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Seabed Mining in Areas Beyond National Jurisdiction: Issues for Congress

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SUMMARY

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Seabed Mining in Areas Beyond National Jurisdiction: Issues for Congress

On April 24, 2025, as part of a broader national effort to secure reliable supplies for critical minerals, the Trump Administration issued Executive Order (E.O.) 14285, "Unleashing America's Offshore Critical Minerals and Resources," making it a policy of the United States to advance U.S. leadership in seabed mineral development. Some scientists estimate that certain mineral deposits, including those containing critical minerals, are more abundant on the seafloor than on land. Such estimates, coupled with demand for critical minerals for national security purposes, have increased interest in the recovery of minerals from areas beyond national jurisdiction (ABNJ). Minerals may be extracted through *seabed mining*, a process that involves recovering minerals from the seafloor. Although some entities hold contracts to explore the seafloor for potential commercial recovery, deep-seabed mining (i.e., mining activities taking place at water depths greater than 200 meters) in ABNJ has yet to occur. The potential of seabed mining in ABNJ raises several issues for Congress given the United States' demand for critical minerals and concerns about potential environmental impacts.

International and U.S. Context for Seabed Mining in ABNJ

The International Seabed Authority (ISA), established under the 1982 United Nations Convention on the Law of the Sea (UNCLOS), is an autonomous organization that regulates parties to UNCLOS conducting mineral-related activities in ABNJ. The ISA has issued 31 exploration contracts for seabed mineral resources to parties to UNCLOS. The ISA has yet to adopt a regulatory regime for extraction of seabed minerals and therefore has not issued exploitation contracts. In 2021, the Republic of Nauru, a Pacific Island country, notified the ISA of its sponsorship of Nauru Ocean Resources (a subsidiary of The Metals Company [TMC], a Canadian firm) and its intention to recover minerals from an ABNJ in the Pacific Ocean. Nauru's action triggered a provision within UNCLOS that required the ISA to establish by summer 2023 a mining code that would allow for deep-seabed mining. At the close of the ISA's March 2025 session, it had not finalized its mining code. Negotiations over the mining code resumed during the June-July 2025 session.

The United States has not ratified UNCLOS and therefore cannot sponsor companies seeking ISA contracts. However, the Deep Seabed Hard Mineral Resources Act (DSHMRA; P.L. 96-283), enacted in 1980 prior to the establishment of the ISA, authorized the National Oceanic and Atmospheric Administration (NOAA) to regulate deep-seabed mining activities (exploration and commercial recovery) of U.S. citizens in ABNJ. NOAA has used this authority and issued licenses to U.S.-based companies to explore the seafloor in ABNJ. Following the issuance of E.O. 14285, which directed NOAA to "expedite the process for reviewing and issuing seabed mineral exploration licenses and commercial recovery permits" in ABNJ, TMC USA LLC (a subsidiary of TMC) applied for two exploration licenses and one commercial recovery permit under DSHMRA.

Issues for Congress

Sourcing minerals from the deep sea could reduce U.S. dependency on importing land-based minerals and reduce potential supply disruptions, including critical mineral supplies controlled by the People's Republic of China. The U.S. Senate could ratify UNCLOS, which would allow U.S. companies to seek ISA contracts, or the United States could unilaterally authorize deep-seabed mining in ABNJ under DSHMRA. H.R. 3803 and H.R. 4018 in the 119th Congress would codify and/or adapt E.O. 14285, which would include (1) directing NOAA to expedite the review and issuance of seabed mining applications and (2) requiring certain federal entities to provide a report about U.S. seabed mineral processing capacity and directing other federal entities to support domestic processing capabilities for such resources. Congress may consider any potential geopolitical consequences of NOAA issuing commercial recovery permits outside of the ISA framework, particularly because, at present, parties to UNCLOS may not be able to proceed with exploitation activities in the absence of an ISA regulatory regime.

Some Members of Congress have expressed concerns about deep-sea habitat disturbance and biodiversity loss associated with seabed mining activities. In the 119th Congress, H.R. 664 would authorize NOAA to "conduct a comprehensive study of the environmental impacts of mining activities on the deep seabed" and would prohibit NOAA from issuing exploration licenses and commercial recovery permits. Another bill in the 119th Congress, H.R. 663, would instruct the President to direct U.S. representatives of relevant international organizations to call for a moratorium on deep-seabed mining until "regulations have been promulgated by the [ISA]" that effectively protect the marine environment from harmful effects.

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Introduction

Interest in mining the seabed in areas beyond national jurisdiction (ABNJ) for deposits that contain valuable minerals, such as critical minerals, has grown in recent years for a few reasons.[1] First, increased investment and improved technologies dedicated to the exploration and mapping of the deep sea have advanced knowledge of seafloor deposits that contain minerals of interest.[2] Second, the development of technologies for systems to collect seabed minerals from the deep ocean and deliver them to ships or surface-based mining platforms has made mining the seafloor more technologically possible and potentially economically feasible.[3] Third, some seabed deposits of some minerals could present an alternative to, and reduce reliance on, terrestrial minerals sourced and/or processed in certain countries of concern, such as the People's Republic of China (PRC, or China).[4] On April 24, 2025, President Trump issued Executive Order (E.O.) 14285, "Unleashing America's Offshore Critical Minerals and Resources," which made it a priority of the United States to "rapidly develop ... domestic capabilities for the exploration, characterization, collection, and processing of seabed mineral resources."[5]

Different types of technologies rely on elements found in both terrestrial deposits and seafloor deposits (e.g., cobalt, copper, manganese, nickel).[6] For example, some batteries—including those that power electric vehicles—commonly use nickel, cobalt, and manganese.[7] According to some scientific estimates, these minerals of interest are more abundant in seafloor deposits than in land deposits.[8] Critical minerals used in the magnets of wind turbines, the motors of electric vehicles, and stationary energy storage also occur in seafloor deposits.

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[1] Section 7002 of the Energy Act of 2020 (Division Z, P.L. 116-260) codifies the methodology to be used by the Secretary of the Interior to determine a list of critical minerals. In 2022, the U.S. Geological Survey (USGS) published a list of 50 critical minerals. See, Department of the Interior, USGS, "2022 Final List of Critical Minerals," 87 *Federal Register* 10381 (February 24, 2022).

[2] For more information about U.S. ocean mapping efforts, see CRS Report R47623, *Frequently Asked Questions: Mapping of U.S. Ocean and Coastal Waters*, coordinated by Caitlin Keating-Bitonti.

[3] U.S. Government Accountability Office (GAO), *Science & Tech Spotlight: Deep-Sea Mining*, GAO-22-105507, December 15, 2021; Massachusetts Institute of Technology, "Deep Sea Mining," https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/oceans.html; and Rosanna Carver et al., "A Critical Social Perspective on Deep Sea Mining: Lessons from the Emergent Industry in Japan," *Ocean and Coastal Management*, vol. 193 (August 2020). Some contend deep-seabed mining cannot be profitable due to the challenges of operating seabed mining machinery at depths of between 3,500 meters and 5,000 meters, under extreme water pressure and cold temperatures. For example, see Brandon Keim, "The Dubious Economics of Deep-Sea Mining," *Nautilus*, June 7, 2023, https://nautil.us/the-dubious-economics-of-deep-sea-mining-309597/.

[4] GAO, "Deep-Sea Mining Could Help Meet Demand for Critical Minerals, But Also Comes with Serious Obstacles," *WatchBlog*, December 16, 2021; GAO, *Science & Tech Spotlight: Deep-Sea Mining*, GAO-22-105507, December 15, 2021; Yasuhiro Kato et al., "Deep-Sea Mud in the Pacific Ocean as a Potential Resource for Rare-Earth Elements," *Nature Geoscience*, vol. 4 (2011), pp. 535-539 (hereinafter Kato et al., "Deep-Sea Mud"); and International Energy Agency (IEA), *The Role of Critical Minerals in Clean Energy Transition*, 2022, p. 156 (hereinafter IEA, *Role of Critical Minerals*).

[5] Executive Office of the President, E.O. 14285, "Unleashing America's Offshore Critical Minerals and Resources," 90 *Federal Register* 17735, April 29, 2025 (hereinafter E.O. 14285).

[6] Minerals can be composed of single elements (e.g., copper) or a compound of elements (e.g., olivine). This report uses the term *mineral* for both. Olive Heffernan, "Deep-Sea Dilemma," *Nature*, vol. 571 (2019), pp. 465-469; and Kato et al., "Deep-Sea Mud."

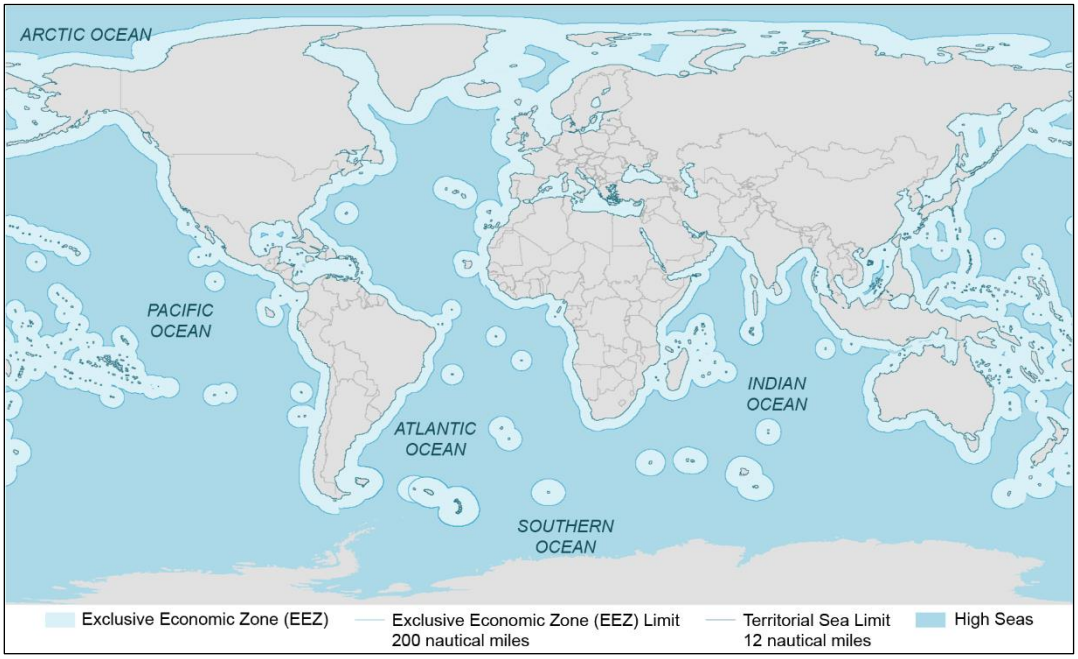
[7] IEA, Role of Critical Minerals, p. 5. For more information about critical minerals for energy technologies, see CRS Report R48149, *Critical Minerals and Materials for Selected Energy Technologies*, by Emma Kaboli.

[8] For example, James R. Hein and Kira Mizell, "Chapter 8: Deep-Ocean Polymetallic Nodules and Cobalt-Rich Ferromanganese Crusts in the Global Ocean," in *The United Nations Convention on the Law of the Sea, Part XI Regime*

(continued...)

