The Rise of Great Mineral Powers

Gregory Wischer
Dr. Morgan Bazilian

Abstract

Minerals play a crucial role in bolstering a state's military capabilities, defining its "mineral power." This study assesses a state's mineral power by evaluating its access to secure mineral supplies from four key sources: domestic production, government stockpiles, overseas production by domestic companies, and imports from aligned states. Analyzing the mineral power of two emerging great powers, the United States and China, across different historical periods, the research reveals the correlation between mineral power and military strength. Amid escalating US–China competition, the US government could enhance its mineral power by supporting domestic production, increasing stockpiles, facilitating overseas acquisitions, and fostering supply agreements with aligned states. Leveraging trade negotiations, particularly in advanced technology, the United States could ensure continued access to crucial minerals from China, discouraging restrictive export policies through strategic warnings.

***

Minerals drive the production of defense platforms and munitions, thus shaping military power.[1] They are essential for manufacturing various defense goods, including submarines, bombers, torpedoes, and missiles. A state's access to secure mineral supplies thus significantly influences—and can serve as a proxy for—its military capabilities. This access is termed *mineral power*,[2] and a state possessing substantial secure mineral supplies wields considerable mineral power. When a state's mineral power and resulting military might reach significant levels, it can attain great-power status in the international system, exerting substantial influence on security-related matters.[3]

Historians, geologists, and government officials have long acknowledged the nexus between a state's mineral resources and its power. In 1902, historian Brooks

[1] C. K. Leith, "The Struggle for Mineral Resources," *The Annals of the American Academy of Political and Social Science* 204, no. 1 (1939), 42, https://doi.org/.

[2] We use the term *power* in the international relations context, as defined by John J. Mearsheimer: "[P]ower is based on the particular material capabilities that a state possesses," which include "tangible assets" like attack submarines and nuclear weapons. *See* John J. Mearsheimer, *The Tragedy of Great Power Politics* (New York: W. W. Norton & Company, 2001), 55.

[3] Jack S. Levy, *War in the Modern Great Power System, 1495–1975* (Lexington, KY: University Press of Kentucky, 1983) 16, https://core.ac.uk/. In pages 9–19, Levy provides other definitions of *great power*, most of which link military capabilities to great power. Similarly, Mearsheimer asserts that great power is largely determined by military capabilities. *See* Mearsheimer, *The Tragedy of Great Power Politics*, 5.

Adams asserted that "all experience has demonstrated that the centre of mineral production is likely, also, to be the seat of empire."[4] In 1916, US Secretary of the Interior Franklin K. Lane prioritized minerals as the foremost "foundations of power," a sentiment echoed by US Geological Survey Director George Otis Smith, who affirmed "that mineral wealth is the foundation of power."[5] More recently, in 2023, David Humphreys observed, "Countries with power have always depended on a healthy supply of mineral resources."[6] These commentators agree that mineral supplies influence state power.

Mineral experts have emphasized the intricate connection between a state's mineral resources and its military capabilities. In 1939, geologist C. K. Leith highlighted, "Military power used to be measured principally by man power, but is coming more and more to be measured in terms of guns, ships, automobiles, and airplanes, and the fuel to drive them. These mean minerals."[7] In 1949, James Boyd, director of the US Bureau of Mines, asserted that "minerals potential is an index of military strength,"[8] while John D. Morgan, Jr., later a minerals expert in the Office of Defense Mobilization, stated, "The activity of the mineral industry of any nation is a major guide to that nation's ability to wage war."[9] These quotes succinctly underscore the influence of a state's mineral supplies on its overall power and, particularly, its military strength.

Building on the established relationship between mineral power and military strength, this article posits that mineral power contributes to military prowess, suggesting that great powers should possess considerable mineral power. To examine this proposition, the article analyzes the mineral power of two ascending great powers: the United States in the early twentieth century and China in the early twenty-first century. If mineral power indeed bolsters military might, both the United States and China during these periods should exhibit significant mineral power. The subsequent sections of this article are structured as follows: Section 2 delves into the components constituting mineral power; Section 3 explores the mineral power of the United States in the early twentieth century,

---

[4] Brooks Adams, *The New Empire* (New York: MacMillan Company, 1902), 175–176.

[5] George Otis Smith, "The Public Interest in Mineral Resources," in *Mineral Resources of the United States 1915* (Washington: Government Printing Office, 1917), 1a, https://www.forgottenbooks.com/.

[6] David Humphreys, "Mining and Might: Reflections on the History of Metals and Power," *Mineral Economics*, 3 May 2023, 2, https://doi.org/.

[7] Leith, "The Struggle for Mineral Resources," 42.

[8] James Boyd, "Strategic Mineral Resources for National Security," *Military Engineer* 41, no. 282 (1949), 261, http://www.jstor.org/.

[9] John D. Morgan, Jr., "The Domestic Mining Industry of the United States in World War II: A Critical Study of the Economic Mobilization of the Mineral Base of National Power" (PhD dissertation, Pennsylvania State College, 1949), 358, https://scholarsphere.psu.edu/.

while Section 4 evaluates China's mineral power in the early twenty-first century. Section 5 presents the findings of these case studies, followed by Section 6, which examines the contemporary mineral power of the United States. Section 7 outlines policy options for enhancing the US government's mineral power, concluding with Section 8.

Variables of Mineral Power

The state can secure mineral supplies from diverse sources, with this article identifying four main sources: (1) domestic production, (2) government stockpiles, (3) overseas production by domestic companies, and (4) aligned imports, which are imports from states aligned geopolitically or commercially with the importing state (e.g., the cobalt trade relationship between the Democratic Republic of the Congo and China). These sources—domestic production, government stockpiles, overseas production, and aligned imports—constitute the variables defining a state's mineral power.

In the computation of mineral power, greater emphasis is placed on domestic production and government stockpiles compared to overseas production and aligned imports. This weighting is attributed to the heightened security of mineral supplies from domestic production and government stockpiles, particularly during periods of conflict. For example, submarine warfare disrupted mineral imports to the United States during World War II,[10] while recent Houthi attacks on Red Sea shipping lanes led to extensive rerouting of container vessels in late 2023 and early 2024.[11] As noted by John D. Morgan, Jr., "Imports in war are rendered much more difficult; consequently, it is the domestic mineral industry that is of primary importance."[12] Thus, domestic mineral production and government stockpiles offer more secure mineral supplies and are accorded greater weight in the calculation of mineral power as well.

Mineral imports from states not aligned geopolitically or commercially also contribute to a state's mineral power. However, these imports are excluded from the calculation due to their vulnerability to supply disruptions such as export controls. For instance, China, responsible for 98 percent of global gallium production,[13]

[10] E. W. Pehrson, "Review of the Mineral Industries in 1942," in *Minerals Yearbook 1942* (Washington, DC: US Government Printing Office, 1943) 19, https://digital.library.wisc.edu/.

[11] Paul Wiseman and Mae Anderson, "Attacks on Ships in the Red Sea Are Disrupting Global Trade. Here's How It Could Affect What You Buy," *Associated Press*, 28 January 2024, https://apnews.com/; and Stefan Nicola, "Over 100 Container Ships Reroute As US Weighs Red Sea Response," *Bloomberg*, 20 December 2023, https://www.bloomberg.com/.

[12] Morgan, "The Domestic Mining Industry," 4.

[13] Brian W. Jaskula, "Gallium," *US Geological Survey*, January 2023, https://pubs.usgs.gov/.

imposed export controls on gallium in August 2023, leading to a significant reduction in exports.[14] Similarly, other mineral-rich states like Indonesia are implementing export controls on mined minerals to promote domestic downstream processing.[15] Consequently, mineral imports from non-aligned states are deemed insecure and are not factored into the calculation of a state's mineral power.

A state's mineral resources, encompassing reserves, serve as a reservoir of secure mineral supplies and thereby contribute to mineral power. However, mineral production better reflects a state's actual mineral power, as it enables the swift conversion of extracted minerals into refined forms suitable for military production, in contrast to the lengthier process of converting mineral resources into extracted ore and then refining them. Illustrating the impact of mineral production versus mineral resources on military power, China in the early twentieth century possessed "the raw materials of a world power," yet its resources remained "almost wholly undeveloped." Consequently, China found itself "unprepared for a struggle with even a third-rate power."[16] Hence, mineral resources are excluded from the calculation of a state's mineral power.

