SENATE COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS

SUBCOMMITTEE ON EMPLOYMENT AND WORKPLACE SAFETY

Hearing: Digging Deeper: Building Our Critical Minerals Workforce

Date: Wednesday, June 12, 2024

Time: 2:30 p.m.

Place: 562 Dirksen Senate Office Building

Senators, staff, and guests. Good afternoon and thank you for the opportunity to address you regarding the urgent need to expand our critical minerals workforce. My name is Barbara Arnold, a professor of practice and chair the mining engineering program at The Pennsylvania State University. I teach and conduct research on mine health & safety focused on respirable dust and on critical minerals, assessing the domestic critical mineral resource especially in Appalachia. I obtained my BS in mining engineering and MS and PhD in mineral processing from Penn State, conducted coal beneficiation research at the Electric Power Research Institute's Coal Cleaning Test Facility in Homer City, PA, and then started my own company, selling coal and mineral processing equipment to engineering contractors and coal and mineral companies, developing flowsheets for coal preparation plant retrofits and new construction. In 2020, I joined the faculty at Penn State.

Allow me to start by saying that there are already issues related to the mining and mineral industry workforce, skilled labor as well as scientists and engineers. This will translate to even greater needs for the critical mineral workforce as we will need even more people equipped with mineral exploration, processing, extractive metallurgy, and refining backgrounds. We have 14 mining engineering programs in the US and even fewer economic geology or processing and metallurgy programs.

Related to the current mining and mineral industry workforce issues, the National Academies hosted a workshop in late January 2024 that was supported by the United States Geological Survey titled, *Building Capacity for the U.S. Mineral Resources Workforce*. The workshop report was recently published. Let me quote from that report:

> Kecojevic described a sharp drop-off in mining engineering enrollments, from a collective total of 1,449 U.S. undergraduate students in 2015 to just 590 in 2023, a 60 percent decline over 9 years. The 14 mining engineering programs across the United States collectively graduated only 162 students in 2023, falling far short of the estimated employment demand for 400–600 mining engineering graduates per year in the United States. By contrast, China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3,000 a year—about 16 times the number of graduates in the United States. Keane stated that while enrollment in geosciences undergraduate

> programs may have rebounded to early 2010s levels following the COVID-19 pandemic, there was a nearly 50 percent drop in enrollment in geoscience graduate programs after 2019.At the same time, demand is rising for geoscience support activities and professional services for mining.

One might think that the need for critical minerals and a domestic supply of these would encourage increased enrollment in our mining engineering programs. But let me quote the NASEM report again:

> A key concern, expressed by several participants, is that negative public perceptions of mining can dissuade students from considering a career in minerals extraction. Climate change and environmental degradation are prominent issues for the current generation, and for many, the minerals industry is linked with a legacy of environmental damage, which has been reinforced by negative depictions of the industry in popular culture. To begin to overcome this perception, several participants suggested focusing on reframing the industry as being part of the solution to environmental issues. For example, minerals extraction provides materials necessary for the technologies that play an important role in achieving decarbonization, such as wind turbines, solar panels, and electric vehicles. Improving awareness of the role of mining in addressing climate change and environmental degradation could help to attract students who are passionate about the environment. "Without turning a blind eye to the real environmental damage that's been done in the history of mining, we can still be very proud of mining and what it has done for our planet," Misael Cabrera, University of Arizona, said. "In fact, modern civilization is simply not possible—medicine, computing, data analytics, take your pick—none of it is possible without minerals, and therefore without mining." Cabrera also pointed to mine waste, remining, and reclamation as opportunities for the minerals industry to advance environmental stewardship.

What can those of us in the trenches do? The Society for Mining, Metallurgy, and Exploration (SME), the lead US based mining professional society, is taking this issue very seriously, and one of its strategic committees is focused on workforce development. As early as 2014, SME released a white paper titled, *Workforce Trends in the U.S. Mining Industry*, indicating significant shortages in scientists, engineers, skilled labor. At that time, SME addressed another critical need—the number of faculty available for our mining engineering programs. Their PhD fellowship and career grant program helped address this along with research funding for capacity building from the National Institute of Occupational Safety and Health. SME notably is also promoting a series of videos, Jobs of Tomorrow, available on YouTube. Yes, jobs of tomorrow.

