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## The Strategic and Security Implications of Rare Earths

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### 1 Why rare earths?

Patrolling near the contested Islands of Senkaku/Diaoyu in the East Asian Sea on 8 September 2010, a Japanese Coast Guard crew detained the captain of a Chinese fishing boat whose crew was plying their trade near the Islands claimed as Japanese territory. The waters around these contested islands contain rich fishing grounds in addition to potentially large deposits of oil and natural gas. The fishing boat captain was taken to Japan. Meanwhile, the Chinese government vehemently protested, and, ultimately, the fishing boat captain was returned to China, 16 days later on, 24 September 2010. During the 16-day diplomatic imbroglio between China and Japan and, it would appear, as part of an effort to increase pressure on Japan to release the Chinese fishing boat captain from custody, the government of China, on 10 September 2010, ceased rare earth metals exports to Japan. This action led to substantial distress within the tight knit circles of Japanese government and business elites owing to Japan's absolute dependency on rare earth imports from China to feed its production of high technology products on which its economic model is based. In effect, China, in combination with other forms of diplomatic pressure, used rare earths as a bludgeon to forcibly coerce Japan into aligning its policy with Chinese interests or suffer economic hardship. The use of rare earths by China in this manner was made possible by the fact that China presently controls 95 percent of global rare earth production, Japan relies on China to supply 80 percent of its rare earths consumption, and that Japan has no readily available natural endowment of rare earths or substitutes. On 24 September 2010, Japan released the Chinese fishing boat captain though rare earth shipments from China to Japan did not resume until 19 November 2010, and then

only at considerably reduced levels. Scarcity and the lack of available substitutes for rare earths in combination with China's dominant rare earths market position and its (ostensible) willingness to use that market position to accomplish political objectives, gives rise to new security risks and vulnerabilities that scholars of global political economy have yet to fully address. The collection of essays in this volume, grapple with the emergence of rare earths as an emergent strategic commodity for which lack of access constitutes a security risk with the potential to escalate to an existential security threat.

The crisis between China and Japan in 2010, underscores that rare earths are crucial for human prosperity and peace in a world increasingly dependent on rare earth enabled advanced technologies. Rare earths are 17 elements on the periodic table that comprise the lanthanides, metallic elements that when combined with other substances form materials with unique magnetic, conductive, and energy storage properties. The distinctive properties of rare earths enable technologically advanced activities that include social networking, internet surfing, computing, buying, driving, flying, greening, hacking, and fighting wars. Rare earths are essential to the information technology revolution on which humans have come to depend for communication, commerce, and, increasingly, to engage in conflict. Safeguarding ready access to rare earths ensures that humans will continue to reap the social, economic, and political benefits of information, transportation, energy production, and energy storage technologies. In short, rare earths are a strategic commodity over which states do and will compete for control. A strategic commodity is a commodity for which lack of access constitutes a security risk in terms of economic prosperity and security. A security risk is of a less urgent nature compared to a security threat which implies that the existence of a political entity is imperiled. Loss of a strategic commodity may contribute to negative economic and political outcomes within and between states but, falls short of contributing to the demise of a state as a sovereign entity, directly threatening substantial loss of life amongst citizens, or radically altering the extent of global political and economic institutions. Nevertheless, scholars have noted the emergence of rare earths as a strategic commodity arguing that policymakers and scholars can no longer ignore the implications of rare earths scarcity to economic outcomes, environmental pollution, and global security (Dobransky, 2012; Campbell, 2014; Gholz, 2014; Golev et al. 2014; Machacek and Fold, 2014; Massari and Ruberti, 2013; Wübbeke, 2013; Zhang, 2013). The advantage of recognizing that rare earths constitute a strategic commodity with security risks is that

scholars and policymakers have a window of opportunity to develop risk mitigation policies *before* rare earths escalate to a security threat.

