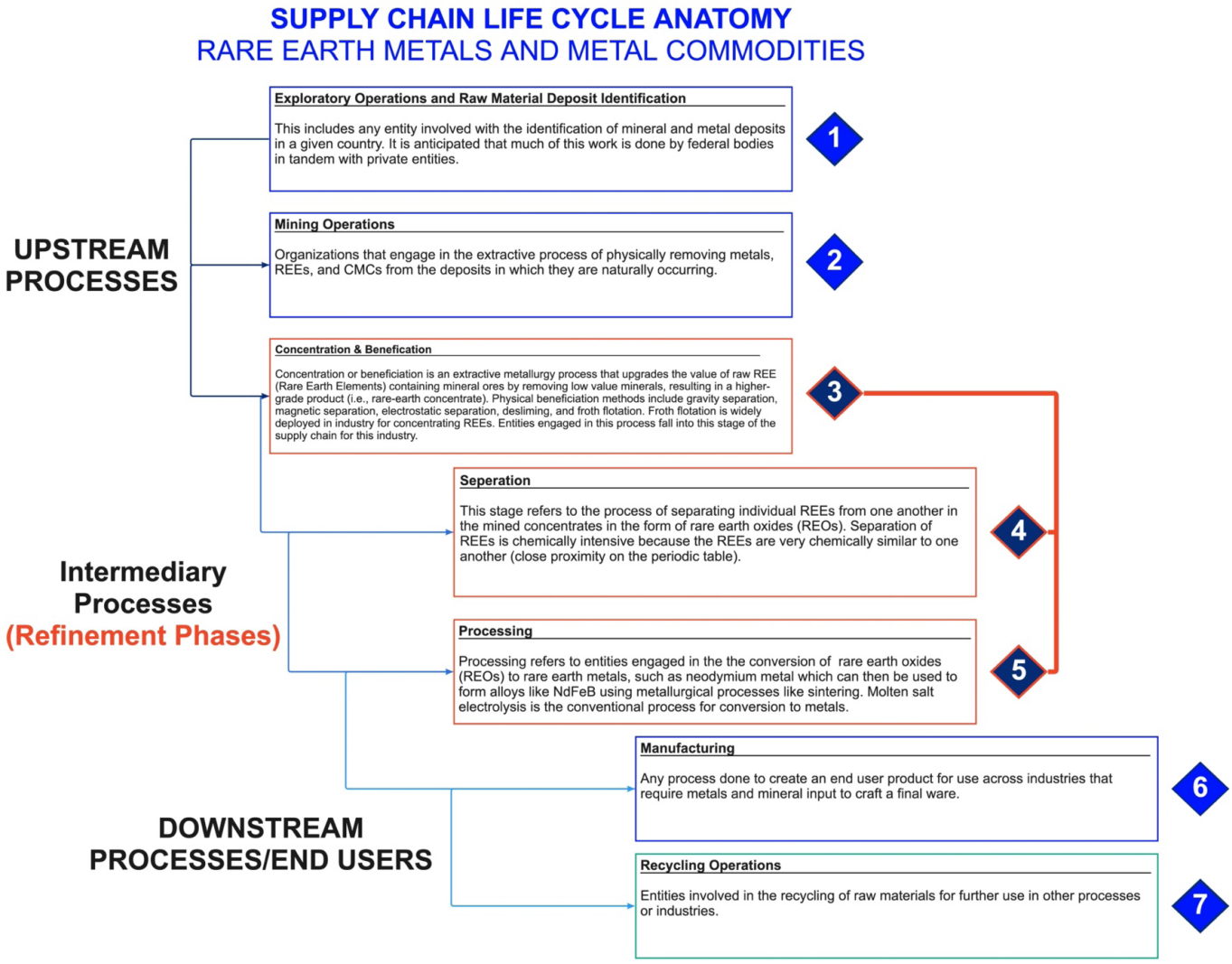
The Rare Earth Metals Supply Chain Life Cycle

The rare earth raw materials life cycle **(Figure 1.0)** can be effectively broken down into seven distinct stages (Exploratory Ops.) (Extractive Ops.) (Benefication) (Separation) (Processing) (Manufacturing) (Recycling). Primarily, identifying naturally occurring deposits of raw materials and metal-rich areas is normally accomplished via private-public partnerships that produce geological surveys. These surveys establish the foundation for the extractive portion of raw material and metal ore harvesting process. Mining companies, both private and state-owned, carry out the physical extraction of the ore from the ground in a systematic manner typically in compliance with local laws, regulations, and guidelines.

Once removed from the ground, ores and raw material require refinement and further processing before they can be directly implemented downstream in manufacturing and end-user products. This group of distinct middle phases can be identified as the "Refinement Processes" (stages 3-5). It is during the multi-step refinement process that the raw ores are separated and sifted into useable materials through a litany of chemical and physical procedures (gravity benefication, flotation benefication, magnetic benefication, electric benefication, and chemical benefication)[1] that produce what is known as "concentrate" (useable material) and "tailings" (excess/waste material). More specifically, concentration or "beneficiation" is an extractive metallurgy process that upgrades the value of raw Rare Earth Elements (REE) containing mineral ores by removing low value minerals, resulting in a higher-grade product (i.e., rare-earth concentrate). Physical beneficiation methods include gravity separation, magnetic separation, electrostatic separation, desliming, and froth flotation. Froth flotation is widely deployed within the metals and mining industry for concentrating REEs. Entities engaged in this process or maintain this capability are a critical piece of the rare earth supply chain and fall into this primary refinement stage.

After the ore has undergone the benefication process (stage 3), it is then transferred either within an organization or to a third party to undergo the separation process (stage 4). In this stage, REEs are separated from one another in the mined concentrates in the form of rare earth oxides (REOs). Separation of REEs is chemically intensive because REEs are very chemically similar to one another due to their close proximity on the periodic table. Post-separation, REOs undergo final processing during which an entity begins conversion of REOs to rare earth metals, such as neodymium metal which can then be used to form alloys like NdFeB using metallurgical processes like sintering. Molten salt electrolysis is the conventional process for conversion to metals.[2] Finished metals are then

shipped off to manufacturers that use the material to create end-user products across various industries. Once the end-user product has reached the end of its lifecycle, it can be recycled and end up back in the supply chain.



Contextualizing China's Rare Earth Dominance via the HHI

The Herfindahl–Hirschman Index (HHI) can be used to contextualize China's rare earth dominance in pragmatic terms as the scale is predominantly used to identify the concentration of various markets and industries. The United States Department of Justice (DOJ) explicates that the HHI takes into account the relative size distribution of the firms in a market. The index approaches zero when a market is occupied by a large number of firms of relatively equal size and reaches its maximum of 10,000 points when a market is controlled by a single firm. The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases.[3]

Broken down further, The HHI is calculated by squaring the market share of each competitor and then summing up the resulting numbers. As mentioned earlier, the index can range from zero to 10,000. The closer a market is to a monopoly, the higher the market's concentration, and the lower its competition. For example, if there were only one company in an industry, that company would have a 100% share of the market and the HHI would equal 10,000, therefore, demonstrating a monopoly. Conversely, if there were thousands of firms competing, the HHI would be near zero, indicating almost perfect competition.[4] The below scale can be consulted to determine overall competitiveness of a given market/industry.