While domestic production, government stockpiles, overseas production, and aligned imports influence mineral power, they are not the sole determinants. Other factors affecting a state's mineral power include other mineral imports, mineral resources, a state's influence on mineral demand, international exchanges, market transparency, mineral companies, and various other considerations. Nonetheless, domestic production, government stockpiles, overseas production, and aligned imports serve as valuable variables of mineral power, and the subsequent sections explore these variables concerning the United States in the early twentieth century and China in the early twenty-first century.

[14] "China Export Curbs Choke Off Shipments of Gallium, Germanium for Second Month," *Reuters*, 19 October 2023, https://www.reuters.com/.

[15] International Energy Agency, "Prohibition of the Export of Nickel Ore," 12 December 2023, https://www.iea.org/.

[16] Joseph E. Pogue, "Mineral Resources in War and Their Bearing on Preparedness," *Scientific Monthly* 5, no. 2 (1917), 123, http://www.jstor.org/.

Case Study 1: US Mineral Power in the Early Twentieth Century

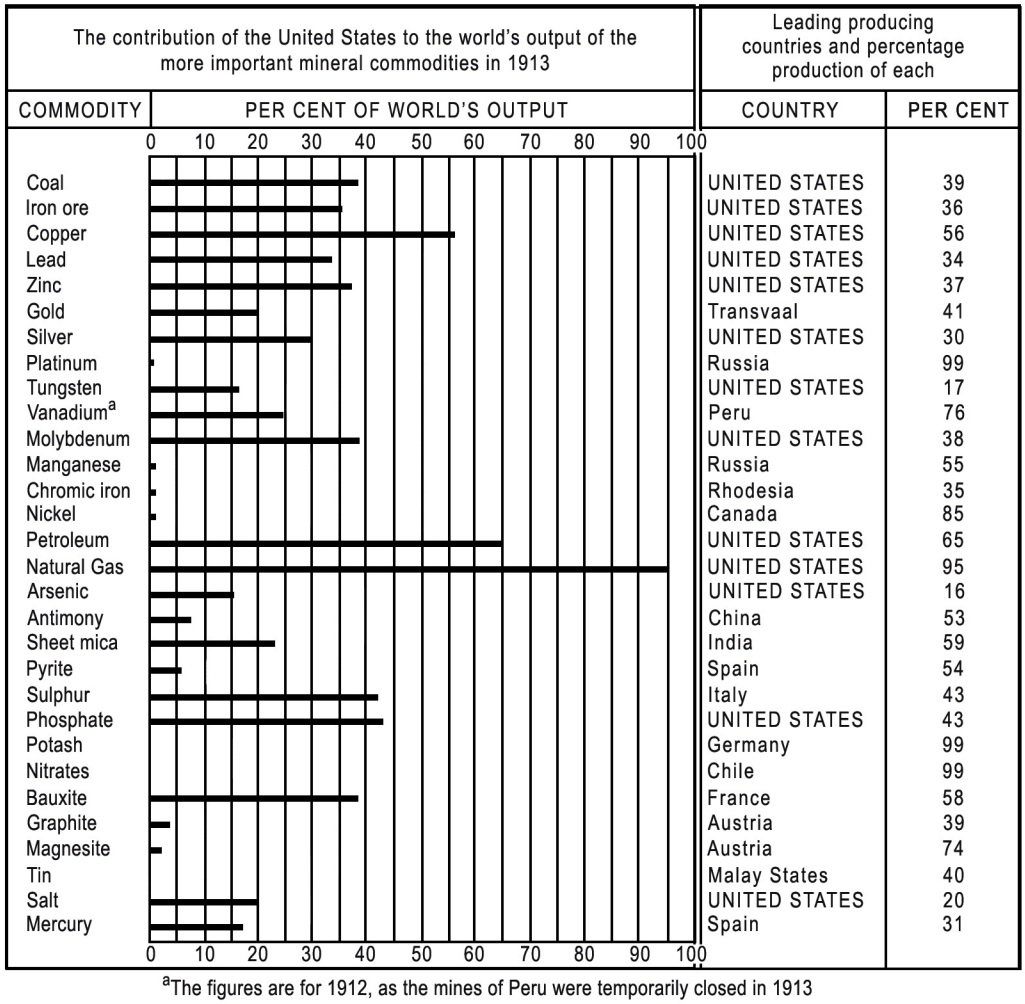

Figure 1. US mineral production as a percentage of global mineral production for various minerals in 1913. (Source: Joseph B. Umpleby, "The Position of the US among the Nations," in *The Strategy of Minerals: A Study of the Mineral Factor in the World Position of America in War and in Peace*, ed. George Otis Smith (New York: D. Appleton and Company, 1919), 288, https://books.google.com/.)

Early in the twentieth century, the United States ascended to great-power status and emerged as the world's foremost mineral producer.[17] By 1913, the United States led in the production of 13 out of 30 key minerals, and ranked second in the production of an additional four minerals (fig.1).[18] For instance, in 1915, the United States accounted for 60 percent of global copper production and 32 percent of lead and zinc production. US Secretary of the Interior Franklin K. Lane remarked, "With the exception of one or two minor minerals, the United States produces every mineral that is needed in industry, and this can be said of no other country."[19] By 1917, the United States had solidified its position as "the world's greatest producer of mineral wealth."[20] Throughout the 1920s, US mineral power continued to burgeon as it assumed the mantle of the world's largest producer of fluorspar, a mineral with applications in steel and chemical production.[21] Consequently, the United States boasted robust domestic mineral production in the early twentieth century (fig. 2).

However, for much of the first half of the twentieth century, the US government lacked a mineral stockpile. Prior to and during World War I, there was no comprehensive stockpiling strategy in place.[22] Following the war in 1922, the US government established the Army and Navy Munitions Board,[23] which aimed to

[17] Many historians attribute the United States' emergence as a great power to the year 1898, following its victory over Spain in the Spanish-American War. This period also marked the United States' rise as a mineral power. In 1899, the United States set a record for the greatest amount of iron ore produced by a single state up to that point in history. Iron ore is the primary mineral used to produce virgin steel, a crucial material for manufacturing military goods. By 1900, the United States accounted for nearly 30 percent of global mining production. *See* Walter Lafeber, "The 'Lion in the Path': The US Emergence as a World Power," *Political Science Quarterly* 101, no. 5 (1986), 705. https://doi.org/; David T. Day, "Summary," in *Twenty-First Annual Report of the United States Geological Survey to the Secretary of the Interior 1899–1900* (Washington: Government Printing Office, 1901), 7, https://pubs.usgs.gov/; Magnus Ericsson and Frida Löf, "Overview of State Ownership in the Global Minerals Industry," Raw Materials Group, commissioned by the World Bank, 2008, 3, https://documents1.worldbank.org/; and Leith, "The Struggle for Mineral Resources," 48.

[18] Joseph B. Umpleby, "The Position of the US among the Nations," in *The Strategy of Minerals: A Study of the Mineral Factor in the World Position of America in War and in Peace*, ed. George Otis Smith (New York: D. Appleton and Company, 1919), 288.

[19] Franklin K. Lane, "Report of the Secretary of the Interior," in *Reports of the Department of the Interior: For the Fiscal Year Ended June 30, 1915* (Washington: Government Printing Office, 1916), 5–6, https://babel.hathitrust.org/.

[20] Pogue, "Mineral Resources in War," 130.

[21] Herbert K. Russell, "State Mineral Helped End World War II," *Illinois Heritage*, 24 September, 2018, 24, https://www.historyillinois.org/.

[22] National Research Council, *Managing Materials for a Twenty-first Century Military* (Washington, DC: National Academies Press, 2008), 23, https://doi.org/; and Robert A. Batchelor and James E. Kirby, "The National Defense Stockpile: An Organizational Perspective" (master's thesis, Air University, March 1985), 10, https://apps.dtic.mil/.