This collection of essays builds on the claim that rare earths are a strategic commodity over which political actors struggle for control, through exploring its implications to human prosperity and peace. The ubiquitous use of rare earths in civilian and military technologies, in addition to scholarly interest in rare earths that transcends academic disciplinary boundaries, demands theoretical and methodologically plural approaches to assessing the effects of rare earths on human prosperity and peace. Contributions to this volume reflect scholarly heterogeneity and interdisciplinarity. From the perspective of theory, animating the interventions presented herein are perspectives drawn from fields within the academic discipline of political science, namely international relations, political theory, and comparative politics; in addition to contributions from the interdisciplinary field of environmental ethics and the academic discipline of geography. Contributions to this volume employ methods of data collection and analysis suitable for addressing the part of the rare earths puzzle to which each gives attention and that reflect the interdisciplinary approach to this volume. Nevertheless, contributors to this volume are, save one exception, in agreement concerning the strategic significance of rare earths to human prosperity and peace, noting that *rare earths rise to the level of security risk, though fall short of rising to the level of existential threat*. Rare earths are essential additives to alloys and materials on which depend efficient function of information and related technologies that have civilian and military applications. Loss in rare earths would inhibit technological innovation, technology function, and productivity gains from technology. However, human beings do not, necessarily, need rare earths for nourishment, shelter, or providing for some level of security, as Walsh (this volume) notes in his contribution. The risk associated with acute rare earth scarcity is more qualitative in nature, quality of human existence or security may suffer by degree or, in Walsh's view, improve.

For some political actors, such a reduction in the degree of quality may be politicized as an existential threat, as Dobransky notes in his contribution. Politicization of rare earths as an existential threat is, perhaps, the most alarming aspect of rare earths as a strategic commodity; for in global politics, risks may be exploited through embellishment for political gain, risking escalation to armed conflict. Perhaps, rare earth-consuming states have political interests related to China's rare earths market dominance such that politicizing rare earths as an existential threat serves those interests. Likewise, perhaps, China has interests

related to its growing domestic consumption of rare earths as it seeks to shift up the value chain (develop expertise producing products worth more in global markets) as part of its economic development and, simultaneously, modernize its military to match that of contemporary great powers. Several of the contributions grapple with this tension arising out of incommensurability of interests – political, economic, and social – attempting to show and warn of the threat associated with over-politicizing rare earths as an existential threat. Accepting that rare earths do constitute a security risk, contributions have relied on the concept of security to structure examination and explication of the unique tensions that have recently pushed rare earth relations into the limelight. Within the academic field of international relations, one area of inquiry is focused on the concept of security and it is from contributions within this area of inquiry that this collection of essays possesses affinity.

Security studies is a research agenda within the field of international relations and discipline of political science. Since the end of the Cold War, security has been treated as an inherently contested concept and security studies scholars have settled in two camps: wideners and traditionalists (Browning and McDonald, 2013; Booth, 2005; Smith, 2005; Dalby, 1997). Wideners, later critical security studies, seek to expand the scope of security as a conceptual and analytical framework beyond the state and parochial national interests (Buzan, Waever, de Wilde, 1998; Hansen and Nissenbaum, 2009; Huysmans, 1998; Williams, 2003). Critical security studies are explicitly interested in the political implications of security as a claim and call to political action punctuated by the extraordinary use of military force. At its ontological and epistemological core, security constitutes a political claim about the proper use of power by political authorities that ought to be scrutinized, for human prosperity, peace, and, importantly, freedom are at stake (Booth, 2005; Dillon, 2002; McSweeney, 1999; Weldes et al. 1999; Wight, 2006). Traditionalists, alternatively, seek to limit the conceptual and analytical scope of security to nation-states in order to maintain parsimony for the purpose of theory construction (Dannreuther, 2014; Huysmans, 1998; Lipschutz, 1995; Walt, 1991). Both camps have very different ontological, epistemological, and methodological views concerning the purpose for analysis and scholarship. Critical security studies is primarily concerned with identifying possibilities for and barriers to human emancipation, whereas traditionalists give priority to explaining the causes of war among a discreet set of nation-states labeled ‘great powers.’ Contributions to this volume may best fit in the widener camp, recognizing inherent political motives in acts that invoke security for the

