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Final Report

Mining for the Future: The Critical Role of Strategic Materials in U.S. National Security

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Executive Summary

The United States faces critical challenges securing supply chains for strategic materials essential for national security and economic prosperity. As global demand for non-fuel minerals—vital for advanced technologies, key defense applications, and renewable energy solutions—continues to rise, the dominance of the People's Republic of China (PRC) compels the United States to enhance its supply chain resilience to mitigate geopolitical risks and reduce dependence on foreign sources.

The PRC's investments in the mining and processing of these materials place the United States at a strategic disadvantage in the era of great power competition. The PRC has solidified its dominance in the strategic materials market through systematic and aggressive strategies, integrating both upstream and downstream processes of the supply chain. This includes substantial state investment in mining and refining, extensive processing capabilities, and assertive expansion within the global trade framework. The PRC's control extends across critical materials, aided by its role as a global manufacturing hub, which positions it advantageously in midstream processing.

The mining industry faces considerable challenges that complicate its operations and profitability. Long lead times, high capital investment requirements, and commodity market volatility pose significant hurdles. Developing a mine can take over a decade and requires substantial upfront financial resources. The cyclical nature of mineral markets adds financial risk, impacting investors' willingness to support projects. To maintain profitability and competitive advantage, companies must design strategies to optimize operational efficiency and innovate in extraction and sustainability.

Faced with rivalry from the PRC and a mining industry that has its own challenges, the United States must take six distinct steps to build resilient and secure supply chains for strategic materials to ensure national security and long-term economic prosperity. These steps include 1.) rebuilding the National Defense Stockpile of reserve strategic materials; 2.) accelerating permitting approvals for domestic mines; 3) continuing targeted investments via the Defense Production Act and other mechanisms; 4.) diversifying U.S. investment strategy; 5.) working with allies and partners to enhance resiliency; and 6.) educating the public about the importance of strategic materials. Together, these steps can strengthen U.S. security and help the national economy tackle future challenges like the transition to renewable energy.

Introduction

A woman boards an airplane and checks her cell phone. She settles into her seat, unaware of the specialized materials underpinning her modern lifestyle. The plane's wing boxes are crafted from specialized aviation alloys infused with titanium, shedding the weight of steel without compromising performance strength.¹ The jet engines that power her flight owe their existence to advancements in metallurgic science.² Fan blades rotating at high speeds and exposed to temperatures exceeding 1,200 degrees Celsius naturally generate friction and heat.³ The alloy composition of these fan blades, containing elements such as rhenium and yttrium, enables airplane jet engines to operate at higher temperatures, enhancing safety and efficiency by reducing fuel consumption.⁴ Beyond the engines and frame of the plane, compact, high-powered magnets within the plane's seats require dysprosium. At the same time, gallium and neodymium enable the creation of small, conforming light-emitting diodes (LEDs) for a spacious cabin experience.⁵ The woman's phone, comprising over seventy elements, is smaller, lighter, and able to function faster than ever. It contains cobalt, lithium, tantalum, tin, gold, copper, and space-age-like indium, allowing for a smooth, buttonless glass screen and responsive texting.⁶

This woman is not alone in her reliance on modern technology. Advancements in space, communications, advanced computing, advanced weaponry, and clean energy require non-fuel minerals or mineral materials.⁷ Global demand is rising for these "strategic materials," which are increasingly vital to national security. However, most of these materials are mined or processed outside the United States, leaving the nation subject to a global supply chain almost entirely controlled by the People's Republic of China (PRC).⁸ In an era of great power competition, control of strategic materials is a new "front" in the geopolitical struggle to define the future international order.

The United States faces significant challenges in building resilient and secure supply chains for strategic materials. To do so requires overcoming industry and market dynamics, macroeconomic forces, and inefficient regulatory practices. By implementing bold and achievable measures such as rebuilding the national stockpile, optimizing market conditions, and strengthening relationships with allies and partners to make strategic investments in crucial sectors, the United States can ensure future national security and long-term economic prosperity.

Strategic Environment

The PRC's stranglehold on strategic materials puts U.S. national security at risk. The U.S. defense industry alone consumes 750,000 tons of strategic materials annually for use in military equipment."⁹ Historically, the United States has stockpiled materials vital to national security. However, today's National Defense Stockpile (NDS) of critical minerals is at its nadir while the PRC's reserves steadily expand. For context, the NDS holds only 5 percent and 2 percent of the PRC's cobalt and zinc stockpiles, respectively.¹⁰ Were the United States and the PRC to become embroiled in a kinetic conflict, the PRC could hold a strategic advantage in replenishing munitions and other warfighting equipment due to its superior stockpiles and control over critical materials, while U.S. supplies could quickly be depleted.

As the "new oil," strategic materials are as critical to modern economies and technologies as fossil fuels once were.¹¹ These materials are not only foundational for military capabilities but are crucial for sustaining global economic infrastructures.¹² Though the Earth is abundant with mineral resources, there is currently not enough production to meet rising global demand, creating resource scarcity.¹³ This scarcity means access to strategic materials is vital for future economic prosperity and national security.¹⁴ In the United States, establishing a productive mine can take decades, placing the nation at risk.

Mining Overview

Appreciating strategic material supply chains requires understanding the dynamics of the mining industry. The supply chain for strategic materials begins with mining, or extracting, the raw materials from the ground and then processing them through multiple steps.¹⁵ The process first involves breaking down boulders of rock physically and chemically to extract the target

mineral.¹⁶ Once the target mineral is separated, it is smelted or chemically leached to remove impurities and then sold to combine with other materials or incorporate into downstream products.¹⁷ Figure 1 demonstrates the multiple stages involved in the strategic materials supply chain.



Figure 1: Stages of the Mineral Supply Chain¹⁸

The steps from extraction to processing can occur in multiple geographic locations and involve multiple companies. However, the PRC has state-owned enterprises focused on the entire mineral production cycle, from extraction through processing, allowing it to dominate the minerals supply chain regardless of the origin of the raw materials.¹⁹ For example, MP Materials, a private company aiming to become a secure domestic supplier of rare earth elements (REE), operates the sole REE mine in the United States.²⁰ Since the United States currently lacks REE processing capabilities, MP Materials must ship its extracted raw material to China for processing and then re-import the processed REE as finished or semi-finished products.²¹ As evidenced in this example, achieving supply chain security requires not only reliable mineral

inputs but also the capability to process those inputs and incorporate them into usable end products.

Environmental, Social, and Governance Impacts of Mining

Mining and mineral processing are disruptive to the environment, often resulting in local communities adopting a stance of “not in my backyard” toward new projects. For example, mineral extraction involves removing and chemically processing vast quantities of rock and soil.²² The resulting waste, called “tailings,” is typically stored in tailings ponds.²³ These ponds draw upon large volumes of water resources from the surrounding areas.²⁴ They must be carefully monitored to avoid chemicals leaching into the environment or dam breaks that could cause catastrophic floods.²⁵ The Environmental Protection Agency reports hard rock mining is responsible for polluting up to 40 percent of the nation’s rivers over the past 150 years.²⁶ Additionally, many abandoned mines across the United States have no owners, leaving the clean-up costs to the U.S. taxpayer. In 2021, the Government Accountability Office estimated it would cost over \$600 billion to mitigate environmental impacts from closed and currently operating mines.²⁷ Mines also consume significant amounts of electricity, often derived from fossil fuels.²⁸ For example, Freeport-McMoran's Henderson Mill is the largest electricity user in Colorado, according to state industry experts.

Mining also has a complicated history with worker safety, leading the public to view it as a dirty, dangerous job that can lead to death, severe injury, or long-term ailments such as cancer. For years, silica dust in mines caused severe black lung disease for miners.²⁹ A recent U.S. rule calls on mining companies to self-monitor silica dust measurements.³⁰ The rule will help to protect some miners, but the dangers of silica dust, present in many U.S. mines, still exist.

Stakeholder Challenges

Mining projects require buy-in from multiple stakeholders, including private and public companies, investors, federal, state, and local government agencies, and local and Indigenous community members.

Private and Public Companies and Investors: Mining is an expensive business. Companies incur significant costs for exploration, discovery, and permitting before they can even break ground on a mine, let alone generate a profit from their products.³¹ Building a mine and its associated infrastructure requires substantial investment in construction, securing essential resources such as power and water, establishing distribution networks, and initiating production.³² While CEOs prioritize efficiency and profitability, they can be incentivized to minimize environmental impacts and promote economic prosperity in surrounding communities to attract labor and garner political support.³³

Mining companies must attract investors by demonstrating the ability to generate returns on invested capital.³⁴ Investors are motivated by the size and quality of the ore body to be mined, forecasted demand and market price, and the ability to keep up-front and operating costs low.³⁵ Investment capital is needed at all stages of the value chain, putting pressure on CEOs to maximize shareholder value. Fluctuations in commodity prices immediately impact investor confidence and often require firms to scale down projects to maintain high returns.³⁶ The recent drop in lithium prices caused Albemarle to delay a highly anticipated domestic lithium processing expansion, demonstrating how sensitive investment decisions are to volatile market conditions.³⁷

Federal Government: Federal agencies enacting Executive policy and Congressional legislation often expend duplicative efforts with multiple layers of regulation and conflicting

objectives. Policymakers must adjudicate between priorities such as protecting the environment, supporting private industry, and securing domestic supply chains for national security benefits. Elected local, state, and federal officials must represent their constituents' desires while appeasing powerful industry and environmental lobbyists. The complexity of these issues is reflected in the Biden Administration's recent denial of a crucial road planned to support a copper mining initiative in Alaska over its potential disruption to local wildlife and indigenous communities, effectively halting the mine's development.³⁸

