The U.S. Military Risks Mineral Shortages in a U.S.-China War

Lessons from World War I, World War II, and the Korean War

Gregory D. Wischer

Minerals are foundational in warfighting.[1] They are used in defense platforms like attack submarines, heavy bombers, and mobile missile launchers, and in munitions like submarine-launched torpedoes, air-launched standoff missiles, and ground-launched rockets and missiles. In its last three great power wars—World War I, World War II, and the Korean War—the United States lacked sizable mineral stockpiles yet was the world's dominant mineral producer.[2] The U.S. military experienced mineral shortages during these wars due to increased defense production, expanded export controls, and contested shipping routes. Today, the U.S. military is at a greater risk of severe mineral shortages if a U.S.-China war were to unfold: the United States has limited mineral stockpiles; low domestic mineral production; and heavy mineral import reliance, including from its great power rival, China.

A mineral shortage can severely undermine war efforts and impact the war's outcome. Importantly, mineral shortages can prove decisive. C. K. Leith partly attributes the loss of the Central Powers in World War I to mineral shortages, saying, "The acute shortage of essential minerals which they experienced was a very considerable factor in their ultimate defeat."[3] Similarly, John D. Morgan argues that mineral shortages undermined U.S. industrial mobilization during World War II and prolonged the war.[4] The Allies also experienced mineral shortages in the early part of 1942, hindering defense production and bringing the Allies "dangerously close to losing the war," according to Donald Nelson, director of the War Production Board during World War II.[5] Critically, mineral shortages in a potential U.S.-China war may not only prolong the conflict but, if severe enough, also contribute to U.S. defeat.

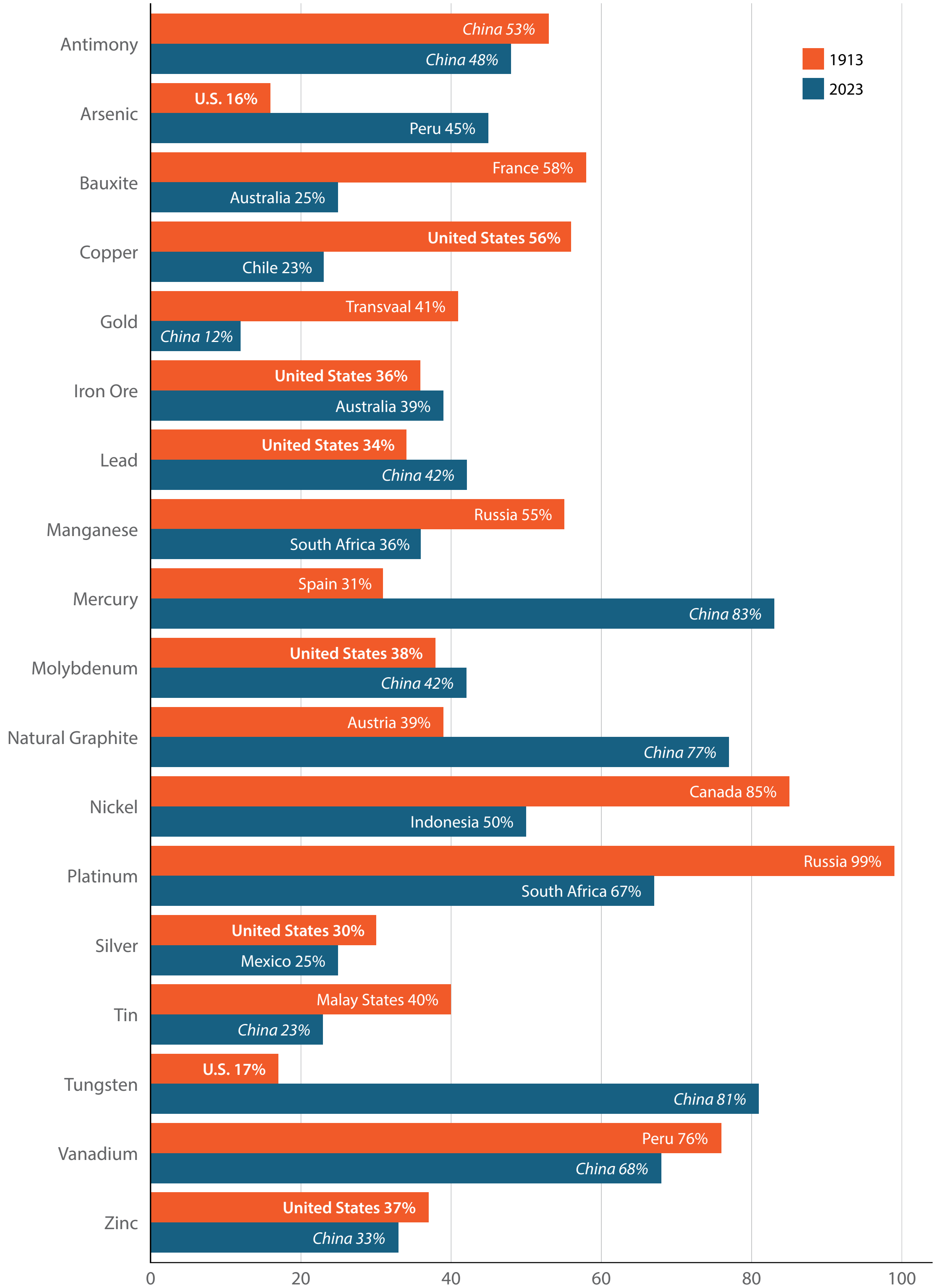
U.S. Mineral Supply: Past and Present

The United States was a dominant mineral producer before the two world wars and the Korean War. At the dawn of World War I in 1913, the United States was the world's leading producer of several important minerals (see the figure).[6] Prior to World War II in 1938, the United States was the world's dominant mineral producer, controlling major mineral resources across Canada, Central America, and South America.[7] The United States was self-sufficient in many minerals before the Korean War in 1949, too. U.S. Bureau of Mines Director James Boyd declared, "During the last fifty years the United States has achieved preeminence among the nations of the world in producing, processing, and fabricating mineral raw materials."[8] However, before these wars, the U.S. government (USG) largely lacked mineral stockpiles because it lacked a comprehensive mineral strategy.[9] Still, the United States was the world's dominant mineral producer before these wars.

