deepsea conservationcoalition

Deep-sea mining: the science and potential impacts

Vast quantities of metal-rich mineral deposits have been found in areas of the deep sea – the water column below 200 meters and the international seabed. This has catalyzed the development of technologies to extract resources from the deep seabed.

The International Seabed Authority (ISA) is the regulatory body that controls deep-sea mining in the international areas of the ocean. To date, it has granted 30 exploration licenses[1] covering 1.3 million square kilometers of seabed in various locations and is currently discussing regulations with a view to opening the international seabed to commercial mining within the next two to three years.

There are three broad types of deep-sea areas and habitats where metal-rich mineral deposits are found and are therefore threatened by deep-sea mining: abyssal plains; seamounts; and hydrothermal vents. Mining activities would have different impacts from site to site, depending on the animals, habitats and ecosystems associated with each.

Each individual mining operation is expected to effectively strip mine between 8,000 and 9,000 square kilometers of deep abyssal plains – an area a third of the size of Belgium – over the course of a 30-year license granted by the ISA.

Below: Casper octopods live at depths of more than 4km in the deep abyssal plain areas.

© JASON 2 ROV team, WHOI, Okeanos Explorer 2011

Habitats threatened by deep-sea mining

Abyssal plains

Abyssal plains are vast, relatively flat, sediment-covered areas of the deep seabed. Extensive deposits of manganese nodules or polymetallic nodules have been found on these plains. Roughly the size of potatoes, they contain manganese, nickel, copper and cobalt which have precipitated around fish teeth, sediment, or other small objects over time. The nodules are spread in varying concentrations across the seafloor at depths between 4,000 and 6,000 meters. Little is known about these abyssal ecosystems and the biodiversity they support, though it is understood that the nodules have taken millions of years to form.

Impacts: Each individual mining operation is expected to effectively strip mine between 8,000 and 9,000 square kilometers of deep abyssal plains – an area a third of the size of Belgium – over the course of a 30-year license granted by the ISA. The proposed scale of the operations has led many scientists to conclude that biodiversity loss would be unavoidable.[2] While some species may begin to repopulate areas of the seabed that have been subject to very limited disturbance, scientists estimate that the nodules and nodule-dependent animals may take millions of years to recover. Even partial recovery of the animals in the surrounding sediment "may take hundreds to thousands of years."[3]

Mining companies propose to gather nodules via methods such as hydraulic suction. They would use a remotely operated tractor to collect the nodules on the seafloor then pump them through a series of pipes called 'risers' up to a collector ship on the surface.

The science and potential impacts

- Removal of the nodules would involve disruption and destruction of the substrate or seabed leading to the loss of species, as well as fragmentation or loss of ecosystem structure and function.
- Sediment plumes would occur when mining stirs up sediments on the seafloor, creating plumes of suspended particles. It is unclear how far these particles may disperse beyond the mining area, and whether they would smother or otherwise damage marine life in areas beyond the actual mining sites. Modeling[4] suggests that the plumes could cover an area of several tens of thousands of square kilometers beyond the actual mining sites, with sediment in the water far in excess of the amount that animals in the area, in particular filter feeding animals such as corals and sponges, have adapted to. In addition, the wastewater, sediment and residual nodule material that is dumped back into the water from the collector ships may cause additional plumes that could spread tens to hundreds of kilometers or more throughout the water column at varying concentrations.[5]
- Wastewater may be pumped back into the ocean at depths of one or two kilometers by some companies, instead of at the seafloor. This could lead to plumes of wastewater, sediment and residual ore flowing hundreds to thousands of kilometers away and would impact species inhabiting the water column at various depths. For example, increasing turbidity or cloudiness of the water could impact species that use bioluminescence to hunt or find mates. In addition, residual metals and other compounds in the wastewater could prove toxic to some forms of marine life and potentially get into the marine food chain.
- Noise and light pollution could seriously disrupt species, such as whales and other deep-diving or deep-dwelling animals, that use noise, echolocation or bioluminescence to communicate, find prey and/or escape predators.
- Toxic metals may be released by grinding up the nodules into a slurry for pumping the ore to the surface and again in the wastewater discharged from the nodule collector ships back into the sea.