Local and Indigenous Communities: Many critical minerals in the United States, including 97 percent of nickel, 89 percent of copper, 79 percent of lithium, and 68 percent of cobalt, are located within 35 miles of Native American reservations or areas recognized by the government as the ancestral lands of the country's 574 tribes.³⁹ Tribal concerns over sacred lands can complicate the opening of new mining projects, potentially slowing U.S. efforts to secure domestic production.⁴⁰ In Nevada, the \$2.3 billion Thacker Pass project, located on the largest known lithium deposit in the United States, has been entangled in legal disputes since its 2021 approval.⁴¹ Local tribes contend that they were inadequately consulted about the project, which they believe desecrates the site of a 19th-century massacre.⁴² Similarly, the Resolution Copper project in Arizona, set to supply a quarter of the U.S. copper demand, has faced delays and controversy over its impact on a site sacred to the San Carlos Apache.⁴³ Despite over \$2 billion invested since 2014, the project has been stalled by legal challenges and significant opposition.⁴⁴

Environmental impacts are a major concern, yet many local communities still support mining for its economic benefits, such as job creation, tax revenue, and infrastructure improvements like roads, power grids, local schools, and parks. Albemarle's effort to reopen the Kings Mountain lithium mine in North Carolina has surfaced tensions with residents worried

about environmental damage and disruptions to their way of life. Balancing economic growth with environmental and social responsibilities in mining projects is a persistent challenge for the industry.⁴⁵

The competing priorities and different perspectives of these stakeholders and the resulting tensions are encapsulated in Figure 2 below. While maximizing shareholder value underpins investment decisions, the USG must develop policies emphasizing comparative advantage while promoting national security interests. Government officials, private industry, and the U.S. public must navigate these complexities to increase the domestic production of strategic materials.



Figure 2. *Competing Priorities and Tensions in Stakeholder Dynamics*⁴⁶

Strategic Material Production in the United States

Over the last sixty years, the United States has steadily outsourced and offshored upper and midstream supply chains of strategic materials to the lowest-cost global producers while attempting to control segments of downstream production where the most profit is realized.⁴⁷

While these practices have bolstered GDP, they have rendered the United States dependent on

strategic materials from foreign sources to satisfy public and private demand.⁴⁸ (See Appendix A).⁴⁹

This dependence on foreign sources incorporates all stages of the supply chain, with significant economic and security consequences. Even when a U.S. company mines a raw material, it might need to send the product overseas for processing, as MP Materials currently does for REE.⁵⁰ Despite producing 12.3 percent of the global supply in 2023, the United States was 95 percent import-reliant for REE.⁵¹ In 2016, the United States consumed \$496 million of REE, but the downstream economic activity driven by demand for advanced electronics and defense applications totaled \$613 billion.⁵² By failing to mine, process, or manufacture REE and associated products at scale, the U.S. economy does not capture the significant value added further downstream.

The United States has ore bodies and production capability to develop domestic supply chains, but domestic companies struggle to compete in the global market. The Department of Defense (DOD), in collaboration with private sector and interagency partners, identified 189 domestic facilities that currently produce or could produce strategic materials.⁵³ However, the existence of these facilities does not guarantee profitability. Fluorspar, used in refrigerants and aluminum processing, is not produced in the United States despite its abundance and strategic importance due to high costs and global competition.⁵⁴ Similarly, tantalum, a critical material, has not been mined in the United States since 1959 because lower-cost foreign sources make domestic extraction subeconomic.⁵⁵ Significant latent strategic material capacity could support U.S. civilian and defense demand if appropriate market incentives were in place to encourage businesses to start or increase production.

The PRC and Global Demand

The PRC's unprecedented rise positions it as the world's second-largest economy.⁵⁶ The Chinese Communist Party (CCP) has openly declared its intention to displace the U.S.-led international order and “lead the reform of the global governance system” to align with its interests.⁵⁷ The resulting “era of great power competition” between the United States and PRC plays out in various arenas, including the green energy transition, which has driven heightened global demand for metals such as copper, cobalt, lithium, and platinum group metals. As highlighted by Appendix A, the PRC is currently dominating the race for strategic materials, gobbling up global supply chains, while the United States is now almost entirely dependent on foreign suppliers.⁵⁸ Based on 2023 data, the United States is completely net import reliant on twelve strategic materials and at least 50 percent net import reliant on an additional 29.⁵⁹ Even worse, the PRC is the primary source for five of the twelve materials that are critical for semiconductors (arsenic metal), rechargeable batteries (natural graphite), integrated circuits (gallium), abrasives, bearings, and seals (yttrium), and electronics research and development (R&D)(rubidium).⁶⁰ Furthermore, the PRC seized the opportunity to corner the international green energy market. The global demand for transition metals doubled from 2019 to 2023, and the PRC now refines 68 percent of nickel, 40 percent of copper, 59 percent of lithium, and 73 percent of cobalt, respectively.⁶¹ Figure 3 illustrates the PRC’s dominance in the production and processing of clean energy metals.

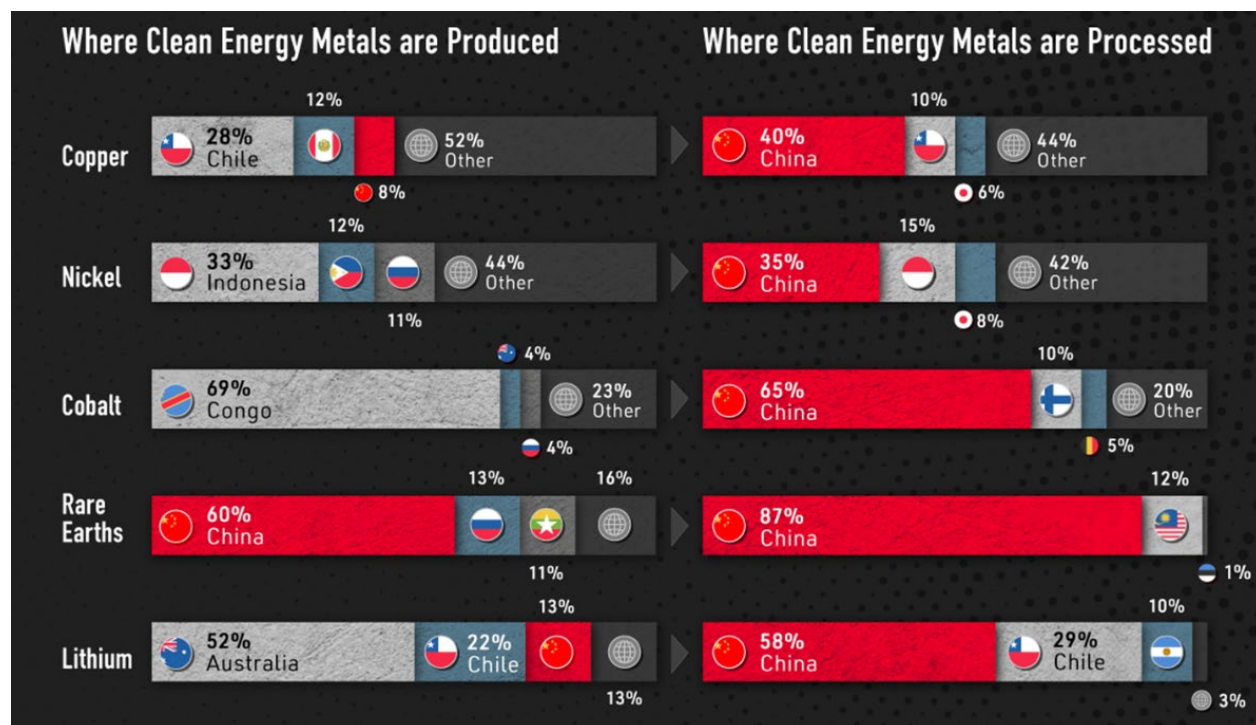


Figure 3: Visualizing China's Dominance in Clean Energy Metals⁶²

The PRC needs a steady supply of raw materials, not all of which are available in China. Through efforts like the Belt and Road Initiative, the PRC invested in mineral-rich nations such as the Democratic Republic of Congo (DRC), where PRC state-owned and private enterprises now control 80 percent of DRC's cobalt mines.⁶³ This investment alone secured 30 percent of the cobalt needed for the PRC's cobalt processing capacity.⁶⁴ Additionally, the PRC has ramped up strategic investments in lithium mines in Australia and Chile, guaranteeing intake for its processing industry.⁶⁵ The PRC is aggressively developing and diversifying raw material supply chains to fuel its scaled and efficient processing infrastructure, aiming to dominate global commodity markets. Figure 4 shows the net import reliance for both the United States and PRC.