The United States today has limited mineral production compared to these prior periods. Moreover, the United States increasingly depends on mineral imports to satisfy its domestic mineral consumption, which indicates a decline in mineral production relative to consumption.[10] From 1954 to 2019, the number of minerals for which the United States was at least 25 percent net import-reliant increased from twenty-one minerals to fifty-eight minerals.[11] It no longer mines many minerals that it previously did, such as gallium, manganese, niobium, or tantalum.[12] More importantly, the United States is heavily import-reliant on China for many of its minerals. For its consumption of twenty-four mineral commodities in 2023, the United States was over 50 percent reliant on minerals imported from

Gregory D. Wischer is the founder and principal of Dei Gratia Minerals. He was previously executive vice president at Westwin Elements. He has written about critical mineral issues in various outlets, including War on the Rocks, the *Journal of Indo-Pacific Affairs*, the Carnegie Endowment for International Peace, the Modern War Institute at West Point, and the Naval Postgraduate School's Energy Academic Group. He has prior experience at the National Defense University, the U.S. Senate Foreign Relations Committee, the U.S. House of Representatives, and the Centre for Policy Research in New Delhi. Wischer received his BA in international business from Boise State University and his MA in security studies from Georgetown University.

Previous page: Piles of rare Earth elements both mined and refined. (Photo by Anastasiia via Adobe Stock)



(Figure by author; adapted from Joseph B. Umpleby, "The Position of the United States 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 [D. Appleton, 1919]; and U.S. Geological Survey, *Mineral Commodity Summaries 2024* [U.S. Geological Survey, 2024])

Figure. Leading Mineral Producers, 1913 and 2023

China.[13] Like the prior periods preceding conflict, the United States has limited mineral volumes in the National Defense Stockpile.[14] In 2023, the Department of Defense (DOD) estimated that, in a hypothetical war with China, the U.S. military would have shortages in sixty-nine materials.[15] Therefore, the United States today has limited mineral production and mineral stockpiles—a more precarious U.S. mineral position versus prior periods before great power wars.

Mineral Shortage Risks in War

The U.S. military would face the following risks that could contribute to mineral shortages in a war with China: increased defense production, expanded export controls, and contested shipping routes.

First, the United States would likely increase defense production to expand U.S. warfighting capabilities and to replenish attrited war materiel. During the two world wars and the Korean War, the United States consumed significant minerals for increased defense production, which contributed to some mineral shortages. For instance, the United States was self-sufficient in many minerals before World War II, but wartime demand contributed to shortages of nickel, tin, zinc, and aluminum.[16] Near the end of the war, E. W. Pehrson of the U.S. Bureau of Mines noted that despite substantial domestic mineral production, "the demands for this war overtaxed our capacity for production."[17] Likewise, during the Korean War in 1951, titanium demand greatly exceeded production capacity.[18]

In a U.S.-China war, the United States would likely face mineral shortage risks from increased defense production for the war effort. A 2016 RAND publication on a possible U.S.-China war over Taiwan said, "War between the two countries could be intense, last a year or more, have no winner, and inflict huge losses and costs on both sides."[19] To illustrate, in U.S.-China war games conducted by the Center for Strategic and International Studies, the U.S. military expended its entire inventory of long-range antiship missiles in the first week of combat.[20] Estimating mineral consumption in a U.S.-China war is difficult given limited open-source information on the material composition of such defense platforms and munitions. Yet as previous great power wars indicate, defense production in a U.S.-China war would heavily demand minerals and may cause mineral shortages (see table 1).

Second, the United States would likely confront expanded export controls implemented by China and possibly Russia. Before U.S. entry into the two world wars and the Korean War, it faced export controls that reduced access to foreign minerals and contributed to mineral shortages. During the Berlin Blockade in the late 1940s, for instance, the Soviet Union restricted mineral exports to the United States.[21] Interestingly, the United States also faced export controls from its geopolitical partners. Before the United States entered World War I, Great Britain imposed export restrictions on tin, prohibiting U.S. manufacturers from exporting such tin or their products to Germany.[22]

In a U.S.-China war, the United States would also face export controls from China. In fact, it already does. The United States imports most of its gallium, germanium, and graphite from China, and China placed export restrictions on these minerals in 2023.[23] Then in December 2024, China banned the export of gallium and germanium and tightened export controls on graphite.[24] As geopolitical tensions rise globally, other countries may impose export restrictions to secure their own mineral supplies or disrupt the mineral supply chains of other countries. A 2023 report by the Organization for Economic Cooperation and Development noted that export restrictions may already be "affecting availability and prices" of critical raw materials.[25] Therefore, if a war unfolds, the United States would likely face mineral export controls, posing mineral shortage risks.

Third, the United States would likely encounter contested shipping routes, including submarine warfare. During the two world wars, U.S. mineral imports faced such disruption. In a 1949 study on the U.S. mineral industry during World War II, John D. Morgan Jr. wrote, "The World War I and World War II records likewise shows [*sic*] that import shipping is a very vulnerable activity."[26] Submarine warfare threatened mineral imports even before the United States entered the wars, and mineral imports experienced significant disruption after U.S. entry into the wars.[27] For example, in World War I, Germany's unrestricted submarine warfare disrupted U.S. imports of Spanish pyrites, causing severe shortages.[28]

The United States would similarly face mineral supply disruption from contested shipping routes and may experience mineral shortages during a potential

