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Executive Summary

As governments around the world, including the United States, increasingly seek to adopt clean technologies that reduce carbon emissions, rare earth elements (REE)—a set of 17 light and heavy metals and alloys—will continue to grow in importance.[1] REEs are important in the transition to a greener economy because of their centrality in enhancing the efficiency and performance of electric motors and turbines, and other types of clean energy technologies.[2] REEs are used in the production of military equipment and are ubiquitous across the civilian economy, powering cell phones, laptops, hybrid vehicles, among other electronic items. America's dependence on imported REEs—particularly from China, a chief competitor—has engendered a review of all available market options. Because of the centrality of REEs in the U.S. economic and defense sectors, the U.S. government has designated them as critical to national security.

The preponderance of mining companies exploring or producing REEs operate outside Africa. However, as global powers turn to African markets to cultivate influence, the mining of the continent's REEs will likely increase. There are nearly 100 REE mineral deposit sites found in half the countries of Africa. Just five countries—Mozambique, Angola, South Africa, Namibia, and Malawi—hold half of all the sites of REE deposits in Africa.[3] Eight countries have REE mining activity, but as of January 2022, Burundi is the only African country with an REE mine that can produce in commercial quantities (others could soon become similarly productive). The most recently available data indicate that ownership of African mines is concentrated in the hands of just a few companies from Europe (Germany, Luxembourg, the United Kingdom), Canada, Australia, and Africa (Mozambique and South Africa).

Securing access to REEs is important for the future of the U.S. economy, as they are key inputs for products used in everyday life. Africa could be an important source of REEs, but natural-resource governance must improve. Good management of natural resources, which results from adhering to democratic, transparent, and accountable governance, ensures that natural resources will benefit both the host country and the investors. Poorly managed natural resources and bad governance often result in corruption, conflict, social grievances, and unfavorable investment environments. In general, Africa's REE-rich countries score low on measures of good governance and democracy.[4] The Extractive Industries Transparency Initiative (EITI), established in 2003, specifically to reduce corruption in the mining sector, can help improve the management of natural resources, as well as governance and democratic practices.[5] Currently, 16 of Africa's 27 REE-rich

countries have pledged to abide by EITI principles.[6] Africa could be an important source of REEs, as the United States continues to identify and cultivate alternative, non-Chinese, sources of these minerals. However, Africa's management of natural resources and indicators of good governance must improve—to ensure that the valuable minerals benefit not only American businesses, but African citizens as well.

Contents

1. Introduction

Rare earth elements (REE), a set of 17 light and heavy metals and alloys used in a wide range of high-tech devices, are increasingly considered critical supply-chain inputs.[7] In February 2021, President Biden issued an Executive Order (E.O.) that directed government agencies to review the U.S. supply-chain risks related to critical minerals, including REEs.[8] This E.O. represents the latest effort by the U.S. government to manage its dependence on foreign-supplied REEs. It also signals the growing role REEs play in the modern economy. REEs are used in the production of military equipment and are ubiquitous across the civilian economy (e.g., in medical equipment and television technologies).[9]

As governments around the world, including the United States, increasingly seek to adopt clean technologies that reduce carbon emissions, REEs will continue to grow in importance.[10] America's dependence on imported REEs—particularly from China, a strategic competitor—has engendered a review of all available market options. Indeed, the U.S. Department of Energy recommends diversifying the U.S. supply chain of critical minerals, which includes REEs, to reduce the country's reliance on a single source.[11] Because of the centrality of REEs in the U.S. defense sector, the government has designated them as critical to national security. Despite their categorization as rare, these elements are abundant in the Earth's crust—in some cases, even more abundant than the more familiar copper, lead, gold, and platinum. Their categorization as "rare earth elements" stems from the small quantities in which they are found. REEs require a complex and costly extraction process that transforms them into a state usable for production of goods.[12] Currently, China extracts and processes the majority of the globe's REEs. Of the active mines in 2020, for which data are available, those in China produced 58% of the global amount of REEs—rendering many countries, including the United States, vulnerable to supply-chain disruptions.[13]