The mining industry itself is moving toward a digital future. We incorporate *digital twins* for optimization of mining and mineral processing technology; we fly drones to monitor tailings impoundments, do areal surveys of stockpiles, and collect water samples. Autonomous haul trucks and trains move materials. Automation and control technologies are becoming more and more sophisticated. Some of this will help to address worker shortages. However, we still need skilled scientists and engineers to ensure that we deliver our mined products in the safest and

most responsible way and to develop new technologies to mine and process ores and waste materials. A recent report, called *The Digital Underground*, from Mining Magazine and Mining Monthly, discusses how data analytics will be key in incorporating the large data streams coming from underground mining equipment. Another report could be written on the digital surface mine or the digital processing plant.

Those of us at the US mining schools continue to address our curricula to incorporate this ever-changing landscape. At Penn State, we've added courses on automation and control and sustainability. Despite these efforts, we still struggle to attract more students into our programs. In spring 2023, we graduated only four students with bachelor's degrees in mining engineering at Penn State. One is working for an engineering company in Utah, one in New York and one in Baltimore are working in the aggregates industry. The fourth recently left an aggregates company in Virginia to work with a gold company in South Carolina. Their average starting salary with their bachelor's degree was $75,000. This May, we graduated two who are starting their careers with aggregate companies, and a third will graduate in December. Good paying jobs, an increasingly safe and environmentally conscious industry, applications of high technology, addressing a key supply chain component—if it can't be grown, it must be mined. Why do we not have more students? In the QS university rankings, our Penn State mining engineering program is ranked second in the US and thirteenth globally (up from seventeenth last year), so we should be attracting talent. We know that the number of traditional-aged college students is decreasing. We know that other industries are also seeing a shortfall of workers. But if we don't address the critical need for more mining and mineral processing engineers, we will not be able to meet our domestic critical mineral needs.

We have offered seminars to students interested in STEM fields, and we have begun collaborating more closely with our College of Engineering advising staff. We're offering our first-ever MINING ROCKS! Penn State Summer Mining Camp in August that is free-of-charge to the first 20 students that sign up. It's free-of-charge because it's being sponsored by our alumni and mining industry contacts. The students that do enter our program often receive scholarships from our program endowments. We encourage them to apply for the many scholarships that are available for students in the industry. They visit mines, attend industry conferences, and hear from industry speakers. Many companies come to recruit interns and full-time employees each fall. Our students get multiple job offers. Our introductory mining course has about 70 students enrolled in both the Fall and Spring semesters. Most are upper-level students who are taking it as an elective and are well past considering mining engineering as a major at that point. Incoming students just don't know that mining exists. And it's not just at Penn State. The University of Arizona's program surveyed incoming students and found that many students were not aware of mining engineering as a career. That's in a state that is ranked number two in the value of non-fuel mineral production in the US (Minerals Commodity Summary, USGS, 2024). Arizona produces cement, copper, molybdenum mineral concentrates, sand and gravel for construction, and crushed stone and their principal commodities.

Some actions were suggested during the NASEM workshop. One specific action is to include the importance of minerals in our daily lives in K-12 curriculum. There are 62 different elements in a cell phone—all need to be mined. Electric vehicles require much more copper and other critical minerals than conventional cars. Wind turbines and solar panels all require critical minerals.

According to a 2021 report by the International Energy Agency titled, *The Role of Critical Minerals in Clean Energy Transitions*, mineral demand will increase by about four times by 2040 to meet climate goals. Where will the minerals come from? Who will mine the minerals safely and responsibly? We need everyone to understand that if it can't be grown, it must be mined.

Social media is a great place to see memes thanking farmers or thanking truck drivers. I agree that we should. But we also need to be thanking miners. Miners provide the fertilizers and the metal for farm implements. Miners provide metals for trucks and the catalysts for catalytic converters in those trucks to reduce pollution. And they provide all the critical minerals in our increasingly high-tech everyday lives. Thank a miner every day!

Thank you for allowing me to discuss the critical mineral workforce with you today. I am happy to answer any questions.