Below: variety of vibrantly colored animals, including an Anthomastus mushroom coral (center), precious pink coral (right), bamboo coral (left), and feather stars (Crinoids), depth approximately 2,240 meters.

Seamounts

There are estimated to be between 30,000 and 100,000 seamounts worldwide – volcanic mountains that rise more than a thousand meters from the seabed. Providing food and habitat for millions of species, they are among the world's most important and vulnerable ecosystems. Seamounts are recognized as biodiversity hotspots both for open ocean species, such as whales, seabirds and migratory species of fish, as well as deep-sea corals and sponges, which in turn serve as homes for other residents of the deep.[6]
Some seamounts – mostly those in the Pacific Ocean – have rock surfaces on which cobalt and other metals have accumulated over tens of millions of years, with the richest deposits found at depths of between 800 and 2,500 meters. This is one of the slowest natural processes on Earth, taking a million years for a crust of up to six millimeters to form.

Cobalt-rich crusts can be up to 25 centimeters thick in some places and are a target for deep-sea mining.[7] The extraction technology is still under development, but one proposal is for a huge bottom-crawling vehicle to use articulated cutters to fragment the crust, while others suggest it can be separated from the rock through water jet stripping, chemical leaching or sonic separation.[8]

© NOAA Office of Ocean Exploration and Research

Above: Riftia tubeworms colonize diffuse vent habitats between broken pieces of lava. Small mussels, less than 5cm in size, were growing in cracks adjacent to vent openings (lower right).

Impacts: Each of these mining methods is expected to destroy the bottom habitat and ecosystems of seamounts,[9] which would likely include corals and sponges that may have taken thousands of years to grow. They would also impact species in the water column through sediment plumes, noise and light generated by the mining operations,

Hydrothermal vents

Hydrothermal vents, which force superheated, chemical-laden water from the Earth's crust, are found on undersea volcanoes and mid-ocean ridges that form along the edges of tectonic plates, such as the Mid-Atlantic Ridge, an underwater mountain range extending from the Arctic to Antarctica. Deep sea vent systems not only support some of the most unique ecological communities known to science, they also form chimney-shaped ore deposits with significant concentrations of metals including gold, silver, copper and zinc.

"The ocean is at risk as never before…At this critical moment in time if we really want to be taking bold steps to address the carbon cycle, carbon capture, planetary stability, why shouldn't we be going all out to protect the high seas and the deep sea while there is time to do so"
Dr. Sylvia Earle, President and Chairman of Mission Blue

Scientists first discovered hydrothermal vents in the late 1970s, along with unique 'chemosynthetic' organisms, such as tubeworms, that live on hydrothermal vents and are unlike any other life forms on the planet. They are unique because they do not derive their energy through photosynthesis from light, like most life forms, but from chemicals in mineralized vent fluids that can reach temperatures of 350 degrees Celsius or more.

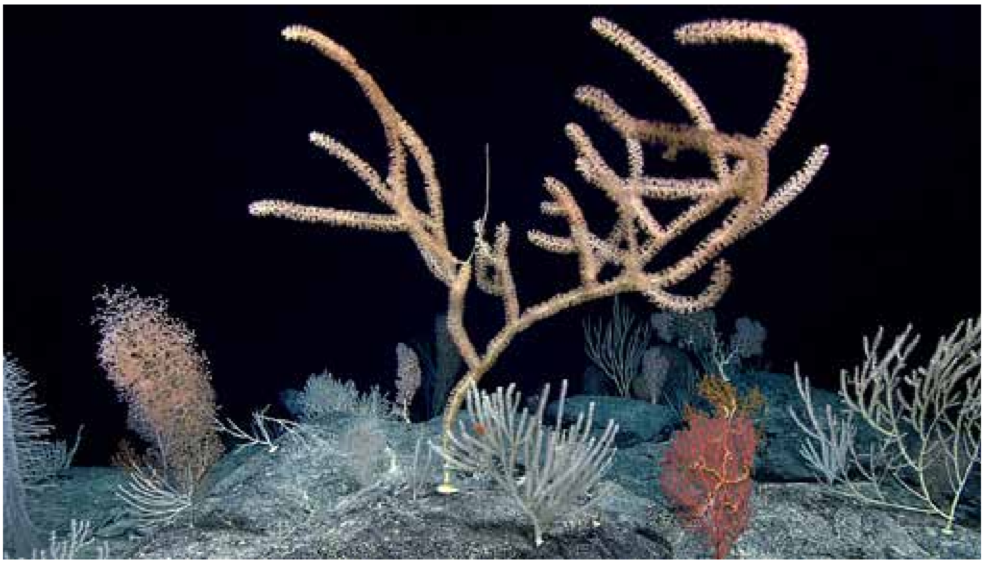
The uniqueness of these ecosystems has led a multidisciplinary group of prominent deep-sea vent scientists, sociologists, geologists, conservationists and legal experts to call for a ban on mining active hydrothermal vents. If mining were to go ahead, the diversity of life they support, with its unique features and adaptations to the extreme environment,[10] would be lost.

