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Securing the Strategic Materials Supply Chain



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Executive Summary

In the case of military aggression by the People’s Republic of China (PRC) against Taiwan, economic shockwaves would ripple across the Pacific. How can the U.S. prepare America’s defense industrial base for this contingency? The answer begins with ensuring access to strategic materials – the essential elements that form the foundation of the modern economy. Since the end of the Cold War, the PRC has cornered the market on a wide range of minerals and downstream processing that converts ore into modern life’s building block materials. More troubling, the PRC has also demonstrated a willingness to flex its power by temporarily cutting off exports of strategic materials to America’s partners and allies, as it did with rare earth elements in 2010 and threatened to do in 2017.

The PRC’s strategic material dominance is vast and growing. According to a 2023 estimate, the U.S. is more than 50 percent reliant on imports from China for 20 critical minerals.¹ These materials underpin nearly every aspect of the U.S. economy, including the automobile and aviation industries, green energy technologies, and the defense industrial sector. Although vulnerable, America is not without resources.

The mineral-rich landscape of the U.S. holds untapped potential that can help the nation even the playing field with the PRC. Multinational companies are eager to tap into those resources and build processing facilities to convert minerals into engineering inputs. Still, challenges remain. The lack of domestic supplies creates a strategic vulnerability vis-à-vis our peer competitors. Moreover, the economics of the mining industry often prove insurmountable. Even when the financial rewards justify the cost, prospective companies must navigate a lengthy permitting process while simultaneously winning buy-in from local stakeholders and addressing

environmental concerns. As a result, critical resources remain trapped in the earth, and the PRC continues to hold the sword of Damocles over American industry.

The following analysis recommends a comprehensive strategy anchored on three pillars, Protect, Promote, and Partner, to meet this challenge and secure America's strategic materials supply chain:

- **Protect** means replenishing America's stockpiles of strategic materials to reduce our short-term dependence on the PRC; unifying a stove-piped federal management system for mining into a streamlined, unified approach consistent with national security goals; and mapping supply-chain dependencies to understand better the source of the minerals and materials that are essential to American society.
- **Promote** includes recommendations to revitalize America's mining production and processing capabilities, update an outdated permitting process, and raise public awareness about the importance of mining to national security.
- **Partner** consists of teaming with allies to secure our supply chains, strengthen the strategic material value chains of developing nations worldwide, and disrupt ethically questionable PRC partnerships.

Effectively addressing this challenge requires government-wide unity of effort. While there have been some attempts at interagency coordination, those attempts have lacked the authority to impact resounding change. These actions require time to mitigate industry-crippling risk and prepare for aggression in the Pacific. The time to act is now.

¹ "Mineral Commodity Summaries 2023," U.S. Geological Survey, January 31, 2023, <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023.pdf>.

Introduction

The year is 2027. Tensions are boiling between the U.S. and the People's Republic of China (PRC). Hours before a U.S. Trade delegation touches down in Taipei, the People's Liberation Army launches a snap exercise that blockades the island, closing the Taiwan Straits to all shipping traffic and the air space over Taiwan. Without explanation, the PRC's Ministry of Foreign Affairs announces it has ceased diplomatic communications with Washington and halts all exports of strategic materials to the U.S. and its allies.

The export ban on strategic materials sends Western militaries into a tailspin. Deprived of its primary source of antimony, the U.S. loses its ability to produce the majority of its ammunition, weapons systems, and high-tech optics. Similarly, a shortage of Chinese-processed lithium and cobalt leaves innumerable, small, portable military weapon systems that provide the U.S. a tactical edge without necessary battery replacements. Perhaps most crippling, the PRC's dominance in rare-earth metals leaves the U.S. without the magnets it needs for technologies ranging from smartphones to stealth fighters. Furthermore, the PRC launches space capabilities unknown and beyond imagination in 2023, which outcompete U.S. technology, resulting from the PRC's strategic development of high-tech mineral science clusters.

This story has two possible endings depending on actions taken in 2023. In the first scenario, U.S. policy and lawmakers have yet to come to a consensus in 2023 on how to respond to the increasing threat of a Chinese strategic monopoly in critical materials, leaving the U.S. beholden to the PRC and its supply chain dominance. In the second scenario, the U.S. takes decisive and clear action in 2023 to secure the strategic material supply chain and is better positioned to respond in kind, maintain its ability to compete economically, and continue its strategy of integrated deterrence. **In anticipation of rising tension and a potential conflict**

between the PRC and Taiwan, the U.S. has a vital interest in restoring strategic material production and processing capability, domestically and in allied and partner nations, and securing the strategic material supply chain to achieve national security objectives.

Strategic Environment

Due to their unique properties, strategic materials are pervasive in modern society and include applications ranging from consumer goods to green energy platforms to the defense industry. For example, the F-35 uses 920 pounds of rare earth elements, the Arleigh Burke DDG-51 destroyer needs 5,200 pounds, and the SSN 774 Virginia class submarine requires 9,200 pounds.² A supply chain disruption of rare earths, such as that resulting from the increased diplomatic tensions following a blockade of Taiwan, would have a resounding impact on the defense industrial base, and production of some systems could be halted overnight.

Strategic materials are located throughout the world, and the PRC not only has significant influence over mineral extraction in many nations but also dominates mineral refining and processing, as well as downstream manufacturing of materials generated from these minerals (see Appendices A through C). According to a 2023 study, the U.S. is more than 50 percent reliant on imports from China for some 20 minerals.³

To address this challenge, the U.S. government has recognized the need to secure a reliable and sustainable supply of critical minerals and strategic materials.^{4, 5} Combining measures of economic vulnerability, trade exposure, and disruption potential, the U.S. Geological Survey (USGS) has developed a list of 50 “critical” minerals.⁶ Rare earth elements, lithium, cobalt, and graphite are critical minerals because they are essential to the manufacturing of numerous defense and commercial applications, such as smartphones, electric vehicles (EVs),

and nuclear reactors. Additionally, many of these minerals are also “strategic” materials used in various defense applications, including missile guidance systems, jet engines, and radar systems.

The crux of this challenge regarding critical minerals and strategic materials for national security lies in recognizing that these resources are vital to modern society, the U.S. economy, and the military (see Appendix D). Furthermore, the availability and accessibility of these critical minerals and strategic materials can have significant implications for U.S. national security and global competitiveness. By investing in secure critical mineral and strategic material supply chains with reliable allies and partners, the U.S. can reduce its dependence on strategic competitors, potential adversaries, and unstable foreign sources to mitigate the risk of supply disruption and protect national security interests. Furthermore, strategic material production is paramount to stay ahead of the PRC in researching and developing advanced materials, such as those needed for space and nuclear sciences. Any significant interruption in reliable and secure access to strategic materials would be deleterious to the ability to procure military equipment while creating tremendous ramifications for the U.S. economy.

For the purposes of this scenario and accompanying analysis, it is safe to assume that the U.S. would actively decry any deliberate supply chain disruption, either official (e.g., through export controls) or unofficial (e.g., unavailability in the market). Were the PRC to take such an action in 2027, it would be built on years of growing tension over Taiwan, likely in an environment of continued U.S. “strategic ambiguity” toward the fate of Taiwan. Moreover, this analysis assumes the PRC’s conflict with Taiwan would be a protracted regional conflict, similar to Russia’s invasion of Ukraine in 2022. This conflict is also expected to have resounding diplomatic impacts with innumerable other nations economically tied to the U.S. and China.

Key constraints on U.S. options in this analysis include deep-rooted globalization and limited domestic production of critical minerals and strategic materials. Moreover, the transition to clean energy and EVs drives demand for critical minerals and strategic materials, far outpacing the domestic supply of new mineral sources. U.S. environmental regulations for mining and processing critical minerals and strategic materials, managed by multiple federal and state agencies, can take up to 10 years on average for permitting, delaying and diminishing the return on investment in any mine operation.⁷ Additionally, the lack of adequate infrastructure and logistics limits the ability to transport, process, and store critical minerals and strategic materials, exacerbating vulnerabilities to supply chain disruption.

Strategic Competition with the PRC

Chinese strategic material export restrictions, spurred by conflict over Taiwan, would expose the U.S.' reliance on the PRC, not only for mineral ores but also processed minerals. Inherent economic and technological features of strategic material industries create unique challenges, particularly when the overall volume of a mineral needed for end products is relatively low while the separation and beneficiation process to produce usable raw materials is highly complex. Such challenges can substantially undermine incentives for investment within the industry. For example, the significant costs associated with processing bauxite ore to extract gallium, a critical mineral used in integrated circuits and optical devices, combined with a relatively low level of demand, causes the extraction of gallium to remain at a subeconomic production level.⁸ Strategic materials such as gallium illustrate the importance of the entire mineral value chain to national security, from the furthest upstream elements of mineral discovery through mining operations to produce ore, to mill processing operations, down through the chemical extraction techniques required to yield critical mineral concentrate.⁹

Both the U.S. and China rely on overall net imports for many strategic materials; however, the PRC's continued foreign direct investment through the Belt and Road Initiative (BRI) provides it increasing access to and control over critical mineral supply chains, such as cobalt and lithium.¹⁰ The PRC's foreign direct investments often come in the form of increased processing capacity for China at the producing countries' own expense. The PRC maintains the ability to control or dictate priority resourcing as a condition for investment.

Discussions of domestic mining operations and broader issues of supply chain resiliency play against the ominous backdrop of strategic competition between the U.S. and China. Examining China's mining industry under the Structure-Conduct-Performance framework provides unique insights into its industrial policy and highlights vulnerabilities for the U.S. Additional analysis applying Porter's Diamond framework can be found in Appendices E through H.

Shaping the battlefield through industrial policy (Structure-Conduct-Performance)

The shift to a global economy and the rise of China's industrial dominance in the 1990s largely shaped the mining industry into its current structure. In 1990, the U.S. led the global production of minerals, but it has been dramatically declining since then.¹¹ Today, the U.S. imports 100 percent of its consumption demand for 12 minerals and has a net import reliance greater than 50 percent for an additional 31 mineral commodities.¹² The geopolitical vacuum that ensued following the collapse of the Soviet Union enabled the U.S. to lead the global order toward an economic structure based on neoliberal ideology with the hopes of universally raising prosperity across a peaceful world. As a result, economic efficiency increased wealth for American firms and the national gross domestic product. Still, it eroded critical industries when

firms made strategic corporate decisions to offshore manufacturing, leading the U.S. to lose control and visibility of essential supply chains.

In contrast, the PRC “nudged” free market forces through industrial policies to specifically attract manufacturing industries leaving the U.S., including metal and mineral supply chains. China’s critical material industry flourished in the last three decades because of industrial policy, investments, and acquisitions. The PRC’s industrial policy leveraged free trade economic principles that underpinned the globalization movement of the 1990s. Specifically, China’s 13th Five-Year Plan (2016-2020) set forth a plan to become a “materials superpower” by becoming self-sufficient and the global supplier of key materials for aerospace, rail, electronic, EV, high-strength alloys, special alloys, steel, display materials, and battery materials industries.¹³ The PRC focused on rare earth elements, tungsten, molybdenum, vanadium, titanium, lithium, graphite, and other materials by investing in mining, smelting, mineral separation, complex processing operations, processing byproduct minor minerals from ore and tailings, and improving recycling of urban waste.¹⁴ China followed its 13th Five-Year Plan with the complementary “Made in China 2025” industrial policy to strategically build out the downstream industrial base that cuts across their defense, science, and technology sectors.¹⁵ Aligned with these two industrial policies, the PRC directed investment and provided capital within the mining industry from extraction through end-use products to secure the entire supply chain, even with an anticipated negative return on invested capital (at least when measured at an individual investment level). As a result, the mining industry’s current structure for many critical materials reflects the PRC’s vision of China as the “material superpower.”

The PRC commands battlefield advantage (Structure-Conduct-Performance)

The global nature of the mining industry obscures the depth of the PRC's hegemony in the worldwide supply chain. On the surface, the mining industry is highly rivalrous and globally competitive. Seven of the top ten publicly traded firms produce a diverse portfolio of commodities with assets worldwide.¹⁶ The list segments out state-owned enterprises and firms with minority stakes in mining assets but brings value to midstream processing operations like smelting and refining.¹⁷ The PRC repeatedly backs privately owned companies with state capital to acquire minority stakes in local mineral firms and junior developers.¹⁸ As the asset develops, the Chinese privately-owned companies incrementally increase their stake and influence in operations to circumvent concerns about foreign control of strategic assets.¹⁹ The PRC consistently uses this strategy throughout the critical material industry to secure its supply chains and become the world's leading mineral producer. The PRC's strategy transformed a naturally rivalrous industry into one which conceals its role as the mineral hegemon. From this hidden but powerful strategic position, the PRC can employ monopolistic behavior when it is in its interest.

Even if the U.S. secures upstream mineral extraction and midstream processing sources, firms face significant challenges countering the influence of the consolidated power from the Chinese downstream manufacturing capacity. Commodities like nickel, cobalt, lithium, and copper are traded on an exchange.²⁰ Ordinarily, commodity exchanges weaken the bargaining power of the buyer's ability to shape sellers' behaviors in terms of product quality, customer service, and driving lower prices. However, China's manufacturing scale captures the majority demand signal for many materials needed for production. For example, in the downstream material processing segment of the critical mineral value chain, China commands most of the global cathode and anode cell component manufacturing capacity and 77 percent of the world's

high-capacity battery manufacturing capacity.²¹ Because of this, the nickel, cobalt, copper, and lithium industries, for example, tend to mimic a monopsonistic market. As a monopsonist, China benefits from significant bargaining power as a buyer. This control allows China to drive the global supply, demand, and commodity prices associated with high-capacity batteries.

High entry bars, systemic delays, and the PRC's deep pockets (Structure-Conduct-Performance)

Firms seek to maximize shareholder wealth by generating and growing cash flow. However, developing a mine operation from extraction to a marketable product requires substantial capital and time. Often, firms only generate positive cash flow many years after significant capital expenditure. Because the fixed capital costs to develop a mine are high, firms that discover a resource may only initiate feasibility studies to lead to a reserve once market prices reach an economic level. The economic threshold to trigger a firm's decision to expand mining operations is driven by the supply and demand for its commodities which is, in turn, driven by the supply and demand for end-use products. As a result, the mining sector experiences dramatic periods of boom and bust due to the delayed systemic response to cost fluctuations, resulting from the high entry (and exit) barriers for the industry.

Firms seeking to develop a new asset face significant hurdles entering the industry. According to one study commissioned by the National Mining Association, the mine permitting process in the U.S. can take an average of seven to ten years due to government-imposed regulation and stakeholder interests.²² In some cases, litigation extends the permitting timeline to more than a decade. In contrast, Canada and Australia permit projects in two years, although they employ similarly rigorous regulations.²³ Unexpected delays reduce a mining project's value by more than one-third, with higher costs and increased risk associated with the permitting

process potentially cutting the expected value by half before production begins.²⁴ Once in production, firms will target the economically viable mineral to separate, refine the mineral to a marketable level, and discard uneconomical byproducts as waste.²⁵

To raise capital, firms seek investments from many sources. Large public firms may possess financial liquidity and can generate money from investors. Other firms may seek capital from venture capital or private equity firms, which seek outsized returns from an asset within a set time frame and heavily weigh risk against anticipated return on investment.²⁶ Through the framework set in the 13th Five-Year Plan, the PRC infused its firms with capital and incentives to invest in projects worldwide.²⁷ The PRC also implemented “streaming deals” to entice cash-hungry mine developers to exchange future goods produced from the asset for upfront capital.²⁸ It successfully used this tactic in Argentina to secure 41 percent of Argentina’s lithium projects, accounting for 37 percent of Argentina’s overall reserves.²⁹ Overall, firms submit to financially agreeable terms if it is in the best interest of their shareholders, generally without regard to national security implications. Their primary aim is to return value on their investments, and many will agree to terms with China if PRC funding helps achieve their purposes.

