Written Testimony of Ms. Allison Carlson, Acting Managing Director, FP Analytics

For: U.S. Senate Committee on Energy and Natural Resources

Hearing : Tuesday, September 17, 2019 – 9:30 a.m. Room 366, Dirksen Senate Office Building, Washington, D.C.

Focus: *The Sourcing and Use of Minerals Needed for Clean Energy Technologies*

As tensions between the United States and China brew over 5G and the question of who can be trusted to control the world's wireless infrastructure, relatively scant attention is being paid to an issue of arguably greater importance to the future of the world's economy and security: China's control of the raw materials necessary to the digital economy.

No new phone, tablet, car, or satellite can be made without certain minerals and metals that are located in a surprisingly small number of countries, and for which few commonly found substitutes are available. Operating in niche markets with limited transparency and often in politically unstable countries, Chinese firms have locked up supplies of these minerals and metals with a combination of state-directed investment and state-backed capital, making long-term strategic plays, sometimes at a financial loss.

Through in-depth analysis of company reports and disclosures, mapping of deal flows, quantification of direct and indirect equity stakes, and other primary research, FP Analytics produced the first consolidated review of this unprecedented concentration of market power. The fact-based analysis details how rapidly and effectively China's state-owned enterprises (SOEs) and state-linked private firms have executed its national ambitions, with far-reaching implications for the U.S. and the rest of the world. A summary of the report's findings is below.

"Going Out and Bringing In"

China's hallmark initiative, "Made in China 2025," aims to build strategic industries in national defense, science, and technology. To meet these objectives, in October 2016, the Ministry of Industry and Information Technology announced an action plan[1] for its metals industry to achieve world-power status: By deploying state-owned enterprises and private

[1] Ministry of Industry and Information Technology of the People's Republic of China, "Nonferrous Metal Industry Development Plan 2016-2020," October 2016, http://www.miit.gov.cn/n1146290/n4388791/c5288773/content.html.

firms to resource-rich hot spots around the globe, China would develop and secure other countries' mineral reserves—including minerals in which China already holds a dominant position.

The timing could not have been better. The fall in metal commodities prices from 2011 to 2015 left many mining companies around the world desperate for capital. By directly acquiring mines, accumulating equity stakes in natural-resource companies, making long-term agreements to buy mines' current or future production (known as "off-take agreements"), and investing in new projects under development, Chinese firms traded much-needed capital for control or influence over large shares of the global production of these resources. Despite China's slowing growth and a major pullback in its foreign direct investment in other sectors, the government has maintained robust financial support for resource acquisition; mergers and acquisitions in metals and chemicals hit a record high in 2018.[2]

Though it boasts a rich endowment of natural resources at home, China lacks significant reserves of three resources vital to its technology ambitions: cobalt, platinum-group metals, and lithium. It has successfully employed two strategies to secure global control of them. The first is driven by China's state-owned enterprises, which use development finance and infrastructure investment in higher-risk countries to establish close ties with government leaders. The second is investment by state-linked private firms in market-based economies. Both strategies have shown an ability to effectively adapt to local circumstances to achieve the same end.

SOE Strategy, Cobalt, and the Case of the Democratic Republic of Congo

With few governments having articulated, let alone implemented, an explicit resource strategy, China is more than a decade ahead in the game. In the Democratic Republic of Congo (DRC), which is home to nearly two-thirds of the world's cobalt production and half of its known reserves,[3] China's SOEs and private firms have targeted debt-stressed mining companies and secured equity shares and influence over a majority of its mines - over 52 percent of the country's production.[4] China's deep investment in copper and cobalt mining—which constitutes 80 percent of the DRC's export revenue[5] and thousands of jobs—has conferred an ability to influence the future of the DRC's economy.

Replicating the State-Owned Enterprise Model

China's SOE-driven strategy remains dominant throughout Africa, where adverse market sentiment and financial hardship in the mining industry have opened the door for SOE

[2] "PwC M&A 2018 Mid-Year Review and Outlook," PricewaterhouseCoopers, https://www.pwccn.com/en/deals/publications/ma-2018-mid-year-review-and-outlook.pdf.
[3] "BP Statistical Review of World Energy," BP, June 2018, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf.
[4] FP Analytics analysis.
[5] "The World Bank in DRC," The World Bank, May 16, 2018, https://www.worldbank.org/en/country/drc/overview.

investment across the region. Notably, SOEs have partnered with the Chinese state-funded China-Africa Development Fund to expand in South Africa's Bushveld Complex. Bushveld is a mineral-rich geological formation that contains the world's largest reserves of platinum-group metals, which are key to making catalytic converters that reduce automobile emissions. The Complex also holds the world's highest-grade and third-largest deposit of vanadium - a resource integral to a broad range of high-tech industries, from renewable-energy storage to aerospace and defense. Such investments in South Africa's highly concentrated and strategic resource deposits have helped make metals the country's leading source of export growth,[6] with nearly 50 percent of its metal exports going to China[7]—tying South Africa's economic welfare directly to Chinese investment.