Table 1. U.S. Defense Use of Minerals

Mineral	Defense Use	U.S. Net Import Reliance in 2022
Antimony	Antimony metal is used in most of the military's lead-acid batteries. Indium antimonide semiconductors are used in forward-looking infrared vision systems and infrared homing missiles. Antimony trisulfide is used in fuses, small arms ammunition, mortar rounds, and artillery projectiles.	84%
Beryllium	Beryllium metal is used in intelligence, surveillance, and reconnaissance guidance systems, chassis and support arm/beam components, neutron reflectors, and X-ray mirrors.	6%
Bismuth	Bismuth-based alloys are used in machining.	97%
Chromium	Chromium metal is used as superalloys in turbine engines for jet aircraft, tanks, and marine applications.	84%
Cobalt	Used in superalloys for jet engines, Stellite alloys, nickel–metal hydride (NiMH) and lithium-ion batteries, samarium-cobalt, and Alnico magnets.	73%
Gallium	Used in electronics and missile guidance systems. Gallium arsenide (GaAs) is used for radar, short wave infrared tracking, night vision, and satellite communications. Gallium antimonide is used for night vision and missile guidance.	100%
Germanium	High-purity germanium is used in infrared lenses for most of the Department of Defense's night vision technology, thermal imaging systems, and infrared tracking systems in combat vehicles. These applications are essential for tracking ground targets and heat-seeking missiles and conducting nighttime operations. High-purity germanium substrates are also used in the manufacture of solar cells that power defense and national security space satellites. These satellites are critical for reconnaissance, missile detection, and communication.	> 50%
Graphite (natural)	Used in batteries, lubricants, body armor, engine turbine components, coatings for aircraft manufacture, and missile parts.	100%
Indium	Used in infrared imaging systems and communications systems.	100%
Lead	High-purity lead is used for thin-plate pure lead batteries used in aircraft and some navy vessels.	38%
Lithium	Used for repairs of fighter jet structures, safety-critical batteries, and batteries in electronics.	> 25%
Magnesium	Used in helicopter transmission housings, armor applications, broadcast and wireless communication equipment, radar equipment, torpedoes, antitank ammunition rounds, batteries, flare and ordnance applications, and infrared and missile countermeasures. Also used an alloy for aircraft, vehicle engine casings, and missile construction.	> 50%
Nickel	Used in superalloys for high-temperature sections of jet engines and maraging steel (aerospace and military use).	54%
Niobium	Used in superalloys for turbine engines, rocket sub-assemblies, and memory metal for hydraulic couplings.	100%
Palladium	Used in circuit boards and brazing and soldering in aerospace applications.	31%
Rhenium	Used in high-temperature alloys including superalloys for air transport and land power generation turbine engines.	70%
Stronitium	Used for pyrotechnics (e.g., signal flares).	100%
Tantalum	Used in nickel superalloys for high-temperature sections of jet engines and capacitors for Department of Defense military specification and U.S. space applications. Also used in shaped charge and explosively formed penetrator liners, missile systems, ignition systems, night vision goggles, and global positioning systems.	100%
Tellurium	Used in thermal imaging devices such as short and mid-wave infrared sensors, thermoelectric coolers for infrared detectors, integrated circuits, and laser diodes.	> 75%
Tin	Used in alloys for bearings.	77%
Tungsten	Used in high-temperature superalloys for military turbine engines, tungsten filaments for electronics, and lighting and armor-piercing ammunition.	> 50%
Vanadium	Used as an additive in steel, specialty steel, catalysts, titanium-aluminum-vanadium alloys for jet engines, cladding, vanadium-gallium tape for superconducting magnets, and glass coatings.	60%

(Table by author; adapted from Under Secretary of Defense for Acquisition, Technology and Logistics, *Strategic and Critical Materials 2015 Report on Stockpile Requirements* [U.S. Department of Defense, 2015]; and U.S. Geological Survey, *Mineral Commodity Summaries 2024* [U.S. Geological Survey, 2024])

Table 2. Mineral Import Demand

Element	U.S. Self-Sufficiency		Increase / -Decrease
	1938	2023	
Aluminum	97%	56%	-41%
Antimony	16%	18%	2%
Arsenic	43%	0%	-43%
Bauxite	47%	25%	-22%
Manganese	6%	0%	-6%
Nickel	2%	43%	41%
Platinum	81%	17%	-64%
Tin	0%	26%	26%
Tungsten	95%	50%	-45%

(Table by author; adapted from H. Herbert Hughes, ed., *Minerals Yearbook 1939* [U.S. Government Printing Office, 1939]; and National Minerals Information Center, "US Geological Survey Mineral Commodity Summaries 2024 Data Release" [U.S. Geological Survey, 30 January 2024])

U.S.-China war. Such a war would severely disrupt supply chains in Northeast Asia and Southeast Asia, regions from which the United States imports significant volumes of minerals.[29] Japan is a major U.S. import source for cobalt, gallium, tellurium, titanium, and rare earth elements including scandium; and South Korea and the Philippines are also major mineral suppliers to the United States: South Korea is a major U.S. import source for bismuth, indium, refined lead, yttrium, and refined zinc, while the Philippines is a major U.S. import source for scandium, selenium, and tellurium.[30]

Shipping routes from other resource-rich countries would also face disruption. For example, Australia is a major mineral producer, but Australia's sea lanes could face disruption in a war that encompasses the South China Sea.[31] Currently, "Beijing is seeking to transform the South China Sea from an international SLOC [sea line of communication] into a Chinese-controlled waterway and a strategic chokepoint for other countries," according to Richard A. Bitzinger.[32] Consequently, U.S. mineral imports would likely face contested shipping routes and may create mineral shortages for the U.S. military.

Can't the United States Just Produce More Minerals in War?

One counterargument to U.S. mineral shortage risks is that the United States can significantly increase its mineral production, as it did in previous wars. For instance, from 1913 to 1918, U.S. tungsten production increased by 222 percent, manganese production by 984 percent, and chromite production by 23,327 percent.[33] However, before and during the two world wars and the Korean War, the United States arguably possessed the world's dominant mineral industry, which even made the United States self-sufficient in some minerals.[34] Since then, the U.S. mineral industry has declined. As previously noted, the United States relies increasingly on imports to meet domestic demand, and it has even stopped mining and refining some minerals (see table 2).[35] For example, the United States has not mined tantalum since 1959 and has not produced cobalt metal since 1983.[36] Therefore, the United States has a relatively weakened mineral industry with less expertise.

Consequently, additional U.S. production lines for defense platforms and munitions may be built quickly in a U.S.-China war, but mines and refineries would take far longer to develop given the lack of U.S. expertise. In 1951, then–U.S. Bureau of Mines Director James Boyd said that "new domestic raw material supplies cannot be made available in less than two to five years."[37] Currently, a mine in the United States takes an average of thirteen years from discovery to production.[38] Compared to other prewar periods, the U.S. mineral industry lacks the production base and expertise to increase mineral production quickly.