Lastly, the PRC protects its interests when the mining industry enters a downturn by subsidizing its state-owned firms, which allows them to sell output at or below cost.³⁰ Such subsidies significantly reduce risk to firms when making investment decisions to enter the market. These subsidies allow firms to remain in business longer as demand decreases, whereas unsubsidized firms ordinarily make market exit decisions. When firms exit, the PRC is willing to outbid its competitors above an economically reasonable value to acquire an asset, and, without other competitors to buy their assets, firms sell to China.³¹

While it is impossible to identify a singular concern underpinning investment decisions in every case, it is evident that the longer return-on-investment times compared to conventional ready-to-produce industries is a key factor. It can take decades between identifying and extracting the ore from the ground to generate any return-on-investment.³² This delay has many causes, but in the U.S., one primary concern is the lengthy permitting process. Permitting agencies will shift some of the blame for the delay onto applicants for failing to follow the arduous process correctly. Regardless of where the fault lies, the extensive delay reduces investment opportunities, especially for entities seeking to enter the mining industry.³³

Another critical consideration for investor hesitancy is the volatility of the commodity markets associated with mining. The best example of the consequences of dynamic pricing revolves around the price fluctuation of lithium carbonate, which is a compound to produce lithium-ion batteries, a keystone for EVs.³⁴ Over the past two years, no commodity has been as vulnerable to changes in projected demand and government-driven incentives as lithium carbonate. In July 2021, lithium carbonate was trading at around \$18 per kilogram (kg); however, after the introduction of various state incentive programs to generate more interest in EVs, that price rose to just \$80 per kg by March 2022 and remained near those levels until early 2023, when the market cratered as the PRC ended incentive programs leading to decreases in projected demand.^{35 36} While investing directly in commodities is possible, most investors focus on publicly traded companies, which feel the real-world impacts of such volatile pricing.

Firms behave on China's terms (Structure-Conduct-Performance)

The PRC's aggressive industrial policy within the critical minerals industry is an invisible hand that manipulates the behavior of firms' corporate strategies in favor of China's interests. Specifically, the PRC willingly operates and subsidizes investment in projects that other firms do

not pursue because of poor economic feasibility, regulation, perception, or geopolitical risk, especially for minerals that China lacks sufficient reserves.

For example, the PRC's interest in mining in the Democratic Republic of Congo (DRC) illuminates how China is willing to assume significant risk to secure cobalt, a mineral needed for batteries and green technology. Human rights issues plague the DRC's mining industry. Specifically, the DRC experiences violent ethnic conflict, public health crises, corruption, child labor, and unsafe work conditions.³⁷ Despite possessing ore with rich mineral density, the DRC's high political and security risks dissuade firms from developing projects or induce decisions to sell their majority stakes.^{38 39} Instead, the PRC committed to fostering a long-term relationship with the DRC to shore up its cobalt supply vulnerability and reduce the risk of operating in the DRC. China invested billions in developing mining projects in the DRC and used its other state-owned enterprises to invest \$6 billion in infrastructure projects through the BRI.⁴⁰ As a result of the PRC's long-term foreign investment strategy, China owns 10 of 18 major operational mines, controlling over half of the DRC's cobalt production. The PRC's involvement in the DRC is an example of its playbook for transactional relationship-building across the developing world. China also has a strong track record of successfully building clusters, where complementary companies and industries are co-located, along with related educational institutions and research facilities, to foster resilient partnerships between the stakeholders.

The Role of Industrial Clusters

The preceding analysis of Chinese and U.S. national competitiveness within the strategic materials industry paints a somewhat dim picture for both nations. Even though historical, empirical data indicate that the growth in the Chinese economy may have peaked as it moves

back towards a command economy, China's total industrial production may still significantly increase. This also happened to the Soviet Union in the 1950s and 1960s and lasted until inefficiencies and corruption became sufficiently prevalent to undermine the entire Soviet economic system leading to its collapse.⁴¹ If the past can teach us anything, the U.S.-led capitalist market economy is more robust and efficient than a command economy. With respect to the mining sector, however, the U.S. has issues getting timely bi-partisan agreement to change the necessary laws and regulations to streamline the permitting process and mitigate litigation risk. Therefore, it is essential to recall that the interest in securing the strategic materials supply chain is about national security and minimizing vulnerability should the PRC restrict supplies, as illustrated in the opening scenario.

The U.S. has been a global leader in research and development (R&D) since WWII, a position slowly challenged by the PRC.⁴² If the U.S. is to secure its supply of strategic materials and stay ahead as the science and technology leader, it needs to lay the foundation for an increase in industry clusters, which are important for innovation. The challenges in permitting and the threats from litigation in the U.S. are such that it may not be possible to re-shore every mineral industry, and clusters will not emerge by subsidizing single companies. However, increasing cooperation with allies and partners within this domain will help establish knowledge clusters and a minerals industry more independent of China. The Internet was one of the founding blocks for the Baldwin shift in the 1990s and the emergence of open, collaborative innovations rather than innovation by a single firm or a producer.⁴³ Today, after the COVID-19 pandemic, it is clear that communities do not need to be physically co-located to function together and share ideas. During the two years of global isolation, everything from contract negotiations to sing-along groups and work coffee breaks emerged virtually. The same possibilities exist to help in

the creation of clusters. These recent collaborative developments help to overcome traditional challenges for building clusters near mines, which are often in remote areas. The U.S. does not necessarily need to establish everything onshore in the U.S. to create clusters and maintain its preeminent position within innovation and R&D. Through increased cooperation with allies and partners and using virtual tools, clusters can be established where it makes the most sense. Whether geographically located in an allied nation or as a virtual community amongst many partner nations, these clusters can benefit U.S. strategic science needs to stay on the cutting edge of knowledge.

Natural Resources, Labor, and Specialized Human Capital

The concentration and distribution of these mineral ores, as well as the physical and chemical properties of the minerals, can have significant economic, environmental, and social impacts. Energy, water, and their associated infrastructure are essential inputs to mining and ore processing because minerals exist where they naturally occur and cannot be relocated for economic convenience. Infrastructure availability and cost significantly affect a mine's economic competitiveness. In perspective, U.S. mines use between seven and nine billion cubic meters of water a year, as much as the entire nation of Malaysia.⁴⁴ Additionally, the mining industry accounts for 3.5 percent of global energy consumption.⁴⁵ A holistic understanding of these inputs and their interactions is crucial to developing and securing a robust and sustainable strategic materials supply chain. Other factors, such as political instability, trade restrictions, or supply chain vulnerabilities, can further complicate strategic materials' economic calculus.

Another factor input is the workforce and talent necessary to extract and refine strategic materials. The mining and minerals industry requires skilled labor (e.g., plumbers, welders, and electricians) and employees with specialized knowledge and expertise in geology, chemistry,

mining, metallurgy, and engineering. However, the availability of skilled labor poses significant challenges to developing a robust and sustainable supply chain for strategic materials. Attracting and retaining skilled labor is particularly challenging for the industry. Many companies have established partnerships with local trade schools or offer in-house training programs to attract and retain talent with these hard-to-find skillsets.⁴⁶ Industry representatives note that while the professional workforce (defined as those with bachelor's or graduate degrees) seems to be robust, there are recruitment challenges related to the remote locations of many mines and other factors such as the quality of local educational systems.⁴⁷

Moreover, specialized human capital in areas such as R&D, innovation, and policy will enable the development and adoption of new technologies. These skill sets can lead to more efficient and sustainable production processes, and the discovery of new deposits and critical minerals sources and/or alternatives. In addition to addressing these factors, companies invest in innovation and technology to remain competitive.

Innovation and Technology

Some critical minerals will remain largely subeconomic without innovation in mining or processing techniques. The mining industry traditionally suffers from low levels of innovation investment with R&D totaling only 0.5 percent of revenue.⁴⁸ However, the labor intensity associated with mining operations and the continued need for environmental responsibility present an opportunity for technological advancement.

Mining innovation includes leveraging new technologies and processes to extend the life of existing mines after running into “lower ore grades, extreme weather conditions, deeper deposits, harder rock mass and high-stress environments.”⁴⁹ Productivity advances extend mine life and the viability of operations. Technology investments and autonomous, remotely operated

platforms, such as those used in Chile’s El Teniente copper mine, lower the risk of injury, mitigate health concerns, increase productivity, and lessen environmental impact while supporting the ability to capture resources from hostile environments. Additionally, innovation in the extraction process through hydraulic fracturing and confined blasting supports mining operations located in high-stress environments.⁵⁰

A renewed focus on critical mineral processing remains equally crucial to mining as the overall supply chain. Ores mined at overseas locations represent opportunities for the U.S. to obtain strategic materials as a byproduct of the extraction process for other materials. Innovations in the milling or chemical extraction processes may turn a subeconomic material into an economic one (see Appendix I).

Additionally, Information Technology (IT) advancement plays a role in making strategic materials economically viable. Improved IT enables efficient and sustainable production processes, enhances the security and resilience of the supply chain, and facilitates recycling and reuse. IT tools can identify and track supply chains from the mining and processing raw materials to their end use in various applications.⁵¹ With effective tracking and monitoring systems, the U.S. can ensure the integrity of the supply chain, prevent illicit activities, and mitigate disruptions.⁵² Furthermore, IT can assist in developing efficient and sustainable production processes, enabling the U.S. to reduce its dependence on foreign sources of rare earth elements.⁵³ Machine learning algorithms can make production more efficient and less environmentally damaging.⁵⁴ Lastly, IT can enable the U.S. to increase its recycling and reuse of strategic materials, reducing the need for new mining and processing activities.⁵⁵

State Investment and the National Role in Mining Policy

Another consideration for mining is the varied and volatile role of national governments. National strategic decisions on corporate vs. state-owned enterprises and sovereign shifts in strategy over time can nullify traditional individual investments. For example, the vast Lithium resources in Chile and the two significant corporations exploiting them, Sociedad Química Y Minera De Chile SA (SQM), a Chilean firm, and Albemarle, a U.S. firm, showcase this risk (see Appendix J).

On April 21, 2023, Chilean President Gabriel Boric announced a plan to nationalize the lithium industry in Chile. This announcement was devastating for SQM and triggered a 23% one-day decline in the firm's share price and decreased the overall outlook.⁵⁶ The stock price for Albemarle took an even more dramatic loss, but it recovered after the Chilean government decided to negotiate with Albemarle to facilitate the transition.^{57 58}

In addition to the possibility of nationalism reducing long-term profits, investors must consider tariffs and other state-imposed trade restrictions. If an investor finds a market dominated by a U.S. mining company, which is becoming rare, an opposing government could impose tariffs making U.S. exports more expensive, encouraging citizens of that country to move towards a domestically sourced mineral.

U.S. Critical Mineral and Strategic Material Policy

Recent U.S. policy actions suggest a renewed focus on strategic materials, specifically regarding the supply chain. One of the stated goals of President Biden's principles for domestic mining reform is to "secure a sustainable domestic supply of critical minerals."⁵⁹ In addition to this guidance, there have been many policy actions beginning in 2017 which are critical to fully understanding the context and current situation.

Since 2017, four executive orders have been issued regarding supply chain access to critical minerals.⁶⁰ The first of these executive orders (E.O.), “Assessing and Strengthening the Manufacturing and Defense Supply Base and Supply Chain Resiliency,” served as an important first step to addressing the vulnerability of America’s critical material supply chain.⁶¹ Through this E.O., President Trump formally acknowledged that “strategic support for a vibrant domestic manufacturing sector, a vibrant defense industrial base, and resilient supply chains is, therefore, a significant national priority.”⁶² The most recent E.O., “America’s Supply Chains,” issued February 2021, signaled unity of effort across the federal government to review supply chain capacities across multiple sectors spanning interest areas across the Departments of Commerce (DOC), Energy (DOE), Defense (DOD), and Health and Human Services.⁶³

In addition to the executive orders, President Biden has signed several pieces of legislation with critical mineral provisions, such as the \$1.2 trillion 2021 Bipartisan Infrastructure Law (BIL), and 2022’s Inflation Reduction Act (IRA) and Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act.⁶⁴ Within one year of BIL’s passage, DOE awarded nearly \$3 billion to private companies to invest in refining battery materials (such as lithium, cobalt, nickel, and graphite), battery recycling facilities, and a demonstration to recover rare earth elements and critical minerals from coal ash and other mine waste, to reduce the need for new mining.⁶⁵ The IRA and CHIPS Acts offer tax incentives for mineral processing, appropriate funds to improve federal mine permitting timelines, and fund basic mineral research, among other provisions.

Additionally, in February 2022, the White House released “The Biden-Harris Plan to Revitalize American Manufacturing and Secure Critical Supply Chains” and the “Biden-Harris Administration Fundamental Principles for Domestic Mining Reform.” Under the Plan, the

Administration announced actions to “expand domestic rare earth processing; strengthen the National Defense Stockpile; update mining regulations to ensure sustainable, responsible practices; and issue recommendations for comprehensive reform of mining laws.”⁶⁶

Furthermore, DOE agreed to award \$44 million under the Mining Innovations for Negative Emissions Resource Recovery (MINER) Program to further commercial-ready technologies that provide a “pathway toward increased domestic supplies of copper, nickel, lithium, cobalt, rare earth elements, and other critical elements required for a clean energy transition.”⁶⁷ The Principles document sets forth a framework of 11 guidelines to shape domestic mining reform.⁶⁸ These guidelines include secure a sustainable domestic supply of critical minerals, protect special places, solicit community input and conduct Tribal consultation, and provide permitting certainty.⁶⁹ These principles acknowledge the U.S. import dependence, the plethora of laws that apply to mining, the lengthy permitting process, and environmental and social considerations.⁷⁰

President Biden and President Trump both invoked Title III of the Defense Production Act (DPA) on several occasions to bolster and support their policies to secure the critical mineral supply chain. Between 2020 and 2022, eight awards exceeding \$187 million have been authorized to shore up the extraction and processing of strategic materials. This is the greatest number of awards in such a concentrated period since the authority was enacted in 1950.⁷¹ Although each of these policy actions provides a framework for the U.S. government’s approach to critical minerals and strategic materials, it does not provide a comprehensive strategy, unlike the national strategies implemented by the PRC, Canada, and the United Kingdom (UK).⁷²

The National Defense Stockpile

One critical U.S. policy is the Strategic and Critical Material Stock Piling Act of 1939. Since the initial \$100 million authorization in 1939, the stockpile has had varying levels of

support (a timeline of the history can be found in Appendix K). Fiscal Year 2022 was the first time in nearly three decades that the National Defense Stockpile Transfer Fund saw a major infusion of cash – almost \$500 million with an additional \$93.5 million in Fiscal Year 2023 – following a period when the stockpile had been drawn down by about 89 percent from its high during the Cold War.⁷³

Stock levels are to be tied to the National Defense Strategy and are supposed to be based on current war plans that DOD concurrently uses to build the base budget. These plans intend for the stockpile to satisfy requirements for the first year of conflict, assuming that supplies of critical materials have been severed, thereby justifying the need for the stockpile. Historically, policymakers assume wars will be swift and decisive. If future PRC aggression toward Taiwan is anything akin to the 20th century’s great power conflicts or even like Russia’s recent invasion of Ukraine, then a swift and decisive result is likely a faulty assumption. Therefore, it is prudent to question whether a one-year stockpile supply is sufficient for defense needs, let alone broader economic and national security necessities.

The National Defense Stockpile maintains 27 distinct materials from ores to alloys, all deemed national defense priorities.⁷⁴ The stockpile contains 20 of the 50 USGS critical minerals and seven additional materials not on the critical minerals list (see Appendix L). The stockpile also varies from other strategic reserves, like the Strategic Petroleum Reserve, in that it is purely for national defense and not an economic tool used to influence market prices.⁷⁵

Permitting process, regulations, and legal concerns in the U.S.

Another crucial policy consideration underpinning the industry is the permitting process, associated regulations, and other legal concerns. The foundational mining law in the U.S. is the Mining Act of 1872, which opened federal lands to mineral exploration and purchase with the

intent of western settlement and is still in effect. In short, individuals could head West, explore federal land, strike a claim, and, if minerals were found, purchase the land from the U.S. government for a small fee. The Act allows companies and individuals to buy, or patent, the land. However, the U.S. government stopped funding the processing of patent applications in 1994, a moratorium that remains in effect to this day.⁷⁶

This moratorium means that a mine, and investments made to it, could be reclaimed by the U.S. government which retains ownership of the land. The federal government currently controls 79.6 percent of Nevada, 63.1 percent of Utah, 61.6 percent of Idaho, 61.3 percent of Alaska, 53.0 percent of Oregon, 48.4 percent of Wyoming, and 45.9 percent of California.⁷⁷ Federal wilderness, National Park, or other designations permanently prohibit mining on much of these lands.