purpose of staking claim to rare earth supplies, in addition to noting insecurities generated through rare earths production and use in products that bind individuals to the vicissitudes of late capitalism. The use of security as an analytical and conceptual framework draws attention to political claims concerning rare earths that carry implications for human prosperity *and* peace – for economic security, environmental security, human security, and national security. Thinking about security in separate categories is not meant to imply that there is no overlap or connection between different categories of security. Rather, thinking through the problem of risk (threat) associated with rare earths is assisted by utilizing security as a conceptual framework in order to focus analysis and offer clear elucidation of this multifaceted political issue.

For our purposes, in thinking about rare earths as an emergent object over which political actors struggle for control, security serves as an interdisciplinary bridge over which the politics associated with rare earths supply may be described, scrutinized, and explained. As previously stated, the essential insight among contributors to this volume is that, while political actors may invoke security in an effort to lay claim or justify certain kinds of extraordinary policies to ensure rare earth supply, and that such claims rest on the notion that rare earth supply disruptions constitute an existential threat, nevertheless rare earths fall short of constituting an existential threat to states, rising to no more than a security risk, presently. In general, invoking security where rare earths are concerned is a mere politicization of the issue. This claim, however, becomes problematic where human and environmental security, associated with rare earth mining and refining, is concerned as Klinger (this volume), Wubbeke (this volume), and Verrax (this volume) note. Both processes produce radioactive and acidic byproducts that marinate in polluted ponds leaching into groundwater supplies contributing to increased incidences of life-threatening disease, loss of biodiversity, and degradation of productive farmland. These set of environmental and human security threats highlight that much of the security risk (and threat) of rare earths is a function of cascade effects associated with rare earths use in civilian and military technologies and the polluting perniciousness of rare earths production. And yet, Walsh (this volume) points to another dimension to rare earths dependence associated with the accoutrements of affluence in late capitalism whereby dissent is suppressed by the dominant through payments made to the subordinate in the form of smartphones, tablet computers, and flat screen televisions. Bread and violence have been replaced in the coliseum with the pleasures of digitized (and distracting) entertainment made

possible through rare earths use. Another dimension which, Dobransky (this volume) explores, is the use of rare earths in military technologies on which certain powerful states rely to project military power. It is, perhaps, this dimension of rare earths risk that provokes the most immediate sense of insecurity on the part of rare earth consuming states, especially those with technologically advanced militaries for which the loss of rare earths is perceived to be militarily catastrophic.

Precision munitions rely on rare earth magnets in the small electrical motors (known as actuators) that alter the angle of fins to effectuate direction changes as the munition flies through the air toward its target. The loss of fin actuators would, over the short-term, undermine the military capability of a nation-state that would then have to rely on munitions technology last used in scale during World War II. While the loss in accuracy of munitions as a result of a loss in rare earth supply used in fin actuators may necessitate the adoption of, what in the digital technology era must be considered archaic war fighting strategies and tactics, the nation-state would not be left defenseless or incapable of projecting force. What would change is how that force is delivered to target, that is to say, the quality of force and the capability of limiting civilian casualties. Think of a shotgun pattern approach as opposed to single-shot rifle approach to hitting a target, surely less efficient, less effective, but no less potent in terms of destroying targets or extinguishing human life. Taken together, the many dimensions of (in) security associated with rare earths incite sufficient anxiety suitable for policymakers and scholars to critically engage and assess the extent to which rare earths promote or detract from human prosperity and peace. Acknowledging the link between security and rare earths leads one to examine the global rare earths market structure in an effort to identify the politics and economics of rare earths supply, potential supply risk, and how to manage that risk.

