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From Awareness to Action:
Securing U.S. Strategic Materials in an Era of Great Power Competition

STRATEGIC MATERIALS-GROUP PAPER

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The United States faces a mounting national security challenge due to its heavy reliance on foreign-controlled supply chains for critical minerals that underpin defense systems, clean energy technologies, and advanced manufacturing. Despite policy measures like the CHIPS and Science Act, the Inflation Reduction Act, and Executive Order 14241, progress remains uneven. Geopolitical shocks—such as Russia's invasion of Ukraine and China's export restrictions on gallium, germanium, and antimony—have exposed the strategic costs of U.S. inaction. This paper frames the problem by tracing how decades of offshoring and regulatory complexity have left the DIB ill-prepared for a surge in demand during a major crisis.

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"Critical minerals" and "strategic materials" are related but distinct categories: the former is defined by economic importance and import vulnerability, while the latter focuses on materials essential for military readiness during emergencies. To sharpen analysis, the scope is narrowed to those minerals where China controls a dominant share of mining, refining, or processing and which are indispensable to U.S. defense systems—chiefly rare earth elements, lithium, cobalt, nickel, gallium, and germanium. By isolating minerals at the nexus of Chinese leverage and U.S. defense necessity, the paper targets the most acute supply chain risks.

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- **Establish a Centralized Critical Minerals Processing Authority** codified within the Executive Office to align agencies, streamline permitting, and coordinate public-private engagement.
- **Deploy Targeted Tax Credits, Offtake Agreements, and Price Stabilization Mechanisms** such as expanding 45X credits to midstream refineries; introduce magnet production and recycled-content tax incentives; create a futures market.
- **Modernize and Accelerate Permitting Reforms** by imposing statutory NEPA deadlines, expanding categorical exclusions, instituting expedited pathways for "critical mineral infrastructure," and funding environmental review staff.
- **Expand Eligibility for Strategic Partnerships and Financing Tools** under DPA Title III and the Mineral Security Partnership to include additional trusted partners and create a new DFC-style investment vehicle for infrastructure and exploration risk mitigation.
- **Establish a National Rare Earth Elements Recycling Strategy** with a dedicated R&D fund, procurement guarantees for recycled content in defense contracts, and decentralized recycling infrastructure grants.
- **Modernize the National Defense Stockpile** by granting DLA multiyear contracting, preposition supplies, stabilize funding, and upgrade digital forecasting and AI analytics. Amend the Strategic and Critical Materials Stockpiling Act to authorize advanced procurement, waiver authorities, and consistent multi-year budgets. Implement a cloud-based, AI-driven Risk Assessment and Mitigation Framework (RAMF-SM) integrated with DoD analytics for proactive supply-chain stress-testing and dynamic stockpile management using predictive models.
- **Develop a Resilient Talent Base** via REE-focused curricula at technical institutes, expanded grants and internships, DoD SkillBridge for transitioning service members, and community engagement incentives to rebuild a mining and materials workforce.

Section 1: Introduction

The secure and uninterrupted supply of critical minerals has become one of the defining national security imperatives of the 21st century. In the context of renewed strategic competition, the United States faces acute vulnerabilities due to its dependence on foreign-controlled supply chains for the materials underpinning its defense industrial base (DIB), clean energy systems, and advanced technologies. While growing policy awareness has led to legislative and executive action, including the CHIPS and Science Act (CHIPS Act), the Inflation Reduction Act (IRA), and most recently in March of 2025, Executive Order 14241 on Immediate Measures to Increase American Mineral Production (EO 14241), progress remains fragmented and insufficient. The convergence of geopolitical shocks, such as the Russian invasion of Ukraine and China's weaponization of its material dominance, has laid bare the strategic consequences of U.S. inaction.

China's control over critical mineral markets is not merely an economic advantage, but also a coercive instrument of state power. Its imposition of a rare earth elements (REEs)export embargo on Japan in 2010, restrictions on gallium and germanium exports in 2023, and export license requirements on antimony in 2024 have clearly demonstrated its willingness to exploit supply chain dominance to achieve geopolitical ends.[1] These minerals are not trivial. REEs, lithium, cobalt, and other critical inputs are essential for the production of permanent magnets, jet propulsion systems, hypersonic weapons, night vision devices, and advanced semiconductors; they are all foundational to U.S. military and technological superiority.[2] Yet the United States remains 100% import-reliant for twelve critical minerals and over 50% reliant for dozens more,

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[1] Kalantzakos, Sophia. 2018. China and the Geopolitics of Rare Earths / Sophia Kalantzakos. Oxford University Press. https://research-ebsco-com.nduezproxy.idm.oclc.org/linkprocessor/plink?id=2cc724ec-1a49-341b-a8d1-a7841beb13f6. p.2

[2] *Science History Institute*, "Rare Earth Elements."

with China processing as much as 90% of global REEs and dominating key nodes of refining and metallurgical conversion.[3]

The United States has taken incremental steps to address these vulnerabilities. The CHIPS Act sought to restore domestic semiconductor manufacturing capacity, while the IRA extended supply chain incentives to include allied sources of key battery minerals.[4] However, both measures focus largely on downstream capacity and consumer-facing technologies. They fail to address the root causes of industrial exposure: 1) foreign dominance of upstream mining and midstream processing; 2) a sluggish domestic permitting regime; 3) insufficient public-private coordination; and 4) structural underinvestment in material substitution, recycling, and workforce development. Recognizing these gaps, EO 14241 marked a turning point by declaring critical mineral access a national security priority and directing a whole-of-government effort to scale domestic production, finance strategic processing capacity, and reinforce coordination across the industrial ecosystem.[5]

This paper argues that despite growing awareness and policy momentum, the U.S. the DIB remains fundamentally unprepared to meet a major surge in demand driven by rapid technological innovation and exacerbated by China's strategic restrictions on critical mineral exports to the United States. The core vulnerabilities, overreliance on foreign adversaries, slow permitting, and weak midstream capacity, persist due to decades of offshoring, fragmented

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[3] Joseph Majkut et al., "Building Larger and More Diverse Supply Chains for Energy Minerals," *Center for Strategic & International Studies*, July 19, 2023.
[4] U.S. Department of Commerce. "Biden Administration Releases Implementation Strategy for $50 Billion CHIPS for America Program." Press release, September 6, 2022. https://www.commerce.gov/news/press-releases/2022/09/biden-administration-releases-implementation-strategy-50-billion-chips.
[5] Joseph Sopcisak et al., "Key Takeaways from President Trump's Executive Order to Strengthen U.S. Mineral Production," Holland & Knight, March 26, 2025, https://www.hklaw.com/en/insights/publications/2025/03/key-takeaways-from-president-trumps-executive-order-to-strengthen.

regulatory processes, and underinvestment in processing infrastructure, all of which would severely undermine industrial mobilization in a crisis. To support this thesis, the paper is organized into eight sections. Section 2 clarifies the definitional distinctions between “critical” and “strategic” minerals and narrows the analytic scope to those inputs where Chinese dominance intersects directly with defense necessity. Section 3 examines the strategic environment and policy context outlined in recent EOs, assessing challenges in domestic production, innovation, factor conditions, and strategic competition. Section 4 uses the Structure-Conduct-Performance (SCP) model to evaluate the structural limitations and behavioral patterns inhibiting U.S. industrial performance. Section 5 expands the lens to the global supply chain landscape, highlighting ally partnerships, investment opportunities, and strategic vulnerabilities abroad. Section 6 assesses U.S. mobilization readiness, with a focus on the Defense Logistics Agency’s (DLA) stockpile posture and the operationalization of the Defense Production Act (DPA). Finally, Section 7 presents policy recommendations structured around seven priority areas: 1) centralized governance; 2) financial incentives; 3) permitting reform; 4) supply chain diversification; 5) recycling; 6) stockpiling; and 7) workforce development.

The time to act decisively is now. In a contested global environment defined by adversarial industrial policy, slow reaction time and disjointed strategies are liabilities. Ensuring strategic material security requires the United States to move beyond awareness and into implementation at scale, with speed, and guided by a cohesive national strategy.

Section 2. From Critical to Strategic: Defining the Problem

The language surrounding critical minerals for national security and the economy is often characterized by overlapping and sometimes ambiguous terms, including "critical minerals," "strategic materials," and "rare earth elements.” While these terms are sometimes used

interchangeably, particularly in public discourse, their precise definitions and the associated lists highlight the need for a more focused approach when evaluating supply chain vulnerabilities impacting U.S. defense readiness. Under U.S. law, 'critical minerals' are non-fuel materials vital to the economy and national security, whose supply chains are vulnerable to disruption.[6] The U.S. Geological Survey (USGS), in coordination with the Department of Defense (DoD) and other agencies, maintains a list based largely on net import reliance. In contrast, 'strategic materials' are defined more broadly as those essential for military, industrial, or civilian needs during emergencies when domestic supply is inadequate.[7]

Though the definitions overlap, strategic materials are closely linked to the DIB and national emergencies, while critical minerals reflect broader economic and security concerns.[8] REEs, a group of 17 elements crucial for technologies like permanent magnets, are a key subset, alongside other vital inputs like lithium, cobalt, and nickel.[9] Nations define these materials based on their own priorities. In the United States, the USGS emphasizes economic importance and supply risk, while the DoD's National Defense Stockpile (NDS), managed by DLA Strategic Materials, focuses on minerals critical for defense and emergency preparedness.[10] Partners and allies such as Canada, the European Union (EU), and Japan maintain similar frameworks,

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[6] The White House, "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017" (Washington D.C., June 2021), https://ndu.blackboard.com/ultra/courses/_3657975_1/outline/file/_2774859_1.

[7] Lucia Livak, "Testimony of Rich Nolan, President & CEO, National Mining Association, before the United States House of Representatives Committee on Natural Resources," *National Mining Association* (blog), February 28, 2023, https://nma.org/2023/02/28/testimony-of-rich-nolan-president-ceo-national-mining-association-before-the-united-states-house-of-representatives-committee-on-natural-resources/.

[8] The White House, "100 Day Reviews under Executive Order 14017."

[9] U.S. Department of Defense, The Defense Department's Strategic and Critical Materials Review, https://www.defense.gov/News/Releases/Release/Article/1234567/the-defense-departments-strategic-and-critical-materials-review/.