[23] National Research Council, *Managing Materials for a Twenty-first Century Military*, 23.

coordinate military procurement and industrial mobilization in preparation for war.[24] Then, in 1939, the Strategic and Critical Materials Stock Piling Act formally established and funded a stockpiling plan.[25] However, after the United States entered World War II, the US government focused on supplying wartime mineral demands rather than stockpiling.[26] Consequently, the United States lacked a mineral stockpile for nearly the entire first half of the twentieth century.[27]

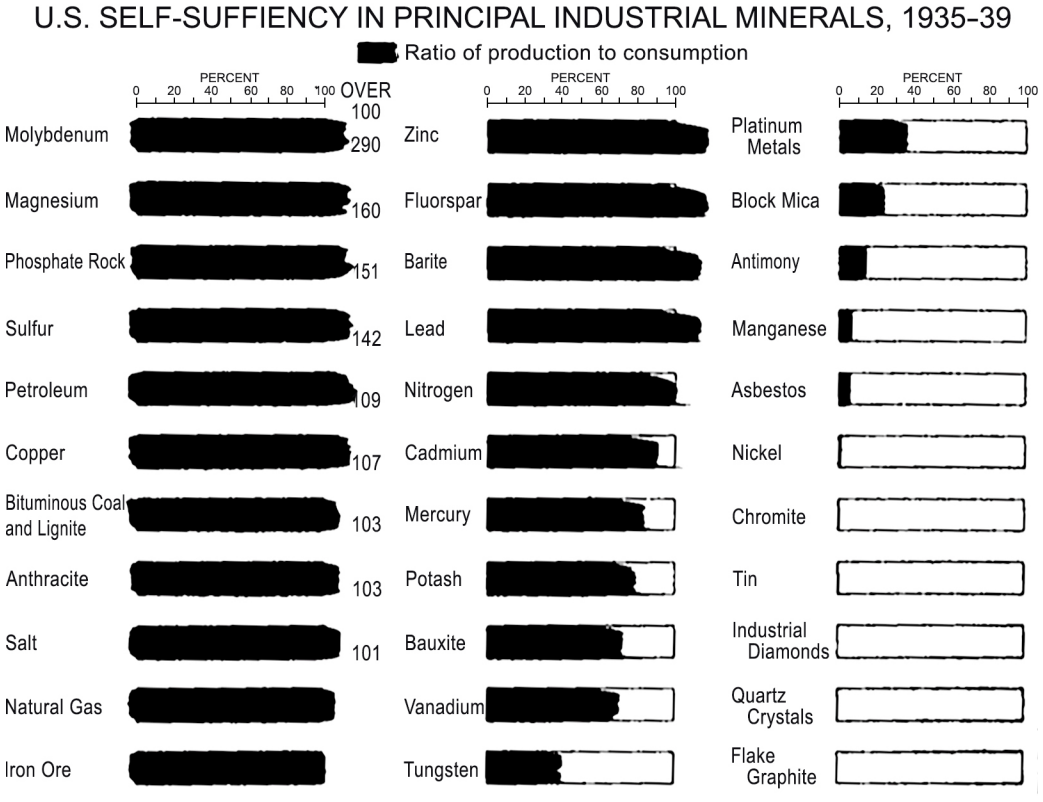

Figure 2. US mineral self-sufficiency—that is, domestic mineral production as a percentage of domestic mineral consumption—for various minerals from 1935 to 1939. (Source: E. W. Pehrson, "Our Mineral Resources and Security," Foreign Affairs 23, no. 4 [1945], 653, https://doi.org/.)

[24] H. W. T. Eglin, "Army and Navy Munitions Board: The Peace-Time Coordination of War Requirements," *Army Ordnance* 17, no. 101 (1937): 275–77, http://www.jstor.org/.

[25] National Research Council, *Managing Materials for a Twenty-first Century Military*, 23.

[26] James S. Thomason et al., "Strategic and Critical Non-Fuel Materials and the National Defense Stockpile," Institute for Defense Analyses, September 1996, 12, https://apps.dtic.mil/; and Robert A. Batchelor and James E. Kirby, "The National Defense Stockpile: An Organizational Perspective" (master's thesis, Air University, March 1985), 11, https://apps.dtic.mil/.

[27] Thomason et al., "Strategic and Critical Non-Fuel Materials," 12.

Nevertheless, US companies boasted substantial overseas mineral production during this period. American companies held significant control over major mineral resources throughout the Western Hemisphere.[28] For instance, the largest copper mines in Canada, Chile, and Mexico were predominantly owned or operated by US companies, collectively wielding considerable influence over the global copper market.[29] By the late 1920s, the four largest US copper firms alone commanded over half of the world's copper production,[30] with US financial interests extending their sway over approximately two-thirds of global output.[31] Additionally, US financial entities exercised significant control over overseas production of other minerals, including nickel in Canada and vanadium in Peru.[32] In essence, US companies wielded significant influence over overseas mineral production in the early twentieth century.

Furthermore, for certain minerals, the United States heavily relied on aligned imports, particularly from the British Empire, with whom it collectively controlled approximately 75 percent of global mineral supplies by 1938.[33] Tin, for instance, was sourced primarily from foreign mines,[34] particularly those within the British Empire's sphere of influence like Malaya.[35] Similarly, the majority of chromite imported into the United States between 1913 and 1933 originated from territories such as the British Empire's Rhodesia and the French colony of New Caledonia.[36] Likewise, US manganese consumption heavily depended on imports,

---

[28] Leith, "The Struggle for Mineral Resources," 48.

[29] Adelaide Walters, "The International Copper Cartel," *Southern Economic Journal* 11, no. 2 (1944), 134, https://www.jstor.org/.

[30] Christopher Schmitz, "The Rise of Big Business in the World Copper Industry 1870-1930," *Economic History Review* 39, no. 3 (1986), 392, https://doi.org/.

[31] F. E. Richter, "The Copper Industry in 1928," *Review of Economics and Statistics* 11, no. 1 (1929), 41, https://doi.org/.

[32] G. A. Roush, "Strategic Mineral Supplies 3. Nickel (Continued)," *Military Engineer* 27, no. 151 (1935): 20–21, https://www.jstor.org/; and William S. Culbertson, "Raw Materials and Foodstuffs in the Commercial Policies of Nations," *Annals of the American Academy of Political and Social Science* 112 (March 1924), 18, https://www.jstor.org/. Regarding nickel, Roush wrote, "Although the deposits are under the political control of Canada primarily, and secondarily of the British Empire, the commercial control has from the beginning been largely in the hands of United States capital." US capital controlled this nickel production mainly through financial interests in the International Nickel Company. See G. A. Roush, "Strategic Mineral Supplies 3," 20–21.

[33] C. K. Leith, "Mineral Resources and Peace," *Foreign Affairs* 16, no. 3 (1938), 516, https://doi.org/.

[34] Charles White Merrill, "Tin," in *Minerals Yearbook 1932–33* (Washington: Government Printing Office, 1933), 281–82, https://search.library.wisc.edu/.

[35] G. A. Roush, "Strategic Mineral Supplies 6. Tin (Continued)," *Military Engineer* 28, no. 158 (1936), 133, https://www.jstor.org/.

[36] G. A. Roush, "Strategic Mineral Supplies 4. Chromium (Continued)," *Military Engineer* 27, no. 153 (1935), 214–15, https://www.jstor.org/.

sometimes accounting for more than 90 percent of total consumption. In 1913, major manganese import sources included British-controlled India, as well as Russia and Brazil.[37] Thus, aligned imports played a crucial role in meeting the United States' mineral demands during the early twentieth century.

Considering its substantial domestic production, overseas production, and aligned imports, the United States wielded significant mineral power in the early twentieth century. During this era, the US government primarily aimed to safeguard and bolster domestic mineral producers through tariff measures. In a comprehensive study of the US mining industry spanning from 1899 to 1939, Harold Barger and Sam Schurr observed, "The principal effect of fiscal policy upon mineral extraction is through the tariff." The US government implemented tariffs on various minerals, including lead, manganese, mercury, tungsten, and zinc.[38] Additionally, the government supported the domestic mineral industry through various other policies. For instance, following World War I, financial assistance was extended to domestic producers of certain minerals—such as chromite, pyrites, manganese, and tungsten—that had developed domestic mineral deposits at the government's behest but subsequently encountered financial losses.[39] These policies, among others, conferred upon the United States significant mineral power during the early twentieth century.

[37] G. A. Roush, "Strategic Mineral Supplies: 2. Manganese," *Military Engineer* 26, no. 148 (1934), 251–52, https://www.jstor.org/.

[38] Harold Barger and Sam H. Schurr, *The Mining Industries, 1899-1939: A Study of Output, Employment, and Productivity* (New York: National Bureau of Economic Research, 1944), 259–60, https://www.nber.org/.