Today, the United States is analogous to Russia during World War I—mineral rich but unprepared for wartime demands and foreign supply restrictions.[39] Despite Russia's efforts to support its mineral industry during World War I—from mapping resources across the country to improving infrastructure in mining regions—Russia could not sufficiently supply its military.[40] Writing in *The Scientific Weekly* in 1917, Joseph Pogue compared the British Empire's well-developed mineral industry with Russia's largely undeveloped mineral industry, saying, "Industrial organization for war is one problem and can be quickly arranged for—behold England; the development of a country's resources is a different matter and can not [*sic*] be accomplished in a brief period of years—that Russia has learned to her loss."[41] Like Russia in World War I, the United States in a U.S.-China war cannot quickly increase mineral production.

U.S. Policy Options

The USG can, however, adopt policies now to mitigate risks of mineral shortages in case a U.S.-China war occurs. First, the USG should stockpile more minerals—both larger volumes and a larger variety.[42] It is already doing so, like seeking to acquire 18,500 metric tons of high-purity aluminum and aluminum alloys.[43] However, the National Defense Stockpile lacks some of the most-used minerals by the U.S. military, such as copper, lead, and fluorspar.[44] An expanded stockpile has precedent. The USG stockpiled minerals at 213 locations around the country during the Cold War in 1961; presently, the USG only stores minerals at six locations.[45]

The DOD should stockpile more minerals in the National Defense Stockpile. Under 50 U.S.C. § 98h-5(b)–(c), the DOD sets target stockpile inventories based on the Pentagon's "base case" conflict scenario, in this instance, a one-year, large-scale conventional U.S.-China war followed by three years of industrial recovery.[46] The DOD can intensify this conflict scenario, increasing the military's mineral demand. For example, the National Security Council in 1950 produced policy paper NSC 68, *A Report to the National Security Council by the Executive Secretary (Lay) on United States Objectives and Programs for National Security*, which updated the U.S. threat planning scenario and corresponding mobilization period, and consequently increased stockpiling appropriations in 1950 and throughout the Korean War.[47] Congress could also increase the one-year combat duration currently in law, just as it did in 1988 when it explicitly required that the stockpile "be sufficient to sustain the United States for a period of not less than three years during a national emergency situation that would necessitate total mobilization of the economy of the United States for a sustained conventional global war of indefinite duration."[48]

Second, the USG should incentivize domestic mineral production. These policies should include supply-side and demand-side policies. The USG already implements supply-side policies through programs like the Department of Energy's Advanced Technology Vehicle Manufacturing program and Office of Manufacturing and Energy Supply Chains, and the DOD's Defense Production Act Title III program and Industrial Base and Sustainment program.[49] The USG also offers demand-side policies, namely tax credits to taxpayers who purchase new electric vehicles with batteries containing a certain percentage of critical minerals extracted or processed in the United States, free-trade agreement countries (e.g., Australia), or critical mineral agreement countries (e.g., Japan).[50]

The USG should increase the available capital for domestic mineral projects and increase the domestic content requirements for mineral-related government incentives. Supply-side policies would include more grants and loans for mineral projects—both mining and refining—while demand-side policies would include stricter domestic mineral content requirements for government procurement (e.g., DOD procurement of nontactical electric vehicles) and domestic mineral feedstock requirements for grants and loans to downstream U.S. projects (e.g., battery gigafactories). The USG should also modify the content requirements for the electric vehicle critical minerals tax credit to establish a higher tax credit for batteries containing U.S.-produced minerals versus foreign-produced minerals.

Third, the USG should restrict mineral imports from China. China is presently an indispensable supplier of several minerals. It produces mineral volumes that other countries cannot easily replace. For example, China is the world's largest producer of yttrium, and it supplied 94 percent of all yttrium compounds consumed in the United States from 2019 to 2022.[51] If the USG were to ban yttrium imports from China, U.S. companies would struggle to find alternative suppliers to satisfy their demand. Rather than outright banning U.S. imports of minerals from China, the United States should apply tariffs on these minerals, making them the highest-cost mineral source. Such tariffs would incentivize U.S. companies to find alternative, non-Chinese mineral sources and incentivize non-Chinese producers to develop other mineral resources.

The USG should also condition any grants, loans, and tax credits related to critical minerals on excluding Chinese minerals. For instance, the critical minerals tax credit for electric vehicles requires no minerals from foreign entities of concern, but the ownership threshold for an entity to be deemed a foreign entity of concern is currently 25 percent ownership by a foreign entity of concern, including Chinese companies.[52] The USG should tighten this restriction: electric vehicles with batteries containing *any* content in their supply chains produced by companies with *any* Chinese ownership should disqualify those vehicles from the critical minerals tax credit. Similarly, government procurement

An aerial view of Santa Rita strip copper mine near Silver City, New Mexico. (Photo by Cavan via Adobe Stock)

should also exclude goods containing any China-produced minerals, and federal grants and loans for U.S. projects should include conditions that prohibit recipients from sourcing any China-produced minerals.

Lastly, for minerals lacking reserves in the United States, the USG should seek to secure overseas mineral production in countries aligned geopolitically with the United States. This supply chain alignment is known as "friendshoring."[53] The United States simply does not have enough reserves of some minerals to fulfill U.S. mineral demand in a large-scale military conflict. For example, during World War II from 1942 to 1945, Canada supplied many minerals to the United States, including 85 percent of the U.S. nickel supply, 49 percent of its platinum group metals, and 15 percent of its aluminum.[54] The United States is currently pursuing various friendshoring initiatives, such as the Mineral Security Partnership, Partnership for Global Infrastructure and Investment, and various bilateral agreements.[55] The success of these friendshoring initiatives remains to be seen.[56]

However, U.S. friendshoring policies should include investing capital in U.S. companies for acquiring ownership stakes in overseas mineral projects. The policy would be similar to how the U.S. International Development Finance Corporation has invested in TechMet, a Dublin-based private investment vehicle, to invest in a nickel-cobalt mine in Brazil and a rare earths project in South Africa.[57] The USG should also offer low-cost loans to U.S. companies for securing long-term mineral offtake agreements with overseas mineral producers. Both investments and offtake agreements provide capital to projects in partner countries for expanding their mineral operations.