This report focuses on deep-seabed mining activities that could take place in ABNJ (**Figure 1**).[9] The report outlines the history of international agreements that establish guidelines and standards for deep-seabed mining activities and provide protection to the marine environment in ABNJ. It also outlines domestic regulations for U.S. interests in pursuing seabed-mining activities in ABNJ as well as the potential geopolitical consequences of the United States operating outside the international framework for seabed mining. The report then examines potential seabed mining impacts to ocean ecosystems and discusses calls for a moratorium on deep-seabed mining over environmental concerns. Finally, the report discusses issues for Congress, including U.S. participation in international agreements regarding deep-seabed mining, possible tradeoffs between domestic- and foreign-supplied minerals, and the potential for domestic processing of seabed minerals to bolster U.S. critical mineral supply chains. For information about seabed mining activities within U.S. waters, see CRS Report R48302, *Critical Minerals on the U.S. Outer Continental Shelf: The Bureau of Ocean Energy Management's Role and Issues for Congress*, by Caitlin Keating-Bitonti and Laura B. Comay.

Figure 1. Illustration of High Seas and Exclusive Economic Zone Boundaries



Source: Illustration created by CRS using the Sovereign Limits database (sovereignlimits.com).

Notes: The term *high seas* applies to areas beyond national jurisdiction (ABNJ). The figure is an illustration and is not for official purposes of identifying ABNJs, exclusive economic zones (EEZs), or territorial sea limits. Boundaries of coastal countries' national jurisdictions (i.e., EEZs) are illustrated in light blue. ABNJ are illustrated in dark blue. As defined in the United Nations Convention on the Law of the Sea (UNCLOS), the territorial sea

and the International Seabed Authority: A Twenty-Five Year Journey, eds. Alfonso Ascencio-Herrera and Myron H. Nordquist (Leiden, The Netherlands: Koninklijke Brill NV, 2022), pp. 177-197, see p. 188.

[9] The United Nations Convention on the Law of the Sea (UNCLOS) established national boundaries for coastal nations that extend to an adjacent *territorial sea*, which extends up to 12 nautical miles from the baseline of the coast of a nation. The territorial sea includes the *exclusive economic zone* (EEZ), which generally extends up to 200 nautical miles from the baseline of low sea level (usually near the coastline). See United Nations, *United Nations Convention on the Law of the Sea of 10 December 1982, Overview and Full Text,* https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm. Although the United States has not ratified UNCLOS, it generally has abided by the convention's terms, as dictated by Presidential Proclamation 5030. See "Proclamation 5030: Exclusive Economic Zone of the United States of America," 48 *Federal Register* 10605 (March 10, 1983).

extends up to 12 nautical miles from the shoreline; the EEZ extends up to 200 nautical miles from the baseline of low sea level (usually near the coastline); and the high seas are "all parts of the sea that are not included in the [EEZ], in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State" (see, UNCLOS Articles 3, 57, and 86). Peru claims a single maritime zone of 200 nautical miles, which it refers to as a *maritime domain*, not an EEZ; for the purposes of this figure, Peru is shown with an EEZ. Antarctica does not have a territorial sea or an EEZ because it is not a sovereign nation and its governance is carried by the Consultative Nations of the Antarctic Treaty.

Background on Seabed Mining

Seabed mining is a process of extracting sediment and mineral resources from the seafloor. In general, water depths less than 200 meters occur within nations' exclusive economic zones (EEZs), to which a coastal nation may claim sovereign rights for the purpose of exploring and exploiting the natural resources of its continental shelf.[10] Seabed mining activities occurring within a nation's EEZ are regulated by that nation's domestic law.[11] In the United States, the seaward boundary of coastal states is generally three nautical miles offshore,[12] and certain states and territories prohibit seabed mining within their waters (e.g., American Samoa, California, Hawaii, Oregon, Washington).[13] An emerging subset of seabed mining is *deep-seabed mining*, or *deep-sea mining*, which occurs at water depths of 200 meters or greater.[14] Water depths greater than 200 meters generally occur in areas beyond the EEZ. This report focuses on seabed minerals found beyond the outer continental shelf in ABNJ.

Deep-seabed mining was first explored in the 1960s, with commercial test mining for metal-rich nodules on the seabed starting in the 1970s.[15] In 1994, the International Seabed Authority (ISA) was created under the United Nations Convention on the Law of the Sea (UNCLOS) as an autonomous organization to regulate and control deep-seabed mining activities taking place in ABNJ.[16] The ISA can issue exploration and exploitation (i.e., commercial recovery) contracts for three types of deep-seabed mineral deposits (**Table 1**).[17] The technologies and machinery to extract raw seabed material vary depending on the type of mineral deposit.[18] Once the seabed material is extracted, it would be transported to land for mineral processing.

[10] UNCLOS Article 77(1).

[11] The Bureau of Ocean Energy Management (BOEM) is the federal agency authorized to oversee mineral leasing in the U.S. outer continental shelf.

[12] Submerged Lands Act (43 U.S.C. §§1301 et seq.).

[13] Or. Rev. Stat. §196.405 (1991); S.B. 5145, 67th Leg., Reg. Sess. (Wash. 2021); A.B. 1832, 2021–2022 State Leg., Reg. Sess. (Cal. 2022); S.B. 2575, 32nd Leg., Reg. Sess. (Haw. 2024); and Office of Governor Lemanu P.S. Mauga, Exec. Order No. 006-2024: An Order Implementing a Moratorium on Deep Seabed Mining Exploration and Exploitation Activities (Am. Sam. July 24, 2024), https://www.americansamoa.gov/_files/ugd/4bfff9_cea25f51dcb84d0bbe5bbac7db513477.pdf.

[14] For example, International Union for Conservation of Nature (IUCN), *Deep-Sea Mining*, Issues Brief, May 2022, https://iucn.org/sites/default/files/2022-07/iucn-issues-brief_dsm_update_final.pdf.

[15] Helen Scales, *The Brilliant Abyss* (New York: Atlantic Monthly Press, 2021), p. 184.

[16] UNCLOS Article 156.

[17] International Seabed Authority (ISA), "Exploration Contracts," https://www.isa.org.jm/exploration-contracts/.

[18] For a discussion about the technologies and machinery used to extract raw seabed material, see the textbox entitled, "Proposed Seabed Mining Operations," below.

Table 1. Types of Seabed Mineral Deposits in Areas Beyond National Jurisdiction

Marine Deposit Type	Deposit Description	Minerals	Occurrences
Polymetallic Nodules	Potato-shaped rocks composed of concentric layers that form over millions of years as minerals from the seawater and sediment pore water accrete around a hard nucleus (e.g., shark tooth, whale ear bone, rock fragment) lying on the deep seafloor.	**Cobalt**, copper, **lithium**, **manganese**, **nickel**, **tellurium**, and **titanium**; some metallic REEs.	Abyssal plains, such as the Clarion-Clipperton Zone in the Pacific Ocean.
Polymetallic Sulfides or Seafloor Massive Sulfide	Mineral accumulations that form from hot waters emitted at seafloor spreading ridges and areas of undersea volcanic activity.	**Antimony**, **bismuth**, copper, **gallium**, **germanium**, gold, iron, lead, silver, **tellurium**, and **zinc**.	Mid-Atlantic Ridge, Red Sea, East Pacific Rise, Galapagos Rift, and Juan de Fuca and Gorda Ridges (located off the Pacific Northwest coast of North America).
Ferromanganese Crusts or Cobalt-rich Crusts	Mineral encrustations that form on hard surfaces from seawater rich in dissolved metals occurring in volcanically active regions such as seamounts.	**Cobalt**, copper, **manganese**, **nickel**, **platinum**, and **tellurium**; some metallic REEs, such as **scandium**.	All ocean basins. Also occur at shallower depths within countries' exclusive economic zones.

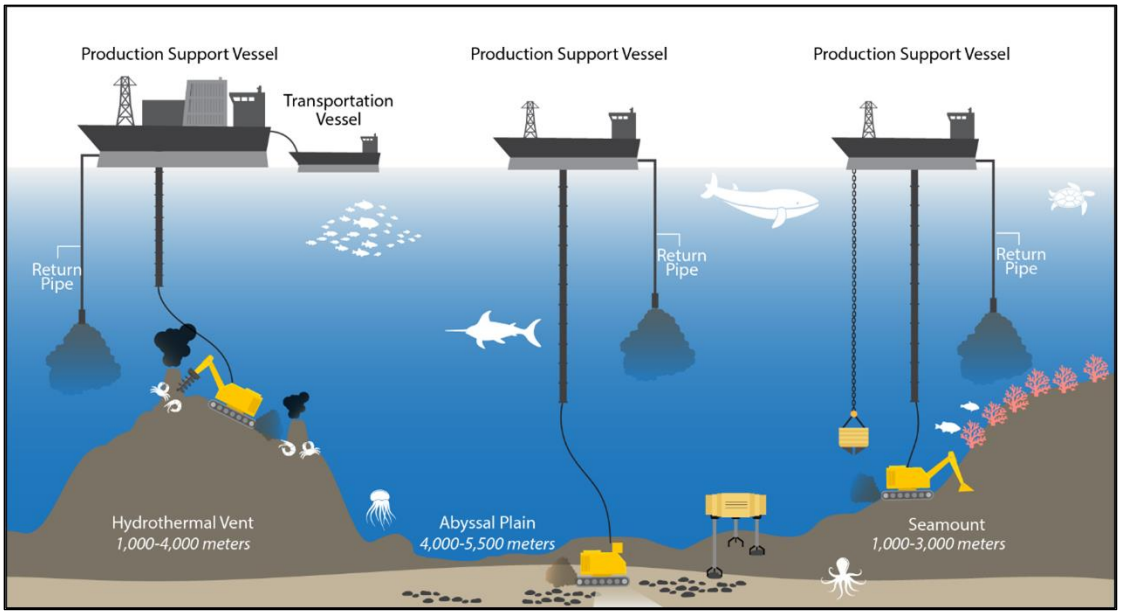
Sources: Bureau of Ocean Energy Management, "Types of Relevant Marine Mineral Deposits," https://www.boem.gov/marine-minerals/critical-minerals/types-relevant-marine-mineral-deposits; Department of Energy, "Notice of Final Determination on 2023 DOE Critical Materials List," 88 *Federal Register* 51792, August 4, 2023; International Seabed Authority (ISA), "Minerals: Polymetallic Nodules," https://www.isa.org.jm/exploration-contracts/polymetallic-nodules; ISA, "Minerals: Polymetallic Sulphides," https://www.isa.org.jm/index.php/exploration-contracts/polymetallic-sulphides; ISA, "Minerals: Cobalt-Rich Ferromanganese Crusts," https://www.isa.org.jm/index.php/exploration-contracts/cobalt-rich-ferromanganese; and U.S. Geological Survey (USGS), "2022 Final List of Critical Minerals," 87 *Federal Register* 10381, February 24, 2022.

Notes: REEs = rare earth elements. Critical minerals as determined by the USGS are bolded. Of the minerals listed in the table, the Department of Energy's Final 2023 Critical Materials List includes cobalt, copper, gallium, lithium, magnesium, nickel, and platinum as critical materials for energy. The three types of marine deposits in the table are of commercial interest. The list of minerals is not exhaustive and includes common minerals of commercial interest. Minerals may not all occur simultaneously in an ocean deposit, and the quality and quantity of minerals within a deposit may vary geographically across the global ocean.

Proposed Seabed Mining Operations

Although no commercial-scale seabed operations currently take place in ABNJ, **Figure 2** illustrates some of the machinery proposed to mine polymetallic sulfides deposits at hydrothermal vents and ferromanganese crusts at seamounts, as well as machinery and technologies proposed to collect polymetallic nodules from the deep-sea abyssal plain. Some seabed mining approaches require a production support vessel (PSV) and a transport vessel. A PSV launches the mining machinery or collector vehicle and provides power to it while operating on the seafloor. A transportation vessel would ship the seabed material to land, where it would be processed and refined into useable metals.