[39] This governmental financial relief came from the War Minerals Relief Act." *See* "Relief in Cases of Contracts Connected with Prosecution of the War," report no. 2041, 69th Cong. 2nd sess. (11 February 1927), https://www.govinfo.gov/; Middleton Beaman et al., "Department of Current Legislation: Federal Legislation," *American Bar Association Journal* 15, no. 10 (1929), 620, https://www.jstor.org/; and Thomas Walker Page et al., *Fourth Annual Report of the United States Tariff Commission* (Washington: Government Printing Office, 1921), 17, https://www.usitc.gov/.

Case Study 2: China's Mineral Power in the Early Twenty-first Century

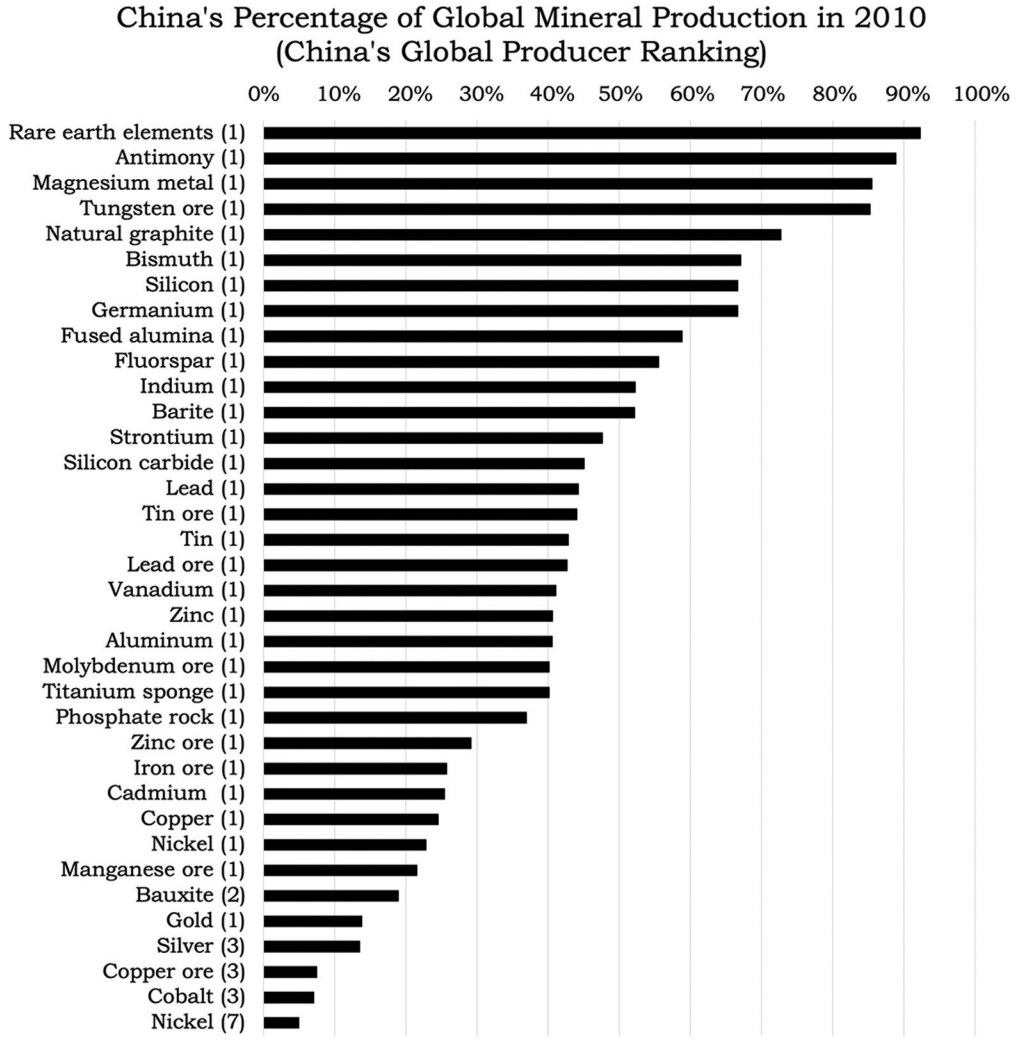

Figure 3. China's mineral production as a percentage of global mineral production for various minerals, including China's global producer ranking. (Source: Hearing on China's Global Quest for Resources and Implications for the United States, before the US–China Economic and Security Review Commission [26 January 2012], testimony of W. David Menzie, chief, Global Minerals Analysis Section, National Minerals Information Center, US Geological Survey, https://www.doi.gov/.)

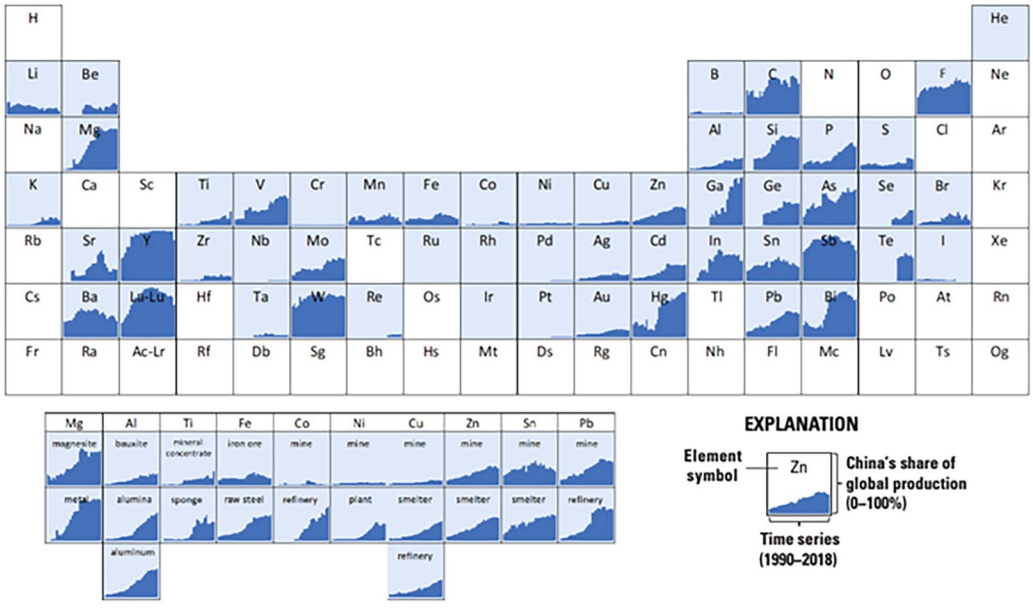

Figure 4. China's percentage of global mineral production from 1990 to 2018 for various minerals. (Source: Nedal T. Nassar, Elisa Alonso, and Jamie L. Brainard, "Investigation of US Foreign Reliance on Critical Minerals: US Geological Survey Technical Input Document in Response to Executive Order No. 13953 Signed September 30, 2020," US Geological Survey, December 7, 2020, 4, https://pubs.usgs.gov/.)

In the early twenty-first century, China emerged as a formidable global power and the predominant mineral producer worldwide (fig. 4).[40] According to the US Geological Survey, the most noteworthy transformation in global mineral production from 1990 to 2018 was the exponential increase in China's mineral output, coinciding with its ascent as a major power, arguably even a superpower.[41] By 2022, China had assumed the top position in the production of 30 out of the 50 minerals listed as critical by the US, solidifying its status as the primary source of many

[40] Jim Garamone, "White House Report Recommends Multi-Pronged Approach to Counter China," *DOD News*, 5 June 2020, https://www.defense.gov/; and US Geological Survey, *Mineral Commodities Summary 2024* (Reston, VA: US Geological Survey, 2024), 5, 8, 19, 23, https://doi.org/.

[41] Nedal T. Nassar, Elisa Alonso, and Jamie L. Brainard, "Investigation of US Foreign Reliance on Critical Minerals: US Geological Survey Technical Input Document in Response to Executive Order No. 13953 Signed September 30, 2020," *US Geological Survey*, 7 December 2020, 2, https://pubs.usgs.gov/. By 2020, "China had become the world's leading producer and consumer of numerous mineral commodities." *See* Sean Xun, "2019 Minerals Yearbook: China [Advanced Release]," *US Geological Survey*, July 2022, 9.1, https://pubs.usgs.gov/; and Jim Garamone, "China Military Power Report Examines Changes in Beijing's Strategy," *DOD News*, 29 November 2022, https://www.defense.gov/.

minerals imported by the United States.[42] Furthermore, in November 2023, China's natural resources minister announced plans to intensify efforts in mineral research, exploration, and extraction.[43] Consequently, China boasts significant domestic mineral production in the early twenty-first century.

