

A fighter jet, likely an F-35, is shown in flight over a vast, snow-covered mountain range. The jet is white with dark grey accents and has the tail code 'AK' and 'AF 295' visible. The background shows a clear blue sky and the rugged peaks of the mountains.

# Securing U.S. Access to Rare Earth Elements

By Tobin Hansen

MARCH 2020

## THE ISSUE

*Control over the production of critical minerals necessary for advanced defense and commercial manufacturing processes is a new feature of the escalating tensions between the United States and China over trade and security. This report explores the state of the supply chain for global critical materials—specifically rare earth elements (REEs)—and the near-monopoly that China holds over it. Additionally, it identifies unique aspects of the critical mineral production process that makes the supply chain particularly difficult to preserve and evaluates ongoing efforts by U.S. industry and policymakers to create a reliable critical minerals supply chain. The report concludes by assessing the likelihood that China cuts off U.S. access to their production capabilities and how effective current U.S. countermeasures are in preserving access to rare earth elements.*

In December, the U.S. Army signaled its intention to fund new rare earth processing facilities. According to reports, the Army is currently reviewing proposals from various U.S. mining companies, which may have up to two thirds of their project costs covered by the military.<sup>1</sup> This move comes after President Xi Jinping and other Chinese officials signaled in May 2019 that they may open a new domain in the trade war with the United States by restricting access to Chinese critical minerals.<sup>2</sup> “Critical minerals” are a set of 35 minerals that are both crucial to advanced manufacturing and subject to significant supply chain risks.<sup>3</sup> The critical minerals list includes 17 rare earth elements (REEs).

REEs are used primarily to create two types of powerful and heat-resilient magnets: samarium cobalt magnets and neodymium iron boron magnets. Among other applications, these types of magnets are essential parts

of military weapon systems, such as guidance and control systems, defense electronic warfare devices, electric motors, and communications systems.<sup>4</sup>

China supplies approximately 80 percent of U.S. REE raw material imports and nearly all imports for other critical minerals such as yttrium, gallium, and tungsten.<sup>56</sup> Estonia is the second largest supplier of REE to the United States, providing 6 percent of U.S. imports.<sup>7</sup> In recent years, U.S. policymakers have grown concerned that China could use its market power to cut off the flow of REEs into the United States, simultaneously compromising manufacturing and halting defense production.

A 2016 Department of Commerce survey of U.S. producers within the REE supply chain found that 66 of the 160 respondents imported REE components, and 28 respondents imported solely from China.<sup>8</sup>

Approximately 40 percent of those surveyed were vendors to the U.S. military.<sup>9</sup> The 2018 DoD Industrial Base Resiliency Report concluded that this dependence on Chinese REEs forces the industrial base to choose between supply dependence on China or elevated costs. The imposition of quotas or an outright embargo on these minerals by China could either halt or drastically raise the costs of some U.S. defense acquisition programs. In 2010, China showed its willingness to exploit its share of the global supply by restricting Japanese access to REEs following a dispute over Senkaku Islands.<sup>10</sup>

With Chinese warnings of potential export restrictions, U.S. policymakers have scrambled to assess the true threat posed by the current global rare earth supply chain. Three questions emerge from this recent interest in REEs: How detrimental would a quota or embargo on critical minerals from China be to U.S. defense and commercial manufacturing? Are current countermeasures to protect the supply chain effective? And what viable options are available to diversify or otherwise strengthen the supply chain of critical minerals and REEs?

## BACKGROUND

Deposits of rare earth elements are admittedly not rare nor specifically located like oil. They exist in many countries, albeit in a diffuse manner that makes the mining of them often economically untenable.