[10] OASD Industrial Base Policy, "Industrial Capabilities Report to Congress FY21" (Washington D.C., March 2023), 75.

reflecting shared concerns about supply chain resilience and past disruptions, particularly from China.[11][12]

Complexity arises because these lists are dynamic and extensive, and not all listed materials pose the same level of immediate risk to the U.S. DIB. To focus this paper's analysis on the most pressing challenges, the scope is narrowed to minerals meeting two key criteria:

1. China dominates the mineral at any significant point in the supply chain, including mining, refining, or production. China generally controls approximately 80% of global refining capacity and 90% of critical mineral processing.[13] For REEs specifically, China dominates approximately 85-90% of processing.[14] It also processes 60-70% of the world's lithium and cobalt, roughly 60% of nickel, and 40% of copper.[15] Recent actions, such as export restrictions on gallium, germanium, and antimony in late 2024 and early 2025, underscore China's willingness to use this dominance as geopolitical leverage.[16]

2. The mineral is essential to defense systems and DIB readiness. These include minerals vital for permanent magnets (requiring REEs like neodymium, praseodymium, dysprosium, and terbium), components in advanced aircraft and guided munitions, satellites, lasers, and night vision devices. Minerals used in batteries (such as lithium, cobalt, and nickel) are increasingly

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[11] Natural Resources Canada. Canada and U.S. Finalize Joint Action Plan on Critical Minerals Collaboration. Ottawa: Government of Canada, 2020. https://www.canada.ca/en/natural-resources-canada/news/2020/01/canada-and-us-finalize-joint-action-plan-on-critical-minerals-collaboration.html.
[12] Natural Resources Canada. Canada and U.S. Finalize Joint Action Plan on Critical Minerals Collaboration.
[13] *U.S. Chamber of Commerce*, "Understanding America's Critical Minerals Supply Chain," last modified March 2024, https://www.uschamber.com/international/understanding-americas-critical-minerals-supply-chain.
[14] *U.S. Chamber of Commerce*, "Understanding America's Critical Minerals Supply Chain."
[15] Marit Kitaw, "Africa and the Global Race for Critical Minerals," Bradley, August 31, 2023, https://www.bradley.com/insights/publications/2023/08/africa-and-the-global-race-for-critical-minerals.
[16] Hugh Cameron, "China Blocks Shipment of Rare Minerals to US: What to Know - Newsweek," Newsweek, December 6, 2024, https://www.newsweek.com/china-bans-critical-minerals-trade-war-1995383.

critical for both electric vehicles and military applications. Other key minerals[17] mentioned include aluminum, which is heavily used in defense applications and is considered a potential alternative to REEs and tungsten. Gallium and germanium are critical for semiconductors, which are also essential for defense technologies.

This approach identifies the intersection of Chinese leverage and U.S. defense necessity, pinpointing the most vulnerable points in the supply chain. Focusing on minerals where China holds significant control and is indispensable for defense, we isolate the core problems and attempt to mitigate incurred risks.

Designed by the Author with assistance from ChatGPT; 22 April 2025

[17] T. Rosen and L. Downs, "The International Race for Rare Earth Elements," *Global Resources Review* (2001).

This narrowed focus aligns with the directives from recent EOs, such as EO 13817 on Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and EO 14017 on Securing America's Supply Chains, which task agencies to identify and prioritize minerals essential to national security and the economy and develop strategies to secure reliable supplies.[18] By refining this call through a DIB-specific lens, this paper targets the most critical vulnerabilities of foreign reliance, particularly on China. Therefore, the minerals of primary concern are those controlled by China that, if restricted access, would directly impede the production and readiness of U.S. defense systems.

Section 3. Strategic Environment: EO Attempts to Address Challenges

Industry Status & Supply Chain Issues

The U.S. critical mineral supply chains are vulnerable due to high import reliance. This was no accident, but a result of intentional policies in Beijing and Washington. As early as 1987, when Deng Xiaoping famously said, "The Middle East has oil… China has rare earths," China has embarked on a decades-long campaign to capture the global mining and processing sectors.[19] The United States, on the other hand, was all too willing to allow the dirty and polluting industry to leave. EOs from the current and previous Administrations attempt to reverse this trend, and have identified supply chain resilience as a priority, specifically focusing on increasing domestic production, refining, and recycling capacity for key materials like REEs, lithium, cobalt, and

[18] The White House, "100 Day Reviews under Executive Order 14017."
[19] Stew Magnuson, "China Maintains Dominance in Rare Earth Production," *National Defense Magazine*, September 8, 2021, 1.

graphite.[20] Despite this growing awareness and policy action, the U.S. DIB continues to experience significant challenges due to these vulnerabilities.

The U.S. industry footprint in critical minerals is limited, especially in the midstream and downstream sectors. While the United States has notable deposits of certain critical minerals, it lacks significant domestic refining and processing capacity. The United States also has only small-scale operations in other critical minerals needed by the DIB, such as lithium, nickel, cobalt, and graphite. For the latter, the United States is 100% reliant on foreign sources.[21] China also processes 60-70% of the world's lithium and cobalt, and roughly 60% of nickel.[22] Key bottlenecks in the U.S. supply chain include sending mined ore to China for necessary processing steps like separation and metal-making, and the near absence of domestic capacity for these critical midstream activities, particularly for heavy REEs and permanent magnets. Lengthy and complex domestic permitting processes also hinder the development of new mines and processing facilities, often taking years and deterring private capital investment.

A significant gap remains between policy intent and industrial reality. EOs such as EO 13817 and EO 14017, issued during the first Trump Administration and the Biden Administration, respectively, mandated the identification of critical minerals and the development of strategies to ensure secure supplies.[23] More recent EOs, such as EO 14241,

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[20] Office of the President of the United States, "Immediate Measures to Increase American Mineral Production," March 20, 2025, https://www.whitehouse.gov/presidential-actions/2025/03/immediate-measures-to-increase-american-mineral-production/.
[21] Steven M. Fortier et al., "Cobalt Availability in the United States—Present and Future, U.S. Geological Survey Open-File Report 2020–1127 (Reston, VA: U.S. Geological Survey, 2020), https://pubs.usgs.gov/of/2020/1127/ofr20201127.pdf.
[22] Fortier, "Cobalt Availability in the United States – Present and Future."
[23] The White House, "Executive Order on America's Supply Chains," February 24, 2021, BidenWhiteHouse.gov Archive, https://bidenwhitehouse.archives.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/.

emphasize the essential nature of processed critical minerals for national security and highlight significant supply chain vulnerabilities.[24] Despite the goals outlined in these EOs and billions of dollars of investments spurred by DPA Title III and legislation like CHIPS and the IRA, progress remains fragmented and insufficient to fully support the U.S. DIB and compete with China's scale and state support. Some of this lack of impact can be attributed to the nature of the mining industry; even fully financed companies take years to bring new capabilities online. Yet other projects fall victim to a lack of coordination within federal, state, and municipal governmental bodies. For example, the U.S. Department of Energy (DOE) funded Tamarack Project, which would mine and process nickel in the Midwest, remains hung up due to the state of Minnesota environmental requirements.[25]

Regarding business-government relations, the government and private sector are increasingly aligned in addressing the national security and economic risks tied to foreign reliance on critical materials. U.S. companies seek stable regulatory and investment environments to offset the high risk and long lead times of mining projects, support for automation and advanced processing to compete globally, and long-term offtake agreements or government-backed procurement to de-risk operations. Collaboration between the public and private sectors is growing through DPA and DOE grants, joint R&D hubs and tech initiatives, and alignment on domestic production, innovation, and environmental, social, and governance (ESG) standards. The U.S. approach relies on co-investment and coordination rather than state

[24] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.
[25] Chloe Johnson, "Minnesota Nickel Mine That Would Supply Tesla Shelves Its Unusual Excavation Method," *Star Tribune*, December 20, 2024, 2.

control, leveraging private innovation with government backing to achieve resilient and secure material supply chains.

Innovation Trends

Current research and development (R&D) trends in the U.S. mining and materials sector focus on advanced extraction methods, separation technologies, and recycling processes. There have been notable improvements in separation, recycling, and extraction methods, supported by initiatives like the CHIPS Act, the IRA, and targeted grants to private sector businesses.[26] The DOE has initiatives examining recycling pilots such as Li-Cycle and Redwood Materials, though challenges remain in scalability and integration with defense industries.[27] U.S. Government (USG)-funded research also attempts to address demand-side dynamics to find substitutes for minerals and metals dominated by China. New aluminum alloys, for example, could reduce the need for rare earth metals, and advanced recycling technologies, such as those for spent lithium batteries and rare earth magnets, could further reduce our dependence on China.[28]

A precursor to E.O. 14241, EO 13817 of 2017, calls for support for innovative technologies, tasking agencies, and programs to catalog R&D efforts.[29] The Energy Act of 2020 subsequently established a Critical Material Collaborative to develop substitutes and promote recycling.[30] The DPA Title III has also emerged as a vital funding mechanism to boost domestic

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[26] Li, Y., and L. Yang. “Phytomining of Rare Earth Elements: A Review.: Journal of Cleaner Production 291 (2021): 125791. https://pubmed.ncbi.nlm.nih.gov/35271907. 9 Clean Technica. “Researchers Discover Substitutes for Rare Earth Materials in Magnets.” Last modified October 29, 2022. https://cleantechnica.com/2022/10/29.

[27] The U.S. Department of Energy Loan Programs Office. "LPO Offers Conditional Commitment to Redwood Materials to Produce Critical Electric Vehicle Battery Materials." *Energy.gov*, February 15, 2023. https://www.energy.gov/lpo/articles/lpo-offers-conditional-commitment-redwood-materials-produce-critical-electric-vehicle.

[28] White House, “Immediate Measures to Increase American Mineral Production,” March 20, 2025.

[29] Donald J. Trump, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," *Federal Register*, December 26, 2017.

