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Before the:
Subcommittee on Oversight and Investigations
Committee on Natural Resources
United States House of Representatives

Hearing on:
"*Exploring the Potential of Deep-Sea Mining to Expand American Mineral Production*"

April 29, 2025

Good morning, Chairman Gosar, Ranking Member Dexter, and Members of the Subcommittee. Thank you for the opportunity to speak to you today.

I am a Professor of Mechanical Engineering at MIT. Ten years ago, I directed my research group's activities to study human activities in the ocean, with one focus being deep sea mining and its potential impacts. We do not take a position on deep-sea mining; our mission is to perform objective research to inform discussions such as we are having today.

My group, the Environmental Dynamics Lab, or ENDLab, has been the only U.S.-based team working on sediment plume disturbances created by deep-sea mining. A sediment plume is like the dust cloud that is stirred up behind a vehicle driving down a dusty road. Deep sea mining activities similarly stir up sediment from the ocean floor, and that sediment can be carried away from the mining area by ocean currents. This is important because of a sediment plume's potential to create impacts away from, and on a larger scale than, the direct mining site.

We are the only team to have participated in both of the deep-sea nodule mining trials in 2021 and 2022 in the Clarion Clipperton Zone of the Pacific Ocean. We have published 11 papers in peer-reviewed journals on the topic. I am a member of the International Seabed Authority (ISA) Expert Working Group on Thresholds, and an advisory board member for the EU's TRIDENT project to research monitoring and modeling systems for deep-sea mining.

In recent years, my research group at MIT and researchers around the world have made significant advances in understanding the potential impacts of nodule mining activities. The key findings indicate that some of the impacts of nodule mining may not be as speculated. Some key findings are as follows:

- For the technologies tested in 2021 and 2022, roughly the first 2 inches of ocean floor sediment was suspended into the water column, which is less than the 6-to-12 inches that has been hypothesized.

- Rather than all the suspended sediment forming a plume, 92-98% of the sediment was either deposited on the seabed within around 300 feet of the mining tracks or remained suspended in the water column less than 2 feet above the seabed.

- The remaining 2-8% of sediment was suspended up to around 15 feet above the seabed, which is less than the hundreds of feet above the seabed that had been conjectured. It is carried away from the mining site by ocean currents in concentrations of a few milligrams per liter, which is roughly equivalent to a grain of sand in a fishbowl.

- Tracks in the seabed from mining trials in the 1970's are still evident today, but there is minimal evidence of the sediment plume to the side of the tracks. While persistent biological effects have been observed, the populations of several organisms, including animals in and on the sediment, and ranging from small to large sizes, have begun to re-establish themselves despite the physical changes to the seafloor.

- Across the Clarion-Clipperton Zone, recent estimates put the total number of biological species between 6,000 and 8,000, only 438 of which have scientific names. Broadly speaking the region has at least two major zones to the east and west, but there is finer scale variability that affects the seafloor life. Therefore, a patchwork of protected areas is needed for effective environmental management. This will entail both putting some large areas off-limits to mining, and protecting some smaller sections within areas that are otherwise open to mining. Such a multiscale approach has been developed by leading scientists for the ISA.

Recent field trials conducted by contractors in 2021 and 2022, which were short-term and pilot-scale, rank among the largest deep-sea monitoring efforts to date, providing a foundation for assessing the long-term impacts of commercial-scale operations. These efforts aim to reduce uncertainty and support informed regulatory decision-making for proposed deep-sea mining operations. While research to date has been valuable and resolved misconceptions, as I described previously, much still remains to be learned about the consequences of scaling up to commercial operations.

Deep-sea mining should only be permitted to move ahead to commercial scales in a step-by-step fashion as the tools and methods required to assess its impacts are further developed and deployed, and learnings obtained. This would allow for essential studies related to biodiversity loss and ecosystem function, to understand at what scale mining in particular areas could be ecologically viable. Furthermore, this would support reliable predictions of the impacts of commercial scale deep-sea mining; guide the creation and enforcement of a strong, effective regulatory framework; and inform any necessary adjustments or critical decisions.

To accomplish this, further advances in sensor technologies and computational modeling are needed. Existing sensors are generally capable, but can also be expensive. Dedicated programs are needed to develop the next generation of cost-effective sensors, platforms such as autonomous vehicles that can host the sensors, energy sources to power the sensors and platforms, and subsea communication tools. This will make monitoring more capable of operating at the scales required, across hundreds of miles and over multiple years.

Even with these advances, monitoring will inevitably be challenged by the vast scales and extreme depths of the ocean. Advanced modeling systems will be needed to analyze the data and to enable prediction, situational awareness, adaptive management, and effective permitting and governance. Emerging computational models, based around GPU processers and enhanced by AI-assisted algorithms, can outperform legacy systems and help derive learnings from sensor data, producing significant gains in insight, confidence, transparency, and trust.

The U.S. should play an active role in the development and operation of technologies, sensors and computational systems for deep-sea mining, but currently it is not. In the 1970's through the mid 1980's, the U.S. was the global leader - a pioneering example being the NOAA Deep Ocean Mining Environmental Study (DOMES) project. Over the past 30 years, however, research funding from the U.S. government has been absent. Meanwhile, China is conducting technology trials at a rate matching every other nation combined. The European Union has funded three projects to the tune of $50 million to develop resource assessment and monitoring technologies. And in Japan, a $100-million initiative is taking place to test nodule technology in its Exclusive Economic Zone. Data is not readily available on funding for programs in countries such as China and India, but over recent years the amounts invested are likely much greater than what is being spent by Europe and Japan.

Without strategic investment, the U.S. risks falling behind. With its immense talent pool in deep ocean operations, however, the U.S. could play a leading role in advancing this critical work. NOAA, with its experience and capabilities, as well as its access to Federally Funded Research and Development Centers across federal agencies, is well positioned to lead U.S.-based efforts. But the U.S. will need to invest significantly and soon, or rely on the learnings and technological advancements made by other countries. That will make it harder for the U.S. to engage in the nascent arena of deep-sea mining, and more challenging to ensure that any future deep-sea mining activities are informed by the best science, the best monitoring capabilities, and the strongest protections.

Thank you again for the opportunity to provide the Committee with information on this topic. I am happy to answer any questions.