The United States was formerly a global supplier of rare earth elements until China's ascent to dominate the rare

earth market in 1992. Coupled with added regulatory constraints on most non-Chinese producers, market share drastically shifted away from the United States and towards China as it became the most cost-efficient location for REE mining.<sup>11</sup> Efficiency creates its own costs as Chinese laborers in mining regions suffer high cancer rates and teeth corrosion from the radioactive residue created by REE mining.<sup>12</sup>

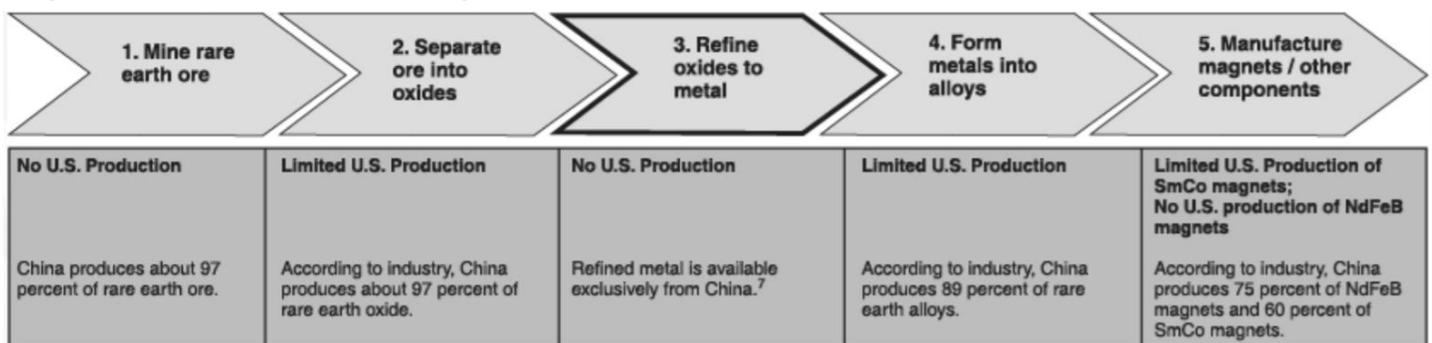
The last straw was the closure of the largest U.S. rare earth mine at the California Mountain Pass mine in 2002. While added regulations disadvantage U.S. rare earth producers, under the new management of the U.S. company, MP Materials, the mine is restarting production but even now must rely on China to process the ore, another concern as discussed in the next section.

## EVALUATING THE CURRENT THREAT TO U.S. ACCESS

The REE supply chain extends far beyond mining before becoming useful manufacturing components. The supply chain, and the lack of U.S. capacity in each step is outlined in Figure 1 from a 2010 Government Accountability Office briefing. Additionally, the capital intensity of both the mining and processing steps impose a significant time-lag in response to market forces.

The complexity of the supply chain allows China to possess a near-monopoly over various segments of the production process. Attention focuses on China's share of REE ore production, but China also exerts significant

Figure 1. Example of Permanent-Magnet Rare Earth Supply Chain



(Note: The United States now mines ore through the Mountain Pass facility. Source: Figure taken from GAO-10-617R *Rare Earth Materials in the Defense Supply Chain* (2010) and developed based on Government Accountability Office analysis of industry data.)