The preponderance of mining companies exploring or producing REEs operate outside Africa; however, as global powers turn to African markets to cultivate influence, the mining of the continent's REEs will likely increase. As of January 2022, Burundi is the only African country with an REE mine that has produced commercial quantities, but others could soon become similarly productive. This paper provides an overview of REEs in Africa and identifies how regime-specific factors, such as good governance, can indirectly affect U.S. national security by ensuring fair access to REEs. Relatively under-explored for its REEs, Africa could be an important source for the minerals, as the United States continues to identify and cultivate alternative, non-Chinese, sources. However, to

ensure that the REEs benefit not only American businesses, but African citizens as well, Africa's management of natural-resources and indicators of good governance must improve.

2. U.S. Vulnerability to REE Supply-Chain Disruptions

The demand for REEs has risen sharply, as markets for green technology and electronics have grown. From 2003 to 2021, the global demand for REEs doubled from approximately 62,500 to 125,000 tons; estimates project that by 2030 demand will rise to 315,000 tons.[14] In the last several decades, China has emerged as the dominant exporter of REEs; in 2020, China produced 58% of the world's REEs.[15] The United States, the world's largest importer of REEs, depends on China for about 80% of its supply.[16] Reliance on any one country for REEs places the United States in a precarious position; given that the country is China—with which foreign and trade relations have suffered—renders U.S. imports of the minerals extremely perilous.

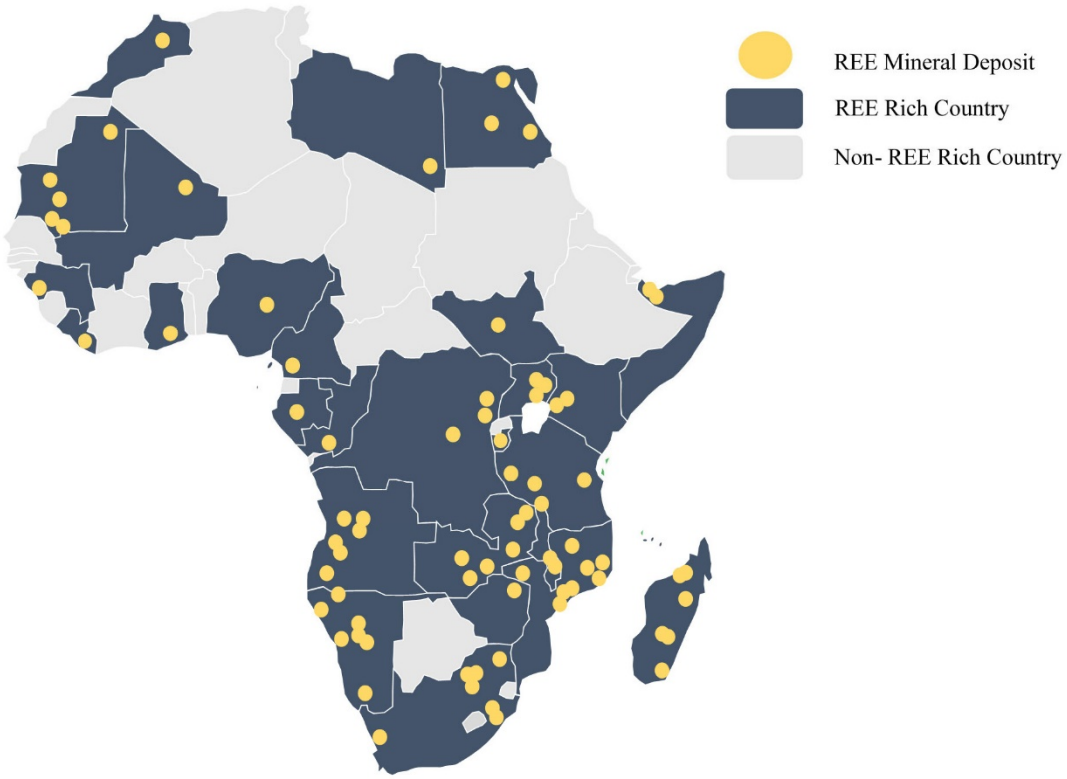
The United States did not always depend on foreign suppliers for REEs. Before the 1980s, the United States produced sufficient amounts of REEs for its industrial base. As much as 99% of the world's supply of heavy REEs was derived from the mining of U.S. reserves of titanium, phosphate, and zircon. In 1980, the U.S. Nuclear Regulatory Commission and the International Atomic Energy Agency classified heavy REEs—inputs in nuclear weapons—as source materials, thereby introducing licensing, regulations, and rules around disposal and liability. The new regulations increased the cost for U.S. companies to produce REEs significantly.[17] Not facing such constraints, China's production of REEs grew, boosted by its comparatively vast reserves of them and its designation by the U.S. government of "most-favored-nation" trading status. Moreover, given the low cost of production in China, other producers—such as Japan, France, and the United States—transferred large shares of their production to China. By 2017, only one domestic producer of REEs remained in the United States, while it imported nearly all of its REE requirements from China.[18] At present, the United States does not have the necessary processing and refining capability to support a domestic REE industry.[19]

