House Committee on Science, Space, and Technology
Subcommittee on Energy
Subsurface Science and Technology: American Energy & Mineral Dominance

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Chairman Weber, Ranking Member Ross, and members of the Energy Subcommittee, thank you for the opportunity to share my perspective on the science and technology needed to strengthen U.S. energy and mineral supply.

My name is Elizabeth Holley, and I am a Professor in the Mining Engineering Department at the Colorado School of Mines, where I lead an interdisciplinary research team focused on the responsible domestic production of critical minerals. Through our work with industry, government, and community partners, I have developed new insights on the science and technology needed to secure a resilient U.S. critical mineral supply.

The U.S. Geological Survey currently identifies 60 critical minerals, while the Department of Energy identifies 19 elements and materials critical to energy technologies. As a geologist, I want to make it clear that critical minerals are not one challenge. Each mineral presents unique geologic, technical, economic, and social considerations that require deposit-specific analysis and tailored technological solutions.

For some elements, such as germanium for defense technology, annual U.S. imports are extremely small—equivalent to about five washing machines. For others, like copper, demand is so large that meeting projected needs requires discovering and developing a new world-class deposit every year. Attempting a one-size-fits-all approach would be like designing a single supply strategy for all agricultural products. If the United States is going to develop secure mineral supply chains, we must first understand our mineral resources and then strategically prioritize investments in science and technology tailored to each case.

A Systems Framework for U.S. Mineral Supply

For the last five years, I have led an interdisciplinary research team at the Colorado School of Mines, Fort Lewis College, and Montana Technological University to develop a systematic framework for responsible U.S. mineral supply. This work has been primarily funded by the National Science Foundation—the only federal agency that brings scientists, engineers, and social scientists together to solve complex, systems-level challenges.

Our research examines six distinct mineral supply pathways:

1. Imports of ores, concentrates, refined materials, or manufactured products
2. Recycling
3. New mine development
4. Recovery of byproduct minerals during active mining
5. Reprocessing of already accumulated mine waste
6. Demand reduction through substitution and efficiency

Meeting demand for each critical mineral will require a different blend of the six pathways. This is a complex optimization problem. Solving that problem—and doing so efficiently—is the focus of our research.

For high-demand materials such as copper, the U.S. will need a combination of all six pathways, including new mining. In contrast, for germanium, our work shows that the entire U.S. supply could be recovered through a single pilot-scale byproduct recovery circuit at one U.S. mine. For materials with moderate demand, such as antimony, supply could be secured through a combination of byproduct recovery and reprocessing of accumulated mine waste at a handful of specific sites.

In recent months, the Department of Energy has made substantial investments in critical mineral projects, ranging from laboratory-scale technology development to large demonstration projects. At Colorado School of Mines, we aim to support these efforts through R&D partnerships across all scales. However, more systematic prioritization would allow better targeting of these federal investments.

Byproduct Recovery & Mine Waste

One of our most important findings is that the United States already mines nearly all of the critical minerals it needs, but most of this material is unrecovered and becomes waste. Recovering even one percent of these mineral byproducts could significantly reduce U.S. reliance on imports. Unlocking this opportunity requires science and technology R&D as well as new economic and policy approaches.

First we must understand which specific minerals host each critical element at each site, and how those elements behave throughout a processing flowsheet. This demands specialized geometallurgical expertise—the integration of geology, mineralogy, metallurgy and mineral processing, geochemistry, mining engineering, and data science. Since the dissolution of the U.S. Bureau of Mines, much of this interdisciplinary expertise has been lost at the federal level or fragmented across agencies. The U.S. mining schools have kept this capability alive.

Our interdisciplinary research team has leveraged its expertise to develop site-specific datasets identifying mines and mine-waste repositories where targeted federal investments could rapidly and systematically reduce U.S. critical mineral vulnerabilities.

Constraints on Critical Mineral Development

When we consider new mine development, our research shows that the geological endowment of many critical minerals in unmined deposits is sufficient for US needs – for example the US has enough undeveloped cobalt, nickel, lithium, manganese, and graphite, to meet projected energy demand**.** However, exploration efficiency must be improved. USGS data, for example Earth MRI, are fundamental to these efforts, but it is still going to take private sector investment and site-specific boots-on-the ground to turn prospectivity maps into confirmed resources and reserves. The average copper property is explored by two to five companies before a discovery is made. Countries such as Canada are improving exploration efficiency by requiring companies to share data. Direct scientific observation through exploration drilling will remain key to investor confidence. Interpolation between the drill holes must leverage advanced sensing techniques to derisk mining and processing.

Even where there are known deposits, many domestic resources remain unavailable due to technical, economic, and social constraints. Mining investors require detailed studies to de-risk projects—often over decades. Our research shows that when social risk is considered, the net present value of many large mining projects could approach zero. Delays or stoppages during construction due to lack of social acceptance incur massive costs to a project, especially during capital-intensive construction. In addition, some known resources, such as cobalt in Idaho, are not economically viable when markets are dominated by China.

A Strategy for U.S. Mineral Security

This brings me back to the fastest and most actionable opportunities to strengthen domestic supply: byproduct recovery and mine-waste reprocessing. These supply taps can be turned on first—but only if we invest in the science and technical expertise needed to measure and recover what we already mine.

To meet U.S. critical mineral demand, an informed national strategy must include three key actions:

First, we must measure what we mine by systematically identifying and quantifying critical mineral byproducts in U.S. operations and in accumulated mine waste.

Second, we must fund targeted, deposit-specific R&D focused on cost-effective byproduct and waste-recovery methods that do not compromise primary production.

Third, we must rebuild interdisciplinary expertise by investing in talent and institutional structures that allow geoscientists, engineers, and social scientists to work together—through mechanisms such as interdisciplinary federally-funded research centers, and expanded collaboration among mining schools, industry, the U.S. Geological Survey, the Department of Energy, and others.

At Colorado School of Mines, we are particularly excited about the planned relocation of the USGS Energy and Minerals Research facility to our campus in 2027. Academia has the missing link in expertise, for example in geometallurgy, and can serve as the bridge between the Department of the Interior's science and the Department of Energy's technology development and site-specific implementation.

With a targeted strategy and sustained investment in subsurface science and technology, the United States can close the gap between national mineral assessments and real-world deployment—and secure the materials needed for long-term energy and mineral supplies.

Thank you for the opportunity to testify. I look forward to your questions.