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U.S.-CHINA RIVALRY OVER CRITICAL MINERALS: STRATEGIC IMPLICATIONS FOR GEOPOLITICS, SUPPLY CHAINS, AND TECHNOLOGICAL DOMINANCE

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ABSTRACT

Critical minerals have become a central arena of U.S.–China strategic competition because they underpin advanced semiconductors, electric vehicles, renewable energy, aerospace and defense technologies. China's advantage is not limited to its access to mineral resources; its extensive control over processing, refining, manufacturing, infrastructure and supply-chain networks creates significant vulnerabilities for the United States and its allies. This paper examines how Washington and Beijing are competing to secure critical-mineral supply chains and how efforts to reduce strategic dependence can generate reciprocal threat perceptions and deepen geopolitical rivalry. It examines three strategically important resource regions— the Democratic Republic of the Congo, Ukraine, and Greenland— to assess how resource endowments, political instability, infrastructure, foreign investment, and strategic partnerships are shaping the competition. The analysis argues that complete decoupling from China is neither immediately feasible nor strategically desirable. Instead, the United States should pursue supply-chain resilience through domestic mining and refining, strategic stockpiling, recycling and technological innovation, cooperation with trusted allies and deeper engagement with resource-rich states. The paper concludes that critical minerals are increasingly instruments of economic statecraft and geopolitical leverage, and that competition over their supply chains will play an important role in determining the future distribution of technological, economic, and strategic power.

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Introduction

Control over critical minerals has become a central battleground in global geopolitics, shaping industrial strength, energy transformation, and military innovation. Minerals such as rare earth elements, lithium, cobalt, and nickel are essential to semiconductor fabrication, electric vehicle batteries, and renewable energy systems. As states and industries shift toward cleaner energy sources, reliance on these minerals has intensified, particularly in the production of solar panels, wind turbines, and energy storage systems. Their role extends to national security, where rare earth elements are integral to advanced military technologies, including missile guidance systems, radar networks, and electronic warfare

At the center of this competition are the United States and China, two global superpowers engaged in a strategic contest to secure reliable supply chains and technological dominance. As global demand for rare earth elements (REEs), lithium, cobalt, nickel, and other strategic minerals surges, the security of supply has become a concern, influencing trade policies, industrial strategies, and diplomatic relations worldwide.

China has long maintained a dominant position in the extraction, processing, and export of critical minerals. Its dominance extends beyond mineral extraction to processing and refining, accounting for approximately 85% of global rare-earth refining output in 2025, reflecting its continued strategic advantage across critical mineral supply chains (International Energy Agency [IEA], 2026). This dominance is not merely a function of geological endowment but also the result of decades of state-driven industrial policy, infrastructure investment, and strategic acquisitions in mineral-rich regions worldwide. In contrast, the United States, despite possessing significant mineral resources, remains dependent on Chinese processing capabilities, raising concerns about supply chain vulnerabilities, economic security, and geopolitical leverage.

Beyond China and the U.S., several regions play crucial roles in the competition over critical minerals. Ukraine, long known for its rich mineral deposits, possesses significant reserves of lithium, titanium, and rare earth elements. The ongoing geopolitical instability in Ukraine, particularly in light of Russian aggression, has further complicated global access to these resources, adding an additional dimension to mineral security discussions.

Greenland is emerging as another strategic mineral hub, boasting vast untapped deposits of rare earth elements, uranium, and other critical materials. Its geographical proximity to North America and potential for resource extraction have attracted growing interest from both Western and Chinese investors, with China attempting to expand its foothold in Arctic resource development.

Africa, particularly the Democratic Republic of the Congo (DRC), remains central to the global supply of cobalt—an essential element in electric vehicle (EV) batteries. The DRC accounted for approximately 73% of global cobalt mine production in 2025, reinforcing its strategic importance in global critical mineral supply chains (U.S. Geological Survey [USGS], 2026), and Chinese firms have established a significant presence in its mining sector, further cementing Beijing's control over supply chains essential to the green energy transition. Other African nations, including South

Africa, Zambia, and Namibia, also hold substantial reserves of lithium, manganese, and graphite, reinforcing the continent's strategic importance in the critical minerals race.

Meanwhile, China itself possesses considerable domestic mineral resources, including vast reserves of rare earth elements in Inner Mongolia, Sichuan, and Jiangxi provinces. However, domestic production is often supplemented by strategic acquisitions abroad, reinforcing its near-monopoly in global refining and processing capabilities.

This research explores the U.S.-China strategic competition in critical minerals by analyzing supply chain vulnerabilities, resource nationalism, and technological dependencies. The contest for mineral security is not merely an economic issue but one aspect of 21st-century geopolitics, influencing energy transitions, defense policies, and global power structures.

Research Design

This study adopts a qualitative, theory-driven comparative case study design to examine the emerging strategic competition between China and U.S. over critical minerals. The research is grounded in the theoretical assumptions of defensive realism and Jervis's security dilemma framework, which provide an analytical basis for understanding how efforts by states to enhance their security can generate reciprocal threat perceptions, mistrust, and intensified strategic competition.

Critical minerals are examined not merely as economic commodities but as strategic resources that influence technological development, defense capabilities, industrial competitiveness, and national security. The study therefore investigates how dependence on critical-mineral supply chains has become incorporated into broader China-U.S geopolitical competition and how attempts by both states to reduce vulnerability may contribute to a security dilemma.

The research employs a comparative case study approach focusing on three strategically significant resource regions: the Democratic Republic of the Congo (DRC), Ukraine and Greenland. These cases were selected purposively because they represent different dimensions of the emerging competition. The DRC represents the importance of resource-rich developing states and China's established involvement in mineral extraction and infrastructure; Ukraine illustrates the intersection of critical minerals, armed conflict, reconstruction and U.S. strategic engagement; while Greenland represents the geopolitical significance of emerging Arctic mineral resources and competition over future access to strategic resources.

Research Objectives

The study seeks to achieve the following objectives:

1. To examine the nature and evolution of U.S.–China strategic competition over critical minerals, with particular focus on China's dominance across extraction, processing, refining, manufacturing, and critical-mineral supply chains and its implications for U.S. economic and national security.

2. To analyze the DRC, Ukraine, and Greenland as strategic cases and assess how resource availability, foreign investment, infrastructure, political conditions, and strategic partnerships are shaping U.S.–China competition over critical minerals.

3. To assess how U.S. and Chinese efforts to secure critical-mineral supply chains generate reciprocal threat perceptions and contribute to the intensification of the security dilemma, and to identify policy options for strengthening U.S. supply-chain resilience without pursuing complete decoupling from China.

Security Dilemma and China–U.S. Strategic Competition in Critical Minerals

The study employs Defensive Realism and Security Dilemma theory as its principal theoretical lenses to examine the intensifying strategic competition between the United States and China over critical minerals. Defensive Realism, rooted in Kenneth Waltz's structural realism and subsequently developed by scholars such as Charles Glaser and Stephen Van Evera, maintains that states operating within an anarchic international system are primarily concerned with ensuring their survival and security rather than pursuing unlimited power (Glaser, 1997; Van Evera, 1998; Waltz, 1979). However, Robert Jervis (1978) argues that measures undertaken by one state to enhance its security may inadvertently diminish the security of another, producing reciprocal threat perceptions, mistrust, and strategic competition. Although originally developed to explain military security relations, this theoretical framework provides a useful basis for examining contemporary economic and technological vulnerabilities, particularly where control over strategic resources influences national security and industrial capabilities.