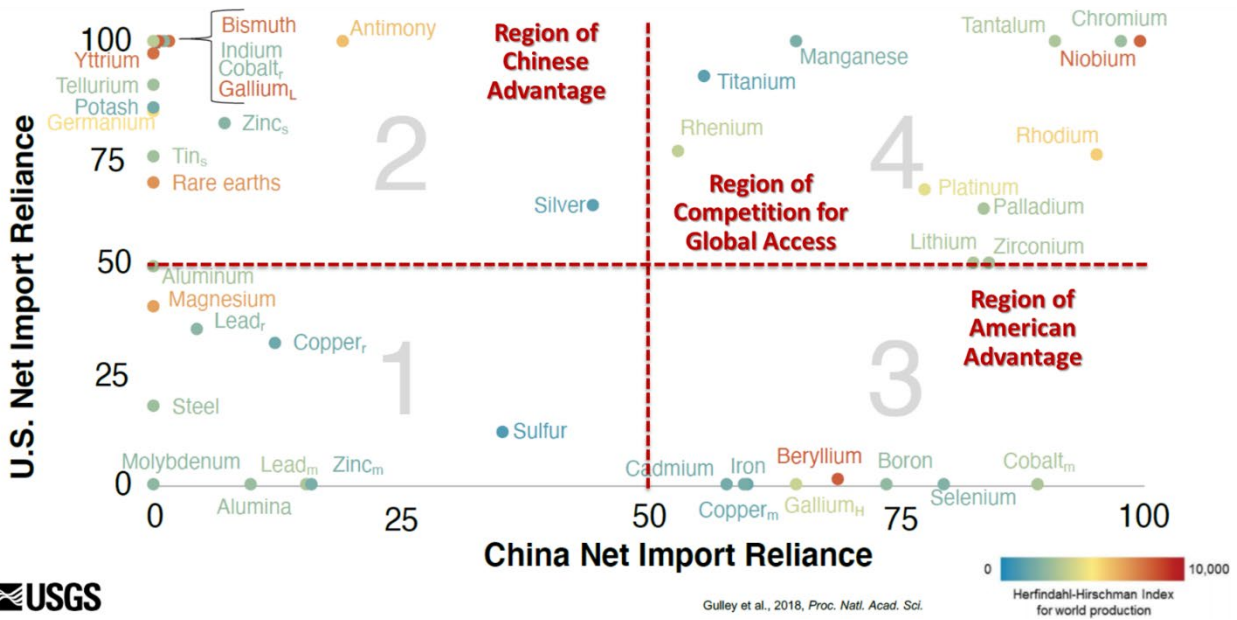


Figure 4: Net Import Reliance for the U.S. and PRC⁶⁶

PRC Business Practices

In addition to state ownership and investment, the CCP uses predatory economic practices and coercion to manipulate mineral markets in their favor. The Party weaponizes the strategic mineral economy by controlling the amount of product on the market to artificially inflate or deflate prices to their economic and political benefit.⁶⁷ Additionally, the CCP has restricted access to rare materials during times of political tension with the United States.⁶⁸ As early as 2011, the PRC reduced export quotas of neodymium, a REE critical for precision-guided munitions and other defense applications.⁶⁹ More recently, in 2023, the PRC unveiled export restrictions of germanium and gallium, both essential for semiconductors and microelectronics, in response to U.S. tariffs and increased tension in the Taiwan Strait.⁷⁰ However, U.S. and PRC policies do not account for all the challenges of creating secure supply chains. Understanding the global strategic landscape involves appreciating industry dynamics.

Analysis of the Strategic Materials Industry

The mining industry encompasses a spectrum of operations, from large multinational corporations to artisanal, locally owned mines. Many firms in the industry face intense competition and must contend with geographical challenges, substantial fixed costs, stringent government regulations, and price volatility to achieve profitability.

Adding to these challenges, over the past century, easily accessible high-grade ore bodies have been exhausted, necessitating higher expenditures by both existing and new companies to extract lower-grade ores.⁷¹ Although innovation and advanced exploration techniques have the potential to enhance efficiency, the implementation of new technology is costly and does not invariably result in reduced operating expenses.⁷² Ore bodies are typically located in remote areas lacking infrastructure, near major population zones, or on protected lands, all requiring significant environmental and social mitigation before new mines can begin operating.⁷³ Once a firm navigates the lengthy process of opening and operating a mine, it must continuously monitor daily commodity price indices to ensure financial stability. Despite these challenges, the mining industry presents significant opportunities. In 2023, the global mining sector was valued at \$3 trillion, with an aggregated growth rate forecast of 6.7 percent.⁷⁴ Given the substantial financial prospects, firms and investors are willing to undertake considerable business risks.

Industrial-scale mining operations often maintain production during low-price periods to manage expenses, leading to strategic material overproduction.⁷⁵ This cyclical overproduction and fluctuating demand can trigger severe market downturns and subsequent booms, intensifying competition.⁷⁶ Firms navigate these cycles by adjusting production to stabilize cash flows and maximize profits, heightening rivalry during economic fluctuations.⁷⁷

Structure of the Mining Industry

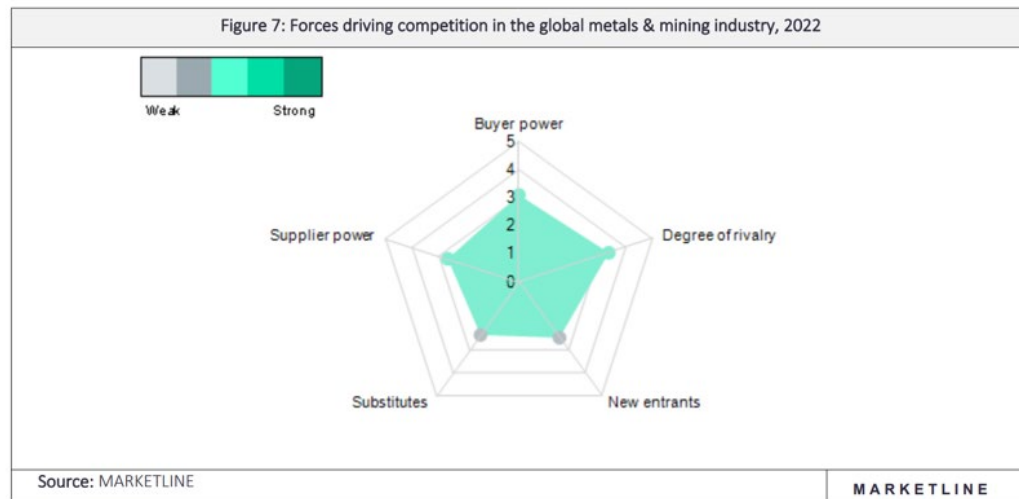


Figure 4: Forces Driving Competition in the Global Metals & Mining Industry, 2022⁷⁸

Michael Porter's Five Forces provides a helpful model for understanding the competitive forces that define the mining industry and influence profitability.⁷⁹ (See Figure 4.) The most significant force is **competition rivalry**.⁸⁰ Though unique alloys and compounds exist, minerals are relatively undifferentiated, driving price competition among similar-sized firms.⁸¹ This lack of differentiation means low switching costs, increasing **buyers' leverage** in the market.⁸² With a relatively high concentration of firms, amplified by high exit costs, firms compete primarily on price, constantly looking for ways to increase efficiency and profits.⁸³

The industry has a relatively **low threat of new entrants** given the barriers of long lead times, high up-front costs for exploration, development, purchase of heavy equipment, cumbersome government regulatory requirements, and price uncertainty.⁸⁴ The cost of establishing a new operation can be billions of dollars, and new mines can take a decade or more to become profitable.⁸⁵ One study revealed that the average time from mineral discovery to

production for 127 mines was 15.7 years.⁸⁶ Exploration and discovery alone can take as long as 12 years.⁸⁷ See Figure 5 for an overview of the timeline to establish a new mining operation.

1. Establish Resource (2-5 years)	2. Mineralogy (1-3 years)	3. Scoping Studies (1-3 years)	4. Beneficiation/Extraction/ Separation Pilot Plant (2-10 years)
<ul style="list-style-type: none"> Establish resource that meets local stock market regulations 	<ul style="list-style-type: none"> Identification of minerals bearing the target product 	<ul style="list-style-type: none"> Inferred resource Bench scale process Baseline environmental study 	<ul style="list-style-type: none"> Demonstrate viability Generate data for feasibility studies Samples sent for customer evaluation Generate data for environmental studies
5. Environmental Assessments & Approvals (Variable)	6. Letters of Intent (Concomitant with 1-5 years)	7. Feasibility Study & Funding (2-4 years)	8. Construction & Startup (2-3 years)
<ul style="list-style-type: none"> Public review 	<ul style="list-style-type: none"> Integrate operations with customer supply chains 	<ul style="list-style-type: none"> ±15 percent accuracy for capital expenditure and operating expenditure estimates 	<ul style="list-style-type: none"> Sophisticated engineering, procurement and construction studies De-bugging/Optimizing operations

Figure 5: Critical Materials Development Timeline Overview⁸⁸

New entrants or existing firms looking to expand operations must also contend with government permitting processes, which are notoriously slow and expensive. The industry's history of poor environmental and social practices has resulted in stringent environmental, safety, and labor regulations.⁸⁹ Mining firms must navigate a layered process involving multiple federal, local, and state agencies, with dozens of permits required to break ground.⁹⁰ Strong opposition to mining activities by various stakeholders often exposes projects to litigation, resulting in project delays or cancellations.⁹¹ Compliance with environmental regulations and securing permits require significant up-front capital, which is complicated by the fact that many investment firms wait until a mining company has obtained necessary permits before committing funds.⁹²

Conduct and Performance in the Mining Industry

Firms respond to these industry forces, strategizing in two key ways: diversification and niche specialization. MP Materials exemplifies the niche approach, operating the sole rare earth mine and processing facility in the United States.⁹³ This company is enhancing its market presence through vertical integration, pursuing a mine-to-magnet strategy that leverages its non-PRC status to attract clients prioritizing supply chain security.⁹⁴ With its pioneering role in Western markets, cutting-edge mineral separation technology, and efficient water and energy use through onsite recycling and production, MP Materials aims to become a long-term, reliable, secure, and competitively priced supplier of rare earths to the USG.⁹⁵

On the other end of the spectrum, giant, diversified mining corporations like the Swiss-registered Glencore focus on promising mining acquisitions and extracting more value from existing assets.⁹⁶ Glencore utilizes its diverse holdings, including coal and oil, to sustain earnings even during downturns in mineral prices, thus maintaining overall profitability. It also uses its agricultural arm, Viterra, to enhance its income streams from agriculture as a buffer against fluctuations in commodity markets.⁹⁷

Between industry giants and niche players are mid-sized companies like Albemarle, which comprises three business units: lithium extraction and processing, bromine, and catalysts.⁹⁸ Albemarle focuses strategically on lithium, which is anticipated to experience a four-to five-fold demand increase over the next decade driven by the shift to clean energy.⁹⁹ Concurrently, it maintains its smaller, less lucrative, but stable bromine division as a financial hedge against market volatility. Despite projections of rising demand, lithium's price has sharply declined in recent months, largely due to an economic downturn in the PRC and fluctuations in the electric vehicle market.¹⁰⁰ Albemarle's decision to hedge with its bromine division helps

stabilize the firm's financial position in the near-term amid commodity price fluctuations. Still, long-term stability and firm growth will depend on the lithium market meeting anticipated demand.