Private Firms and the Extension of State Strategy Abroad

China is also proving agile at adapting to conditions in market-oriented, democratic countries, using privately owned companies that are backed by state capital. By incrementally acquiring equity stakes in major local resource companies and financing junior developers, Chinese firms are strengthening their market presence. Nowhere is this privately driven resource strategy more evident than in the three countries where nearly 90 percent of global lithium production and more than three-quarters of the world's known lithium reserves are located: Chile, Argentina, and Australia.[8] By acquiring a major stake in the leading producer in Chile, financing new development in Argentina, and acquiring mines and building up processing capacity in Australia, Chinese firms are dominating the global market: More than 59 percent of the world's lithium resources are now under their control or influence.[9]

China Reinforcing Its Resource Dominance

Already the dominant producer in a range of critical minerals and metals, China is investing in additional supplies in foreign markets thereby strengthening its global position. Natural resources are abundant in China; it is the No. 1 producer and processor of at least ten critical minerals and metals[10,11] that are essential to high-tech industries and upon which China's commercial and strategic competitors depend. To reinforce its dominant position,

---

[6] "Statistical Release P0441: Gross Domestic Product, Fourth quarter 2017," Statistics South Africa, June 5, 2018, http://www.dmr.gov.za/Portals/0/files/P04414thQuarter2017(1).pdf?ver=2018-03-09-063718-170.

[7] "South Africa Minerals Exports By Country 2017," World Integrated Trade Solution (WITS), The World Bank, https://wits.worldbank.org/CountryProfile/en/Country/ZAF/Year/LTST/TradeFlow/Export/Partner/by-country/Product/25-26_Minerals.

[8] "BP Statistical Review of World Energy," BP, June 2018, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf.

[9] FP Analytics analysis.

[10] "Mineral Commodities Summaries," U.S. Geological Survey, 2019, https://minerals.usgs.gov/minerals/pubs/mcs/.

[11] The definition of "critical" or "strategic" and the exact list of minerals, metals, or materials varies by jurisdiction, but a literature review of major studies assessing "criticality" identifies the resources most commonly categorized and cited in official documents. China is the leading global producer of the majority of those listed, including natural graphite, rare-earth elements, vanadium, indium, tungsten, gallium, antimony, tellurium, cadmium, and molybdenum. Also see: https://www.sciencedirect.com/science/article/pii/S0301420718301296?via%3Dihub.

Chinese firms are acquiring mines and output from the next-largest producers and reserves, giving China both an economic edge in the next high-tech industrial revolution and increasing geopolitical power.

Perhaps the best-known example both of China's natural-resource dominance and its willingness to exploit it is rare-earth elements. Rare earths are a group of 17 elements that (despite their name) are commonly found, but rarely in concentrations that can be economically extracted. They are important materials for the defense, aerospace, electronics, and renewable energy industries. Over the past two decades China has produced more than 80 percent of the world's rare-earth elements and processed chemicals. Six state-owned enterprises control the industry.[12] In 2010 China cut off exports to Japan[13] amid rising tensions over the East China Sea - demonstrating China's ability and willingness to exert control over critical minerals for commercial and geopolitical ends. With global demand for rare-earth elements projected at a compound average growth rate of more than 17 percent to 2025,[14] a supply crunch is likely approaching—and China is already securing other nations' supplies, including in the U.S., Australia, and Greenland.

China is also expanding its dominant market position in vanadium and graphite, securing additional supplies and building integrated supply chains. Vanadium is a transition metal that is used in flow batteries, superconducting magnets, and high-strength alloys for jet engines and high-speed aircraft. Chinese firms already produce 56 percent of the world's vanadium domestically, and China is home to 48 percent of the world's reserves.[15] Now, they are targeting South Africa - ranked third in vanadium production and reserves behind China and Russia[16] - and tapping into local companies' plans to develop an integrated platform to produce vanadium redox flow batteries for distributed energy across South Africa.[17] The vanadium resources will also flow toward China, feeding its battery industry and the National Development and Reform Commission's planned rollout of 100-megawatt stationary energy storage stations to manage its wind and solar energy.[18]

China's position is even stronger in graphite, a crystalline form of the element carbon whose high conductivity makes it a major component in electrodes, batteries, and solar

---

[12] "Barbara Lewis and Ernest Scheyder, "China cutting rare earth output, unnerving global manufacturers," *Reuters,* Oct. 24, 2018, https://www.reuters.com/article/us-china-rareearths/china-cutting-rare-earth-output-unnerving-global-manufacturers-idUSKCN1MY2GZ.