- HHI below 1,500: a competitive marketplace
- HHI between 1,500 – 2,500: a moderately concentrated marketplace
- HHI of 2,500 or greater: a highly concentrated marketplace

With an HHI score of 7,219, the REE industry can be classified a highly concentrated marketplace at risk of monopolization. China dominates the industry in terms of the production of REEs and maintains 84% of the overall market share. Data indicates [5] that only four other countries, Australia, Russia, Brazil, and Malaysia, produce REEs at notable levels.[6] The following table outlines the top 10 least-competitive raw materials markets by HHI score.

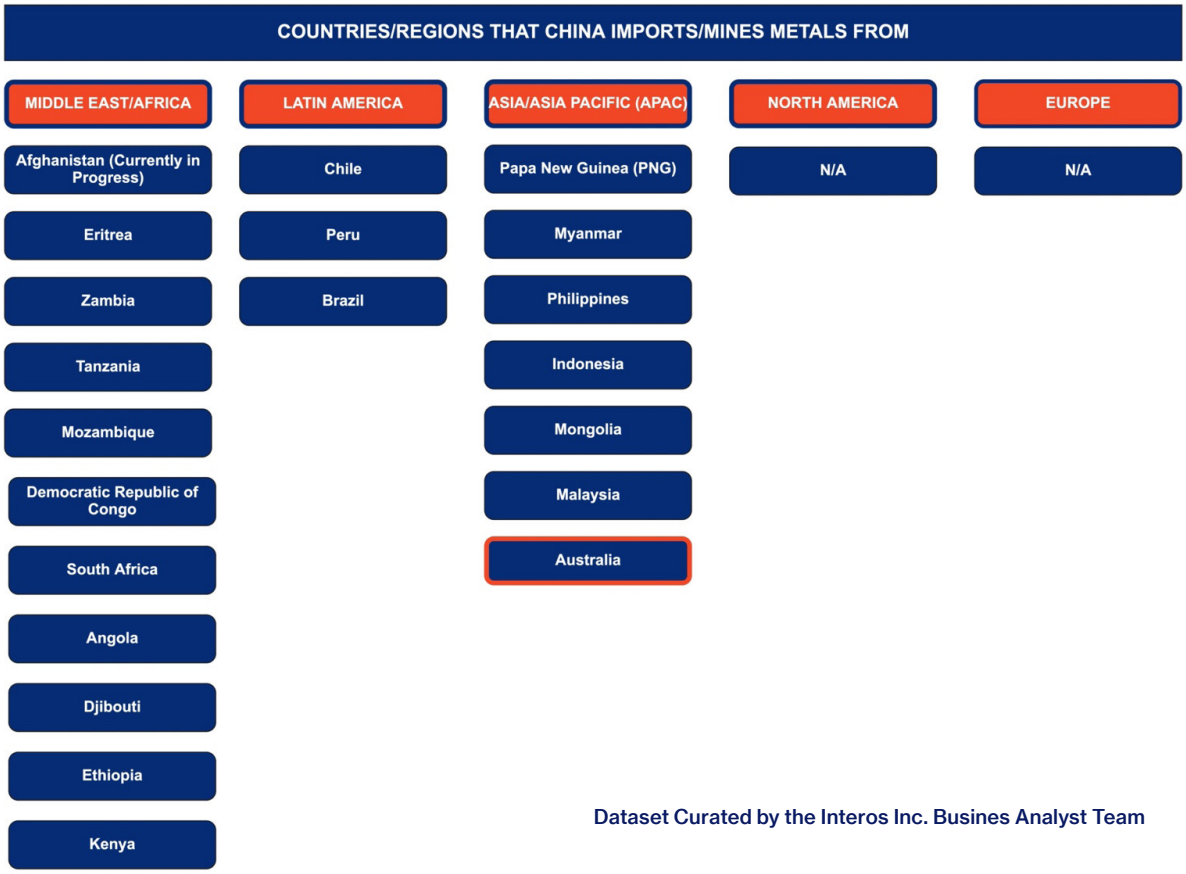
Raw Material	HHI Score	Type of Mineral	Rank
Niobium	8,413	Iron & Ferro-Alloy Metals	1
REE (Rare Earths)	7,219	Non-Ferrous Metals	2
Oil Sands	6,871	Mineral Fuels	3
Tungsten	6,828	Iron & Ferro-Alloy Metals	4
Platinum	5,383	Precious Metals	5
Graphite	4,990	Industrial Minerals	6
Asbestos	3,738	Industrial Minerals	7
Vandium	3,573	Iron & Ferro-Alloy Metals	8
Cooking Coal	3,423	Mineral Fuels	9
Cobalt	3,184	Iron & Ferro-Alloy Metals	10

Data Source: World Mining Congress

2.0
Chinese Import/Export Operations

Chinese Metal Resources Import Operations

China supplements its already fruitful natural metal deposits by extracting ore abroad and importing it back to the mainland. There are few opportunities for Chinese companies to operate in developed mining areas such as Canada and Australia, leaving it with more challenging terrain. Moreover, Chinese companies face a steep learning curve in adapting to overseas conditions due to differences in regulations, reporting standards, and technical procedures. Despite not being able to physically mine for resources in adversarial/developed nations, Chinese companies have restructured their processes to circumnavigate restrictions and bans by purchasing rare earth resources in other countries.[7] For example, in 2009 China Non-Ferrous Metal Mining Company bought a majority stake in Lynas Corporation, an Australian company that has one of the highest outputs of rare earth elements outside of China. They also purchased the Baluba Mine in Zambia in a bid to further diversify their resource stream. [8] The consolidation of overseas REE resources creates further implications for organizations looking to stymie the flow of Chinese rare earths into their supply chains as the country has become staunchly integrated within the international REE material mining process.



Dataset Curated by the Interos Inc. Busines Analyst Team

Chinese Metal Resources Export Operations

According to the Department of Commerce, China was the largest steel exporter in 2019.[9] Its top three export markets were South Korea, Vietnam, and Thailand.[10] The top ten markets for Chinese steel include India, Saudi Arabia, and the Philippines.[11] Since 2007, China has consistently capped its export of refined lead to the rest of the world. The government placed an export tax on the commodity and exports slowed. However, in 2021 China exported its largest amount of lead since 2007 when it "shipped surplus to a deficit Western market."[12]

Aside from its steel and lead exports, China is a major exporter of rare-earth elements, it is one of the largest exporters of rare-earth elements with its top export destination being Japan, the United States, and South Korea. Despite its behemoth status in the global export market, Chinese rare earth minerals exports have consistently shrunk for the past three years.[13] The total tonnage of rare earth metals decrease 23.5 percent in 2020 and 12.6 percent in 2019. The massive contraction in 2020, partly due to the Coronavirus lockdowns around the world, shuttered production in Europe and import demand. However, the overall trend in the reduction of rare earth minerals and exports is also in part due to China's domestic demand for these metals. As a response to increased geopolitical tensions with advanced western democracies and the U.S.-China trade war, China has prioritized the creation and nurturing of advanced domestic industries utilizing these minerals.[14] Rare earth minerals are essential in next-generation technology which China wants to domestically produce and set standards. These industries include the internet of things, advanced robotics, and electric batteries, all of which have been highlighted by the current Chinese President Xi Jinping as crucial industries in his Made in China 2025 policy goals.[15] This prioritization of domestic industry is coupled with the Export Control Law enacted by the Chinese Communist Party on December 1, 2020.[16] The law is designed to restrict the export of sensitive materials, technology, and data that could threaten Chinese national security.