The U.S. has domestic resources, although not always economically viable reserves, for many of the critical minerals it imports.⁷⁸ Two key considerations created this situation. The first is the complex permitting process. Mining companies often cite this challenge as the single greatest barrier to expanding mining in the U.S. The time-consuming permitting process can cost billions before the first dollar is returned in revenue.⁷⁹ The permitting process involves engagement with multiple federal agencies, including the Department of the Interior (DOI), the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers, in addition to state and local agencies. The process includes environmental impact assessments, public comment periods, and compliance with numerous laws, such as the Clean Water Act, the Clean Air Act, the National Environmental Policy Act, and the Endangered Species Act. On May 10, 2023, the Biden-Harris Administration identified “Priorities for Building America’s Energy Infrastructure Faster, Safer, and Cleaner.”⁸⁰ These

priorities include modernizing the mining laws from the 19th century and expanding and accelerating domestic production of critical minerals consistent with robust environmental standards, Tribal consultation, and community engagement.⁸¹ Furthermore, these priorities include clear recommendations to streamline the permitting process.⁸²

The second consideration is litigation risk. When polled, the largest percentage of Americans appear indifferent to mining, with 43 percent stating they are “neither favorable nor unfavorable” to mining.⁸³ For those that have an opinion, significantly more Americans are favorable to mining (34 percent) than those who are not (23 percent). This implies a vocal minority may have an oversized effect on the mining industry. This effect is most exercised through protests and litigation. Lawsuits are a fact of life for businesses in the U.S., and mining is no exception.⁸⁴ One example is the recent 9th Circuit Court ruling against the Rosemont Copper Company.⁸⁵ In 2022, the Rosemont Copper Company successfully completed a much-delayed 15-year permitting process. However, environmentally concerned groups sued, arguing that the U.S. government incorrectly granted the permits. The 9th Circuit agreed and sent the issue back to the U.S. Forest Service, as part of the USDA, to review its permitting process. This decision places the project on hold yet again and is expected to have ramifications for the DOI’s Bureau of Land Management permit process.⁸⁶ These delays are costly to the company and perpetuate industry concerns about litigation risk.

A national crisis instigated by PRC aggression toward Taiwan may generate the necessary political will to take the hard steps to streamline permitting and provide litigation protections. However, mining’s long production lead times mean that legal relief from today’s arcane permitting system and litigation risk may be too little and too late.

Environmental, Social, and Governance Policy Issues

Another aspect of the industry that can take time to address is environmental, social, and governance (ESG) policy issues. By their nature, mining operations can be challenging neighbors. They have large industrial footprints. Extracting massive quantities of ore from the earth produces giant open pits or mountains that are literally collapsing in on themselves from above.⁸⁷ Frequently, mines are associated with noisy trucks rumbling through communities to and from processing facilities. Moreover, the tailings (or waste) from processing facilities have drawn concern from residents and local stakeholders, who fear these industrial waste ponds pose an environmental risk.⁸⁸

Research indicates that the mining industry could do better to build public trust. In its 2022 report, for example, the independent, Swiss-based Responsible Mining Foundation reported that “the vast majority of the 250 assessed mine sites across 53 countries cannot demonstrate that they are informing and engaging with host communities and workers on basic risk factors such as environmental impacts, safety issues, or grievances.”⁸⁹ It is hardly surprising, therefore, that mining companies often run into a vocal refrain of not-in-my-backyard (NIMBY) from residents and local stakeholders. In the U.S., this NIMBY-ism frequently manifests as legal challenges, as seen in the Rosemont decision, that derail or delay mining projects for years as judgments and appeals wind their way through the courts.

To address and preempt such concerns, the mining industry is focused more than ever on potential ESG issues surrounding their projects. ESG is an important industry catch-all term to highlight the interconnected concerns mining places on communities. A particular mining project’s ESG impact is a critical consideration for investors. In addition to securing extraction permits, a mining company’s ability to navigate the ESG landscape often determines whether the

firm will earn a so-called “social license to operate” from the community. This challenge raises important questions for the mining industry: What are the best practices for community engagement and public messaging? And what should the industry do to improve its public image more broadly? These questions have important national security implications as the U.S. seeks to boost its domestic supply of strategic materials and reduce its dependence on the PRC for these building blocks of modern society.

The “Iron Triangle,” consisting of the U.S. Congress, the executive branch, and defense industry, is generally a useful national security resource policy analysis tool; however, the complexity of U.S. domestic policy and ESG concerns requires a more robust model. Domestic mining’s public-private policy relationships are more akin to a multi-faceted diamond. Mining policy is forged amid intense pressures of competing interests pushing and pulling (see Appendix M). In the “Policy Diamond,” interest pressures directly affecting critical minerals emanate from one or many facets, uniting erstwhile opponents and dividing typical allies. Key players in the policy diamond include the executive branch agencies and departments, industry, advocacy groups such as lobbying organizations, the judiciary, and the legislature.

Based on the preceding analysis, eight primary recommendations have been identified in the following categories: protect, promote, and partner (see Appendix N). Various stakeholders have presented many recommendations over the years and the following recommendations reflect the highest priorities and include a combination of short-, mid-, and long-term actions to strengthen the critical mineral supply chain, decrease import dependence on China, and bolster U.S. resilience in a situation of PRC military aggression against Taiwan.

Recommendations: Protect

Replenish Domestic Stockpiles

The first recommendation is to replenish the domestic stockpile and the stockpiles of allied and partner nations. Mineral stockpiles are intended to be a short-term solution to ensure access to raw materials in wartime. Replenishing the stockpile can bolster immediate accessibility to materials while mid- and long-term solutions come to fruition.

Rather than expend cash to replenish the stockpile, as has been done in recent years, another sourcing option takes a page from targeted historical trade arrangements. In the 1930s, nations could repay their war debt to the U.S. with the equivalent price in strategic materials. Today, nations could repay their debt with strategic materials. Nations could also purchase agricultural goods, through the Commodity Credit Corporation, and military equipment, through foreign military sales and foreign military financing, in exchange for strategic materials. These trading arrangements can be piloted with some of the most needed materials.

Additionally, the Defense Logistics Agency (DLA) can be funded to accelerate the rebuilding of the strategic mineral stockpiles for targeted high-vulnerability minerals. The “peace dividend” evaporated like a mirage in the 1990s, and DLA has now relaunched its stockpiles of 47 unique commodities.⁹⁰ The stockpiles should be funded and prioritized in accordance with the risk to DOD and the manufacture of critical weapon systems. A targeted risk-based approach could significantly descope the current supply vulnerability.

Allied and partner stockpiles can augment U.S. stockpiles. The U.S. can build from existing international agreements, such as bilateral security of supply agreements, to minimize vulnerabilities in the critical materials supply chains. Free trade agreements can serve as the foundation to strengthen and, in some cases, create stockpiles in other nations. Additionally, these agreements may include provisions for signatories to access partner stockpiles if specified criteria are met.

Unify U.S. Federal Government Effort

The most fundamental step toward unifying “stove-piped” executive branch strategic materials efforts is to create unity of effort, first within the authority of the President and, more enduringly, through legislative changes. Various executive branch departments and agencies play a role in reducing strategic materials supply risk, including USDA, DOC, DOD, DOE, DOI, and EPA. Meaningful positive change toward reducing strategic material supply risk will occur when agencies work together toward a common purpose.

Nestled inside the White House’s Office of Science and Technology Policy sits the National Science and Technology Council, which oversees the Critical Materials Subcommittee (CMS). As of January 2023, the CMS is realigning to ensure compliance with recently enacted legislation, including the Energy Act of 2020 and the BIL of 2021.⁹¹ The development of a new White House strategy on critical materials remains pending during this realignment.

The White House should take advantage of this realignment as an opportunity to reconstitute the CMS as an Interagency Policy Committee (IPC) charged with addressing three core issues: (1) streamlining an outdated and cumbersome federal permitting process, (2) coordinating with allies and partners to ensure America’s long-term access to the critical materials needed for national security, and (3) fostering the development of mining clusters in the U.S. that leverage the innovation of the private sector, the expertise of academia, and the resources of the federal government. Elevating the subcommittee to an IPC is within the executive branch’s purview and will underscore the urgent need to reduce strategic material supply risk.

In the longer term, the U.S. Congress should consider a legislative change to provide continuity to this improved unity of effort. Though long debated, re-establishing the defunct

U.S. Bureau of Mines is an unrealistic recommendation with federal deficits continuing to grow. Yet even a resurrected mining bureau is limited in scope to domestic solutions. Because this issue cuts across so many agencies, it may be more prudent for the U.S. Congress to enact legislation requiring executive branch coordination rather than expanding executive branch structure. One method for forced coordination could be a Goldwater-Nichols Act-style approach to require “jointness.” Additionally, the Act should require a periodic National Strategic Materials Security Strategy similar to the requirement codified in the Goldwater-Nichols Act for National Security and National Defense Strategies. This action will integrate disparate executive branch efforts and demonstrate genuine commitment toward securing critical mineral supply chains. The U.S. Congress can further incentive unity of effort with specified strategic materials’ appropriations based on priority areas identified in the strategy.

Map Supply Chain Dependencies

The final recommendation to protect the strategic material supply chain is through validated mapping of U.S. supply chains. The Dodd-Frank Act in 2010 required certain companies to disclose their use of conflict minerals (identified as tantalum, tin, gold, and tungsten) if those minerals were in products manufactured by the company.⁹² Additionally, the U.S. Congress is trying to drive a cultural shift within the DOD, which finds itself 100 percent import reliant on 16 minerals deemed “critical” to national security.⁹³ In the last several years, the U.S. Congress has legislated mandates which require the DOD to validate sources of rare earth elements for permanent magnets and sensitive materials from non-allied foreign nations.⁹⁴ ⁹⁵ Further, the 2022 National Defense Strategy (NDS) directs the DOD to “build a resilient joint force and defense ecosystem.”⁹⁶ To meet this objective, the NDS states that the DOD must “fortify the defense industrial base, logistical systems, and relevant global supply chains.”⁹⁷

However, a 2022 report from the DOD stated it does not have visibility into low-tier suppliers, nor do they track low-tier vulnerabilities as they impact weapons programs.⁹⁸ This is after a 2017 Government Accountability Office report which warned the DOD of national security impacts due to supplier visibility.⁹⁹

Illuminating the supply chain from mine to finished product, and identifying vulnerabilities, are critical steps toward protecting U.S. strategic materials supply. Enacting legislation to require companies to identify where the strategic materials they use are extracted and refined, as Dodd-Frank did for the four conflict minerals, would provide necessary information beyond current requirements for DOD regarding supply chain dependencies, which can then be used to inform further policy decisions.

Challenges with Protecting U.S. Strategic Material Interests

Replenishing – and expanding – strategic material stockpiles to meaningfully reduce risk by 2027 comes with a significant price tag. More government spending is needed not only to purchase stockpile materials in the near-term but also for longer-term lifecycle sustainment costs to maintain stockpiles in anticipation of a “break glass” emergency. Despite the U.S.’ current strategic materials supply risk, it often takes a crisis for policymakers to prioritize risk reduction. Absent the Chinese actions described in the study’s scenario occurring, it is unlikely that the U.S. Congress will prioritize stockpile expansion over competing spending priorities. Regarding federal government unity of effort, it is conceivable that an administration elevates the CMS into an IPC to unify the executive branch. However, the real challenge lies in maintaining continuity between presidential administrations. If the U.S. Congress took legislative action to create a cabinet-level agency to handle U.S. critical mineral policy in 2023, the agency’s personnel would likely come via reorganization from other departments and agencies. The

bureaucratic staff reshuffling could take several years. Any restructuring of the executive branch would likely need to be zero growth in terms of personnel to make it feasible. Finally, supply chain mapping is an important step, but regulating secure supply chains requires regulators, which means expanded bureaucracy and cost. Additionally, in terms of strategic material supply chains, it will take many years before they do not pass through China due to the PRC's current strategic advantage.

Recommendations: Promote

Investing in Domestic Production and Processing Capacity

The first “Promote” recommendation is investing in domestic production and processing capacity, including through enhanced industrial and innovation policy. Little doubt exists about the need to expand U.S. domestic avenues for mining, production of strategic minerals, and ore processing. Continued subeconomic conditions and overall scarcity have the potential to disrupt access just as much as shifts in foreign affairs, with expended lithium batteries remaining a viable future source.

The U.S. and the current Administration moved quickly to support these efforts, most recently with DPA investments, and momentum continues in other areas to include the continued potential for bringing lithium production online through Berkshire Hathaway Energy Renewables researching the commercial viability of lithium extracted from geothermal brine.¹⁰⁰ These efforts reflect a combined approach through DOD and DOE, and additional efforts should be expanded and directed towards basic research to support existing mining operators to create greater efficiencies and possibly to explore the development of viable substitutes for the use of existing critical materials.

The U.S. government should leverage opportunities to support the criticality of domestic mining, production, and processing activities via federally supported loan programs through programs coordinated by the DOC that focus on resolving gaps in the critical materials supply chain. The use of tax incentives, including tax holidays and a tax depletion allowance, to encourage industry to reinvest in R&D should remain a continued priority to help foster the competitive growth of the domestic mining and processing industry. The mining industry's success remains a function of its profitability and competitiveness. Additional efforts should be taken to foster startup companies through loans akin to those received through DOE for Energy Infrastructure Reinvestment but identified and focused on the direct support of fulfilling the needs of the U.S. and removing materials from the USGS list of critical minerals.¹⁰¹

Reform Permitting and Litigation Processes

The second recommendation to promote strategic materials, which goes hand in hand with domestic government investment, is to remove constraints to private investment through permitting (regulatory) and litigation reform. Through a coordinated process with stakeholders, the federal government can lead the development of a clear, streamlined process to license and permit mining and refining operations, with appropriate time limits for public commentary and protections against litigation and legal action. This recommendation is intended to enhance the permitting reform work already underway, and supplement that work with litigation protection.

In consultation with industry stakeholders, the single most requested policy improvement for this industry is the idea of a standardized federal approval process to accelerate permitting new operations. Additionally, mitigating investor risk needs a more controlled legal process that will limit the miner's liability to litigation after permits for operations are acquired. This

protection is essential to draw in new capital from investors that may have previously steered away from the mining sector.

A shift in approach to meet the nation's strategic objectives comes down to resourcing for these agencies and spirals quickly into a budgetary issue. In the past, attempts to reform the existing 1872 Mining Law included the consideration of royalties in exchange for licenses to permit which could help shore up budget shortfalls within the various permitting agencies while also reinforcing a customer model that recognizes that the customer framework involves multiple customers from industry to residents who may suffer from downstream negligence.¹⁰² Amending the 1872 Mining Law to include royalties for hard rock mining may harm investment but may also be required for true permitting reform.

Build Social Consensus

The final recommendation to promote strategic materials is to build social consensus. Mining's historical environmental degradation, prior to the U.S. adopting world-class environmental standards, and a general lack of public awareness of mining's importance speak to this need. Two effective ways to build consensus include a renewed broad public relations effort and targeted communications with people locally affected by mining.

Improved public relations efforts should come from both government and industry. For the government, an effort led by DOC and coordinated with DOI, DOE, and the EPA can improve the public understanding of mines and minerals for the U.S. economy and national security. Meanwhile, consumer industries should expand their marketing endeavors to effectively communicate to the average American the essentiality of strategic materials in everyday products. While multi-billion-dollar campaigns market products like smartphones, tablets, and EVs, the public remains largely unaware that access to strategic materials serves as

the lifeblood of their supply chains. The general lack of understanding creates negative perceptions and residual impacts on the industry regarding investments, access to capital, talent acquisition, exploration, overhead costs, and local acceptance of business operations.

Mining operations often draw local opposition despite firms' emphasis on minimal environmental impacts. Greater emphasis on other positive themes may yield improved local social consensus. In a recently published study, for example, researchers explored public sentiment over Thacker Pass, a controversial lithium mine in Nevada. The study revealed two framing themes associated with support for the project: the localized economic benefits of the mine to the community and the broader contribution the mine offers to national security priorities.¹⁰³ Based on the economic impact, the researchers conclude that mining projects like Thacker Pass can win support from local communities by focusing less on climate mitigation and more on national security and local economic development. In short, these findings suggest a new way forward regarding public messaging for the mining community and an opportunity to rebrand an industry whose outdated stereotypes belie its importance to national security and competition with the PRC.

