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# Rare Earth Elements: China's Monopoly and Implications for U.S. National Security

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It is the year 2030 and as projected nearly two decades ago, China has risen to be not only a hegemon in the Asia-Pacific region but also a nation capable of significant power projection outside of its normal sphere of influence. China's military has grown in size and capability to a point where it is at near parity with the United States. Confrontations between competing claimants in the South China Sea have increased considerably over the years due to the exploration and now production of both oil and natural gas resources within the area. Additionally, the Association of Southeast Asian Nations (ASEAN) and China were never able to negotiate a final agreement on a code of conduct for operations in the South China Sea, with China preferring a bilateral approach to the issue in order to exert its power more decisively against smaller states. These events have culminated in a crisis in the South China Sea between the Philippines and China over competing claims to the Scarborough Shoal. Repeated Chinese bullying via harassing naval operations against both Philippine commercial and military vessels has prompted the Philippines to seek assistance from

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the United States based on the mutual defense agreement between the two nations. At this point, the United States and China are poised for a possible military confrontation in the South China Sea.

This hypothetical scenario hopefully will never come to fruition; however, it is not inconceivable. In fact, many would argue it is very plausible based on present day Chinese military expenditures, a lack of transparency of Chinese intentions, and ongoing territorial disputes in the South China Sea. The above scenario could be used as a backdrop for a multitude of potential security issues between the United States and China. This article, however, will focus on the single issue of China's monopoly on the production of rare earth elements and the pursuant implications to U.S. national security.

Currently, China produces nearly 95 percent of the global supply of rare earth elements.<sup>1</sup> These elements are critical resources in the manufacturing of both commercial and military goods. Precision guided munitions, engine coatings for fighter aircraft, and ship-building components are just

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a few examples of defense weapons systems that require rare earths.<sup>2</sup> For a nation to rely on a near sole producer of a vital resource is imprudent. This point is especially concerning when put into a contextual framework vis-à-vis the United States and China. Can the United States afford to remain dependent on a potential adversary for a resource that has direct implications on the outcome of a military confrontation? Can the United States find viable

alternatives from either within its borders or from more reliable partners in the global community? Finally, what are the costs with regards to national security?

In order to answer these questions and develop a deeper understanding of the rare earths challenge from a security context, this article will first define rare earth elements, including where they are found, how they are mined and processed into the end-use product, and who currently has the capacity to produce these elements. Next, the article will examine China's monopoly of the industry as well as China's export policies. The 2010 crisis between China and Japan over territorial claims to the Senkaku/Diaoyu Islands illustrates the control China exercises over importing nations who rely on Chinese rare earth elements for commercial manufacturing, and

serves as an example of potential adverse effects of not finding an alternative source. Finally, this piece will scrutinize four potential solutions to release China's stranglehold on the production of rare earths.

## RARE EARTH ELEMENTS

The elements known as rare earths are a series of fifteen elements residing within the periodic table and having an atomic number ranging from fifty-seven to seventy-one.<sup>3</sup> The elements are commonly known as the lanthanides and include lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.<sup>4</sup> Yttrium and scandium are also considered rare earth elements due to their similar chemical and physical properties with the lanthanides.<sup>5</sup>

The term "rare" is somewhat of a misnomer. The lanthanides are not so much as rare in abundance as they are seldom found in large quantities together.<sup>6</sup> This fact makes mining for the elements more difficult and therefore costly with respect to return on investment. Cerium is the most abundant rare earth and is actually more common than copper or lead in the Earth's crust.<sup>7</sup> With the exception of promethium, all of the rare earths are more prominent than silver or mercury.<sup>8</sup> As an example, most rare earths range from 150 to 220 parts per million in the crust versus the more commercially mined elements such as copper (fifty-five parts per million) and zinc (seventy parts per million).<sup>9</sup>

In order to mine and produce rare earth elements, geologists must first locate a base mineral with known rare earth elements-bearing capacity in a commercially viable quantity. Furthermore, it is advantageous to find rare earth elements-bearing minerals in their lowest phase. A phase is defined as having distinct physical and chemical attributes that can be physically separated from a system.<sup>10</sup> Minerals that have multiple phases require more complex separation techniques thus increasing the cost of production.<sup>11</sup> Therefore, minerals consisting of a single phase provide the most cost effective means for producing rare earth elements.<sup>12</sup>

With regards to mining rare earths, bastnasite and monazite are single phase minerals found in the most abundant quantities.<sup>13</sup> A significant downside to monazite, however, is its tendency to contain the radioactive element thorium, which encumbers additional environmental protection and health safety issues.<sup>14</sup> Once the base ore is discovered in sufficient quantity, the ore is extracted and then processed into rare earth oxides (REO). The process for separating the ore into a REO is complex,

requiring the use of acid solutions to dissolve the rare earth ions followed by further processing to separate the rare earths into both heavy and light oxides.<sup>15</sup> REOs are the key element for the production of specific metals, which are in turn manufactured into a number of commercial and defense products.

