Deep Sea Mining: The Underwater Gold Rush

Executive Summary & Key Takeaways

Long considered an industry of the far future, commercially viable Deep Sea Mining (DSM) is now imminent. Growing demand for these limited resources, paired with depleting terrestrial sources, technological advancements, and a push to rapidly finalize regulations means DSM is on the verge of taking off on a great commercial scale. The push for action is only intensified by current dependence of many countries, including the United States, on China to provide and process rare earth elements. Since the late 1990s, China has provided more than 90 percent of the world’s supply of rare earth elements by controlling at least 85 percent of the world’s capacity to process rare earth ores into material manufacturers can use. It also holds the most contracts to explore seabed mining areas that contain these rare earth elements and other critical minerals, such as cobalt and manganese.

- Resources extracted from the deep sea could play a key role in renewable energy technology and other components of a low-carbon future.
- The deep-sea ecosystems in which these resources are found are extremely remote, so relatively little is known about the biodiversity and ecosystem functions of these areas.
- The ISA is dealing with a dual mandate to protect the environment and jumpstart the industry but has very limited information with which to form regulations.
- There is disagreement about the amount of information needed before extractive mining activity can begin.

What is Deep Sea Mining?

Deep Sea Mining (DSM) is a collective term used to refer to extraction of three main resources of commercial interest: polymetallic nodules, seafloor massive sulfides, and cobalt rich crusts. These resources provide copper, nickel, aluminum, manganese, zinc, lithium and cobalt, as well as rare earth elements that are key components of smartphones, electric cars, batteries, aerospace hardware, communications infrastructure, and other technology that is crucial for national security and touted as key to our collective global divestment from fossil fuels in a low-carbon future. Proponents of seabed mining argue that extracting these deposits from the seafloor will impose less environmental damage than mining on land, which displaces communities; eliminates ecosystems; worsens erosion; and pollutes groundwater, rivers, and streams. However, many experts caution that seabed mining will not come without its own environmental impacts, the specifics and scale of which are not yet known.

Regulating the Deep Sea

On the high seas, which are the ocean areas beyond national jurisdiction, DSM is regulated by the International Seabed Authority (ISA), an autonomous intergovernmental organization established by the 1982 United Nations Convention on the Law of the Sea (UNCLOS) and its subsequent 1994 Implementing Agreement. Because UNCLOS establishes the high seas as the “common heritage of mankind,” the ISA has a dual mandate to both protect the environment for current and future generations and regulate mining activity so that all states and generations can reap the benefits.
of extraction. There is not currently mining activity as the ISA is in the process of finalizing a mining code that will address permitting, environmental protections, and financial considerations. As the United States has not ratified UNCLOS, it cannot participate in the formation of the regulations. The ISA plans to finalize regulations by the end of 2020, but extraction activity will not likely begin until the later part of the decade.

Understanding and Assessing Potential Impacts

The greatest concern with moving forward on DSM is the limited understanding of deep-sea ecology and environments. Without a greater knowledge of what biodiversity and ecosystem function exists, scientists agree that a true baseline characterization or assessment of possible mining areas is not possible, and without this knowledge, it will be difficult to predict or measure the scale and extent of damage as well as the timescale for recovery. Until more species can be named, and their roles and distribution defined, it is nearly impossible to ascertain the threshold where mining causes the serious or unacceptable harm that the ISA is charged with preventing. The flora and fauna of the deep sea have uniquely evolved to survive in the low disturbance environment of the deep sea, so many have very slow growth rates and late-life reproduction. This means both the species and the ecosystem are vulnerable, with very slow rates of recovery and low resilience, indicating that loss of biodiversity from mining activity is likely to last forever on human scales.

Direct Impacts of Mining

- Habitat loss from removing or fragmenting nodules or crusts
- Loss of biodiversity from organism mortality
- Modification of vent fluid geochemistry, which will negatively affect the organisms that have adapted to these unique chemical environments

Indirect Impacts

- Degradation of the surrounding environment
- Digging up nodules creates sediment plumes, which can smother respiration and feeding structures of organisms with an unknown dispersal distance, duration, toxicity and survivability thresholds
- Toxic chemicals/metals released by disrupting geochemical processes
- Noise, light, and vibration involved with any anthropogenic activity in the ocean

There is also consensus that while a single mining area could have a limited impact, cumulative effects of the above named direct and indirect impacts would potentially disrupt population connectivity, genetic links, ecosystem services, and ecosystem function on a regional scale, even up to regional and global species extinction events. Thus far, it has not been possible to conduct studies at the scale that would be able to measure these effects.