China also maintains substantial mineral stockpiles. Through its National Food and Strategic Reserves Administration, China stockpiles critical minerals, including aluminum, cobalt, copper, rare earth elements, and zinc.[44] While the specific quantities of stockpiled minerals remain undisclosed, they are presumed to be considerable—and increasing.[45] China stockpiles minerals to safeguard against external supply disruptions, procuring these minerals from domestic producers and providing them with financial support.[46] Given that global trade volumes for many of the stockpiled minerals are relatively modest, China's stockpiling—or speculation thereof—can increase global mineral prices,[47] with the release of minerals—or rumors thereof—having the opposite effect.[48] Therefore, China possesses substantial mineral stockpiles in the early twenty-first century.

Chinese companies also wield significant control over overseas mineral production. For instance, through direct and indirect ownership, Chinese companies controlled between 40 percent and 50 percent of all cobalt produced in the Dem-

[42] US Geological Survey, *Mineral Commodities Summary 2023* (Reston, VA: US Geological Survey, 2023), 20, https://doi.org/. In 2023, China was the leading producer for 29 of 43 critical minerals for which reliable information was available. Mark Burton also notes in *Bloomberg*, "Today, China is the leading producer of twenty critical raw materials, as measured by its share of global mined or refined production." *See* US Geological Survey, *Mineral Commodities Summary 2024* (Reston, VA: US Geological Survey, 2024), 21, https://doi.org/; Mark Burton, "Why the Fight for 'Critical Minerals' Is Heating Up," *Bloomberg*, 20 November 2023, https://www.bloomberg.com/; and US Geological Survey, *Mineral Commodities Summary 2024* (Reston, VA: US Geological Survey, 2024), 5–6, 23, https://doi.org/.

[43] Kinling Lo, "China's Strategic Mineral Supply Push 'a Very Urgent Mission', Says Resources Minister, amid Self-Reliance Push," *South China Morning Post*, 10 November 2023, https://www.scmp.com/.

[44] "China's State Reserve Expected to Buy 3,100 T of Cobalt—Sources," *Reuters*, 20 October 2023, https://www.reuters.com/; and James T. Areddy, "China Moves to Strengthen Grip Over Supply of Rare-Earth Metals," *Wall Street Journal*, 7 February 2011, https://www.wsj.com/.

[45] In June 2021, Andy Home estimated the amounts for some minerals in China's stockpile, such as 800,000–900,000 metric tons of aluminum. *See* Andy Home, "Home: Learning to Live with (Talk of) Chinese State Metal Sales," *Reuters*, 17 June 2021, https://www.mining.com/; and "China's State Reserve Expected to Buy 3,100 T of Cobalt – Sources," *Reuters*, 20 October 2023, https://www.reuters.com/.

[46] Tracy Hu, "Analysts Expect Long-Term Cobalt Price Support in China amid Stockpiling Reports," *S&P Global*, 5 October 2020, https://www.spglobal.com/.

[47] "China Plans to Stockpile Cobalt after Price Rout," *Benchmark Source*, 25 October 2023, https://source.benchmarkminerals.com/; and Alexander Cook, "China Plans State Reserve Tender to Increase Cobalt Stockpile," *Fastmarkets*, 7 July 2023, https://www.fastmarkets.com/.

[48] "Copper Sinks to Two-Month Low on China's Plan to Release Reserves," *Mining.com*, 17 June 2021, https://www.mining.com/; and Min Zhang and Tom Daly, "Explainer: What We Know about China's Metals Reserves Release," *Reuters*, 17 June 2021, https://www.reuters.com/.

ocratic Republic of the Congo in 2020.[49] Additionally, Chinese companies hold ownership interests in the majority of large nickel projects in Indonesia, with companies predominantly owned by Chinese entities accounting for an estimated 84 percent of Indonesia's output of nickel suitable for batteries in 2023.[50] Chinese companies are also actively investing in and acquiring overseas lithium projects.[51] Notably, for certain minerals, individual Chinese companies hold significant shares of global production. Despite China's share of global cobalt mine production being only 1 percent in 2022, Chinese company CMOC, through its ownership stakes in overseas mines, is projected to control approximately 30 percent of global cobalt mine production by 2025.[52] Hence, China boasts exceptional overseas mineral production in the early twenty-first century.

Moreover, China imports substantial quantities of minerals from states with aligned commercial interests. Approximately 40 percent of its heavy rare earths are sourced from Myanmar,[53] while it heavily relies on imported lithium, including from Australian lithium producers with whom Chinese companies often share aligned commercial interests.[54] For example, in January 2024, the Chinese company Ganfeng expanded its agreement to purchase lithium from the Australian company Pilbara Minerals.[55] Concerning cobalt, China imports cobalt produced not only by Chinese companies in the Democratic Republic but also by Congolese "artisanal" miners, consisting of men, women, and children from the informal sector who

[49] Luiza Ch. Savage, "How America Got Outmaneuvered in a Critical Mining Race," *Politico*, 2 December 2020, https://www.politico.com/.

[50] Andrea Hotter, "FEOC Definition Leaves Most Indonesian Nickel outside IRA Tax Credits | Hotter Commodities," *Fastmarkets*, 5 December 2023, https://www.fastmarkets.com/. In November 2022, an Indonesian lawmaker claimed that Chinese companies control 90 percent of Indonesia's nickel industry. *See* Gusty da Costa, "China Controls Indonesia's Nickel Industry," *Indonesia Business Post*, 30 November 2022, https://indonesiabusinesspost.com/; and Benchmark Mineral Intelligence (@benchmarkmin), "Majority Chinese-owned companies will produce a large but declining share of nickel suitable for #batteries made in Indonesia out to 2030…." *X*, 10:10AM EST, 25 January 2024, https://x.com/.

[51] Charles Chang et al., "China's Global Reach Grows behind Critical Minerals," *S&P Global*, August 2023, 3–4, 6, 9, 12–13, https://www.spglobal.com/.

[52] Kim B. Shedd, "Cobalt," *US Geological Survey*, January 2023, https://pubs.usgs.gov/; and Eric Onstad, "China Turbo-charges Cobalt Mine Output despite Price Crash," *Reuters*, 6 December 2023, https://www.reuters.com/.

[53] "China's Rare Earth Imports from Myanmar Surge in First Half of 2023," *Reuters*, 20 July 2023, https://www.reuters.com/; Tom Daly, "Chian Rare Earths Extend Surge on Worries over Myanmar Supply, Inspection Threat," *Reuters*, 26 March 2021, https://www.reuters.com/; and Xun, "2019 Minerals Yearbook,", 9.6.

[54] "China's Lithium Vulnerability: Reliance on Imports Set to Rise This Decade," *Benchmark Source*, 29 June 2023, https://source.benchmarkminerals.com/; and Natasha Frost, "Australia Tries to Break Its Dependence on China for Lithium Mining," N*ew York Times*, 23 May 2023, https://www.nytimes.com/.

[55] "Pilbara Minerals Expands Ganfeng Offtake Agreement" (press release, Pilbara Minerals, 15 January 2024), https://company-announcements.afr.com/.

frequently toil in hazardous conditions.[56] Consequently, China commands notable volumes of aligned mineral imports in the early twenty-first century.

Given its significant domestic production, government stockpiles, overseas production, and aligned imports, China possesses great mineral power in the early twenty-first century. China's mineral policies primarily aim to secure ample mineral supplies for both the Chinese economy and military.[57] Consequently, China subsidizes domestic production of strategic minerals,[58] including mineral research, exploration, and extraction, as well as the acquisition of overseas mineral supplies.[59] In its 10th Five-Year Plan in 2001, China emphasized the "effective use of overseas resources,"[60] prompting heavy Chinese outward investment targeting the mineral sector.[61] Following the 2017 reforms on outward investments, the Chinese government further incentivized Chinese companies to invest in overseas mining.[62] The Chinese government, through state-led development banks and commercial banks,

[56] Andrew L. Gulley, "China, the Democratic Republic of the Congo, and Artisanal Cobalt Mining from 2000 through 2020," *Proceedings of the National Academy of Sciences* 120, no. 26 (June 27, 2023), 7, https://doi.org/.