As previously explained, rare earths exist throughout the planet. However, there are currently only limited locations where the mining and production of rare earths occur. The largest rare earths mines are in China and account for almost 95 percent of the planet's production. The Bayan Obo mine in southern China and the Mountain Pass mine in California are

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the largest known single phase mineral deposits of bastnasite.<sup>16</sup> Proven reserves also exist in Australia, Brazil, Russia, India, Malaysia, and the United States, while other nations account for approximately twenty percent of the remaining reserves.<sup>17</sup> Currently, the only manufacturers of rare earth elements are China, India, Brazil, and Malaysia, in descending order of production.<sup>18</sup> The United States and Australia are in the

process of restarting and developing the production of rare earth elements.<sup>19</sup> This article will later cover in more detail China's current monopoly and the potential growth of the industry outside of China.

## USES OF RARE EARTH ELEMENTS

The concern over access to a secure and reliable supply of rare earths stems from the ubiquitous nature of the commercial and defense sector products made from these elements. These products range from touch screens for iPhones to guidance components on advanced air-to-air missiles. Without a sufficient supply of rare earths, numerous everyday products would no longer be available to the American consumer. More importantly, essential components in U.S. weapons systems would be difficult if not impossible to produce without them.

Rare earths are important in the manufacture of a myriad of products due to their unique ability to readily give up and accept electrons.<sup>20</sup> This property makes them beneficial in many electronic, optical, magnetic, and catalytic applications.<sup>21</sup> Permanent magnets and rare earth phosphors are the most prevalent of the rare earths-based products in today's market.

Permanent magnets incorporate neodymium, praseodymium, dysprosium, and terbium as key elements.<sup>22</sup> Rare earth phosphors use yttrium, europium, terbium, gadolinium, and cerium, which contribute to the brilliant display of colors on flat panel television screens.<sup>23</sup> Additionally, rare earths also aid in fiber optic signal amplification through the incorporation of yttrium, europium, terbium, and erbium.<sup>24</sup> Nickel metal hydride batteries use lanthanum to increase energy storage capacity.<sup>25</sup> Finally, catalytic crackers and convertors employ cerium and lanthanum.<sup>26</sup>

Many rare earth products and technologies possess dual-use attributes, meaning they are used for both commercial and military purposes. In the commercial sector, for example, today's hybrid vehicles employ rare earths permanent magnets in their electric traction drives,<sup>27</sup> which either replace or supplement internal combustion engines in hybrid automobiles, increasing energy efficiency.<sup>28</sup> Additionally, the Toyota Prius has a nickel metal hydride (Ni-MH) battery for energy storage, which increases overall fuel economy.<sup>29</sup> Wind turbines also integrate permanent magnets in gearless generators for better reliability and online performance.<sup>30</sup> The new fluorescent light bulbs on the market utilize rare earth phosphors. These light bulbs consume 70 percent less energy than the older incandescent bulbs.<sup>31</sup> Finally, rare earths are found in automobile catalytic convertors to reduce dangerous emissions of CO<sub>2</sub> and ozone, contributing to a cleaner environment.<sup>32</sup>

Furthermore, dual-use components made from rare earths play a vital role in U.S. national security through defense sector applications. Permanent magnets are incorporated in critical guidance and control mechanisms of U.S.-built weapons, enabling kinetic weapons to impact their target.<sup>33</sup> Today's advanced jet engines are coated with rare earth elements for increased thermal stress resistance.<sup>34</sup> The performance requirements for the engines on the F-22A Raptor and F-35 Joint Strike Fighter (JSF) are extremely stringent based on the environment in which these aircraft routinely operate. Without the added thermal protection rare earths provide, engine performance may be degraded with catastrophic results.