Challenges with Promoting U.S. Strategic Material Interests

Increasing federal government investment, reforming the permitting process, and building greater social consensus are not without significant challenges. Government intervention in markets alters other market actors' behavior. No policy should create artificial benefits required in perpetuity. Significant government investment to close the gap between future strategic material demand and lagging supply may create unsustainable market situations where the industry is reluctant to take on projects without government intervention. Well-meaning, but disjointed environmental regulation and a litigation-friendly climate over the

preceding generation, among other factors, likely contributed to the strategic materials risk the U.S. currently faces. Additionally, meaningful, lasting permitting reform is a tall order. Until significant action is taken to consistently reduce permitting time, private investors will likely continue to invest in other industries with lower hurdle rates and less time to achieve a return on invested capital. A major constraint is the distrust between mining companies that doubt the economic benefit of ESG standards, and environmental and social activists that highlight the risks, but undercount the economic, energy transition, and national security benefits of responsible mining. Bridging this gap to meaningfully reduce the strategic materials supply risk by 2027 will require significant political capital, time, and effort.

Recommendations: Partner

Increase Ally and Partner Supply Chain Integration

An effective national strategic materials strategy requires an international partner component, since some mineral resources are either not located in the U.S., or do not exist as economically viable reserves in the U.S. This proposed international strategy includes diplomatic and private investment components.

In 2022, the U.S. convened the Minerals Security Partnership (MSP) with Australia, Canada, Finland, France, Japan, the Republic of Korea, Norway, Sweden, the UK, and the European Union. The partnership intends to offset the risk associated with China's mineral production and processing dominance.¹⁰⁴ In addition to the MSP, the U.S. benefits from its strong bilateral relationship with Canada and other partner nations. Bolstering the MSP requires new bilateral agreements and provisions, such as trading strategic materials for military equipment purchases from the U.S., not unlike the earlier recommendation to reinforce

stockpiles. Such a provision would support the defense industrial base, establish greater supply chain resiliency, and strengthen allied military capability.

Aggressively refining these relationships into opportunities for the U.S. and other countries remains critical, especially as some mineral-endowed nations consider nationalizing industry sectors – as demonstrated by Chile’s recent announcement to nationalize its lithium production.¹⁰⁵ An enhanced MSP would focus on the larger issue of strategic materials and not just on EVs and advanced batteries to be effective.¹⁰⁶ A stronger international role also includes policies encouraging U.S. firms to invest in foreign mining sectors. For example, companies conducting foreign direct investment into partner countries to expand mining or processing capacities should be incentivized through tax policy and afforded opportunities for federally backed loans.

Strengthen developing countries’ strategic material value chains

The second partnership recommendation is to better compete with the PRC for sourcing by strengthening developing countries’ strategic material value chains. This recommendation can be achieved by providing enhanced trading status and other economic incentives to partner nations that seek to either build a resource extraction capacity or add refining capability.

This recommendation seeks to disrupt the PRC’s control of the strategic materials industry. Disruption will require coordination with partner nations through economic arrangements and defense cooperation agreements to strengthen the overall supply chains while supporting the U.S. defense industrial base. Achieving this objective will require the combined use of each partner nation’s information instrument of power to identify the PRC’s unacceptable trade practices and demonstrate a willingness to turn off China’s supply chains as a consumer without corrective action. Engagement with local civic advocacy for environmental and social

justice would create a level playing field for mining and impose costs on exploitative Chinese BRI and mineral extraction projects. The U.S. also should intervene early to broker alternative, responsible investments to promising early-stage mining projects, such as through the Supply Chain Integrity and Freedom program managed by USAID. Some value chains are more labor intensive and, due to natural resource endowments and other advantages, some critical minerals are more efficiently sourced from outside the U.S.

At the same time, strengthening the resilience of countries to respond to conflict, natural disasters, or other risks can also stabilize supply chains. The U.S. would benefit geopolitically by not ceding the space for critical mineral partnerships with developing countries to the PRC. Specifically, the U.S. should build programs to strengthen critical mineral supply chains with developing countries using tools available to the U.S. Agency for International Development (USAID), Millennium Challenge Corporation, U.S. International Development Finance Corporation, Export-Import Bank, Trade Development Agency, DOS, DOD, and other agencies. Complementary development assistance could strengthen fiscal policy, public procurement, the business climate, and environmental governance, and facilitate civic engagement in these nations to promote the social license to operate. By partnering with developing countries to secure critical materials supply chains, the U.S. can safeguard its national security and lead the way in promoting global prosperity and resiliency.

Opportunities exist in Asia, the Western Hemisphere, and Africa to scale up local production and processing to mitigate potential disruptions to the supply chain of critical minerals from China. India, for example, which has six percent of global reserves of rare earth elements despite only about one percent of global output, recently uncovered significant new sites for rare earths and lithium and is pursuing efforts to expand mineral processing.¹⁰⁷

Continuing to strengthen partnerships through other regional cooperation, such as the Quadrilateral Security Dialogue (Quad) or Australia, UK, U.S. (AUKUS) security pact, represent opportunities to invest in secondary processing and leverage this extensive network to counter influences from China's BRI and disrupt its long-term objectives.

In Africa, where there is substantial raw material sourcing but minimal processing, the U.S. and its allies could enhance the critical minerals value chain by facilitating regional integration. For example, in December 2022, the U.S. co-signed a Memorandum of Understanding with the DRC and Zambia on "Development of a Value Chain in the Electric Vehicle Battery Sector." Local value addition in countries with large copper and cobalt resources offers a development model that competes with the PRC's model and could generate a more stable source of supply for the U.S. Similarly, South Africa is a potential regional hub in that it possesses rare earth elements, platinum group metals, chromium, manganese, and other critical minerals.¹⁰⁸ South Africa also benefits from strengths in mining of iron, precious metals, and base metals, all of which have synergies for critical mineral value chains, and excellent transportation via its seaports (see Appendix O). The U.S. and its allies should aim to integrate more with South Africa as a hedge against the PRC's unpredictable policies and mercantilist trade policies. This would not require South Africa to choose, per se, but could be "both and." European and Canadian firms are investing in nearby nations such as Angola and Malawi's rare earth element potential, which could take advantage of such a hub. These cases suggest that Western investors are not only confident enough to commit resources to extract resources in promising rare earth sites in developing countries but also seek to develop global critical mineral value chains that mitigate dependence on the PRC.

Challenges with Partnering to bolster U.S. Strategic Materials' interests

Leveraging partners and allies is feasible to offset the PRC's leverage, but it does not necessarily eliminate the risk. Most key partners are oceans away, and an armed peer-to-peer conflict will endanger those supply lines. Friend-shoring supply chains without sufficient knowledge of the needs of the U.S. defense and domestic industrial base may ultimately fail to mitigate the risk in critical specific areas if these are not identified. Meaningful friend-shoring must include improved supply chain mapping. Providing U.S. miners and investors with tax shelters and loan guarantees for overseas enterprises will cost the U.S. taxpayer without any clearly defined economic return and complicate the appropriation of these funds. This incentive may be better used for domestic investment. Assisting developing countries in creating their own strategic materials value chain will require U.S. funding and cooperation with political leadership that sometimes does not share U.S. or Western values. Appropriation of these funds will be politically challenging, and cooperating with authoritarian regimes will generate international criticism of U.S. and Western hypocrisy. Any such investment must be economically viable or will lead to a loss of investment, taxpayers' money, and political face.

Conclusion

The initial scenario laid out two courses of action in 2023, resulting in a different outcome if the PRC stops exporting strategic materials to the U.S. and its allies. In a global and interconnected world, the U.S. does not stand alone; however, without clear, directive action in 2023 to promote, protect, and partner, the U.S. and its allies and partners will be unable to obtain the strategic materials needed for economic prosperity and national security in time to avert a crisis in 2027. Effectively and promptly addressing this challenge necessitates a coordinated government-wide unity of effort across all three points. These actions will require time to prepare for a conflict in 2027. The time to act is now.

Endnotes

² AY 22-23 ES Strategic Materials Industry Study engagement with federal government representative, April 27, 2023.

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⁴ The term “critical minerals” refers to minerals that are of strategic importance to the U.S. economy and/or national security of the U.S., and whose supply may be at risk due to factors such as geopolitical instability, trade restrictions, or supply chain vulnerabilities. “Critical Mineral Basics,” American Geosciences Institute, March 28, 2018, <https://www.americangeosciences.org/critical-issues/critical-mineral-basics>.

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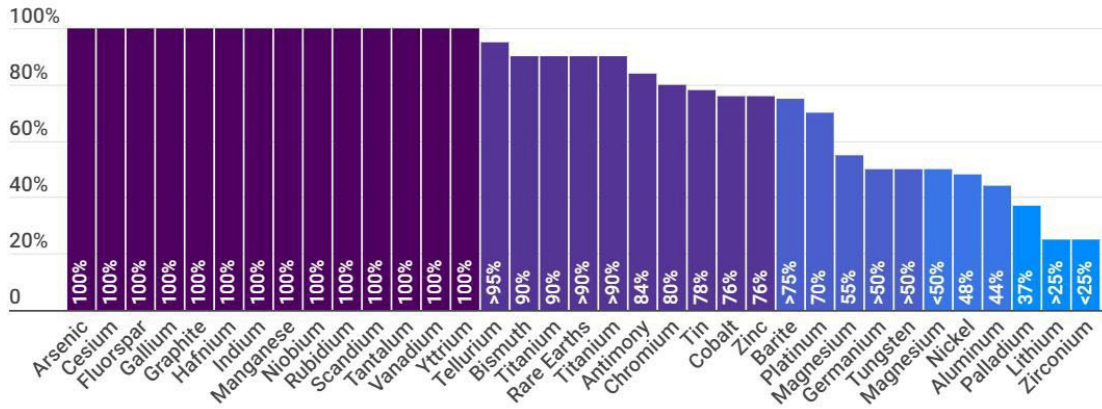
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Appendix A: U.S. Net Import Reliance

U.S. Net Import Reliance for Critical Minerals

Net import reliance as a percentage of U.S. consumption, 2021



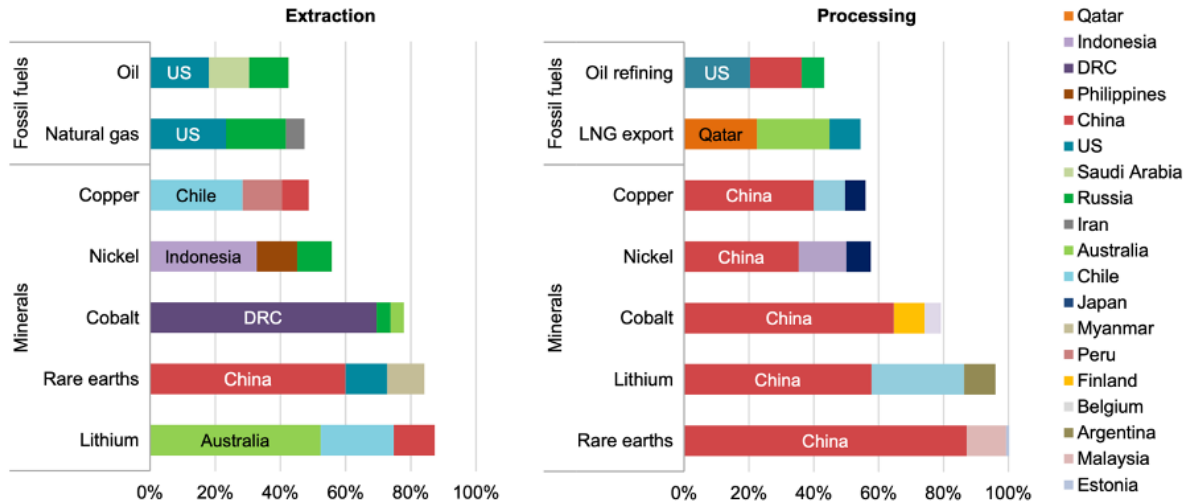
Source: [Mineral Commodity Summaries 2022](#), USGS

Source: John Jacobs and Danny Broberg. “Deploying a Domestic Mining Workforce with the Chips and Science Act.” Bipartisan Policy Center, September 30, 2022, <https://bipartisanpolicy.org/blog/domestic-mining-workforce-chips-science-act/>.

Appendix B: Global Leaders in Mineral Extraction and Processing

<<The Role of Critical Minerals in Clean Energy Tran.pdf>>

Share of top three producing countries in production of selected minerals and fossil fuels, 2019

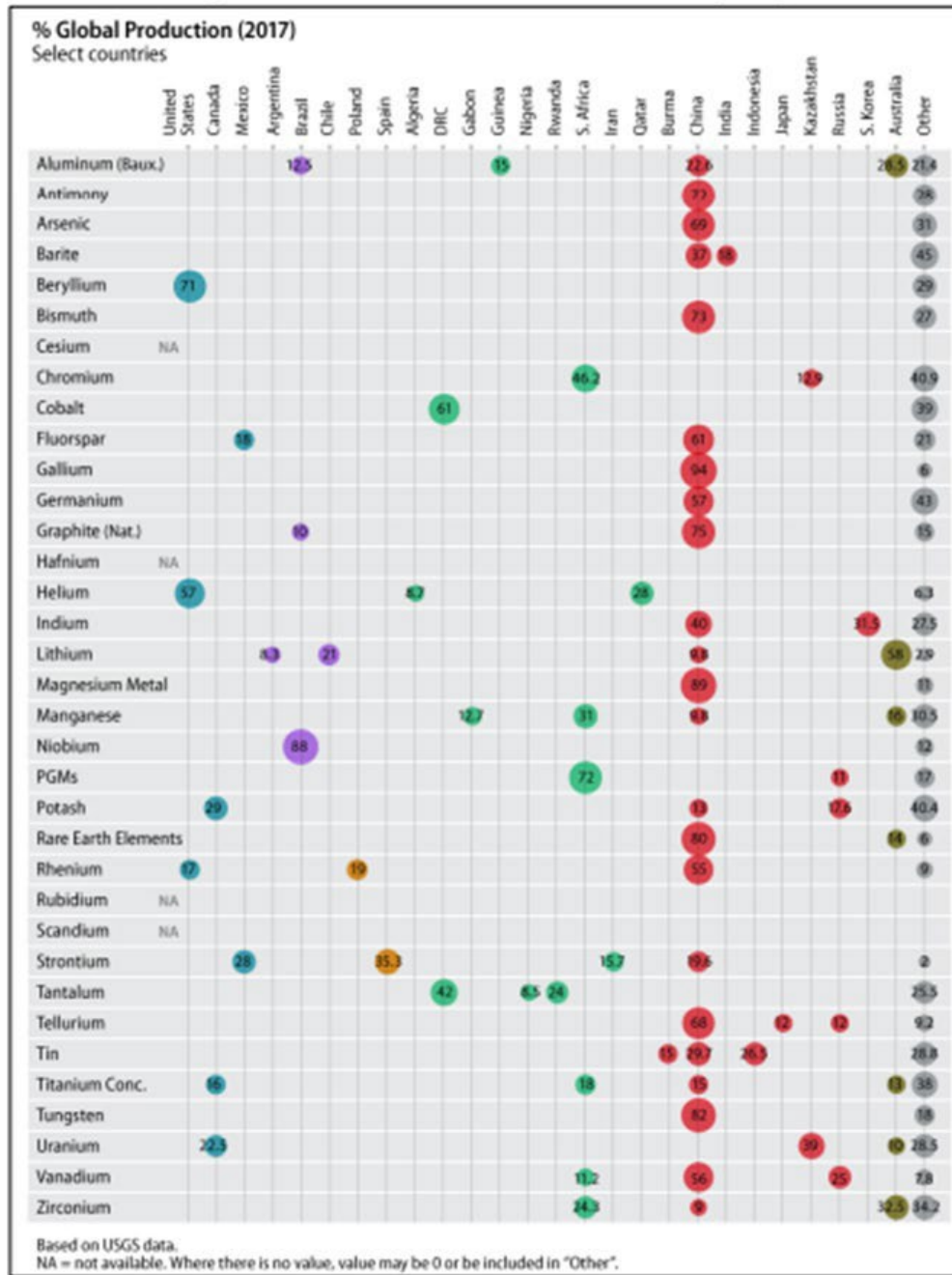


IEA. All rights reserved.

Notes: LNG = liquefied natural gas; US = United States. The values for copper processing are for refining operations.
Sources: IEA (2020a); USGS (2021), World Bureau of Metal Statistics (2020); Adamas Intelligence (2020).