Firms of all sizes are addressing environmental, social, and governance (ESG) risks and incorporating innovation in their strategy development.¹⁰¹ Both governments and customers are increasingly interested in ensuring their strategic materials are sourced responsibly, giving a competitive edge to companies that adhere to high standards and meet traceability requirements. Large mining firms have worked together to launch the Initiative for Responsible Mining Assurance (IRMA), defining a set of socially and environmentally responsible mining standards and best practices.¹⁰² Companies that receive favorable reviews from voluntary IRMA audits can enhance their public image, potentially easing approvals for new projects.¹⁰³ Albemarle's recent IRMA audit of its Chilean lithium operation makes it the first lithium producer to be independently assessed as having sustainability practices that reduce social and environmental impacts.¹⁰⁴

Innovation is another critical component of firm strategy. Leveraging existing industrial capabilities by focusing on incremental and process innovations can foster sustainable economic growth.¹⁰⁵ This is apparent in the mining sector, where much of the innovation focuses on equipment, technology, and services, but companies are also pursuing process innovation in their operations. Given the high capital costs of mining infrastructure, internally focused process innovation can improve operational efficiency and enhance profitability. Regulatory pressures and environmental concerns further motivate companies to develop environmentally friendly technologies and practices.¹⁰⁶ Direct Lithium Extraction is poised to be a disruptive innovation,

with demonstrated potential to significantly reduce water usage in lithium mining, thereby mitigating a serious environmental impact.¹⁰⁷

Firms measure the success of their strategy by comparing the return on invested capital (ROIC) to the weighted average cost of capital (WACC).¹⁰⁸ If ROIC is greater than WACC, the firm is creating value by investing in projects that generate more revenue than their funding costs.¹⁰⁹ In 2023, the average metals and mining industry WACC across 1,815 global firms was 9.6 percent.¹¹⁰ For the same firms, the average ROIC was 14.84 percent, well above the average across all industries, as shown in Appendix B.¹¹¹ With ROIC exceeding WACC, mining is creating value for its shareholders.

Despite challenges in the mining industry, the top 40 global mining companies, as measured by total revenue, produced an average net profit margin of 15.67 percent from 2021 to 2023.¹¹² The overall market value of those firms increased by two percent, exceeding the gains of benchmarks such as the Standard and Poor's 500 index fund.¹¹³ The industry's forecast is favorable over the next several years, with annual market growth rates projected to steadily increase from 3.3 in 2024 to 6.5 percent by the end of 2027.¹¹⁴ Despite high ROIC, profits are closely linked to commodity prices, which can be highly volatile as the market adjusts to current and future demand for clean energy technology. With significant opportunities available, firms and investors willing to endure price fluctuations and invest for the long term may see substantial rewards.

Comparison of Competitive Advantages

Michael Porter offers a model to depict a country's competitive advantage.¹¹⁵ Porter's Diamond framework analyzes how conditions related to demand, production, supporting industries, and firm strategy, structure, and rivalry create the "playing field that each nation

establishes and operates for its industries.”¹¹⁶ A detailed depiction of Porter’s Diamond as it relates to U.S. national advantage can be found in Appendix C.

PRC Competitive Advantages

While global metals and mining markets share structural characteristics, the PRC dominates the industry, as a Porter’s Diamond analysis demonstrates. While state ownership, investment, and industrial policy are not unique to the PRC, the degree of CCP influence over the PRC’s mining industry is significant. Effectively providing a financial backstop, the PRC’s state-owned and state-influenced enterprises can navigate (and create) market volatility and price fluctuations while continuing to funnel capital toward improvements, expansion, and innovation. Industrial policies such as steep subsidies and tax incentives for state enterprises make it difficult for external firms to compete.¹¹⁷ Historically, the PRC has traded worker safety and environmental protection for speed and profit, enabling the PRC to undercut prices in ways that more regulated markets cannot.

Moreover, CCP policies encourage strategic material R&D, including a “super deduction” policy that allows a 200% tax deduction for R&D costs incurred by most companies.¹¹⁸ Rapidly becoming world leaders in technology, PRC companies also produce much of the world’s strategic material processing and manufacturing equipment, vertically integrating wherever advantageous to dominate supply chains.¹¹⁹ Economic “clusters” in regions such as Inner Mongolia or the Pearl River Delta bring together associated industries, boosting production capacity and fostering collaboration and innovation through robust supplier-manufacturer-distributor linkages.¹²⁰

The global transformation driven by advancements in information and communication technology enabled countries like the PRC to integrate into global value chains, leveraging their

manufacturing capabilities to become major players in the global economy.¹²¹ As the “world's factory,” the PRC generates immense domestic and international demand for strategic materials across sectors such as automotive, electronics, and consumer goods.¹²² The rising purchasing power of its growing middle class amplifies this demand, especially for high-quality consumer products.¹²³ The CCP's 13th Five-Year Plan's focus on sustainability drives demand for eco-friendly technologies and materials like lithium and cobalt.¹²⁴ For a depiction of Porter's Diamond for the PRC, please refer to Appendix D.

Russia Competitive Advantages

Russia strives to mine and process strategic materials at home and abroad. Unlike the PRC, Russia's goal serves as a hedge for Russia's oil and gas reserves, which may lose their geopolitical importance as much of the world seeks to transition to renewable energy.

Russia has significant mining resources within its borders as a leading producer of aluminum, nickel, and titanium, among other minerals.¹²⁵ In recent years, Russia has also begun to extract minerals from abroad.¹²⁶ Many minerals Russia aims to control are crucial for the global shift to renewable energy. One analyst noted that Russia's pursuit of strategic materials for renewable projects aligns with its goal to maintain its “goeconomic relevance.”¹²⁷ Russia has sought to achieve this relevance in a variety of ways. Close to 80 percent of Ukraine's mineral resources are found in the Dnieper-Donetsk region, most of which Russia has controlled since the start of its 2022 invasion.¹²⁸ The quasi-official paramilitary organization initially named the Wagner Group (now known as the Expeditionary Corps) signed regime protection contracts with resource-rich countries like Libya, Mali, Niger, Burkina Faso, and the Central African Republic.¹²⁹ Each of those countries paid for Wagner's services with lucrative mineral extraction contracts, including lithium and uranium.¹³⁰ The resources Wagner received for these

commodities enhanced its operations in Ukraine, making that conflict bloodier and more intractable.¹³¹

Russia has also sought to secure mining rights through more legitimate bidding. Russia's state-owned Rosatom won a valuable lithium extraction contract in Bolivia.¹³² Two U.S. start-up mining firms submitted bids but did not win any part of the deal.¹³³ One analyst suggested that the agreement would not have been advantageous for any U.S. company because tax credits from the Inflation Reduction Act (IRA) only applied to companies working in countries with a U.S. free trade agreement, which Bolivia does not have.¹³⁴ Nevertheless, Russia's advance into Latin America arguably serves as a strategic blow to the United States as nations worldwide move to secure lithium resources in anticipation of the green energy transition. Appendix E shows Porter's Diamond for Russia.

Current Approach

Recognizing the importance of securing strategic materials, the United States is addressing critical mineral supply chain issues. These efforts have laid the groundwork for strengthening national resilience against global supply challenges. While these initiatives represent progress, vulnerabilities remain, as does the need for more focused actions to fortify supply chains.

National Defense Stockpile

A historic USG approach to securing strategic materials is the National Defense Stockpile (NDS), established to supply the U.S. defense industrial base with raw materials during national emergencies.¹³⁵ Ideally, the NDS would address security vulnerabilities from a supply chain heavily dependent on the PRC. However, the NDS remains significantly underfunded. Post-Cold War reductions and policy changes have reduced the stockpile to less than 10% of its 1989 size, rendering it back to pre-World War II levels and exacerbating strategic deficits amid growing competition with the PRC.¹³⁶

With the stockpile under-resourced, the United States will lack needed strategic materials during emergencies. While a proposed funding increase of approximately \$100 million marks progress in resupplying the NDS, it is insufficient to hedge against the PRC.¹³⁷ Even with sustained funding at FY25 levels, it would take over ten years to address the \$2.1 billion shortfall.¹³⁸ Recent PRC export limits on strategic materials needed for advanced technology like germanium and gallium underscore the urgency of addressing stockpile challenges.¹³⁹

Permitting Process

The permitting process is particularly problematic for mining firms. Without a central regulatory authority or mechanism for accountability, mining companies must navigate complex legal frameworks, incurring delays and deterring investment.¹⁴⁰ To address these issues, federal officials recently included mining projects under Title 41 of the Fixing America's Surface Transportation Act (FAST-41), which enhances the efficiency, predictability, and transparency of the federal environmental review and authorization processes for domestic infrastructure projects.¹⁴¹ Established in 2015, FAST-41 allows the Federal Permitting Improvement Steering Committee (FPISC) to act as a central coordinating agency, expediting permit schedules for large-scale projects.¹⁴² By qualifying specific mining projects for FAST-41, the FPISC aims to streamline the permitting process by providing a unified platform for coordination and enhancing transparency and accountability.¹⁴³ However, critics argue that this measure is limited, as it only covers critical minerals listed by the USGS.¹⁴⁴ Moreover, it still requires significant administrative procedures for applicants and could potentially dilute stakeholder engagement and thoroughness of environmental assessments.¹⁴⁵