[57] Lu Yutong et al., "China's Hunt for Strategic New Energy Minerals," *Caixin*, 14 February 2023, https://asia.nikkei.com/; Christina Lu, "Beijing Tightens Its Grip on the Critical Minerals Sector," *Foreign Policy*, 7 November 2023, https://foreignpolicy.com/; Edward A. Burrier and Thomas P. Sheehy, "Challenging China's Grip on Critical Minerals Can Be a Boon for Africa's Future," *US Institute of Peace*, 7 June 2023, https://www.usip.org/; Chang et al., "China's Global Reach Grows," 3; and Zeyi Yang, "How China Hopes to Secure Its Supply Chain for Critical Minerals," *MIT Technology Review*, 13 September 2023, https://www.technologyreview.com/.

[58] Weihuan Zhou, Victor Crochet, and Haoxue Wang, "Demystifying China's Critical Minerals Strategies: Rethinking 'De-risking' Supply Chains," University of New South Wales Law Research Paper No. 23-23, 1 September 2023, 12–13, http://dx.doi.org/; Bruce Shen, "China's Dominance over Critical Minerals Faces New Challengers," *The Diplomat*, 10 November 2022, https://thediplomat.com/; Daniel F. Runde and Austin Hardman, "Elevating the Role of Critical Minerals for Development and Security," *CSIS*, September 2023, 3, https://csis-website-prod.s3.amazonaws.com/; and Nabeel A. Mancheri, "Effect of Chinese Policies on Rare Earth Supply Chain Resilience," *Resources, Conservation and Recycling* 142 (March 2019), 108, https://doi.org/.

[59] Lo, "China's Strategic Mineral Supply Push."

[60] National People's Congress of the People's Republic of China, "Report on the Outline of the Tenth Five-Year Plan for National Economic and Social Development (2001)," delivered at the Fourth Session of the Ninth National People's Congress on March 5, 2001, http://www.npc.gov.cn/.

[61] Organisation for Economic Co-operation and Development, "OECD Investment Policy Reviews: China 2008," 5 December 2008, 75–76, https://www.oecd.org/; and Charles Wolf, Jr., Xiao Wang, and Eric Warner, *China's Foreign Aid and Government-Sponsored Investment Activities: Scale, Content, Destinations, and Implications* (Santa Monica, CA: RAND Corporation, 2013), xi; https://www.rand.org/.

[62] Hernan Cristerna et al., "2018 Global M&A Outlook: Navigating Consolidation and Disruption," J. P. Morgan, January 2018, 19, https://www.jpmorgan.com/.

coordinates financing for such projects with Chinese companies.[63] These policies have endowed China with great mineral power in the early twenty-first century.

Results

The case studies reveal that both the United States and China, as ascending great powers, enjoyed secure access to substantial mineral supplies. Specifically, the United States possessed significant mineral power during the early twentieth century, while China exhibits great mineral power in the early twenty-first century. Both nations required access to ample secure mineral supplies to sustain their heightened defense production and sizable military forces. These findings suggest that mineral power plays a crucial role in enabling military prowess and that enhancing mineral power may be a prerequisite for a state to augment its military capabilities.

The Modern Mineral Power of the United States

Currently, the United States exhibits limited domestic mineral production—evident in its heavy reliance on imports—and a constrained government mineral stockpile.[64] In terms of overseas mineral production, US companies hold stakes in mineral production ventures in Peru, Indonesia, and Chile, but the United States heavily relies on mineral imports controlled by Chinese companies, rather than those aligned with American interests.[65] Despite America's restricted access to secure mineral supplies, it has maintained significant mineral power owing to its diplomatic, economic, and military prowess, ensuring continued access to mineral imports and international sea lanes. As noted by C. K. Leith in 1939, although the United States and the British Empire controlled nearly 75 percent of global mineral production, equally crucial was their control over the seas through which these products traversed.[66] Even with limited domestic mineral production, the United States can still tap into overseas mineral production, thus securing the requisite mineral supplies to sustain its great-power military.

---

[63] Gregory T. Chin and Kevin P. Gallagher term China's state financing model as a "coordinated credit space model." *See* Gregory T. Chin and Kevin P. Gallagher, "Coordinated Credit Spaces: The Globalization of Chinese Development Finance," *Development and Change* 50, no. 1 (13 January 2019): https://onlinelibrary.wiley.com/.

[64] US Geological Survey, *Mineral Commodities Summary 2023* (Reston, VA: US Geological Survey, 2023), 6–8, 21, https://doi.org/; and Bryant Harris, "Congress and Pentagon Seek to Shore Up Strategic Mineral Stockpile Dominated by China," *DOD News*, 23 May 2022, https://www.defensenews.com/.

[65] Polly Bindman, "The Countries Controlling the Critical Minerals Supply Chain: In Four Charts," *Energy Monitor*, 30 October 2023, https://www.energymonitor.ai/; and US Geological Survey, *Mineral Commodities Summary 2024* (Reston, VA: US Geological Survey, 2024), 5–6, 23, https://doi.org/.

[66] Leith, "The Struggle for Mineral Resources," 42; and Leith, "Mineral Resources and Peace," 516.

Nevertheless, risks to US mineral imports are mounting.[67] China has already imposed export controls on gallium, germanium, graphite, rare earths, and rare earths processing technology.[68] If US–China competition escalates further, China—upon which the United States heavily relies for minerals—could curtail other mineral exports to the United States. Moreover, in the event of a US–China conflict, mineral exports from China and possibly other mineral-producing Asian states could face disruption.[69] The substantial US dependence on imported minerals, coupled with vulnerabilities to import disruptions, poses serious risks to US mineral power and, consequently, its military power.[70] As E. W. Pherson warned in 1945, "Dependence on supplies of raw materials from overseas poses a serious problem of national defense."[71]

Given the risks associated with imported minerals, US officials have frequently advocated for US mineral independence and self-sufficiency, particularly during periods of great-power competition. In 1919, following World War I, US Secretary of the Interior Franklin Lane emphasized, "The war taught us the need for mineral independence, and now that peace has come we should not forget it and be lured into the sweet illusion that all is forever to be well."[72] Similarly, in 1935, US Geological Survey Director Walter Mendenhall stressed, "There is great unrest in the world, and all that it is possible to do should be done to make this country self-sufficient in the mineral field."[73] Despite these warnings, the United States' dependence on imported minerals has persisted, as evidenced by the number of

---

[67] Nassar, Alonso, and Brainard, "Investigation of US Foreign Reliance."

[68] "China to Restrict Exports of Chipmaking Materials As US Mulls New Curbs," *Reuters*, 3 July 2023, https://www.reuters.com/; Siyi Liu and Dominique Patton, "China, World's Top Graphite Producer, Tightens Exports of Key Battery Material," *Reuters*, 20 October 2023, https://www.reuters.com/; Shunsuke Tabeta, "China Tightens Rare-Earth Export Curbs amid Tension with US," *Nikkei Asia*, 7 November, 2023, https://asia.nikkei.com/; and Siyi Liu and Dominique Patton, "China Bans Export of Rare Earths Processing Tech over National Security," *Reuters*, 22 December 2023, https://www.reuters.com/.

[69] "Conflict over Taiwan: Assessing Exposure in Asia," *Economist Intelligence Unit*, 2023, 1–7, https://www.eiu.com/. The Economist Intelligence Unit report asserts that a conflict between the United States and China could disrupt supply chain networks in Southeast and Northeast Asia, impacting countries such as the Philippines and South Korea. Importantly, both nations are significant suppliers of minerals to the United States: the Philippines serves as a major import source for scandium, tellurium, and selenium, while South Korea is a key import source for indium, yttrium, bismuth, and lead.

[70] Leith, "The Struggle for Mineral Resources," 42.

[71] E. W. Pehrson, "Our Mineral Resources and Security," *Foreign Affairs* 23, no. 4 (1945), 655, https://doi.org/.

[72] Franklin K. Lane, "Introduction," in *The Strategy of Minerals: A Study of the Mineral Factor in the World Position of America in War and in Peace*, ed. George Otis Smith (New York: D. Appleton and Company, 1919), xx.