Source: International Energy Agency, "World Energy Outlook Special Report: The Role of Critical Minerals in Clean Energy Transitions," March 2022, 13.

Appendix C: Global Production of Critical Minerals (2017)



Source: Figure created by CRS based on USGS Mineral Commodity Summaries, 2019.
Notes: Color codes: Blue = North America; Purple = South America; Orange = Europe; Green = Africa & Middle East; Red = Asia and Russia; Dark Green = Australia; and Gray = Other countries that are not specifically mentioned in the previous columns.

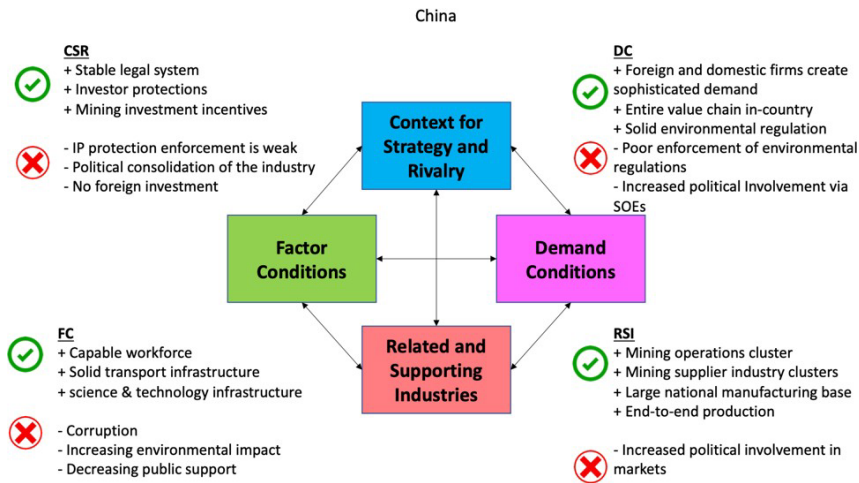
Source: Congressional Research Service, *Critical Minerals and U.S. Policy*, R45810, June 28, 2019

Appendix D: Mitre Problem Framing Canvas

PROBLEM FRAMING CANVAS: Defining the Right Problem MITRE | Innovation Toolkit

Look Inward	<p>What is the problem? <i>Describe it</i> U.S. dependence on foreign sources for mineral extraction and processing. Increasing need for minerals for defense industrial base, transition to green energy, and dual-use products.</p> <p><i>List some symptoms</i> China has cornered the market on processing and is expanding access to raw materials through BRI; 2010 supply chain disruption; 2017 supply chain threatened</p>	<p>Why haven't we solved it?</p> <p><input type="checkbox"/> It's new XX It's hard <input type="checkbox"/> It's low priority <input type="checkbox"/> Lack of resources <input type="checkbox"/> Lack of authority XX A (situational) inequity <input type="checkbox"/> Other: _____</p> <p><i>Explain more...</i> High-cost barrier to entry; challenging to secure permits and mitigate litigation risk; other nations use SOE to make the industry financially competitive; ESG concerns; lack of awareness</p>	<p>How are we part of the problem? Competing political priorities; concerns about foreign dependence are not well understood by stakeholders; lack of awareness about the need for strategic materials</p>	<p>Who experiences the problem? Military; consumers; indigenous populations</p> <p><i>When and where do they experience it?</i> Continually; will be more acute if action not taken</p> <p><i>What consequences do they experience? How do lived experiences of the problem vary?</i> Market supply disruption; inability to produce military equipment and systems domestically; mining does not leave land intact and can be damaging to cultural heritage</p>				
	<p>What assumptions and biases surround this problem? <i>Individual, system, explicit, implicit...</i> Hard rock mining is often grouped with oil/gas/coal mining; assumption that mining is dirty and environmentally hazardous; NIMBY; BANANA <i>Which of these might be redesigned, reframed, or removed?</i> Through tech and process re-design, mining is less environmentally degrading than it has been historically</p>	Look Outward	<p>Who else has it? <i>Colleagues, competitors, other domains, etc. How do they deal with it?</i> Allied and partner nations: less litigious culture; faster permitting process due to more centralized authority; Department or Ministry of Mines to advocate for and prioritize industry Nonaligned nations: partner with companies and nations who are willing to fund as much as possible with as few requirements/restrictions as possible</p>	<p>Who does not have it? <i>Colleagues, competitors, other domains, etc.</i> Diamond industry – In 2006 the World Diamond Council launched a conflict diamond education strategy in 2006. Spent \$15 million.</p> <p>Why not?</p> <p><input type="checkbox"/> Avoided XX Mitigated <input type="checkbox"/> Solved <input type="checkbox"/> Transferred <input type="checkbox"/> Other: _____</p>	<p>Who has been left out so far? <i>Let's broaden our perspective...</i></p> <ul style="list-style-type: none"> • Environmental Stakeholders • Indigenous communities • Individuals who oppose development or changes in the community • Collective mining industry (most initiatives have been by single companies) • Shareholders • Consumers 	<p>Who benefits when...</p> <table border="1"> <tr> <td> <p>...this problem exists? China Unscrupulous companies</p> </td> <td> <p>...this problem does not exist? US Defense Industrial Base Consumers Allied and Partner nations Mining Industry Shareholders</p> </td> </tr> </table>		<p>...this problem exists? China Unscrupulous companies</p>
<p>...this problem exists? China Unscrupulous companies</p>	<p>...this problem does not exist? US Defense Industrial Base Consumers Allied and Partner nations Mining Industry Shareholders</p>							
<p>Reframe</p> <p>Stated another way, the problem is: Securing access to strategic materials through domestic sources and allied and partner nations.</p> <p>Make it actionable: How might we foster a domestic competitive mining industry as we aim to diversify sourcing and limit dependence on any one source/nation? <i>(action that addresses the stakeholder/user problem)</i> _____ <i>(objective / desired condition to be achieved)</i></p>								

Appendix E: Porter Diamond, China



In its efforts to industrialize after the end of the Cold War, Chairman Deng Xiaoping strategically created geographic areas, within the confines of the authoritarian regime, with near-perfect capitalist free market economies. This combination triggered an economic development never seen before in history.¹⁰⁹ China has been the ideal case of a nation creating a national competitive advantage by improving its weaknesses and playing to its strengths for thirty years.¹¹⁰

Looking at the two foundational elements for national competitiveness, Government and Chance, Chinese Communist Party (CCP) leadership has prioritized economic growth for 30 years. Chance gave it deposits of rare earth elements it could extract, refine and produce first for Western markets, then its own. By copying the U.S. approach to federal research and development (R&D) investment in rare earth element extraction, separation, and refinement in the 1950s and 1960s, and what can seem as the same disregard for environmental concerns as the U.S. had in the same period, China managed to capture the world market and uses its market power to maintain control.^{111 112} Furthermore, where the U.S. government stopped supporting

mining, China has continued to invest and subsidize this industry, creating clusters within rare earth elements, mining, and advanced materials.¹¹³ The Chinese state subsidies directly impact the industry in China's favor.¹¹⁴ The weighted average cost of capital for state-owned enterprises in China and the required return on invested capital is therefore incompatible with markets in the U.S. and the free world and skews any competition in China's favor.

Having a government that clearly defines its ambitions and goals for economic growth has given a clear Context for Firm Strategy and Rivalry (CFSR) within the Chinese rare earth element industry. This clear context has, in turn, influenced the three other corners of Porter's diamond: Factor Conditions (FC), Demand Conditions (DC), and Related and Supporting Industries (RSI). These four factors together create a dynamic rare earth element industry supporting China's industrial and scientific ambitions. It is too early, however, to assess the impact Chairman Xi and the CCP's return to a command economy has on this industry. The Chinese state has started to pick winners and force mergers within the industry.¹¹⁵ These actions influence all four factors in the diamond. The CFSR is impacted dramatically; incentives for investment are reduced, local competition is stifled, and sound corporate management deteriorates.

Furthermore, the DC becomes unclear when the CCP has a political opinion on domestic supply and civilian unrest leads to better enforcement of environmental rules and regulations.¹¹⁶¹¹⁷ The restriction on foreign investment and foreign company involvement restricts the FC and may, in time, also reduce the RSI. As many of these changes have occurred within the last few years, and there has been a global pandemic, assessing the competitive impact of the political transition is difficult. However, Chairman Xi has poor odds when looking at the success of other

command economies throughout history. This is an appropriate time for the U.S., its allies, and its partners to incentivize a non-Chinese controlled competing rare earth element industry.

¹⁰⁹ Wayne Morrison, “China’s Economic Rise: History, Trends, Challenges, and Implications for the United States,” CRS, June 25, 2019, <https://crsreports.congress.gov/product/details?prodcode=RL33534>.

¹¹⁰ Michael Porter, *The Competitive Advantage of Nations* (New York: The Free Press, 1990).

¹¹¹ “China’s Control of Rare Earth Metals,” *The National Bureau of Asian Research (NBR)* (blog), August 13, 2019, <https://www.nbr.org/publication/chinas-control-of-rare-earth-metals/>.

¹¹² “China’s Control of Rare Earth Metals.”

¹¹³ Michael Porter, “Clusters and the New Economics of Competition,” *Harvard Business Review*, November 1, 1998, <https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition>.

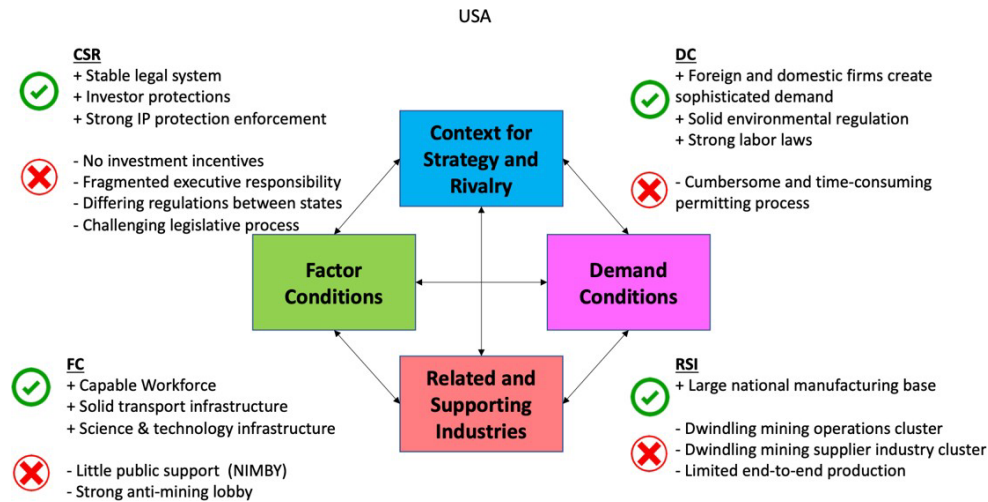
¹¹⁴ “An Assessment of China’s Subsidies to Strategic and Heavyweight Industries,” *Capital Trade Incorporated*, date unknown, accessed April 23, 2023, <https://www.uscc.gov/sites/default/files/Research/AnAssessmentofChina%27sSubsidiestoStrategicandHeavyweightIndustries.pdf>.

¹¹⁵ Qian Zhou and Sofia Brooke, “China Merges Three Rare Earths State-Owned Entities to Increase Pricing Power and Efficiency,” *China Briefing News*, January 12, 2022, <https://www.china-briefing.com/news/china-merges-three-rare-earths-state-owned-entities-to-increase-pricing-power-and-efficiency/>.

¹¹⁶ Alice Su, “The Hidden Costs of China’s Rare-Earth Trade,” *Los Angeles Times*, July 29, 2019, <https://www.latimes.com/world-nation/story/2019-07-28/china-rare-earth-tech-pollution-supply-chain-trade>.

¹¹⁷ Lindsay Maizland, “China’s Fight Against Climate Change and Environmental Degradation,” *Council on Foreign Relations*, May 19, 2021, <https://www.cfr.org/backgrounder/china-climate-change-policies-environmental-degradation>.

Appendix F: Porter Diamond, United States



The U.S. has long had a large domestic minerals mining industry. Today the industry supports approximately 1 million jobs and has one of the highest-paying average salaries in the private sector.¹¹⁸ Despite being an important industry, mineral mining has an unfortunate reputation as a dirty industry in the U.S. and is struggling with recruitment.¹¹⁹ ¹²⁰ This reputation was gained because of the environmental damage mineral and coal mining caused during the early to mid-1900s when the U.S. did not have as stringent environmental, social, and governance (ESG) laws and regulations as today. The U.S. should; however, be very competitive in terms of national competitiveness regarding minerals and rare earth element mining. It has a stable federal government focused on prioritizing a national supply chain of strategic materials, including rare earth elements.¹²¹ Furthermore, The U.S. ranks ten on the World Competitive Center's ranking, while China ranks seventeen.¹²² ¹²³ The U.S. should, in theory, be well-placed to compete with China. Like China, it has a government that defines its ambitions and goals regarding strategic materials. By chance, it has large deposits of critical minerals. The U.S. is a well-regulated, capitalist country that is open to competition and promotes sound corporate

practices. This baseline should give a clear context for firm strategic rivalry (CFSR) within the critical minerals industry. With Defense Production Act (DPA) funds, the government has supported MP Materials, the only U.S. rare earth element producer, and its only Western competitor Lynas.^{124 125} This funding signals political intent and demand for the product, establishing clear demand conditions. All factors point towards more investment in this industry in the U.S. than is the case.

The crux of the issue with investment in mining in the U.S. is threefold. The fragmented permitting process and the legislative and tax systems do not favor the long-term investments needed in the mining and processing industry. The permitting process in the U.S. is fragmented, complex, time-consuming, and costly, and even after a permit is granted, a judge may change the conditions for the permit.^{126 127} On average, it takes up to ten years to get a permit to mine in the U.S. compared to allied nations such as Australia and Canada, where permitting takes two to three years.¹²⁸ The combination of local, state, and federal requirements, including tribal requirements in some areas, combined with the U.S. tradition for litigation, makes any investment in a future mine a high-risk enterprise best left to the experts.¹²⁹ Furthermore, no tax or investment incentives exist for long-term investment in the U.S. The stock market revolves around quarterly reports, and the average holding period for shares on the U.S. stock exchange is below six months.¹³⁰ This combination creates an almost unsurmountable hurdle for any new entry into the market. In addition, the federal demand for strategic materials for national security is insufficient to drive a competitive U.S.-based mining industry alone.¹³¹ So even if the federal government prioritizes new mines and refining strategic materials, the fragmented permitting process, lack of will to invest in long-term projects, and the risk of litigation from dissatisfied

ESG stakeholders negatively influence this effort which again impacts the CSFR, factor conditions, and related and supporting industry factors in Porter’s diamond.

¹¹⁸ “Economic Growth,” Minerals Make Life, accessed April 19, 2023, <https://mineralsmakelife.org/economic-growth/>.

¹¹⁹ AY 22-23 ES Strategic Materials Industry engagements, March-April 2023.

¹²⁰ “Mining Industry Employment and Talent Challenges,” McKinsey & Company, February 14, 2023, <https://www.mckinsey.com/industries/metals-and-mining/our-insights/has-mining-lost-its-luster-why-talent-is-moving-elsewhere-and-how-to-bring-them-back>.

¹²¹ The White House, “Executive Order on the Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022,” September 12, 2022, <https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-the-implementation-of-the-energy-and-infrastructure-provisions-of-the-inflation-reduction-act-of-2022/>.

¹²² “Country Overview: USA,” *IMD World Competitiveness Online*, accessed April 19, 2023, <https://worldcompetitiveness.imd.org/countryprofile/overview/US>.

¹²³ *Ibid.*

¹²⁴ DOD, “DoD Awards \$35 Million to MP Materials to Build U.S. Heavy Rare Earth Separation Capacity,” February 22, 2022, <https://www.defense.gov/News/Releases/Release/Article/2941793/dod-awards-35-million-to-mp-materials-to-build-us-heavy-rare-earth-separation-c/>.

¹²⁵ Craig Bettenhausen, “Lynas Wins Defense Contract for Heavy Rare Earth Production,” *Chemical & Engineering News*, June 16, 2022, <https://cen.acs.org/materials/Lynas-wins-defense-contract-heavy/100/i22>.

¹²⁶ AY 22-23 ES Strategic Materials Industry engagements, March-April 2023.