The growing importance of critical minerals, including lithium, cobalt, gallium, germanium and REEs has extended national security considerations beyond traditional military capabilities to encompass technological innovation, industrial resilience, and supply-chain dependence. China's commanding position in the processing and refining of several critical minerals provides Beijing with considerable economic and strategic leverage, while simultaneously exposing the United States and its allies to potential supply disruptions. From the perspective of Defensive Realism, Washington's efforts to diversify mineral supplies, expand domestic extraction and refining, strengthen strategic stockpiles, and establish international partnerships can be interpreted as measures intended to reduce structural vulnerabilities. The establishment of the Minerals Security Partnership (MSP) in June 2022 illustrates this approach, seeking to strengthen critical-mineral supply chains through cooperation, investment, and responsible resource development (U.S. Department of State, 2022). More recently, the U.S. Department of Energy announced $45.7 million for 19 projects in May 2026 to strengthen domestic critical-material supply chains, further demonstrating Washington's emphasis on reducing dependence on foreign processing capabilities (U.S. Department of Energy, 2026).

However, these protective measures can also generate strategic uncertainty for China. American efforts to establish alternative supply chains and strengthen cooperation with allied and resource-rich countries may be perceived by Beijing as attempts to diminish its established industrial advantages and reduce its geopolitical influence. Conversely, China's efforts to preserve its

strategic position through domestic industrial development and export-control policies can reinforce American concerns regarding economic coercion and supply-chain vulnerability. This interaction reflects Jervis's (1978) security-dilemma argument: measures considered necessary for one state's security may appear threatening to another, encouraging additional defensive preparations. Glaser (1997) further explains that uncertainty regarding intentions and the consequences of security-enhancing measures can produce competition even when states have compatible security interests. In the critical-minerals sector, such uncertainty is intensified by the dual-use applications of these resources in civilian industries, advanced technologies, and military systems.

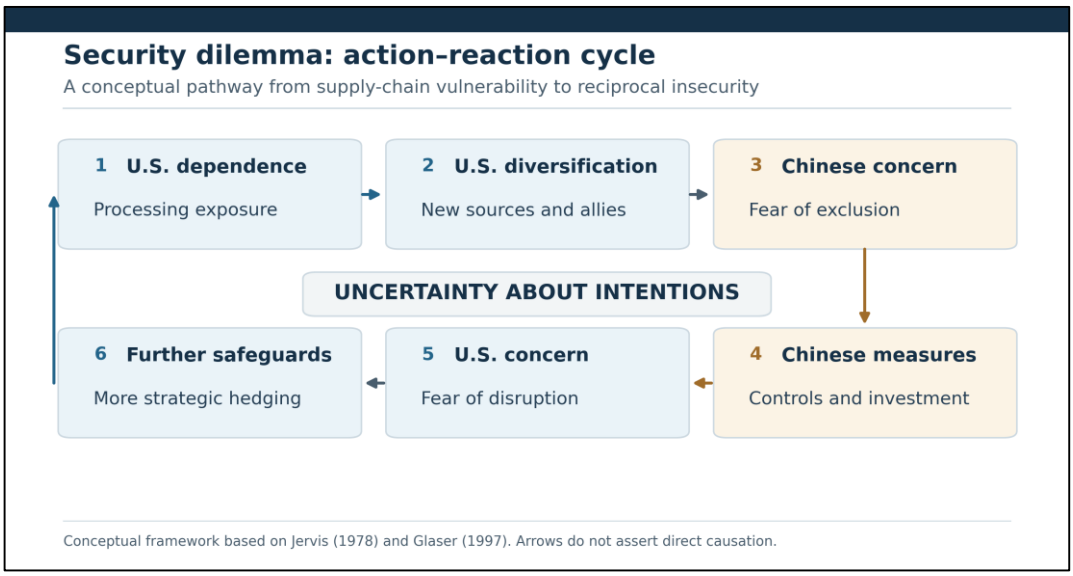
The reciprocal dimension of this competition becomes evident in the interaction between American supply-chain security initiatives and Chinese export restrictions. In July 2023, China announced export licensing requirements for gallium and germanium-related materials, justifying these measures on national security and nonproliferation grounds (Ministry of Commerce of the People's Republic of China, 2023). Beijing subsequently introduced additional restrictions, including country-specific measures affecting exports of several strategic materials to the United States in December 2024. Although these particular prohibitions were suspended in November 2025 until November 27, 2026, broader licensing requirements remained relevant (Xinhua News Agency, 2025). Such developments illustrate how critical minerals can become instruments of economic statecraft, allowing states to exploit asymmetrical dependencies within international supply networks. Farrell and Newman's (2019) concept of *weaponized interdependence* complements the security-dilemma explanation by demonstrating how states possessing strategic advantages within interconnected economic networks can employ those advantages to exercise coercive influence.

Nevertheless, the existence of export restrictions and competing industrial policies does not automatically establish a security dilemma. Certain measures may reflect deliberate geopolitical coercion, economic protectionism or attempts to preserve industrial dominance rather than unintended consequences of defensive behavior. The security-dilemma mechanism becomes analytically relevant when uncertainty regarding intentions encourages one state to adopt precautionary measures that the other interprets as threatening, generating further responses and reinforcing mutual insecurity (Glaser, 1997; Jervis, 1978). In this context, China's mineral export controls and American efforts to develop independent supply chains should be examined as interacting strategic policies rather than assuming that every action directly caused a particular countermeasure. The central concern is that policies intended to reduce dependence or preserve strategic advantages can contribute to a broader cycle of competitive adjustments, increasing the costs of cooperation and potentially intensifying bilateral mistrust.

The geopolitical implications of this competition extend beyond the United States and China into resource-rich regions, particularly the Democratic Republic of the Congo (DRC), Ukraine, and Greenland. These three cases represent distinct dimensions of critical-mineral competition: China's established mining and infrastructure presence in the DRC, American strategic engagement with Ukraine's mineral resources, and the emerging geopolitical significance of Greenland's untapped

mineral potential. From a defensive realist perspective, competition for access to these resources reflects attempts to reduce vulnerabilities and strengthen long-term economic and technological security. However, the same investments and strategic partnerships may also be interpreted as efforts to constrain a rival's future access to essential resources. Consequently, mineral diplomacy, foreign investment and supply-chain diversification may simultaneously serve legitimate economic objectives and generate geopolitical suspicion. These cases therefore provide an opportunity to assess how structural dependence, competing national interests, and uncertainty about intentions shape the broader U.S.–China rivalry.

In sum, Defensive Realism explains why the United States and China seek to strengthen their respective positions within critical-mineral supply chains, while Security Dilemma theory illuminates how these measures may generate reciprocal insecurity and intensify strategic competition. China's dominance in mineral processing, American efforts to reduce dependence, and the increasing use of export restrictions demonstrate the strategic importance of critical minerals in contemporary international relations. However, the security dilemma should be understood as a potential mechanism of competitive escalation rather than an inevitable outcome of economic rivalry. The interaction between defensive diversification, strategic leverage and reciprocal threat perceptions suggests that complete economic decoupling may deepen insecurity rather than eliminate it. A more sustainable approach requires resilient and diversified supply chains, international cooperation, greater transparency and credible assurances that reduce uncertainty while allowing states to safeguard legitimate national security interests (Glaser, 1997; Jervis, 1978).



Data Selection

The study adopts a qualitative, theory-driven comparative case study approach based primarily on primary and secondary documentary data. No primary surveys or interviews are employed. The primary data comprise U.S. government documents, executive orders, Department of Defense and Department of State publications, U.S. Geological Survey and Congressional Research Service reports while secondary data incorporates various international and intergovernmental sources, academic literature, think-tank and policy research, industry publications and credible international media. Sources from institutions such as CSIS, Carnegie Endowment for International Peace, Stimson Center, Jamestown Foundation, Federation of American Scientists, Reuters, BBC, Financial Times, and other specialist publications are used to examine critical-mineral supply chains, U.S.–China strategic competition, economic statecraft, and mineral security. The use of multiple and independent categories of sources facilitates source triangulation, allowing empirical claims and interpretations to be cross-checked for reliability and validity.