Figure 2. Proposed Machinery and Technology for Collecting Seabed Minerals



Source: Illustration created by CRS, modifying figure 4 in Kathryn Miller et al., "An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps," *Frontiers in Marine Science*, vol. 4 (2018), and using Allseas, "Hidden Gem," https://www.allseas.com/en/who-we-are/our-fleet/hidden-gem; International Seabed Authority, *CARMU Inspection Report 01/2023*, February 21, 2023, pp. 1-38, https://www.isa.org.jm/wp-content/uploads/2023/02/ISA_inspection_report_NORI_mining_collector_system_test.pdf; Impossible Metals, Inc., "Robotic Collection System," https://impossiblemetals.com/technology/robotic-collection-system/; and Wendy Laursen, "The Nodule Collectors Are Lining Up, Ready to Go," *Maritime Magazine*, March 2024, https://www.maritimemagazines.com/offshore-engineer/202403/the-nodule-collectors-are-lining-up-ready-to-go/.

Notes: Proposed seabed mining machinery, with associated vessels, for polymetallic sulfides deposits at hydrothermal vents and ferromanganese crusts at seamounts, as well as machinery and technologies proposed to collect polymetallic nodules from the deep-sea abyssal plain. Depths depicted in meters refer to the typical depth at which these seafloor features (and potential mineral deposits) are located below the surface of the ocean. For illustrative purposes only, not to scale.

For polymetallic nodules, remotely operated collector vehicles fitted with caterpillar-like tracks use a water stream aimed at nodules laying on the seafloor to create a pressure drop and a suction effect to lift sediment with nodules into a collector system.[19] Some companies have proposed using sonar technology on the collector vehicles to identify the location of nodules.[20] As a vehicle moved across the seafloor, a diffusor at the rear of the vehicle would emit seafloor sediment back into the environment, forming a sediment *plume* (i.e., resuspended sediment).[21] The slurry (i.e.,

[19] For example, Zenghui Liu et al., "Deep-Sea Rock Mechanics and Mining Technology: State of the Art and Perspectives," *International Journal of Mining Science and Technology*, vol. 33, no. 9 (September 2023), pp. 1083-1115, see pp. 1099-1100 (hereinafter Liu et al., "Deep-Sea Rock Mechanics and Mining Technology"); Allseas, "Hidden Gem," https://www.allseas.com/en/who-we-are/our-fleet/hidden-gem (hereinafter Allseas, "Hidden Gem"); Deep Sea Mining, "Mining Subsea Minerals—How It Works," https://deepseamining.ac/how_it_works; and Wendy Laursen, "The Nodule Collectors Are Lining Up, Ready to Go," *Maritime Magazine*, March 2024, https://www.maritimemagazines.com/offshore-engineer/202403/the-nodule-collectors-are-lining-up-ready-to-go/ (hereinafter Laursen, "The Nodule Collectors Are Lining Up, Ready to Go").

[20] Laursen, "The Nodule Collectors Are Lining Up, Ready to Go."

[21] Kathryn Miller et al., "Challenging the Need for Deep Seabed Mining from the Perspective of Metal Demand, Biodiversity, Ecosystem Services, and Benefit Sharing," *Frontiers in Marine Science*, vol. 8 (July 2021), pp. 1-7, see p. 15 (hereinafter Miller et al., "Challenging the Need for Deep Seabed Mining").

mix of water, sediment, and nodules) would be transported via a riser pump to a PSV.[22] At the ocean surface, nodules would be separated and the sediment and water mix would be returned to the ocean at an unspecified water depth via a return pipe,[23] creating a sediment plume at the discharged depth.[24] One company has proposed an autonomous underwater vehicle (AUV) that would hover over the seafloor and use robotic arms with a vision system to pick individual nodules from the seafloor.[25] Once the AUV was full, it would return to the support vessel to offload nodules and have its battery recharged.

For polymetallic sulfides (or seafloor massive sulfide) deposits at hydrothermal vents, some companies have proposed remotely operated mining machines to cut and drill into the hydrothermal vent chimney to crush and extract internal minerals.[26] For ferromanganese crusts (or cobalt-rich crusts) at seamounts, remotely operated mining machines have been proposed to scrape across the surfaces of the seamount (or other geologic features) to remove surficial mineral crusts.[27] The mining processes for both polymetallic sulfides and ferromanganese crusts would create a slurry (i.e., mix of water and crushed material), which would be transported via a riser pump to a PSV.[28] At the ocean surface, the fine crushed material would be separated from the water.[29] The water and discarded material would be returned to the ocean at an unspecified water depth via a return pipe, creating a sediment plume at the discharged depth.[30] In addition, some companies propose lifting large whole rock material in buckets to a PSV.[31]

Certain federal agencies have supported research and development of seabed mining technologies. For example, the Department of Energy's (DOE's) Advanced Research Projects Agency-Energy (ARPA-E), authorized by P.L. 110-69 (commonly known as the America COMPETES Act), has supported transformational energy technology research projects. In the past, ARPA-E has funded several projects related to seabed mining, including the design and development of technologies for seabed mineral collection and monitoring systems to assess sediment disturbance associated with seabed mining.[32] In the DOE's FY2026 budget request, the Administration is requesting $200 million for ARPA-E, a reduction of $260 million (-56.5%)

[22] Allseas, "Hidden Gem."

[23] ISA, *CARMU Inspection Report 01/2023*, February 21, 2023, p. 18, https://www.isa.org.jm/wp-content/uploads/2023/02/ISA_inspection_report_NORI_mining_collector_system_test.pdf (hereinafter ISA, *CARMU Inspection Report 01/2023*).

[24] Miller et al., "Challenging the Need for Deep Seabed Mining," p. 15.

[25] Impossible Metals Inc., "Robotic Collection System," https://impossiblemetals.com/technology/robotic-collection-system/ (hereinafter Impossible Metals Inc., "Robotic Collection System").

[26] For example, Liu et al., "Deep-Sea Rock Mechanics and Mining Technology," pp. 1100-1102; and David Hambling, "Giant Robots Are the Future of Underwater Mining," *Popular Mechanics*, February 13, 2018, https://www.popularmechanics.com/technology/robots/a16674275/underwater-robot-mining-nautilus-solwara-1-papua-new-guinea/ (hereinafter Hambling, "Giant Robots Are the Future of Underwater Mining").

[27] Liu et al., "Deep-Sea Rock Mechanics and Mining Technology," pp. 1102-1103.

[28] Miller et al., "Challenging the Need for Deep Seabed Mining," p. 14.

[29] Liu et al., "Deep-Sea Rock Mechanics and Mining Technology," pp. 1100-1102; and Hambling, "Giant Robots Are the Future of Underwater Mining."

[30] Liu et al., "Deep-Sea Rock Mechanics and Mining Technology," pp. 1100-1102.

[31] Liu et al., "Deep-Sea Rock Mechanics and Mining Technology," p. 1098.

[32] For example, Department of Energy (DOE), Advanced Research Projects Agency-Energy (ARPA-E), "Deep Reach Technology," https://arpa-e.energy.gov/programs-and-initiatives/search-all-projects/improved-nodule-collector-design-mitigate-sediment-plumes; DOE, ARPA-E, "Artimus Robotics," https://arpa-e.energy.gov/programs-and-initiatives/search-all-projects/low-cost-electronics-pressure-agnostic-actuators-driving-bio-inspired-vehicles-deep-sea-mining; and DOE, ARPA-E, "Sequoia Scientific," https://arpa-e.energy.gov/programs-and-initiatives/search-all-projects/real-time-situ-sensing-sediment-properties-environmental-monitoring-deep-sea-polymetallic-nodule-mining-real-time-situ-sensing-sediment-properties-environmental-monitoring-deep-sea-polymetallic-nodule-mining.

from FY2025 levels.[33] According to the request, this level of funding would provide "a fiscally responsible level for high risk, high reward research advancing reliable energy technologies and other critical and emerging technologies."[34]

Regulations for Deep-Seabed Mining in Areas Beyond National Jurisdiction

International bodies and agreements regulate international exploration and exploitation of seabed minerals or provide guidance to prevent harm to the marine environment associated with deep-seabed mining. The following sections describe the international bodies and agreements that regulate deep-seabed mining in ABNJ, as well as relevant U.S. domestic laws.

United Nations Convention on the Law of the Sea and the 1994 Agreement

In 1982, UNCLOS established a framework governing activities on, over, and under the world's ocean. A recurring theme throughout UNCLOS is the "protection and preservation of the marine environment."[35] UNCLOS specifies that necessary measures be taken to protect the marine environment with respect to certain activities. For example, Article 145 states

> Necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities. To this end the Authority shall adopt appropriate rules, regulations and procedures for *inter alia*:
>
> (a) the prevention, reduction and control of pollution and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities;
>
> (b) the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment.

In 1982, the United States and some other industrialized countries did not sign the convention or announced they could not ratify it without important changes to Part XI of UNCLOS, which deals with deep-seabed resources in ABNJ.[36] UNCLOS refers to resources recovered from ABNJ as *minerals*, which includes all solid, liquid, or gaseous mineral resources as well as polymetallic nodules at or beneath the seabed.[37] UNCLOS also considers minerals collected from ABNJ as the common heritage of mankind, meaning seabed resources are available for everyone's use and benefit, including Small Island Developing States, Landlocked Developing Countries, and Least

[33] DOE, *Detailed Budget Justification, Energy and Water Development Appropriations, Volume 2*, Advanced Research Projects Agency–Energy, 2025, https://www.energy.gov/sites/default/files/2025-06/doe-fy-2026-vol-2-arpa-e.pdf (hereinafter DOE, *Detailed Budget Justification*, 2025).

[34] DOE, *Detailed Budget Justification*, 2025.

[35] For example, see UNCLOS's Preamble and Part XII: "Protection and Preservation of the Marine Environment."

[36] Bernard Gwertzman, "U.S. Will Not Sign Sea Law Treaty," *New York Times*, July 10, 1982, p. 5.

[37] UNCLOS Article 133.

Developed Countries.[38] The Reagan Administration was not comfortable with some of these seabed mining provisions.[39]

In 1994, the United Nations General Assembly adopted a resolution opening the Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea (the *1994 Agreement*), which amended UNCLOS Part XI by removing many of the provisions objectionable to industrialized nations.[40] Following the adoption of the 1994 Agreement, UNCLOS entered into force. In October 1994, President Clinton submitted UNCLOS and the 1994 Agreement as a package to the Senate for advice and consent to ratification. To date, the Senate has not ratified UNCLOS or the 1994 Agreement, which are to be applied and interpreted together as a single treaty.[41] Some members of the executive branch have stated that some (but not all) provisions of UNCLOS reflect customary international law, except for the seabed mining provisions.[42] Some stakeholders have argued that U.S. practice with regard to seabed activities has been consistent with customary international law, such as signing the 1994 Agreement and engaging with the ISA as an observer since 1998.[43]

International Seabed Authority

UNCLOS established the ISA, an autonomous organization that regulates and controls mineral-related activities in ABNJ for parties to UNCLOS.[44] According to the ISA, it has a "mandate to ensure the effective protection of the marine environment from harmful effects that may arise from deep-seabed-related activities."[45] Deep-seabed activities include exploration of the seabed and exploitation of seabed mineral resources. Parties to UNCLOS are ipso facto members of the ISA.[46] As a United Nations member nation, the United States has an observer delegate status at the ISA.[47]

As of June 2025, the ISA had issued 31 exploration contracts to public and private mining enterprises for seabed mineral resources.[48] The ISA has issued 17 exploration contracts for

[38] UNCLOS Articles 136, 140, and 141.