[13] Keith Bradsher, "Amid Tension, China Blocks Vital Exports to Japan," *The New York Times,* Sep. 22, 2010, https://www.nytimes.com/2010/09/23/business/global/23rare.html.

[14] "United States Securities and Exchange Commission Form 10-K: Rare Element Resources Ltd.," fiscal year ended Dec. 31, 2017, http://www.rareelementresources.com/docs/default-source/financial-reports/p05218_rare-element-resources_2018_10k_v2.pdf?sfvrsn=0.

[15] "Mineral Commodities Summaries 2019," U.S. Geological Survey, https://minerals.usgs.gov/minerals/pubs/mcs/2019/mcs2019.pdf.

[16] Ibid.

[17] "Bushveld Minerals: Right commodity, right asset, right time," Alternate Resource Capital, March 1, 2018, http://www.bushveldminerals.com/wp-content/uploads/2018/03/BMN_010318.pdf

[18] "Bushveld Minerals acquisition of Bushveld Vametco Limited," Bushveld Minerals, December 2017, http://www.bushveldminerals.com/wp-content/uploads/2017/12/Bushveld-Minerals-acquisition-of-Bushveld-Vametco-Limited_Final.pdf

panels, as well as industrial products such as steel and composites. Rapidly growing demand for batteries and other end uses, coupled with environmental restrictions in China, are driving prices higher and stimulating investment in new projects concentrated in Mozambique, where the world's largest graphite mine and fourth-largest known reserves are located.[19]

Controlling most of the world's graphite, China has expanded down the supply chain, becoming the world's leading producer of anodes, positively charged electrodes that are essential for making lithium-ion batteries. Increasing volumes of graphite are being channeled toward China's booming domestic battery and new electric-vehicle industries. Stockpiling domestic production and restricting graphite exports could result in a supply crunch for other end users.

Controlling the Fuel of the Future

This resource consolidation could determine whether China is able to overcome the last major hurdle to achieving its ambitions: a competitive semiconductor industry. The lifeblood of high-tech industries, semiconductors are made of the very minerals and metals over which China is securing control. Several materials are now being used to improve speed and performance, including rare-earth elements, graphite, indium, gallium, tantalum, and cadmium. China is the dominant producer of five out of the six, controls more than 75 percent of the world's supply of three,[20] and is consolidating control over them all.

However, China still lacks the technological capability to produce semiconductors on par with the industry's leading companies and remains highly dependent on imports, at a cost of roughly $260 billion per year.[21] Should China succeed technologically, its capacity to scale production and flood markets has serious implications not only for leading semiconductor producers, but also for national security. The ramifications for U.S. national security could be severe if Chinese-manufactured chips are embedded in the devices upon which our data-driven lives, our economies, and our defense systems increasingly depend.

This is not a foregone conclusion. It will, however, require us to fundamentally rethink how we understand strategic industries and the long-term investments needed to ensure economic prosperity and national security in the digital age. While sustainable resource development will be part of that analysis, intensified focus on industrial and post-consumer minerals recycling and robust investments in materials science R&D could help reduce dependence on extraction, mitigate supply chain vulnerabilities, and provide alternative sources of supply that are critical to high-tech industries' competitiveness and security.

---

[19] Mozambique has the fourth highest reserves at 17 million tons, tied with Tanzania which also as 17 million tons of estimated reserves. "Mineral Commodities Summaries: Graphite (Natural)," U.S. Geological Survey, 2019, https://minerals.usgs.gov/minerals/pubs/commodity/graphite/mcs-2019-graph.pdf.

[20] "Mineral Commodities Summaries 2019" U.S. Geological Survey, https://minerals.usgs.gov/minerals/pubs/mcs/2019/mcs2019.pdf.

[21] Shunsuke Tabeta, "Chinese companies rush to make own chips as trade war bites," *Nikkei Asian Review,* Nov. 7, 2018, https://asia.nikkei.com/Business/China-tech/Chinese-companies-rush-to-make-own-chips-as-trade-war-bites.

FP Analytics is the research and advisory division of The Foreign Policy Group. Allison Carlson is FP Analytics' Acting Managing Director, overseeing all global research and analysis. She counsels clients on current and prospective market, policy, and security developments. Prior to this role, Carlson led FP Analytics' energy and technology team for over a decade. Carlson received her master's degree from the Johns Hopkins School of Advanced International Studies (SAIS) in international relations and international economics.