[30] U.S. Department of Energy, "Critical Materials Collaborative," *Department of Energy*, accessed May 7, 2025

processing.[31] Federal R&D grants and tax incentives to national labs, universities, and private sector innovators have promoted clean mining, recycling, and advanced manufacturing. Despite these federal programs, innovation is not always commercialized fast enough to support national security needs. Progress remains fragmented; for instance, the IRA's 45X credit may exclude standalone midstream refining facilities,[32] and CHIPS Act funding has largely favored semiconductor investments over mineral processing.[33]

Comparatively, China employs a vertically integrated innovation model.[34] China is outpacing the world in battery technology R&D, with a significantly higher percentage of citations in battery industry publications than the United States.[35] China has established state-backed innovation centers aligned with industrial clusters to foster breakthroughs in areas like rare earth permanent magnets and battery technologies.[36] While the United States should aim to become an innovation hub for smarter, cleaner mining practices, the current pace and scale of commercialization are insufficient to fully overcome supply chain vulnerabilities and compete with China's integrated approach. We simply lack the vertical integration of mining, processing, and equipment manufacturing to re-create in the short term what China has built since Deng Xiaoping's 1987 declaration.

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[31] Alvin Camba, "A Federal Critical Mineral Processing Initiative: Securing U.S. Mineral Independence from China," War on the Rocks, April 14, 2025, https://warontherocks.com/2025/04/a-federal-critical-mineral-processing-initiative-securing-u-s-mineral-independence-from-china/.
[32] Alvin Camba, "A Federal Critical Mineral Processing Initiative: Securing U.S. Mineral Independence from China."
[33] Alvin Camba, "A Federal Critical Mineral Processing Initiative: Securing U.S. Mineral Independence from China."
[34] "China's Rare Earth Innovation Push: A Strategic Leap," *Rare Earth Exchanges*, accessed April 17, 2025, https://rareearthexchanges.com/news/rare-earth-digital-manufacturing/.
[35] "Winning the Battery Race: How the United States Can Leapfrog China to Dominate Next -Generation Battery Technologies?," Carnegie Endowment for International Peace, October 2024, https://carnegieendowment.org/research/2024/10/winning-the-battery-race-how-the-united-states-can-leapfrog-china-to-dominate-next-generation-battery-technologies?lang=en.
[36] Rare Earth Exchanges, "China's Rare Earth Innovation Push: A Strategic Leap."

Factor Conditions

Addressing domestic production constraints, including infrastructure, labor, permitting, and access to capital, is essential for building a resilient critical mineral supply chain, a priority acknowledged by EO 14241.[37] These "input" factors significantly slow the United States' capacity growth and hinder efforts to reduce reliance on foreign sources. A key constraint is the availability of a skilled workforce. The skilled labor pipeline is aging, and United States universities produce few graduates trained in crucial areas like mining, metallurgy, or rare earth-specific chemistry. The decentralized nature of current workforce development efforts results in limited public exposure for these careers, small hiring markets, and competition for the same human resource assets. Unlike Beijing, Washington cannot simply dictate the number of mining engineers or metallurgists produced by its university system. Gaps in domestic production due to labor shortages directly impact national security by limiting the ability to scale up essential industries. Strategic workforce development is necessary, potentially including awareness campaigns and integrating relevant programs into schools and governmental job placement services. The DOE's Critical Minerals Collaborative, which already connects industry and researchers, could play a crucial role by liaising between government agencies, private industry, and educational institutions for talent acquisition and placement.

Environmental permitting delays are another significant bottleneck. Processes under frameworks like the National Environmental Policy Act (NEPA) can take 5–10 years or even an average of 29 years to bring a new mine online in the United States, making it one of the slowest countries globally for mine development.[38] These protracted processes drive away private capital

[37] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.
[38] Alvin Camba, "A Federal Critical Mineral Processing Initiative: Securing U.S. Mineral Independence from China."

and hinder the development of new mines and processing facilities. While EO-backed reforms aim to improve coordination and reduce duplication between federal agencies, reforms are not moving fast enough to remove these barriers. Environmental permitting can also be a pretext for those opposed to mining projects, such as environmental groups or Native American rights organizations, to weaponize lawsuits, throwing sand in the gears of an already long process. As one expert witness before the House explained, “Litigants exploit these delays, knowing that time is money. By repeatedly filing lawsuits, they aim to stretch the process until developers run out of funding and abandon their projects.” [39]

Capital availability and investor reluctance also impede domestic growth. U.S. producers face difficulty attracting long-term investment due to regulatory uncertainty and limited government offtake guarantees. While DPA Title III can be used for cost-sharing and investing in capital expenditures, and the U.S. Development Finance Corporation (DFC) has the authority to invest in critical minerals, these tools may be underutilized or face limitations.[40]

Strategic Competition (U.S.–China Comparison)

EO 14241 explicitly frames the challenge of securing critical minerals as one of strategic competition, directly addressing the need to reduce reliance on "foreign adversary control.”[41] This reflects a critical assessment of the global landscape, where China's dominance presents significant vulnerabilities for the United States and its allies. China has established a vertically integrated, state-directed industrial policy that aligns national objectives with resource control,

[39] Jeremy Harrell, "The Importance of Domestic Mining for U.S. National Security," February 6 Testimony Before the U.S. House Committee on Natural Resources Subcommittee on Energy & Mineral Resources.
[40] Gracelin Baskaran, “A Strategy for Minerals Diplomacy in Emerging Markets,” in Critical Minerals and the Future of the U.S. Economy (Center for Strategic & International Studies, 2025), 92.
[41] White House, “Immediate Measures to Increase American Mineral Production,” March 20, 2025.

processing, and export.[42] This model of cost structure, state support, and faster permitting processes provides China a competitive advantage and immense geopolitical influence and control over pricing and supply. In stark contrast, the United States relies on a more fragmented, market-driven system that often lacks the necessary coordination, long-term investment, and strategic oversight to compete effectively. There are also structural asymmetries in environmental and labor standards between the United States and China; the United States emphasizes stronger worker protections and environmental safeguards.

China's strategy includes investments in mineral assets globally, including in Africa, Southeast Asia, and Latin America, expanding its reach beyond domestic reserves. Crucially, China has repeatedly demonstrated a willingness to use its control over critical minerals as geopolitical and economic leverage.[43] Notable instances include restricting rare earth exports to Japan in 2010 and implementing recent restrictions on gallium, germanium, and antimony exports.[44] This exposes significant vulnerabilities in U.S. supply chains, particularly for defense and high-tech sectors that rely on processed materials like magnet-grade rare earths. To counter China's advantage and make the U.S. industry commercially viable while supporting the DIB, the United States needs a concerted approach by all Cabinet agencies and all levels of government, federal, state, and municipal.

Tariffs are mentioned as a potential tool to push back against Chinese domination of the sector. In April 2025, President Trump ordered the Department of Commerce (DOC) to initiate a Section 232 review of the national security vulnerabilities of imported critical minerals.[45] The

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[42] Rare Earth Exchanges, “China’s Rare Earth Innovation Push: A Strategic Leap.”
[43] Majkut et al., “Building Larger and More Diverse Supply Chains for Energy Minerals,” July 19, 2023.
[44] Kalantzákos, Sophia, China and the Geopolitics of Rare Earths.
[45] Ernest Scheyder and Costas Pitas, "Trump Signs Order Launching Probe into Reliance on Imported Critical Minerals," *Reuters*, April 15, 2025,

Section 232 investigation could result in the imposition of tariffs on Chinese processed minerals and metals which, in theory, could spur production domestically or among our allies if prices were to rise to the level of making these investments more economical. However, these tariffs would also carry substantial risks, including the possibility of triggering retaliation that could restrict access to essential materials or the equipment to process them. There is also the very real risk that U.S. and allied countries' industries would have insufficient capacity to replace Chinese supply. The result would be U.S. buyers falling back on Chinese goods albeit at far higher prices, causing inflationary ripples throughout the economy with little or no national security benefit.

Section 4. U.S. Industrial Structure: Can We Compete?

Evaluating the condition of the U.S. critical minerals sector through the SCP model reveals significant challenges inhibiting its ability to compete globally and support national security requirements. The SCP framework assesses how market structure influences firm behavior (conduct) and resulting outcomes (performance).[46] When applied to the critical minerals industry, it highlights key structural weaknesses, risk-averse industry conduct, and lagging performance outcomes compared to state-backed competitors like China.[47] This industry encompasses the upstream and midstream production, processing, and supply of non-fuel materials that are essential to U.S. national defense systems and DIB readiness and vulnerable due to significant Chinese control at key points in the global supply chain. It includes critical minerals and strategic materials such as REEs, lithium, cobalt, nickel, gallium, germanium, aluminum, and others used in advanced defense technologies.

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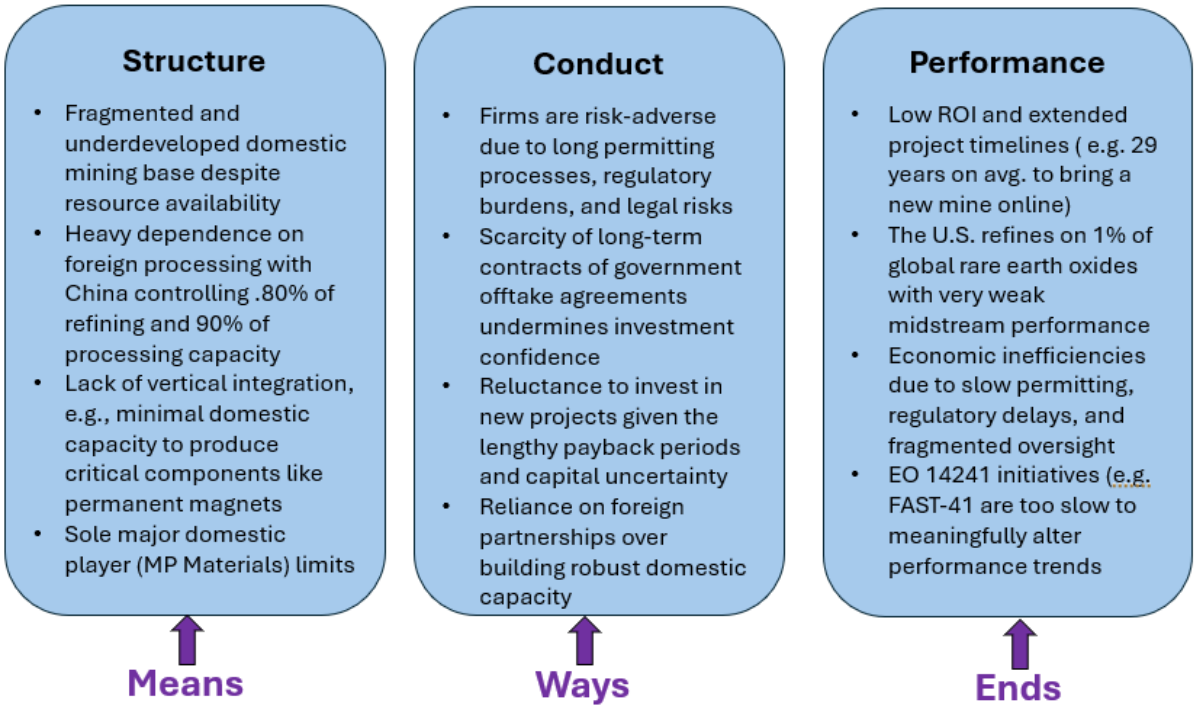
[46] Jean Belin and Keith Hartley, *The Economics of the Global Defence Industry*, 2019, https://www.researchgate.net/publication/335529316_The_Economics_of_the_Global_Defence_Industry.
[47] Michelle Michot Foss and Jacob Koelsch, "Of Chinese Behemoths: What China's Rare Earths Dominance Means for the US," *Research Paper*, December 19, 2022, https://www.bakerinstitute.org/research/chinese-behemoths-what-chinas-rare-earths-dominance-means-us.