[39] Bernard Gwertzman, "U.S. Will Not Sign Sea Law Treaty," *New York Times*, July 10, 1982, p. 5.

[40] For more information about UNCLOS implementing agreements, see CRS In Focus IF12578, *Implementing Agreements Under the United Nations Convention on the Law of the Sea (UNCLOS)*, by Caitlin Keating-Bitonti and Matthew C. Weed.

[41] In the past, some Members of Congress have expressed concerns regarding the ability of an international organization to regulate a commercial activity (i.e., deep-seabed mining) and distribute revenues from such activity.

[42] For example, Department of Defense (DOD), Joint Chiefs of Staff, *Joint Maritime Operations: 8 June 2018*, Joint Publication 3-32, 2018, see p. xiv.

[43] For example, ISA, "FAQs for the Media About the International Seabed Authority and Deep-Sea Mining," https://www.isa.org.jm/faq-for-media/ (hereinafter ISA, "FAQs for the Media"); in particular, see "What Is ISA's Reaction to the US Executive Order Unleashing America's Offshore Critical Minerals and Resources?"

[44] ISA, "About ISA," https://www.isa.org.jm/about-isa/.

[45] ISA, "About ISA," https://www.isa.org.jm/about-isa/.

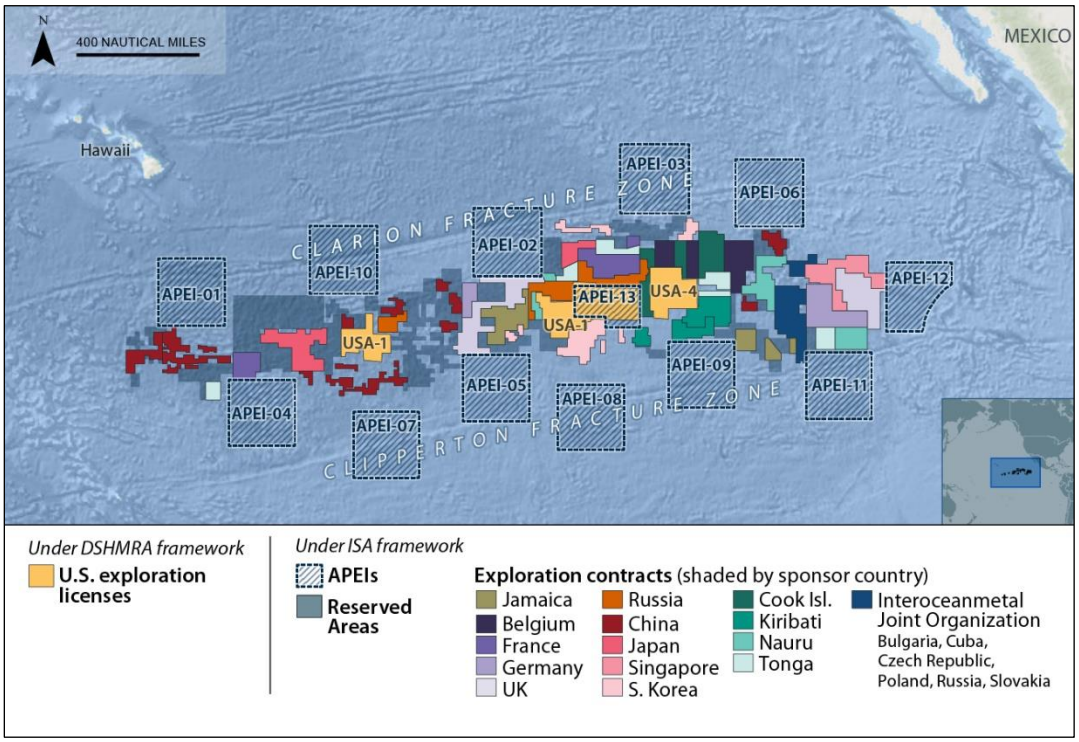
[46] As of November 2024, the ISA had 170 members (169 states and the European Union). The lists of ratifications of, accessions and successions to UNCLOS and related Agreements can be viewed at http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm.

[47] The U.S. delegation to the ISA includes representatives from the Department of State's Bureau of Oceans and International Environmental and Scientific Affairs, NOAA, BOEM, and USGS.

[48] ISA, "Exploration Contracts," https://www.isa.org.jm/exploration-contracts/.

polymetallic nodules in the Clarion-Clipperton Zone (CCZ; **Figure 3**).[49] The CCZ is estimated to contain more copper, cobalt, nickel, and manganese than all known land deposits combined.[50]

Figure 3. Clarion-Clipperton Zone (CCZ)



Source: Map created by CRS using International Seabed Authority (ISA), "Maps," https://www.isa.org.jm/exploration-contracts/maps/; and National Oceanic and Atmospheric Administration (NOAA), *Deep Sea Mining: A Report to Congress*, 1995, p. 6; and ESRI.

Notes: APEI = Areas of Particular Environmental Interest, which refers to no-mining zones as designated by the ISA to protect the full range of biodiversity and habitats; DSHMRA = Deep Seabed Hard Mineral Resources Act (30 U.S.C. §§1441 et seq.); and UK = United Kingdom. Most commercial interest in deep-seabed mining focuses on the CCZ. The CCZ is approximately 1.7 million square miles (up to 3.4 miles beneath the ocean's surface), spanning an area as wide as the continental United States on the Pacific seafloor. Since 2001, ISA has awarded 17 exploration contracts for polymetallic nodules in the CCZ. In addition to APEIs, the ISA also designates reserved areas to ensure developing countries have access to mineral resources in areas beyond national jurisdiction. NOAA issued two exploration licenses in the CCZ in 1984 that have been extended through June 2027 pursuant to DSHMRA. For more information about ISA exploration contracts and U.S. exploration licenses issued by the NOAA pursuant to DSHMRA in the CCZ and the duration of these contracts and U.S. licenses, see CRS Infographic IG10053, *Seabed Mining in the Clarion-Clipperton Zone*, by Caitlin Keating-Bitonti, Corrie E. Clark, and Emma Kaboli.

Because the United States is not a party to UNCLOS, the United States cannot sponsor companies interested in seeking ISA contracts for exploration or exploitation of seabed mineral resources through the ISA framework. Under domestic law, however, the United States has authorized exploration licenses to U.S.-based companies in the CCZ (see "Deep Seabed Hard Mineral Resources Act and Other Applicable U.S. Laws," below).

[49] See CRS Infographic IG10053, *Seabed Mining in the Clarion-Clipperton Zone*, by Caitlin Keating-Bitonti, Corrie E. Clark, and Emma Kaboli.

[50] For example, Olive Heffernan, "Deep-Sea Dilemma," *Nature*, vol. 571 (2019), p. 467.

The ISA has yet to develop a regulatory regime for extraction of seabed minerals and therefore has not issued exploitation contracts. The issuance of exploitation contracts would include information about mining operations and actions to minimize harm to marine habitats and species at the proposed site.[51] In 2014, the ISA began to draft standards and guidelines for exploitation of seabed minerals in ABNJ and initially set a self-imposed deadline of 2020 for the release of its "Mining Code," which was delayed due to the Coronavirus Disease 2019 pandemic.[52]

In 2021, the Republic of Nauru, a Pacific Island country, notified the ISA of its sponsorship of Nauru Ocean Resources Inc. (NORI; a subsidiary of The Metals Company [TMC], a Canadian firm) and its intention to mine the CCZ by early 2026.[53] The Republic of Nauru claimed its efforts to mine the seabed would support the global transition to clean energy technologies and would help reduce carbon emissions.[54]

The Republic of Nauru's application triggered a legal provision within UNCLOS that compels the ISA to establish standards and guidelines for mining deep-sea resources while minimizing environmental risks.[55] According to the provision, commonly referred to as the *two-year rule*, the ISA must finalize its deep-seabed mining regulations within two years (i.e., by summer 2023).[56] The ISA did not meet this two-year deadline and pushed the deadline to 2025.[57] Outstanding matters to be considered within the ISA's regulations for exploitation of seabed minerals could include the following, for example:

- Threshold of environmental harm to apply when assessing applications, including knowledge of environmental baseline data
- Processes relating to the preparation and evaluation of environmental plans
- Monitoring programs
- Environmental performance guarantees
- Environmental compensation fund
- Adjacent coastal states and transboundary harm[58]

[51] ISA, "Protection of the Marine Environment," https://www.isa.org.jm/protection-of-the-marine-environment/ (hereinafter ISA, "Protection of the Marine Environment").

[52] ISA, "Protection of the Marine Environment;" and Helen Scales, *The Brilliant Abyss*, (New York: Atlantic Monthly Press, 2021), p. 187.

[53] ISA, "Letter Dated 30 June 2021 from the President of the Council of the International Seabed Authority Addressed to Members of the Council," ISBA/26/C/38, July 1, 2021; and The Metals Company (TMC), "NORI-D Project – Nauru Ocean Resources Inc.," https://metals.co/nori/.

[54] Republic of Nauru, "Statement Delivered by His Excellency David Adeang, President of the Republic of Nauru at the 29th Session of the International Seabed Authority," July 30, 2024, https://www.isa.org.jm/wp-content/uploads/2024/07/National_Statement-by-H.E.-David-Adeang_ISA-Assembly.pdf.

[55] United Nations, Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, July 28, 1994, https://www.un.org/depts/los/convention_agreements/texts/agreement_part_xi/agreement_part_xi.htm (hereinafter 1994 Agreement).

[56] Pradeep Singh, "The Two-Year Deadline to Complete the International Seabed Authority's Mining Code: Key Outstanding Matters That Still Need to Be Resolved," *Marine Policy*, vol. 134, no. 104804 (2021).

[57] The ISA Council intends to adopt exploitation regulations during the 30th sess. of the ISA, which will take place in 2025. ISA, *Decision of the Council of the International Seabed Authority on a Timeline following the Expiration of the Two-year Period Pursuant to Section 1, Paragraph 15, of the Annex to the Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea*, ISBA/28/C/24, July 21, 2023 (hereinafter ISA, ISBA/28/C/24). Dates for the 30th sess. of the ISA can be found at https://www.isa.org.jm/sessions/30th-session-2025/.

[58] ISA, ISBA/28/C/24.

On January 1, 2025, Leticia Carvalho began her four-year term as Secretary-General of the ISA, replacing Michael Lodge, who had held the position since 2017.[59] Carvalho has been reported as saying commercial-scale deep-seabed mining should not start until environmental regulations are finalized.[60] However, ISA Council decisions provide that if an ISA exploitation application is submitted before the exploitation regulations have been adopted, the council will consider the process for reaching a decision on such an application at its next meeting.[61] TMC had previously announced that NORI and the Republic of Nauru would submit their ISA exploitation application by June 27, 2025, but they did not submit an application to ISA by that date.[62] In a March 2025 statement, TMC asserted that "the ISA has neither the Mining Code nor the willingness to engage with their commercial contractors," signaling a shift in the company's priority away from pursuing ISA seabed mining options toward those under the U.S. framework for seabed mining in ABNJ (discussed in the following section).[63]

Deep Seabed Hard Mineral Resources Act and Other Applicable U.S. Laws

In 1980, Congress passed the Deep Seabed Hard Mineral Resources Act (DSHMRA; P.L. 96-283) as an interim measure to allow U.S. citizens to proceed with seabed mineral exploration and recovery until an international regime was in place (i.e., UNCLOS).[64] The 96th Congress stated among the findings of DSHMRA that "the nations of the world, including the United States, will benefit if the hard mineral resources [, including nickel, copper, cobalt, and manganese,] of the deep seabed beyond limits of national jurisdiction can be developed and made available for their use."[65] Further, the 96th Congress stated the purposes of DSHMRA are to "encourage the successful conclusion of a comprehensive [UNCLOS],"[66] and to "assure that such exploration and recovery activities are conducted in a manner which will encourage the conservation of such resources, protect the quality of the environment, and promote the safety of life and property at sea,"[67] among others.