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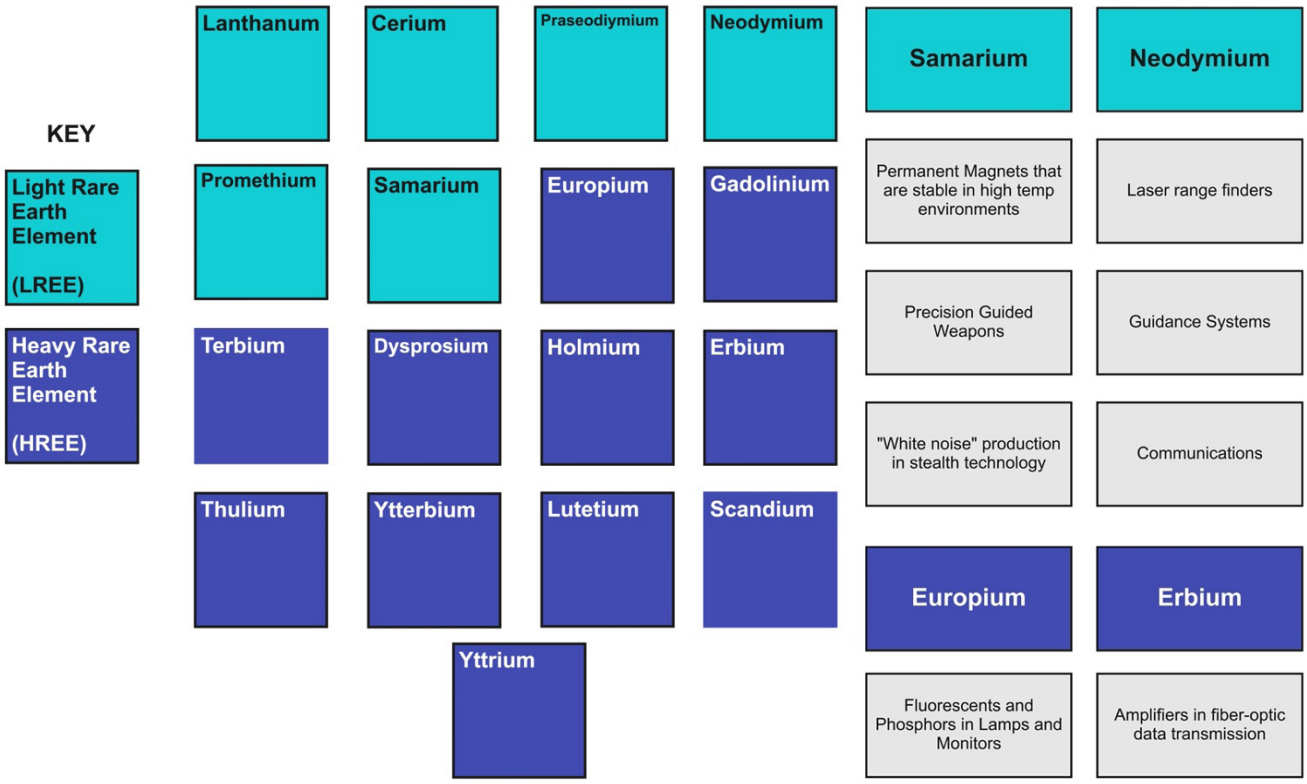
3.0
Chinese REE Refinement Dominance

China's Refinement Dominance Overview

China's REE dominance is the result of massive policy shifts within the IAEA's regulations ; the voluntary transfer of expertise and intellectual property; and an absence of proactive industrial policy.

Rare earth elements/metals (REEs) are more abundant than their name suggests. The REE group is comprised of 17 chemically similar metallic elements (the lanthanides, Scandium and Yttrium)[18] occur in a wide range of REE bearing minerals and are mined collectively. They are usually divided into the light REE (LREE) and the heavy REE (HREE)[19] ; the latter are found in relatively lower concentrations in the Earth's crust. Due to their chemical similarities, REE extraction is a technically complicated process, requiring intense handling. It is in this refinement phase that China has honed their expertise in turn creating a global dependence on Chinese refiners for processed and useable REE materials.

Figure 2.1 - REE Use Examples



Data Source: International Energy Agency (IEA)

The REE group are essential raw materials for a wide range of applications, including metallurgy (metal refining and metal alloying), catalysts in the automotive and the petro-chemical industry, colouring of glass/ceramics, phosphors (LEDs, compact fluorescent lamps, flat panel displays), lasers, rechargeable solid-state batteries (Ni-MH), fibre optics and others. Additionally, REE are vital elements in emerging technologies such as solid-state fuel cells, superconductors, magnetic cooling, hydrogen storage and high-performance permanent magnets. The latter are crucial in a variety of high-tech applications ranging from wind-turbines and hybrid cars to HD drives and cell phone speakers and microphones.

During the 1980's, the International Atomic Energy Agency (IAEA) amended their definition of source material [20] to include rare earth by-products effectively subjecting them to extensive licensing, regulatory, disposal, and liability rules. [21] These new added liabilities associated with REEs resulted in the termination of both production and refinement among IAEA member nations and the United States. It was at this point in which China was able to step in as chief producer and refiner as it was not constrained by the regulations of the IAEA through its observer status at the time. China did not ratify its membership status until 1984 thus giving it the lead time to develop its rare earth processing capabilities.[22]

Further accelerating the downfall of western REE development was the bestowment of permanent normal trade relations (PNTR) status upon China by the U.S. Congress in 2000.[23] This move incentivized the turnover of western refinement technology and intellectual property (IP)[24] to Chinese manufacturers that were able to produce REE and REO materials at a much lower cost; had cheaper labor; and were not hindered by strict environmental concerns[25] and regulations. Armed with newly developed know-how and advanced western tech, China became poised to lead, and dominate, the industry at large.

Based on timely data gathered from the France-based International Energy Agency (IEA), China today extracts 60% of all rare earth elements that are consumed by the global market. The country also refines 87% of the world's REE supply. Data also revealed an overall Chinese refinement dominance for Lithium, Copper, Nickle, and Cobalt. Although these metals do not fall under the purview of REEs, it further highlights how pervasive Chinese influence within this subset of the mining and metals supply chain has become.

Raw Material	Extraction (of World Supply)	Refinement (of World Supply)
Rare Earth Elements (REEs)	60%	87%
Lithium	13%	58%
Copper	8%	40%
Nickle	5%	35%
Cobalt	1.5%	65%

Consequently, the small percentage of REEs born of foreign extraction/mining must be sent back to China for final processing as most countries do not maintain the capability to refine rare earth materials into useable REOs and ores. The modern hinderance of western refinement capabilities growth has been chiefly stymied by concerns of impact to conservational efforts as mining and refining operations come at the expense of environmental degradation. Despite this, avenues are being explored by North American firms to increase refinement capacity and ability with the goal of further reducing overall dependence on China.

The United States Department of Defense (DoD) recently (February 2022) awarded a $35 million contract to MP Materials Corp. (MP) of Las Vegas, Nevada for the purpose of designing and building a facility to process HREE at the company's Mountain Pass, California production site.[26] The DoD further explicated that this project would establish the first processing and separation facility of its kind for HREEs in support of both defense and commercial applications in the United States.[27]

This award is part of DoD's rare earth supply chain resiliency efforts, and directly supports the administration's initiatives to strengthen America's supply chains as outlined in Executive Order 14017, America's Supply Chains. To date, DoD has invested over $100M in enhancing America's rare earth supply chain resiliency as part of its commitments to expanding domestic rare earth element processing capabilities and capacity. [28]

REE/REO Recycling as Means of Combatting Import Reliance

REE/REO recycling is a highly specified and materially intensive process that yields small returns on investment both environmentally and financially driving a low recycling rate of 1-5% globally. Although Chinese dominance has sparked a growing interest in REE/REO recycling, limited technological advancements, low REE/REO concentration, and a lack of recyclable devices have limited widespread adoption of recycling practices.