The U.S. government and private industry have taken several steps in the last few years to address the country's dependence on foreign sources of critical minerals, including REEs. In 2008, a group of investors reopened the Mountain Pass mine, which is now the only REE mine in the United States.[20] Analysts estimate that the Mountain Pass mine, owned by MP Materials, contains the eighth largest deposit of REEs in the world. The U.S. Department of Energy prohibits U.S. scientists from engaging with it, however, because a Chinese investor, Shenghe Resources, owns nearly 10% of the mine and depends on Chinese sales and technology.[21]

In 2012, the U.S. government filed a complaint against China with the World Trade Organization, requesting it lift its export restrictions on REEs, alleging the restrictions served to raise global prices, offering an advantage to its domestic producers, while restricting access to the rest of the world.[22] Additionally, the 2013 National Strategic and Critical Minerals Production Act aimed to draw attention to REEs' criticality in the U.S. supply chain and boost internal production of REEs.[23] In fact, in July 2019, a Presidential Determination declared domestic production of REEs and alloys as "essential to national defense."[24] As a follow-on, E.O. 13953, signed in September 2020, further highlighted the dependence of the United States on critical minerals from China—including REEs. E.O. 13953 required reports, primarily from the Department of Interior, on the state of REEs in the United States, how the United States should respond to China's market practices, and how the U.S. government can support internal production of REEs.[25] Most recently, E.O.14017, issued in February 2021, directed the Department of Defense to identify the "risks in the supply chain for critical minerals and other identified strategic materials, including rare earth elements."[26]

3. REEs in Africa

Diversifying the United States' source of REEs beyond China is important to the economic and national security interests of the United States. As such, the interest in African REE mines will only increase as U.S. needs for these elements grow. As the CEO of Rainbow Rare Earths, which operates the Gakara mine in Burundi, recently noted, an intensifying trade war between the United States and China, "would leave us in a good position."[27] The most recent data by the United States Geological Survey indicate that there are 99 REE deposit sites in Africa, found in 27 countries (see Figure 1).[28] The REEs are found among hundreds of different minerals in Africa (see Appendix A).



Source: U.S. Geological Survey.