Yet, friendshoring with overseas partners bears risks during wars as sea lanes are vulnerable.[58] Moreover, international cooperation is particularly challenging amid great power competition. For instance, after World War I, some U.S. mineral experts proposed an internationalist approach, including free trade for mineral supply chains, but countries sought to increase domestic mineral production and reduce their reliance on imports.[59] Today, many countries are doing the same for economic and geopolitical reasons.[60] Therefore, the

USG should prioritize onshoring mineral production over friendshoring.

The Outlook for U.S. Mineral Security—and U.S. Military Power

Minerals influence war. In 1949, U.S. Bureau of Mines Director James Boyd said,

> The strength or weakness of our raw materials position, in respect to certain essential minerals, may well determine the status of our country as a world power in the years to come. Our national potential in both peace and war is intrinsically bound to the availability of minerals because many of them are the foundation of our industrial and technologic structure.[61]

Minerals undergird industrial and technological power, which undergirds military power, ultimately affecting great power wars.[62] Previously, the United States was the world's leading mineral power; today, China is.[63]

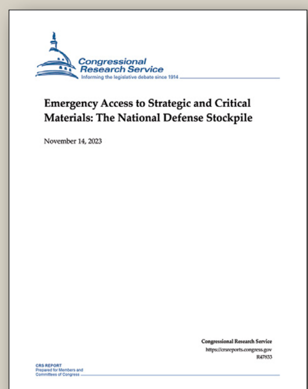
If a U.S.-China war occurs, the U.S. military will likely face mineral shortages. The United States already has limited mineral stockpiles, low domestic mineral production, and heavy mineral import reliance from China, its geopolitical rival. The United States would consume significant mineral volumes for increased defense production in a war, and it would face disrupted mineral imports from expanded export controls and contested shipping routes, posing mineral shortage risks. The USG should stockpile more minerals, incentivize domestic mineral production, and restrict mineral imports from China to mitigate such shortage risks.

Mineral shortages could prove disastrous for the United States, given the serious—sometimes decisive—role of minerals in war.[64] In its last three great power wars—World War I, World War II, and the Korean War—the United States lacked sizable mineral stockpiles but was the world's dominant mineral producer. Still, it experienced mineral shortages. Following these wars, U.S. officials highlighted the importance of minerals in wartime, urging the country to pursue mineral independence and self-sufficiency.[65] Yet, the United States now has a relatively weak mineral base and faces the possibility of a major war against a minerally superior adversary. Past wars indicate that the United States risks defeat if such a war occurs.

In this case, the words of U.S. Bureau of Mines Director R. R. Sayers in 1941 may be particularly prescient.

> Events in 1940 have demonstrated again that in this age of mechanization minerals are indeed the sinews of war. The British have shown that valor can offset, to a remarkable extent, the advantages of superior armament and munitions; but the experience of Finland, Belgium, Greece, and others has revealed the ineffectiveness of heroic men against an avalanche of iron, manganese, aluminum, and petroleum utilized in tanks and airplanes, bullets and bombs.[66]

But instead of Finland, Belgium, and Greece succumbing to Germany's mineral superiority in World War I, Taiwan, Japan, and the United States may succumb to China's mineral superiority in a U.S.-China war. ■


Congressional Research Service

Emergency Access to Strategic and Critical Materials: The National Defense Stockpile

November 14, 2023

Military Review Recommends

The Department of Defense manages the National Defense Stockpile (NDS) and has delegated authority as the NDS manager to release stockpiled materials to eligible domestic manufacturers in the defense industrial base and other critical infrastructure sectors under certain conditions. This report, *Emergency Access to Strategic and Critical Materials: The National Defense Stockpile*, provides background on this NDS and analyzes selected issues that Congress may face related to its management.

To read this report online, visit https://crsreports.congress.gov/product/pdf/R/R47833.

Notes

1. Kenneth A. Kessel, *Strategic Minerals: U.S. Alternatives* (Washington, DC: National Defense University Press, 1990), 52, https://apps.dtic.mil/sti/pdfs/ADA229895.pdf.

2. See Jack S. Levy, "Historical Trends in Great Power War, 1495-1975," *International Studies Quarterly* 26, no. 2 (1982): 285, https://doi.org/10.2307/2600652. Levy lists the following as great powers wars in which the United States has participated: War of the American Revolution, World War I, World War II, and Korean War.

3. C. K. Leith, "Mineral Resources and Peace," *Foreign Affairs* 16, no. 3 (April 1938): 515–16, https://doi.org/10.2307/20028870.

4. 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 diss., Pennsylvania State College, 1949), iv, https://scholarsphere.psu.edu/resources/f6527d5d-8bc0-4c98-8c7d-4a21b0a69685.

5. Clifton G. Chappell, Roderick Gainer, and Kristin Guss, "An Organizational History of the Defense National Stockpile Center: America's National Stockpile" (Fort Belvoir, VA: Defense Logistics Agency [DLA], n.d.), 17, https://www.dla.mil/Portals/104/Documents/Strategic%20Materials/DNSC%20History.pdf.

6. Joseph B. Umpleby, "The Position of the United States 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, 1919), 288, https://books.google.com/books/about/The_Strategy_of_Minerals.html?id=h4xu6ENaSi4C.

7. Leith, "Mineral Resources and Peace," 516; C. K. Leith, "The Struggle for Mineral Resources," *Annals of the American Academy of Political and Social Science* 204, no. 1 (1939): 48, https://doi.org/10.1177/000271623920400107.

8. Allan F. Matthews, ed., "Review of the Mineral Industries in 1949," in *Minerals Yearbook, 1949* (Washington, DC: U.S. Government Printing Office [GPO], 1951), 10, https://digital.library.wisc.edu/1711.dl/LL364NRQA5IFL8W; James Boyd, foreword to Matthews, *Minerals Yearbook, 1949*, iii.

9. Gregory Wischer and Morgan Bazilian, "The Rise of Great Mineral Powers," *Journal of Indo-Pacific Affairs* 7, no. 2 (March-April 2024): 167–68, https://media.defense.gov/2024/Mar/11/2003410998/-1/-1/1/VIEW%20-%20WISCHER%20&%20BAZILIAN.PDF/VIEW%20-%20WISCHER%20&%20BAZILIAN.PDF. The Institute for Defense Analyses writes, "[S]tockpiling in earnest really did not begin until 1950." See James S. Thomason et al., "Strategic and Critical Non-Fuel Materials and the National Defense Stockpile" (Alexandria, VA: Institute for Defense Analyses, September 1996), 12, https://apps.dtic.mil/sti/pdfs/ADA316714.pdf.