Overall Process

The process of recycling rare Earth elements (REEs) is more complicated and costly than the initial separation process of raw materials. Chemical processes used are dependent on the type of element being recycled. These chemically based recycling processes are long, complex, and energy-intensive procedures.

According to Yale University industrial ecologist Thomas Graedel, separation of REEs from devices for the case of recycling generally involves "very aggressive solvents or very high temperature molten metal processing." In some methods requiring hundreds of fluid chambers, chemical filtration of the elements is achieved by combining an aqueous and acidic fluid with an organic fluid that dissolves the metals and makes them extractable, though this requires thousands of repetitions.[29]

Difficulty

The tiresome technical process of REE recycling is not the only limiting factor. Not only does the recycling take weeks and require massive amounts of solvents, but it is expensive and consumes great amounts of energy. It is for these reasons that only 1-5% of the world's rare earths get recycled. Those that do generate a lot of waste that can offset any environmental benefit of recycling.[30] A 2011 publication put forth by the United States Geological Survey (USGS) says this low rate of recycling suggests that "the value of REOs that could potentially be recovered from recycling is insufficient to cover the cost to do so based on current technology."[31] Rather stagnant technological advancements, in combination with increased REE use, is shown in more recent figures that as of 2022, still only about 2% of REEs are recycled.[32] While recycling processes have advanced at least somewhat in the past decade, technological shortcomings still prevent recycling from becoming a more viable way to re-shore sources of REEs.

An important consideration of REE recycling is their abundance per device or medium that they are used in which, for the most part, is miniscule. In devices like consumer electronics, which contribute to a large portion of REE usage around the globe, a touchscreen's composition of these resources "are distributed throughout the material at the molecular scale."[33] As tech professionals aim to make devices even smaller by the year, Alex King, Director of the Critical Materials Institute, claims "It's easier to separate rare earth elements from rocks than from cell phones."

In sum, the initial separation as well as any recycling efforts are not only technically complex, but require a large degree of resources, money, and time. These large investments can have even a larger negative impact on the environment, and with current technology, are often wasted effort based on a simple cost-benefit analysis.

Prospective Viability

Technical capabilities, geopolitical factors, consumer trends, legislation, and much more play into the viability/future success of REE recycling. While the main roadblock is widely regarded as the cost required to separate the elements from consumer devices, investment and R&D to even solve these problems is heavily dependent on international trade and regulation.

However, these limitations are encouraging further discovery of recycling. Whether by increased demand or decreased supply, REE shortages would likely increase prices and recycling activity can be expected to also increase from its current level of near-zero to a higher level where shortages are partially or wholly mitigated. Recent years have shown exciting developments in the recycling of REEs. For example, a group of UPenn researchers discovered a cheaper separation process that may prove viable for all 17 elements.[34]

Though, even if we were able to achieve a 100% recycle rate tomorrow, it is projected that less than 10-15% of demand for these elements is even available for recycling, as most devices have not yet reached the end of their life. It is for this reason that researchers are brainstorming compliments to end-of-life recycling, such as designing products that isolate rare earths in a device's design and make later-stage recycling easier overall.

4.0
Forward: Sanctions, Compliance, and Regulations

Sanctions play an essential role in deterring bad behavior, enforcing economic punishment, and forcing rehabilitative behavior on a targeted country. The U.S currently uses sanctions as part of its foreign policy approach to ensure collaboration and order.

Overview of Sanctions

Sanctions are punitive tools that levy restrictive economic and financial measures on a country, individuals, or companies.[35] They aim to achieve the following results: settle conflicts, restrict nuclear proliferation, ensure national security, and combat terrorism and human rights violations. Though initially implemented as a corrective tool on a particular entity, sanctions have become an additional extension of U.S. foreign policy.[36] The severity of sanctions can range from limiting trade (blocking assets and interest in assets subject to U.S. jurisdiction), restricting access to the U.S. financial system, prohibiting transactions involving American individuals and businesses, restricting private and public loans, and more.

U.S. sanction laws and regulations are incredibly complex and unpredictable, it is important for American companies to understand the various types of U.S. sanctions and the potential impact on the supply chain as well as risk to their organizations. Companies that stay informed on critical developments can also anticipate, prepare, and respond to the U.S. sanctions risk and compliance challenges associated with their industry.

Currently, the United States maintains sanctions against dozens of countries, individuals, and entities worldwide and are implemented in conjunction with military efforts to mitigate activities that threaten U.S. national interest.[2] These sanction laws are primarily administered by the U.S. Department of Treasury, Office of Foreign Assets Control (OFAC), and in some cases, the U.S. Department of State. The U.S. sanctions can be primary or secondary in nature. Primary sanctions typically involve freezing assets and trade embargoes that forbid transactions by individuals in the sanctioning country with sanction countries or persons.2 U.S. primary sanctions apply to the following:

- All entities organized in the US
- US citizens and permanent residents, regardless of residence
- All persons physically located in the U.S., regardless of nationality
- Non-US entities owned or controlled by U.S. persons (exclusive to Iran and Cuba)

On the other hand, secondary sanctions impose penalties on non-US persons and organizations not subject to U.S. legal jurisdiction. Generally, they are used against entities engaged in the same dealings under primary sanctions. While sanctions can be differentiated by prohibitions listed in the primary and secondary restrictions, U.S. sanctions can be further divided into the comprehensive (whole country) or targeted sanctions (individuals, entities). Under the targeted sanction, OFAC prohibits transactions between U.S. persons, individuals, and entities on the Specially Designated Nationals and Blocked Persons List (SDN List) and restricts trade with crucial commodities.[37]

The United States Sanction Process

The U.S. sanction policy originates from either the executive or legislative branch. Under the executive branch, the President initiates a sanction by issuing an executive order (E.O.) to declare a national emergency response to an "unusual and extraordinary" foreign threat.[38] Invoking such an order grants the President extraordinary powers per the International Emergency Economic Powers Act to regulate commerce concerning the danger for a year unless extended or terminated by joint resolutions of congress.[4]

Under the legislative approach, Congress passes legislation imposing new sanctions or modifying existing ones. In instances where multiple legal authorities are involved, such as in Iran and Cuba, legislative and executive actions may be required to alter or lift the restrictions.[4]

How Sanctions Are Implemented in the United States

Immediately when a foreign policy event occurs, or a threat is detected, the National Security Council facilitates an interagency meeting between experts from relevant executive branch agencies to determine the severity of the threat and possible response options. Subsequent recommendations are drafted and presented to senior-level officials in relevant agencies and then to the President to decide the policy direction the U.S. will pursue. Once an approach has been approved, OFAC selects targets and the sanction measures, then works with the Department of Justice and the Department of State to create the executive order for the President's approval.4 Upon approval, the President declares a national emergency, releases the sanctions, and rolls out support for agencies and the private sector.

The Precedent of Sanctions in the Mining Industry

With the U.S. dependent on imported processed rare materials, companies need to be proactive in knowing their exposure when dealing with foreign and local entities that have business dealings in areas likely to be sanctioned. Companies choosing to partner or work in a new jurisdiction with a surplus of natural resources or refined products should be conscious of the potential unstable domestic situation or working with countries that pose a security risk.