DSHMRA establishes a framework for authorizing U.S. citizens to explore for and recover minerals from the seabed in ABNJ. Congress authorized the National Oceanic and Atmospheric Administration (NOAA) to issue exploration licenses and commercial recovery permits to U.S. citizens for deep-seabed mining activities.[68] After NOAA receives an application by an entity seeking an exploration license or commercial recovery permit and before it issues the license or

[59] ISA, "The Secretary-General," https://www.isa.org.jm/the-secretary-general/.

[60] Todd Woody, "A Fraught Election Just Reshaped the Next Steps for Deep Sea Mining," *Bloomberg*, August 2, 2024, https://www.bloomberg.com/news/articles/2024-08-02/a-fraught-election-just-shaped-the-next-steps-for-deep-sea-mining.

[61] ISA, ISBA/28/C/24; and ISA, *Decision of the Council of the International Seabed Authority Relating to the Understanding and Application of Section 1, Paragraph 15, of the Annex to the Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea*, ISBA/28/C/25, July 21, 2023.

[62] TMC, "TMC Announces June 27, 2025 Submission Date for Subsidiary NORI's ISA Application, and Expanded Company Strategy," November 12, 2024, https://investors.metals.co/news-releases/news-release-details/tmc-announces-june-27-2025-submission-date-subsidiary-noris-isa.

[63] TMC, "CEO Statement on ISA and USA," March 2025, https://metals.co/ceo-statement-on-isa-and-usa/.

[64] 30 U.S.C. §1401(b)(3). The Deep Seabed Hard Mineral Resources Act (P.L. 96-283) refers to UNCLOS as the *Law of the Sea Treaty*.

[65] 30 U.S.C. §1401(a).

[66] 30 U.S.C. §1401(b)(1).

[67] 30 U.S.C. §1401(b)(4).

[68] 30 U.S.C. §1412. 15 C.F.R. §970 and 15 C.F.R. §971.

permit, NOAA is to prepare and publish an environmental impact statement for its issuance of the license or permit.[69] The National Environmental Policy Act (42 U.S.C. §§4321-4347) is the source of the substantive requirements for preparing an environmental impact statement. U.S. companies pursuing deep-seabed mining activities in ABNJ may be subject to other U.S. federal laws, such as the Marine Mammal Protection Act (16 U.S.C. §§1361-1423h). In addition, Section 109(e) of DSHMRA provides that any discharge of a pollutant from a vessel or other floating craft associated with deep-seabed mining activities is subject to the provisions of the Clean Water Act (33 U.S.C. §§1251-1387).[70]

The lack of accession by the United States to UNCLOS does not preclude NOAA from issuing exploration licenses or commercial recovery permits pursuant to DSHMRA.[71] However, "any rights a U.S. company may have domestically [under DSHMRA] are not secured internationally," according to a 2017 NOAA notice.[72] According to the ISA, parties to UNCLOS have "a duty not to recognize any claim, acquisition, or exercise of rights over minerals recovered from the Area by any State or by any natural or juridical person, unless conducted in accordance with Part XI of UNCLOS."[73] Therefore, parties to UNCLOS may not recognize exploration licenses or commercial recovery permits issued by NOAA. The ISA also could issue exploration or exploitation contracts to a company sponsored by a nation party to UNCLOS or make other designations (e.g., *areas of particular environmental interest*[74]) in the same area where NOAA has issued a license or permit.[75] Without the United States being a party to UNCLOS, U.S. citizens issued licenses or permits by NOAA would have no legal recourse under UNCLOS mechanisms to protect their claim to explore and/or recover seabed minerals in ANBJ.[76]

Exploration Licenses Issued Under the Deep Seabed Hard Mineral Resources Act

In 1984, NOAA issued exploration licenses for four sites located in the CCZ, predating the establishment of the ISA in 1994. NOAA has not issued any exploration licenses since 1984, although the agency has approved extension requests. To date, two exploration licenses (USA-1 and USA-4), both held by Lockheed Martin, remain active pursuant to DSHMRA and in effect through June 2, 2027 (**Figure 3**).[77] According to a 2017 *Federal Register* notice, Lockheed Martin has delayed at-sea exploration activities, citing "the need to have security of tenure through international recognition of the licenses by the [ISA] following accession by the United

[69] 30 U.S.C. §1419(d).

[70] 30 U.S.C. §1419(e).

[71] Email correspondence between CRS and NOAA, November 23, 2022 (hereinafter CRS correspondence with NOAA, 2022).

[72] NOAA, "Deep Seabed Mining: Approval of Exploration License Extensions," 82 *Federal Register* 42327, September 7, 2017 (hereinafter NOAA, "Deep Seabed Mining," 82 *Federal Register* 42327).

[73] ISA, "FAQs for the Media." UNCLOS Article 137(3) states, "No State or natural or juridical person shall claim, acquire or exercise rights with respect to the minerals recovered from the Area except in accordance with [Part XI of UNCLOS]. Otherwise, no such claim, acquisition or exercise of such rights shall be recognized."

[74] The ISA designates areas of particular environmental interest to "protect biodiversity and ecosystem structure and function across the region and are protected from future exploitation of mineral resources." ISA, "Environmental Management Plan for the Clarion-Clipperton Zone," https://www.isa.org.jm/protection-of-the-marine-environment/regional-environmental-management-plans/ccz/.

[75] CRS correspondence with NOAA, 2022.

[76] NOAA, "Deep Seabed Mining," 82 *Federal Register* 42327.

[77] NOAA, "Deep Seabed Mining: Approval of Exploration License Extensions," 87 *Federal Register* 52743, August 29, 2022.

States to the UNCLOS."[78] In December 2021, the ISA designated an area of the CCZ that partially overlaps with USA-1 as an area of particular environmental interest, thereby precluding seabed mining activities conducted by parties to UNCLOS from taking place in the area (refer to APEI 13 in **Figure 3**).[79] For more information about the history and status of these licenses, see CRS In Focus IF12608, *U.S. Interest in Seabed Mining in Areas Beyond National Jurisdiction: Brief Background and Recent Developments*, by Caitlin Keating-Bitonti.

Pending Applications to the National Oceanic and Atmospheric Administration

On April 29, 2025, TMC's U.S. subsidiary, TMC USA LLC (TMC USA), submitted applications to NOAA for two exploration licenses and one commercial recovery permit under DSHMRA for areas in the CCZ.[80] Under deep-seabed mining regulations for exploration licenses, NOAA is to provide written notice to the applicant regarding its determination as to whether the application is in substantial compliance within 30 days after receipt of an application.[81] On May 28, 2025, TMC USA received written notice from NOAA "that its exploration license applications … have been found to be in substantial compliance" with DSHMRA and its regulations.[82] Under deep-seabed mining regulations for commercial recovery permits, NOAA is to notify the applicant whether an application is complete within 60 days after it is received.[83] The application processing will not begin until NOAA determines that the commercial recover permit application is complete.[84] Once NOAA has deemed the application is in full compliance, each application is to be published in the *Federal Register* with at least 60 days available to submit written comments to the NOAA Administrator.[85] On July 7, 2025, NOAA proposed revisions to the regulations for exploration license and commercial recover permit applications for seabed mining, including a consolidated license and permit review process.[86] In particular, the proposal would

> add a process whereby U.S. citizens who are qualified for these consolidated procedures may concurrently apply for an exploration license and a commercial recovery permit. A U.S. citizen would be qualified to use these consolidated procedures if it can demonstrate that the applicant possesses the scientific, technical, and financial resources to pursue commercial recovery activities in an expeditious and diligent manner.

The comment period for the proposed revisions ends on September 5, 2025.[87]

[78] NOAA, "Deep Seabed Mining," 82 *Federal Register* 42327.

[79] ISA, *Decision of the Council of the International Seabed Authority Relating to the Review of the Environmental Management Plan for the Clarion-Clipperton Zone*, ISBA/26/C/58, December 10, 2021.

[80] TMC, "World First: TMC USA Submits Application for Commercial Recovery of Deep-Sea Minerals in the High Seas Under U.S. Seabed Mining Code," April 29, 2025, https://investors.metals.co/news-releases/news-release-details/world-first-tmc-usa-submits-application-commercial-recovery-deep.

[81] 15 C.F.R. §970.209.

[82] U.S. Securities and Exchange Commission, *TMC The Metals Company Inc.*, Form 8-K, May 29, 2025, https://www.sec.gov/Archives/edgar/data/1798562/000110465925053875/tm2516473d1_8k.htm.

[83] 15 C.F.R. §971.210.

[84] 15 C.F.R. §971.210.

[85] 15 C.F.R. §970.212(a); 15 C.F.R. §971.212(a).

[86] NOAA, "Deep Seabed Mining: Revisions to Regulations for Exploration License and Commercial Recovery Permit Applications," 90 *Federal Register* 29806, July 7, 2025 (hereinafter NOAA, "Deep Seabed Mining," 90 *Federal Register* 29806).

[87] NOAA, "Deep Seabed Mining," 90 *Federal Register* 29806.

TMC holds two ISA exploration contracts for polymetallic nodules in the CCZ, through sponsorships with the Republic of Nauru and the Kingdom of Tonga.[88] Some stakeholders speculate that TMC USA's applications to NOAA may be part of "a tactic to put pressure on the ISA" to adopt its exploitation regulations.[89] The adoption of the ISA's exploitation regulations would allow seabed mining companies sponsored by countries party to UNCLOS to apply for exploitation contracts and potentially proceed with commercial-scale mining through the ISA framework.[90] However, TMC's chair and chief executive officer testified in a House Natural Resources Subcommittee Oversight and Investigation hearing in the 119th Congress that the "ISA failed to deliver on its goal to adopt the final mining code, in 2020, 2023 and will almost certainly fail again in 2025."[91]

Ratification of the United Nations Convention on the Law of the Sea

The U.S. Senate has considered ratifying UNCLOS multiple times.[92] From the 115th through 118th Congresses, some Members have introduced resolutions calling on the U.S. Senate to give its advice and consent to the ratification of UNCLOS.[93] Members of Congress and other stakeholders may call for the United States to join UNCLOS for several reasons related to deep-seabed mining issues, including allowing the United States to (1) sponsor U.S. companies seeking ISA contracts and (2) formally participate in the ISA decisionmaking.

Seabed Mining Options for U.S. Companies

By ratifying UNCLOS, the United States would become a member of the ISA and then could sponsor U.S. companies seeking ISA contracts. Currently, U.S. companies would have to establish a subsidiary in a nation party to UNCLOS to seek ISA contracts. For example, the United Kingdom (UK) arm of Lockheed Martin established UK Seabed Resources.[94] Through sponsorship of the UK of Great Britain and Northern Ireland, UK Seabed Resources held two ISA exploration contracts for polymetallic nodules in the CCZ.[95] On March 16, 2023, Loke Marine Minerals, a Norwegian company, acquired 100% of UK Seabed Resources.[96] This acquisition also included the transfer of UK Seabed Resources' two ISA-issued exploration contracts to Loke

[88] TMC, "Sponsoring States," https://metals.co/sponsoring-states/.

[89] SDG Knowledge Hub, "Amid Concerns over Exploitation, ISA Forges Ahead with Deep Sea Mining Rules," April 2, 2025, https://sdg.iisd.org/news/amid-concerns-over-exploitation-isa-forges-ahead-with-deep-sea-mining-rules/.