[73] Mary C. Rabbitt and Clifford M. Nelson, *Minerals, Lands, and Geology for the Common Defence and General Welfare, Volume 4, 1939-1961: A History of Geology in Relation to the Development of Public-Land, Federal Science, and Mapping Policies and the Development of Mineral Resources in the United States from the 60th to the 82d Year of the US Geological Survey* (Reston, VA: US Geological Survey), 9, https://pubs.usgs.gov/.

minerals for which the United States is at least 25 percent net import reliant, increasing from 21 percent in 1954 to 58 percent in 2019.[74]

Policy Options for the US Government

Several policies could help increase US access to secure mineral supplies and thus enhance US mineral power. First, to boost domestic mineral production, the US government could expand financial support for domestic exploration, mining, and processing. Presently, the Department of Defense provides financial backing for cobalt and nickel exploration;[75] antimony, graphite, and lithium mining;[76] and aluminum, graphite, and titanium refining.[77] Expanding such financial support for domestic mineral production is crucial, as underscored by America's great-power rival, China. In November 2023, China's natural resources minister emphasized, "The exploration and mining of mineral resources and being at the top of the supply chain is the key to protecting our supply chain."[78]

Additionally, the US government could ramp up support for secondary production, such as metal recovery from recycled scrap. Historically, secondary production has yielded significant mineral volumes compared to mining, which is known as primary production. For instance, prior to US entry into World War II, secondary copper production accounted for 61 to 76 percent of US primary copper production.[79] However, as with other minerals, America's secondary copper industry has witnessed a decline. While the United States had five secondary copper smelters

[74] Nassar, Alonso, and Brainard, "Investigation of US Foreign Reliance," 2.

[75] "DOD Enters Agreement to Expand Domestic Manufacturing and Strengthen US Cobalt Supply Chains" (press release, US Department of Defense, 15 June 2023), https://www.defense.gov/; and "Department of Defense Enters an Agreement to Strengthen the US Supply Chain for Nickel Production" (press release, US Department of Defense, 12 September 2023, https://www.defense.gov/.

[76] "DoD Issues $24.8M Critical Minerals Award to Perpetua Resources" (press release, US Department of Defense, 19 December 2022), https://www.defense.gov/; "DOD Enters Agreement to Expand Capabilities for Domestic Graphite Mining and Processing for Large-Capacity Batteries" (press release, US Department of Defense, 17 July 2023, https://www.defense.gov/; and "DoD Enters Agreement to Expand Domestic Lithium Mining for US Battery Supply Chains" (press release, US Department of Defense, 12 September 2023, https://www.defense.gov/.

[77] "DoD Enters Agreement to Expand Domestic Manufacturing to Strengthen U.S. Missiles and Munitions Supply Chains" (press release, US Department of Defense, 16 June 2023, https://www.defense.gov/; "DOD Enters Agreement to Expand Domestic Graphite Supply Chain" (press release, US Department of Defense, 29 November 2023), https://www.defense.gov/; and "DOD Awards $12.7 Million to Increase Titanium Powder Production for Defense Supply Chains" (press release, US Department of Defense, 30 October 2023, https://www.defense.gov/.

[78] Lo, "China's Strategic Mineral Supply Push."

[79] T. H. Miller and H. M. Meyer, "Copper," in *Minerals Yearbook Review of 1941* (Washington, DC: US Government Printing Office, 1943), 105, https://digital.library.wisc.edu/.

in 1995, all were shuttered by 2002.[80] Nonetheless, one new US secondary smelter commenced operations in 2022, and two other secondary smelter projects have since been announced.[81] For copper and other minerals, the US government could provide financial support for existing secondary production facilities, their expansions, and the establishment of new facilities.

The US government could explore other policy options to bolster domestic mineral production, such as government procurement and tariffs. For example, during the Korean War, the US government—under the Defense Production Act—guaranteed the purchase of tungsten for its stockpile at a predetermined price from domestic producers for five years, leading to a surge in domestic tungsten production.[82] Similarly, imposing tariffs on foreign minerals could deter cheap imports from undermining domestic producers. Foreign competitors often offer lower mineral prices due to state support and adherence to lower labor and environmental standards.[83] Tariffs could mitigate this foreign cost advantage and safeguard domestic mineral production. As noted by E. W. Pehrson toward the end of World War II, "[A] large measure of [mineral] self-sufficiency has been maintained for many years with moderate tariff protection."[84]

Secondly, the US government could bolster its mineral stockpiles, focusing on minerals heavily utilized by the military. Notably, aluminum and copper rank as the most utilized elements by weight in the US military. In the 1960s, the US government stockpiled nearly 920,000 short tons of aluminum and over one mil-

[80] Daniel L. Edelstein, "Copper," *US Geological Survey*, 1994, 1, https://d9-wret.s3.us-west-2.amazonaws.com/; and Daniel L. Edelstein, "Copper," 2003, 21.1, https://d9-wret.s3.us-west-2.amazonaws.com/.

[81] DeAnne Toto, "ISRI2023: Critical Copper," *Recycling Today*, 22 April 2023, https://www.recyclingtoday.com/.

[82] John D. Morgan, Jr., "National Stockpile and United States Strategy," Industrial College of the Armed Forces, 6 December 1955, 10–12, https://www.hsdl.org/.

[83] According to Jorge Uzcategui of Benchmark Mineral Intelligence, Chinese mineral companies, even when not state-owned, can access inexpensive government financing, allowing them to operate at lower mineral prices than their international competitors. *See* Eric Onstad, "China Turbo-charges Cobalt Mine Output despite Price Crash," *Reuters*, 6 December 2023, https://www.reuters.com/. For example, companies producing nickel in Indonesia adhere to lower labor and environmental standards (e.g., tailings management) than companies operating in Western jurisdictions, giving Indonesian nickel producers a cost advantage. *See* Ken Moriyasu, "US Senators Oppose Indonesia FTA That Paves Way for Nickel Subsidies," *Nikkei Asia*, 2 November 2023, https://asia.nikkei.com/.

[84] Pehrson, "Our Mineral Resources and Security," 656–57.

lion short tons of copper.[85] However, presently, the US government does not stockpile aluminum or copper.[86] Additionally, the military's third and fourth most used elements, lead and fluorspar, are also absent from the stockpile.[87] This decline in stockpile levels is further highlighted by the fact that while the US government stored materials at 213 locations in 1961;[88] today, it does so at only six locations.[89] To address this issue, recommendations from the White House, Department of Defense, and Department of Energy advocate for increased stockpiling efforts.[90] Given China's dominance in the mineral realm, the US government may need to consider sourcing minerals from China to swiftly augment its stockpile. For many minerals, such as rare earth elements, China stands as the sole provider with the necessary production volume to rapidly expand the US mineral stockpile.

Thirdly, although the United States lacks major domestic mineral companies, it could enhance overseas mineral production by providing capital to US companies to acquire ownership stakes in foreign mineral production. Currently, the US government is allocating funds to foreign entities for this purpose; for instance, the US Development Finance Corporation has invested USD 105 million in TechMet, a Dublin-based private investment vehicle, to support a nickel-cobalt mine in

---

[85] Institute for Defense Analyses, "Key Materials for High-Priority Weapon Systems, and Assessing Risks to Their Supply: A Report for the US Defense National Stockpile Center," July 31, 2008, in US Department of Defense, "Reconfiguration of the National Defense Stockpile Report to Congress," April 2009, B-2, https://www.scribd.com/; Bureau of Industry and Security, "The Effect of Imports of Aluminum on the National Security: An Investigation Conducted under Section 232 of the Trade Expansion Act of 1962, as Amended," US Department of Commerce, 17 January 2018, 34, https://www.bis.doc.gov/; and "Copper Sale Set to Ease Supplies," *New York Times*, 17 December 1964, https://www.nytimes.com/.

[86] Adam M. Merrill, "Aluminum," *US Geological Survey*, January 2023, https://pubs.usgs.gov/; and Daniel M. Flanagan, "Copper," *US Geological Survey*, January 2023, https://pubs.usgs.gov/.

[87] Amy C. Tolcin, "Lead," *US Geological Survey*, January 2023, https://pubs.usgs.gov/; Michele E. McRae, "Fluorspar," *US Geological Survey*, January 2023, https://pubs.usgs.gov/; and Institute for Defense Analyses, "Key Materials for High-Priority Weapon Systems, and Assessing Risks to Their Supply: A Report for the US Defense National Stockpile Center," 31 July 2008, in US Department of Defense, "Reconfiguration of the National Defense Stockpile Report to Congress," April 2009, B-2, https://www.scribd.com/.

[88] Office of Emergency Planning, *Stockpile Report to Congress* (Washington: Executive Office of the President, June–January 1961), 5.

[89] "About Strategic Materials," Defense Logistics Agency, 2024, https://www.dla.mil/.