¹²⁷ Scott Sonner, “Judge Affirms Stricter Interpretation of Federal Mining Law,” *Associated Press*, April 12, 2023, <https://apnews.com/article/mining-nevada-lithium-renewables-energy-d12b9c4c3f7d70f3e6f9b0f42bf81a3f>.

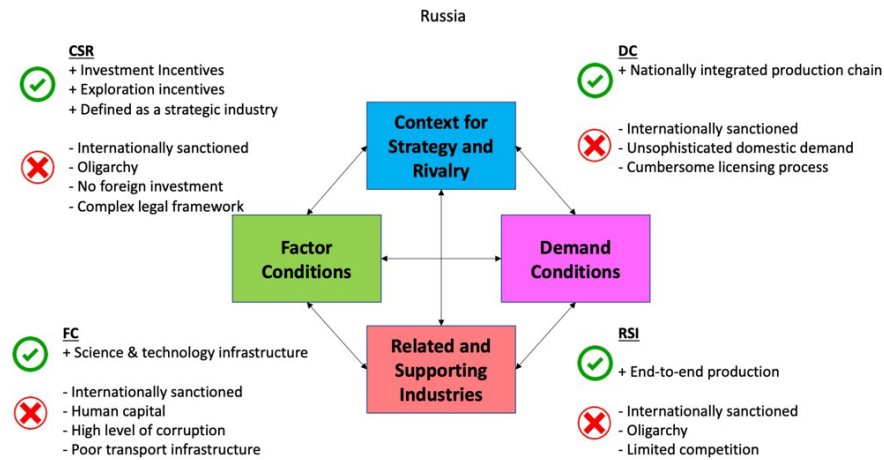
¹²⁸ Ernest Scheyder and Valerie Volcovici, “Push to Shorten U.S. Mine Permit Review Process Gains Steam,” *Reuters*, September 1, 2022, <https://www.reuters.com/business/autos-transportation/push-shorten-us-mine-permit-review-process-gains-steam-2022-09-01/>.

¹²⁹ AY 22-23 ES Strategic Materials Industry engagements, March-April 2023.

¹³⁰ Marcus Lu, “The Decline of Long-Term Investing,” *Visual Capitalist*, December 8, 2021, <https://www.visualcapitalist.com/the-decline-of-long-term-investing/>.

¹³¹ “The Geopolitics of Rare Earth Elements,” *Stratfor*, April 8, 2019, <https://worldview.stratfor.com/article/article/geopolitics-rare-earth-elements>.

Appendix G: Porter Diamond, Russia



Russia is the world's largest country and has an abundance of discovered and undiscovered natural resources.¹³² It has huge reserves of minerals and long-lasting mining traditions stretching back to the Soviet period. The government has had a clear priority on the strategic importance of mining, and the ownership of the mining industry and the resources was kept in Russian hands after the dissolution of the Soviet Union. Much of Russia's mining industry is old and obsolete, still using infrastructure from the Soviet period. Even though the mining companies and resources were national, the supporting industries necessary to modernize the Russian mining industry were Western.¹³³ The Russian economy has issues with widespread corruption, which, even before the sanctions of 2022, limited its economic development and national competitiveness. With the current international sanctions in place, the Russian mining industry faces two major challenges: (1), continuing with the industry's modernization and (2), developing the human expertise necessary to be internationally competitive and moving the mineral products to the international market.¹³⁴ Russian minerals remain important to the U.S. and its allies, and some are strategically important, so the trade in these minerals will most likely

continue short term.¹³⁵ In the long term, however, if the current regime survives the Ukraine war, the Russian mining industry will most likely pivot toward Asia, strengthening China's land access to strategic raw materials.

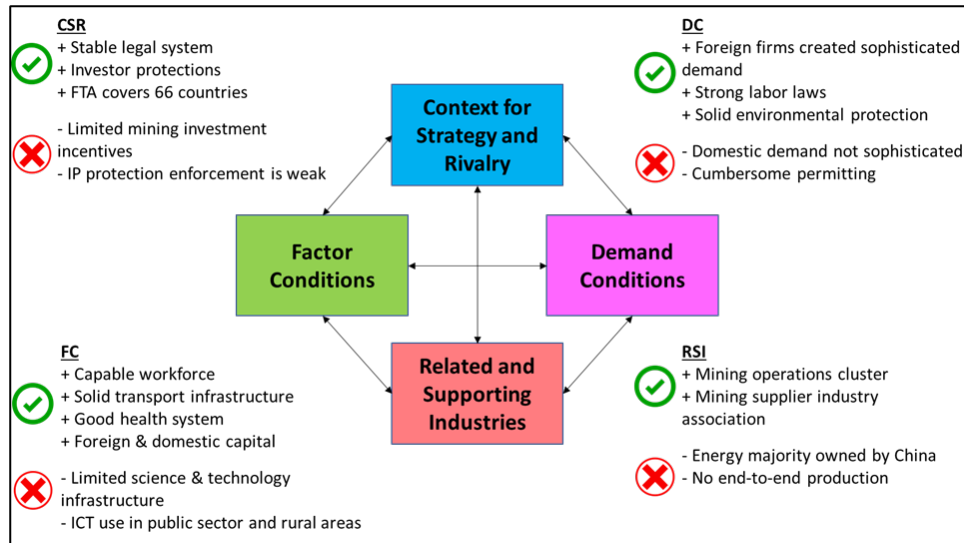
¹³² Esther Naikal, et al., "How Wealthy is Russia? Measuring Russia's Comprehensive Wealth from 2000-2017," *World Bank Group*, 2019, <https://documents1.worldbank.org/curated/en/811321575350027422/pdf/How-Wealthy-is-Russia-Measuring-Russias-Comprehensive-Wealth-from-2000-2017.pdf>.

¹³³ Florian Vidal, "Russia's Mining Strategy," *The French Institute for International Relations (IFRI)*, April 2023, https://www.ifri.org/sites/default/files/atoms/files/vidal_russiaminingstrategy_2023.pdf

¹³⁴ Ibid.

¹³⁵ Robert "RJ" Johnston, "Supply of Critical Minerals Amid the Russia-Ukraine War and Possible Sanctions," *Center on Global Energy Policy*, Columbia University, April 19, 2022, <https://www.energypolicy.columbia.edu/publications/supply-critical-minerals-amid-russia-ukraine-war-and-possible-sanctions/>.

Appendix H: Porter Diamond, Chile



Porter's Diamond reveals that Chile has many strengths which allow it to compete globally in the mining industry. Its capable workforce, access to foreign & domestic capital, good health system, and solid transportation infrastructure are the factors in its favor.¹³⁶ The large increase in enrollment at the college level provides skilled workers and enhances competitiveness.¹³⁷ The robust transportation infrastructure, especially its highway and road system and maritime and ports along the coastline, supports logistics and supply lines for mining and trade.¹³⁸ In the area of context for strategy and rivalry, Chile's stable legal system, investor protections, and free trade agreements foster its ability to compete.¹³⁹ The demand conditions are mixed with sophisticated demand from foreign firms to go with strong labor laws and solid environmental protection. Chile has a strong cluster for mining operations for related and supporting industries, primarily in the machinery, environmental solutions, energy, and transportation sub-sectors.¹⁴⁰ The cluster has spawned mining operations innovations such as automated transportation and remote drilling operations. In addition, the supplier industry has an advocate in its mining supplier industry association.¹⁴¹ The efforts of the mining supplier

industry association enable Chile to compete through efforts to internationalize and conduct business globally, foster long-term business, and cultivate competition.

While Chile has many strengths, Porter's Diamond also uncovers Chile's weaknesses in its ability to compete. It does not have a strong science & technology infrastructure and does not spend much on research & development, which limits its ability to innovate.¹⁴² Additionally, information and communications technology (ICT) is less widely used in the public sector and rural areas. In the context of strategy and rivalry, Chile has limited incentives for mining investments, and its intellectual property (IP) protection enforcement needs to be stronger.¹⁴³ For demand conditions, Chile's domestic firms do not have sophisticated demand. In addition, court proceedings and environmental permitting have recently become cumbersome, slowing down approvals of large projects.¹⁴⁴ The current administration favors streamlining the process to encourage foreign investment. Chile does not possess majority ownership of its energy production for the related and supporting industries.¹⁴⁵ In addition, the clusters are limited to mining operations. Despite its increase in skilled workers from increased college-level enrollments, there has yet to be an increase in end product manufacturers or end-to-end producers, especially in emerging industries such as renewable energy technologies.

Overall, Chile's positive factors in Porter's diamond framework allow it to compete globally. The infrastructure, strong governance, and efforts to attract foreign investment drive its competitiveness. Chile's mining supply industry also makes a concerted effort to foster domestic and international competition. While Chile does have weaknesses, its drawbacks are growth opportunities and expand its ability to compete.

¹³⁶ Juan Manuel Costa, “Chile Mining Sector 2022-2023,” *EMIS*, accessed May 19, 2023, <https://interactive.emis.com/chile-mining-sector-report-2022-2023>.

¹³⁷ U.S. Department of State, “Chile (blog),” accessed April 24, 2023, <https://www.state.gov/reports/2021-investment-climate-statements/chile/>.

¹³⁸ Costa, “Chile Mining Sector 2022-2023.”

¹³⁹ “Chile.”

¹⁴⁰ Lucrezia Falcidia and Germaine Aboud, “Chile Mining 2021,” *Global Business Reports*, June 18, 2021, <https://www.gbreports.com>.

¹⁴¹ Ibid.

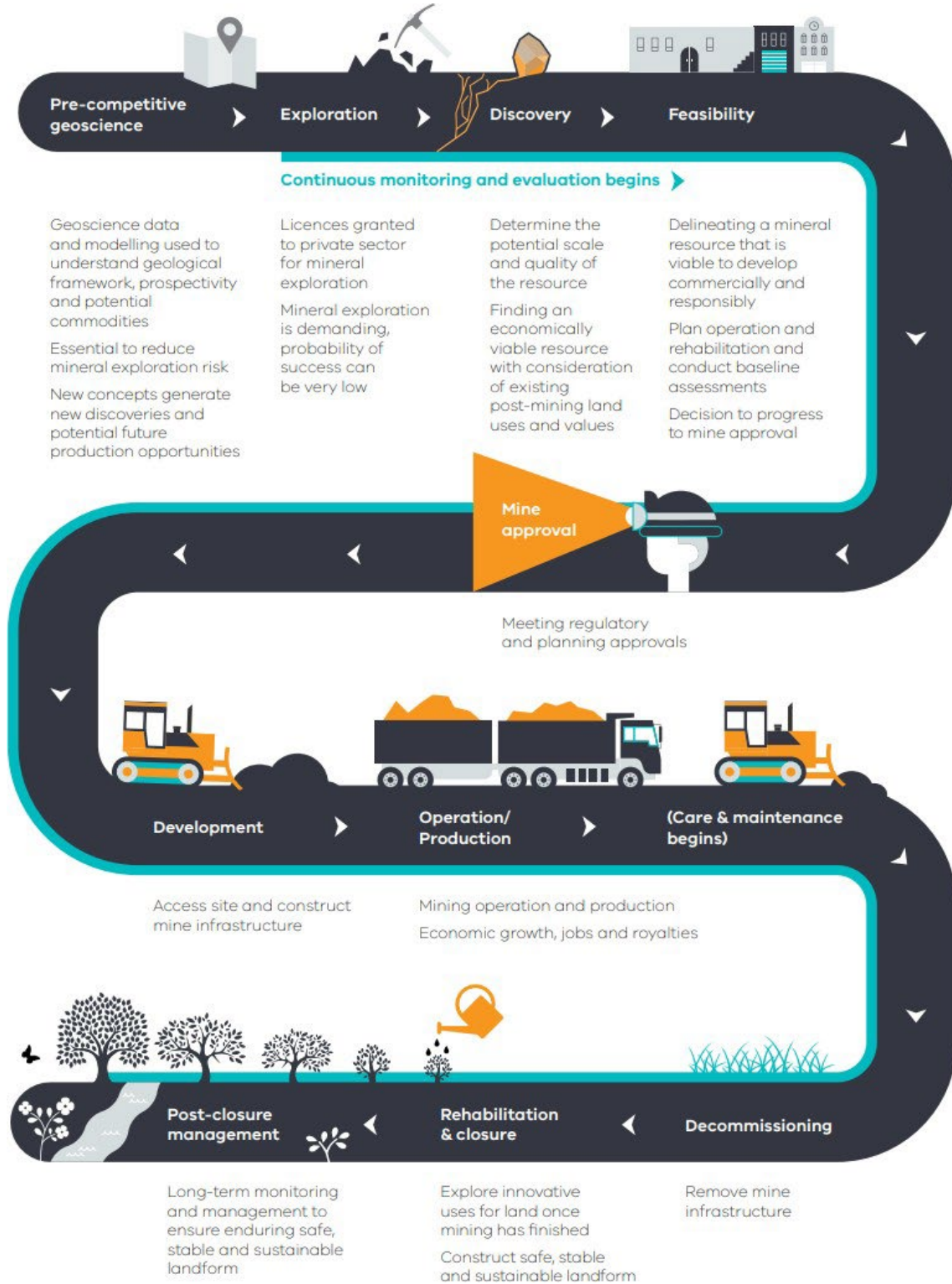
¹⁴² Costa, “Chile Mining Sector 2022-2023.”

¹⁴³ “Chile.”

¹⁴⁴ Ibid.

¹⁴⁵ Costa, “Chile Mining Sector 2022-2023.”

Appendix J: Mine Life Cycle



Source: Victoria State Government, “State of Discovery: Mineral Resources Strategy, 2018-2023,” 2018, 5, https://www.vgls.vic.gov.au/client/en_AU/search/asset/1297069/0.

Appendix J: Context for Chile's Mining Industry and U.S. National Security

Chile's mining industry plays an indirect role in U.S. national security. The minerals it produces, mainly copper and lithium, form the initial supply chain for end-user products to feed U.S. commercial and defense systems. For example, Aluminum-Lithium alloys are lighter and stronger than standard aluminum alloys and are ideal for use in aerospace systems.

Chile's ability to compete provides a reliable source of copper and lithium for the U.S. while decreasing reliance on China for the same resources. Maintaining a good relationship with Chile benefits the economies and national security of Chile and the U.S. In 2021, the U.S. imported \$8.78 billion worth of copper, where \$6.47 billion is from Chile.¹⁴⁶ Meanwhile, from 2016 to 2019, the U.S. imported approximately 36 percent of its lithium from Chile.¹⁴⁷ In addition, it is important for Chile to successfully compete internationally in mining and mining supplier industries to avoid China providing capital and ultimately possessing controlling interests in Chilean mining.

Recently, the President of Chile, Gabriel Boric, announced plans to nationalize the lithium mining industry. The effort to nationalize lithium mining would follow Mexico in nationalizing its lithium mines in 2022.¹⁴⁸ Additionally, there have been discussions among Argentina, Chile, Bolivia, and Brazil to set up an organization such as the Organization of the Petroleum Exporting Countries (OPEC) for lithium.¹⁴⁹ Such an organization would impact the prices and supply of lithium, much like OPEC does with crude oil. Potential downstream effects include end product supply chain issues, geopolitical leverage by the 'lithium OPEC,' and price fluctuations from the organization's decisions.

From a diplomatic, information, military, and economic (DIME) perspective, the U.S.-Chile relationship plays a role in national security. With the reliance on copper and lithium

imports from Chile, the U.S. must continue to foster diplomatic relations with Chile and maintain trade to ensure a secure supply chain while boosting the economies of both countries. Although the U.S. produces copper, the imports from Chile supplement demand. For lithium, the U.S. must consider boosting lithium processing at home or with close allies, pending the ‘lithium OPEC’ outcome. China continues to offer infrastructure to Chile for lithium processing in exchange for priority in lithium concentrate, but the nation has rebuffed its efforts.

¹⁴⁶ “United States Imports from Chile of Copper - 2023 Data 2024 Forecast 1991-2021 Historical,” accessed April 24, 2023, <https://tradingeconomics.com/united-states/imports/chile/copper>.

¹⁴⁷ DoE, “FOTW #1225, February 14, 2022: From 2016-2019, over 90% of U.S. Lithium Imports Came from Argentina and Chile,” February 14, 2022, <https://www.energy.gov/eere/vehicles/articles/fotw-1225-february-14-2022-2016-2019-over-90-us-lithium-imports-came>.

¹⁴⁸ Alexandra Sharp, “Chile’s White Gold Rush,” *Foreign Policy*, April 21, 2023, <https://foreignpolicy.com/2023/04/21/chile-lithium-reserves-albemarle-sqm-nationalize-boric-santiago/>.