Key Legislation in the Critical Minerals Space

Recognizing the PRC's threat to strategic materials and technology supply chains, Congress and the White House have enacted policies to onshore and friend-shore semiconductor manufacturing and energy storage production. In 2022, President Biden signed the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, which bolsters these supply chains by offering funding, tax credits, and incentives for businesses that extract and process critical minerals essential for semiconductors and related technologies.¹⁴⁶ In 2022, President Biden signed the IRA, allocating nearly \$1 trillion over the next decade to accelerate

the domestic shift to clean energy.¹⁴⁷ This includes incentives for businesses to invest in future energy technologies and for consumers to buy electric vehicles or solar power. The IRA also provides tax credits to domestic mining companies and, by 2025, will remove tax breaks on EVs using critical minerals sourced or processed abroad.¹⁴⁸

The CHIPS Act and IRA demonstrate the USG's commitment to fortifying critical mineral supply chains for national security. However, the effectiveness of this legislation in boosting the domestic mining industry remains to be determined. While the IRA supports investments in some foreign companies, U.S. firms must source 80 percent of their critical minerals domestically or from countries with U.S. free trade agreements by 2028.¹⁴⁹ These stipulations may hinder U.S. firms from readily utilizing these tax credits and incentives without expanding domestic or other qualifying supply chains.

Investments

“The two chokepoints [in mining] are investment and capital flows. There are signals coming out of [the Biden] administration that there will be resources available to improve that. We also need improved permitting for mines and processing. The most effective and impactful way to attract capital is to signal to the markets that you can actually build this stuff.”

– Rich Nolan, President & CEO, National Mining Association¹⁵⁰

While the IRA focuses on tax incentives and credits, the government can use additional methods to stimulate the critical minerals sector. For instance, the DOD can utilize the Defense Production Act (DPA) “to accelerate domestic manufacturing and develop key technologies as a way to bolster national security.”¹⁵¹ At the same time, the Department of Energy (DOE) can utilize DPA authority to support clean energy projects, including mining for designated critical minerals.¹⁵² Significant examples include a \$90 million award to Albemarle to enhance domestic lithium production and up to \$2.26 billion in loans to Lithium Americas to build Nevada’s

Thacker Pass lithium project.¹⁵³ See Appendix F for a list of recent DPA-funded projects that support mining for strategic and critical minerals.

Many executive-level departments and U.S. agencies invest in critical minerals projects, both domestically and abroad. For instance, the DOE's Loan Program Office has made substantial investments in critical minerals supply chains, including \$2 billion for a battery materials campus, \$700 million for lithium and boron mining, and \$102 million for a graphite processing facility.¹⁵⁴ DOE's Office of Fossil Energy and Carbon Management has also channeled millions of dollars into critical minerals projects.¹⁵⁵ The Export-Import Bank of the United States (EXIM) offers varied financing products tailored to critical minerals, as evidenced by the recent issuance of a letter of interest to Perpetua Resources for a loan of up to \$1.8 billion for an antimony and gold mine in Idaho.¹⁵⁶

The United States is actively engaged in supporting critical minerals projects abroad. For instance, the United States is aiding Angola, which is on the verge of becoming a mining superpower, in accessing critical materials thanks to a historic 2023 agreement with the U.S. Geologic Survey (USGS).¹⁵⁷ Through the agreement, USGS will provide geological mapping expertise and engage in other scientific collaborations with the Angolan government.¹⁵⁸ Until now, Angola's mineral resources of copper, cobalt, manganese, lithium, and rare earths largely remained unmapped. The USGS collaboration will allow Angola to focus on where mining activities could take place.

The Department of State (DOS), the U.S. Agency for International Development (USAID), and the Development Finance Corporation (DFC) are similarly engaged in financing critical minerals projects, including supporting infrastructure. These agencies invested hundreds of millions of dollars jointly in the Lobito Corridor railroad, which connects Angola with its

neighbors Zambia and the DRC.¹⁵⁹ The Lobito Corridor railroad will allow for improved shipping of minerals and other resources to commercial buyers, provide all three African nations with more robust integration into regional and global trade, and prompt more development along the corridor.¹⁶⁰ Significantly, this project also included EU participation, potentially representing a new model for how the United States and allied nations could match the power and reach of the PRC's Belt and Road Initiative.¹⁶¹

While the United States is pursuing a diversified strategy for critical minerals investments, there are still gaps in the approach. USAID is conducting extensive work to grow safe and socially responsible critical minerals sectors in developing nations.¹⁶² This task involves strengthening governance, improving accountability, and promoting policy reforms. Creative programs, like the Just Energy Transition Challenge grants, seek to stimulate economic growth in developing nations that adhere to U.S. values and norms.¹⁶³ Yet, these programs, such as the USAID team dedicated to critical minerals development in the DRC, are under-resourced, with demand for grant money exceeding available funding by a factor of ten.¹⁶⁴ This example showcases opportunities for the USG to make low-cost, high-pay-off investments if these initiatives are adequately resourced. Secondly, current investment strategies primarily focus on the front end of project development. This approach overlooks several investment mechanisms common in the private sector that focus on securing production output. For example, in offtake agreements, a buyer agrees to purchase a specified amount of a mine's production before it is produced.¹⁶⁵ Streaming agreements take this model a step further, striking a pre-negotiated price for output but requiring an upfront capital investment.¹⁶⁶ Meanwhile, prepay agreements establish a price floor, effectively serving as an interest-free loan for the producer.¹⁶⁷ While distinct, these models offer various advantages, such as price stability and supply security.

Efforts by Allies and Partners

U.S. allies and partners are equally dependent on the PRC for critical minerals. Moreover, many nations rely on the United States for military equipment containing PRC-sourced critical minerals, making them vulnerable to supply chain disruptions.¹⁶⁸ Consequently, nations are taking unilateral and multilateral actions to tackle these strategic material challenges. The European Union (EU)'s Critical Raw Materials Act (CRMA) is a multi-pronged approach to funnel resources into extraction, processing, and recycling to build diversified mineral supply chains by 2030.¹⁶⁹ The Australian government is making “generational investments” in the domestic mining industry, infusing billions in exploration, R&D, and tax credits to become the world's leading producer of copper, lithium, nickel, and rare earth elements.¹⁷⁰ Nations are also working together to drive innovation in energy and critical minerals. For example, in 2023, NATO established the world's first multi-sovereign venture capital fund to invest up to \$1 billion in innovative, nascent dual-use technologies, many of which require strategic materials.¹⁷¹ Such NATO investments could result in significant military advantages over rivals.

The United States is leading international efforts to secure global strategic material supply chains. In 2022, the United States, along with 14 founding member countries, established the Mineral Security Partnership (MSP), which aims to “accelerate the development of diverse and sustainable critical mineral supply chains through working with host governments and industry to facilitate targeted financial and diplomatic support for strategic products along the value chain.”¹⁷² MSP nations seek to establish standard ESG practices and build inclusive, transparent, ethical, and fair strategic materials sourcing.¹⁷³ Currently, MSP has 23 projects across the strategic material value chain, targeting sought-after minerals such as cobalt, gallium, germanium, graphite, and REE.¹⁷⁴

The United States and the EU have partnered with other nations to diversify supply chains and strengthen economic ties. For instance, the United States and Japan signed a critical minerals agreement to “diversify key supply chains and strengthen the bilateral economic and trade relationship.”¹⁷⁵ Similarly, Angola signed a sustainable investment facilitation agreement with the EU, encouraging EU investors to devote resources to mining critical materials in Angola.¹⁷⁶ This example is significant from a geopolitical perspective. As a result of U.S. and EU commitment to Angola’s development, Western companies have successfully started mining projects in a country that, until recently, enjoyed exclusive development ties with the PRC.¹⁷⁷ Pensana, a United Kingdom (UK) firm, is constructing a REE mine in Angola; when completed, the company will ship the REE ore to the UK for processing.¹⁷⁸ Ivanhoe Mines, a Canadian firm, won the rights to explore and mine a copper-rich area in Angola, roughly the size of Switzerland; Ivanhoe has also started using the newly completed Lobito Corridor rail to ship copper from its mine in the DRC.¹⁷⁹

Despite earnest efforts from allies and partners, various obstacles hinder full cooperation. First, MSP participating nations lack political consensus on how to deal with the PRC’s economic coercion in the strategic material sector.¹⁸⁰ Some member states hesitate to reduce dependency on PRC-produced minerals, complicating the MSP’s ability to pursue meaningful trade policy or industry investments that could provoke Beijing’s disapproval.¹⁸¹ Additionally, internal politics can spill over into the partnership. For instance, the United States and EU are locked in a dispute over “protectionist” provisions in the “Buy America” Act and IRA.¹⁸² Bureaucratic and legislative barriers also pose challenges, particularly concerning the financing of overseas projects. For example, DPA creates a pathway for U.S. investment in NATO and other allied nations but no mechanism to provide funds to other mineral-rich but non-allied

countries like Chile.¹⁸³ Finally, while the United States and EU are aligned on most ESG issues, other nations in the MSP are less able culturally, politically, or economically to effect or enforce changes to labor, safety, and environmental rules. Ultimately, addressing supply chain security requires global solutions. Current efforts, while forging a path ahead, are not yet comprehensive. To truly enhance supply chain resilience, further action is essential.

Policy Recommendations

The USG possesses strategies to secure supply chains in the context of global power competition. Whole-of-government policies aimed at rebuilding the domestic stockpile, implementing permitting reforms, strategically allocating government resources while diversifying investment strategies, and collaborating with allies and partners will offset Beijing's strategic materials advantage and reinforce mineral supply chains imperative for national security.