The study employs purposive case selection to examine the Democratic Republic of the Congo (DRC), Ukraine, and Greenland as three strategically significant cases. The DRC represents an important upstream resource environment, particularly because of its significance in global cobalt production and the involvement of external powers in mining, infrastructure, and investment. Ukraine represents the intersection of critical minerals with armed conflict, reconstruction, foreign investment, and strategic partnerships, while Greenland represents an emerging Arctic resource frontier with substantial mineral potential and increasing geopolitical significance. The cases are analyzed comparatively according to common dimensions, including resource availability, Chinese and U.S. involvement, infrastructure, foreign investment, political and security conditions, strategic partnerships, and geopolitical significance.

For data analysis, the study employs qualitative content analysis and comparative analysis, guided by defensive realism and security dilemma theory. The analysis focuses on resource dependence and strategic vulnerability, China's extraction and processing capabilities, U.S. supply-chain diversification, economic statecraft, foreign investment, mineral diplomacy, export restrictions, reciprocal threat perceptions, and the tension between decoupling and supply-chain resilience. The analysis proceeds by first examining the structure of global critical-mineral supply chains and areas of U.S. and Chinese dependence, followed by comparative examination of the three cases, and finally interpretation of the findings through the theoretical framework. The study is limited to the geopolitical and strategic dimensions of critical minerals and does not provide a comprehensive geological or economic assessment of individual mineral deposits. Since the research relies exclusively on publicly available secondary sources and does not involve human participants, interviews, or surveys, no significant ethical concerns relating to human-subject research arise.

What Are Critical Minerals?

Critical minerals are raw materials essential for high-tech industries, clean energy, defense, and advanced manufacturing. Materials such as lithium, cobalt, nickel, and graphite are crucial for batteries, semiconductors, and renewable systems. The category also includes rare earth

elements—17 chemical elements like neodymium, dysprosium, and terbium—widely used in powerful magnets, military equipment, and electronic devices. They are called "rare" not because they are scarce in quantity, but because they are found in low concentrations in the earth's crust, making their extraction and processing technically challenging and expensive.

Executive Order 13817, signed in December 2017, classified critical minerals as non-fuel resources essential to national security and vulnerable to disruption. It marked the beginning of a more proactive U.S. approach to securing access, including stockpiling and incentivizing domestic production (Executive Office of the President, 2017).

The Energy Act of 2020 establishes three criteria for identifying critical minerals: they must be essential to U.S. economic or national security, have supply chains vulnerable to disruption, and perform essential functions in manufacturing processes, such that their absence would have significant consequences for the country's economic or national security (U.S. Geological Survey [USGS], 2025).

In recent years, critical minerals have attracted growing attention as modern green and digital technologies—collectively known as the 'twin transition'—require significantly larger quantities of minerals compared to older, conventional technologies.

Mining plays an increasingly important role in global economic development, particularly in supporting industrial growth and the energy transition. In 2022, the world's 40 largest mining companies generated combined revenues of approximately $711 billion. The global mining market expanded by 6.1% between 2022 and 2023, reaching approximately $2.15 trillion, with projections published in 2023 anticipating growth to $2.78 trillion by 2027 (Runde & Hardman, 2023). In the United States, the mining sector accounted for approximately 1.3% of gross domestic product (GDP) and supported 579,500 jobs in 2025 (U.S. Bureau of Labor Statistics [BLS], 2026).

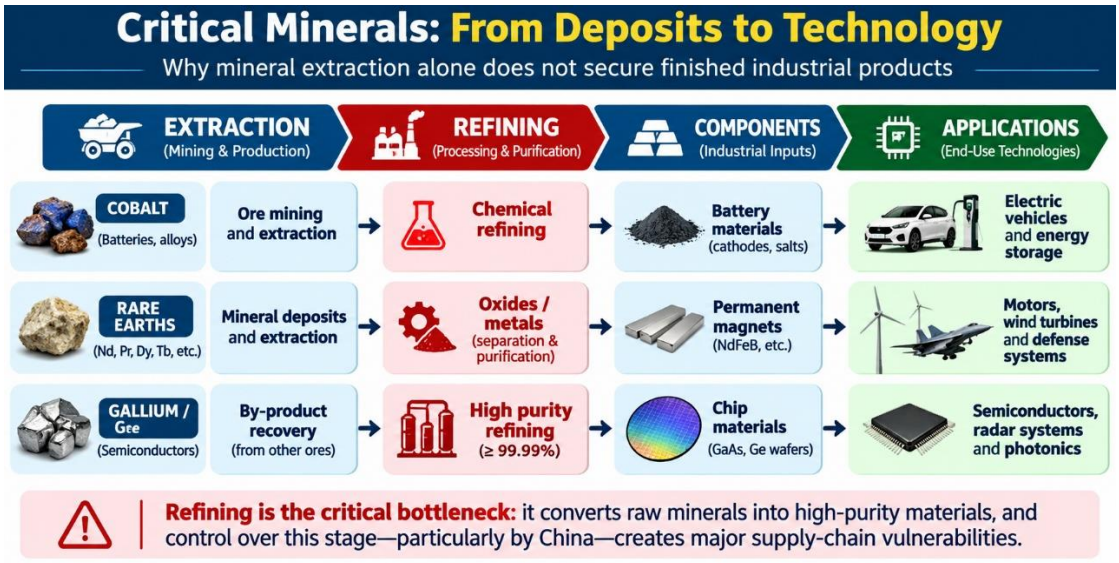
Critical minerals serve as the backbone of modern technological and industrial development. They are indispensable for manufacturing clean energy systems, such as batteries for electric vehicles and storage for renewable energy, as well as for semiconductors, defense technologies, and aerospace applications. Their significance lies not only in their function but also in their supply risk—many are sourced from a limited number of countries, making supply chains vulnerable to geopolitical tensions, trade restrictions, or market manipulation

As countries push for energy transition and technological advancement, control over critical mineral supply chains has become a strategic priority. This urgency has brought the issue to the heart of the US–China rivalry. Both powers see critical minerals not only as economic assets but as tools of influence, each striving to secure access, reduce dependence, and shape global rules. This has turned critical minerals into a key front in their broader strategic competition.

The intensifying global race for critical minerals has emerged as a defining feature of 21st-century geopolitics, especially as great powers reposition their economic and security policies to match the scale of technological transformation underway. The United States and China lie at the center of

this competition, driven by the indispensable role critical minerals play in green technologies, AI, semiconductors, and defense applications. From cobalt and lithium to gallium and rare earth elements, these materials are now considered strategic assets, whose control determines not only industrial leadership but national security leverage.