Figure 1. Distribution of REE Deposits in Africa

Half of all REE deposits are found in just five countries: Mozambique, Angola, South Africa, Namibia, and Malawi (see Tables 1 and 2).[29] Not all deposits are being explored by mining companies. As of 2016, the most recent survey of REE-mines in Africa lists

mining projects in eight countries on the continent (as shown in Table 1, center column). The headquarters of the mining companies, indicated in parentheses, are located in Africa (Mozambique and South Africa), Europe (Germany, Luxembourg, the United Kingdom), Canada, and Australia.[30]

Table 1. Deposits of REEs in Africa (by Number of Deposits)

Country	Mining Projects (as of 2016)[a]	REE Deposit Sites [b]
REE-rich Countries with Known Mining Projects		
Mozambique	Xiluvo (Promac, Mozambique)	14
South Africa	Steenkampskraal (Steenkampskraal Monazite Mine (Pty) Limited, South Africa); Glenover Complex (Glenover Pty, South Africa; Galileo Resources, South Africa); Zandkopsdrift (Frontier Rare Earths Ltd, Luxembourg)	11
Namibia	Lofdal (Namibia Rare Earths Inc, Canada)	10
Malawi	Songwe (Lancaster Exploration, UK); Kangankunde (Lindian, Australia)	8
Madagascar	Tantalus (Tantalus Rare Earths AG, Germany); QMM (Rio Tinto, London, UK)[c]	7
Tanzania	Ngualla Hill (Peak Resources, Australia); Wigu Hill (Montero Mining and Exploration, Canada)	5
Kenya	Mrima Hill (Cortec Mining, Kenya); Pacific Wildcat Resources Corporation, Canada)	3
Burundi	Gakara (Rainbow Rare Earths, Guernsey, UK)	2

Sources: [a] The latest data available on mine ownership are from Harmer and Rex (2016); [b] U.S. Geological Survey; [c] Reuters (2020).

The remaining 19 countries with known REE deposits do not have any identified mining projects. Table 2 shows the number of deposits in these set of countries.

Table 2. REE-rich Countries with no Known Mining Projects

Country	Number of REE Deposits
Angola	10
Mauritania	5
Zambia	5
Democratic Republic of Congo (DRC)	3
Egypt	3
Uganda	3
Somalia	2

Country	Number of REE Deposits
Mali	2
Cameroon	1
Republic of Congo	1
Gabon	1
Ghana	1
Guinea	1
Liberia	1
Libya	1
Morocco	1
Nigeria	1
South Sudan	1
Zimbabwe	1

Source: U.S. Geological Survey.

Despite discoveries dating back decades, most African REE extraction enterprises are still only in early stages of exploration or construction. Just one country, Burundi, has a mine close to exporting REEs in significant amounts. Until recently, the Rainbow Rare Earths mine in Burundi sold REEs to the German company, thyssenkrupp. There were plans to expand to produce 5,000 tons by 2022, but the Burundian government's pause on Rainbow Rare Earth's mining in June 2021 put those plans on hold.[31] The Burundian government wants to renegotiate the contract with Rainbow Rare Earths (and other foreign-run mines), alleging that it is not providing the government with a fair share of revenues.[32] The developments in Burundi underscore the importance of understanding a country's policies for managing natural resources and associated risks for corruption, investment, and political stability—variables that can impact access to REEs.

4. Corruption and Natural Resource Management

Countries rich in natural resources often do not enjoy comparably high levels of economic growth or development—a phenomenon referred to as the natural resource curse.[33] In fact, such countries may be worse off, according to several indicators. In particular, those related to the quality of its democracy, including good governance and accountability, tend to be relatively low. Efforts to prevent or mitigate the effects of the resource curse have focused on increasing transparency and including affected stakeholders as partners in monitoring the sector.

The Extractive Industries Transparency Initiative (EITI), established in 2003 by a consortium of 40 institutional investors committed to disclosing payments and revenues from extractive industries, stands out as one of the most recognized efforts to improve the management of natural resources. Today, 65 companies, 8 civil society organizations, and 15 governments provide financial, political, and advocacy support to the EITI.[34] Governments apply to join the EITI, agreeing to publicly disclose information on contracts and licenses, production, and revenue collection and allocation.[35] In signatory countries, EITI includes a broad set of stakeholders in monitoring the management of resources in a bid to ensure that proceeds from a country's natural resource benefit its citizens. In this regard, EITI seeks to build trust between government, civil society, and industry, creating a multi-stakeholder platform for managing and overseeing a country's natural resources.[36] Currently, 56 countries—of which 27 are African—are members of the EITI. Of the REE-rich African countries, 16 have pledged to abide by EITI principles: Cameroon, Democratic Republic of Congo (DRC), Gabon, Ghana, Guinea, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Nigeria, Republic of Congo, Tanzania, Uganda, and Zambia.[37]