Impacts: Mining hydrothermal vents would destroy vent habitats and kill the associated organisms before the biodiversity of these unique and fragile ecosystems is well understood. One such animal, the scaly foot snail, found on vent sites along Indian Ocean ridges, was recently classified as endangered because of the threat of seabed mining in the area.[11] In addition, sulphide deposits from hydrothermal vents may play an important role in climate regulation and there is emerging research that suggests their destruction could lead to the release of sequestered methane with global climate impacts.

Scientists' concerns over deep-sea mining

Concerns that the risks associated with deep-sea mining outweigh the potential net benefits for humankind are being raised by politicians, the fishing industry, civil society and the scientific community.[12] Deep-sea ecosystems are already facing multiple environmental stressors from pollutants, plastics and climate change related impacts, such as acidification, warming, deoxygenation and reduced supply of nutrients from surface waters.[13] The scientific community considers that deep-sea mining risks causing irreversible environmental and ecological impacts, resulting in the loss of ecosystem services, habitats and species.[14]

Dr. Diva Amon, a deep-sea biologist and scientific associate at the Natural History Museum in London, asserts that the rush to open mines should slow down while more science is gathered. She said: "We need that fundamental science to be able to make informed decisions about whether we should or



Above: diverse, dense coral community, Debussy Seamount. Several colonies were very large, indicating a stable environment for many years.

should not go ahead with deep-sea mining…We can't manage what we don't understand and we can't protect what we don't know."[15]

Dr. Sylvia Earle, President and Chairman of Mission Blue, summed up the scientific community's concerns during a panel discussion at Davos in 2020 when she said: "The ocean is at risk as never before…At this critical moment in time if we really want to be taking bold steps to address the carbon cycle, carbon capture, planetary stability, why shouldn't we be going all out to protect the high seas and the deep sea while there is time to do so, before vested interests get further invested…Could we, might we put a moratorium on industrial extraction of wildlife from the high seas?"[16]

This notion was echoed by Professor Jane Lubchenco, marine ecologist at Oregon State University and a former administrator of the U.S. National Oceanic and Atmospheric Administration, who succinctly stated that it was "time to press pause [on seabed mining]."[17]

Recommendation

Mining in the biologically rich areas of the deep sea would knowingly put valuable ecosystems at risk, thereby contravening international obligations to ensure the protection of the marine environment.

Widespread concern about the vulnerability of deep-sea habitats and ecosystems, the scale and nature of proposed mining practices, the lack of information to conduct a thorough environmental impact assessment and deficiencies in the ISA as a regulatory body all make a clear case that a moratorium on deep-sea mining is essential.

Endnotes

1 International Seabed Authority. Deep Seabed Minerals Contractors. (2019). Available at: https://www.isa.org.jm/deep-seabed-minerals-contractors [Date accessed: 12/05/2020].