¹⁴⁹ “Chile’s Lithium Nationalization Plan May Have Negative Impact on China’s Supply,” *Global Times*, April 24, 2023, <https://www.globaltimes.cn/page/202304/1289705.shtml>.

Appendix K: Timeline of National Defense Stockpile

June 1922 – Joint Army Navy Munitions Board (ANMB) established.

Early 1920s – ANMB Published report inventorying domestic mineral supplies. First recommendation of a national stockpile.

1922 – Congress passed the Fordney-McCumber Tariff – protectionist legislation which was designed to spur domestic production of minerals.

Feb 1934 – Office of the Assistant Secretary of War developed a strategic stockpile plan (even recommended a payment in-kind of strategic materials to settle war debts, however no action was taken). Suggested a 24-month build-up of a reserve to sustain conflict once M-day began.

1937 – S.R. 4012 (Thomas Bill) gave U.S. Bureau of Mines responsibility for continuing studies of strategic materials and for developing existing domestic reserves.

1938 – H.R. 1608 (Naval Appropriations Act of 1938) is passed appropriating \$3.5M for the first stockpile.

1939 - \$500K additional appropriation for Navy stockpile.

7 June 1939 – PL 117-76 (The Strategic and Critical Stock Piling Act of 1939) authorized \$100M over FY40-43, included \$500K for exploration and development.

9 August 1939 – PL 361-76 Appropriations act only appropriated \$10M of the \$100M authorized.

11 August 1939 – Congress enacted law to create the Commodity Credit Corporation under USDA to exchange surplus agricultural goods from the US for strategic materials from foreign countries.

1940 - \$500K additional appropriation for Navy stockpile.

25 March 1940 – Additional \$3M appropriated for National Stockpile (PL 442-76).

26 June 1940 – Additional \$57M appropriated for National Stockpile.

28 May 1941 – Amended Sec 6 of PL117-76 to authorize a revolving fund to support disposal and repurchase from the national stockpile.

Summer 1941 – General George Marshall develops Victory Plan to show production estimates of the services wartime needs.

1944 – PL 457-78 (War Surplus Act of 1944) – provided for the transfer of government owned surpluses to the National Stockpile.

23 Jul 1946 - PL 520-79 (Strategic and Critical Materials Stockpiling Act of 1946) – Department of Defense retained control over strategic stockpile. Overturned Buy America Act provisions from original stockpile act of 1939.

1987 – Congress transfers responsibility of the National Defense Stockpile to Defense Logistics Agency (DLA).


25 Feb 2022 - Departments of Energy, State and Defense executed a memorandum of agreement to launch an effort to include critical minerals necessary for the transition to clean energy alongside those needed for defense purposes. The memorandum created a new, interagency process for stockpiling minerals that enables vital clean energy technologies.

15 Mar 2022 – Congress appropriated \$125M for the NDS (PL 117-103). First new appropriation in the last three decades.

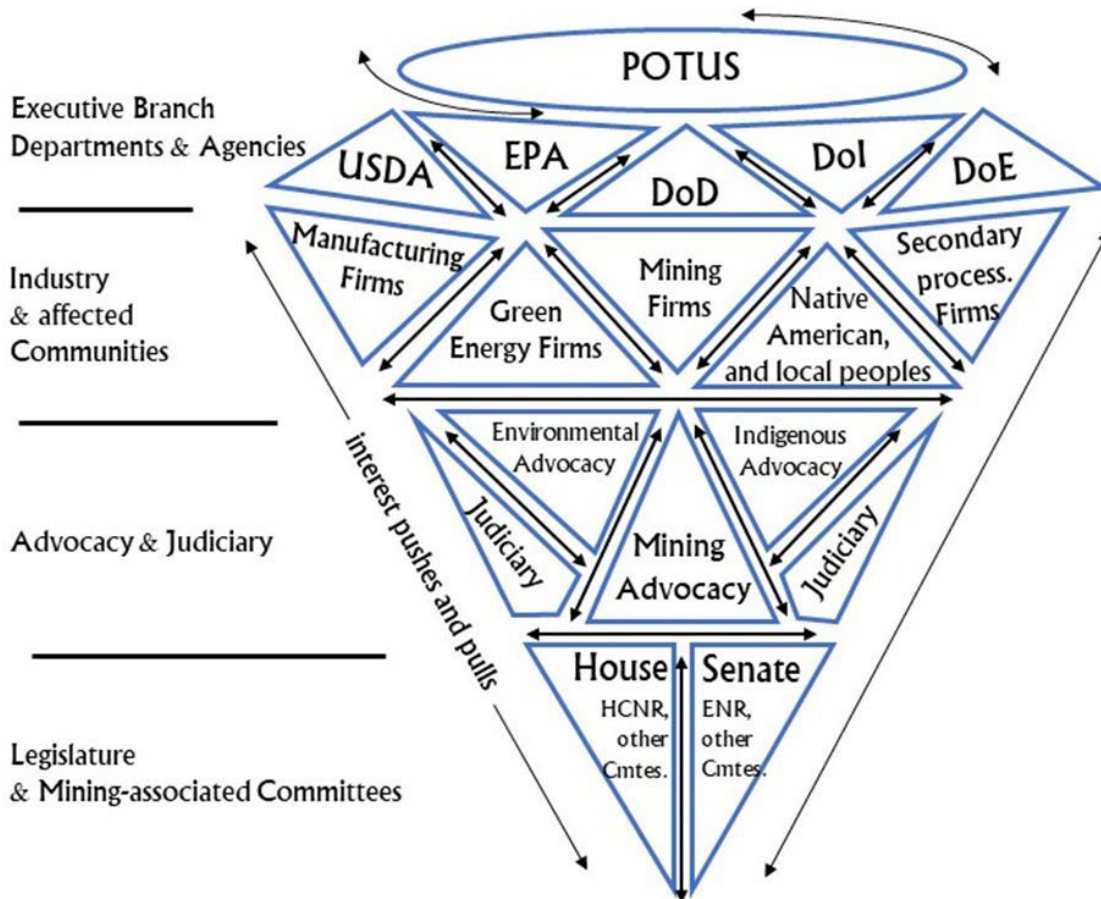
29 Dec 2022 - Congress appropriated \$93.5M for the NDS (PL 117-328). Down from the \$253.5M requested in the President’s Budget.

Appendix L: National Defense Stockpile and USGS Critical Minerals List Comparison

Alloys	Metals	Miscellaneous Non-Metals	Rare Earths	Ores and Compounds	Precious Metals
Cadmium Zinc Telluride	Aluminum	Carbon Fibers	Cerium	Fluorspar	Palladium
	Antimony	Quartz Crystals	Dysprosium	Graphite	Platinum
	Arsenic	Plastic Bonded Explosive (TATB)	Erbium		Barite
	Chromium		Europium		Beryllium
	Cobalt		Gadolinium		Bismuth
	Columbian Metal Ingots		Holmium		Cesium
	Gallium		Lanthanum		Germanium
	Hafnium		Lutetium		Rhodium
	Indium		Neodymium		Rubidium
	Iron Alloys		Praseodymium		Ruthenium
	Iridium		Samarium		Tellurium
	Lithium		Scandium		
	Magnesium		Terbium		
	Manganese		Thulium		
	Mercury		Ytterbium		
	Nickel		Yttrium		
	Niobium				
	Tantalum				
	Tin				
	Titanium				
	Tungsten				
	Vanadium				
	Zinc				
	Zirconium				


 Items with No highlight are only on the USGS Critical Minerals List
 Items highlighted in yellow are on both the USGS Critical Minerals List and in the NDS
 Items in Red are in the NDS but NOT on the USGS Critical Mineral List

Appendix M: The U.S. domestic Critical Mineral “Policy Diamond”



Legend*

DoD: Department of Defense
 DoE: Department of Energy
 DoI: Department of Interior
 DoL: Department of Labor
 ENR: Senate Committee on Environment and Natural Resources
 EPA: Environmental Protection Agency
 HCNR: House Committee on Natural Resources
 POTUS: President of the United States
 USDA: U.S. Dept. of Agriculture

** Not pictured are State and Local governments and other interest groups*

Source: LTC Michael C. Hunter, U.S. Army, AY 22-23 Strategic Materials Industry Study

Appendix N: Coordinated Strategy

STRATEGIC SITUATION:

Problem Statement: PRC dominance in certain strategic materials, especially in processing, giving it the ability to cut off supply to the U.S. and its allies and disrupt markets, jeopardizing the defense industrial base and economic security. It is likely to exercise this leverage in a future conflict over Taiwan.

Interests: The U.S. has a vital national interest in reliable access to strategic materials needed for its defense industrial base and economic prosperity.

Political aims: Limit the PRC’s ability to wield control over strategic materials to disrupt U.S. military and economic capabilities and constrain U.S. political action.

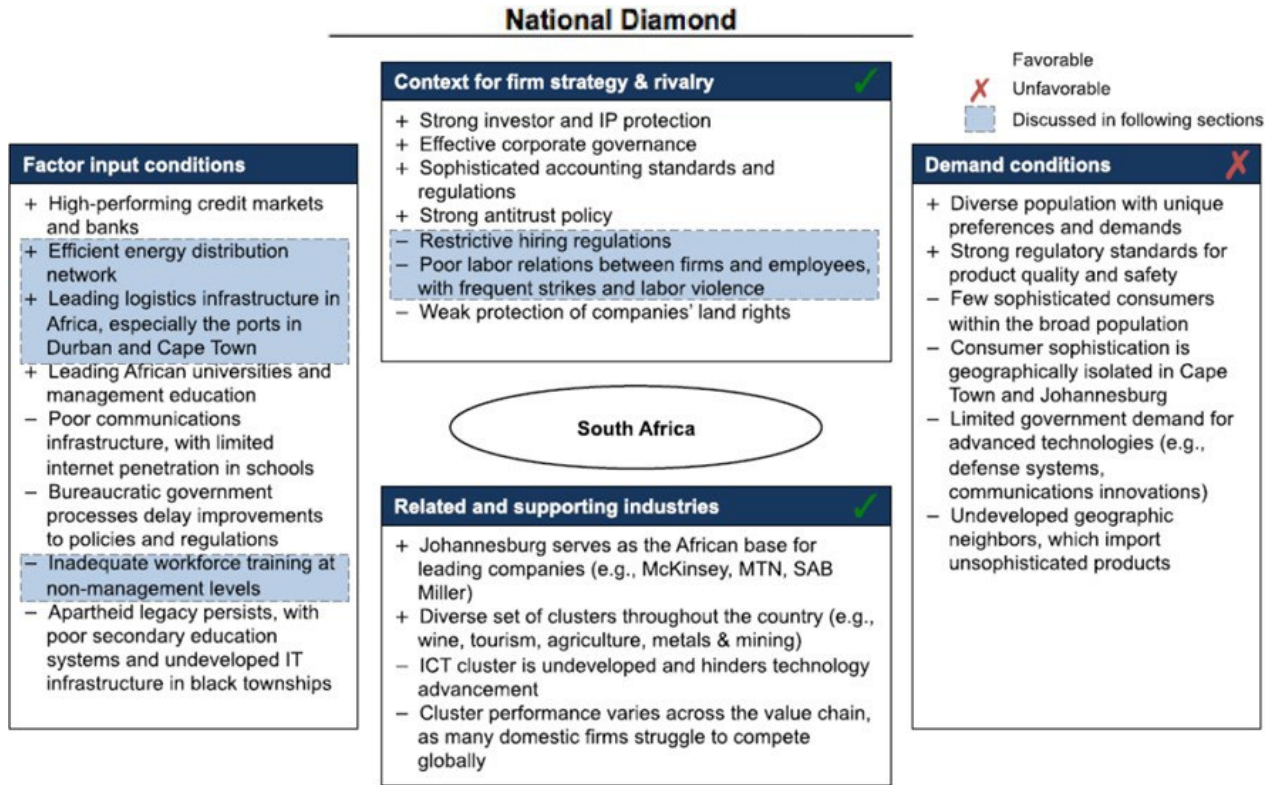
Threats: Using its monopolistic control of key supply chain chokepoints, the PRC could restrict strategic materials to the U.S.

Opportunities: The U.S. has untapped natural resources, financial, organizational, technological, and human potential as well as a network of allies and partners to challenge the PRC’s dominance.

Ends/Specific Objectives	Ways	Means	Risks/Costs
<p><u>Protect</u> defense industrial base against short-term supply chain disruptions.</p>	<p>1. Replenish the domestic stockpile and stockpiles of allied and partner nations.</p> <p>2. Sponsor an IPC to plan, direct, and coordinate Federal actions regarding strategic materials.</p> <p>3. Compel companies to map supply chain dependencies.</p>	<p>(I) Amend stockpiling rules and practices. (DOD/DLA)</p> <p>(D,E) Encourage allies/partners to expand stockpiling. (DOD/State)</p> <p>(I,E) Coordinate and resource national strategy (NSC/DPC/OMB/DOD/DOC/DOI/USDA/EPA/DOS/USAID)</p> <p>(E) Introduce and enact legislation on supply chain mapping. (Congress, DOD, SEC, Treasury)</p>	<p>Cost of stockpiling. Administrative burden of additional requirements.</p> <p>Increased budgetary cost of strategy, grants.</p>

Ends/Specific Objectives	Ways	Means	Risks/Costs
<p><u>Promote</u> to reduce U.S. import dependence on the PRC for strategic materials</p>	<p>1. Incentivize domestic production and processing capacity.</p> <p>2. Remove regulatory/litigation barriers to private investment in mineral extraction & processing.</p> <p>3. Build social consensus for strategic material sourcing.</p>	<p>(E) Offer loan guarantees, tax incentives, tax holidays, and tax depletion allowances. (DOD/DFC/DOC/DOE/USTR/Treasury/DOI/EPA/USDA/EXIM)</p> <p>(I) Enable permitting regulation reform and implement litigation protection for mineral extraction and processing. (Congress/DOE/DOI/USDA/EPA/OMB/DOJ/state agencies)</p> <p>(I) Organize public education and multistakeholder input on strategic material needs and tradeoffs (DOD/DOI/USDA/DOE/EPA/state government/industry/civil society organizations)</p> <p>(I) Expand company and consumer adoption of responsible mineral sourcing (DPC/OMB/DOC/USTR/DOI/EPA/OECD/UN)</p>	<p>Budgetary cost for incentives, subsidies.</p> <p>Increased risk of unresolved social disputes and perceived risk of increased environmental damage.</p> <p>Risk outreach and dialogue may polarize rather than reach consensus.</p>
<p><u>Partner</u> to diversify global supply chains and limit PRC monopoly power</p>	<p>1. Persuade allies and partners to forge supply chain relationships that do not depend on the PRC.</p> <p>2. Enable developing countries to enhance strategic material value chains.</p>	<p>(D) Expand global/regional partnerships and bilateral supply chain sourcing coordination (State, DOD, DOC, DOE, USAID)</p> <p>(D,I,E) Assist developing countries' capacity to upgrade extraction and processing governance, infrastructure, workforce, and networks. (USAID, MCC, DFC, EXIM, TDA)</p> <p>(D,E) Promote global ESG mining standards (State, DOC, DOE, USAID)</p>	<p>Risk of escalation, retaliation by PRC.</p> <p>Risk of fragmenting global commodity markets.</p> <p>Risk that ESG standards may restrict U.S./allies more than PRC.</p> <p>Increased cost of foreign assistance.</p>

Appendix O: South Africa National Competitiveness



Source: Dr. Peter J. Coughlan, AY22-23 Strategic Materials Industry Study class presentation

Appendix P: Essays on Selected Topics. U.S./Ukraine/Russia - impacts to mining

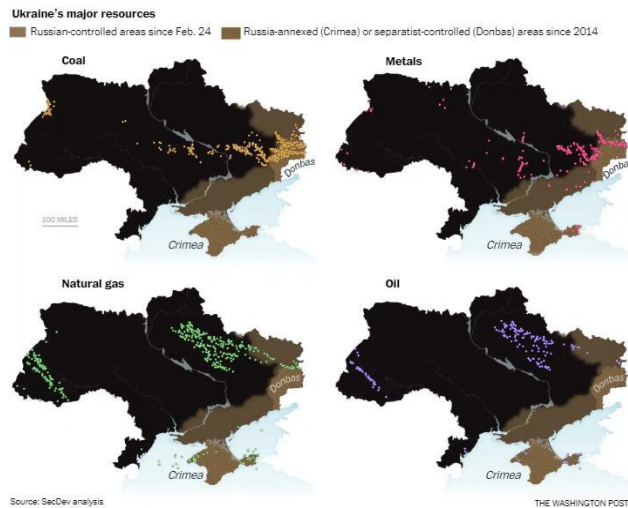
On 24 February 2022, Russian President Vladimir Putin ordered an unprovoked military invasion against the sovereign country of Ukraine. The Russo-Ukraine conflict provides a glimpse of how a conflict, even when regionalized, can drive widespread supply chain disruptions to a globalized economy. The Russo-Ukrainian conflict is the “first major interstate conflict since the decade-long U.S. policy focus on critical minerals began with the 2010 Chinese embargo on rare exports to Japan.”¹⁵⁰

Impacts on the mineral and mining industry are often not acute; it is not uncommon for minerals to be single-source, or, in some instances, production disruptions alone can skyrocket the respective commodity market. Russia and Ukraine are no exception and have a long history of mineral exports. How have these exports been disrupted since the onset of the conflict? Understanding these mineral and mining impacts must be understood. Moreover, the conflict should drive broader U.S. national security questions. How can countries respond when faced with mineral and mining disruptions? How can future disruptions be mitigated? The mineral and mining industry is pivotal to the global economy and supply chain. The U.S. must use the Russo-Ukraine conflict, the resulting impacts on the mineral and mining industry, and self-assess Western dependency on critical minerals that unpin the U.S. economy and national security projection.