Designed by the Author with assistance from ChatGPT; 5 May 2025

Structure

The U.S. critical minerals industry is characterized by a fragmented and underdeveloped domestic mining base. While the United States possesses mineral resources, including rare earth ores like those at Mountain Pass, California, it lacks essential midstream capacity, particularly for processing and refining. This results in an overreliance on foreign processing. There are substantial gaps in vertical integration; for instance, the United States lacks the full capacity to produce permanent magnets crucial for defense and high-tech applications. Current domestic efforts, such as MP Materials, have made significant advancements in midstream refining and downstream production. Since the opening of MP Materials' neodymium-iron-boron permanent magnet production facility in 2024, U.S. downstream production of critical permanent magnets is

now 1,000 metric tons per year, with a near-future goal of dramatically increasing production.[48] However, MP Materials is the only domestic company refining rare earth ore and producing magnets. Furthermore, there are gaps in processing capability necessary to facilitate mining industry projects, suggesting a potential need to review the structure of government agencies like the Bureau of Land Management and the U.S. Forest Service, for opportunities in administrative support. The government's own structure contributes to the problem, with responsibilities siloed across numerous agencies (e.g., DOE, DoD, Department of the Interior, DOC, DFC), leading to regulatory inconsistencies and a fragmented approach.[49]

Conduct

This challenging structure fosters risk-averse industry behavior among U.S. firms. Companies face significant disincentives due to permitting uncertainty, lengthy regulatory processes, legal exposure, and the long payback periods associated with mineral projects associated with both mining and refining. Unlike competitors with state-backed demand or subsidies, U.S. producers find it difficult to attract long-term investment due to the lack of capital certainty and limited government offtake guarantees. Few long-term contracts or offtake agreements are available to de-risk investment in domestic production. Consequently, U.S. firms often exhibit dependence on foreign intermediaries and strategic partnerships rather than building robust domestic capabilities.

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[48] MP Materials leadership, discussion with the author, April 5, 2025.
[49] Jane Nakano, “Seven Recommendations for a New Administration and Congress: Building U.S. Critical Minerals Strategy,” Center for Strategic and International Studies (CSIS), December 10, 2020, https://www.csis.org/analysis/seven-recommendations-new-administration-and-congress-building-us-critical-minerals.

Performance

The outcomes reflect these structural and behavioral challenges, resulting in weak Return on Investment (ROI) and increased schedule delays for new mining/refining investments. Overall project timelines can stretch to 10–15 years. These protracted timelines have significant economic consequences, increasing costs and reducing the value of mining projects. Examples include the delays in the Mountain Pass ramp-up and the challenges projects face due to environmental, cultural, and regulatory hurdles.[50] As a result, the United States refines only about 1 percent of global rare earth oxides, highlighting its minimal midstream performance.[51]

EO 14241 Tie-In

EO 14241 explicitly calls for a whole-of-government effort to reduce permitting barriers and expand domestic production. While the EO signals intent and initiatives are underway, such as the Permitting Council decision to designate the critical minerals supply chain as a FAST-41 sector, reforms are not moving fast enough to effectively remove these barriers.[52] Permitting delays remain a significant obstacle, and coordination across federal agencies remains fragmented rather than operating under a unified industrial strategy.

Key Questions Answered:

• *Why are U.S. firms reluctant to invest in new capacity?* U.S. firms are reluctant due to lengthy and uncertain permitting processes, high regulatory burdens, lack of capital certainty and stable

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[50] Mining - Quarterly Update 3/17/2025. Fort Mill, South Carolina: Mergent, 2025. https://login.nduezproxy.idm.oclc.org/login?url=https://www.proquest.com/reports/mining-quarterly-update-3-17-2025/docview/3178235797/se-2.

[51] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.

[52] "Permitting Council Moves to Designate the Critical Minerals Supply Chain as a FAST-41 Sector | Permitting Dashboard," accessed April 20, 2025, https://www.permits.performance.gov/fpisc-content/permitting-council-moves-designate-critical-minerals-supply-chain-fast-41-sector_old?utm_source=chatgpt.com.

demand signals (like long-term contracts), and the resulting long payback periods and weak ROI compared to foreign competitors.

• *How do permitting timelines and investment risk affect industry performance?* Protracted permitting timelines and high investment risk significantly hinder performance by discouraging domestic investment, driving capital abroad, making projects economically unviable, contributing to import reliance, and slowing the development of necessary domestic capacity.

• *Is the EO doing enough to change industry behavior?* While the EO articulates the right goals and some policy tools exist (like DPA Title III and DFC authority), current efforts are fragmented and insufficient to fundamentally change industry behavior or overcome systemic barriers like permitting delays and lack of coordinated investment signals at the necessary scale. Private capital largely remains on the sidelines.

Section 5. Global Landscape: Allies, Opportunities, and Vulnerabilities

Trusted Allies

Securing a resilient supply chain for strategic materials necessitates a comprehensive understanding of the global landscape, moving beyond domestic production to encompass key allies, potential investment regions, and strategic flashpoints where geopolitical risks intersect with resource availability. The DIB remains significantly vulnerable due to its heavy reliance on foreign sources, particularly China, for critical minerals and their processing. This reality underscores the imperative to cultivate diversified supply networks through trusted international partnerships and strategic investments abroad. EO 14241 emphasizes securing supply chains before crises hit and highlights the importance of cooperation with like-minded nations.[53]

[53] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.

Evaluating the global terrain reveals opportunities for collaboration and acute vulnerabilities where U.S. presence and influence are limited.

Friend-shoring and enhanced strategic economic relationships with trusted allies are central to mitigating risks associated with adversarial supply control. Key partners include Australia, Japan, and nations within the EU.[54] Australia possesses vast mineral reserves and a robust mining sector, making it a crucial potential source for diversification.[55] Working with Australia through initiatives like the Minerals Security Partnership (MSP), a coalition of 14 countries and the EU aimed at securing responsible supply chains, is critical.[56] Japan, having experienced the impact of Chinese rare earth export restrictions in 2010, actively pursued recycling programs to reduce its vulnerability, offering a collaboration and technology-sharing model. EU countries are also focused on securing critical raw materials, as seen in the European Commission's Critical Raw Materials Act, which provides a basis for coordinated efforts with the United States.[57] Operationalizing partnerships with these allies through joint ventures, defense-relevant trade agreements, and coordinated production initiatives is essential for building integrated value chains that enhance resilience.

Canada is a paramount ally with significant untapped reserves of REEs and other critical minerals. Canada's proximity and shared values make it a natural partner for establishing a more resilient North American supply chain. Collaborative efforts, including joint mining ventures and

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[54] European Commission, "Critical Raw Materials Act," single-market-economy.ec.europa.eu, 2023, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en.
[55] Joseph Majkut et al., "Building Larger and More Diverse Supply Chains for Energy Minerals," *CSIS*, July 19, 2023, 9, https://www.csis.org/analysis/building-larger-and-more-diverse-supply-chains-energy-minerals.
[56] "Minerals Security Partnership - United States Department of State," accessed April 9, 2025, https://2021-2025.state.gov/minerals-security-partnership/.
[57] European Commission, "Critical Raw Materials Act."

developing processing infrastructure in Canada, can ensure a reliable, secure, and diversified supply of REEs and other minerals for both nations, reducing geopolitical risks tied to China's dominance.[58] Expanding the scope of "domestic source" under DPA Title III to include Canada and Australia is a policy recommendation to leverage these key allies for strategic capacity building.[59] Effective friend-shoring initiatives may require carving out space in tariff negotiations to strengthen the critical minerals supply chain.

Investment Partners Abroad

Beyond traditional allies, U.S. companies and investment partners are exploring opportunities in other resource-rich countries, particularly in Latin America and potentially Southeast Asia. Countries like Chile, Argentina, and Peru hold significant reserves of minerals vital for modern technologies, including lithium and copper. Indonesia is also noted for its potential nickel opportunities. Investments in these regions, often facilitated through mechanisms like the DFC, can contribute to supply chain diversification. The DFC is highlighted as a primary financing tool for the U.S. government, with the authority to invest in critical minerals and infrastructure abroad.[60] However, operating in these countries presents challenges, including unstable politics, shifting regulations, and the need to offer attractive partnership models that include value-addition and technology transfer. Ensuring that DFC resources are utilized effectively to develop capacity while protecting American taxpayer interests requires careful oversight.

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[58] The US, Canada, and Mexico Need a More Coordinated Approach to Their Trade Relationships with China. https://www.brookings.edu/articles/the-us-canada-and-mexico-need-a-more-coordinated-approach-to-their trade-relationships-with-china/

[59] Majkut et al., “Building Larger and More Diverse Supply Chains for Energy Minerals,” July 19, 2023, 9.

[60] Jane Nakano, “An Evaluation of the Minerals Security Partnership,” in Critical Minerals and the Future of the U.S. Economy (Center for Strategic & International Studies, 2025), 67.