[90] *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017* (Washington: The White House, June 2021), 16, 200–201, https://www.whitehouse.gov/; *Securing Defense-Critical Supply Chains: An Action Plan Developed in Response to President Biden's Executive Order 14017* (Washington: DOD, February 2022), 43–45, https://media.defense.gov/; and Tsisilile Igogo, *America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition: US Department of Energy Response to Executive Order 14017, "America's Supply Chains"* (Washington: US Department of Energy, February 2022), 25, 46, https://www.energy.gov/.

Brazil and a rare earths project in South Africa.[91] Prioritizing such funding for US companies would enable them to secure control over overseas mineral production. Moreover, as domestic mineral companies boost production and revenue domestically, they would have more capital to invest in overseas mineral projects, reminiscent of practices observed in the early twentieth century.

Fourthly, the US government could augment its aligned imports by facilitating offtake agreements between US companies and overseas mines in states and owned by companies aligned geopolitically with the United States. To prevent undermining mineral production within the United States, the government should only finance offtake agreements for minerals lacking reserves domestically. For instance, since the United States lacks manganese reserves while Australia possesses them; thus, the government could offer financing to US manufacturers, particularly those in the defense supply chain, to secure long-term offtake agreements with Australian manganese producers.

Importantly, offtake agreements not only secure overseas mineral supplies for US companies but also stimulate mineral production in the supplier states, as mining companies often utilize capital from offtake agreements to develop or expand their mineral production.[92] Additionally, signed offtake agreements can attract greater capital for the mining project, as other investors and lenders perceive the project as partially de-risked. The US government could coordinate such financing under the Mineral Security Partnership—an international consortium of 14 states aimed at establishing secure mineral supply chains. Many US partners, including Australia, have expressed their interest in attracting US investment in their mining sectors.[93]

Fifthly, as the US government endeavors to enhance its mineral security, it could utilize its trade leverage in advanced technology to ensure continued access to minerals produced in China. For various minerals, China currently serves as an indispensable supplier to the United States. For instance, China mines 90 percent of the world's gallium, 88 percent of the world's magnesium, 81 percent of the world's tungsten, 80 percent of the world's bismuth, and 77 percent of the world's

[91] Yvonne Yue Li, "US Gives $50 Million Boost to Critical Minerals Investor TechMet," *Bloomberg*, 1 December 2023, https://www.bloomberg.com/.

[92] Clyde Russell, "Supply Anxiety Is the New Hope for Developing Energy Transition Mines," *Reuters*, 25 May 2023, https://www.reuters.com/.

[93] Phil Mercer, "Australia Unveils $1.25 Billion Critical Minerals Plan," *Voice of America*, 26 October 2023, https://www.voanews.com/.

natural graphite.[94] To maintain access to these minerals, the US government, through diplomatic channels, could convey to the Chinese government that any export controls on minerals—and mineral processing technology—from China will result in retaliatory US export controls on technology to China.[95] Moreover, the US government should consider the risks associated with imposing export controls on technology, as the Chinese government can and has retaliated with export controls on minerals.[96]

Challenges to implementing the aforementioned US government policies include concerns regarding labor practices and market intervention, but the primary challenge revolves around environmental considerations. Mining, like all major industrial activities, entails tradeoffs with the environment. For instance, mining currently accounts for 4 percent to 7 percent of global greenhouse gas emissions.[97] However, when evaluating mining's economic impact, its footprint is relatively small: the mining industry exhibits a higher economic impact per metric ton of carbon dioxide emissions compared to the agricultural, construction, and energy industries.[98] Moreover, minerals are essential for various new energy technologies, such as electric vehicle batteries, which can mitigate carbon emissions when paired with low-carbon electricity sources.

On a local scale, mining also affects the environment to varying degrees depending on factors such as mine type (e.g., open pit or underground), mine size, and mine tailings management. For example, mine tailings—waste material, usually in

---

[94] US Geological Survey, *Mineral Commodities Summary 2024* (Reston, VA: US Geological Survey, 2024), 23, https://pubs.usgs.gov/. China is also the dominant processor for many minerals. For example, China processes 98 percent of the world's natural graphite, 93 percent of the world's manganese, and 77 percent of the world's cobalt. *See* Eric Onstad, "Auto Firms Race to Secure Non-Chinese Graphite for EVs As Shortages Loom," *Reuters*, 21 June 2023, https://www.reuters.com/; Organisation for Economic Co-operation and Development, "Strengthening Clean Energy Supply Chains for Decarbonisation and Economic Security: OECD Report for the G7 Finance Ministers and Central Bank Governors," May 2023, 5, https://www.oecd.org/; and Harry Dempsey and Leslie Hook, "China Set to Tighten Grip over Global Cobalt Supply As Price Hits 32-Month Low," *Financial Times*, 12 March 2023, https://www.ft.com/.

[95] Siyi Liu and Dominique Patton, "China Bans Export of Rare Earths Processing Tech over National Security," *Reuters*, 22 December 2023, https://www.reuters.com/.

[96] Potentially in response to US export controls on semiconductor technology, China retaliated with export controls on gallium and germanium. *See* James T. Areddy and Sha Hua, "China Restricts Exports of Two Minerals Used in High-Performance Chips," *Wall Street Journal*, 4 July 2023, https://www.wsj.com/; and Mia Nulimaimaiti, "China's Gallium and Germanium Exports Tumble As Controls on Shipments to the West Take Toll," *South China Morning Post*, 21 January 2024, https://www.scmp.com/.

[97] Lindsay Delevingne et al., "Climate Risk and Decarbonization: What Every Mining CEO Needs to Know," McKinsey & Company, January 2020, 2, https://www.mckinsey.com/.

[98] Benjamin Cox et al., "The Mining Industry as a Net Beneficiary of a Global Tax on Carbon Emissions," *Communications Earth & Environment* 3, no. 17 (2022), 2, https://doi.org/.

a slurry, produced during mining and processing—are typically disposed of in ponds or impoundment dams, which present seepage and breach risks. However, employing dry stacking tailings, which involve dewatering tailings, poses fewer pollution and safety risks. Therefore, for both domestic and overseas mineral projects to receive US government support, the US government should mandate that recipient projects adhere to best-in-industry standards, such as dry stacking tailings.

Conclusion

Minerals enable the production of defense platforms and munitions, which influence a state's military power. Thus, a state's domestic mineral production, government mineral stockpiles, overseas mineral production, and aligned mineral imports comprise—what we call—a state's mineral power. The case studies in this article find that the United States was a rising great power *and* had great mineral power in the early twentieth century and that China is a rising great power *and* has great mineral power in the early twenty-first century. These results indicate that a state's mineral power helps enable its military power.

Presently, the United States confronts a formidable mineral power in China. Unlike previous scenarios, where the United States faced minimal challenges to its mineral power, the escalating competition between the United States and China poses a significant threat to US mineral security. Potential mineral shortages could severely undermine US military capabilities amid the intensifying rivalry with China.[99] Therefore, it is imperative for the US government to take proactive measures to bolster domestic mineral production, enhance government mineral stockpiles, provide financial support and risk mitigation tools for US investments in overseas mineral production, and facilitate offtake agreements between US companies and mineral producers aligned with US interests. Additionally, the US government should utilize its trade leverage to ensure continued access to Chinese minerals by warning of potential export controls on certain technologies should China impose restrictions on mineral exports. ✪

Gregory Wischer

Mr. Wischer is the founder and principal at Dei Gratia Minerals, bringing a wealth of experience from his previous roles as executive vice president and vice president for government affairs at Westwin Elements. His background includes internships with the National Defense University, the US Senate Committee on Foreign Relations, and US Representative Russell Fulcher (R–ID), providing him with a solid foundation in both foreign and domestic policy. With an MA in security studies from Georgetown University and a bachelor's degree in international business from Boise State University, he possesses a unique blend of expertise that informs his expertise within the mineral industry.

[99] Leith, "Mineral Resources and Peace," 515–16; and Leith, "Mineral Resources in Their International Relations," *Proceedings of the American Philosophical Society* 91, no. 1 (1947), 85, http://www.jstor.org/.

Dr. Morgan Bazilian

Dr. Bazilian is the director of the Payne Institute and a professor of public policy at the Colorado School of Mines. Previously, he served as lead energy specialist at the World Bank and held key roles in international organizations including the United Nations. Dr. Bazilian holds multiple master's degrees and a PhD in energy systems, and has authored more than 200 articles in learned journals, as well as the book Analytical Methods for Energy Diversity and Security. He is a member of the Council on Foreign Relations and Ireland's Climate Change Council.

Disclaimer