Any measure implemented during a sanction can potentially be a double-edged sword when applied to a significant industry. When sanctioning authorities convene to determine the layout, the designers tend to limit the negative implications on their own country. Due to the importance of the resources needed and received from mining in every American sector, designers of the regulations rarely sanction the mining sector in order to limit the damage by taking a secondary sanction approach. [39]

Since 1945, the mining sector has been subjected to three direct (primary) sanctions:

- In 1986, Congress passed the Comprehensive Anti-Apartheid Act of 1986, which applied economic sanctions to the South African economy. This sanction banned South African Uranium, Steel, Coal, and Iron Ore imports.[40]
- In 2003, the U.S. imposed sanctions against Burmese mining companies after a coup. This sanction was eventually lifted in 2016 to support a democratic process in Myanmar. [41]
- In 2017, the U.S. reimposed sanctions on Iran following its withdrawal from the Joint Comprehensive Plan Action, which included a total ban on Iranian Gold, precious metals, and the sale and or supply to or from Iran of graphite, raw semi-finished metals such as Aluminum, steel, and coal.[42]

Unlike the direct sanctions, most sanctions that have been imposed have been targeted sanctions:

Understanding the specifics and likely regions of sanctions by the U.S. enables companies to leverage and dampen the effect of sanctions levied against them and suppliers.

- In 2021 the U.S. reissued new sanctions against crucial mining companies and seven members of the Myanmar military due to the recent government restructuring/ coup.[7]
- On March 18th, 2022, the United States sanctioned a Belgian businessman over allegations of illicit gold trade in Congo.[43]
- In 2020, the United States sanctioned 17 Iranian metals producers and mining companies. The U.S. Department of the Treasury's Office of Foreign Asset Control (OFAC) designated several entities linked to the Iranian steel, aluminum, and iron sectors. In addition to these entities, companies affiliated with the Islamic Revolutionary Guard Corps (IRGC), a select number of trading companies located based in Dubai, Germany, and China were designated as SDNs (Specially Designated Nationals) for being sales agents, owned or controlled by IRGC affiliates owned or controlled by IRGC. [44]
- In 2018, the U.S. imposed sanctions directly against Rusal, the second-largest

aluminum producer globally, and its principal shareholder Oleg Deripaska for illegal wiretapping, racketeering, money laundering, etc.[45]

- In 2019, the U.S. imposed sanctions against Venezuela's state-run gold mining company Minerven and its President, Adrian Perdomo, accusing them of illegal operations and propping up the government of President Nicolas Maduro.[46]
- In 2021, the U.S. imposed sanctions on Israeli mining executive Dan Gertler for corruption in Congo. [47]

Reshoring Tactic: Acts, Laws, Incentives to Companies, and More

In recent years, the U.S. has become overwhelmingly dependent on China to supply the metals and minerals needed for advanced technology, defense, and electric vehicles. To combat U.S. dependency, the executive and legislative branches have been working on creating laws to encourage private and public companies to re-shore the mining sector back to the U.S. Here is a list of regulations and executive orders passed to that effect:

- In 2019, Senator Lisa Murkowski introduced the American Mineral Security Act, whose sole purpose is to modernize the permitting system for U.S. mining.[48]
- In 2013, Representative Mark Amodei introduced the National Strategic and Critical Minerals Production Act of 2015 intended to alter the rules and regulations surrounding getting permits and permissions to undertake mining projects in the U. S. [49]
- In 2021, Representative Pete Stauber introduced the Manufacturing America's Minerals Security Act (H.R.4932). This law allows an additional 10% tax deduction for the cost of specified domestically produced materials if such materials are acquired by the taxpayer directly from the domestic smelter or processor of such material. [50]
- In 2021, Representative Eric Swalwell introduced the bill Rare Earth Magnet Manufacturing Production Tax Credit Act of 2021 (H.R.5033) which allows a new tax credit for the domestic production of rare earth magnets manufactured in the ordinary course of a taxpayer trade or business.[51]
- In 2022, Senators Tom Cotton and Mark Kelly introduced the Restoring Essential Energy and Security Holdings Onshore for Rare Earths (REEShore) Act of 2022, intended to protect America from the threat of rare-earth elements supply disruptions. This bill is designed to encourage domestic products of rare earth elements and reduce U.S. reliance on China. [52]
- In 2021, Representative Gooden Lance introduced the H.R.2688 bill, which aims

to amend the Internal Revenue code of 1986 to allow the following[53];

- Permanent expensing of property used in the mining, reclaiming, or recycling of certain critical minerals and metals within the United States and of nonresidential real property used in mining such minerals and metals.
- Tax deduction for 200% of the cost of purchasing or acquiring such critical minerals and metals extracted from deposits in the United States and a 22% rate of percentage depletion for such essential minerals and metals.
- Requires the Department of the Interior to establish a pilot project grant program to develop critical minerals and metals in the United States.

In addition to the above bills, the executive branch is also working ways to revitalize the mining sector. In February of 2022, President Biden announced several public and private investments to expand the domestic supply of minerals needed to make electric vehicles, computers, and other currently outsourced products. The Pentagon awarded M.P. Materials, an American Mining company, $35 million to expand a rare earth project in Mountain, Pass, California.[54] Another effort made by the White House in 2017 was the passage of Executive Order 13817 (A Federal Strategy to Ensure Secure and Reliable).[55] This order required the Secretary of the Interior to identify critical minerals and made it the policy of the Federal Government to reduce the Nation's vulnerability to disruptions in the supply of essential minerals.

On March 30th, 2022, President Joe Biden invoked the Defense Production Act, a Korean war-era power, to boost the domestic supply of minerals crucial for E.V. and large capacity batteries to reduce U.S. dependence on overseas energy.[56] Under this act, the administration can compel companies to prioritize government contracts over private contracts. The President hopes that the Defense Production Act will help increase the availability of cobalt, lithium, nickel, graphite, and manganese in the country.

As the government makes further commitments to American mining companies, additional efforts have been made with the allies to encourage collaboration. In 2021, the Pentagon awarded $30 million in funding to Lynas, an Australian mining company and the most significant rare mining and processing firm outside China.[57] This funding will help the company set up a processing plant in Texas with the hope of becoming the supplier of a quarter of the world's REOs.

Barriers to U.S. Mining

Though recent laws and orders show the U.S. government's effort and commitment to re-shoring and reviving the American Mineral Sector, several obstacles lie in its path. According to a report by the SNL Metals and Mining "from the discovery phase to first output, the development process for a mine can take an excess of 10 years and cost several billion dollars"[25]. Unfortunately, federal permitting, land management policies and additional regulations have slowed the access to and development of rare domestic minerals, which has led to increased dependency on foreign sources.

The following obstacles by regulatory and licensing authorities further disrupts the re-shoring efforts[58]:

- The Bureau of Land Management and U.S Forest services (USFS) framework for multiple-use resource management does not possess a mineral resource inventory or assessment, making mineral exploration impossible on special-land use designation.
- Mixed ownerships of the lands further complicate the process and the ability of a company to establish a site for further exploration.
- Mining each resource requires different permits depending on its location and proximity to infrastructure. Additionally, navigating the local, state, federal, and tribal regulations for each mine is very complex, stretching the permit approval timeline.

Once a location has been approved for mining, the additional permitting and licensing process can be arbitrary with no expected timeline or benchmark to gauge the expected license approval or denial. For example, the U.S. requires companies at the Federal level to acquire the following permits under each of the following acts: Federal Clean Water Act, National Pollutant Discharge Elimination System, Air Quality Act, and an Environmental Impact Statement. Additionally, individual states require permits and licenses at the local levels . According to a report by the SNL Metals and Mining the average timeline for the licensing and permit process takes more than 7 years. The U.S. government should reevaluate the current approach to encourage the sector with extra emphasis on efficiency.