Strategic Hot Zones

Identifying and addressing vulnerabilities in strategic hot zones where China exerts significant influence or where supply is susceptible to disruption is critical. The Democratic Republic of Congo (DRC), Zambia, and Angola are prime examples of countries where China has heavily invested in financing and infrastructure to secure control over vast reserves of cobalt, copper, and other critical minerals.[61] The U.S. and EU's support for the Lobito Corridor project, connecting the DRC and Zambia to Angola's coast, is an effort to build a presence in the region by improving transportation infrastructure for mineral exports and countering China's established influence in the region.[62] More broadly, Africa is endowed with substantial critical mineral reserves, offering a pathway to diversify away from China.

Ukraine also holds significant mineral deposits and a potential future framework for joint development with the United States, which could help secure critical mineral supplies during reconstruction.[63] Several key barriers include outdated geological surveys, degraded energy infrastructure, and ongoing security risks.[64] The conflict in Ukraine serves as a case study of supply chain vulnerability, highlighting the risks of accessing materials like titanium, uranium, and rare metals. The conflict itself increases risks for companies and impacts the ability to freely export those minerals, and if Russia conquers that territory, those companies could lose the entirety of their investments. Resource competition also extends to the Arctic, specifically Greenland, which possesses substantial rare earth reserves. Greenland recently became a focus of

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[61] Marit Kitaw, "Africa and the Global Race for Critical Minerals," Bradley, August 31, 2023, https://www.bradley.com/insights/publications/2023/08/africa-and-the-global-race-for-critical-minerals.
[62] Amy Rotman, "A Turning Point in African Critical Minerals," The Assay, April 20, 2024, https://miningindaba.com/articles/investor-insight/a-turning-point-in-african-critical-minerals.
[63] Reuters, “Framework Agreement of US, Ukraine on Developing Critical Minerals,” Reuters, February 26, 2025, https://www.reuters.commarkets/deals/framework-agreement-us-ukraine-developing-critical-minerals-2025-02-26.
[64] Gracelin Baskaran and Meredith Schwartz, “What to Know About the Signed U.S.-Ukraine Minerals Deal,” *CSIS*, May 1, 2025, https://www.csis.org/analysis/what-know-about-signed-us-ukraine-minerals-deal.

the current Administration, not only due to its mineral resources but also for its strategic location off the North American coast. Securing access in such frontier environments requires proactive engagement and strategic investments.

EO 14241 Tie-In

EO 14241 frames the challenge explicitly in terms of strategic competition, responding to "foreign adversary control," and the need to reduce reliance on geopolitical competitors.[65] While EO 14241 sets the right intention by emphasizing friend-shoring and cooperation, the assessment indicates significant gaps remain in translating intent into effectively leveraged partnerships and reduced risks in areas where China is dominant. The U.S. strategy must distinguish between true allies with shared values and long-term strategic alignment and purely transactional suppliers influenced by geopolitical competitors. Deepening partnerships should prioritize countries with resource wealth, political convergence, and a willingness to integrate into secure supply chains while actively countering adversarial influence in key resource zones where the United States is less present. Addressing these vulnerabilities requires sustained government support for private sector investment, integrated planning with allies, and a clear, coordinated strategy to compete effectively in the global critical minerals market.

Section 6. Mobilization Readiness: The DIB's Strategic Risk

The ability of the U.S. DIB to meet rapid surge requirements in a major conflict scenario is directly tied to its secure access to critical minerals. Despite growing awareness and some policy actions, the United States remains unprepared for a major surge in demand due to its overreliance on foreign adversaries, slow domestic processes, and weak midstream capacity. A

[65] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.

key question is whether the U.S. system can realistically ramp up production within a critical timeframe, such as a 6-12-month crisis window.

Current Readiness Assessment: The State of the National Defense Stockpile

A cornerstone of historical U.S. strategic resilience, the National Defense Stockpile (NDS), has diminished in scale and relevance. Decades of underinvestment and shifting priorities have led to its decline.[66] While the NDS is intended to ensure materials are available for national defense and essential civilian needs during emergencies and not sufficiently produced domestically, its current inventory covers only about 6 percent of total critical mineral needs under a baseline national emergency scenario. Closing this substantial gap, estimated at $13.5 billion, requires a fundamental rethinking of how minerals are prioritized, acquired, and positioned.[67]

The DLA Strategic Materials manages the NDS and acquires high-risk materials after identifying insufficient supplies. These include value-added engineered minerals unique to specific sources. DLA monitors over 100 minerals and assesses DoD-wide demand and available supply to identify shortfalls.[68] Government acquisition for stockpiling is the preferred mitigation when U.S. defense demand exceeds supply and shortfalls are expected. However, it is not clear that the NDS has a well-developed mechanism or logistics plan for rapidly deploying these essential items.[69] Modern stockpile management demands forecasting disruption, modeling

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[66] Clifton G Chappell and Kristin Guss, "An Organizational History of the Defense National Stockpile Center: America's National Stockpile," n.d., 3–11.
[67] Cameron M Keys, "Emergency Access to Strategic and Critical Materials: The National Defense Stockpile," n.d., 2.
[68] OASD Industrial Base Policy, "Industrial Capabilities Report to Congress FY21" (Washington D.C., March 2023), 75.
[69] OASD Industrial Base Policy, 75.

supply chain risk, and acting on time-sensitive data, capabilities DLA's current digital infrastructure limits due to lack of modernization.

Specific DoD shortfalls in critical minerals are a significant concern. Minerals like REEs are essential for military technologies such as permanent magnets in guided missiles, advanced alloys in aircraft, and phosphors in imaging devices.[70] Key components in defense systems, such as neodymium magnets and advanced ceramics, rely heavily on REEs.[71] The U.S. military's reliance on specific REEs like dysprosium and neodymium, largely controlled by China, poses a significant risk to defense readiness.[72] Delays or halts in the production of critical defense systems could result from shortages. Titanium and tungsten are also highlighted as minerals essential to defense systems where supply chain vulnerability exists. Establishing a strategic reserve network, potentially including critical processed minerals like neodymium iron boron (NdFeB) magnets, samarium cobalt, and heavy rare earth oxides, is recommended to support sustained industrial output and national security during a crisis.

The DPA and its Implementation

The DPA, particularly Title III, is a crucial tool for strengthening the U.S. industrial base. It has been used for emergency interventions in areas such as battery minerals and REEs, and to expand munitions production or address needs during events like COVID-19. EO 14241 explicitly invoked the DPA, mandated a stockpile reassessment, and established an interagency

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[70] T. Rosen and L. Downs, "The International Race for Rare Earth Elements," Global Resources Review (2001).
[71] Department of Defense, “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States,” DoD, September 2018,
[72] Vlado Vivoda, Ron Matthews, and Jensine Andresen, “Securing Defense Critical Minerals: Challenges and U.S. Strategic Responses in an Evolving Geopolitical Landscape,” Comparative Strategy, March 5, 2025, 1–35, https://doi.org/10.1080/01495933.2025.2456427.

coordination mechanism.[73] This EO validates the urgency of transforming the DPA from a reactive instrument into a structured, long-term strategy.

Despite these use cases, the DPA remains underutilized as a forward-looking tool for strategic capacity building. Its application is often fragmented and reactive. Limitations include funding constraints, limited scope, and a lack of built-in commercial incentives sufficient to de-risk investments for private industry. The 30-day notification period and the $50 million authorization threshold can also pose challenges for high-priority minerals.[74] While DLA Strategic Materials uses the Defense Priorities and Allocations System (DPAS) under DPA Title I to manage asset accountability and prioritize contracts, this system lacks the predictive capabilities needed for effective modern stockpile management.[75] Institutionalizing Title III into routine planning cycles is suggested to align stockpile goals with industrial readiness.

EO 14241 Tie-In and Future Readiness

EO 14241 emphasizes securing supply chains before crises occur. This section's assessment reveals that, while the EO sets the right intention, significant gaps remain in execution and the system's current state of readiness to mobilize. The analysis suggests the DIB is not yet equipped to handle a major surge.

Section 7. Policy Gaps & Recommendations

Addressing the persistent vulnerabilities in the U.S. critical mineral supply chain requires a strategic policy framework that is both comprehensive and actionable. While recent legislative

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[73] White House, “Immediate Measures to Increase American Mineral Production,” March 20, 2025.
[74] “The Defense Production Act of 1950: History, Authorities, and Considerations for Congress,” legislation, accessed April 17, 2025, https://www.congress.gov/crs-product/R43767.
[75] “DPA Title I Overview 10.20.21.Pdf,” accessed April 18, 2025, https://www.dau.edu/sites/default/files/Migrate/EventAttachments/447/DPA%20Title%20I%20Overview%2010.20.21.pdf.

efforts and executive actions mark important progress, they remain insufficient to meet the scale and urgency of the challenge. The following policy recommendations are designed to operationalize national objectives by overcoming institutional fragmentation, de-risking private investment, and reinforcing supply chain resilience. These measures reflect a whole-of-government approach, integrating centralized governance, financial incentives, permitting reform, allied cooperation, recycling innovation, and workforce development. Collectively, they aim to align industrial capacity with national security imperatives to deliver the speed, scale, and certainty necessary to outpace geopolitical competitors and ensure long-term mineral independence for the United States.

Establish a Centralized Critical Minerals Processing Authority

Centralized coordination and governance are essential to overcoming the persistent fragmentation that jeopardizes U.S. critical minerals security. To unify federal efforts, drive industrial investment, and coordinate permitting and supply chain initiatives, the National Energy Dominance Council (NEDC), established by EO 14241, should be codified in statute and formally housed within the Executive Office of the President.[76] This placement will enable cross-agency enforcement, strategic alignment, and long-term continuity across administrations.

The NEDC must serve as the government's lead body for critical minerals planning, directing permitting timelines, project prioritization, funding coordination, and strategic offtake alignment. To anchor its leadership, Congress should confirm a Chair with deep economic and industrial expertise, capable of bridging national policy with global market dynamics. The Chair should oversee interagency planning, receive project nominations, and lead structured public-private engagement. To mobilize private-sector support, the NEDC should institutionalize

[76] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.

industry consultation through a standing Industry Advisory Committee and quarterly strategic forums focused on investment barriers, market signals, and surge requirements. The NEDC should also act as the central U.S. interface for allied co-investment and global resource partnerships.

Additionally, DPA Title III must be restructured as a proactive strategic planning instrument rather than a reactive tool. Title III authorities should fully integrate into five-year defense planning cycles, anchored by material shortfall assessments to anticipate future requirements.[77] Congressional action to streamline statutory constraints, such as notification periods and authorization thresholds, will further enhance agility and speed.[78] Without codification and resourcing, the NEDC risks becoming another short-lived coordination body. Empowered with the right authorities, leadership, and structure, it can serve as the enduring mechanism to secure and synchronize U.S. critical mineral supply chains in both peacetime and crisis.