Rare earths technology used in electronics also has numerous defense applications. The same technology used in manufacturing commercial Ni-MH batteries is also found in both electronic warfare systems and directed energy weapons.<sup>35</sup> Examples of their use include smart jammers on advanced U.S. fighter aircraft, area denial weapons systems, and the electromagnetic railgun.<sup>36</sup> All of these weapons require high efficiency battery technology to function properly. Additionally, computer drives manufactured with critical rare earths enable precision weapons systems

to reach their targets, while laser technology depends on the amplification properties of rare earths for targeting.<sup>37</sup> Without these critical components, accuracy would deteriorate, potentially resulting in increased collateral damage and weapons expenditure.

### CHINA'S HOLD ON RARE EARTHS

China has not always been the leader in the mining and production of rare earth elements. Only since the mid-1980s has China become the predominant producer on the global market. Before that time, the United States was the world's largest supplier of rare earths. The decline of U.S. rare earth mining coincided with China's growth, which has contributed to China's stranglehold on the trade. China's appetite for internal consumption of rare earths has also increased due to its booming economy, which is starting to affect availability. With 95 percent of the world's production capacity in China, rare earths are simply not readily available outside of the Chinese market.

The reason for the decline in the U.S. industry was due in part to lower labor costs in China, combined with environmental issues at the Mountain Pass mine, the largest source of U.S. rare earths during this period.<sup>38</sup> The latter issue was over a main wastewater pipeline that did not meet regulatory and environmental standards under U.S. law, leading to a shutdown of the mine.<sup>39</sup> Since that time, a small amount of rare earths has been produced from bastnasite stockpiles that existed prior to the closure.<sup>40</sup> Molycorp reopened the Mountain Pass mine in 2011, and its potential impact on the rare earths industry will be discussed later.

China's ability to provide low cost labor significantly contributed to its rise to the top of the industry. Lower labor costs allowed China to produce rare earths at a more competitive price than other, smaller producers around the world, thus making it economically unattractive for those producers to stay in the market or for new producers to enter. Second, China's low environmental standards played a role in its emergence as the world's leader in rare earths production.<sup>41</sup> It certainly helped that China was more concerned during this rise with fueling its growing economy than addressing environmental concerns pertaining to rare earths production.

A third contributor to China's rise is its access to large deposits of ores within its borders. The majority of China's rare earths are produced at the Bayan Obo mine in northeast China and at a number of mines in southern China and Sichuan.<sup>42</sup> These mines have significant deposits of bastnasite.<sup>43</sup> The Bayan Obo mine provides 50 percent of the rare earths mining

production for China's industry, while the mines in southern China and Sichuan account for 41 percent and 9 percent of production respectively.<sup>44</sup>

The demand for rare earths continues to rise. In 2010, the worldwide demand for rare earth oxides was 127,500 metric tons.<sup>45</sup> China produced over 130,000 metric tons of rare earths in 2010 and 2011, eclipsing world demand.<sup>46</sup> The next largest producer was India with a paltry 3,000 metric tons, followed by Brazil at 550 metric tons, and Malaysia at thirty metric tons.<sup>47</sup> These production rates exemplify the disparity between China and its closest competitors in the industry.

By 2014, it is estimated that total demand for rare earth oxides will reach 177,200 metric tons.<sup>48</sup> This increase equates to a 75 percent growth in demand for battery alloy production and a 57 percent growth in demand for permanent magnets.<sup>49</sup> Capacity for meeting the increased demand is uncertain. Of the world's estimated 110,000,000 metric tons of reserves, China controls half.<sup>50</sup> The Commonwealth of Independent States is second, controlling approximately 19,000,000 metric tons, with the U.S. in third at 13,000,000 metric tons.<sup>51</sup> Despite the large number of reserves deposited across the planet, very few countries possess the capacity to mine the ores and process them into rare earth oxides. However, with increasing demand on the horizon accompanied by increasing value, more nations as well as private corporations may be willing to enter the market.

With a firm hold over the industry, China clearly has the upper hand with regards to controlling both supply and overall pricing of rare earths. The price for rare earth elements has risen exponentially over the past several

years due to both increased demand for rare earths products and a limited supply chain. For example, lanthanum sold for \$3.44 per kilogram in 2007 but, by the third quarter of 2011, was selling for \$153 per kilogram.<sup>52</sup> That is a forty-four-fold increase in just under four years. Other rare earths have seen similar price spikes over the same period. Neodymium, which is a key ingredient in the manufacturing of permanent magnets, sold for \$30.24 per kilogram in 2007 and, in July 2011, hovered near \$340 per kilogram.<sup>53</sup>

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As of April 2013, the market prices for lanthanum and neodymium declined and are approximately \$11 and \$75 per kilogram respectfully.<sup>54</sup> The decrease in price is welcome news for manufacturers and is attributed mostly to lower demand for rare earths due to recent high prices.