Rebuild the Strategic Stockpile

The first step the United States should take to protect against PRC economic coercion or future supply shocks is to rebuild the NDS. Bolstering the NDS can reduce supply chain risks and vulnerabilities in the immediate term. While DPA Title III funding can encourage and accelerate domestic mineral extraction or processing operations, these efforts are often mired in political uncertainty and, in the best cases, can take 7-10 years to materialize.¹⁸⁴ In an increasingly volatile geopolitical environment, particularly as DOD forecasts conflict with the PRC as early as 2026, increasing funding to restock the nation's most critical materials is urgent and essential.¹⁸⁵

Congress and DOD should boost NDS funding above the \$193 million currently requested in the FY25 DOD budget.¹⁸⁶ Policymakers could address gaps by deferring less certain medium- and long-term strategic material supply chain investments to future fiscal years and prioritizing sustained funding to mitigate the current \$2 billion shortfall.¹⁸⁷ Doing so would reduce immediate risk to warfighters.

In addition to increasing the budget to replenish stockpile reserves, policymakers must recognize the potential impact of a bulk buy on commodity markets. Federal legislation

governing the NDS requires policymakers to “consult with producers and processors” of materials “to avoid undue disruption” in commodities markets before disposing of or procuring strategic materials for the NDS.¹⁸⁸ Policymakers should remain steadfast in the face of temporary price fluctuations and maintain transparency with the industry to mitigate the effects of temporary price shocks.

The NDS could also benefit from reforms that reduce or eliminate the mandatory notification periods for the procurement or disposal of materials, which can extend up to 45 days and impede the agility of the NDS Manager (NDSM) to make timely decisions.¹⁸⁹ Further, the NDSM should be empowered to swiftly address deficiencies and shortfalls as resources allow, which would require additional authority from Congress. Such legislative changes would recalibrate the NDS to effectively respond to modern challenges of great power competition, enhancing U.S. readiness and security with minimal risk increase.

Accelerate Permitting Approvals

Permitting remains the biggest obstacle to domestic mining progress. Streamlining the process can accelerate critical mineral supply chain security and send a clear message of support from policymakers to mining companies and investors looking to establish operations in the United States.

FAST-41 Implementation and Timelines. The USG’s decision to include critical mineral projects across the value chain in the FAST-41 program marks a promising improvement in interagency coordination and visibility.¹⁹⁰ Further efforts are necessary, however, to accelerate the timeline for federal permit applications. To ensure efficient oversight, Congress should enact legislation that sets clear permitting goals, imposes time limits on the permit process, and holds government agencies accountable for bureaucratic delays and inefficiencies. Previous legislative

efforts have suggested a 30-month limit for federal permitting.¹⁹¹ Notably, the EU recently enacted more stringent legislation, imposing a maximum 24-month cap on the process for strategic projects.¹⁹²

Continue Targeted Investments

The USG should look to other countries and private industry for best practices for targeted investments. Just as Australia provides funding across the mine development lifecycle, USG grants to further R&D, mapping, feasibility studies, environmental assessments, and public education could help mining companies overcome the “valley of death” and increase domestic mineral resources.¹⁹³ Additionally, structured tax incentives could help offset upfront expenditures, retaining critical private investors during the early stages of a project.

The USG should continue targeted investments in U.S. and friend-shored companies to help them remain competitive with the PRC’s state-owned industries. This includes providing upfront capital through existing mechanisms like DPA Title III authority and DOE’s loan programs. It also means using these authorities to their full extent. The DOD can use DPA “to pursue various investments, purchase commitments, and purchase vehicles to support strategic and critical material mining and production.”¹⁹⁴ It would benefit from approaching this and other authorities more creatively.

Diversify the U.S. Investment Strategy

The USG should look beyond providing upfront capital and tax incentives for critical mineral investments. A key strategy to diversify its approach is to commit to long-term purchasing of critical minerals, thereby providing a clear demand signal to private industry. By aggregating demand, the USG could use economies of scale to concurrently replenish the stockpile. While offtake agreements may mobilize private markets to meet government

requirements, financial risk persists for private industry without an agreed-upon price for the commodity. Therefore, the USG should explore purchasing commodities at predetermined prices and quantities through streaming and prepay agreements. This approach would stabilize commodity markets and, in some cases, provide essential low-cost capital. Moreover, it would convey the certainty that companies and their shareholders require to be willing to initiate or expand production.

The United States has already embarked on creative approaches to securing strategic materials; these efforts must be expanded. Increasing U.S. attention to countries like Angola, the DRC, and Zambia demonstrates that efforts to diversify investment strategies need not be unilateral or focused exclusively on developed nations. The United States should allocate more USAID and DFC resources to developing countries seeking to expand strategic materials mining opportunities. By advancing innovative financing mechanisms with allied pools of capital, the United States can rapidly grow its influence in global markets for minerals it critically needs.

Work with Allies and Partners

U.S. national security hinges on the collective capacity of nations to promote and protect the rules-based international order. The U.S. global network of allies and partners remains a critical asymmetric advantage over the PRC and can significantly secure strategic material supply chains. Multilateral efforts such as the MSP and the joint U.S.-EU partnership in developing the Lobito Corridor in Africa are steps in the right direction. The United States should leverage existing security partnerships to aggregate demand and accelerate the development and sustainment of strategic material supply chains.¹⁹⁵

NATO's combined GDP stands near \$50 trillion.¹⁹⁶ Including like-minded nations such as South Korea, Japan, and Australia, this coalition controls nearly 60 percent of global GDP.¹⁹⁷

This collective "buying power" can be used to facilitate investments in stockpiling, mining, processing, and market price stability, making friend-shoring viable.¹⁹⁸ The United States should lead allies in developing free trade agreements and standardized purchasing practices to create a market independent of the PRC. Like the EU's restrictions on Russian oil imports, the United States and its partners should reduce reliance on PRC materials, develop long-term contracts, and invest strategically in mining and processing domestically and abroad. Partnering with the EU on the CRMA could accelerate development in critical industries by adapting legislation and trade policy to support investment in EU-critical mineral projects and aiming for diversification targets, such as the EU's goal of relying on no more than 65 percent from any single supplier.¹⁹⁹ Congress should revisit laws, like the Buy America Act, that pose challenges to international cooperation to make them more conducive to international partnerships.²⁰⁰ By broadening investment opportunities to responsible global companies, the USG can drive demand and address supply chain issues on a global scale while reinforcing alliances.

Educate and Engage

Many citizens view the mining industry as a relic of the past, associated with death, injury, and environmental destruction.²⁰¹ Few understand how dramatically the industry has evolved with innovative technology and engineering that improve safety, quality, and efficiency while minimizing environmental damage. The USG should leverage strategic messaging and knowledge sharing to rectify these misunderstandings while continuing to promote sustainable mining practices.

Mining literacy is important for voting constituents. National policymakers fund and regulate environmental and mining standards, while local and state officials approve permits,

enact zoning laws, and introduce ballot initiatives for new projects. A well-informed electorate ensures that election decisions hold officials accountable to community interests.

Conclusion

Strategic materials will remain vital to the world economy as long as people text on smartphones, travel by airplane, and rely on everyday technology. These minerals underpin nearly every industrial sector. The PRC's decades-long strategy to control mineral markets presents a major geostrategic challenge for the United States. Ensuring the supply of strategic materials amid PRC dominance remains difficult in an interconnected global environment. The PRC maintains its control of mineral extraction and processing through aggressive industrial policies and market manipulation. While sufficient U.S. mineral reserves exist, domestic production is not always economically viable. Permitting challenges, high startup costs, and intense competition characterize a domestic industry that cannot meet rising demand, leaving the United States reliant on imports, largely from the PRC, for critical mineral needs.

While the PRC holds significant advantages in the industry, the United States has many factors in its favor. With access to abundant strategic material reserves and a dynamic, risk-rewarding economic environment, U.S. mining companies can succeed domestically and internationally if they overcome market entry hurdles. The United States hosts leading mining academic and research institutions and attracts a significant labor pool. Coupled with robust energy and transportation infrastructure, these conditions support cultivating a domestic mining industry across the value chain. Geopolitically, the United States remains an influential global leader, with the world's largest economy and a robust network of allies and partners. Together, these advantages position the United States to access the strategic materials necessary for national security.