10. Steven M. Fortier et al., "Comparison of U.S. Net Import Reliance for Nonfuel Mineral Commodities—A 60-Year Retrospective (1954–1984–2014)" (Reston, VA: U.S. Geological Survey [USGS], December 2015), 1, https://pubs.usgs.gov/fs/2015/3082/fs20153082.pdf; Nedal T. Nassar, Elisa Alonso, and Jamie L. Brainard, "Investigation of U.S. Foreign Reliance on Critical Minerals—U.S. Geological Survey Technical Input Document in Response to Executive Order No. 13953 Signed September 30, 2020" (Reston, VA: USGS, 7 December 2020), 1, https://pubs.usgs.gov/of/2020/1127/ofr20201127.pdf.

11. Nassar, Alonso, and Brainard, "Investigation of U.S. Foreign Reliance on Critical Minerals," 2.

12. Brian W. Jaskula, "Gallium," in *Mineral Commodity Summaries 2024* (Reston, VA: USGS, January 2024), 74–75, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-gallium.pdf; Ji-Eun Kim, "Manganese," in USGS, *Mineral Commodity Summaries 2024*, 116–17, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-manganese.pdf; Chad A. Friedline, "Niobium (Columbium)," in USGS, *Mineral Commodity Summaries 2024*, 126–27, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-niobium.pdf; Chad A. Friedline, "Tantalum," in USGS, *Mineral Commodity Summaries 2024*, 176–77, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-tantalum.pdf.

13. USGS, *Mineral Commodities Summaries 2024*, 6.

14. Cameron Keys, *Emergency Access to Strategic and Critical Materials: The National Defense Stockpile*, Congressional Research Service (CRS) Report No. R47833 (Washington, DC: U.S. CRS, 14 November 2023), https://crsreports.congress.gov/product/pdf/R/R47833.

15. Ibid., 9.

16. E. W. Pehrson, "Review of the Mineral Industries in 1942," in *Minerals Yearbook, 1942*, ed. C. E. Needham (Washington, DC: U.S. GPO, 1943), 19, https://digital.library.wisc.edu/1711.dl/POA2SM44KGB3I8X; Erna Risch, *The Quartermaster Corps: Organization, Supply, and Services*, vol. 1 (Washington, DC: U.S. GPO, 1953), 60, https://history.army.mil/html/books/010/10-12/CMH_Pub_10-12-1.pdf.

17. E. W. Pehrson, "Our Mineral Resources and Security," *Foreign Affairs* 23, no. 4 (1945): 644, https://doi.org/10.2307/20029929.

18. James Boyd, "Our Strategic Minerals Resources" (address, 14th Annual Seminar of the California Institute of Technology Alumni Association, Pasadena, CA, 14 April 1951), 22, https://calteches.library.caltech.edu/1193/1/Minerals.pdf.

19. David C. Gompert, Astrid Stuth Cevallos, and Cristina L. Garafola, *War with China: Thinking Through the Unthinkable* (Santa Monica, CA: RAND Corporation, 2016), 72–73, https://www.rand.org/pubs/research_reports/RR1140.html.

20. Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, *The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan* (Washington, DC: Center for Strategic and International Studies, January 2023), 88, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ.

21. Kent Hughes Butts, *Strategic Minerals in the New World Order* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 30 November 1993), 2, https://apps.dtic.mil/sti/tr/pdf/ADA274394.pdf.

22. Edwin J. Clapp, "Chapter XII: The Import Situation," chap. 11 in *Economic Aspects of the War: Neutral Rights, Belligerent Claims and American Commerce in the Years* (New Haven, CT: Yale University Press, 1915), https://net.lib.byu.edu/estu/wwi/comment/Clapp/Clapp5.htm.

23. Jaskula, "Gallium," in USGS, Mineral Commodity Summaries 2024, 74–75; Amy C. Tolcin, "Germanium," in USGS, *Mineral Commodity Summaries 2024*, 80–81, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-germanium.pdf; Andrew A. Stewart, "Graphite (Natural)," in USGS, *Mineral Commodity Summaries 2024*, 84–85,

https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-graphite.pdf; "China to Restrict Exports of Chipmaking Materials as US Mulls New Curbs," Reuters, 3 July 2023, https://www.reuters.com/markets/commodities/china-restrict-exports-chipmaking-materials-us-mulls-new-curbs-2023-07-04/; 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/world/china/china-require-export-permits-some-graphite-products-dec-1-2023-10-20/.

24. "Announcement No. 46 of 2024 of the Ministry of Commerce on Strengthening Export Control of Relevant Dual-Use Items to the United States," Ministry of Commerce of the People's Republic of China, 3 December 2024, https://www.mofcom.gov.cn/zwgk/zcfb/art/2024/art_3d5e990b43424e60828030f58a547b60.html.

25. Przemyslaw Kowalski and Clarisse Legendre, "Raw Materials Critical for the Green Transition: Production, International Trade and Export Restrictions" (Paris: Organization for Economic Cooperation and Development, April 2023), 51, https://doi.org/10.1787/c6bb598b-en.

26. Morgan, "The Domestic Mining Industry of the United States in World War II," 412.

27. Mary C. Rabbitt, *Minerals, Lands, and Geology for the Common Defence and General Welfare, Volume 3, 1904–1939* (Washington, DC: U.S. GPO, 1986), 168, https://pubs.usgs.gov/book/1986/rabbitt-vol3/report.pdf; E. W. Pehrson, "Review of the Mineral Industries in 1941," in *Minerals Yearbook, 1941*, ed. F. M. Shore (Washington, DC: U.S. GPO, 1943), ix, https://digital.library.wisc.edu/1711.dl/VZLKWT7LNXCK39B.

28. Robert H. Ridgway, Allan F. Matthews, and A. W. Mitchell, "Sulfur and Pyrites," in *Minerals Yearbook Review of 1940*, ed. H. D. Keiser (Washington, DC: U.S. GPO, 1941), 1256, https://digital.library.wisc.edu/1711.dl/NL3GAHUQMHTGL8Q.