### **1.1 China and the strategic importance of rare earths**

Since 2010, the puzzle animating rare earths discussions concerns the intentions of China, given its current dominant rare earths market position, and whether or not China is willing to weaponize rare earths for the purpose of coercing others to align with Chinese interests. From the view of those largely dependent on China for rare earths, reductions in rare earths exported from China constitute a security risk and use of extraordinary power by China, a blatant coercion. As previously noted, much of the security risk associated with rare earths is a function of cascade effects occurring with the loss in rare earth supply. Rare earths 'are used in a range

of increasingly important commercial products such as energy-efficient applications from hybrid cars to wind turbines, in addition to mobile phones and iPods. They are also essential used in the radar systems and lasers required in weapons such as America's advanced arsenal of "smart bombs" and other precision-guided explosives' (Lee, 2011, no pg.; see Table 1.1). Humphries (2012) has listed many industrial uses of rare earths (see Table 1.1), while Lee (2011) and Hart (2013), independently note that China controls 95 percent of the global market and that the US imports 87 percent of its rare earths from China. Rare earths have economic and political value that China has demonstrated, on the view of Dobransky (this volume), that it is willing to leverage in order to achieve economic and political ends. Understanding how China achieved rare earth market dominance, which did not occur by happenstance, may assist our understanding of China's intentions going forward.

*Table 1.1* Rare earth elements (lanthanides): selected end uses

| <b>Light rare earths<br/>(more abundant)</b> | <b>Major end use</b>  | <b>Heavy rare earth<br/>(less abundant)</b> | <b>Major end use</b>   |
|--|---|---|--|
| Lanthanum                                    | hybrid engines,<br>metal alloys   | Terbium                                     | phosphors,<br>permanent<br>magnets                                     |
| Cerium                                       | auto catalyst,<br>petroleum<br>refining, metal<br>alloys  | Dysprosium                                  | permanent<br>magnets, hybrid<br>engines                                |
| Praseodymium                                 | magnets   | Erbium                                      | phosphors  |
| Neodymium                                    | auto catalyst,<br>petroleum,<br>refining, hard<br>drives in laptops,<br>headphones,<br>hybrid engines | Yttrium                                     | red color,<br>fluorescent,<br>lamps, ceramics,<br>metal alloy<br>agent |
| Samarium                                     | magnets   | Holmium                                     | glass coloring,<br>lasers  |
| Europium                                     | red color for<br>television and<br>computer screen  | Thulium                                     | medical x-ray<br>units   |
|  |   | Lutetium                                    | catalysts in<br>petroleum<br>refining                                  |
|  |   | Ytterbium                                   | lasers, steel alloys   |
|  |   | Gadolinium                                  | magnets  |

*Source:* DOI, U.S. Geological Survey, Circular 930-N; adapted from Humphries (2012).

While conducting an official tour of southern China in 1992, then Chinese Premier, Deng Xiaoping, is reputed to have claimed, ‘The Middle East has its oil, China has rare earth: China’s rare earth deposits account for 80 percent of identified global reserves, you can compare the status of these reserves to that of oil in the Middle East: it is of extremely important strategic significance; we must be sure to handle the rare earth issue properly and make the fullest use of our country’s advantage in rare earth resources’ (Zepf, 2013, p. 41; also see Mancheri, 2012). The strategic significance of rare earths to China is threefold. First, developing indigenous industry serves economic development in China; second, the peaceful rise of China is, in part, dependent on rare earth enhanced technologies that are used in the development of transportation, communications, computing, and defense related industries; third, dominating the global supply of rare earths enables China to exert influence on other states, for dependency is the currency of power in global political economy.

Leaders in China linked rare earths industry development with the economic development of China as early as 1985 through offering rebates to rare earths exporters (Zepf, 2013). Not until Deng gave his endorsement of rare earths, couching them in his broader strategic vision of China improving its economy through developing competitive market shares in strategic resources, did China seek rare earths industry development through a strategy of price competition. As foreign producers of rare earths have dwindled, unable to compete on a price basis with Chinese produced rare earths, China’s control over the global rare earth supply has increased, as Figure 1.1 illustrates. In early 2010, China begun to rationalize – as Weber (2009) articulated this term – domestic production of rare earths through forced consolidation of mining companies into tightly controlled enterprises with state minority ownership and the reassignment of the Rare Earths Office from the Ministry of Land and Resources to the Ministry of Industry and Information Technology (Zepf, 2013). Rationalizing domestic production of rare earths enables China to improve the efficiency, productivity, and environmental impact of rare earth manufacturers consistent with promoting continued economic development of China (Zhang, 2013). Since 2010, China has struggled to corral small independent producers who continue to violate state export restrictions on rare earths through smuggling, an enduring theme and threat to sustained positive economic development in China and its more direct influence over global rare earths production (Gholz, 2014). Another aspect of the role that rare earths play in the economic development of China is that as China continues to develop its economy,