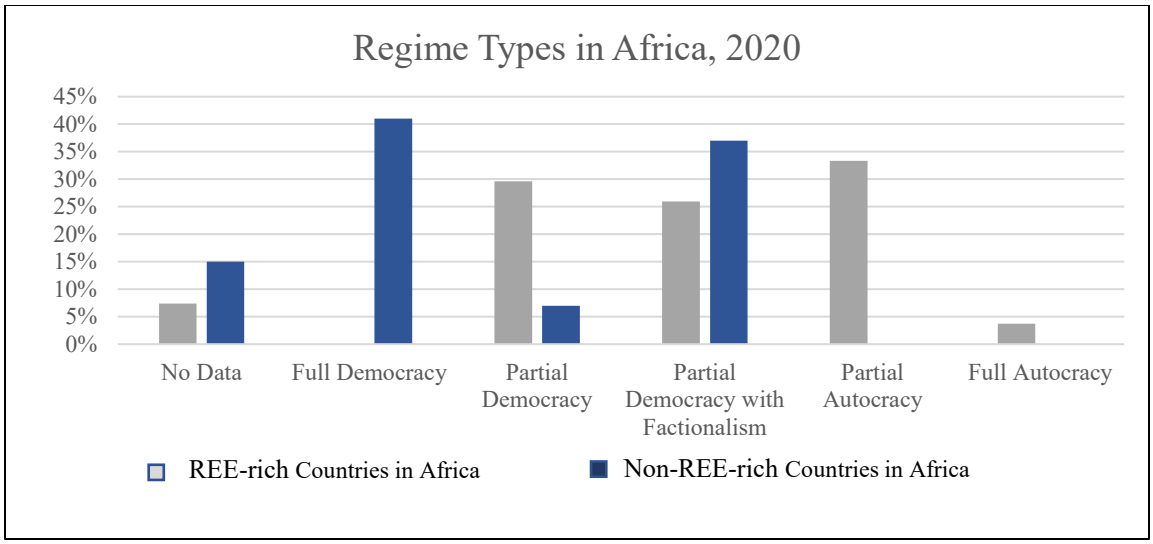
A. Anti-corruption Efforts Help U.S. Businesses

Recent studies show that a strong commitment to EITI principles results in greater transparency, which in turn can create a more favorable investment environment for U.S. businesses. While mineral-rich countries experience an increase in corruption, mineral-rich countries that also demonstrate a commitment to EITI principles see an improvement in transparency. Even when countries become richer and adopt democratic principles, which can result in lowering corruption, committing to EITI principles produces a greater positive impact on increasing good governance.[38]

Reducing corruption in African countries will help U.S. businesses. When good governance, rule of law, and accountability improve, U.S. businesses benefit from a more level playing field, enforceable contracts, and lower costs of doing business. Badly managed natural resources lead to instability that could eventually hurt businesses, as well. Communities may not receive benefits commensurate with their share of the resources. Over time, such perceived and real deprivation can lead to conflict. The Niger Delta, in Nigeria, is a case in point: the oil that the region produces is the main source of Nigeria's foreign currency, but the region remains poor. The grievances of the Niger Delta's communities eventually led to the formation of armed groups that attacked foreign firms, kidnapped for ransom, sabotaged the oil pipelines, and generally rendered the region insecure.[39] Similarly, the presence of liquified natural gas in northern Mozambique has led to fears in the surrounding communities that they will not benefit from the resource. Some speculate that such fears are driving the rise of violent extremism in the area.[40] Armed groups can also use natural resources to finance conflict; diamonds were used by armed groups in Sierra Leone, Liberia, and Angola.[41]