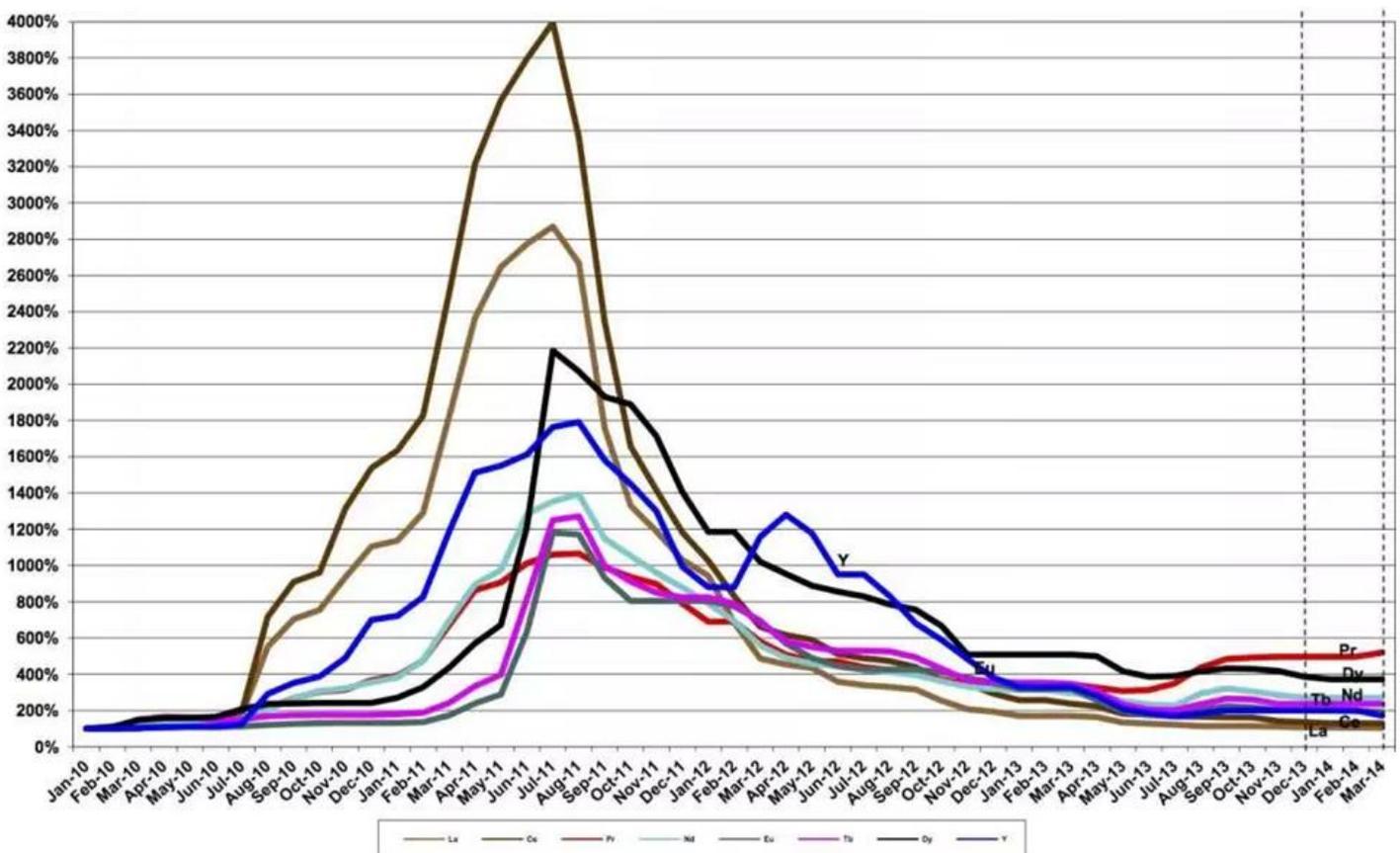
control over the extraction, oxidation, and refinement processes. Even if the United States finds other sources for REE ore, there are not currently available substitutes for China’s downstream processing.<sup>13</sup> While alternative international processing facilities exist, almost every critical mineral supply chain includes China in some stage of production.<sup>14</sup> As noted previously, the development of alternative supply chains would entail significant delay. The most recent action by the U.S. Army initiates a process to create new U.S. capacity in the refining step of the supply chain. A 2010 GAO report estimated that creating a new facility takes 10 to 15 years due to capital requirements and complex permitting.<sup>15</sup> Permitting delays are partially driven by the toxic and radioactive wastes created through processing these minerals. Such risks make environmentally certifying such projects nearly as challenging as finding communities willing to host such a facility.

Some analysts note that while industrial capacity is slow to respond to market pressures, there are enough supply alternatives to avoid catastrophe in the event of a prolonged quota or embargo. In a 2014 report for the Council on Foreign Relations, Eugene Gholz evaluated the 2010 Japan case study and concluded that it was less of a crisis than “alarmists” often find.<sup>16</sup>

According to Gholz’s analysis, when China imposed restrictions and raised prices, non-Chinese suppliers saw an opportunity and invested in new facilities, initiating the reopening of the Mountain Pass mine. Despite export restrictions, Chinese companies continued seeking profit and 15 to 30 percent of total Chinese exports were smuggled to buyers.<sup>17</sup> The quantities demanded by high-priority consumers such as the U.S. military could be met by these marginal adjustments, albeit at top prices.<sup>18</sup>

Many of these adjustments could be made in the event of sanctions against the United States, though

Figure 2. Rare Earth Index Prices: (% based on January 2010 prices)



(Source: Figure taken from “Molycorp, the Poster Child for What Was One a ‘Can’t Lose’, Is Filing for Bankruptcy,” *Financial Post*, June 25, 2015, and developed originally by Molycorp based on Metal-Prices, FOB China min sources.)