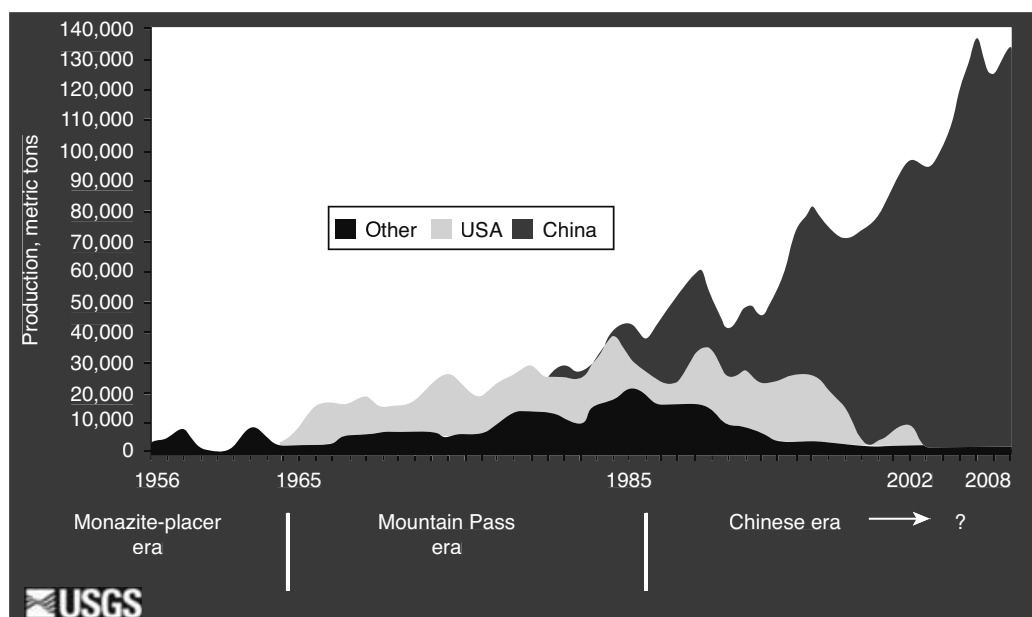


Figure 1.1 Rare earth oxides production, 1956–2008

Source: Tse (2011).

the point at which value can be extracted from primary commodity and assembling economic activities becomes insufficient to support further economic growth and development (Lee, 2011; Zhang, 2013). To sustain economic development, China must shift up the value added chain to produce products worth more in global markets, from which China may earn a higher income sufficient to fund further economic development. Effectuating this shift will require more rare earths, as will China's efforts at modernizing its military for the purpose of achieving great power status.

Within global political economy, the most efficacious power resource available to states is military capability. Developing and maintaining world class military capability is limited to those states willing and able to invest time, talent, money, and resources. China is such a state. As China begins to field fifth generation fighters, militarized drones, robots, and other advanced military technologies to match, and even exceed, US military capability, its domestic military technology producers will increase use of rare earths. Zhang (2013) argues that the economic and national security of China is at stake where indigenously produced rare earths are concerned, the mirror image view of Dobransky (this volume). Recognizing the strategic value of rare earths has led China to restrict exports to meet increases in domestic demand among Chinese high technology producers that China will champion as global competitors

and on which it will rely to innovate and field military technologies, consistent with its economic development model and political ambitions (see Baek, 2005; Carney, Gedajlovic, and Yang, 2009; Kohli, 2009; Lin, 2011; Rodrik, 2003). Ensuring a ready supply of rare earths will be available for use by economic champions will come at the expense of high technology producers and consumers in foreign markets that have come to depend on rare earths produced by China. Consequently, rare earth consumers have resorted to sourcing alternative rare earths supply to mitigate long-term supply risk, while ensuring that China abides by World Trade Organization (WTO) commitments to mitigate short-term supply risk.