Ukraine - Mineral and Mining Industry

The mining industry in Ukraine has been hit hard since the onslaught of the Russo-Ukrainian conflict. Before the full-scale invasion by Russia, “the mining and metal complex of Ukraine provided about 10 percent of gross domestic product and 33 percent of exports.”¹⁵¹ Moreover, “Ukraine harbors some of the world’s largest reserves of titanium and iron ore, fields

of untapped lithium, and massive deposits of coal.”¹⁵² These reserves are estimated to be worth tens of trillions of dollars.¹⁵³



Survey, U.S. Geological. “Mineral Commodity Summaries 2023.” Mineral Commodity Summaries. The U.S. Geological Survey, January 31, 2023. <https://pubs.er.usgs.gov/publication/mcs2023>. (Figure 2¹⁵⁴)

Many of Ukraine’s reserves are in the country’s eastern region, which is occupied by Russian forces. Moscow is currently exploiting this critical resource to the Ukrainian economy as part of a deliberate effort for the war campaign:

*According to Ukrainian mining and steel industry executives, [the Kremlin] has seized: 41 coal fields, 27 natural gas sites, 14 propane sites, nine oil fields, six iron ore deposits, two titanium ore sites, two zirconium ore sites, one strontium site, one lithium site, one uranium site, one gold deposit and a significant quarry of limestone previously used for Ukrainian steel production.*¹⁵⁵

Stanislav Zinchenko, chief executive of GMK, a Kyiv-based economic think tank, said, “This is what Russia wants. The worst scenario is that Ukraine loses land, no longer has a strong commodity economy, and becomes a nation unable to sustain its industrial economy.”¹⁵⁶

Before the conflict, Ukraine produced 3.3 percent of the world’s iron ore in 2021.¹⁵⁷ This is not a significant portion but “any prolonged military campaign will severely impact annual

iron ore exports, eventually tightening the global balance,” said Atilla Widnell, managing director at Navigate Commodities in Singapore.¹⁵⁸ This statement highlights how even minor disruptions, when measured at the scale of the entirety of the iron ore market, can create a pinch point for the rest of the global economy.

Even beyond iron ore, Ukraine had ‘approximately 500,000 tons of high-quality lithium and vast quantities of rare earth elements and was poised to be a key player in the global transition to green technology.’¹⁵⁹ On the contrary, experts now predict foreign natural resource development in Ukraine is probably off the table after the war as investors will not want to deal with the landmines and unexploded ordnance left behind from the war.¹⁶⁰ This is a major setback from the once promising country that recently signed a raw materials strategic agreement with the European Commission in 2021. This agreement had already positioned foreign mining companies to secure Ukrainian exploration permits, but these companies have since left following the onset of the war.¹⁶¹

The long-term impacts on Ukraine’s mining sector remain unknown, but it does not appear promising for a country that relies on the mineral market for its economic growth. If one thing is sure, Ukraine will want most of its territory back with any war termination agreement. It is understandable, given that many of their critical resources reside in the east.

Likewise, Russia will not be quick to give up this territory either. They are aware of Ukraine’s natural resource locations and value, recognizing the geopolitical power such natural resources offer economically to the Kremlin.

Russia - Mineral and Mining Industry

For Putin, he realizes the value of Ukraine’s natural resources. His stronghold in the east was not only about land occupation but the capture and use of minerals that serve as a source of

power for Ukraine. Further, the U.S. has seen Putin’s paramilitary organization, the “Wagner Group,” uses stolen raw materials as a means of income.¹⁶²

The overall impacts on Russian mining remain uncertain too. There has been some production decline in the mining industry, but unlike Ukraine, some mineral impacts are from sanctions from the West. However, public data suggests also suggests there have been pockets of trade growth. For example, “from the end of 2021 to the end of 2022, Russian domestic iron ore production fell by 16.3 percent, gold production fell by 11.6 percent, and copper production fell by 11.5 percent.”¹⁶³ Alternatively, it is “estimated that the Asia-Pacific region imported up to 30 percent of all Russian steel exports by the end of 2022, up from a high of 10 percent in previous years.”¹⁶⁴ This statistic suggests some enclaves of the Russian mineral export market are hindered by the demands of war and Western sanctions while others grown by increased demand by China.

Economically, Russia could impact the global market the most with any disruptions to mining production. Russia “accounts for 10 percent of global nickel production, behind only Indonesia and the Philippines.”¹⁶⁵ Unsurprisingly, nickel prices increased by 100 percent after Russia’s invasion.¹⁶⁶ Additionally, palladium is another key mineral controlled by Russia. Russia supplies nearly 37 percent of global palladium production, a critical mineral input to the automotive and semiconductor industries.¹⁶⁷ Limiting access to palladium production could further hinder the semiconductor recovery following the 2022 COVID-19 pandemic, a time when the global saw semiconductor shortfalls.

Some of the mineral and mining impacts are not production related but instead driven by Western companies sourcing material elsewhere due to sanctions. In April 2023, Apple declared they will no longer source rare earth minerals from Russia.¹⁶⁸ Titanium is another strategic

mineral for aerospace and defense applications, and Russia is the world's third-largest producer of titanium sponge.¹⁶⁹ However, Boeing suspended all titanium imports from Russia.

Unfortunately, European aerospace giant Airbus still exports titanium due to its reliance on the material.¹⁷⁰ The continued imports suggest that even with pressure to isolate the Kremlin economically, the West still has sectors that remain very dependent on Russian mineral resources to fuel their economy. Even a year after the conflict began and sanctions were imposed, the U.S. reportedly imported over 900 shipments of metals from Russia, totaling 264 million tons.

Russo-Ukrainian Conflict – A Lesson for China

The Russo-Ukrainian conflict should be a starting point for broader national policy options for the U.S., specifically in mineral production and economic influence. The U.S. saw first-hand how a regionalized conflict with two countries, neither of which ranks in the top 10 of economic power within the world, drove global impacts on the mineral supply chain. How would a similar scenario affect the market if the U.S. was cut off from China's mineral market?

China could easily decide to restrict access to rare earths again with disastrous consequences. China accounts for 63 percent of the world's rare earth mining, 85 percent of rare earth processing, and 92 percent of rare earth magnet production. Rare earth alloys and magnets that China controls are critical components in missiles, firearms, radars, and stealth aircraft.¹⁷¹

Even some U.S. mines which receive millions of dollars of Defense Production Act (DPA) funds – targeted funds used to bolster U.S. national security industrial capacity – rely on China to refine the minerals.¹⁷² This presents a real vulnerability the U.S. must mitigate to avoid a scenario that could leave the U.S. industrial base without critical minerals.

The U.S. has a recent history of decline in domestic mining. The growth of corporate horizontal integration and global diversification resulted in critical minerals being mined and processed abroad. Correcting the mining market so resources are less concentrated within China,

which is the most significant pacing threat to the U.S., will take time. The current permitting process in the U.S. is controlled by lengthy government bureaucratic processes and often court litigation. A report cited by the National Mining Association states the average permitting timeline is 7-10 years, and sometimes longer due to litigation.¹⁷³ However, places like Canada and Australia, which have similar strict environmental standards, take around two years to gain government approval.¹⁷⁴ It is important to note that even after approval, companies can take 10 more years to deliver minerals to the market. This means it could take nearly 25 years to regain domestic mineral sourcing under the current U.S. processes.

Due to growing concern, the Biden-Harris administration has taken action to regain the lost national security with reliable access to critical minerals. President Biden signed Executive Order 14017 in 2022, directing “major investments to expand domestic critical minerals supply chain, breaking dependence on China and boosting sustainable practices.”¹⁷⁵ In addition to the executive branch, in 2022, Congress passed the Inflation Reduction Act (IRA), which sets mineral sourcing requirements for lucrative tax credits. They also passed the CHIPS and Science Act which provides funding to the Critical Minerals Mining research and development program to bolster a new generation of students for mining jobs.¹⁷⁶ America has woken up to its overreliance on sourcing minerals abroad and is postured to take steps to avoid being cut off from critical resources.

Beyond the actions already taken by President Biden and Congress, more needs to be done to secure critical minerals for the U.S. The first step must include streamlining mining access to domestic resources. No company is eager to invest in a mining venture if it will take 15 years for the government to approve the effort. Instead, the U.S. should use Canadian and Australian permit processes as a benchmark for consideration. If the process was emulated, it

would likely draw the attention – and investments – of major mining companies to increase business within the U.S. Further, it would be wise for U.S. policymakers and environmental organizations to take note of the major mining companies which have well-established environmental, social, and governance (ESG) credentials.¹⁷⁷ These ESG standards, together with lessons learned from Canada and Australia, should calm the outcries from environmental activists and guide the U.S. in a way that streamlines mining approvals to align with the rest of the Western world. Once complete, it offers a long-term mitigation strategy for China's dominating control over the mineral market.

The long-term mitigation recommendation of bolstering U.S. domestic mining will take over a generation to materialize. This lengthy timeline for resolution does not mean the U.S. must remain vulnerable to its reliance on foreign resources. The Russo-Ukrainian conflict offers to clear findings for U.S. consideration. First, the U.S. cannot wait until an invasion of Taiwan or a conflict with China to act on critical mineral shortfalls. Putin showed the world how the Kremlin would weaponize national resources to gain global influence.¹⁷⁸ The leader of the Chinese Communist Party (CCP), Chairman Xi Jinping, will likely be in the same position as he would try to influence foreign governments with minerals and trade as well.

However, despite the desires of these two autocratic regimes to use natural resources to dissuade the influence of their foreign aggression, the West showed their resilience against Putin when they bolstered trade with each other to offset the losses of key Russian national resources. This same approach, building an economic coalition of Western nations, is the best tool of deterrence against Xi. Unlike Putin, Chairman Xi's ability to maintain power is his ability to grow the Chinese economy. This need for a strong Chinese economy offers a real vulnerability to the CCP leader as China's top 4 national importers, including the U.S., are nations with strong

democratic values and would likely align with strong economic sanctions should Xi ever invade Taiwan.

In an effort called Economic for Deterrence (E4D), Western nations must weaponize their collective economic might to temper Xi's vision of using the military to unify Taiwan with mainland China. The E4D model would be a public show of force, an alliance of Western governments and companies, which would impose economic isolation towards China immediately upon any military invasion. This E4D framework also offers other smaller nations, some of which may be involved in China's Belt and Road Initiative (BRI), the opportunity to align with the West while gaining more favorable trade agreements. These steps would bolster the Western alliance and dismantle the CCP's economic vision. This effort, integrated with strong military deterrence, offers the best opportunity to avoid any scenario where the U.S. might find itself cut off from critical resources. The time it would take for Xi to insulate the Chinese economy from being cut off from Western trade would be too timely and costly to implement.

Critics of this plan might suggest that China already owns a monopoly on the critical mineral market and would cut off the West as soon as an economic alliance is proposed. However, it is important to note that China imports over 2.6 trillion dollars of goods annually.¹⁷⁹ While much of the West almost exclusively relies on China for critical minerals, the CCP also relies on critical imports to support the Chinese economy. The current global economic posture between the West and China is best described using the same narrative for why nations seek nuclear weapons as a means of ultimate deterrence and mutually assured self-destruction. Should China ever choose to cut off the West from minerals, the West could easily take steps against China to feel similar economic pain.

In conclusion, the Russo-Ukrainian conflict is a regional conflict that drove global impacts on the mineral and mining sector. These impacts awoke world leaders to the fragility of a globalized economy that could suddenly become cut off from critical resources. Putin's invasion, while tragic for the people of Ukraine, presents an opportunity for other Western politicians to invest and establish domestic access to minerals rapidly. The U.S. is now taking steps to boost the domestic mining sector, but more zeal is needed. The hope is over time. Western efforts will marginalize China's current dominance of the mineral market. In conjunction, while the domestic mining sector grows, the U.S. should leverage Western resolve to form a global economic alliance that will isolate governments that invade territories. This E4D framework, which would only be used should Chairman Xi choose to invade Taiwan, attacks the most significant vulnerability to Xi's power within the CCP, Chinese economic strength. Weaponizing the Western economy capitalizes on lessons learned from the Russo-Ukrainian conflict. This offers the best opportunity to deter Chairman Xi from invading Taiwan while the West re-shores the critical minerals sector foundational to future U.S. national security.

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¹⁶⁶ Ibid.

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Appendix O: China-Taiwan CAPSTONE

NOTE: This essay is also the report's Executive Summary.

In the case of military aggression by the People's Republic of China (PRC) against Taiwan, economic shockwaves would ripple across the Pacific. How can the U.S. prepare America's defense industrial base for this contingency? The answer begins with ensuring access to strategic materials – the essential elements that form the foundation of the modern economy. Since the end of the Cold War, the PRC has cornered the market on a wide range of minerals and downstream processing that converts ore into modern life's building block materials. More troubling, the PRC has also demonstrated a willingness to flex its power by temporarily cutting off exports of strategic materials to America's partners and allies, as it did with rare earth elements in 2010 and threatened to do in 2017.

The PRC's strategic material dominance is vast and growing. According to a 2023 estimate, the U.S. is more than 50 percent reliant on imports from China for 20 critical minerals.¹⁸⁰ These materials underpin nearly every aspect of the U.S. economy, including the automobile and aviation industries, green energy technologies, and the defense industrial sector. Although vulnerable, America is not without resources.

The mineral-rich landscape of the U.S. holds untapped potential that can help the nation even the playing field with the PRC. Multinational companies are eager to tap into those resources and build processing facilities to convert minerals into engineering inputs. Still, challenges remain. The lack of domestic supplies creates a strategic vulnerability vis-à-vis our peer competitors. Moreover, the economics of the mining industry often prove insurmountable. Even when the financial rewards justify the cost, prospective companies must navigate a lengthy

permitting process while simultaneously winning buy-in from local stakeholders and addressing environmental concerns. As a result, critical resources remain trapped in the earth, and the PRC continues to hold the sword of Damocles over American industry.

The following analysis recommends a comprehensive strategy anchored on three pillars, Protect, Promote, and Partner, to meet this challenge and secure America's strategic materials supply chain:

- **Protect** means replenishing America's stockpiles of strategic materials to reduce our short-term dependence on the PRC; unifying a stove-piped federal management system for mining into a streamlined, unified approach consistent with national security goals; and mapping supply-chain dependencies to understand better the source of the minerals and materials that are essential to American society.
- **Promote** includes recommendations to revitalize America's mining production and processing capabilities, update an outdated permitting process, and raise public awareness about the importance of mining to national security.
- **Partner** consists of teaming with allies to secure our supply chains, strengthen the strategic material value chains of developing nations worldwide, and disrupt ethically questionable PRC partnerships.

Effectively addressing this challenge requires government-wide unity of effort. While there have been some attempts at interagency coordination, those attempts have lacked the authority to impact resounding change. These actions require time to mitigate industry-crippling risk and prepare for aggression in the Pacific. The time to act is now.

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