B. Governance and Transparency in Africa's REE-rich Countries

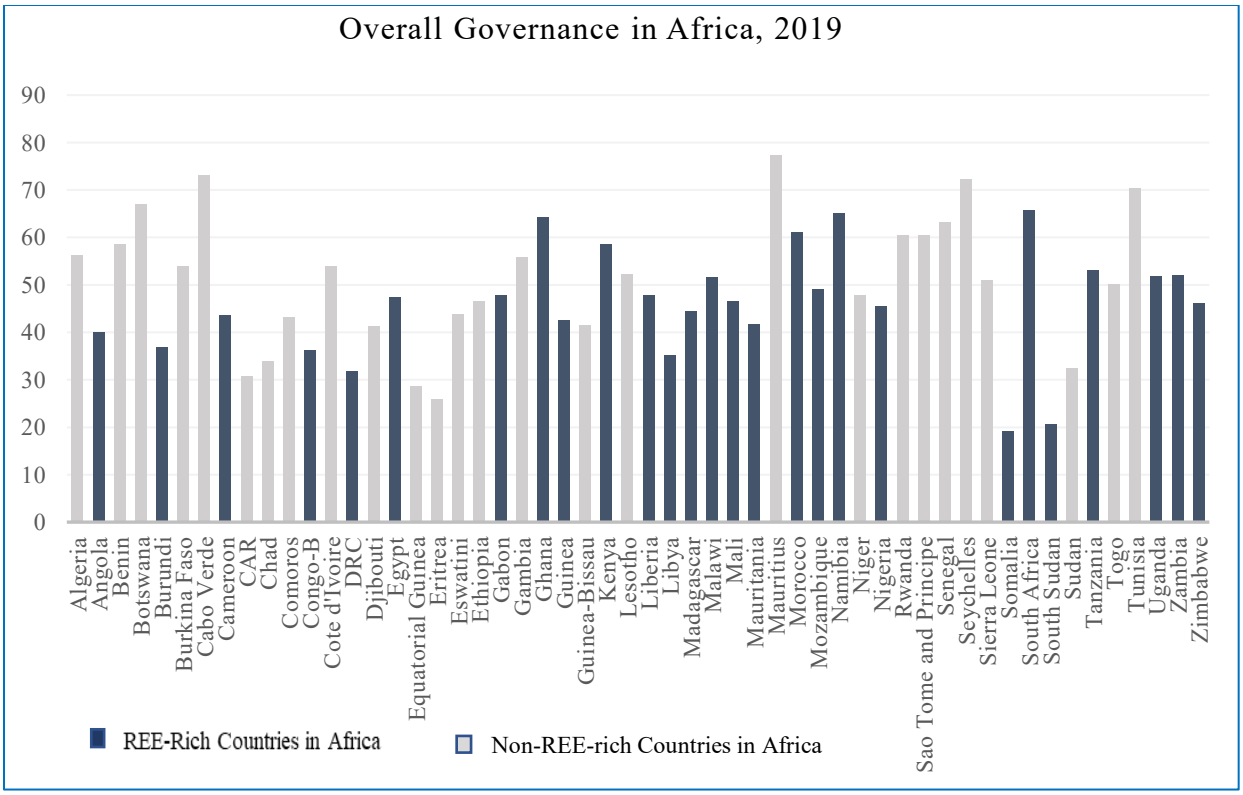
Among the countries with REE deposits, governance and democracy indicators are uneven, though mostly unfavorable. As reported by Freedom House, 89% of the 27 REE-rich countries are designated as either "partly free" or "not free," compared with 79% of non-REE-rich countries.[42] Moreover, according to the Polity V dataset which tracks regime types,[43] there are no full democracy REE-rich countries. Most are designated as partial democracies (30%), partial democracies with factionalism (26%), or partial autocracies (33%). The sole country on the continent designated as a full autocracy, Mauritania, contains REEs. Figure 2 is a comparison of the proportions of regime types between REE-rich countries and all countries in Africa.



Source: Polity V data, 2020; Goldstone et al (2010).