## **1.2 Strategic commodities**

The strategic significance of rare earths enables the identification and analysis of effects associated with strategic commodities in global political economy. The dual nature of strategic commodities – political and economic – affords potentially significant power to those states or entities that can control the production and/or distribution of a given strategic commodity if those states are willing to flout global trade rules and agreements. Yet, significant power is available to those states willing to utilize global trade institutions to coerce or persuade violators to align their interests with global trade institutions. Such has been the case with rare earths as China has been brought to task through the WTO by no less than 16 rare earth consuming states. Dobransky (this volume), Hatakeyama (this volume), and Rech (this volume) all focus attention on the role of the WTO in the global rare earths controversy. Dobransky questions the efficacy of the US rare earths policy that relies on the WTO, whereas Rech notes the important role that international institutions, such as the WTO and European Union, play in mediating trade disputes. Where the use of rare earths as a means to achieve political ends is concerned, Hatakeyama explores the effects of power and interdependence in the rare earths relationship between China and Japan. Within global political economy and, more broadly, its cognate discipline of international relations, power is an inherently contested concept (see Baldwin 2002, 1980; Barnett and Duvall, 2005; Lukes, 2005; Morgenthau, 2006; Nye, 2011). For our purposes, power may be understood as getting others to do or think what they otherwise would not do or think, at a reasonable cost to that actor (Keohane and Nye, 2001). Rare earths constitute a power resource that can be strategically applied, consistent with national interest due to negative cascade effects associated with increased rare earth scarcity, to affect change in

others (Butler, 2014; Dobransky, 2012; Du and Graedel, 2011; Hedrick, 2004; Shaw and Constatinides, 2012; Seaman, 2010). Importantly, the nature of interdependence such that all interdependent parties share sensitivity and vulnerability to changes within and to the structure of interdependence to which each contributes. China is dependent on rare earth consuming states to continue to buy its rare earths; however, the degree of dependence China experiences differs from that of rare earth consuming states where the loss of rare earths may provoke economic and political cascade effects including deterioration of military capability, economic productivity, and technological innovation. It is the interdependency between rare earth producers and consumers which may provoke cooperation that ameliorates the politics of security associated with rare earths and, more broadly, strategic commodities.

## **2 Interdependence and differing perspectives**

International relations scholars have explored the relationship between interdependency and power noting two aspects to the structure of an interdependent relationship between two or more states (Baldwin, 1989, 1980; de Lange, 2010; Keohane and Nye, 2001). States are either more or less vulnerable or sensitive to changes to the relationship structure. If vulnerable, states bear more costs than relationship partners for changes to the relationship structure that originate outside that structure. If sensitive, states bear more costs than relationship partners to changes that originate within the structure of that relationship. Put baldly, dependency is the currency of power in global political economy; the more dependent is state A on state B, the less power, the more at risk, is state A vis-à-vis state B. Japan is more dependent on China for rare earths than is China on Japan, ergo China is more powerful than Japan within the structure of their rare earths relationship. Utilizing this framework for scrutinizing interdependence, Hatakeyama (this volume) argues that Japan is sensitive to changes in the structure of its rare earths relationship with China that may originate from price changes associated with reductions in supply of rare earths from China. Likewise, other rare earth consuming states are sensitive to changes in their rare earths relationships with China, being confronted with the risk that their sensitivity may be used as leverage at a time and in a set of circumstances convenient to China. A framing of China's rare earths export restriction, shared by Hatakeyama (this volume) and Dobransky (this volume), is that China utilized Japan's sensitivity to rare earths from China to get Japan to do what it otherwise would not do. Other

rare earth consuming states, notably Germany and the European Union, as Rech (this volume) finds, took notice and have begun to do what they otherwise were unwilling to do: commit to increasing domestic production and/or sourcing alternative rare earth supply which, ironically, leaves more of China's rare earths available for China to sustain its economic development and modernization of its military.