additional factors must also be considered. If an embargo were accompanied by full-scale conflict, the shipping routes that provide alternatives could be unavailable and global demand would surge as supply constricts. The accompanying price shock would likely exceed the increase observed following the 2010 Japan incident, as shown in Figure 2. Such price fluctuations would have dire effects on planning and executing defense procurement programs, in addition to the consumer and commercial ramifications. The best case under Gholz's assumptions still entails volatile pricing and a reliance on black-markets for sourcing at least some of the U.S. military's priorities. Gholz's observations provide some room for optimism and possibly a reason to curb concern, though not enough to endorse passivity or a reliance on market forces alone.

## EXISTING EFFORTS

The countermeasures in place to protect the integrity of critical mineral-reliant supply chains fail to consider the breadth of China's monopoly. The two most visible countermeasures are the inclusion of import restrictions in some of the annual defense authorization bills, which ban the Pentagon from acquiring rare earth magnets from China, Russia, Iran, and North Korea, and the National Defense Stockpile.<sup>19</sup>

Similar to Gholz's observations of the restrictions China implemented in 2010, previous import restrictions have proven difficult to administer, and these rules are usually broken or relaxed. In the F-35 program, contractors received waivers for these import requirements. In other instances, suppliers continued using critical minerals that had no known sources outside of China, implying restriction breaches occurred.<sup>20</sup>

The National Defense Stockpile challenge is two-fold. In the 1990s, much of the REE stockpile was sold. In FY 2018, the National Defense Stockpile resumed purchasing REEs, though the reserve is still minimal and will require continued investment to become a viable backstop. Secondly, the National Defense Stockpile primarily contains minerals in pre-processed form, which would still require the involvement of Chinese

refining capabilities to turn into usable components.<sup>21</sup> However, the National Defense Stockpile recently began acquiring rare earth magnet feedstock, moving the reserves closer to a usable state.<sup>22</sup>

The Chinese near-monopoly *throughout* the supply chain undermines both the National Defense Stockpile and import restriction countermeasures. The U.S. defense industry is still vulnerable to Chinese geoeconomic statecraft unless there is a reliable, vertically integrated supply chain among the United States and partner nations.

## NEW PROPOSALS

### Congress

Both Congress and the Trump administration have proposed measures that would provide advantages to the domestic mining industry and seek to broaden U.S. access to new supplies of critical minerals. Senator Marco Rubio (R-FL), proposed a bill in July 2019 that would allow mining operations to circumvent antitrust laws in order to compete with low Chinese prices. Senator Lisa Murkowski (R-ME), Chairwoman of the Senate Committee on Energy and Natural Resources, introduced a bipartisan bill with several Democratic co-sponsors, including Ranking Member Joe Manchin (D-WV), that seeks to streamline permitting to expedite the creation of new rare earth mines in the United States.<sup>23</sup>

Senator Tom Udall (D-NM) and Representative Raul Grijalva (D-AZ) introduced their own proposal which would reduce mine exploration on federal lands and introduce the same royalty excise tax to mining that currently applies to the oil and gas industries.<sup>24</sup> The environmental concerns of these lawmakers have merit, given that the Mountain Pass mine closed in 2002 due to a toxic spill. Regions near rare earth mines in China are also experiencing ongoing environmental damage due to loose regulations.<sup>25</sup>

However, this proposal does not move the U.S. toward a reliable critical minerals supply chain. While the expediting of mine permitting must be executed deftly to avoid overly loose oversight that leads to environmental catastrophe, Canada maintains similar

environmental regulations as the United States but has an estimated permitting timeline of 1 to 2 years rather than the U.S. average of 5 to 10 years.<sup>26</sup> These proposals provide the goalposts for possible bipartisan work towards a secure rare earth supply chain.