2 J. Niner, H.J, Ardon, J.A, Escobar, E.G, Gianni, M. et al. (2018). Deep Sea Mining With No Net Loss of Biodiversity–An Impossible Aim. Frontiers in Marine Science. https://www.frontiersin.org/articles/10.3389/fmars.2018.00053/full. See also Van Dover et. al. 2017. https://t.co/2guvyvGfmC

3 Kaiser, S., Smith, C.R. & Arbizu, P.M. (2017). Editorial: Biodiversity of the Clarion Clipperton Fracture Zone. Mar Biodiv 47, 259–264. https://doi.org/10.1007/s12526-017-0733-0

4 Managing Impacts of Deep Sea Resource Exploitation. Research Highlights. (2016). Available at: https://www.eu-midas.net/sites/default/files/downloads/MIDAS_research_highlights_low_res.pdf. 7-8 [Date accessed: 12/05/2020].

5 Thiel, H. (2001) Evaluation of the environmental consequences of polymetallic nodule mining based on the results of the TUSCH Research Association Forschungsverbund Tiefsee-Umweltschutz Alfred-Wegener-Institut f. ur Polar- und Meeresforschung, Bremerhaven, Germany. Pergamon. Deep-Sea Research II 48 (2001) 3433–3452.

6 Watling and Auster, Seamounts on the High Seas Should Be Managed as Vulnerable Marine Ecosystems. Front. Mar. Sci., 25 January 2017. https://doi.org/10.3389/fmars.2017.00014. Derville et al., Horizontal and vertical movements of humpback whales inform the use of critical pelagic habitats in the western South Pacific. Scientific Reports. (2020) 10:4871. https://doi.org/10.1038/s41598-020-61771-z

7 Herzig, P.M., Petersen, S., Hannington, M.D., Hein, J. and Juniper, K., 2002. Polymetallic Massive Sulphides and Cobalt-rich Ferromanganese Crusts: Status and Prospects. ISA Technical Study No. 2. International Seabed Authority, Kingston, Jamaica.

8 International Seabed Authority. (2008). Cobalt-Rich Crusts. https://www.isa.org.jm/files/documents/EN/Brochures/ENG9.pdf [Date accessed: 12/05/2020].

9 Watling and Auster, Seamounts on the High Seas Should Be Managed as Vulnerable Marine Ecosystems. Front. Mar. Sci., 25 January 2017. https://doi.org/10.3389/fmars.2017.00014 and Derville et al., Horizontal and vertical movements of humpback whales inform the use of critical pelagic habitats in the western South Pacific. Scientific Reports. (2020) 10:4871 | https://doi.org/10.1038/s41598-020-61771-z

10 Van Dover, Arnaud-Haond, S., C. L., Gianni, M., et al. (2018). Scientific rationale and international obligations for protection of active hydrothermal vent ecosystems from deep-sea mining. https://www.sciencedirect.com/science/article/pii/S0308597X17306061#bib68

11 Sigwart, J., Chen, C. & Thomas, E.A. 2019. Chrysomallon squamiferum. The IUCN Red List of Threatened Species 2019: e.T103636217A103636261. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T103636217A103636261.en. Downloaded on 15 April 2020.

12 Refer to DSCC briefing on deep-sea mining: growing support for a moratorium

13 Sweetman et al. 2017; Levin et. al 2016; Jamieson et. al. 2017.

14 Jones, D.O.B., Amon, D.J. and Chapman, A.S.A. (2018). Mining Deep-Ocean Mineral Deposits: What are the Ecological Risks? Elements 14: 325-330.

15 Science Focus. (2019). Deep sea mining: new depths. Available at: https://www.sciencefocus.com/planet-earth/deep-sea-mining-new-depths/ [Date accessed: 12/05/2020].

16 Ibid.

17 Financial Times (2019) Who's in charge of the high seas? https://www.ft.com/content/dcbc6e94-de26-11e9-b8e0-026e07cbe5b4 [Date accessed: 12/05/2020]

About the DSCC

The Deep Sea Conservation Coalition (DSCC) was founded in 2004 to address the need to prevent damage to deep-sea ecosystems and the depletion of deep-sea species on the high seas from bottom trawling and other forms of deep-sea fishing. The DSCC is made up of over 80 non-governmental organizations (NGOs), fishers organizations and law and policy institutes, all committed to protecting the deep sea.

For further information:

info@savethehighseas.org

www.savethehighseas.org

@DeepSeaConserve

deepsea conservationcoalition