The cost of research and difficulty in accessing remote deep-sea ecosystems has left major gaps in knowledge of biodiversity, ecosystem structure, and ecosystem function, which policymakers have had to deal with in crafting the mining code. There are no threshold values for harm or set scientific standards that clearly determine whether a proposed mining operation would cause an unacceptable loss of biodiversity, "significant adverse change," or "serious harm," which are the mandates of the ISA to deep-sea ecosystems.

Moving forward, there are several tools that scientists and policymakers are advocating for in the mining code that the ISA is working on implementing. Management will be needed at all levels, from global environmental strategies to regional management plans to site-level regulations and risk assessments. To deal with the unknown impacts and uncertainty about the severity of mining impacts, most agree on a precautionary approach in which

Who is active in the mining exploration right now?

While there is no mining extraction activity until the ISA finalizes the mining code, as of June 2020, the ISA has issued 30 exploration licenses to contractors to explore the viability of mining in their claim areas and collect environmental baseline data. A large portion of these claims are for the nodule-rich abyssal plains of the Clarion-Clipperton Zone (CCZ) in the central Pacific Ocean (Figure 2). Some major countries with contractors involved include: China, United Kingdom, Belgium, Germany, France, Japan, Russia, Republic of Korea, and India

As the United States has not ratified United Nations Convention on the Law of the Sea (UNCLOS), American firms cannot apply for these licenses or participate in the drafting of the regulations.
protection and mitigation efforts are put in place before mining starts to hopefully avoid more serious harm. The mining community will also need to commit to adaptive management strategies that allow a feedback loop for policies. By starting with a known base state, monitoring and reporting on the effects of the activity through comparison with the base state, and having decision points or thresholds, policymakers can modify activity and regulations in response to new knowledge. The ISA has already begun the process of incorporating spatial management techniques into management through protected areas. These include Areas of Particular Environmental Interest (APEIs) that have been defined in the CCZ (Fig. 2). Advocates of spatial management are calling for networks of protected areas that match habitat characteristics of mined areas, protect specific vulnerable or important ecosystems, and are large enough to maintain minimum viable population sizes for geographically restricted species and populations.

Many in and around the mining community see an advantage in moving forward because of the adaptive management strategies that can be implemented. However, opinions diverge on the timeline and pace at which activity would occur, especially because the pace of scientific research is much slower than the pace of drafting regulations. Some advocate for continued exploration and research until a comprehensive set of biologically meaningful, enforceable indicators and limits can be created and the base state of ecosystems can be better characterized, while others feel exploitation can begin despite the unknowns and adaptive management will follow. Once mining begins, many are concerned about exactly who will be responsible for monitoring and how environmental requirements will be enforced. This is the most preparation ever done for an industrial activity, however, no matter the amount of preparation, the industry will not be able to deliver an outcome with no loss of biodiversity, so the ISA and greater mining community will need to establish a balance in addressing the needs of contractors, scientists, the deep sea ecosystems, and the current and future generations of humankind to which this area belongs.

**What exactly do scientists want to know?**

- Want to be able to define habitat indicators, biodiversity drivers, metrics for climate change stressors, and other indicators of ecosystem health prior to the onset of commercial-scale mining operations to prevent long term, potentially irreversible harm.

- To do so, scientists require a better understanding of the abundance and composition of flora and fauna in each of these environments.

- They also require more knowledge on the biogeochemical functions and oceanographic conditions at and around each type of mining environment.

![Figure 2. Map of the Clarion Clipperton Zone (CCZ), a mining hotspot. Out of the 30 exploration licenses issued thus far by the ISA, 16 are for polymetallic nodules from the CCZ. Credit: adapted from the International Seabed Authority, courtesy of NOAA, public domain](image-url)
To learn more:


Dunn et al., A strategy for the conservation of biodiversity on mid-ocean ridges from deep-sea mining, https://advances.sciencemag.org/content/4/7/eaar4313

Heffernan, Seabed mining is coming — bringing mineral riches and fears of epic extinctions, https://www.nature.com/articles/d41586-019-02242-y

International Seabed Authority, https://www.isa.org.jm/

Jones et al., Biological responses to disturbance from simulated deep-sea polymetallic nodule mining, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0171750


Ramirez-Llodra et al., Deep, diverse and definitely different: unique attributes of the world’s largest ecosystem, https://bg.copernicus.org/articles/7/2851/2010/


Vanreusel et al., Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna, https://www.nature.com/articles/srep26808

Wedding et al., Managing mining of the deep seabed, https://science.sciencemag.org/content/349/6244/144

Figure 3. Manganese nodules from deep offshore of the Cook Islands. Credit: USGS, public domain.