Deploy Targeted Tax Credits, Offtake Agreements, and Price Stabilization Mechanisms

To strengthen U.S. critical mineral supply chains, a multipronged financial strategy leveraging tax incentives, demand guarantees, and market stabilization mechanisms is essential. The IRA's Section 45X tax credit should expand to include midstream refining and standalone facilities, harmonized across federal agencies, and aligned with the proposed definitions of critical minerals in the Critical Mineral Consistency Act of 2025.[79] This would

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[77] Office of the Assistant Secretary of Defense for Industrial Base Policy, Defense Production Act Title III Overview (Washington, D.C.: U.S. Department of Defense, n.d.), 4–5.
[78] Matthew Seaford, Title III of the Defense Production Act (Washington, D.C.: U.S. Department of Defense, n.d.), 5–7.
[79] Ashleigh Myers et al., "Beyond the Executive Orders: Legislative Proposals to Strengthen the U.S. Critical Minerals Supply Chain," Gravel2Gavel Construction & Real Estate Law Blog, March 11, 2025, https://www.gravel2gavel.com/legislative-proposals-critical-minerals-supply-chain/.

correct a critical imbalance that disproportionately favors downstream manufacturing. Recent IRS rule changes allowing material and extraction costs to qualify for the 10% production credit lay the groundwork for such reforms.[81] A proposed Rare Earth Magnet Tax Credit, offering $20/kg for U.S.-produced magnets and $30/kg for those using recycled content, would directly incentivize domestic value-added production.[80] This production-based tax credit is essential to overcoming cost and scale hurdles for firms like MP Materials, as it targets 1,000 metric tons of NdFeB magnet output in 2025.[81]

The NEDC should build on EO 14241's authorization for a Critical Minerals Investment Fund under DPA Section 303.[82] Properly executed, this initiative, alongside the National Security Capital Forum, would link private capital to viable domestic projects. A McKinsey study of 80 mining ventures found capital expenditures ranged from $300 million to over $5 billion.[83] Multi-year appropriations would stabilize financing for capital-intensive facilities producing rare earth oxides and battery-grade materials.

To complement this, a Defense Mineral Offtake Program, modeled after DoD's Title III procurement tools, could guarantee long-term purchase agreements, de-risking private investment, and mirror successful examples in rocket motors and artillery shell forgings.[82] When paired with a rare earth futures market, developed through Commerce and DFC to establish transparent pricing, such mechanisms would bring liquidity and predictability to an opaque

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[80] Clint Treadway, "Bill Would Give Tax Credits for Rare Earth Magnets Made in the U.S.," CPA Practice Advisor, December 15, 2023, https://www.cpapracticeadvisor.com/2023/12/15/bill-would-give-tax-credits-for-rare-earth-magnets-made-in-the-u-s/99282/.
[81] "MP Materials Restores U.S. Rare Earth Magnet Production," accessed May 7, 2025, https://investors.mpmaterials.com/investor-news/news-details/2025/MP-Materials-Restores-U.S.-Rare-Earth-Magnet-Production/default.aspx.
[82] White House, "Immediate Measures to Increase American Mineral Production," March 20, 2025.
[83] "Predicting Cost and Schedule Overruns in Mining | McKinsey," accessed May 7, 2025, https://www.mckinsey.com/industries/metals-and-mining/our-insights/the-capex-crystal-ball-beating-the-odds-in-mining-project-delivery?utm_source=chatgpt.com.

sector. Additionally, a Strategic Price Stabilization Program would further mitigate China's market manipulation by introducing "sustainment price floors" tied to independent cost benchmarks. This mechanism, potentially funded through strategic reserve sales during price upswings, could neutralize predatory pricing without burdening taxpayers. ESG-linked eligibility criteria would ensure federal subsidies align with traceability and environmental performance.[83]

Together, these measures form a coherent investment framework. While they address market failures, close supply chain gaps, and align security priorities with long-term industrial and sustainability goals, they also recognize that upstream investments in refining and smelting remain high-risk, capital-intensive, and often delayed, requiring not just incentives but long-term commitment and strategic risk-sharing to succeed.

Modernize and Accelerate Permitting Reforms for Critical Mineral Projects

To strengthen U.S. critical mineral independence and reduce strategic vulnerabilities, Congress and federal agencies must enact targeted permitting reforms that accelerate project approvals while maintaining strong environmental safeguards. A top priority is codifying statutory timelines for environmental reviews under the NEPA, setting a two-year maximum for completing Environmental Impact Statements (EISs). Clear, enforceable deadlines would eliminate open-ended review processes that deter investment, hinder private sector confidence, and undermine broader national security objectives. In parallel, Congress should expand categorical exclusions for non-invasive critical mineral exploration activities. These are defined as early-stage efforts that cause little or no ground disturbance, such as airborne geophysical surveys, geologic mapping, and rock sampling. Because they pose minimal environmental risk, such activities can be responsibly excluded from a full NEPA review. Streamlining this phase of

exploration is essential to accelerating resource discoveries and building a sustainable critical mineral supply base.

Complementary structural reforms are also needed to expedite further development. Policymakers should establish expedited permitting pathways for projects formally designated as "critical mineral infrastructure," ensuring that strategically significant initiatives receive priority treatment akin to traditional defense and energy projects. In addition, federal agencies should develop pre-approved land use templates for areas near existing industrial corridors. These templates would offer standardized environmental and permitting frameworks that significantly reduce repetitive case-by-case analysis. To support faster reviews without weakening environmental safeguards, a modest federal royalty on critical mineral production from public lands should be implemented. Revenues from this royalty should be explicitly earmarked to hire and retain additional permitting and environmental review staff. Furthermore, each priority mineral project should be assigned a dedicated federal project liaison to coordinate interagency actions, engage local stakeholders early in the process, and ensure that permitting milestones are met on schedule. This proactive engagement, combined with transparent documentation, can reduce litigation risks by addressing community concerns before they escalate into legal challenges.

Finally, federal agencies should expand the use of programmatic environmental reviews for mineral projects, evaluating categories of similar initiatives through a single comprehensive review process. This approach would dramatically shorten permitting timelines while upholding environmental integrity and public trust. Collectively, these reforms would modernize America's outdated permitting system, balance speed with environmental responsibility, and position the

United States to revitalize its critical mineral sector, strengthen economic resilience, and maintain technological and industrial leadership in an era of intensifying global competition.

Expand Eligibility for Strategic Partnerships and Financing Tools

The United States should expand the framework for the National Technology and Industrial Base (NTIB) beyond Canada, the United Kingdom, and Australia. This would allow the United States to treat additional trusted partners, such as Saudi Arabia, Chile, and Brazil, as "domestic sources" for critical mineral investments, thereby increasing supply chain resilience and reducing reliance on adversarial nations. Most importantly, this would expand DPA Title III eligibility to include additional strategic partners beyond Canada, Australia, and the United Kingdom. Saudi Arabia, in particular, has made significant infrastructure investments that position it as a promising mineral processing hub with low energy costs.[84]

The U.S.-led Mineral Security Partnership's (MSP) current membership does not adequately reflect the critical mineral wealth of Latin America. The United States should include countries like Argentina, Chile, Brazil, and Peru, major producers of lithium, copper, and other critical minerals, with close geographic proximity.[85] A more inclusive MSP would open developing countries to MSP resources such as technical assistance, better leverage regional resources, and strengthen collective supply chain security and resilience against Chinese market dominance.

Meanwhile, the current mandate of the DFC is limited by income thresholds and a focus on development, which restricts investments from higher income yet strategically critical

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[84] Gracelin Baskaran, "A Strategy for Minerals Diplomacy in Emerging Markets," in *Critical Minerals and the Future of the U.S. Economy* (Center for Strategic & International Studies, 2025), 93.
[85] Christopher Hernandez-Roy, Henry Ziemer, and Nathaniel Laske, "De-Risking Critical Mineral Supply Chains: The Role of Latin America," April 11, 2024, https://www.csis.org/analysis/de-risking-critical-mineral-supply-chains-role-latin-america.

countries like Canada, Australia, and Chile. To address this gap, the United States should establish a new foreign investment mechanism dedicated solely to critical mineral and energy security infrastructure.[86] Such a tool would allow the United States to invest flexibly wherever strategic needs arise, unbound by current DFC income restrictions and development mandates.

Emerging critical mineral producers such as Namibia and Tanzania possess significant reserves but often lack the infrastructure to develop their industries fully. China's success in securing Chilean copper through infrastructure investments, as seen under its Belt and Road Initiative (BRI), underscores the importance of infrastructure development for securing raw materials. The United States should not seek to mirror the scope of China's BRI but rather focus on public-private financing for transportation corridors, power systems, and refining facilities in strategic jurisdictions, thus creating secure alternative supply sources.[87] Exploration risk remains a significant barrier to private sector investment in new mining ventures, particularly in underexplored regions. The United States, leveraging the USGS and working through multilateral initiatives like the MSP, should prioritize funding comprehensive geological mapping and mineral resource assessments in developing countries.[88] This would de-risk exploration efforts, attract private investment, and promote more sustainable and diversified supply chains.

Establish a National REEs Recycling Strategy

Research, development, and recycling infrastructure investments are pivotal to mitigating U.S. vulnerabilities in REEs supply chains. A dedicated critical minerals recycling and substitutes R&D fund, supported by the DOE and DPA, would accelerate innovation in material

[86] Baskaran, "A Strategy for Minerals Diplomacy in Emerging Markets," 69–70.
[87] Baskaran, 99.
[88] Baskaran, 69.

science and processing technologies. While it is difficult to ascertain the economic cost, such a fund could prioritize projects targeting high-impact applications, including developing synthetic alternatives to dysprosium and neodymium elements critical for defense systems and renewable energy technologies. By aligning R&D with national security priorities, this initiative would reduce reliance on Chinese-controlled supplies while fostering domestic technological leadership.