29. Economist Intelligence Unit (EIU), *Conflict over Taiwan: Assessing Exposure in Asia* (London: EIU, 2023), 1, https://www.eiu.com/n/campaigns/asia-exposure-to-a-conflict-over-taiwan/; USGS, *Mineral Commodities Summaries 2024*, 7.

30. USGS, *Mineral Commodities Summaries 2024*, 7.

31. Ibid., 7–8, 23; John H. Noer, *Maritime Economic Interests and the Sea Lines of Communication through the South China Sea: The Value of Trade in Southeast Asia* (Alexandria, VA: Center for Naval Analyses, March 1996), 7, 13, https://apps.dtic.mil/sti/pdfs/ADA362458.pdf; EIU, *Conflict over Taiwan*, 2–3, 5.

32. Richard A. Bitzinger, "Why Beijing Is Militarizing the South China Sea," *Asia Times*, 10 May 2018, https://asiatimes.com/2018/05/why-beijing-is-militarizing-the-south-china-sea/.

33. Edson S. Bastin, "Minor Metals," in Smith, *The Strategy of Minerals*, 207.

34. Umpleby, "The Position of the United States among the Nations," in Smith, *The Strategy of Minerals*, 288; Leith, "Mineral Resources and Peace," 516; Boyd, foreword to Matthews, *Minerals Yearbook, 1949*, iii; Pehrson, "Our Mineral Resources and Security," 653.

35. Fortier et al., "Comparison of U.S. Net Import Reliance for Nonfuel Mineral Commodities," 1; Nassar, Alonso, and Brainard, "Investigation of U.S. Foreign Reliance on Critical Minerals," 1.

36. William S. Kirk, "Cobalt," in *Minerals Yearbook, 1987: Volume 1* (Washington, DC: U.S. GPO, 1989), 277, https://digital.library.wisc.edu/1711.dl/PCUAWIWNUXSEF9A.

37. Boyd, "Our Strategic Minerals Resources," 18–20.

38. Paul Manalo, "Discovery to Production Averages 15.7 Years for 127 Mines," S&P Global, 6 June 2023, https://www.spglobal.com/marketintelligence/en/news-insights/research/discovery-to-production-averages-15-7-years-for-127-mines.

39. Joseph E. Pogue, "Mineral Resources in War and Their Bearing on Preparedness," *The Scientific Monthly* 5, no. 2 (1917): 128, http://www.jstor.org/stable/22641.

40. Ibid., 122, 128.

41. Ibid., 122.

42. For current National Defense Stockpile inventories, see Keys, *Emergency Access to Strategic and Critical Materials*, 43–44.

43. "Annual Materials Plan for FY 2024," DLA Strategic Materials, 3 October 2023, https://www.dla.mil/Portals/104/Documents/Strategic%20Materials/Announcements/3239%20FY24%20AMP_ACQ.pdf.

44. Institute for Defense Analyses, *Key Materials for High-Priority Weapon Systems, and Assessing Risks to Their Supply: A Report for the U.S. Defense National Stockpile Center* (Alexandria, VA: Institute for Defense Analyses, 31 July 2008), in *Reconfiguration of the National Defense Stockpile Report to Congress* (Washington, DC: U.S. Department of Defense, April 2009), B-2, https://www.scribd.com/document/16483302/Reconfiguration-of-the-National-Defense-Stockpile-Report-to-Congress; Daniel M. Flanagan, "Copper," in USGS, *Mineral Commodity Summaries 2024*, 64–65, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-copper.pdf; Kateryna Klochko, "Lead," in USGS, *Mineral Commodity Summaries 2024*, 106–7, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-lead.pdf; Michele E. McRae, "Fluorspar," in USGS, *Mineral Commodity Summaries 2024*, 72–73, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-fluorspar.pdf.

45. Office of Emergency Planning, *Stockpile Report to Congress, January–June 1961* (Washington, DC: Executive Office of the President, 1961), 5, https://books.google.com/books?id=R4YBn0zv2DQC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false; "About Strategic Materials," DLA, accessed 17 June 2024, https://www.dla.mil/Strategic-Materials/About/.

46. Keys, *Emergency Access to Strategic and Critical Materials*, 14, 22. The Department of Defense provides this combat scenario to the Institute for Defense Analyses, which assesses stockpile requirements.

47. National Security Council (NSC), *A Report to the National Security Council by the Executive Secretary (Lay) on United States Objectives and Programs for National Security*, NSC Paper 68 (Washington, DC: NSC, 14 April 1950), https://history.state.gov/historicaldocuments/frus1950v01/d85; Thomason et al., "Strategic and Critical Non-Fuel Materials and the National Defense Stockpile," 13; Keys, *Emergency Access to Strategic and Critical Materials*, 10.

48. National Defense Authorization Ace for Fiscal Years 1988 and 1989, Public L. No. 100-180, § 1246, 101 Stat. 1019 (4 December 1987), https://www.congress.gov/100/statute/STATUTE-101/STATUTE-101-Pg1019.pdf.

49. Loan Programs Office, "Sector Spotlight: Critical Materials," U.S. Department of Energy, 29 March 2024, https://www.energy.gov/lpo/articles/sector-spotlight-critical-materials; Office of Manufacturing and Energy Supply Chains, "Battery Materials Processing Grants," U.S. Department of Energy, accessed 17 March 2024, https://www.energy.gov/mesc/battery-materials-processing-grants; Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD A&S), "Defense Production Act

Investments," LinkedIn, 15 November 2023, https://www.linkedin.com/posts/ousd-as_defense-production-act-investments-activity-7132757979564539904-l7QB; "MCEIP Investment Areas," OUSD A&S, archived 24 December 2023 at the Wayback Machine, https://web.archive.org/web/20231224055139/https://www.businessdefense.gov/ibr/mceip/docs/ir/MCEIP-Investment-Areas.pdf.

50. "Treasury Releases Proposed Guidance to Continue U.S. Manufacturing Boom in Batteries and Clean Vehicles, Strengthen Energy Security," U.S. Department of the Treasury, 1 December 2023, https://home.treasury.gov/news/press-releases/jy1939.

