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DEEP-SEA AND ESG: BALANCING CRITICAL MINERAL DEMAND WITH OCEAN SUSTAINABILITY

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I. THE RACE FOR CRITICAL MINERALS

As the world moves towards cleaner energy technologies, the demand for critical minerals such as cobalt, nickel, copper, and manganese, which are used in electric vehicles, batteries, and renewable energy infrastructures, has increased significantly. However, terrestrial mineral resources are becoming increasingly restricted by environmental, economic, and geopolitical constraints [1]. Therefore, there is increasing interest in the use of deep-sea mining as an alternative source of these precious materials. There has been a surge in government and corporate interest in carrying out exploratory work in mineral-rich areas of the ocean floor, particularly those located beyond national boundary limits. Nonetheless, the potential for the exploitation of deep-ocean resources raises significant ESG issues and how these factors will be included in the decision-making process by governments and corporations. ESG considerations will be critical in determining if deep-sea mining can realistically be classified as a solution for the green movement.

II. LOOKING BENEATH THE SURFACE: DEEP-SEA MINING THROUGH AN ESG LENS

Deep-sea mining is the process of extracting valuable minerals from the sea floor, it generally takes place at depths greater than 4,000 metres and occurs via commercial activity such as a so-called 'polymetallic nodule', sulphide, and cobalt rich crust mines are also found underwater and are commonly used to support modern technologies and help facilitate global clean energy conversion efforts because all these types have essential components for their production processes (or will be considered as some of the most useful materials available soon).[2]

The ESG framework (Environmental, Social and Governance framework) is one of the most commonly used methods for evaluating sustainability to assess the environmental impacts of an

[1]The Role of Critical Minerals in Clean Energy Transitions – Analysis - IEA, (May 5, 2021), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[2] What We Know About Deep-sea Mining — And What We Don't, World Resources Institute (Feb. 23, 2024), https://www.wri.org/insights/deep-sea-mining-explained.

activity, its social impacts on the community and stakeholders and the effectiveness of the governance mechanisms that regulate it.[3]

III. ENVIRONMENTAL RISKS IN THE DEEP OCEAN LEVEL

Concerns about the environment represent the biggest challenge that will limit or even prevent the development of deep sea mining; an industry that is not well understood due to the limited amount of research done to determine how deep ocean ecosystems function compared with land-based ecosystems, and thus the damage caused by mining will likely irreversibly destroy delicate ecosystems before their importance is known.

A significant concern has been the potential destruction of biodiversity. There are unique species living in the ocean at deep-sea environments that have evolved over millions of years to survive extreme conditions. Mining of polymetallic nodules and other seabed resources could cause loss of these habitats and introduce a potentially large threat to many species that have not yet been found or studied by scientists.[4]

Mining may harm the seabed and alter sediment patterns. When sediment is disturbed from the seabed, large clouds of sediment may be released into the surrounding waters. This could affect marine creatures, change food webs, and degrade water quality in large areas. Since all parts of the ocean interact with each other within the ecosystem, the repercussions of this form of disturbances can extend far beyond the current site of mining operations.[5]

In addition, through sediment cloud formation, mining impacts the ability of seabed ecosystems to sequester carbon. The release of carbon from disturbance also hampers climate change mitigation efforts. The limited scientific understanding of deep-sea ecosystems makes it hard to understand the full extent of any commercial mining operation on future environmental conditions. While environmental issues typically dominate discussions surrounding deep-sea mining, equally serious social issues are involved with using our shared oceans.[6]

IV. WHO BEARS THE COST? SOCIAL IMPLICATIONS OF DEEP-SEA MINING

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[3] David W Duffy, What is ESG and why is it important?, https://www.thecorporategovernanceinstitute.com/insights/guides/what-is-esg-and-why-is-it-important/?srsltid=AfmBOorBVjBAUwLJnRNLrryNE4wTXrTpaSBFYaiu1f-fM_flLBue8ca_.