There are several reasons for the skyrocketing rare earths prices from 2007 to 2011, and they all stem from policy decisions within China. These policy decisions resulted in a decrease in supply of rare earths to the outside world. One such policy decision was China's deliberate move to address environmental issues within the mining industry. According to a 2011 *New York Times* article, Chinese officials were concerned with polluted water, air, and radioactive residues from the rare earths industry.<sup>55</sup> Most of China's rare earths facilities closed during the fall of 2011 in order to install pollution control equipment.<sup>56</sup> Another policy decision addressed the overwhelming number of mine operators operating illegally without a license. These operators conducted business without any concern for the environment or labor practices.<sup>57</sup> China's solution for these issues is to consolidate the mining industry into larger enterprises under government control. For example, in northern China a single, government-controlled monopoly named Bao Gang Rare Earth was formed incorporating thirty-one mostly private rare earths processing companies.<sup>58</sup> The same consolidation process is occurring in southern China, where the government has created three distinct companies en route to consolidating 80 percent of

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production in the region.<sup>59</sup> The combination of stricter adherence to environmental regulations and government consolidation of the industry equates to an increase in prices.

A third, more ominous factor is also affecting overall supply of Chinese rare earths. China has deliberately cut export quotas for rare earths over the past several years due to its own internal appetite for the resource. This trend is not likely to change in the near future. Molycorp's former chief executive officer, Mark Smith, reported after a trip to China that Chinese officials told him they did not intend to remain the world's major supplier of rare earths.<sup>60</sup> Molycorp also predicts China may be a net importer of rare earths by as early as 2015.<sup>61</sup> This prediction may be a ploy by Molycorp to boost outside investment or to gain greater attention from Congress;

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however, China's export quotas provide empirical data that is hard to refute. In 2004 and 2005, China exported 65,609 metric tons of rare earths against a global demand of 90,000 and 98,000 respectively.<sup>62</sup> From 2006 through 2009, Chinese exports decreased at a 6 to 7 percent annual rate to 50,145 metric tons in 2009.<sup>63</sup> According to a U.S. Geological Survey report, China's 2010 rare earth elements export quota was 37 percent lower than that of 2009, and a further reduction of 35 percent was designated for 2011.<sup>64</sup> Global demand over that period rose to 124,000 metric tons in 2008 with a precipitous drop-off to 85,000 metric tons in 2009 due to the global economic downturn.<sup>65</sup> Despite the downturn, demand climbed back up to 127,500 metric tons in 2010. China's domestic consumption has risen rapidly over the last ten years from an estimated 19,000 metric tons in 2001 to 77,000 metric tons in 2010.<sup>66</sup> The increased internal demand combined with a somewhat lower production capacity due to consolidation of the Chinese industry and tougher enforcement of environmental laws signals that declining export quotas will remain a Chinese policy for years to come.

China's rise to become the world leader in rare earths production was not by chance. The U.S. decision to suspend operations at Mountain Pass in the 1990s versus financing the cleanup and upgrade costs required to meet environmental regulations was a key contributor. Furthermore, China's own decision to increase its production capacity through investment in research and development projects culminated in their monopoly of the rare earths industry.

## **GEO-STRATEGIC IMPLICATIONS**

For one nation to possess 95 percent of the production capacity of an increasingly global, vital natural resource is cause for concern. The fact that the nation that controls that resource has not proven to be a transparent and accountable global partner with regards to territorial claims and increased military spending raises the level of concern significantly. For these reasons, China's monopoly of the rare earths industry presents national security and manufacturing concerns for the United States and its partners and allies.

It is difficult to envision the United States or any other nation relying exclusively on a single supplier for its vital resource needs. The United States diversifies its petroleum imports to avoid such a scenario. Even if the United States were able to import all of its petroleum requirements from a single, secure, external source, such as Canada, it would be a dangerous

choice due to a number of factors. For instance, contingencies such as labor strikes, souring diplomatic relations, and natural disasters make over-reliance on one source a strategic miscalculation. It is therefore wise for nations to diversify their imports of vital natural resources, using a variety of suppliers and geographic regions if domestic sources are insufficient or unavailable.