A view of the power that China presently holds over rare earth dependent states is based on certain observations made during the diplomatic entanglement between China and Japan in late 2010. The actions of China, its apparent willingness to use rare earths as a cudgel to coerce modification of policy on the part of another state, and its unilateral reduction of rare earth exports to all rare earth consumers by 35 percent, jolted policymakers in rare earth consuming states. Owing to its direct experience of losing access to rare earths on which its economy relies to produce high technology products, Japan increased its rare earth imports by 400 percent year over year in 2011 for the purpose of building up a strategic rare earths reserve. In response to China's reduction of rare earth exports, the US filed an unfair trade complaint against China through the World Trade Organization (WTO) on 22 March 2011. The WTO complaint has been joined by no less than 18 WTO members including Argentina, Australia, Brazil, Canada, Chinese Taipei, Colombia, the European Union, India, Indonesia, Japan, Norway, Oman, Peru, Russia, Saudi Arabia, South Korea, Turkey, and Vietnam. The diplomatic row between China and Japan, combined with the filing of an unfair trade complaint against China, underscores the strategic significance of rare earths to human prosperity, security, and peace in an increasingly technology dependent world.

An alternative reading of these events combined with taking statements from policymakers in China seriously, may lead to a more nuanced and less anxious stance on the issue of China and rare earths as Wubbeke (this volume) notes. In addition, Klinger (this volume) establishes that China is facing an environmental crisis stemming from its unregulated and unrestrained mining and refining of rare earths. Why should China not seek to rationalize domestic rare earths production in an effort to achieve economies of scale, environmental remediation, and provoke other rare earth consuming states to seek an alternative supply, to share the burden of supplying rare earths to rare earth consumers? Indeed, consolidating rare earths production into a few corporate behemoths and limiting rare earth exports leading to increased prices for rare earths benefits China over the short term but leads to more competition and potentially reduced prices, market power, and political power over

the long term. What does China gain in terms of power over against other rare earth consumers? China gains more control over its domestic rare earth supply through economically and politically incentivizing rare earth consumers to search out an alternative supply. Rare earth consumers are incentivized economically through increased prices as a result of China using its rare earths market power to generate scarcity. As prices increase, rare earth consumers seek for alternative rare earth supplies that can be had at cheaper prices or, for new supplies that can be brought to market and compete with rare earths produced in China. Rare earth consumers are incentivized politically through the exploitation of sensitivity dependency by China to re-evaluate environmental regulations that have made domestically producing rare earths economically unviable or, as Skinner (this volume) notes, identify a new supply in geographic locations such as Afghanistan, or, as Verrax (this volume) advocates develop rare earth recycling and substitutes. In the end, the global politics of rare earths will remain contentious over the short term until such time that additional rare earth supply is brought to market. That contention, however, has been mediated, Furmanski (this volume) argues through the judicialization of trade disputes through erecting international organizations such as the WTO that increase the transaction costs for cheating on trade agreements, as China experienced with its recent loss of the WTO suit brought against it for unilaterally reducing rare earth exports. Understanding the global market for, and the strategic significance of, rare earths is made possible in this volume with the use of the supply chain concept.

### **3 Rare earths supply chains, strategic significance, and security**

Part of the challenge for contributors to this volume is how to account for the strategic significance of rare earths, a class of materials with disparate uses in myriad products. Indeed, the strategic significance of rare earths directly emerges from the utility of this class of materials to high technology products with numerous civilian and military applications. A useful concept developed by scholars focused on understanding commercial logistics is the supply chain. Supply chains may be thought of as a model of factor inputs within the production process that assists commercial logistics to identify potential supply problems that may impede the production process, putting profitability at risk. For our purposes, we substitute the idea of profitability with the idea of security. Thus, supply chains assist the contributions herein by demonstrating with precision

the strategic significance of rare earths for the purpose of scrutinizing the degree of security risk rare earths possess for rare earth producing and consuming states and other actors. Caraccioli (this volume) offers a take on the politics of mining lithium, another key high technology raw material that demonstrates the broad applicability of thinking through the politics of strategic commodities by employing the concept of security combined with supply chains to assess security risk.