[4] Ryan Murdock, Deep Sea Mining and the Green Transition, (Oct. 16, 2023), https://hir.harvard.edu/deep-sea-mining-and-the-green-transition/.

[5] Changhoon Lee, Enhancing seabed sediment classification with multibeam echo-sounding and self-training: a case study from the East Sea of South Korea, Enhancing seabed sediment classification with mult (June 25, 2025), https://www.frontiersin.org/journals/earth-science/articles/10.3389/feart.2025.1550244/full.

[6] Wen Yao, Development of deep-sea mining and its environmental impacts: a review, Development of deep-sea mining and its environment (May 26, 2025), https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2025.1598584/full.

In addition to environmental issues, deep-sea mining brings up a lot of social and ethical dilemmas. Mining is conducted miles away from shore, but the results of such activities could affect communities reliant on marine ecosystems for jobs. If fisheries, biodiversity, or ocean health were impacted, it could create serious problems for food security or create an unstable economy, especially for coastal and island dwellers.[7]

Many Pacific Island nations, environmental groups, and social justice agencies have expressed concern about the possible social and ecological implications of commercial deep-sea mining. These concerns are closely linked to the principle of the "common heritage of mankind," which underpins the governance of international seabed resources through the International Seabed Authority and the broader framework of the United Nations Convention on the Law of the Sea. Addressing these social concerns ultimately depends on the strength of governance mechanisms that regulate access to and management of seabed resources.

V. GOVERNING THE UNKNOWN: REGULATORY AND ESG CHALLENGES

The regulation of deep-sea mining is one of the most controversial issues in this field today. Although companies are increasingly interested in extracting minerals from the ocean floor, there is still a great deal of uncertainty about how to establish the necessary regulations to govern these types of mining activities. This lack of an internationally accepted regulatory framework raises a legitimate concern about whether or not there will be sufficient protection from environmental and social risks associated with deep-sea mining operations.

A major factor impacting this state of affairs is the role of the International Seabed Authority (ISA) in regulating mineral-related activities on the seabed located beyond the boundaries of individual nations. The ISA has already established regulations to govern the exploration phase of this type of mineral extraction, but there are ongoing discussions among various stakeholders related to the development of regulations to support the implementation of the exploitation phase of this activity.[8] To date, there continues to be significant disagreement regarding whether or not the current rule set for exploration and exploitation provide sufficient safeguards and/or oversight against undesirable environmental and social consequences.

VI. SUSTAINABILITY OR UNCERTAINTY? THE ROAD AHEAD

The growing demand for critical minerals has intensified interest in deep-sea mining as a potential source of resources essential for the global clean energy transition. However, the environmental, social, and governance challenges associated with seabed mining raise important questions regarding its long-term sustainability. From the potential destruction of fragile marine ecosystems to concerns surrounding intergenerational equity and regulatory oversight, deep-sea mining presents both opportunities and significant risks.

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[7](Mar. 6, 2025), https://wwfint.awsassets.panda.org/downloads/wwf-report---analysis-of-the-implications-of-deep-seabed-mining-for-the-global-biodiv.pdf.

[8] Navni Krishna, (Apr. 10, 2025), https://ijlae.com/wp-content/uploads/2025/04/The-Physics-of-Extraction-and-the-Law-of-Sovereignty-Reconciling-Space-Mining-with-the-Outer-Space-By-Navni-Krishna-and-Fazil-Nazeeb.pdf.

The ESG framework provides a valuable tool for assessing these competing considerations and promoting responsible decision-making. As scientific understanding of deep-ocean ecosystems continues to evolve, policymakers, regulators, and industry stakeholders must adopt a precautionary approach supported by robust governance and transparency. Until the environmental and social consequences of deep-sea mining are better understood, a precautionary and ESG-centred approach remains essential to ensuring that the pursuit of critical minerals does not come at the expense of ocean sustainability.

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