As demonstrated in the hypothetical scenario at the beginning of this paper, China's hold on rare earths may be a decisive factor in a future confrontation with the United States. The numerous weapons systems that rely on rare earths technology place the United States at a strategic disadvantage with regards to China. If a prolonged, large-scale conflict between the two nations broke out over a Taiwan Strait or South China Sea dispute, the United States may find itself squeezed to obtain sufficient supplies of rare earths to manufacture replacement parts or systems to remain engaged in the fight. Much as the lack of secure access to oil was crippling to the Germans at the end of World War II, rare earths could play a similar, pivotal role in a future conflict with China. In the air-to-air arena alone, the requirement to replace expended stockpiles of advanced air-to-air missiles could become a factor very quickly based on the number of aircraft China would be capable of employing.

Japan recently learned that relying on a single resource supplier was imprudent following an incident between the Japanese Coast Guard and a Chinese fishing trawler near the Senkaku, or Diaoyu Islands.<sup>67</sup> In September 2010, a Japanese Coast Guard vessel attempted to stop a

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Chinese trawler purported to be fishing illegally in Japanese waters. During the incident, the captain of the trawler intentionally rammed the coast guard vessel. Subsequently, the Japanese Coast Guard apprehended the captain. The ensuing political spat boiled over for several weeks with the Japanese threatening to try the captain, while the Chinese suspended high-level contacts with Japan.<sup>68</sup> During this period, an unanticipated consequence unfolded. The Chinese were scheduled to deliver several metric tons of rare earths to

Japan for use in Japanese commercial industries. In what can only be seen as a direct use of its economic power in a diplomatic tussle, the Chinese

withheld shipments of the rare earths during the dispute while awaiting an apology, reparations, and the release of the captain.<sup>69</sup> China denied all accusations that it was purposefully withholding the shipments as a political bargaining tool against Japan.<sup>70</sup>

Whether China purposefully withheld the shipments or not, the lesson learned by Japan as well as outside observers was that China possesses a powerful economic instrument to employ against nations that depend on Chinese rare earths to sustain their economic livelihood.

### **BREAKING CHINA'S GRIP**

The United States cannot remain dependent on China for its rare earths needs. In order to gain resource independence, the United States must formulate a plan that will ensure reliable, secure access to rare earths. Fortunately, this issue has not been ignored. Currently, Congress has multiple acts addressing the issue in different stages of approval on the floors of the House of Representatives and the Senate. These bills recommend exploring options for stockpiling, recycling, and domestic production of rare earths. This section will examine all three options, as well as a fourth incorporating a multi-national course of action. It will conclude by recommending that the United States develop a program similar to its approach to building the JSE.<sup>71</sup>

The first option for ensuring U.S. access to rare earths is through stockpiling. Stockpiling would allow the United States to build up a predetermined level of rare earths as insurance against any decline in availability in the international market. Stockpiling would also alleviate strains on domestic production in times of crisis. Congressional legislation mandating stockpiling should be enacted based on sound analysis of the appropriate level and types of reserves required to ensure availability to U.S. weapons makers.<sup>72</sup>

Recycling is a second option for providing an alternative source of rare earths. Currently, very little recycling occurs due to the high costs of the recycling process coupled with the low market price of rare earths.<sup>73</sup> However, if the supply of Chinese rare earths for global manufacturing continues to decrease due to export quotas, recycling may become more economically feasible compared to the higher prices for the remaining sources.<sup>74</sup> The United States should develop affordable technologies for rare earths recycling. As an illustrative example, large neodymium-iron-boron magnets contain as much as 200 grams of neodymium and thirty grams of dysprosium.<sup>75</sup> Additionally, wind turbines incorporate up to one ton of

neodymium.<sup>76</sup> These numbers demonstrate a small portion of the capacity for recycling rare earths in an economically viable quantity as a potential feedstock for new products.

The United States may also be able to follow the lead of other nations when it comes to recycling rare earths. Japan began researching the viability of recycling old, worn out components containing rare earths in response to China's export limitations.<sup>77</sup> Hitachi developed recycling technology to extract rare earths from disc drives as well as permanent magnets.<sup>78</sup>

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Japanese Kosaka Smelting and Refining is working on the means to recycle rare earths from scrap electronics.<sup>79</sup> The common need to increase the availability of rare earths may provide a joint partnership solution through shared development of new recycling technologies.

The third option for obtaining a reliable source of rare earths is to produce them domestically. As mentioned previously, the United States was the lead producer of rare earths until the late 1980s. There is no reason why the United States cannot again be a major supplier of rare earths; it possesses an estimated 13,000,000 metric tons of proven rare earths reserves. Previous problems with meeting strict environmental standards should not keep the United States from making a determined investment in restarting its domestic production capacity. The issue is now gaining enough support and interest to attract U.S. companies, like Molycorp, to invest in the mining and production of rare earths.