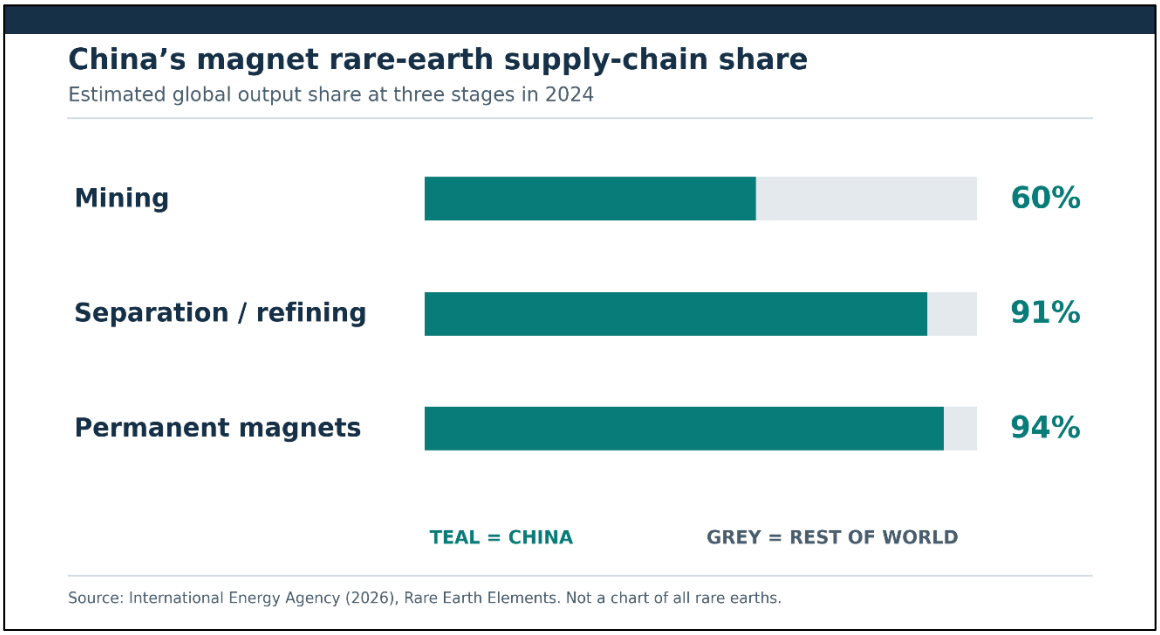
China–U.S. Competition in Critical Minerals



China's dominance in the extraction, processing, and refining of critical minerals constitutes a major strategic advantage in global supply chains. According to the U.S. Geological Survey (USGS, 2026), China produced approximately 270,000 metric tonnes of rare-earth oxides in 2025 and possessed estimated reserves of 44 million metric tonnes. The United States produced approximately 51,000 metric tonnes during the same year, with reserves estimated at 1.9 million metric tonnes. China's influence is particularly pronounced in downstream activities, accounting for approximately 85% of global rare-earth refining output in 2025 (International Energy Agency [IEA], 2026).

China produces about 80% of the world's natural graphite and around 60% of all mined rare earth elements used in magnets (Cooper, 2024). In 2024, the country accounted for approximately 60% of global mining output of magnet rare-earth elements, 91% of their refining output, and 94% of sintered permanent magnet production (International Energy Agency [IEA], 2025).

It refines 73 percent of the world's cobalt, 59 percent of lithium, and 68 percent of nickel (Nadjibulla & Liu, 2025)—each essential to the manufacture of lithium-ion batteries, a cornerstone of electric vehicle (EV) and renewable energy deployment. Eric Buisson, a critical minerals analyst at the IEA, notes that China's portion of global lithium mining rose from 6% in 2016 to 17% in 2023.



CSIS reports that China currently produces about 60% of the world's rare earth minerals, a decline from roughly 90% in 2008. Despite this decrease, China continues to lead globally with little indication of this shifting soon. Additionally, China processes nearly 90% of the world's rare earth materials and produced 70 kilotons of refined rare earths in 2023.

To stay dominant, China frequently accepts losses throughout the rare earth supply chain to keep prices low. For instance, the price of neodymium-praseodymium fell by 20% between January and July 2024, as reported by the Institute for Energy Research. Thanks to its centralized system, China can absorb these losses, a strategy its leadership seems prepared to follow to maintain control over these vital resources (Body, 2025).

In chip manufacturing, Beijing also leads the global supply of gallium and germanium—minerals critical to semiconductors and high-performance electronics. The geopolitical implications of this monopoly are far-reaching, especially as China has demonstrated a willingness to exploit its mineral advantage as a political tool.

Historically, key destinations for Chinese germanium exports included Hong Kong, Germany, Russia, Japan, the United States, Belgium, and Taiwan. However, between 2022 and 2024, shipments to many of these countries dropped precipitously—falling by 97 to 100 percent for the United States and Taiwan, and by 75 percent for Japan. Exports to Hong Kong ceased entirely (Stanzel, 2025).

In July 2023, China imposed restrictions on gallium and germanium exports. By October 2023, it temporarily halted the export of high-purity and natural flake graphite—key to EV battery

production. In August 2024, it added antimony, a dual-use material, to its controlled export list. Then in December 2024, Beijing explicitly suspended exports of gallium, germanium, and antimony to the United States. In January 2025, following the Trump administration's imposition of 10 percent tariffs on all Chinese imports, Beijing retaliated with restrictions on five essential minerals—tungsten, indium, bismuth, tellurium, and molybdenum—highlighting how strategic resources are now weaponized in global politics. Analysts like Andy Home from Reuters have aptly described critical minerals as the new "bargaining chip on the geopolitical table." (Denton-Townshend, 2025; Nadjibulla & Liu, 2025)

The scale of U.S. dependence on foreign mineral sources, especially China, has set off alarm bells in Washington. Of the 50 mineral commodities designated as "critical" by the U.S. government, China dominates the extraction or processing of around 30. Out of these 30, there are 21 minerals for which USA mostly or entirely relies on China (Nadjibulla & Liu, 2025). While China has not yet restricted sales to third-party countries that re-export to the United States, a comprehensive ban could inflict an estimated $3.4 billion loss on the U.S. economy (Bayly, 2025).

In response, the United States and its allies have doubled down on international collaboration. The Minerals Security Partnership (MSP), a coalition comprising countries such as Australia, Canada, Japan, South Korea, India, several EU member states, and the U.S., was formed to build resilient supply chains for critical minerals (U.S. Department of State, n.d.).

Finalized in 2020, the Canada–U.S. Joint Action Plan on Critical Minerals Collaboration extends the goals of the Minerals Security Partnership (MSP) through a bilateral framework. It prioritizes the development of secure, integrated supply chains for high-demand critical minerals essential to sectors such as clean energy, defense, aerospace, and advanced communication technologies. The agreement emphasizes cross-border cooperation on geological data sharing, joint R&D on mineral processing, and aligned industrial strategies (Natural Resources Canada, 2020).

Yet the scale of China's industrial advantage remains formidable. And while Washington considers financial retaliation—such as restricting Chinese firms' access to U.S. capital markets or even SWIFT (Currently, there are 286 Chinese companies listed on American Securities market with aggregate wealth of $1.1 Trillion, restricting them will hurt USA more than China) (Center for Strategic and International Studies, 2025)—Beijing's smaller, state-controlled financial markets arguably insulate it better from external shocks. American capital markets, equating to about 140 percent of GDP, are far more globally entangled than China's, which represent only 60 percent of its GDP.

The International Energy Agency forecasts that demand for critical minerals in the energy sector alone could triple by 2030 (Queensland Government, n.d.-a) and potentially rising by as much as sixfold should initiatives to attain net zero emissions by 2050 intensify (Queensland Government, n.d.-b). With over 95 percent of growth in battery-grade spherical graphite attributed to China, this surge will only amplify existing dependencies unless concerted action is taken. By 2030, China is expected to supply nearly 77 percent of refined rare earths worldwide (Jamestown Foundation, 2025).

To match China's industrial strategy, the U.S. has turned to investment and ownership. Through the Development Finance Corporation (DFC), Washington has financed rare earth projects in Brazil (Hook, 2024) (though raw material from Brazil is still sent to China for refining) and has invested in TechMet—a critical minerals fund—which in turn pledged $50 million to Rainbow Rare Earths for developing South Africa's Phalaborwa mine, aiming to reduce reliance on China (Dempsey, 2024).