## The White House

On July 22, 2019, the Trump administration used authority from the Defense Production Act to declare various rare earth elements and magnets as “essential to the national defense.” In doing so, the administration laid the groundwork for the provision of subsidies to rare earth mining companies.<sup>27</sup> If such support materializes, domestic industry would benefit but also risks becoming overly buttressed by subsidies in the event of a Chinese price drop. The Mountain Pass mine experienced this after it was revived during the 2010-2011 price spike and declared bankruptcy in 2015 when prices fell again.<sup>28</sup>

A recommendation from a 2018 Department of Defense report also points towards coordination with allies to address joint industrial base challenges.<sup>29</sup> This proposal holds promise and is one of the opportunities that Gholz highlights for mitigating rare earth supply chain risk. Australia and Japan are emerging sources of rare earth materials, which contract with a handful of firms in Malaysia, Estonia, France, and Thailand to complete the various processing steps.<sup>30</sup>

The domestic front also shows progress. MP Materials, the company that owns Mountain Pass, is expected to begin processing Neodymium and Praseodymium into magnets in late 2020.<sup>31</sup> Meanwhile, a new deal between the largest non-China REE mine, Australian Lynas Corporation, and Texas-based Blue Line will create new U.S. processing facilities by 2021.<sup>32</sup> Pursuing international arrangements may provide access to a supply of critical minerals that satisfies the needs of the U.S. military. However, in the event of a complete stop of REE exports from China, the non-China supply would be insufficient to satisfy the commercial demand of just the U.S. and Japan combined. The United States and Japanese imported a combined 29,014 tons of rare earths in 2013, while non-Chinese production from the

other top ten exporters of rare earth total 23,233 ton.<sup>33</sup> As global demand for rare earths grows alongside demand for electric vehicles and other forms of advanced manufacturing, this shortcoming will only grow.

## CONCLUSION

If China hopes to leverage its near-monopoly in rare earths and critical minerals, it will find the United States woefully unprepared based on the current countermeasures. However, alarmists may overstate the threat posed by Chinese export limitations. The near-monopoly China possesses is driven by economic factors, not natural resource endowment, and the resulting higher prices from an embargo would incentivize further mining and processing investment outside of China. That process is already underway, spurred by China’s threats of restricting access to REEs. By emphasizing this potential point of leverage, China weakens its hand in the long term by encouraging the development of alternative sources. However, if an embargo was instituted immediately, the short-term disruption from export limitation would lead to delays, shortages, and higher costs as critical mineral prices surge. Industrial policy must thread the needle of political feasibility as the government aims to strengthen the U.S. critical mineral supply chain without sacrificing environmental protections or prolonging industry reliance on subsidies. The bipartisan support for addressing China’s rise in the world order creates room to improve these countermeasures through Congressional action. The United States must take advantage of the opportunity created by China’s explicit REE threats to undermine the near-monopoly it faces. For now, the leverage China holds is undeniable, though this leverage is unlikely to remain effective indefinitely.

## Authors

*Tobin Hansen is a former research intern for Defense Budget Analysis in the International Security Program at the Center for Strategic and International Studies.*

## About CSIS

The Center for Strategic and International Studies (CSIS) is a bipartisan, nonprofit policy research organization dedicated to advancing practical ideas to address the world's greatest challenges.

Thomas J. Pritzker was named chairman of the CSIS Board of Trustees in 2015, succeeding former U.S. Senator Sam Nunn (D-GA). Founded in 1962, CSIS is led by John J. Hamre, who has served as president and chief executive officer since 2000.

CSIS's purpose is to define the future of national security. We are guided by a distinct set of values—non-partisanship, independent thought, innovative thinking, cross-disciplinary scholarship, integrity and professionalism, and talent development. CSIS's values work in concert toward the goal of making real-world impact.

CSIS scholars bring their policy expertise, judgment, and robust networks to their research, analysis, and recommendations. We organize conferences, publish, lecture, and make media appearances that aim to increase the knowledge, awareness, and salience of policy issues with relevant stakeholders and the interested public.

CSIS has impact when our research helps to inform the decisionmaking of key policymakers and the thinking of key influencers. We work toward a vision of a safer and more prosperous world.

CSIS is ranked the number one think tank in the United States by the University of Pennsylvania's annual think tank report.

CSIS does not take specific policy positions; accordingly, all views expressed herein should be understood to be solely those of the author(s).

© 2020 by the Center for Strategic and International Studies. All rights reserved.

## About Defense360

The Defense360 microsite is the home for research conducted by experts from the CSIS International Security Program (ISP). Defense360 features reliable, nonpartisan analysis and commentary from ISP experts on key elements of national security policy including strategy, budget, forces, acquisition, and reform. This analysis informs policymakers' decisions on the threats and opportunities shaping U.S. interests at home and abroad.