Additionally, linking recycling pilot projects to DoD procurement contracts creates a stable demand signal for recycled REEs and ensures market viability for emerging technologies. For example, requiring contractors to incorporate a percentage of recycled content in defense components like permanent magnets or radar systems would incentivize scalable recycling solutions. This approach strengthens supply chain resilience and aligns with DoD's mandate to secure defense-critical materials. Concurrently, expanding recycling infrastructure funding through targeted DOE and DPA grants addresses systemic bottlenecks in collection, separation, and reprocessing. Grants could prioritize modular, regionally distributed facilities to minimize logistical challenges and enhance adaptability to fluctuating demand.

These strategies must be integrated with policy mechanisms to maximize efficacy. The DPA's Title III authorities could underwrite public-private partnerships, de-risking capital investments in recycling technologies while ensuring adherence to environmental and labor standards. Additionally, harmonizing federal grant criteria with state-level recycling programs would optimize resource allocation and avoid redundancies. The United States can cultivate a closed-loop REEs ecosystem by coupling R&D investments with procurement guarantees and infrastructure scaling, reducing extractive dependence and insulating critical industries from geopolitical coercion. This multi-tiered approach, spanning innovation, market creation, and

infrastructure, positions recycling as a supplementary measure and a cornerstone of long-term mineral security strategy.

Modernize the National Defense Stockpile

Restoring the NDS as a credible instrument of national power requires deliberate action across policy, operational, and organizational lines. The following components of this recommendation reflect an integrated strategy to address structural gaps, anticipate future threats, and position the DLA to operate as a proactive steward of national material readiness and advance stockpile modernization beyond current institutional baselines.

Strengthen DLA Authorities and Budget

DLA serves as the primary manager of the NDS, but it operates under statutory and institutional constraints that limit its ability to anticipate and address material shortfalls. DLA faces significant barriers in acquiring timely supply and demand data from defense program offices, hindering its ability to model strategic risk or make informed acquisition decisions. Between 2019 and 2023, the number of materials identified as shortfalls surged by 167 percent, highlighting the urgency of reform. Over 40 percent of materials reviewed in DoD assessments lack sufficient data to inform stockpile planning.[89]

Congress should amend the Strategic and Critical Materials Stock Piling Act to grant DLA modernized acquisition authorities aligned with its mission. These should include the ability to engage in multiyear contracting, conduct advanced procurement based on projected needs, and preposition minerals closer to key industrial nodes for faster mobilization. DLA should also be granted limited waiver authority to expedite time-sensitive acquisitions in

[89] "Gao-24-106959.Pdf," 2, accessed March 4, 2025, https://www.gao.gov/assets/gao-24-106959.pdf.

response to market disruptions or supply chain instability. These tools would allow DLA to operate with the flexibility already afforded to major defense acquisition programs.[90]

Additionally, stabilizing funding is equally essential. DLA's reliance on the Stockpile Transaction Fund, mainly sourced from legacy material sales, is increasingly misaligned with current requirements.[91] GAO findings confirm that recent sales proceeds are insufficient to sustain modern acquisition needs, forcing DLA to depend on unpredictable annual appropriations. Establishing a dedicated, multi-year appropriation for critical minerals would provide the financial continuity necessary for long-term planning, industrial engagement, and acquisition agility.[92]

Modernize DLA's Digital Infrastructure and Forecasting Capabilities

The second item is to modernize DLA's digital infrastructure and forecasting capabilities. DLA's digital infrastructure remains limited in synthesizing multi-source information, anticipating demand shifts, or informing procurement decisions. To move from reactive logistics to strategic risk management, DLA must invest in an integrated digital architecture that enables real-time visibility, predictive analytics, and scenario-based planning. Central to this effort is operationalizing the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM), developed by the Institute for Defense Analyses. RAMF-SM models supply and demand under crisis scenarios, identifying supplier risk, and recommending mitigation strategies. However, its utility is constrained by inconsistent data inputs and limited integration with

[90] "Gao-24-106959.Pdf," 7–16.
[91] "Strategic and Critical Materials Stock Piling Act Amended through FY2024.Pdf," 6–7, accessed March 4, 2025, https://www.dla.mil/Portals/104/Documents/Strategic%20Materials/Strategic%20and%20Critical%20Materials%20Stock%20Piling%20Act%20Amended%20through%20FY2024.pdf?ver=zv3-91BwvELuTfB7K6F3xw%3D%3D.
[92] "Gao-24-106959.Pdf," 5–8.

broader acquisition and planning systems.[93] To realize its full potential, DLA should deploy cloud-based inventory tools and automated data pipelines.

Applying AI models to the RAMF-SM would enhance its predictive precision, allowing DLA to identify material shortfalls earlier, simulate contingency scenarios, and proactively adjust procurement and prepositioning strategies. AI-enabled forecasting tools, such as those developed under the Air Force's Predictive Logistics initiative, demonstrate how advanced analytics can improve operational readiness by anticipating system failures and optimizing resource allocation.[94] DLA's current system lacks the predictive capabilities and integrated analytics required for effective modern stockpile management.[95] A next-generation platform, modeled on DPAS but tailored for strategic materials, could provide the digital backbone for more intelligent management of inventory, supplier risk, and global supply disruptions.

Develop a Resilient Talent Base

The aging workforce dilemma exists across multiple sectors outside of mining, but the decline in enrollment at educational institutions signals poor student recruitment and growing international competition. U.S. mining schools have declined from 25 in 1982 to 14 today, with only a handful considered healthy.[96] The remaining institutions struggle to attract students, hire qualified faculty, and modernize curricula.[97] Despite decades of 100% job placement and

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[93] Julie C Kelly, "The Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)," n.d., 8–9.
[94] "Rapid Sustainment Office's Condition Based Maintenance Plus Artificial Intelligence Toolkit," Air Force Materiel Command, May 2, 2023, https://www.afmc.af.mil/News/Article-Display/Article/3382942/https%3A%2F%2Fwww.afmc.af.mil%2FNews%2FArticle-Display%2FArticle%2F3382942%2Frapid-sustainment-offices-condition-based-maintenance-plus-artificial-intellige%2F.
[95] "DPA Title I Overview 10.20.21.Pdf."
[96] Jonathan Rowland, "Mining Schools Play A Vital Role In Equipping The Industry With The Next Generation Of Talent", North American Mining, February 8, 2022. Last accessed on April 20, 2025. https://northamericanmining.com/index.php/2022/02/08/north-american-mining-universities/
[97] "The University of Arizona: Building Rock-Solid Minds: Engineering, Geology, Mineralogy, Metallurgy, Chemistry, etc." Engineering and Mining Journal 226, no. 1 (01, 2025): AZ36-AZ38. https://login.nduezproxy.idm.oclc.org/login?url=https://www.proquest.com/scholarly-journals/university-arizona-building-rock-solid-minds/docview/3163570068/se-2.

competitive starting salaries, often exceeding those of assistant professors, student interest remains low. Enrollment in mining programs across Australia and Canada has also reached historic lows, even though the demand for mining engineers, metallurgists, and process specialists continues to rise. The United States produces only around 170 students, while China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3,000 a year, about 16 times the number of graduates in the United States.[98] Over half of U.S. mining engineering students come from China and India, raising concerns about domestic capacity and long-term talent retention. This dilemma compounds the issue of individual researchers from China being pressured to develop proposals to satisfy PRC publication quotas. To help encourage future development within the mining sector, policy options include strengthening education and workforce development, investing in workforce retention and local amenities, and fostering community engagement and benefit sharing.

To strengthen the resilience of the U.S. REEs supply chain, senior policymakers should prioritize the development of a specialized workforce and innovation ecosystem through a coordinated set of actions. First, in collaboration with industry stakeholders, the Department of Education and the DOE should establish REE-focused curricula at community colleges and technical institutes. These programs must be tailored to meet industry demands in extraction, processing, separation, and advanced materials manufacturing. At the same time, policymakers should increase federal investment in advanced REEs research and training facilities by expanding competitive grant programs and incentivizing public-private partnerships. These

[98] Senate Health, Education, Labor and Pensions Subcommittee on Employment and Workplace Safety Hearing. Washington: Federal Information & News Dispatch, LLC, 2024. https://login.nduezproxy.idm.oclc.org/login?url=https://www.proquest.com/other-sources/senate-health-education-labor-pensions/docview/3068109709/se-2.

facilities will play a dual role: advancing technological innovation and serving as hands-on training environments for the next generation of technical specialists. Federal grants, scholarships, and internships should be expanded specifically for students and workers entering critical mineral and REE-related fields to accelerate workforce development and reduce retraining time. Expand the DoD Skill Bridge program into critical mineral industries for separating service members into mining engineering, metallurgy, and process operations. Incentivizing industry participation through tax credits or wage subsidies would further accelerate adoption and strengthen the defense-industrial talent base. Strengthening direct pipelines between industry and academia will help ensure a steady flow of qualified talent into strategically important sectors and reinforce national efforts to reduce foreign dependence and enhance economic and national security.

To promote equitable and sustainable development in regions impacted by critical mineral extraction, senior policymakers should implement measures that foster community engagement and benefit-sharing. One such approach is to offer corporate tax incentives to companies that commit a fixed percentage of their profits to approved community development projects. These incentives would encourage private sector participation in local uplift initiatives while aligning corporate interests with the public good. As part of this framework, mining companies should be required to establish community development funds governed and managed by local stakeholders. This ensures that investments reflect community priorities and build trust between industry and affected populations. Policymakers should also encourage participatory budgeting practices and mandate transparent reporting of all community investment activities. These steps will increase accountability, empower local voices, and ensure that the economic benefits of resource development are broadly shared.

Section 8 Conclusion. Securing Strategic Materials in an Uncertain Future

The critical mineral challenge confronting the United States is not a theoretical concern—it is an active and escalating threat to national security and industrial sovereignty. As this paper has shown, the DIB remains structurally unprepared to respond to a surge in demand driven by geopolitical conflict, rapid technological shifts, or adversarial economic coercion. This vulnerability stems from three interlocking deficits: overreliance on foreign adversaries, most notably China; a domestic permitting regime ill-suited to urgency; and chronic underdevelopment of midstream processing capabilities essential for turning mined resources into deployable defense inputs.

Executive Order 14241 represents a watershed moment in U.S. mineral policy. By framing critical mineral security as a national security imperative and mandating a whole-of-government response, EO 14241 provides the necessary strategic clarity that previous piecemeal efforts lacked. Yet, its success will depend entirely on execution. It must catalyze enduring structural reforms—centralized governance, accelerated permitting, strategic offtake programs, and targeted investment in workforce, recycling, and stockpiling. Otherwise, the United States risks repeating the same pattern of recognition without response.