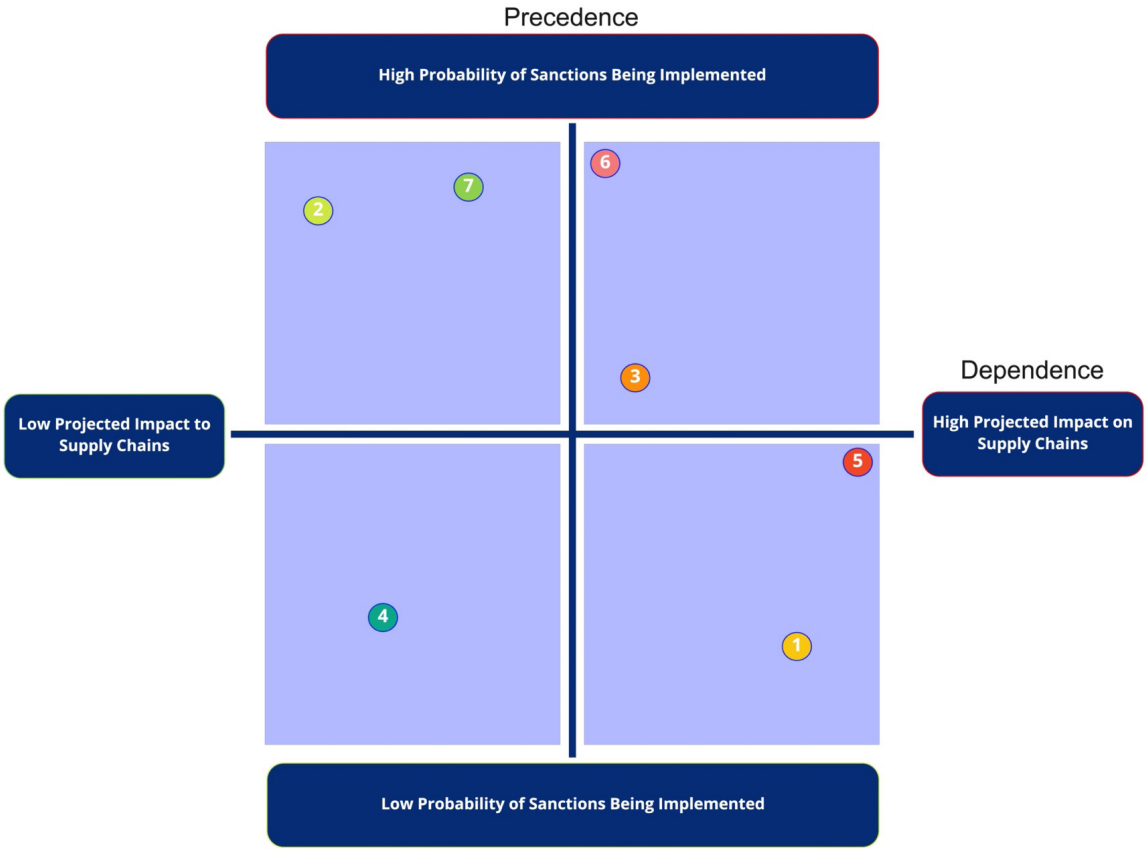
Possible Sanctions on China

With U.S total dependence on foreign mineral imports, particularly from China, imposing sanctions on the Chinese mining sector would be ill-advised and debilitating to the economy. Additionally, rising tensions between the U.S. and China have launched the desire to domestically mine for rare earth metals. Despite the numerous bills and government initiatives aimed at re-shoring to the U.S, the U.S has yet to develop sustainable mining, processing, and refining process; it needs to wean off foreign suppliers. Before the U.S can think of implementing sanctions on China and other foreign suppliers without significant disruption to its supply chain, it will need the following:

- A domestic functional and scaled mining sector that could offer competitive price to the market
- Supplies from allies who can provide all the minerals and metals without input from China
- Well-established mining, processing, and refining process that should be domestically done

Sanctions Scenario Matrix/Analysis of Competing Hypotheses

The subsequent scenario matrix represents seven distinct hypothetical situations with varying degrees of probability examined through the overarching scope of precedence (probability) and dependence (Impact). This matrix is intended to be utilized as an edifying tool that better informs an analysis of competing hypotheses and should in no way be interpreted in terms of absolutes. Scenarios have been arbitrarily assigned an ID number but color-coded based on their varying degrees of probability and impact. Hypotheticals characterized by a greater amount of anticipated impact to supply chain and greater probability of manifesting appear as varying shades of red – yellow. Conversely, hypotheticals characterized by a lesser amount of anticipated impact to supply chain and lesser probability of manifesting appear as varying shades of green – yellow. All scenarios will be discussed in detail within the ensuing pages. A table has been provided at the top of the next page as an identifier mechanism that connects each hypothetical's corresponding ID # to a brief description.



This matrix is intended to be utilized as an edifying tool that better informs an analysis of competing hypotheses and should in no way be interpreted in terms of absolutes.

Scenario #	Scenario Description
1	Sanctions are placed on Chinese State-Owned mines and mining operations
2	A targeted sanction placed on C-suite leadership of a Chinese mining companies
3	A sanction is placed on Chinese minerals/metals from the Xinjiang region
4	Sanction metal producers and mining companies and designate them to the NS-CMIC
5	Quota on any U.S. persons or entity importing over 50% in rare earth minerals and metals from China.
6	Sanctioning of Chinese mining companies operating in Afghanistan/Africa
7	Sanctioning of American individuals or entities from doing business with Chinese mining companies acquiring minerals and metals from Taliban/Afghanistan

Sanction & Tariff Scenarios

SCENARIO 1:
Sanctions are placed on Chinese State-Owned mines and mining operations

Scenario Likelihood: Low

Projected Impact to Metals Supply Chain: High

Under this scenario, OFAC would sanction Chinese state-owned mines hence restricting American entities from purchasing or doing business with such mines. With over a dozen Chinese-owned mining companies in China, one-third are State-Owned. On December 23rd, 2021, China approved the merger of three of its largest state-owned mines MinMetals, the Aluminum Corp of China, and Ganzhou Rare Earth Group.

This effort helps Beijing consolidate its position over the mining sector by allowing the government to have control over the entire supply chain of rare earth metals in the country.[61] This move led to the creation of a single state-owned company with 70% share of the domestic production quota, which is vital to the creation of high-tech product. Due to the ongoing geopolitical tension between the U.S. and Chinese government, the merger will give the Chinese government the leverage it needs while negotiating with the U.S. Most importantly, it will advance China's goal of total dominance, pricing power, and influence in rare earth production. For the U.S. to levy such a sanction, it would need to increase its rare earth output to supplement the heavy losses.

SCENARIO 2:
A targeted sanction placed on C-suite leadership of a Chinese mining companies

Scenario Likelihood: High

Projected Impact to Metals Supply Chain: Low

Under this scenario, the U.S could take a similar approach as it did when it sanctioned Rusal. Using the template from the Rusal sanction, OFAC would designate specific Chinese mine owners along with the mines they control or own. Concurrent with this designation, OFAC would issue general licenses to minimize immediate disruptions to U.S. persons, partners, and allies. Since the sanction targets a single entity rather than all the mining companies, U.S. entities can go to other suppliers. The license provided by OFAC would allow them to continue businesses with the sanctioned companies. In the sanctions levied against Rusal and its leadership, the state department removed the entity sanction when its biggest shareholder Oleg Deripaska reduced his stake in the company.