*Cover Photo: U.S. Marine Corps photo by Cpl. Suzanne Dickson*

## NOTES

<sup>1</sup> Ernest Scheyder, “Exclusive: U.S. Army Will Fund Rare Earths Plant for Weapons Development,” *Reuters*, December 20, 2019, <https://www.reuters.com/article/us-usa-rareearths-army-exclusive/exclusive-u-s-army-will-fund-rare-earths-plant-for-weapons-development-idUSKBN1YF0HU>.

<sup>2</sup> Kelsey Reichmann, “Defense Could Be Cut off from Critical Materials as Trade War Rhetoric with China Grows,” *DefenseNews*, June 1, 2019, <https://www.defensenews.com/pentagon/2019/06/01/defense-could-be-cut-off-from-critical-materials-as-trade-war-rhetoric-with-china-grows/>.

<sup>3</sup> Office of the Interior, Notice, “Final List of Critical Materials 2018,” *Federal Register* 83, no. 97 (May 21, 2018): 23295, <https://www.govinfo.gov/content/pkg/FR-2018-05-18/pdf/2018-10667.pdf>

<sup>4</sup> U.S. Library of Congress, Congressional Research Service, *Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress*, by Valerie Bailey Grasso, R41744 (2013).

<https://fas.org/sgp/crs/natsec/R41744.pdf#page=11>

<sup>5</sup> Office of the Interior, U.S. Geological Survey, *Mineral Commodity Summaries, Rare Earth Elements* (February, 2019), 132-133, <https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-rare.pdf>

<sup>6</sup> U.S. Library of Congress, Congressional Research Service, *Critical Minerals and U.S. Public Policy*, by Marc Humphries, R45810 (2019)

[https://www.everycrsreport.com/files/20190628\\_R45810\\_b3112ce909b130b5d525d2265a62ce8236464664.pdf#page=2](https://www.everycrsreport.com/files/20190628_R45810_b3112ce909b130b5d525d2265a62ce8236464664.pdf#page=2)

<sup>7</sup> Office of the Interior, *Mineral Commodity Summaries*.

<sup>8</sup> Department of Commerce, Bureau of Industry and Security, *U.S. Strategic Material Supply Chain Assessment: Select Rare Earth Elements* (2016),

<https://www.bis.doc.gov/index.php/documents/technology-evaluation/2188-rare-earth-supply-chain-assessment/file#page=9>

<sup>9</sup> *Ibid.*

<sup>10</sup> Keith Bradsher, “Amid Tension, China Blocks Vital Exports to Japan,” *New York Times*, September 22, 2010, <https://www.nytimes.com/2010/09/23/business/global/23rare.html>.

<sup>11</sup> James Kennedy, “China Solidifies Dominance in Rare Earth Processing,” *National Defense Magazine*, March 21, 2019, <https://www.nationaldefensemagazine.org/articles/2019/3/21/viewpoint-china-solidifies-dominance-in-rare-earth-processing>.

<sup>12</sup> Alice Su, “The Hidden Cost of China’s Rare-Earth Trade,” *Los Angeles Times*, July 29, 2019, <https://www.latimes.com/world-nation/story/2019-07-28/china-rare-earth-tech-pollution-supply-chain-trade>.

<sup>13</sup> Ernest Scheyder, “China Set to Control Rare Earth Supply for Years Due to Processing Dominance,” *Reuters*, May 29, 2019,

<https://www.reuters.com/article/us-china-usa-rareearth-refining/china-set-to-control-rare-earth-supply-for-years-due-to-processing-dominance-idUSKCN1T004J>.

<sup>14</sup> Kennedy, “China Solidifies Dominance in Rare Earth Processing.”

<sup>15</sup> U.S. Government Accountability Office, *Rare Earth Materials in the Defense Supply Chain*, (GA)-10-617R (Washington, DC, 2010), <https://www.gao.gov/new.items/d10617r.pdf>

<sup>16</sup> Eugene Gholz, “Rare Earth Elements and National Security” (Council on Foreign Relations, October 2014), [https://www.cfr.org/sites/default/files/pdf/2014/10/Energy%20Report\\_Gholz.pdf](https://www.cfr.org/sites/default/files/pdf/2014/10/Energy%20Report_Gholz.pdf).