Molycorp began redevelopment of the Mountain Pass mine in 2008 with the goal of producing both heavy and light rare earths beginning in 2012.<sup>80</sup> In February 2012, Molycorp announced the successful launch of its new rare earths manufacturing facility at Mountain Pass, dubbed Project Phoenix.<sup>81</sup> Molycorp announced in January 2013 that Phase 1 production is on schedule to be at full capacity by mid-2013.<sup>82</sup> The goal, if reached, will produce 19,050 metric tons of rare earth oxides per year.<sup>83</sup> At the completion of Phase 2 construction, Molycorp estimates it will be capable of producing 40,000 metric tons of rare earth oxides on an annual basis.<sup>84</sup> For now, Molycorp is delaying completion of Phase 2 until market demand and product pricing shows more promise for return on investment.<sup>85</sup> The rare earths produced at Mountain Pass consist mostly of the light elements;

however, Molycorp claims it will also be able to produce the more scarce heavy rare earths such as terbium and dysprosium.<sup>86</sup> This new, domestic capacity is an encouraging development for those U.S. and foreign companies that rely solely on Chinese sources for their rare earths needs.

Molycorp's initiatives at Mountain Pass are commendable and provide one example of the effort to create a domestic supply of rare earths. Although there are numerous other sites within the U.S. border with the potential to provide significant quantities of rare earths, at present no other rare earths mining operations are near production. The U.S. government should provide incentives to entice corporations to enter the rare earths production business. More specifically, Congress should implement Title III statutes under the Defense Production Act of 1950 to attract companies to develop the capacity to extract rare earths from inside the United States. Currently, there are seven projects being funded by government appropriations under Title III, including the reestablishment of domestic beryllium production capacity.<sup>87</sup> Title III allows the government to "provide incentives to create, expand, or preserve domestic industrial manufacturing capabilities for technologies, items, and materials needed to meet national security requirements to include homeland security."<sup>88</sup> If it is determined that Molycorp cannot produce the required quantity of rare earths, then initiating a Title III program may deliver a solution. One drawback, however, is the lead time required to develop a new mine and production facility, which can take ten years or longer.<sup>89</sup> This long lead time requires a commitment today, not when a crisis arises in the future.

In addition to efforts by Congress and Molycorp to address the rare earths supply issue, there is another means to gain a secure, reliable supply of rare earths. This solution expands on a recommendation by Valerie Grasso from the Congressional Research Service to pursue joint ventures with partner nations, and follows a similar model being used to build the F-35 Joint Strike Fighter.<sup>90</sup> The JSF program provides an example for burden sharing when it comes to meeting the defense needs of partner nations. Instead of designing, testing, and producing its newest fifth generation fighter alone, the United States elected to work with a coalition of steadfast allies. This approach allowed all participating nations to become stakeholders in the final results.

Under a similar joint venture, the United States could partner with some of its closest allies, such as Australia, Japan, and Canada in order to become self-reliant with regards to rare earths production. The four nations could embark on a comprehensive rare earths production project with the goal of achieving not only element resource independence, but also true

independence across the entire manufacturing process, from mining to end product. Drawing on proven reserves of rare earths in Australia, Canada,

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and the United States, as well as Japan's end-use production of numerous rare earths-derived products, the four nations can work together to achieve a secure, self-sufficient, closed loop system. Furthermore, shared research and development can be used to explore recycling solutions and possible alternatives to rare earths.

Through a combination of stock-piling, recycling, domestic production, and a joint venture with trusted allies, rare earths independence is achievable, but the overarching question remains

whether the U.S. government will make the commitment.

## CONCLUSION

Recent events in the Asia-Pacific region regarding competing resource claims and territorial disputes, along with the U.S. strategic pivot toward the region, have brought the issue of China's monopoly of rare earths to the attention of the United States and its allies.

In particular, the hypothetical scenario of a U.S.-China crisis in the South China Sea exposes the danger of overreliance on a sole supplier of a critical resource. Whether or not one believes such an armed conflict will arise does not negate China's control over nearly 95 percent of the planet's rare earths industry. It is necessary to offset China's monopoly through responsible strategic planning. With the right focus and determination, the United States can achieve an appropriate level of resource independence in the future. *f*

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