Response to Question for the Record
By Misael Cabrera. PE
June 23, 2024

regarding

Committee on Natural Resources
Subcommittee on Energy and Mineral Resources
Legislative Hearing
1334 Longworth House Office Building
June 4, 2024
11:15 AM

H.R. 6395 (Rep. Curtis), "*Recognizing the Importance of Critical Minerals in Healthcare Act of 2023*";

H.R. 8446 (Rep. Ciscomani), To amend the Energy Act of 2020 to include critical materials in the definition of critical mineral, and for other purposes; and

H.R. 8450 (Rep. Cammack), "*Phosphate and Potash Protection Act of 2024*".

Question from Rep. Curtis for Professor Cabrera, Director, School of Mining & Mineral Resources

1. Reliance on foreign anode suppliers persists, and the U.S. is nearly 100% reliant on imports of anode materials. U.S. leadership in this critical mineral is possible, and ensuring its listing on the USGS list of critical minerals is another market signal and accelerator to showcase our domestic capabilities. Can you discuss the importance of research and development, and the domestic sourcing of these essential resources, including silicon and silicon carbide in next-generation battery technology?

Answer from Professor Cabrera, Director, School of Mining & Mineral Resources

Critical minerals and materials are available mainly through the refining of ore. Chrysocolla, a naturally occurring copper oxide ore, cannot be extruded directly into electric wire; quartz, sans an electric arc furnace and further chemical processing, cannot be used to manufacture semiconductors; and hematite, a naturally occurring iron oxide, cannot be used to manufacture efficient motors. A refined material, electric steel, is needed for that. Minerals and materials become critical – in almost every practical modern sense – by reducing ore to near-elemental form through refining. For example, copper used in potable water piping has a purity of 99.9%.[i] Similarly, silicon semiconductors must be more than 99.9999% pure.[ii] Further, copper and silicon are also essential to the energy transition. Thus, everyday modern life and decarbonization rely heavily on refining ore.

Given the importance of refining for critical materials and minerals, it is imperative that we invest in research and development for domestic production. A long-standing lack of funding opportunities has unfortunately resulted in critical minerals and materials dominance from an unfriendly global competitor. A recent editorial in *Nature* succinctly captures the urgency of the current situation: "…just one country – China – has become the world leader in refining and processing these crucial elements for use in finished products."[iii] Further, according to the United States Geologic Survey, China was the leading nation, producing roughly two-thirds of critical minerals in 2023.[iv] This dominance results in more than just economic and supply chain impacts. In 2022, coal consumption in China, the world's largest CO_2 emitter, increased by 4%.[v] The US decreased coal consumption by 5.5% in the same year.[vi]

Domestic research and development for critical minerals and materials is particularly urgent as we innovate during the energy transition. The International Energy Agency reports, "Since 2010 the average amount of minerals needed for a new unit of power generation capacity has increased by 50% as renewables increase their share of total capacity additions. The transition to clean energy means a shift from a fuel-intensive to a material-intensive system."[vii]

One of the most significant and mineral-intensive challenges in moving towards renewable energy is storage, i.e., batteries. Domestic research in energy storage and the minerals and materials that enable the technology should be accelerated. For instance, the development of solid-state lithium batteries using silicon as the anode has shown promise, with limited commercial manufacturing already underway. These discoveries could create significant advances in various battery applications.[viii] Beyond batteries, the electric vehicle market's expansion has opened new prospects for silicon carbide, given its superior performance in EV inverters and controllers. Silicon carbide provides higher switching frequency, thermal resistance, and breakdown voltage, contributing to higher powertrain efficiency.[ix]

As stated during my testimony on June 4, 2024, the four DOE Critical Materials absent from the USGS Critical Minerals List are copper, silicon, electric steel, and silicon carbide. These materials are essential to the energy transition and modern life and require research and domestic supply funding. I applaud the House Committee on Natural Resources for approving H.R. 8446 on June 12, 2024, moving closer to providing equal benefits to both lists.

In conclusion, I encourage Congress to dramatically accelerate research funding of critical minerals and materials, particularly for innovative and sustainable refining methods. For instance, bioleaching, a process that uses microorganisms to extract metals from ores, has shown promise in reducing the environmental impact of traditional mining. Our reliance on critical minerals and materials from foreign refining creates defense insecurity, economic insult, and environmental injury.

[i] Copper Development Association Inc. "Why Copper." Accessed June 22, 2024. https://www.copper.org/applications/plumbing/water_service/why_copper.html

[ii] 7.10: Semiconductor Grade Silicon. "Chemistry of the Main Group Elements (Barron)." LibreTexts. Accessed June 22, 2024. https://chem.libretexts.org

[iii] Nature. "Sustainability, Equity and Security at Risk in Rush for Rare-Earth Metals." Nature 619, 436 (2023).

[iv] U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p., https://doi.org/10.3133/mcs2024

[v] Shihui Zhang, Chi Zhang, Wenjia Cai, et al. "The 2023 China report of the Lancet Countdown on health and climate change: taking stock for a thriving future." The Lancet Public Health, Volume 8, Issue 12, 2023, Pages e978-e995. Accessed June 22, 2024. https://doi.org/10.1016/S2468-2667(23)00245-1 (https://www.sciencedirect.com/science/article/pii/S2468266723002451)

[vi] EIA. 2023. "Annual Coal Report - Energy Information Administration." Accessed June 22, 2024. https://www.eia.gov/coal/annual/

[vii] IEA (2021), "The Role of Critical Minerals in Clean Energy Transitions." IEA, Paris. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

[viii] Ye, L., Lu, Y., Wang, Y. et al. "Fast cycling of lithium metal in solid-state batteries by constriction-susceptible anode materials." Nat. Mater. 23, 244–251 (2024). https://doi.org/10.1038/s41563-023-01722-x

[ix] NIKKEI Tech Foresight, Battle to secure SiC wafers - power semiconductors for EVS. Accessed June 22, 2024. https://www.coherent.com/news/battle-to-secure-sic-wafers-power-semiconductors-for-evs-en