In just a few years, critical mineral supply chain security became an important sphere of US policymaking, evidenced by the creation in 2021 of the Bipartisan Infrastructure Law (BIL) and, in 2022, both the Inflation Reduction Act (IRA) and CHIPS and Science Act. There is also growing recognition in American policy circles that rare earths and related critical minerals must be embedded into defense and industrial strategy at the highest level, as reflected in recent documents such as the 2023 National Defense Industrial Strategy and the 2024 National Defense Authorization Act (U.S. Department of Defense, 2023).

The strategic calculus behind mineral acquisition is not limited to economic growth—it encompasses military preparedness and geopolitical leverage as well. The significance of these minerals can be gauged from the fact that each SSN-774 Virginia-class submarine requires approximately 9,200 pounds of rare earth materials, each DDG-51 Aegis destroyer requires approximately 5,200 pounds of these materials, and each F-35 Lightning II aircraft requires approximately 920 pounds of these materials (Humphries, 2013).

Building on the wider US-China competition in AI and technology, this paper now focuses on specific case studies to examine the geopolitical contest over critical minerals. It looks at Greenland, the Democratic Republic of Congo (DRC), and Ukraine—areas rich in natural resources and of strategic importance.

Structural Asymmetry in Critical Mineral Investment: State-Backed Financing Versus Market-Driven Capital

An important but frequently overlooked dimension of U.S.–China strategic competition over critical minerals is the structural difference between their investment and financing systems. Critical mineral extraction and processing are capital-intensive activities characterized by prolonged development periods, substantial upfront expenditure, geological uncertainty, regulatory requirements, and fluctuating commodity prices. According to Manalo (2026), the average discovery-to-production period across 232 mining assets studied was approximately 16 years, with considerably longer timelines projected for certain undeveloped projects. Importantly, the commencement of commercial production does not necessarily signify the immediate recovery of initial investment. Consequently, investors must commit substantial capital for extended periods before realizing financial returns, exposing projects to considerable commercial and political risks.

China's state-directed industrial development model provides an important advantage in navigating these challenges. Through state-owned enterprises, government-supported financing, industrial policies and vertically integrated supply chains, Beijing can support strategically

significant mineral projects with longer investment horizons than those typically acceptable to commercially oriented investors. The International Energy Agency (IEA, 2025) reports that Chinese enterprises actively invest in overseas mineral extraction with government support, while mining attracted approximately USD 21.4 billion in investment under China's Belt and Road Initiative in 2024. Such institutional arrangements can facilitate long-term resource acquisition, infrastructure development, and the establishment of integrated extraction and refining capabilities. This does not eliminate financial risks, but it can enable Chinese enterprises to pursue strategic supply-chain objectives alongside commercial considerations.

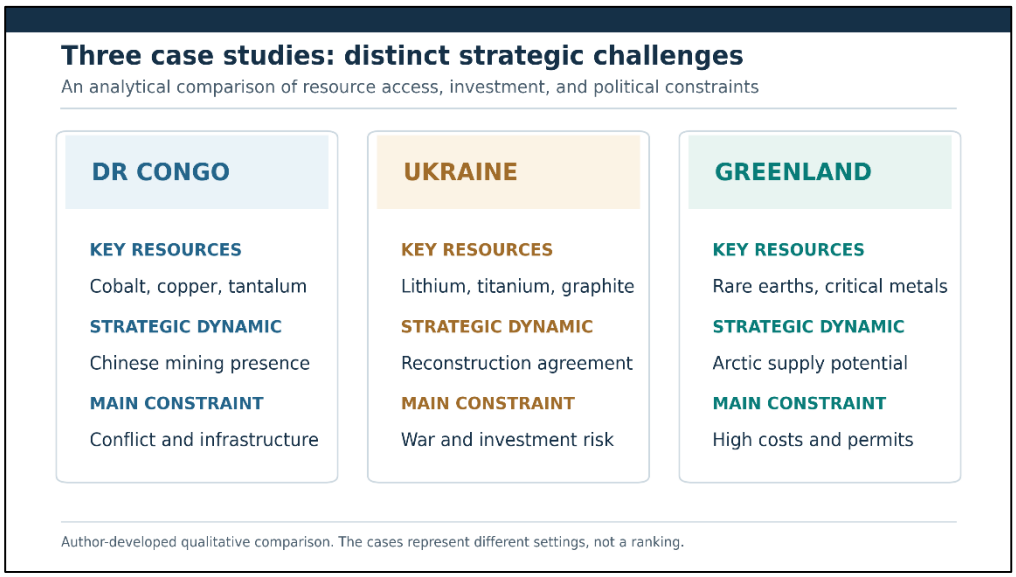
In contrast, the United States relies more extensively on private-sector investment, where financial decisions are generally influenced by anticipated profitability, financing costs, market demand and investment risks. The U.S. Department of Energy (2025) identified high startup costs, volatile mineral prices, extended permitting requirements and financing conditions as major factors discouraging private investment in domestic critical mineral projects. Moreover, the IEA (2026) reported a 9% decline in global critical mineral investment during 2025, demonstrating the sensitivity of mining investment to economic uncertainty and price volatility. These conditions can place American investors at a disadvantage when competing against Chinese enterprises benefiting from more coordinated and sustained financial support.

Nevertheless, the distinction between the two systems should not be overstated. The United States has increasingly adopted targeted industrial policy mechanisms to address financing constraints. For example, the U.S. Department of Defense's 2025 partnership with MP Materials included equity investment, financing support, long-term purchasing commitments, and a ten-year rare-earth price-floor arrangement (MP Materials, 2025). Baskaran and Schwartz (2026) likewise highlight Washington's growing use of public financing and price-support mechanisms to strengthen critical mineral supply chains. These developments suggest an emerging convergence toward greater state involvement, although substantial differences in institutional coordination and investment structures remain.

Viewed through defensive realism and security dilemma theory, this financial asymmetry has broader geopolitical implications. China's ability to sustain long-term investment in mineral extraction and processing reinforces its strategic position, while American dependence on concentrated foreign supply chains encourages Washington to pursue diversification, domestic industrial investment, and partnerships with resource-rich countries. Such measures, although intended to reduce economic and security vulnerabilities, can also intensify competition for overseas mineral assets and infrastructure. The central strategic challenge for the United States is therefore not simply securing additional mineral deposits, but establishing financially sustainable extraction, refining, and processing capabilities capable of competing with China's established industrial ecosystem.

The structural differences between China's state-backed investment model and the U.S. market-driven financing system become particularly evident in resource-rich regions where mineral extraction requires substantial capital, prolonged development periods, and sustained political

engagement. To examine how these asymmetries influence the broader U.S.–China strategic competition, the following sections analyze three geographically and geopolitically distinct cases: the **Democratic Republic of the Congo (DRC), Ukraine, and Greenland**. The DRC illustrates China's established presence in mineral extraction and infrastructure development, alongside emerging American efforts to secure alternative supplies. Ukraine demonstrates how critical mineral resources intersect with armed conflict, reconstruction, and strategic partnerships, while Greenland highlights the challenges of developing mineral wealth amid infrastructural limitations, environmental concerns, and geopolitical competition. Together, these cases provide a comparative basis for assessing how investment structures, resource dependencies, and competing security interests shape the evolving U.S.–China rivalry over critical minerals.