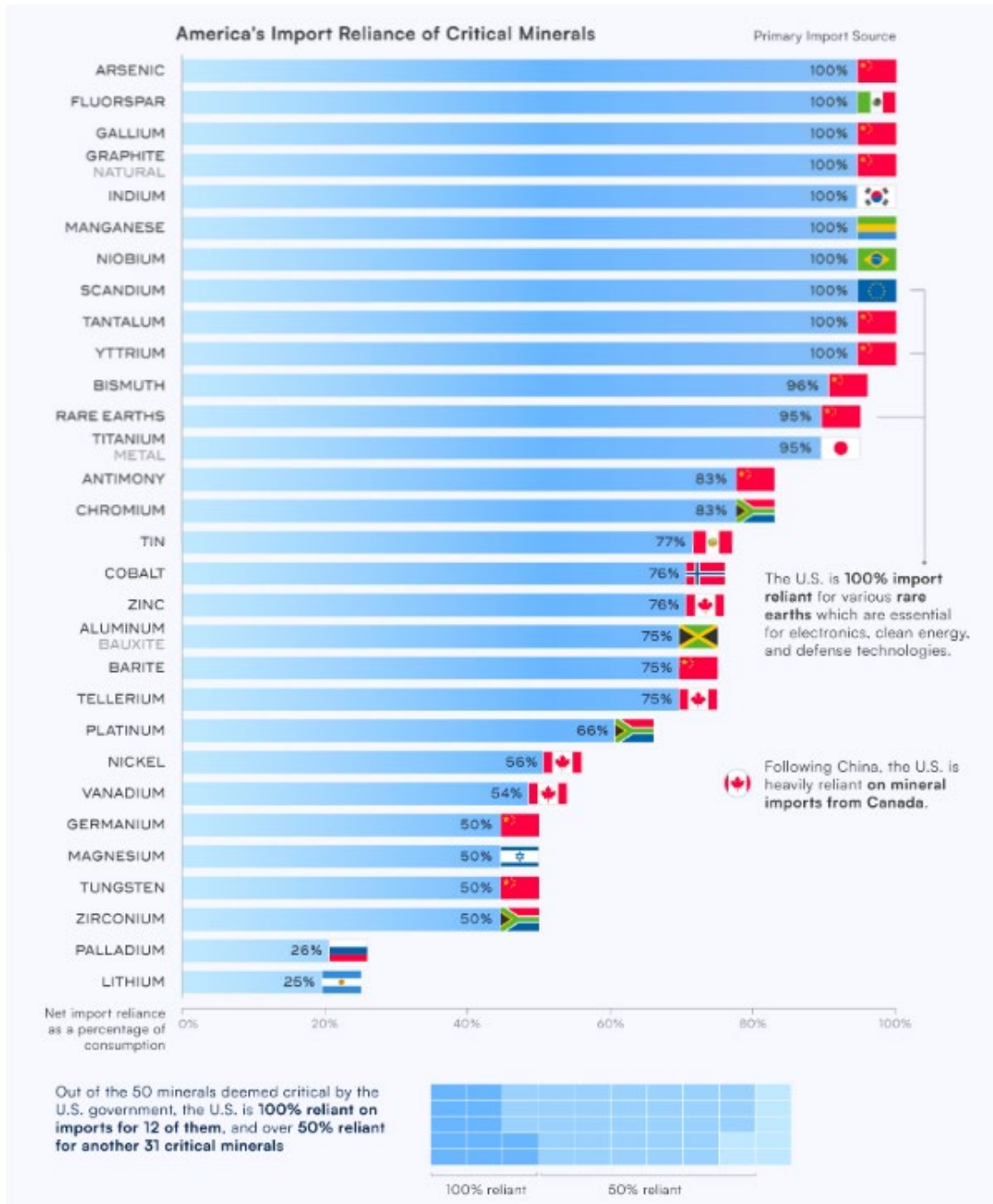
The consensus surrounding the PRC's threat to U.S. national security has spurred USG action. The IRA, the CHIPS and Science Act, and interagency collaboration on mining

regulation reflect this consensus, acknowledging the importance of strategic materials. Initiatives like FAST-41 can expedite permitting, thereby reducing financial risks for firms and optimizing capital allocation towards mine development and long-term supply chain security. DOE loans and DPA investments have targeted some minerals, and international alliances are forming to create ex-PRC supply chains. A whole-of-government approach is indeed underway to address strategic material supply chain vulnerabilities.

Significant work remains to address these vulnerabilities. The USG must replenish the NDS to mitigate short-term vulnerabilities. In addition to fully implementing FAST-41, the USG should establish reasonable timelines for federal permitting processes. It must incentivize U.S. firms to boost domestic production at all stages of the supply chain while expanding networks with allies and partners to reduce reliance on PRC suppliers. While continuing to utilize existing investment methods that allocate up-front capital, the USG should broaden the scope of its approach with collaborative partnerships, innovative financial mechanisms, and initiatives in developing nations to provide infrastructure and investments for critical minerals projects. By leveraging competitiveness, innovation, and robust partnerships, the United States can secure supply chains for strategic materials critical to national security.