SCENARIO 3:
A sanction is placed on Chinese minerals/metals from the Xinjiang region

Scenario Likelihood: High

Projected Impact to Metals Supply Chain: Medium

With the U.S.' latest efforts to curb the harsh treatment of Uyghur Muslims, bills and sanctions have been implemented to ban imports from China's Xinjiang region. In 2021, President Joe Biden signed "The Uyghur Forced Labor Prevention Act" that prohibits imports from Xinjiang and imposed sanctions on individuals responsible for forced labor in the area.[62] Under this scenario, OFAC would require U.S. companies to exit supply chains or ventures that connects them to Xinjiang region. Mining companies would be required to ask their suppliers to provide an affidavit to determine the product's origin. In this scenario, the likelihood of this sanction being implemented would be high, but it would also affect American businesses' supply chains and lead to prices in consumer products.

SCENARIO 4:
Sanction metal producers and mining companies and designate them to the NS-CMIC

Scenario Likelihood: Low

Projected Impact to Metals Supply Chain: Low

Under this scenario, the U.S. government would prohibit American investments by "U.S. persons from purchasing or selling publicly traded securities of any persons designated or determined to meet certain criteria, including having operations in defense and related materials sector or the surveillance sector of the Chinese economy or being affiliated with such entities."[63] Designating a company as Non-SDN Chinese Military – Industry Complex Companies List (NS-CMIC list) prohibits U.S. investments in Chinese companies that undermine the security or democratic values of the U.S. and its allies. Presently, none of the Chinese mining companies have ties to the military complex making the likelihood of such sanction being implemented low and its effect on the supply chain rated insignificant.

SCENARIO 5:
Quota on any U.S. persons or entity importing over 50% in rare earth minerals and metals from China.

Scenario Likelihood: Low

Projected Impact to Metals Supply Chain: High

Under this scenario, the U.S. would place a quota on U.S persons or entities importing over 50% of their overall rare earth metals imports. Any Chinese metal and minerals imported over the 50% threshold would be required to pay a 10% tariff. The President would then exercise his authority under Section 232 of the Trade Expansion Act of 1962. Section 232 of the Trade Expansion Act of 1962 "allows any department, agency head or "interested party" to request that commerce investigate to ascertain the effect of specific imports on U.S. national security".[64] President Trump utilized this approach when he imposed a 10% tariff on aluminum imports with exemptions for Canada and Mexico to protect national security. Implementing a similar strategy on rare-earth minerals would be detrimental to American entities and consumers. It would increase the price of imported goods, create inefficiencies and trigger retaliation from China. The probability of this sanction being implemented is low as it would have a high impact on the supply chain.

SCENARIO 6:
Sanctioning of Chinese mining companies operating in Afghanistan/Africa

Scenario Likelihood: High

Projected Impact to Metals Supply Chain: Low

With the U.S. exit from Afghanistan and the Taliban takeover of the country, China is working on filling the void by offering economic investment in the country's mining sector. Though politically and economically unstable, Afghanistan holds copper, cobalt, iron, sulfur, lead, silver, zinc, niobium, and 1.4million metric tons of rare-earth metals, which the Taliban will seek to exploit. As of March of 2022, mining company Metallurgical Corp of China has discussed plans to open an office in Afghanistan's capital city Kabul in early spring to begin mining copper and lithium. Currently, the U.S. maintains sanctions on the Taliban as an entity with the power to veto any moves by China and Russia to ease United Nations Security Council restrictions on the military group. [65] Additionally, the U.S. has frozen nearly $9.5 billion in Afghanistan's reserves and the International Monetary Fund has restricted Afghanistan access to its resources.[66] Using this approach, OFAC can possibly sanction Chinese mining companies in Afghanistan and certain African countries and prohibit American entities from purchasing rare-earth metal from mining companies located in the targeted regions. Due to the U.S. having other options to buy its metals and minerals, the probability of such a sanction being implemented is high, with a low chance of impacting the supply chain.

SCENARIO 7:
Sanctioning of American individuals or entities from doing business with Chinese mining companies acquiring minerals and metals from Taliban/Afghanistan

Scenario Likelihood: High

Projected Impact to Metals Supply Chain: Low

Under this scenario, OFAC would sanction American individuals or entities doing business with Chinese mining companies acquiring minerals and metals from Afghanistan or the Taliban. Currently, the Taliban has been designated as a Specially Designated Global Terrorist (SDGTs) under Executive Order 13224. This order prohibits transactions with persons who commit, threaten to commit, or support terrorism. It also prohibits U.S. individuals and entities from making any contribution of funds to or for the benefit of entities or persons named on the OFAC-controlled master list of Specially Designated Nationals & Blocked Persons. [67] Using the guidelines provided in this order, the U.S. would sanction persons and entities doing business with Chinese firms acquiring metals from the Taliban. This sanction's probability is high with a low impact on the supply chain. It would be easy for U.S entities to require a supplier to provide a country of origin for its minerals. This approach would also encourage more transparency in the supply chain and ensure compliance with the Executive Order.

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6.0
Interos Resilience Entities of Interest (EOI)

The following Chinese metals mining and refining EOIs have been listed for cross-reference in the Interos Resilience platform.

Chinese Metals & Mining Manufacturing EOIs

China Shenhua Energy Co., Ltd.
(PARTIAL STATE OWNERSHIP)
(Resilience ID: 01ee77c0-69d6-4f74-ba43-c1cad277720d)

China Shenhua is an integrated energy company that operates primarily through its coal division. The company operates several coal mines and is involved in the production and transportation of coal and coal products.

China Coal Energy Co., Ltd.
(PUBLIC LIMITED COMPANY)
(Resilience ID f42a794c-b409-4d5a-9deb-0ea78cf7699d)

China Coal Energy Company Limited mines and processes coal products. It produces thermal coal and coking coal products and also conducts coal chemical production, coal mining equipment manufacturing, pit mouth power generation, and coal mine design businesses.

Zijin Mining Group Co., Ltd.
(PUBLIC LIMITED COMPANY)
(Resilience ID: e12ce632-8b6b-4276-901d-a10bbdcf98b4)

Zijin Mining Group is principally involved in gold mining and smelting, though the company also mines for copper, lead, zinc, silver, and iron products in smaller quantities.

China Northern Rare Earth Group High-Tech Co., Ltd.
(OWNERSHIP UNKNOWN)
(Resilience ID: 7a2a5aa0-5080-44f6-aa32-d3143e453d4f)

China Northern Rare Earth Group, formerly known as the Inner Mongolia Baotou Steel Rare Group, is engaged in producing rare earth metals, oxides, and salts.

Jiangxi Copper Co., Ltd.
(STATE OWNED ENTERPRISE)
(Resilience ID: 11c5ba5f-bc56-4deb-bed3-9875f8c9a49c)

Jiangxi Copper is one of China's largest copper producers. It manufactures, distributes copper products, and produces copper cathode and other copper products. Jiangxi Copper also operates minerals development, finance, investment, trade, logistics, and other businesses.

Shaanxi Coal and Chemical Industry Group Co., Ltd.
(STATE OWNED ENTERPRISE)
(Resilience ID: e4583175-904a-4875-bfc5-4c0f56b2fc12)

Shaanxi Coal and Chemical mines, processes, and sells coal products. It also produces long flame coal, caking coal, noncaking coal, gas coal, lump coal, washed coal, coal chemicals, and other products.