China–U.S. Competition in the DRC

The Democratic Republic of Congo has approximately $24 Trillion of untapped minerals deposits making it resource wise one of the richest countries (Panzi Foundation, n.d.). According to the U.S. Geological Survey (USGS, 2026), the DRC accounted for approximately 73% of global cobalt mine production, 52% of tantalum production, and 14% of copper production in 2025. The country also possesses significant deposits of lithium, gold, and coltan, reinforcing its strategic importance in global critical-mineral supply chains. Despite its abundant natural resources, the DRC continues to face widespread poverty, armed conflict, corruption, and governance challenges that constrain the effective utilization of its mineral wealth.

For many years, China has been the DR Congo's leading trading partner, according to the UN Comtrade Database. To secure access to the country's vast mineral resources, China has provided $3.2 billion in loans between 2005 and 2022—mainly for developing roads, bridges, and the national power grid (Lau, 2025). Chinese firms, including China Molybdenum and Zhejiang

Huayou Cobalt, have secured major stakes in Congolese mines, reinforcing China's dominance in critical minerals. Nine of the most prominent cobalt-producing areas are located in the southern Katanga region of the DRC, where Chinese firms operate approximately half of the active mines (Lawal, 2025).

A major factor in play is Rwanda's involvement in eastern DRC which centers on supporting rebel groups like M23 to exploit mineral-rich territories and maintain regional influence under the guise of security concerns. Under President Tshisekedi, the DRC is signaling a shift from its China-centric approach by encouraging investment from other global players, including the EU, India, and notably the US. President Tshisekedi is trying to use minerals for security for US, similar to China's minerals-for-infrastructure model, by offering access to critical resources in exchange for political and military backing from Washington (Neema, 2025).

In February 2025, the Republican majority of the U.S. House Foreign Affairs Committee publicly urged the Congolese government to reject the proposed acquisition of a significant cobalt and copper project by Norin Mining, a subsidiary of the Chinese state-owned defense conglomerate Norinco. While Congolese officials express openness to American investment in mining, experts argue Washington is unlikely to directly operate mines, as doing so would only place it behind China. Instead, the U.S. may prefer purchasing minerals from the Congolese government, avoiding direct competition with China on the ground (Neema, 2025). US investors also remain hesitant to invest in its mining sector due to several reasons: -

- China has maintained a long-standing presence in Africa's mining industry, whereas the United States has entered the field only recently, making it difficult to bridge the gap in influence and infrastructure.
- Chinese firms benefit from extensive financial support backed by the state, while American companies typically depend on private capital, which tends to be more cautious, particularly in high-risk environments.
- Issues such as political volatility, corruption, and uneven regulatory systems in several African nations pose significant obstacles for prospective U.S. investors.
- Poor infrastructure like weak transportation and unreliable power further complicates mining operations and increases costs. Additionally, frequent changes in mining regulations and corruption, environmental and social concerns, such as pollution and human rights abuses also undermine confidence in the sector.

To effectively compete with China for access to the Democratic Republic of Congo's critical minerals, the United States must increase its investment in the country's mining sector in a manner comparable to its support for infrastructure projects like the Lobito Corridor. Developing the domestic mining industry through targeted funding, technology sharing, and partnerships with Congolese stakeholders will help the U.S. establish a stronger foothold in the mineral supply chain. Additionally, addressing regional security concerns—particularly by curbing the influence of Rwandan-backed groups such as M23—will strengthen political ties with President Tshisekedi's government, which is open to a minerals-for-security arrangement with Washington. By

combining economic investment with efforts to improve security and governance, the U.S. can better challenge China's dominance and secure more reliable access to the critical minerals essential for technological and energy development worldwide.

Ukraine: The Hotbed of Critical Minerals Rivalry

Ukraine possesses substantial critical-mineral resources, including deposits of 25 of the 34 raw materials classified as critical by the European Union (International Trade Administration, 2026). These include rare-earth elements such as lanthanum, cerium, and neodymium, which are essential for advanced technologies in defense, aerospace, electronics, and renewable energy. Ukraine's mineral resources have been estimated to represent approximately 5% of global critical raw materials, although this figure should be treated as an indicative estimate rather than a verified share of economically recoverable reserves (United Nations Regional Information Centre for Western Europe, 2025).

Historically a significant producer of titanium minerals, Ukraine accounted for approximately 3.1% of global ilmenite production in 2024 (U.S. Geological Survey, n.d.). Additionally, the country possesses substantial lithium resources, estimated at approximately 500,000 metric tonnes, among the largest in Europe (Council of the European Union, n.d.). Ukraine has identified approximately 20,000 mineral deposits and occurrences, although many remain undeveloped or require further geological and commercial assessment (Mayer Brown, 2025). These resources, including iron ore, manganese, nickel, titanium, uranium, and rare-earth elements, reinforce Ukraine's strategic importance in global mineral supply chains.

Following intense negotiations, the United States and Ukraine signed a minerals agreement on April 30, 2025, granting the U.S. preferential access to Ukrainian mineral and natural resource licenses. In exchange, Washington has pledged continued financial and military support to aid Ukraine's post-war reconstruction. Central to the deal is the establishment of the United States–Ukraine Reinvestment Fund, a jointly managed initiative designed to reinvest the proceeds of resource extraction into Ukraine's economy over the next decade (Al Jazeera, 2025).

While Ukraine retains full sovereignty over its natural resources, it has agreed to allocate 50 percent of revenues from new critical minerals licenses—such as those involving titanium, graphite, lithium, and rare earth elements—into the fund (Baskaran & Schwartz, 2025). Significantly, the agreement excludes any repayment for past military aid, a key demand by Kyiv. Although the deal does not include formal U.S. security guarantees, it signals Washington's strategic stake in Ukraine and sustains the potential for military support in the event of renewed Russian aggression.

Analysts view the agreement as a diplomatic success for Ukraine, given that initial U.S. proposals had sought broader control over Ukraine's assets.

The U.S.–Ukraine minerals agreement presents significant opportunities but also faces several challenges:

- **Investment constraints:** Attracting sustained U.S. private-sector investment remains challenging due to the ongoing conflict, political uncertainty, infrastructure damage, and security risks. Nevertheless, the U.S.–Ukraine Reconstruction Investment Fund has begun supporting investment initiatives, including additional critical-mineral projects approved in October 2026 (U.S. International Development Finance Corporation [DFC], 2026).
- **Long development timelines:** Mineral exploration, extraction, and processing projects typically require substantial capital investment and several years before reaching commercial production. Their profitability is further influenced by fluctuating commodity prices, infrastructure requirements, financing costs, and operational risks.
- **Russian territorial occupation:** As of November 3, 2026, Russia controlled approximately 19% of Ukraine's internationally recognized territory, including Crimea and occupied areas of Donetsk, Luhansk, and Zaporizhzhia (Russia Matters, 2026). Earlier estimates suggested that approximately 40% of Ukraine's metal reserves were located in Russian-controlled territories (Center for Strategic and International Studies [CSIS], 2025). This occupation restricts access to valuable mineral deposits and creates substantial security and investment challenges.
- **Uncertain economic returns:** Collectively, these factors complicate the implementation of the U.S.–Ukraine minerals agreement, raising questions about the timeframe, economic viability, and potential strategic benefits for both countries.

While the US-Ukraine minerals agreement signals Washington's intent to reduce reliance on China for critical minerals, its effectiveness in shifting the strategic balance remains uncertain. Although Ukraine holds considerable reserves of key inputs such as lithium, titanium, and rare earth elements, the actual realization of these resources faces multiple delays due to ongoing conflict, infrastructural damage, and investor hesitation. Moreover, China's dominance stems not only from resource control but also from its command over the entire processing and manufacturing chain—an area where Ukraine currently lacks capacity. Unless the U.S. complements this agreement with long-term investments in extraction infrastructure and refining capabilities within Ukraine, the deal may do little in the immediate term to alter the asymmetry in global critical minerals supply chains.