Figure 2. Regime Types in Africa, 2020

REE-rich countries differ significantly from countries without REEs in terms of governance and improvement in governance. According to data from the Ibrahim Index of African Governance, REE-rich countries in Africa scored, on average, below the continental average for governance in 2019. The average score for governance among REE-rich countries was 46/100, while the non-REE countries averaged 51/100; the continental average was 49/100 (see Figure 3).[44] These differences in governance scores between REE-rich and non-REE-rich countries are statistically significant. REE-rich countries performed marginally worse (at the 10% level) than non-REE-rich countries. From 2010 to 2019, REE-rich countries have improved significantly more slowly (at the 1% level), averaging .44 from 2010 to 2019, while countries without REEs improved 2.8 points on average.[45]



Source: Ibrahim Index of African Governance, 2020.

Figure 3. Overall Governance in Africa, 2019

The poor performance of REE-rich countries on indicators of good governance and democracy do not suggest that REEs are the cause; Africa does not likely mine or export REEs in sufficient amounts to impact governance. Rather, the intent of noting this information is to underscore the importance of understanding the business climate and the risk to good governance posed by mismanaging natural resources. While it is unclear which countries will become major exporters of REEs, knowing the type of regime that will manage the natural resources is an important consideration in determining not only where a U.S. company may invest, but the mitigation or institutional reforms that may improve conditions for that investment.

5. Conclusions and Way Forward

Securing access to REEs is important to the future of the U.S. economy as they are key inputs for products used in everyday life. However, the United States' very limited domestic mining and processing capabilities, coupled with the reliance on China for REEs, raises these inputs to the level of a national security concern. As a result, the U.S. government has designated REEs as critical supply-chain elements; promulgated new policies and laws, related to fostering domestic production and reducing reliance on imports; filed formal complaints regarding Chinese REE trade practices; and endorsed various REE domestic-production activities. The United States continues to identify and cultivate alternative, non-Chinese, sources of these minerals. Africa could be an important source of REEs, but natural-resource governance must improve, as must Africa's democratic governance.

A. Africa is a relatively untapped potential exporter of REEs.

As the global competition for international influence moves to include Africa, REEs are not an exception. In the search for alternative sources of REEs, Africa emerges as a relatively untapped source. The U.S. Geological Survey identifies 99 deposits of REEs in 27 African countries, but the most recent available information indicates that mining companies have contracts to explore in only 8 countries, which presents an opportunity for the U.S. market.

B. REE-rich countries must improve natural resource management.

The history of natural resource exploration and acquisition should serve as a guide to the United States, as well as the international community, in general. REEs, like the rest of the natural resource family, best serve the host nation and the trading partner nation when the following elements exist: a strong infrastructure to ensure transparency and accountability, good governance practices, and a functional democracy with a diversified economy. Moreover, some environments do not yield level playing fields for international investors because they have less ability to enforce contracts and rely upon the rule of law. Adherence to EITI principles has improved countries' performance on these important metrics, but only 16 of the 27 REE-rich countries in Africa are members of EITI. The international community should provide incentives for the remaining countries to join EITI.

C. Africa's level of democracy must improve.

REE-rich African countries differ significantly on measures of good governance from non-REE-rich African countries. On average, the continent performs poorly on such measures, having a predominance of non-democratic regimes and low levels of political rights and civil liberties. International attention to improve Africa's democratic institutions could potentially improve the continent's security landscape, rendering it a more stable and beneficial partner across all sectors. In this regard, strengthening democracy advances the U.S. national security strategy.