<sup>17</sup> *Ibid.*

<sup>18</sup> *Ibid.*

<sup>19</sup> Shane Lasley, “Pentagon Funding Bans China Rare Earths,” *Mining News*, October 24, 2018, <https://www.miningnewsnorth.com/story/2018/08/17/news-nuggets/pentagon-funding-bans-china-rare-earths/5312.html>.

<sup>20</sup> David An, “Critical Rare Earths, National Security, and U.S.-China Interactions” (Pardee Rand Graduate School, 2015), [https://www.rand.org/content/dam/rand/pubs/rgs\\_dissertations/RGSD300/RGSD337/RAND\\_RGSD337.pdf](https://www.rand.org/content/dam/rand/pubs/rgs_dissertations/RGSD300/RGSD337/RAND_RGSD337.pdf).

<sup>21</sup> “Strategic Materials,” Defense Logistics Agency, <https://www.dla.mil/HQ/Acquisition/StrategicMaterials/Materials/>.

<sup>22</sup> Office of the Interior, *Mineral Commodity Summaries*.

<sup>23</sup> “Murkowski, Manchin, Colleagues Introduce Bipartisan Legislation to Strengthen America’s Mineral Security,” *Republican News*, U.S. Senate Committee on Energy and Natural Resources, May 3, 2019,

<https://www.energy.senate.gov/public/index.cfm/2019/5/murkowski-manchin-colleagues-introduce-bipartisan>

<sup>24</sup> “Chair Grijalva, Sen. Udall Introduce Hardrock Mining Reform Legislation to Modernize Mining Royalties, Address Taxpayer-Funded Mine Cleanups,” *News and Media*, Congressman Raul M. Grijalva, May 9, 2019, <https://grijalva.house.gov/press-releases/chair-grijalva-sen-udall-introduce-hardrock-mining-reform-legislation-to-modernize-mining-royalties-address-taxpayerfunded-mine-cleanups/>

<sup>25</sup> Su, “The Hidden Cost of China’s Rare-Earth Trade.”

<sup>26</sup> An, “Critical Rare Earths, National Security, and U.S.-China Interactions.”

<sup>27</sup> Tony Bertuca, “Trump Moves to Ensure Domestic Access to Rare Earth Elements,” *Inside Defense*, July 23, 2019, <https://insidedefense.com/insider/trump-moves-ensure-domestic-access-rare-earth-elements>.

<sup>28</sup> Andrew Topf, “Mountain Pass Sells for \$20.5 Million,” *Mining.Com*, June 16, 2017, <https://www.mining.com/mountain-pass-sells-20-5-million/>.

<sup>29</sup> “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the

United States: Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806,” September 2018,  
<https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF>.

<sup>30</sup> Eugene Gholz, “The Rare Earths Industry Can Weather Any Chinese Trade Battle,” *CNN Business*, July 23, 2019,  
<https://www.cnn.com/2019/07/23/perspectives/rare-earths-china-argentina-trade-war/index.html>.

<sup>31</sup> Matthew Bohlsen, “The U.S. Rare Earths Saga Continues...,” *Investor Intel*, July 22, 2019,  
[\[metals/technology-metals-intel/the-rare-earths-state-of-the-market-july-2019/\]\(https://investorintel.com/sectors/technology-metals/technology-metals-intel/the-rare-earths-state-of-the-market-july-2019/\).](https://investorintel.com/sectors/technology-</a></p></div><div data-bbox=)

<sup>32</sup> Fumi Matsumoto, “US and Australia Team up against China’s Dominance in Rare Earths,” *Nikkei Asian Review*, July 28, 2019,  
<https://asia.nikkei.com/Business/Markets/Commodities/US-and-Australia-team-up-against-China-s-dominance-in-rare-earths>.

<sup>33</sup> Nabeel Mancheri and Tomoo Marukawa, “Rare Earth Elements: China and Japan in Industry, Trade and Value Chain” (Institute of Social Science, University of Tokyo, March 2016),  
<http://threeconsulting.com/pdfs/RareEarthsNabeel.pdf>.