Greenland: Critical Mineral Resources and U.S.–China Strategic Competition

In recent years, Greenland has reemerged as a focal point of global strategic interest, driven by its vast reserves of critical minerals and its geostrategic location in the Arctic. In 2019, President Donald Trump expressed interest in purchasing Greenland, an autonomous Danish territory rich in strategic resources and located along key Arctic shipping routes. The proposal was met with swift rejection from Danish Prime Minister Mette Frederiksen, leading Trump to cancel a planned state visit to Denmark (BBC News, 2019). The issue has resurfaced after the 2024 presidential election, when US president declared that he is going to "have Greenland" (Aikman, 2025). Greenland's then-Prime Minister Múte Egede reiterated that the island is "not for sale," emphasizing the

importance of cooperation while maintaining autonomy. The situation has heightened geopolitical tensions, with Denmark summoning the U.S. ambassador over reports of American intelligence (Nilsson-Julien & Associated Press, 2025) activities related to Greenland's independence movement. While some Greenlanders support closer ties with the U.S., the majority oppose any form of annexation, underscoring the complex dynamics at play in the Arctic region.

In a separate effort, the Pentagon is considering shifting Greenland from the U.S. European Command to the Northern Command (Humpert, 2025), symbolically bringing it closer to the U.S. while distancing it from Denmark. There's also talk of establishing a Compact of Free Association (Reuters, 2025b), similar to U.S. ties with some Pacific island nations, though this would require Greenland's approval and likely end its connection with Denmark. Public opposition to these plans remains high, but Trump insists Greenland is vital to U.S. security and hasn't ruled out any means, including military, to secure American interests there.

According to a 2023 geological assessment, Greenland possesses deposits or identified occurrences of 25 of the 34 raw materials classified as critical by the European Union, underscoring its strategic significance in global mineral supply chains (Geological Survey of Denmark and Greenland [GEUS], 2023). Although Greenland has restricted oil and natural gas extraction for environmental reasons, its mining sector continues to face regulatory challenges, inadequate infrastructure, high operational costs, and opposition from local communities (Reuters, 2025).

The island possesses substantial rare-earth element (REE) deposits, particularly at Kvanefjeld (Kuannersuit) in southern Greenland, which contains significant rare-earth and uranium resources. Heavy rare-earth elements, including dysprosium and terbium, are particularly important for high-performance permanent magnets used in electric vehicles, wind turbines, and advanced defense technologies. However, the project's development has been constrained by Greenland's 2021 uranium-mining legislation and subsequent licensing disputes, including the rejection of its exploration licence renewal in June 2026 (Reuters, 2026).

Other strategically important deposits include Tanbreez (Kringlerne) and Motzfeldt in southern Greenland, which contain rare-earth elements and other critical minerals (GEUS, 2023). Despite this substantial resource potential, commercially viable extraction remains dependent on geological assessment, infrastructure investment, environmental approval, and favorable market conditions. If developed, Greenland's mineral sector could become a major economic pillar, with projected values of critical mineral assets ranging between $200 billion and $700 billion, subject to technical feasibility and global market trends (Wass, 2025).

Greenland has long shown interest in building stronger economic ties with China, hoping that Chinese investment could boost its mining sector and support its ambitions for greater independence from Denmark. Since gaining greater autonomy in 2009, Greenlandic leaders have vigorously pursued opportunities with Chinese investors, attending events like the China Mining Conference. However, despite this openness, Chinese investment has remained limited and cautious.

One major reason is the severe logistical challenges and lack of infrastructure in Greenland, which make mining projects expensive and difficult to develop. The harsh Arctic environment, remote locations, and absence of existing transport and energy networks mean that each project requires significant upfront investment just to become operational. Facing these hurdles, Chinese companies have found Greenland less attractive compared to other markets where resources are easier and cheaper to extract. Combined with growing political and security concerns raised by Denmark and the United States, many Chinese investors have redirected their attention to more accessible and profitable opportunities elsewhere (Andersson, 2025). Consequently, China has scaled back its ambitions in Greenland, focusing instead on trade relations—particularly in fish exports—while avoiding heavy investment in Greenland's complex and costly mining sector.

Greenland presents the United States with both strategic opportunities and operational hurdles in the realm of critical minerals. While the island holds vast untapped reserves essential for U.S. technological and defense supply chains, realizing this potential is complicated by severe infrastructural and environmental constraints. The absence of roads, ports, and reliable energy sources significantly inflates development costs and delays project timelines. Moreover, Washington must balance its mineral ambitions with Denmark's political oversight and Greenland's local sensitivities. Although the urgency to reduce reliance on China adds pressure to act, the U.S. must approach Greenland not merely as a resource hub but as a partner requiring long-term investment, sustained diplomacy, and sensitivity to regional dynamics.

Recommendations

The U.S. must urgently recapitalize and expand the National Defense Stockpile (NDS) of critical minerals to hedge against global supply shocks and coercive Chinese export behavior. The current stockpile remains underfunded and lacks adequate volumes of rare earths, cobalt, lithium, and other strategic inputs essential for military and clean energy systems. A well-financed NDS can serve as a material reserve for defense contractors and essential industries during disruptions, stabilizing industrial baselines while long-term supply chains are restructured (Crebo-Rediker, 2025).

Secondly, the U.S should deepen its leadership role in the Mineral Security Partnership (MSP) to build a collective buffer against China's dominance. By coordinating with key allies—such as Japan, South Korea, Australia, and European states—the MSP can jointly invest in upstream and midstream projects in Africa, Latin America, and Southeast Asia. A central government-backed fund should be created to finance mineral exploration, processing infrastructure, and logistics in trusted regions. This fund would reduce investment risk, ensure shared offtake agreements, and enhance geopolitical alignment among likeminded partners.

Third, expanding and streamlining the extraction of domestic critical minerals is vital. The U.S. currently operates rare earth mines in Georgia and California, which have limited capacity and relies on China for processing (Tang & McWhorter, 2025). Private investors remain hesitant due to delayed returns, limited output potential, price volatility, and high operational costs. To overcome these barriers, the permitting process for new mines must be accelerated without compromising

environmental standards, using fast-track mechanisms and interagency coordination. Additionally, the U.S. needs to establish a government-backed fund to support exploration, infrastructure development, and operational stability.

While expanding domestic mining is essential, the U.S. must simultaneously prioritize investment in midstream processing and refining facilities for rare earth elements and other critical minerals. China's strategic advantage stems not only from its control over mineral extraction but, more importantly, from its overwhelming dominance in refining and separation technologies. Federal tax incentives, concessional financing, and public-private partnerships should therefore be directed towards establishing commercially viable processing facilities in the U.S. and trusted allied countries. Without a resilient domestic refining base, increased mining alone will continue to leave U.S. defence industries dependent on Chinese processing capabilities.

The U.S. needs to establish a dedicated interagency mechanism responsible for continuously monitoring global critical mineral markets, Chinese export controls, geopolitical risks, pricing trends, and supply chain vulnerabilities. Integrating intelligence from the Departments of Defense, Energy, Commerce, and State would provide policymakers with timely assessments of emerging disruptions and enable proactive rather than reactive responses to future supply shocks.

Providing a stable price floor for domestic producers and ensuring forward contracts would reduce market volatility and improve supply predictability. This could be modeled on the Commodity Credit Corporation used in agricultural markets, allowing U.S. producers to hedge against Chinese price manipulation. Legislative efforts, such as the proposed Critical Materials Future Act (Federation of American Scientists, 2025), deserve immediate attention, but even without new laws, existing institutions like the Defense Logistics Agency could be authorized to expand financial instruments that support domestic processing and recycling.