[90] Article 10 of the Annex to UNCLOS states that an operator who holds an ISA-issued exploration contract "shall have a preference and a priority among applicants for a plan of work covering exploitation of the same area and resources."

[91] Gerard Barron, Chairman and CEO, TMC, written testimony for *Exploring the Potential of Deep-Sea Mining*, hearing, 119th Congress.

[92] To date, UNCLOS and the 1994 Agreement have been considered by Senate Committee on Foreign Relations three times (1994, 2003, and 2007).

[93] S.Res. 598 and H.Res. 339 in the 115th Cong.; S.Res. 284 and H.Res. 454 in the 116th Cong.; S.Res. 220 and H.Res. 361 in the 117th Cong.; and S.Res. 466 in the 118th Cong.

[94] Reuters, "Lockheed Martin Sells Deep-Sea Mining Firm to Norway's Loke," March 16, 2024, https://www.reuters.com/markets/deals/norways-loke-buys-uk-deep-sea-mining-firm-lockheed-2023-03-16/.

[95] ISA, "Minerals: Polymetallic Nodules," https://www.isa.org.jm/exploration-contracts/polymetallic-nodules/.

[96] Loke Marine Minerals, "Loke Acquires Deep Sea Mineral Licenses in the Pacific Ocean," press release, March 16, 2023, https://lokemm.com/wp-content/uploads/LOKE-Press-release.pdf (hereinafter Loke Marine Minerals, "Loke Acquires Deep Sea Mineral Licenses in the Pacific Ocean").

Marine Minerals (**Figure 3**).[97] However, Loke Marine Minerals filed for bankruptcy in April 2025, claiming "it was difficult to raise capital" due to uncertainty over the ability of the ISA to adopt exploitation regulations in the near future.[98] Reportedly, the UK government is seeking a domestic buyer to acquire its two ISA exploration contracts.[99]

Some stakeholders who oppose U.S. ratification of UNCLOS contend that the United States already has the authority to explore and recover seabed minerals in ABNJ.[100] However, some U.S.-based companies may find it too risky to pursue NOAA exploration licenses for seabed mining or to act on such licenses in the absence of U.S. ratification of UNCLOS.[101] Lack of accession by the United States to UNCLOS has not precluded NOAA from extending two DSHMRA exploration licenses to Lockheed Martin through 2027.[102] Conflicting claims between DSHMRA exploration licenses and ISA contracts could deter financiers from backing U.S.-authorized deep-seabed mining projects.[103]

In addition to uncertainties facing private companies, state actors have commented on U.S. actions to promote seabed mining in ABNJ. For example, the Secretary-General of the ISA warned that any unilateral action outside the UNCLOS framework "sets a dangerous precedent that could destabilize the entire system of global ocean governance."[104] Also, China's Ministry of Foreign Affairs said these actions show that the United States "would brush aside international law and international order in pursuit of its selfish interests."[105]

International Seabed Authority Decisionmaking

During the negotiation of the 1994 Agreement, one permanent seat on the 36-member ISA Council was created for the country "having the largest economy in terms of gross domestic product" on the date UNCLOS entered into force, which at the time was the United States.[106] Because that is still the case, if the United States ratified UNCLOS, it would occupy the only permanent seat on the ISA Council.[107] The Council establishes ISA policies, proposes rules of

[97] Loke Marine Minerals, "Loke Acquires Deep Sea Mineral Licenses in the Pacific Ocean."

[98] Yusuf Khan, "A Miner Goes Bust, Another Goes Solo as Progress on U.N. Seabed Rules Stalls," *Wall Street Journal*, April 11, 2025.

[99] Kenza Bryan, "UK Says Transfer of Deep-Sea Mining Permits Could Prompt Security Review," *Financial Times*, April 18, 2025.

[100] For example, see the Statement of Steven Groves, Bernard and Barbara Lomas Fellow, the Heritage Foundation, Washington, DC, in U.S. Congress, Senate Committee on Foreign Relations, *The Law of the Sea Convention (Treaty Doc. 103-39)*, 112th Cong., 2nd sess., May 23, June 14, and June 28, 2012, S.Hrg. 112-654 (Washington, DC: GPO, 2013), p. 191.

[101] For example, NOAA, "Deep Seabed Mining," 82 *Federal Register* 42327.

[102] NOAA, "Deep Seabed Mining," 87 *Federal Register* 52743.

[103] CRS correspondence with NOAA, 2022. Some financial institutions have made statements that they will not fund exploration and extraction activities associated with deep-seabed mining. For example, see Stop Deep Seabed Mining, "Endorsers," https://www.stopdeepseabedmining.org/endorsers/.

[104] ISA, "Statement on the US Executive Order: 'Unleashing America's Offshore Critical Minerals and Resources'," April 30, 2025, https://www.isa.org.jm/news/statement-on-the-us-executive-order-unleashing-americas-offshore-critical-minerals-and-resources/.

[105] The People's Republic of China, Ministry of Foreign Affairs, "Foreign Ministry Spokesperson Guo Jiakun's Regular Press Conference on April 25, 2025," April 25, 2025, https://www.mfa.gov.cn/eng/xw/fyrbt/lxjzh/202504/t20250425_11604503.html.

[106] Section 3, paragraph 15(a), of the Annex to the 1994 Agreement.

[107] For example, see U.S. Congress, Senate Committee on Foreign Relations, *The Law of the Sea Convention (Treaty Doc. 103-39)*, 112th Cong., 2nd sess., May 23, June 14, and June 28, 2012, S.Hrg. 112-654 (Washington, DC: GPO, (continued...)

procedure, enters into agreements with the United Nations or other international organizations, exercises control over activities occurring on or within the seabed in ABNJ (for parties to UNCLOS), and disapproves areas for exploitation, among other powers.[108] In general, the Council makes decisions by consensus for administrative, budgetary, and financial matters, including distribution fees.[109]

Negotiations are ongoing for ISA regulations for the exploitation of mineral resources in ABNJ,[110] and some stakeholders contend that the United States should ratify UNCLOS to formally participate in the development of these regulations.[111] Despite not ratifying UNCLOS, however, the United States' input as an observer delegate to the ISA has been generally respected and accepted in the drafting of the ISA's exploitation regulations, according to the Department of State.[112] Other matters, such as a mechanism for the equitable sharing of financial and other economic benefits derived from deep-seabed mining activities, have yet to be developed and adopted by the ISA.[113]

Global Critical Minerals Marketplace and China's Dominance

Dependence on foreign sources of minerals may lead to U.S. uncertainties in supply ranging from cost instability to supply disruptions. For example, China has restricted or prohibited the export of certain critical minerals to the United States.[114] A 2024 study by the U.S. Geological Survey (USGS) identified that China had a monopoly over cobalt battery materials.[115] China owns or finances mines in the Democratic Republic of the Congo, some of which have been associated with unsafe working conditions and forced labor.[116] In addition to mining critical minerals, in

2013), p. 222. The permanent seat is currently occupied by Italy. ISA, "The Council," https://isa.org.jm/organs/the-council/.

[108] UNCLOS Article 162.

[109] Section 3, paragraphs 2 and 4, of the Annex to the 1994 Agreement.

[110] ISA, "The Mining Code," https://www.isa.org.jm/the-mining-code/draft-exploitation-regulations-2/.

[111] For example, Dan Ackerman, "Why the U.S. Is Absent from International Seabed Mining Talks," NPR, March 29, 2024, https://www.npr.org/2024/03/29/1241726831/why-the-u-s-is-absent-from-international-seabed-mining-talks.

[112] Telephone conversation between CRS and the U.S. Department of State, October 17, 2022.

[113] See ISA, "A Collective Vision of a Shared Future," https://www.isa.org.jm/equitable-sharing-of-benefits/.

[114] For example, see Institute for Energy Research, "China Has Banned Exports of Some Rare Minerals to the United States," December 12, 2024, https://www.instituteforenergyresearch.org/international-issues/china-has-banned-exports-of-some-rare-minerals-to-the-united-states/; and Joseph Sopcisak, "China Imposes Export Controls on Medium and Heavy Rare Earth Materials," Holland & Knight, *Holland & Knight Alert*, April 4, 2025, https://www.hklaw.com/en/insights/publications/2025/04/china-imposes-export-controls-on-medium-and-heavy-rare-earth-materials.

[115] According to the USGS, "in 2022 Chinese firms had control over 62% of cobalt mine materials primarily used for cobalt chemical refining, 95% control of refined commercial-grade cobalt chemicals, 92% control of battery-grade tricobalt tetroxide, 85% control of battery-grade cobalt sulfate, and 91% control of nickel–cobalt-manganese cathode precursor materials." Andrew L. Gulley, "The Development of China's Monopoly over Cobalt Battery Materials," Mineral Economics (2024).

[116] Andrew L. Gulley et al., "China's Domestic and Foreign Influence in the Global Cobalt Supply Chain," *Resources Policy*, vol. 62 (August 2019), pp. 317-323; and Eric Lipton and Dionne Searcey, "Chinese Company Removed as Operator of Cobalt Mine in Congo," *New York Times*, February 28, 2002.

2022 China processed approximately 31% of the nickel, 74% of the cobalt, and 90% of REEs extracted globally.[117]

Some stakeholders may look to seabed mining to reduce dependence on sources with weak protective labor and environmental standards and practices.[118] Other stakeholders have promoted seabed mining "as an opportunity to introduce new mineral supplies that are independent of Chinese-controlled supply chains."[119] In addition to seabed minerals as potential alternative sources for critical minerals, the Biden Administration promoted recycling and recapture of minerals from waste or mine tailings as other options.[120]

Some Members of Congress have expressed concern about China's dominance of the global critical mineral market place and potential dominance over deep-sea assets, pointing to China's five ISA exploration contracts (the most of any country).[121] China holds three contracts for polymetallic nodules (two of these are located in the CCZ); one contract for polymetallic sulfides; and one contract for cobalt-rich ferromanganese crusts (**Figure 4**).[122] One of China's state-owned enterprises plans to test its prototype collector vehicle in the CCZ during the July-October 2025 period.[123] Some stakeholders speculate that China has acquired several exploration contracts in order to quickly convert them to exploitation contracts when the ISA adopts its regulations for the exploitation of seabed minerals.[124]

[117] Rifat Jabbar et al., *Polymetallic Nodules and the Critical Mineral Supply Chain: A North American Approach*, Wilson Center and Hatch, 2022, p. 3, https://www.wilsoncenter.org/publication/polymetallic-nodules-and-critical-minerals-supply-chain-north-american-approach (hereinafter Jabbar et al., *Polymetallic Nodules and the Critical Mineral Supply Chain*).

[118] NOAA, *Deep Sea Mining: A Report to Congress*, 1995, p. 2 (hereinafter NOAA, *1995 Report to Congress*).

[119] Tom LaTourrette et al., *The Potential Impact of Seabed Mining on Critical Mineral Supply Chains and Global Geopolitics*, RAND, 2025, p. 3 (hereinafter LaTourrette et al., *Potential Impact of Seabed Mining*).

[120] For example, White House, *Executive Order on America's Supply Chains: A Year of Action and Progress*, February 2022, see p. 16, https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/02/Capstone-Report-Biden.pdf.