51. Daniel J. Cordier, "Yttrium," in USGS, *Mineral Commodity Summaries 2024*, 198–99, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-yttrium.pdf.

52. U.S. Department of the Treasury, "Treasury Releases Proposed Guidance."

53. The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017* (Washington, DC: The White House, June 2021), 8, https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf. U.S. Treasury Secretary Janet Yellen said, "Friend-shoring is about deepening relationships and diversifying our supply chains with a greater number of trusted partners to lower risks for our economy and theirs." See Christopher Condon, Heejin Kim, and Sam Kim, "Yellen Touts 'Friend-Shoring' as Global Supply Chain Fix," Bloomberg, 18 July 2022, https://www.bloomberg.com/news/articles/2022-07-18/yellen-touts-friend-shoring-as-fix-for-global-supply-chains. For articles on friendshoring critical mineral supply chains, see Vlado Vivoda, "Friend-Shoring and Critical Minerals: Exploring the Role of the Minerals Security Partnership," *Energy Research & Social Science* 100 (2023): Article 103085, https://doi.org/10.1016/j.erss.2023.103085; Bentley Allan, Noah Gordon, and Cathy Wang, "Friendshoring Critical Minerals: What Could the U.S. and Its Partners Produce?," Carnegie Endowment for International Peace, 3 May 2023, https://carnegieendowment.org/2023/05/03/friendshoring-critical-minerals-what-could-u.s.-and-its-partners-produce-pub-89659; Samantha DeCarlo and Anna Perry, "Why Can't We be Friends? Friendshoring the REE Supply Chain," U.S. International Trade Commission, accessed 17 June 2024, https://www.usitc.gov/publications/332/executive_briefings/ebot_friendshoring_ree.pdf.

54. Central Intelligence Agency (CIA), "Canada" (Langley, VA: CIA, 5 May 1950), 27, https://www.cia.gov/readingroom/docs/CIA-RDP78-01617A001700050001-7.pdf.

55. "Minerals Security Partnership," U.S. Department of State, accessed 17 June 2024, https://www.state.gov/minerals-security-partnership/; "Memorandum on the Partnership for Global Infrastructure and Investment," The White House, 26 June 2022, https://www.whitehouse.gov/briefing-room/presidential-actions/2022/06/26/memorandum-on-the-partnership-for-global-infrastructure-and-investment/; "Australia-United States Climate, Critical Minerals and Clean Energy Transformation Compact," The White House, 20 May 2023, https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/australia-united-states-climate-critical-minerals-and-clean-energy-transformation-compact/; "Agreement between the Government of Japan and the Government of the United States of America on Strengthening Critical Minerals Supply Chains," Office of the United States Trade Representative, 28 March 2023, https://ustr.gov/sites/default/files/2023-03/US%20Japan%20Critical%20Minerals%20Agreement%202023%2003%2028.pdf; "The United States Releases Signed Memorandum of Understanding with the Democratic Republic of Congo and Zambia to Strengthen Electric Vehicle Battery Value Chain," U.S. Department of State, 18 January 2023, https://www.state.gov/the-united-states-releases-signed-memorandum-of-understanding-with-the-democratic-republic-of-congo-and-zambia-to-strengthen-electric-vehicle-battery-value-chain/; "United States and Canada Finalize Action Plan on Critical Minerals Cooperation," U.S. Department of State, 9 January 2020, https://ca.usembassy.gov/united-states-and-canada-finalize-action-plan-on-critical-minerals-cooperation/.

56. For project updates for the Mineral Security Partnership, see Ellen Milligan, "US Turns to Private Investment for Minerals Projects," Bloomberg, 5 October 2023, https://www.bloomberg.com/news/articles/2023-10-05/us-turns-to-private-investment-for-critical-mineral-projects. For project updates for the Partnership for Global Infrastructure and Investment, see "Fact Sheet: Partnership for Global Infrastructure and Investment at the G7 Summit," The White House, 20 May 2023, https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/fact-sheet-partnership-for-global-infrastructure-and-investment-at-the-g7-summit/.

57. Yvonne Yue Li, "US Gives $50 Million Boost to Critical Minerals Investor TechMet," Bloomberg, 1 December 2023, https://www.bloomberg.com/news/articles/2023-12-01/us-gives-50-million-boost-to-critical-minerals-investor-techmet.

58. Morgan, "The Domestic Mining Industry of the United States in World War II," 412.

59. Alfred E. Eckes Jr., *The United States and the Global Struggle for Minerals* (Austin: University of Texas Press, 1979), 28–31, https://books.google.com/books?id=4zrPDAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

60. Jared Cohen, Wilson Shirley, and Klara Svensson, "Resource Realism: The Geopolitics of Critical Mineral Supply Chains," Goldman Sachs, 13 September 2023, https://www.goldmansachs.com/intelligence/pages/resource-realism-the-geopolitics-of-critical-mineral-supply-chains.html.

61. James Boyd, "Strategic Mineral Resources for National Security," *Military Engineer* 41, no. 282 (1949): 261, http://www.jstor.org/stable/44564718.

62. Leith, "The Struggle for Mineral Resources," 42.

63. USGS, Mineral Commodities Summaries 2024, 23; Mark Burton, "Why the Fight for 'Critical Minerals' Is Heating Up," Bloomberg, 20 November 2023, https://www.bloomberg.com/news/articles/2023-11-20/critical-minerals-china-s-dominance-as-supplier-is-a-problem-for-the-west.

64. Pehrson, "Our Mineral Resources and Security," 644.

65. Franklin K. Lane, introduction to Smith, T*he Strategy of Minerals*, xx; Mary C. Rabbitt and Clifford M. Nelson, *Minerals, Lands, and Geology for the Common Defence and General Welfare, Volume 4, 1939–1961* (Reston, VA: USGS), 9, https://pubs.usgs.gov/book/2015/rabbitt-vol4/pdf/vol4_chapter2.pdf; Dwight D. Eisenhower, "Letter to Secretary of the Interior McKay Establishing a Cabinet Committee on Minerals Policy," American Presidency Project, 26 October 1953, https://www.presidency.ucsb.edu/documents/letter-secretary-the-interior-mckay-establishing-cabinet-committee-minerals-policy.

66. R. R. Sayers, foreword to Keiser, *Minerals Yearbook Review of 1940*, iii.