Appendix A.
Minerals with REE Deposits in Africa

		Namibia	South Africa	Mozambique	Malawi	Angola	Tanzania	Madagascar	Zambia	Burundi	Mauritania	DRC	Gabon	Guinea	Kenya	Egypt
Minerals with REE Deposits	***Totals***	27	23	21	20	17	12	11	9	6	6	5	5	5	5	3
Monazite	43	9	4	7	3		3	3	3	1	2		1		2	1
Bastnasite	20	3	1	1	4	1	2	2	1	2	2				1	
Carbonite	15		1	1	1	5	2					1			1	
Synchysite	12	2	2		2	2	1									
Eudidymite	11	1	1		3	2		1						1	1	
Parasite	9	1			1	2	2	1								
Allanite	8	1	2	1							1					1
pyrochlore	7		1						1				1	1		
Xenotime	7	3	1						1				1			
Florencite	4				2					1			1			
Other igneous-affiliated	4			4												
Mosandrite	4		1			1		2								
Akalic igneous	3		1						1							
Britholite	3		1	1	1											
Chevknite	3	1		1								1				
Fergusonite	3	1	1	1												
Lavenite	3					2						1				
Rinkite	3							2						1		
Rosenbuschite	3				1	1								1		
Yttrium Florite	3	3														
Apatite	2		1													
Daqingshanite	2				1				1							
Loparite	2		1	1												
Other, uncertain	2			2												
Phosphorite	2										1					1
Samarskite	2		1	1												
Ancylite	1	1														
Astrophyllite	1													1		
Carbocernaite	1	1														
Cerianite	1									1						
Cerite	1											1				
Cerium Goyazite	1						1									
Churchite	1		1													
Crandallite	1												1			
Europium Monazite	1											1				
Euxenite	1		1													
Florencite-Goyazite	1				1											
Goyazite	1		1													
Hydroxlapatite	1								1							
Rare earth carbonates	1						1									
Rare earth phosphates	1					1										
Rhabdophane	1									1						
Wöhlerite	1															

		Mali	Morocco	Uganda	Congo - B	Ghana	Nigeria	Somalia	Cameroon	Liberia	Libya	South Sudan	Zimbabwe
Minerals with REE Deposits	***Totals***	3	3	3	2	2	2	2	1	1	1	1	1
Monazite	43		1			1	1			1			
Bastnasite	20												
Carbonite	15			2								1	
Synchysite	12	1	1		1								
Eudidymite	11										1		
Parasite	9		1		1								
Allanite	8					1		1					
pyrochlore	7	1		1				1					
Xenotime	7						1						
Florencite	4												
Other igneous-affiliated	4												
Mosandrite	4												
Akalic igneous	3								1				
Britholite	3												
Chevknite	3												
Fergusonite	3												
Lavenite	3												
Rinkite	3												
Rosenbuschite	3												
Yttrium Florite	3												
Apatite	2												1
Daqingshanite	2												
Loparite	2												
Other, uncertain	2												
Phosphorite	2												
Samarskite	2												
Ancylite	1												
Astrophyllite	1												
Carbocernaite	1												
Cerianite	1												
Cerite	1												
Cerium Goyazite	1												
Churchite	1												
Crandallite	1												
Europium Monazite	1												
Euxenite	1												
Florencite-Goyazite	1												
Goyazite	1												
Hydroxlapatite	1												
Rare earth carbonates	1												
Rare earth phosphates	1												
Rhabdophane	1												
Wöhlerite	1	1											

Endnotes

[1] Alex Tilley and David Manley, "In a Low-Carbon Future, Better Mineral Governance Could Power Development," Natural Resource Governance Institute, September 27, 2017, https://resourcegovernance.org/blog/low-carbon-future-better-mineral-governance-could-power-development.

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[6] EITI, "Countries," https://eiti.org.

[7] REEs include the 15 lanthanides of the periodic table—lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium—plus yttrium and scandium (see: Marc Humphries, "Rare Earth Elements: The Global Supply Chain," Congressional Research Services, December 16, 2013, https://fas.org/sgp/crs/natsec/R41347.pdf).

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14. ABSTRACT

This paper provides an overview of rare earth elements in Africa; summarizes the current U.S. supply-chain vulnerability in Africa; and discusses how regime-specific factors, such as good governance, can indirectly affect U.S. national security and investment decisions.

15. SUBJECT TERMS

Africa; critical minerals; governance; natural resource management; rare earth elements; supply chain

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