Sinosteel Corporation
(STATE OWNED ENTERPRISE)
(Resilience ID: 5363d202-7bcb-4887-961c-ef9fe55c81b1)

Founded in 1993, Sinosteel Corporation is a state-owned enterprise primarily in mining and mineral processing, related trading and logistics, equipment manufacturing, construction, and engineering. In tandem with ferrous metal and many non-metal offerings, Sinosteel acts as an agent for many Chinese and international equipment and technology suppliers. Since its founding, Sinosteel has expanded its global presence and capabilities, namely through its acquisition of Australia's Midwest Corporation in 2008. Sinosteel administers 86 subsidiaries, 63 of which are in China.

China Baowu Steel Group
(STATE OWNED ENTERPRISE)
(Resilience ID: 7cbf97c9-d8b1-45df-b232-267b1c51ffd0)

China Baowu Steel Group Corp, Ltd. Is a state-owned iron and steel company which produces strip steels, steel plates, hot rolled steels, cold rolled steels, steel wires, and more. China Baowu Steel Group also operates new materials, intelligent services, industrial finance, and other businesses. Commonly referred to as Baowu, this enterprise was formed in 1978 as the government's flagship steel company as the country sought to develop large-scale domestic steel production. In recent years, mergers and acquisitions have expanded the size and scope of Baowu's work, holding its spot among the top 5 largest steel producers globally.

Yanzhou Coal Mining Co., Ltd.
(PUBLIC LIMITED COMPANY)

(Resilience ID: 7733b722-29ea-4133-ba98-6ae3874a84e6)

Yanzhou Coal Mining Company Limited operates coal businesses. The company produces fine coal, blown coal, power coal, and coal chemical products. Yanzhou Coal Mining also operates power generation, railway transport, machinery manufacturing, and heating businesses.

China Non-Ferrous Metal Mining
(PUBLIC LIMITED COMPANY)

(Resilience ID: 6268317e-9c77-46ae-83ac-ff87dc4affaf)

China Nonferrous Mining Corporation Limited is an investment holding company principally engaged in the production and sales of cooper related products. The Company operates through two business segments. The Leaching segment is engaged in the production and sales of copper cathodes with solvent extraction-electrowinning technology. The Smelting segment is engaged in the production and sales of blister copper, bismuth and sulfuric aci with smelting technology

Chinese Metals Refinement EOIs

China Rare Earth Holdings Limited
(PUBLIC LIMITED COMPANY)

(Resilience ID: 44984095-441a-4b83-a981-665c691331e4)

China Rare Earth Holdings Limited is a Hong Kong-based investment holding company engaged in the manufacture and sales of rare earth and refractory products. The Group operates a rare earth separating factory and a refractory production factory.

China Minmetals Rare Earth Co., Ltd.
(STATE OWNED ENTERPRISE)

(Resilience ID: 38f02799-9eaa-4587-b192-f46646ac3f0d)

China-based company engaged in production and sales of rare earth oxides. Company's main products include single rare earth oxides and rare earth co-precipitates. Company is also engaged in the provision of geological prospecting technical services for rare earth minerals, the investment and operation of rare earth mineral rights, as well as the operation of minerals.

China Southern Rare Earth Group
(STATE OWNED ENTERPRISE)

(Resilience ID: f8951c1b-e847-4ce8-8040-247200a45cbc)

Merging with the 2 companies mentioned above along with Ganzhou Zhonglan Rare Earth New Material Technology and Jiangxi Ganzhou Rare Metal Exchange, announced in December 2021.

Chinalco Rare Earth & Metals Co., Ltd.
(STATE OWNED ENTERPRISE)

(Resilience ID: 0a998d27-1cf2-48de-bf57-93b58f75bf94)

Offers rare earth resources development services. The Company mainly mines, smelts, processes, and distributes rare earth metals, minerals, and other products. Chinalco Rare Earth & Metals markets its products throughout China.

POST-MERGER - China Rare Earth Group
(STATE OWNED ENTERPRISE)

(Resilience ID: Unavailable)

The new entity is the result of a merger of some major assets of several key State-owned producers and research organizations, including assets owned by Aluminum Corp of China, or Chinalco, China Minmetals Corp and Ganzhou Rare Earth Group Co Ltd.. The merger also includes technology and R&D companies Grinm Group Co Ltd and China Iron & Steel Research Institute Group. The state-owned assets supervision and administration commission will hold a 31.21% stake in the new group, while Chinalco, China Minmetals and the Ganzhou Rare Earth Group will each own 20.33%.

JL MAG Rare-Earth Co., Ltd.
(PUBLIC LIMITED COMPANY)

(Resilience ID: de886e30-72af-4c89-9a4d-0086d9c0a3f4)

A professional high-tech enterprise integrating R&D, production and sales of high-performance NdFeB permanent magnetic materials. The products of JL MAG are widely used in new energy vehicles and auto parts, energy-saving inverter air conditioners, wind power, 3C, energy-saving elevators, robots & intelligent manufacturing, rail transit and other fields.

China Northern Rare Earth (Group) High-Tech Co.,Ltd
(PUBLIC LIMITED COMPANY)

(Resilience ID: 7a2a5aa0-5080-44f6-aa32-d3143e453d4f)

The Company is principally engaged in the production and sale of rare earth raw materials, rare earth functional materials and rare earth application products.

Xiamen Tungsten Co., Ltd.
(PUBLIC LIMITED COMPANY)

(Resilience ID: 6fd7542e-e57c-4740-890b-886cfc6abf91)

Xiamen Tungsten Co., Ltd. is a China-based company, principally engaged in the smelting, processing and distribution of tungsten, molybdenum and other non-ferrous metal products. The Company is also engaged in the operation of rare earth business, the provision of battery materials, and property development and management businesses.

Shenghe Resources Holdings Co Ltd.
(UNKNOWN)

(Resilience ID: 865c3c44-e1a0-46b2-a899-427e59f726d3)

Shenghe Resources Holding Co., Ltd is a China-based company principally engaged in the mining, smelting and separation, and deep processing of rare earth.

Ningbo Yunsheng Co., Ltd.

(Resilience ID: 6df8aeea-f7aa-4314-996d-011b03fa7de0)

China-based company, principally engaged in the manufacture and distribution of rare earth permanent magnets and electric motors.

Hengdian Group DMEGC Magnetics Co., Ltd.

(Resilience ID: be2afe51-de33-46bb-8f50-7bbf3eb353ef)

Hengdian Group DMEGC Magnetics Co., Ltd is a China-based company, principally engaged in the operation of electronic components manufacturing and solar photovoltaic business. The Company's main products include permanent magnetic ferrite, soft magnetic ferrite, solar cell panels and other magnetic materials, rare earth materials, battery products, photovoltaic products, chassis products, moulds, gas, purifiers, new energy batteries, plastic magnetic products and others.

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About Interos

Interos is the operational resilience company. We are reinventing how companies manage their supply chains and business relationships through a breakthrough SaaS platform that uses artificial intelligence to model and transform the ecosystems of complex businesses into a living global map, down to any single supplier, anywhere. Reducing months of backward-looking manual spreadsheet inputs to instant visualizations and continuous monitoring, the Interos Operational Resilience Cloud helps the world's companies reduce risk, avoid disruptions, and achieve superior enterprise adaptability. Businesses can also uncover game-changing opportunities to radically change the way they see, learn and profit from their relationships.

Contact us today to schedule a demonstration:

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