The thesis of this paper—that awareness alone is insufficient—is affirmed by the persistent gaps in U.S. surge capacity, supply diversification, and allied coordination. Strategic competition with China demands more than rhetoric; it demands an industrial mobilization ethos capable of outpacing an adversary with vertically integrated control over the very materials that power modern warfare and economic competitiveness. If implemented at scale, EO 14241 can become the organizing framework for that mobilization. If neglected, it will remain a missed opportunity in a race the United States cannot afford to lose.

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Appendix A

Artificial Intelligence
Current and Future Roles in Strategic Materials and Critical Supply Chains

Current Use of AI

Today, Artificial Intelligence (AI) plays a vital role in optimizing critical mineral extraction, refining, and securing supply chains — especially for rare earth elements essential for defense and clean energy technologies.[1] The U.S. Department of Defense (DoD) has highlighted AI as a critical enabling technology in its research priorities, with efforts underway to integrate AI into strategic decision-making related to resource security and critical material forecasting.[23]

AI also supports the strategic mapping of mineral resources, predictive maintenance of mining equipment, automated refining processes, and logistics optimization for rare earth supply chains.[4] These capabilities could help mitigate supply risks, particularly amid geopolitical actions like China's imposition of REE export controls, and lower costs for Western companies already working on tight margins. Furthermore, AI-driven analysis is being employed by governments, such as Canada, to monitor global market shifts, predict adversarial actions (such as export restrictions), and design countermeasures like stockpiling and alternative sourcing.[5]

How AI Could Be Used (Next 5 Years)

In the near term (2025–2030), AI applications in mining and processing are expected to expand significantly. Predictive AI models could strengthen supply chain resilience by simulating disruptions (e.g., China's 202 rare earth blockade) and recommending mitigation strategies in real-time.[6] AI-driven mineral processing plants could become increasingly common, lowering dependency on foreign refining.[7] Finally, AI can help model the environmental impacts of new mining projects, such analysis of waste and water management. [8] These applications of AI could help industry demonstrate compliance with increasingly stringent regulations like those cited in NEPA discussions.

How AI Should Be Used

Looking strategically, AI should be used to enhance strategic stockpile management. The USG could use machine learning to dynamically adjust critical mineral stockpiles based on consumption patterns, political risk, and technological innovation. There is ample evidence that our current models are overestimating our supply and access to future partner production.[9] The USG and its allied nations could build AI-powered platforms to share real-time data on mineral production, shipping, and geopolitical threats to fine tune our stockpiling models to ensure that the DIB has what it needs in a time of conflict.

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Appendix B

Wargaming for Strategic Materials

Introduction

Wargaming is indispensable for testing strategic assumptions, identifying vulnerabilities, and shaping policy to strengthen critical mineral supply chain resilience. Beyond traditional military applications, wargaming also encompasses economic statecraft simulations, supply chain disruption stress tests, and industrial mobilization exercises.

Scenario Planning

To stress test the systems discussed in the research paper, war gamers can consider a scenario like a Taiwan 2027 surge event. In such a crisis, an immediate cutoff of Chinese rare earth and tungsten exports, or materials like antimony, could occur. The immediate impacts could be severe: U.S. precision-guided munitions production might halt, naval sonar systems could face magnet shortages, and defense contractors would scramble to find substitutes or retool. The likely response options highlight the current system's weaknesses:

1. Stockpile drawdown: The NDS might only cover a small percentage (e.g., 20%) of demand, quickly depleting reserves.
2. DPA activation: While useful, activating the DPA for new capacity building could involve a significant lag of 12-18 months.
3. Allied support: While friend-shoring is a strategy, allied responses might be slow or fragmented.

This scenario underscores critical timeline bottlenecks in reconstituting domestic production or substituting supply. The lesson of this scenario is clear - early investment and capacity building are essential because once a crisis hits, it is likely too late.

Use of Wargaming in the Industry Study

Throughout the academic year, two applications focused on the Strategic Materials IS: the Global Supply Chain & Logistics (GSL) Wargame and the Industry Analysis Firm Brief. These applications explored the complex challenges facing U.S. critical minerals security. Collectively, these exercises highlight the necessity of embedding wargaming into national strategic materials planning to ensure mobilization readiness and national security advantage.

1. Global Supply Chain & Logistics (GSL) Wargame. The GSL Elective simulated the strategic challenges of securing rare earth elements (REEs) and active pharmaceutical ingredient (API) supply chains under contested conditions. Players confronted scenarios where adversaries, primarily China, leveraged control of supply routes and strategic materials to exert economic pressure. Events such as Chinese interference with the Panama Canal tested participants' ability to diversify sourcing and protect vulnerable transit points.

Outcome: The exercise revealed that complete decoupling from China was unrealistic in the near-term and that resilience depended on rapidly developing alternative suppliers through diplomatic, economic, and industrial partnerships. Critical gaps in midstream processing and stockpiling capacity were exposed as major vulnerabilities. The GSL Wargame demonstrated that maintaining access to strategic materials is not merely a commercial issue, but an essential component of national power projection and conflict deterrence.

2. Industry Analysis (IA) Firm Brief – MP Materials Strategic Posture Wargame. The IA Firm Brief on MP Materials utilized a 2x2 Game Theory framework to examine strategic decision-making in the critical minerals sector. Participants analyzed potential outcomes based on aggressive or conservative postures from both MP Materials and China. Aggressive Chinese expansionism and a passive U.S. industry response rapidly declined U.S. supply chain independence. At the same time, proactive innovation and vertical integration efforts by MP Materials offered a path to resilience.

Outcome: The wargame reinforced that strategic success in the critical minerals industry requires bold action aligned with national security imperatives. U.S. companies cannot rely on market forces alone; deliberate government support and strategic planning are necessary to build independent, secure supply chains. MP Materials' role as a keystone player highlighted the broader need for aggressive investment, public-private collaboration, and long-term commitment to supply chain sovereignty.

National Security Implications

The wargames collectively emphasized that strategic material resilience is decisive for U.S. national security. The GSL Wargame revealed the vulnerability of key industry supply chains to adversary disruption, stressing the need for diversified sourcing, stockpiling, and allied collaboration. The IA Firm Brief on MP Materials demonstrated that private sector passivity risks permanent dependency, reinforcing the urgency for aggressive investment and vertical integration in domestic critical minerals capabilities. These exercises illustrate that securing access to strategic materials is not an economic accessory but a strategic necessity integral to force projection, technological advantage, and national decision-making freedom. Wargaming consistently revealed that adversaries exploit industrial vulnerabilities before open conflict, making early resilience investments essential to credible deterrence. Embedding routine strategic materials wargaming into DoD and interagency planning efforts is vital to validating assumptions, stress-testing vulnerabilities, and preserving national power in competition.

Conclusion

The GSL Wargame and Firm Brief exercises clearly show that wargaming must be institutionalized within U.S. strategic minerals planning. Proactively stress-testing supply chains, validating industrial resilience strategies, and forecasting surge requirements will be decisive in sustaining operational endurance and ensuring a strategic advantage. The United States can secure its critical mineral supply chains and ensure national resilience in emerging global challenges through disciplined, recurring wargaming and interagency coordination.

Appendix C

Field Study Locations for Strategic Materials Concentration

- **National Mining Association Visit,** Washington, D.C.
- **US Geological Survey (Virtual Visit)-** David G. Pineault, Sean Y. Xun, Robert C. Goodin, Elena A. Safirova
- **Lithion Battery-**Henderson, NV, Dr. James D. Hodge
- **McCaw School of Mines – The Mine Experience,** Henderson, NV, Phil Luna
- **University of Nevada – Las Vegas,** Andrew Woods, Daniela Rincon, Bret Birdsong
- **MP Materials Rare Earth Mine,** Mountain Pass, CA, Michael Rosenthal
- **US Forest Service and Federal Mineral Management,** Mindy Sue Vogel, Geologist, USFS Washington Office
- **OSD Industrial Base Policy – Strategic Materials,** Office of the Assistant Secretary of Defense for Industrial Base Policy
- **Materion Brush Beryllium & Composites,** Elmore, OH, Tara Tabbart, Keith Smith
- **Wright-Patterson AFB – Air Force Research Lab Materials and Manufacturing Directorate (AFRL/RX),** Wright-Patterson AFB, OH, Col. Christina F. Rusnock

  Sessions:
  - RX Overview: Col. Rusnock
  - Defense Production Act Title III: Ms. Diana Carlin
  - AI for Materials & Manufacturing Innovation: Drs. Benji Maruyama, David Simone, Sean Donegan, Luke Baldwin
- **Institute for Defense Analyses (IDA), DLA, DARPA Visit,** Jessica Stewart, Laura Baldwin, Norton Schwartz, Theresa Leland
- **Electron Energy Corporation (Virtual),** Rare Earth Permanent Magnets (REPM)

CONUS Field Visit

- **Colorado School of Mines (CSoM),** Golden, CO, Professors Hugh Miller & Rod Eggert
- **Resource Capital Funds,** Denver, CO
- **Henderson Mine,** Empire, CO
- **Materion Mill,** Delta, UT
- **Rio Tinto Kennecott Mine,** Herriman, UT
- **MP Materials,** Fort Worth, TX, Martin Sheehan

OCONUS – Chile Field Study:

- **Capstone Copper – Santo Domingo Cobalt Project Briefing,** Las Condes, Santiago, Edgar Rocha, Marcela Espinoza
- **ANEPE (National Academy of Political and Strategic Studies),** Providencia, Santiago, Capt. Kevin Gilbert, Gen. Dahir Guzman
- **University of Chile – Engineering Faculty,** Beaucheff, Santiago, Dr. Emilio Castillo
- **Consejo Minero de Chile,** Las Condes, Santiago, Carlos Urenda, Claudia Gaete
- **U.S. Embassy – Country Team Brief,** Santiago, Capt. Kevin Gilbert; Paul Nichols
- **El Teniente Mine Visit,** Control Maitenes, Machalí, O'Higgins Region, Alicia Reyes, Gonzalo Recart, Carolina Ruiz Lazcano; Pía Lopez; Andrea Vilches
- **Resource Capital Funds,** Nueva Costanera, Santiago, Fabiano Tavares