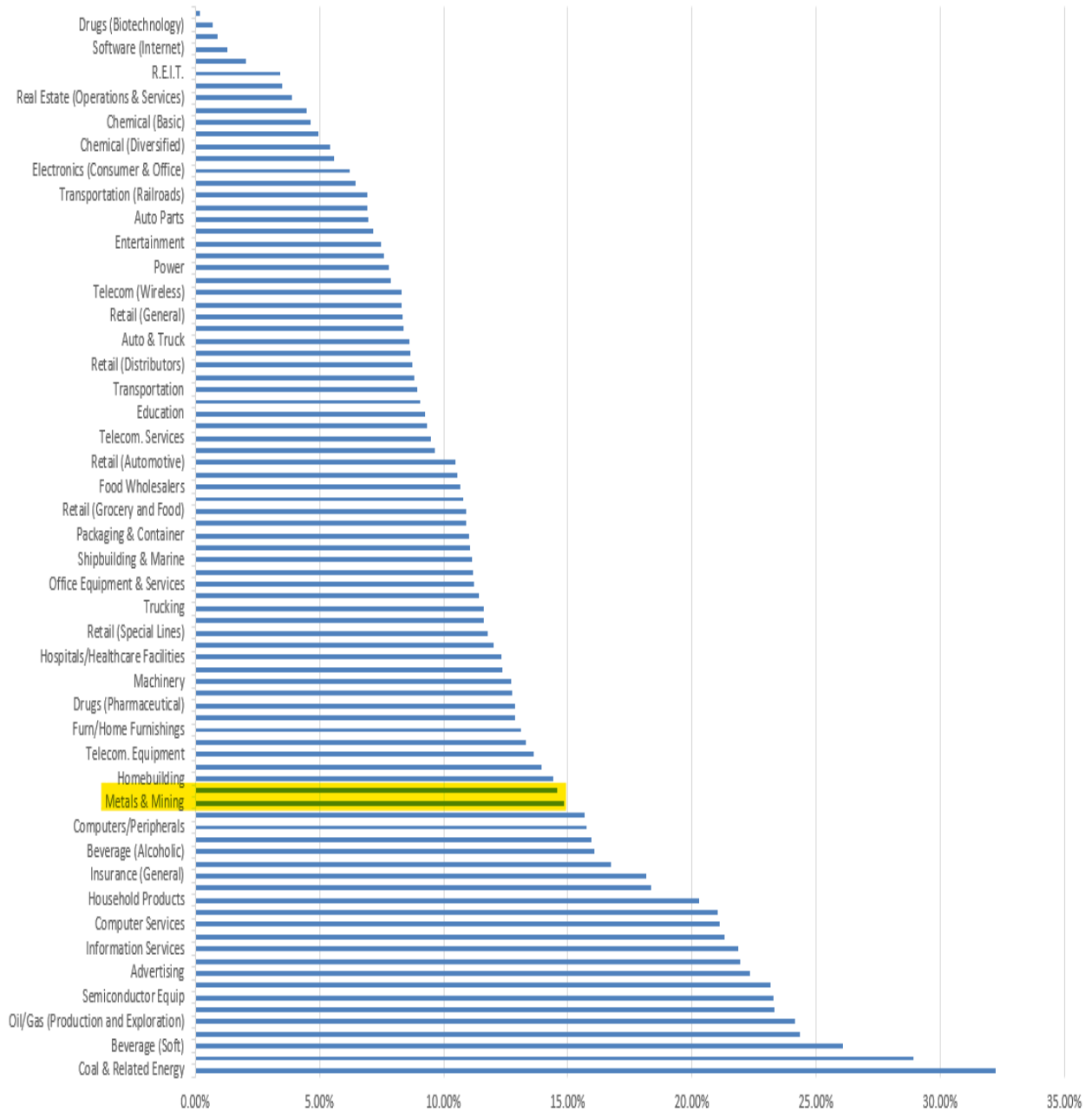
Appendix A

America's Import Reliance of Critical Minerals²⁰²



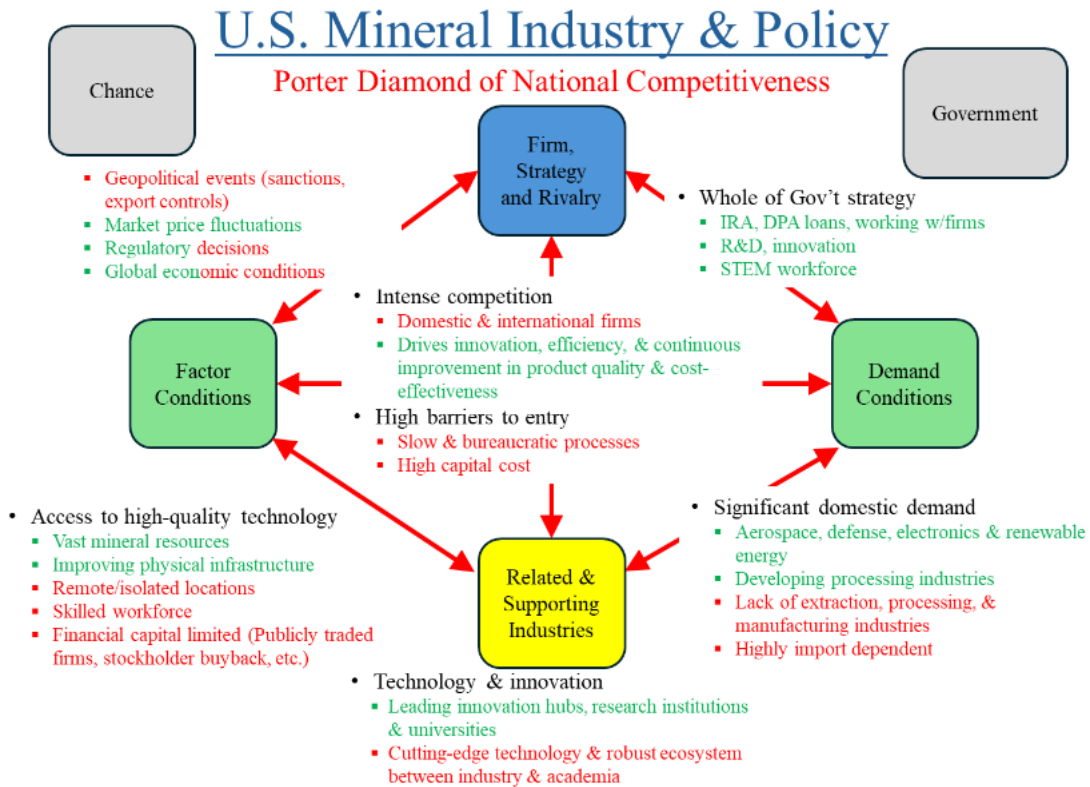
Appendix B

2023 Global ROIC Percentages by Industry²⁰³



Appendix C

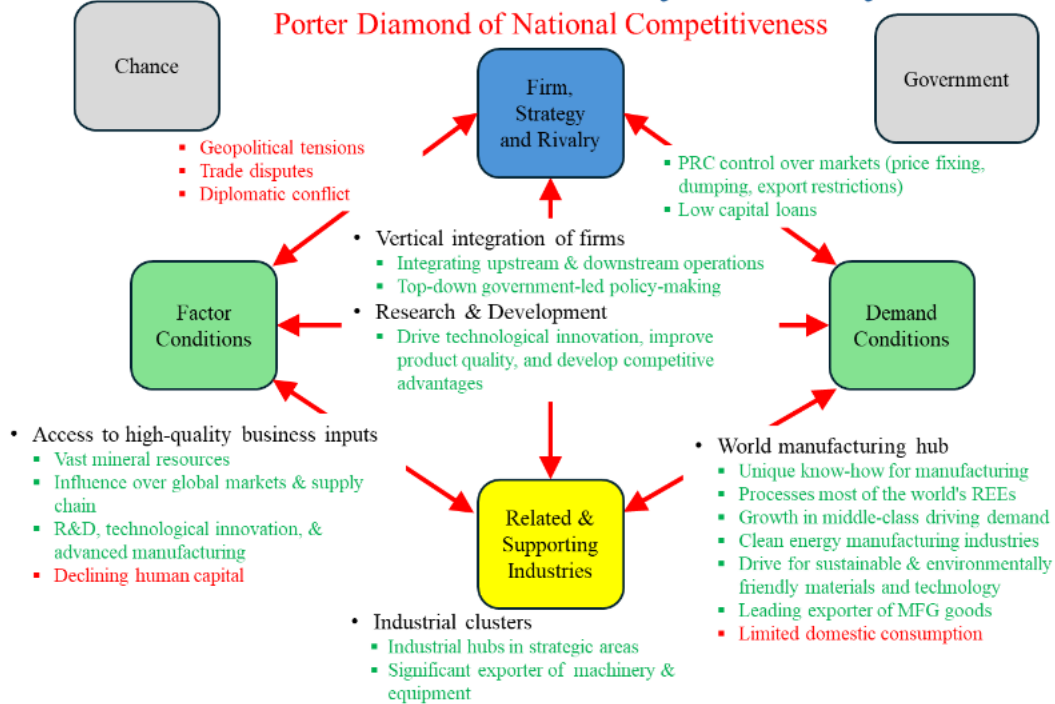
Porter's Diamond – United States²⁰⁴



Appendix D

Porter's Diamond – People's Republic of China²⁰⁵

PRC Mineral Industry & Policy

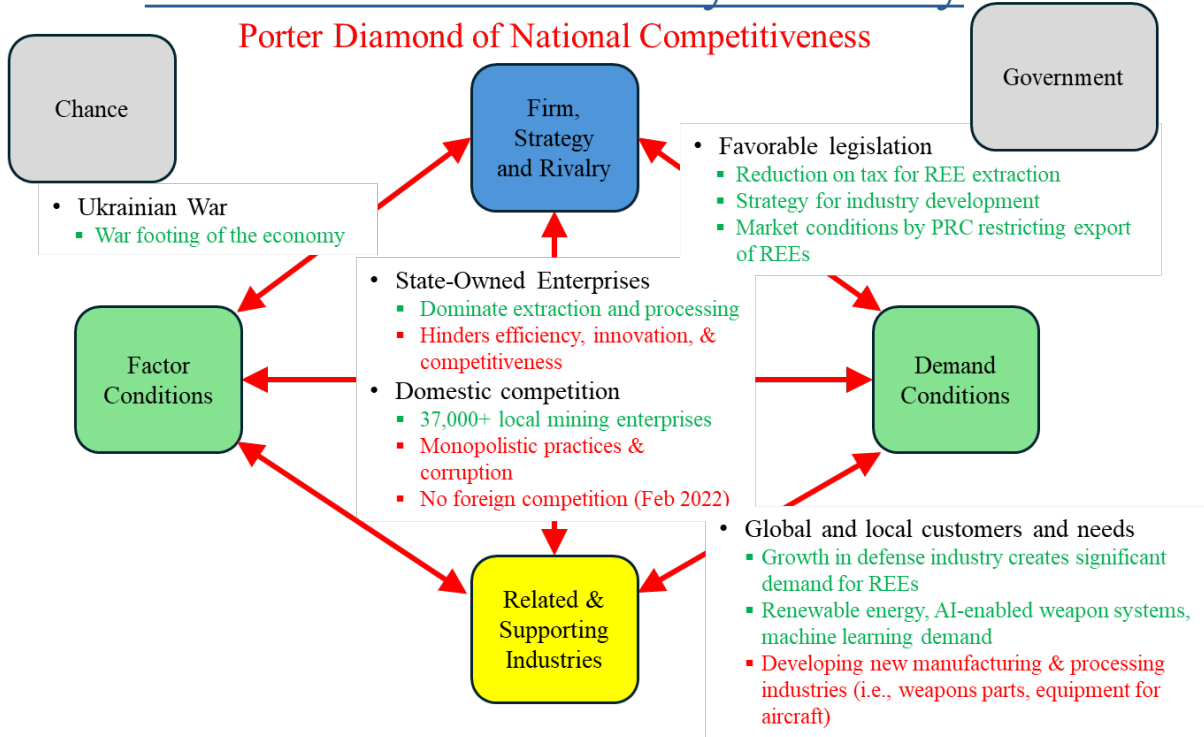


Source: 2021 IS StratMat Seminar Coursework

Appendix E

Porter's Diamond - Russia²⁰⁶

Russia – Porter Diamond of National Competitiveness Russia Mineral Industry & Policy



Source: 2021 IS StratMat Seminar Coursework

Appendix F

DPA List of Recently Awarded Critical Minerals Projects

DPA Investment Awards				
Project/Purpose	Company	State	Awarded (\$M)	Date Awarded
Expansion of domestic production capability of nickel and cobalt ²⁰⁷	The Doe Run Company	MO	\$7	Mar 2024
Domestic manufacturing capabilities for critical defense chemicals ²⁰⁸	CoorsTek, Goex/Estes Energetics, Lacamas Laboratories, Magrathea Metals, METSS Corp., Powdermet, Synthio Chemicals	LA, OR, CA, OH, CO	\$192.5	Feb 2024
Upcycle waste & scrap to prime units for critical materials ²⁰⁹	6K Additive	PA	\$23.3	Dec 2023
Enhance existing production capabilities for integrated circuits substrate, high-density interconnect, ultra-high-density interconnect, and advanced packaging ²¹⁰	GreenSource Fabrication	NH	\$46.2	Dec 2023
Support domestic production of coated, spheronized, purified graphite ²¹¹	South Star Battery Metals Corporation	Canada	\$3.2	Nov 2023
Near term domestic solutions for manufacturing innovative organic substrates for defense overmatched technologies ²¹²	Calumet Electronics Corporation	PA	\$39.9	Nov 2023
Titanium processing plant ²¹³	IperionX Limited	NC	\$12.7	Oct 2023
Support the expansion of domestic mining and production of lithium ²¹⁴	Albemarle Corporation	NC	\$90	Sep 2023
Manufacturing facility for sintered NdFeB RE permanent magnets and RE metals and alloys ²¹⁵	E-VAC Magnetics LLC	KY	\$94.1	Sep 2023

Accelerated domestic nickel exploration in Minnesota-Michigan Nickel Belt ²¹⁶	Talon Nickel (USA) LLC	MN	\$20.6	Sep 2023
Secure a reliable, sustainable supply of graphite materials within the U.S. to be used in the production of large-capacity batteries ²¹⁷	Graphite One	AK	\$37.5	Jul 2023
Controlled atmosphere vacuum furnace for production of titanium project ²¹⁸	Consolidated Precision Products – Selmec, Inc.	OR	\$1.3	Jul 2023
Increase production of high purity aluminum for use in missile and munition production ²¹⁹	Arconic Corporation	NY	\$45.5	Jun 2023
Conduct feasibility studies to expand cobalt extraction in Idaho ²²⁰	Jervois Mining USA	ID	\$15	Jun 2023
Heavy rare earth elements separation facility ²²¹	MP Materials	CA	\$35	Feb 2022

END NOTES

¹ David S. Abraham, *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age* (Yale University Press, 2015).

² Ibid.

³ Takehiro Okura, “Materials for Aircraft Engines,” Asen 5063 Aircraft Propulsion Final Report, 2015, 1-12.

⁴ David S. Abraham, *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age* (Yale University Press, 2015).

⁵ Ibid.

⁶ “Smartphones: Smart Chemistry,” American Chemical Society, Brian Rohrig, accessed April 20, 2024, <https://www.acs.org/education/resources/highschool/chemmatters/past-issues/archive-2014-2015/smartphones.html>.

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