A robust literature on supply chains exists that includes a number of definitions (Gereffi, 2013; Roh, Hong, and Min, 2013; Porterfield, Macdonald, and Griffis, 2012; Gibson, Mentzer, and Cook, 2005; Mentzer et al. 2001). For our purposes, supply chains may be defined *‘as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer’* (Mentzer et al. 2001, p. 4; emphasis original). Others have investigated how organizations manage supply chains (Bask and Tinnila, 2013; Sanders, Zacharia, and Fugate, 2013; Seuring and Gold, 2012; Burgess, Singh, & Koroglu, 2006; Gunasekaran & Ngai 2005; Croom, Romano, and Giannakis, 2000) and address potential supply chain disruptions (Manuj 2013; Vanany, Zailani, and Pujawan, 2009; Manuj and Metzner, 2008; Tang, 2006; Jüttner, Peck, and Christopher, 2003). Within global political economy, the utility of supply chains as a conceptual lens has not been overlooked by scholars investigating patterns of global governance (Tran et al. 2013; Crang et al. 2013; Gibbon, Bair, and Stefano, 2008), patterns of global trade (Yeung, 2014; Bair, 2008), and patterns of economic development (Pietrobelli and Rabellotti, 2011; Palpaucer, 2008; Gibbon, 2001). The collection of essays in this volume demonstrates the usefulness of supply chains to investigations of economic security, an issue that has grown in importance to policymakers, scholars, and transnational enterprises as the world economy has been globalized in the post-Cold War era. Supply chains offer a powerful conceptual tool that models how production has shifted from being internationalized – geographically distributed across sovereign actors – to being globalized – functionally integrated and coordinated across sovereign boundaries (Gereffi, Humphrey, and Strugeon, 2005). The globalized nature of production means that policymakers and scholars must confront risks associated with dependence on the other actors to maintain steady supply of strategic resources (Klare, 2012). Supply chains offer a means to grapple with and account for such risk enabling policymakers and scholars to develop political remedies or economic substitutes that mitigate risk associated with strategically significant resources, in this case rare earths. Contributions in

this volume employ the supply chain concept as a means to articulate the strategic significance of rare earths, identify the security risk associated with rare earths, and offer policy recommendations that may serve to ameliorate the global politics of rare earths.

## **Conclusion**

This introduction argued that rare earths are a strategic commodity over which states and other actors do and will compete for control. While constituting a security risk, rare earths presently fall short of constituting a security threat to state actors though, for human actors at the individual and group levels of analysis, rare earths may constitute a security threat as a consequence of environmental degradation, including pollution of water supplies and farmland. The security risk of rare earths forms the conceptual foundation for the strategic significance of rare earths. The material foundation for the strategic significance of rare earths emerges from the widespread use of rare earths in the production of numerous consumables, including high technology products, with civilian and military applications. A window of opportunity is available to scholars and policymakers to develop rare earth security risk mitigation policy before rare earths become a pressing security threat. China has aggressively pursued rare earth market dominance as a means to further domestic economic development reaching a point where, on the view of Chinese policymakers, China can no longer bear the costs for supplying rare earths at a level that will meet domestic and global demand. China has, consequently, restricted rare earth exports leading to rare earth consuming states to pursue political remedy through the WTO and economic remedy through securing alternative rare earth supply or the development of substitutes. Supply chains offer a conceptual tool useful for identifying, analyzing, and explaining supply risk associated with rare earths and, more broadly, articulating the effects of rare earths scarcity on security in terms of both economic security and national security. Contributions in this volume scrutinize rare earths through the lens of security employing the supply chain concept as a means to concretely examine the many dimensions of rare earths as an emergent strategic commodity.

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