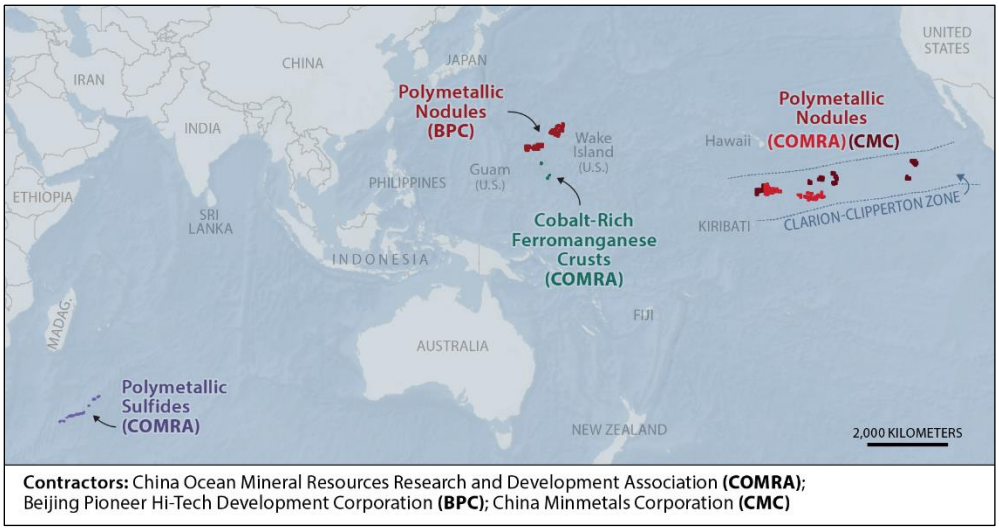
[121] For example, Letter from U.S. Representative Robert J. Wittman and 30 other Members to then-U.S. Secretary of Defense Lloyd Austin, December 7, 2023, https://wittman.house.gov/uploadedfiles/20231207_-_wittmanstefanik_-_national_security_impacts_of_seabed_mining_-_signed.pdf.

[122] ISA, "Exploration Contracts," https://www.isa.org.jm/exploration-contracts/.

[123] ISA, "FAQs for the Media."

[124] Article 10 of the Annex to UNCLOS states that an operator who holds an ISA-issued exploration contract "shall have a preference and a priority among applicants for a plan of work covering exploitation of the same area and resources."

Figure 4. Locations of China's Five Exploration Contracts



Source: Map created by CRS using International Seabed Authority (ISA), "Maps," https://www.isa.org.jm/exploration-contracts/maps/.

Notes: The ISA issues exploration contracts for three types of seabed deposits: polymetallic nodules, cobalt-rich ferromanganese crust, and polymetallic sulfides. Under the ISA framework, exploration contracts can include more than one locality but may not exceed 75,000 square kilometers (km^2) for polymetallic nodules (red shades), 3,000 km^2 consisting of 150 blocks (no block greater than 20 km^2) for cobalt-rich ferromanganese crusts (green), and 10,000 km^2 consisting of 100 blocks (no block greater than 100 km^2) for polymetallic sulfides (purple).

In 2023, some Members of Congress voiced concerns about China's seabed mining activities and its potential to "seize unfettered control of deep-sea assets."[125] Some stakeholders also have expressed concern that "deep-sea mining could act as cover for less peaceful activities."[126] Although a 2022 RAND report "found no evidence to support the notion that China's seabed mining program is intended as cover for military purposes," the authors "urge[d] continued monitoring" of China's seabed mining technology development and ship activity.[127] Some speculate that data collected from ABNJ by PRC civilian vessels for research or other purposes may be used for military purposes and may present national security concerns for some countries.[128] For example, in 2021, a PRC research vessel detoured from its ISA exploration site in the CCZ and spent five days offshore of Hawaii.[129] During a House Science, Space, and Technology Subcommittee on Environment hearing in the 119th Congress, a Member of Congress

[125] Letter from U.S. Representative Robert J. Wittman and 30 other Members to then-U.S. Secretary of Defense Lloyd Austin, December 7, 2023, https://wittman.house.gov/uploadedfiles/20231207_-_wittmanstefanik_-_national_security_impacts_of_seabed_mining_-_signed.pdf. Also see U.S. Congress, House Committee on Natural Resources, Subcommittee on Oversight and Investigations, *Exploring the Potential of Deep-Sea Mining to Expand American Mineral Production*, hearing, 119th Congress, 1st sess., April 29, 2025 (hereinafter *Exploring the Potential of Deep-Sea Mining*, hearing, 119th Congress). In particular, see the majority's hearing memorandum at https://naturalresources.house.gov/uploadedfiles/hearing_memo_—_sub_on_oi_ov_hrg_on_seabed_mining_04.29.25.pdf.

[126] *Economist*, "China Is Itching to Mine the Ocean Floor," July 28, 2024.

[127] Tom LaTourrette et al., "China's Role in the Global Development of Critical Resources," RAND, November 22, 2022, p. ix.

[128] Austin Ramzy, "China Is Mapping the Seabed to Unlock New Edge in Warfare," *Wall Street Journal*, updated March 12, 2025.

[129] *Economist*, "China Is Itching to Mine the Ocean Floor," July 28, 2024.

echoed these potential concerns about "how China is supercharging its ocean mapping and drilling enterprise."[130]

Potential Marine Environmental Impacts of Seabed Mining

The potential effects of seabed mining on the marine environment remain incompletely understood. This is in part because commercial-scale deep-seabed mining in ABNJ has yet to occur. Some governments and stakeholders, including some Members of Congress, have raised concerns regarding the potential environmental impacts of seabed mining and have called for a moratorium, precautionary pause, or ban on deep-sea mining, either in international waters, national waters, or both (see textbox below entitled, "Calls for a Deep-Seabed Mining Moratorium"). Proponents of seabed mining that is "properly managed with appropriate governance safeguards" argue that sourcing minerals from the deep sea has the potential to have less pollution (e.g., tailings, waste), fewer impacts on freshwater sources, and fewer social impacts (e.g., human fatalities, injuries, health effects) than traditional land-based open-pit and underground mining.[131]

Calls for a Deep-Seabed Mining Moratorium

Some stakeholders point to the lack of deep-sea *environmental baseline* data—which are used to discern whether, and to what degree, habitats and species are vulnerable to disturbance—as one reason to delay or ban deep-seabed mining. Several technology companies (e.g., Apple, Google, Samsung) and automakers (e.g., BMW, Volkswagen, Volvo) have announced support for a moratorium on seabed minerals being used in electric vehicle batteries and other technologies until seabed mining activities can be performed in a way that protects the marine environment. More than 35 foreign governments also have called for a moratorium on deep-seabed mining. Although France holds an International Seabed Authority (ISA) exploration license for seabed mining in areas beyond national jurisdiction, France also supports a moratorium. France's State Secretary for the Sea has said that France will continue to hold its ISA contract and use it for "more research, more science, more data" to better understand the deep sea.

In 2024, some Members of Congress signed a letter urging President Biden to "support a precautionary pause or moratorium on deep-seabed mining until and unless there is sufficient scientific information and knowledge of the deep sea." In the 119th Congress, some Members of Congress introduced H.R. 663 instructing the President to direct U.S. representatives to relevant international organizations to call for a moratorium on deep-seabed mining until "regulations have been promulgated by the [ISA]." Some Members of Congress proposed legislation in the 119th Congress that could improve understanding of seabed mining impacts. For example, H.R. 664 would authorize the National Oceanic and Atmospheric Administration (NOAA) to enter into an agreement with the National Academies of Sciences, Engineering, and Medicine to "conduct a comprehensive study of the environmental impacts of mining activities on the deep seabed and the Outer Continental Shelf." The bill also would prohibit NOAA from issuing a license, permit, or other authorization for exploration or commercial recovery under the Deep Seabed Hard Mineral Resources Act (P.L. 96-283).

Sources: Elizabeth Claire Alberts, "The Deep Sea Is Vital to Protect the Ocean: Q&A with France's Herné Berville," *Mongabay*, August 2, 2023, https://news.mongabay.com/2023/08/the-deep-sea-is-vital-to-protect-the-ocean-qa-with-frances-herve-berville/; Diva Amon et al., "Assessment of Scientific Gaps Related to the Effective Environmental Management of Deep-Sea Mining," *Marine Policy*, vol. 138 (2022), pp. 1-22; Deep Sea Conservation Coalition, "Voices Calling for a Moratorium: Governments and Parliamentarians," https://deep-sea-conservation.org/solutions/no-deep-sea-mining/momentum-for-a-moratorium/governments-and-parliamentarians/; ISA, "Institut Français de Recherche pour l'Exploitation de la Mer," https://www.isa.org.jm/

[130] See Representative Brian Babin, Chairman of the Committee on Science, Space, and Technology, opening statement, U.S. Congress, House Committee on Science, Space, and Technology, Subcommittee on Environment, *To the Depths and Beyond: Examining Blue Economy Technologies*, hearing, 119th Congress, 1st sess., March 26, 2025.

[131] For example, Daina Paulikas et al., "Life Cycle Climate Change Impacts of Producing Battery Metals from Land Ores Versus Deep-Sea Polymetallic Nodules," *Journal of Cleaner Production*, vol. 275 (2020), p. 17.

contractor/institut-francais-de-recherche-pour-lexploitation-de-la-mer/; Letter from U.S. Representatives Grijalva, Case, Tlaib, Huffman, Norton, McCollum, Cohen, Lofgren, Jackson, Kamlager-Dove, Garcia, and Jayapal to President Biden, June 28, 2024, https://plus.cq.com/pdf/8043575; Lisa Levin et al., "Defining 'Serious Harm' to the Marine Environment in the Context of Deep-Seabed Mining," *Marine Policy*, vol. 74 (2016), pp. 245-259; Stop Deep Seabed Mining, "Endorsers;" https://www.stopdeepseabedmining.org/endorsers/.

Exploration of deep-sea habitats can provide *environmental baselines* for understanding whether—and to what degree—these habitats and their species are vulnerable to disturbance or change. NOAA's 1975-1980 Deep Ocean Mining Environmental Studies Project and subsequent projects through the 1990s as directed by Congress under DSHMRA were limited to the biological effects of increased sedimentation on the seafloor.[132] In more recent years, NOAA has collaborated with the Bureau of Ocean Energy Management (BOEM) and the USGS to study a 1970s test site for seabed mining equipment on the Blake Plateau, off the Georgia coast, "to quantify the extent of the impacts, search for visual signs of ecosystem recovery, plan for additional research, and, ultimately, inform reviews, future decisions, and mitigation measures related to deep-sea mining in other areas."[133] Mining technologies for the recovery of seabed minerals have evolved since DSHMRA was enacted.[134] For example, Impossible Metals Inc., a U.S. seabed mining company, has developed an AUV fixed with robotic arms and computer vision system that would hover over the seafloor to pick up individual polymetallic nodules.[135] Impossible Metals posits its AUV would have minimum sediment disturbance compared with other collection approaches and claims that its computer vision could help avoid nodules with attached marine life.[136]

Seabed mining companies have worked with scientists to collect environmental and biological data in deep-sea areas with mineral deposits of interest.[137] These companies collect and share data with the ISA—a requirement of ISA exploration contracts—in part to understand the potential impacts of seabed mining activities.[138] Although scientists have worked with seabed mining companies to establish environmental baselines, some stakeholders may perceive their scientific research as a potential conflict of interest.[139] Some stakeholders may call for a third party or

[132] The Deep Ocean Mining Environmental Study conducted by NOAA was directed by Congress under the Deep Seabed Hard Mineral Resources Act (DSHMRA; 30 U.S.C. §1419(a)). The study focused primarily on determining the biological effects of increased sedimentation on the seafloor that would result from seabed mining operations. See, NOAA, *1995 Report to Congress*, p. 12.

[133] NOAA, "Investigation of a Historic Seabed Mining Equipment Test Site on the Blake Plateau," September 19, 2022, https://oceanexplorer.noaa.gov/explorations/22seabed-mining/welcome.html.