Fourthly, The Defense Production Act (DPA) grants the U.S. government authority to swiftly support industry during national emergencies by addressing supply chain disruptions and accelerating production of essential materials. Its recent extension to include firms from the United Kingdom and Australia aims to encourage investment in mining projects within these countries, thereby reducing reliance on China for critical minerals. Despite this progress, cooperation under the AUKUS framework has been limited in scale and pace, with a predominant focus on green energy rather than defense requirements. Given China's significant control over critical mineral resources and its willingness to leverage this for geopolitical advantage, it is imperative that AUKUS elevate critical minerals to a core strategic priority (Hurst & Butler, 2023). Establish a permanent AUKUS Critical Minerals Coordination Unit for real-time strategic planning and supply prioritization (especially military-grade materials).

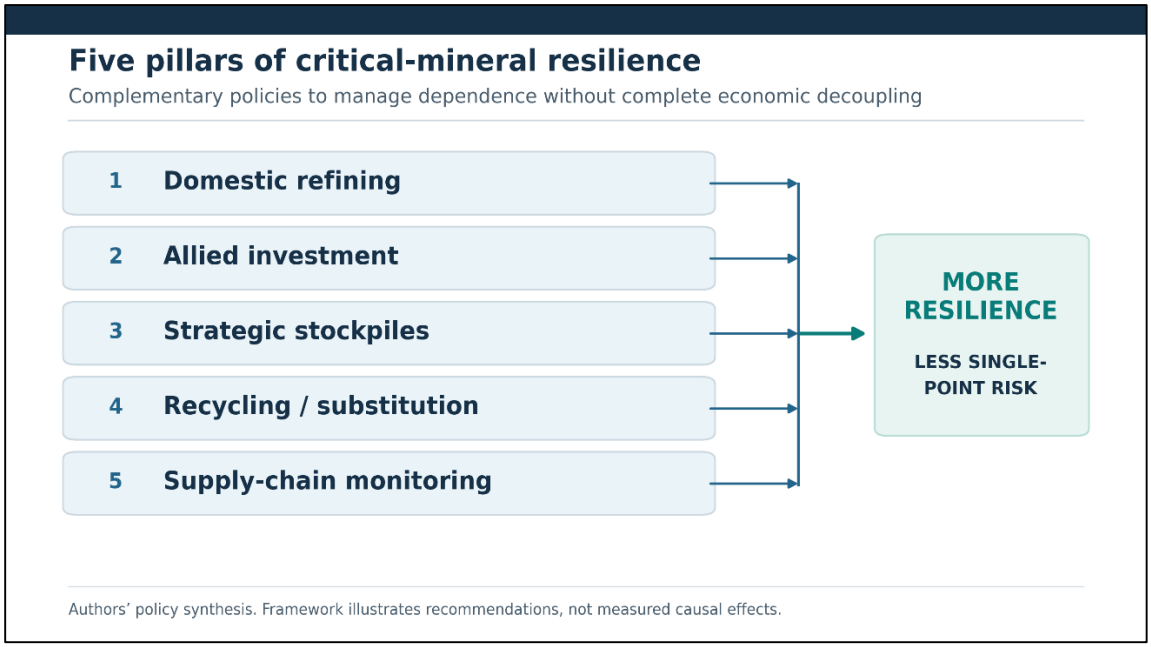
Strategic partnerships must extend to resource-rich countries in Africa (particularly DRC), Ukraine and even Greenland where significant deposits of critical minerals remain untapped due to investment shortfalls and political instability. The United States ought to adopt constructive collaboration in its foreign relations rather than following confrontational approaches, as exemplified by the tensions surrounding Greenland.

Innovation must remain at the heart of America's strategy. Public-private partnerships should be deepened to accelerate breakthroughs in less toxic and more energy-efficient recycling processes. Universities and national laboratories are already developing technologies to extract rare earths from geothermal brines, coal byproducts, and even fracking wastewater. These initiatives must be scaled through federal funding and regulatory support. In parallel, the U.S. should implement mandates for battery producers to take responsibility for end-of-life recycling, similar to regulations in China and the European Union. This not only reduces raw material dependency but also creates a parallel stream of secondary resources for defense and industry.

The U.S. should deploy AI and digital traceability systems to monitor critical mineral supply chains from extraction to end use. AI-enabled monitoring can improve transparency, detect supply disruptions, identify geopolitical risks, verify mineral provenance, and strengthen resilience against market manipulation and illicit trade, thereby enhancing both economic security and defence preparedness.

Fifth, investment in domestic recycling infrastructure and innovation is essential for long-term supply resilience. End-of-life electric vehicle batteries, wind turbines, and electronic waste contain significant amounts of reusable critical materials. Federal and state programs should support public-private partnerships for scaling recycling technology and promoting circular supply chains. Simultaneously, funding should be directed toward R&D in substitution and mineral-efficient design to reduce dependence on scarce inputs.

Finally, the U.S. should exercise strategic patience and avoid direct confrontation with China over critical minerals until supply chain vulnerabilities are mitigated. Aggressive decoupling or sanctions before securing alternative sources would expose U.S. industry and defense to unacceptable risks. A measured posture—focused on quietly building redundancy, enhancing allied coordination, and avoiding retaliatory escalation—offers the best path to strategic insulation without triggering premature supply disruptions.



Conclusion

China's dominance of global critical mineral supply chains has emerged as one of the most significant strategic challenges confronting the U.S. in the twenty-first century. Through decades of sustained investment in mining, processing, refining, and industrial policy, Beijing has secured a commanding position across the critical minerals value chain, enabling it to exercise considerable economic leverage and influence over industries that underpin advanced manufacturing, clean energy, and defence technologies. Recent export restrictions on strategic minerals have further demonstrated that critical minerals are no longer merely commercial commodities but increasingly serve as instruments of economic statecraft and geopolitical competition.

Although the U.S. has responded through domestic industrial policies, strategic stockpiling, allied partnerships, and supply-chain diversification initiatives, these measures remain insufficient to offset China's structural advantages, particularly in mineral processing and refining. Addressing this challenge requires a comprehensive long-term strategy that integrates domestic production, processing capacity, technological innovation, recycling, overseas investment, strategic stockpiles, and closer coordination with trusted allies. Such a strategy should prioritize resilience rather than complete decoupling, thereby reducing strategic vulnerabilities while maintaining the stability of global supply chains.

An equally important dimension of this competition is the growing strategic importance of resource-rich developing countries, particularly in Africa. States such as the Democratic Republic of the Congo, Zambia, Namibia, and other mineral-producing nations possess vast reserves of cobalt, lithium, graphite, copper, and rare earth elements that are indispensable for the technologies shaping the future global economy. Consequently, competition between the U.S. and China is increasingly extending beyond technological rivalry towards a broader contest for investment, infrastructure development, diplomatic engagement, and long-term strategic partnerships across Africa and other regions of the Global South. The policies adopted by these countries, together with their ability to leverage mineral wealth for sustainable economic development, will significantly influence the future configuration of global critical mineral supply chains.

Ultimately, the geopolitics of critical minerals reflects a broader transformation in international politics, where control over strategic resources has become inseparable from technological leadership, economic resilience, and national security. As emerging technologies—including artificial intelligence, advanced semiconductors, quantum computing, renewable energy systems, and next-generation military capabilities become increasingly dependent upon secure access to critical minerals, competition over these resources will remain a defining feature of great-power rivalry. The extent to which the U.S. can reduce its strategic dependence through diversified and resilient supply chains, while simultaneously fostering equitable and mutually beneficial partnerships with resource-rich nations, will play a decisive role in shaping the future balance of economic and geopolitical power in the twenty-first century.

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