[134] For example, the 96th Cong. included among the purposes of DSHMRA "to encourage the continued development of technology necessary to recover the hard mineral resources of the deep seabed." See 30 U.S.C. §1401(b)(5).

[135] Impossible Metals Inc., "Robotic Collection System."

[136] Impossible Metals Inc., "Frequently Asked Questions (FAQS)," https://impossiblemetals.com/frequently-asked-questions/faqs-environmental-and-social-responsibility-for-deep-sea-mining/.

[137] For example, TMC, "The Metals Company Partners with Global Research Institutions to Advance Deep-Sea Science Program," August 2020, https://metals.co/deepgreen-partners-with-global-research-institutions-to-advance-deep-sea-science-program/.

[138] ISA, *Decision of the Council of the International Seabed Authority Relating to Amendments to the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area and Related Matters*, ISBA/19/C/17, July 22, 2013; ISA, *Decision of the Assembly of the International Seabed Authority Relating to the Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area*, ISBA/16/A/12/Rev.1, November 15, 2010; and ISA, *Decision of the Assembly of the International Seabed Authority Relating to the Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area*, ISBA/18/A/11, October 22, 2012. The ISA stores and makes publicly available the data collected by seabed mining companies at https://data.isa.org.jm/isa/map/.

[139] For example, Elham Shabahat, "'Antithetical to Science': When Deep-Sea Research Meets Mining Interests," (continued...)

independent scientific institution to collect deep-sea data, although this type of research may be considered cost prohibitive.[140]

Mineral deposits occur in various ocean environments, so different machinery and technology would be required to collect seabed material from different locations (**Figure 2**). Consequently, extrapolating marine environmental impacts from one area of the ocean to another may be challenging. For instance, a self-propelled remotely operated mining vehicle connected by a riser pump and pump system to a surface ship likely would be used to collect polymetallic nodules from the surface of the seabed. In general, this operation would disturb the seafloor in three ways: (1) leave tracks in the seafloor, (2) remove sediment and nodules between the tracks, and (3) create a plume of resuspended sediment released by the movement of the mining vehicle.[141] Some additional potential seabed mining impacts to the marine environment are described below.

Biodiversity Loss and Habitat Disturbance

Seabed mining machinery could crush, smother, or disperse benthic (i.e., living on or within the seafloor) organisms while disturbing their habitats.[142] Some species inhabiting the deep sea live under cold conditions without sunlight and survive on little food.[143] To be successful under such conditions, deep-sea species have low metabolic rates—they move slowly, live for a long time, and take many years to reproduce.[144] In general, these traits mean species may be slow to recover from disturbances, making them potentially vulnerable to deep-sea exploitation activities, such as seabed mining, and making the deep-sea environment potentially susceptible to biodiversity loss.[145] In 2023, scientists compared modern-day conditions of a 1979 mining test collector site in the CCZ with seafloor photographs of the area taken in 1978 that were provided for analysis by a seabed mining company.[146] The analysis showed that some types of organisms "are living in the most disturbed areas" 44 years later. Although the analysis compared the modern-day biological abundance (i.e., how many organisms) with pre-disturbance conditions, it did not provide information about biological diversity (i.e., the number of different types of organisms).[147]

The removal of nodules and other hard mineral resources from the seabed also may impact species living or depending on these resources.[148] For example, some organisms require a hard

Mongabay, October 4, 2021, https://news.mongabay.com/2021/10/antithetical-to-science-when-deep-sea-research-meets-mining-interests/.

[140] For example, Laura Ruth, "Gambling in the Deep-Sea," *EMBO reports*, vol. 7, no. 1 (2006), pp. 17-21.

[141] Daniel O. B. Jones et al., "Long-Term Impact and Biological Recovery in a Deep-Sea Mining Track," *Nature*, vol. 642 (2025), pp. 112-118 (hereinafter Jones et al., "Long-Term Impact and Biological Recovery").

[142] Holly Niner et al., "Deep-Sea Mining with No Net Loss of Biodiversity—An Impossible Aim," *Frontiers in Marine Science*, vol. 5 (2018) (hereinafter Niner et al., "Impossible Aim"); and Rahul Sharma, "Environmental Issues of Deep-Sea Mining," *Procedia Earth and Planetary Science*, vol. 11 (2015), pp. 204-211 (hereinafter Sharma, "Environmental Issues").

[143] NOAA, "What Conditions Exist for Life in the Deep Ocean?," https://oceanexplorer.noaa.gov/facts/deep-habitat.html.

[144] Craig R. McClain et al., "Energetics of Life on the Deep Seafloor," *Proceedings of the National Academy of Sciences*, vol. 109, no. 38 (2012), pp. 15366-15371; and Robert Danovaro, "The Deep-Sea Under Global Change," *Current Biol*ogy, vol. 27, no. 11 (2017), pp. R461-R465.

[145] Niner et al., "Impossible Aim;" and Daniel Jones et al., "Biological Responses to Disturbance from Simulated Deep-Sea Polymetallic Nodule Mining," *PLOS One*, vol. 12, no. 2 (2017).

[146] Jones et al., "Long-Term Impact and Biological Recovery."

[147] Jones et al., "Long-term Impact and Biological Recovery in a Deep-sea Mining Track."

[148] Lisa Levin et al., "Defining 'Serious Harm' to the Marine Environment in the Context of Deep-Seabed Mining," *Marine Policy*, vol. 74 (2016), pp. 245-259.

surface, such as a mineral nodule, to attach their bodies to in order to live and grow. Some species of sponges and some microbes live on seabed nodules,[149] and a species of deep-sea octopus lays its eggs on sponges attached to seabed nodules.[150] Because deep-sea nodules form over millions of years,[151] their removal in an area of the seafloor could equate to the permanent loss of a part of the marine habitat that some deep-sea species depend on for their survival.[152] Scientists suggest that "in a typical mining scenario near complete removal of nodules would likely lead to further reductions in nodule-dwelling [organisms'] density" in the collector's tracks.[153]

Resuspended Sediment and Buried Carbon

Resuspended sediment dispersal (i.e., the plume) by seabed mining machinery disturbing seafloor deposits has the potential to impact environments immediate and adjacent to the mined area.[154] The distance to which resuspended sediment disperses through the water column primarily depends on the presence of ocean currents and, if near the surface of the ocean, wave energy. A modeling study of a plume associated with a self-propelled remotely operated mining vehicle in the CCZ predicts deposition of sediment up to 10 millimeters in thickness over a distance of tens of meters.[155] Suspended sediment in the water column could reduce water quality and clarity. The dispersion of seafloor sediment may threaten certain groups of benthic invertebrate organisms in specific ways:

- *Deposit feeders*, organisms that feed on organic matter that settled onto the seafloor, may be impacted by sediment diluting or burying their food resources.[156]
- *Suspension feeders* (also known as *filter feeders*), organisms that filter small food particles directly from the water, may be affected by suspended sediment clogging the water column.[157]

Some extractive activities, including seabed mining and bottom trawling, could disturb the natural processes (i.e., microbes) that regulate carbon in the deep sea, in addition to existing carbon buried in deep-sea sediments.[158] Some scientists speculate that activities affecting carbon burial in sediments could have "far-reaching effects on carbon sequestration that in turn is connected to climate regulation";[159] others have stated that "deep seabed mining may be directly at odds with

[149] Diva Amon et al., "Assessment of Scientific Gaps Related to the Effective Environmental Management of Deep-Sea Mining," *Marine Policy*, vol. 138 (2022), pp. 1-22 (hereinafter Amon et al., "Assessment of Scientific Gaps").

[150] Autun Purser et al., "Association of Deep-Sea Incirrate Octopods with Manganese Crusts and Nodule Fields in the Pacific Ocean," *Current Biology*, vol. 26 (2016), pp. R1268-R1269.

[151] ISA, *Polymetallic Nodules*, 2022, https://www.isa.org.jm/wp-content/uploads/2022/06/eng7.pdf.

[152] Helen Scales, *The Brilliant Abyss* (New York: Atlantic Monthly Press, 2021), p. 192.

[153] Jones et al., "Long-Term Impact and Biological Recovery."

[154] Sharma, "Environmental Issues"; Amon et al., "Assessment of Scientific Gaps"; Niner et al., "Impossible Aim"; and NOAA, *1995 Report to Congress*, p. 12.

[155] Jones et al., "Long-Term Impact and Biological Recovery."

[156] Sharma, "Environmental Issues."

[157] Sharma, "Environmental Issues."

[158] For example, Miller et al., "Challenging the Need for Deep Seabed Mining," p. 4; and Beth Orcutt et al., "Impacts of Deep-Sea Mining on Microbial Ecosystem Services," *Limnology and Oceanography*, vol. 17, no. 7 (2020), pp. 1489-1510, see p. 1499 (hereinafter Orcutt et al., "Impacts of Deep-Sea Mining").

[159] Kristen F. Thompson et al., "Seabed Mining and Approaches to Governance of the Deep Seabed," *Frontiers in Marine Science*, vol. 5 (December 2018), pp. 1-12, see p. 7. *Carbon sequestration* refers to the process of removing carbon dioxide from the atmosphere and storing it in carbon stocks (e.g., deep-sea sediments, soil, plant vegetation).

current climate goals if such regulatory services [provided by microbial communities] are degraded."[160] Other stakeholders state that the scale at which seabed mining would take place would have minimum impact on net deep-sea carbon storage.[161] The 2023 analysis of modern-day versus pre-disturbed conditions of a 1979 mining test collector site in the CCZ found microbial biomass was similar in and out of the disturbed areas.[162]

Noise Pollution

Noise and vibration associated with seabed mining operations may affect the behaviors of marine mammals and other animals living near the ocean's surface.[163] Sound waves travel through the ocean approximately four times faster than they can travel through air and could increase the ambient background noise level in areas up to 500 kilometers away from the mining site, potentially impacting animals in that radius.[164] Noise pollution from mining operations may mask communication and echolocation sounds of cetaceans (whales, porpoises, and dolphins), affecting their abilities to detect and avoid predators and to find food and mates.[165] It also may cause temporary or permanent hearing loss in some marine mammals and may increase their stress levels.[166]

Concerns Associated with Ship Activity

The processing of recovered seabed material at the ocean surface and its transport to land may have impacts near or at the ocean surface. For example, seabed material may be processed on a production support vessel (PSV) or surface-based mining platform and seafloor sediment discarded back into the ocean may cloud the near surface water column (**Figure 2**), potentially inhibiting photosynthesis in some plankton.[167] Collected seabed material and water also may potentially overflow off the PSV or mining platform.[168] In addition, ship traffic associated with seabed mining operations may pose a threat to animals living near the ocean's surface. The increased potential for a vessel strike is one concern.[169] Another concern would be the discharge of ballast water and other wastes, including marine debris, from mining vessels.[170]

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[160] Miller et al., "Challenging the Need for Deep Seabed Mining," p. 4.

[161] For example, Orcutt et al., "Impacts of Deep-Sea Mining," p. 1499; and Seaver Wang, "No, Collecting Seafloor Metals Won't Wreck the Ocean Carbon Cycle," *The Breakthrough Institute*, July 9, 2024, https://thebreakthrough.org/issues/energy/no-collecting-seafloor-metals-wont-wreck-the-ocean-carbon-cycle.

[162] Jones et al., "Long-Term Impact and Biological Recovery."

[163] Christine Erbe et al., "The Effects of Ship Noise on Marine Mammals—A Review," *Frontiers in Marine Science*, vol. 6 (2019) (hereinafter Erbe et al., "The Effects of Ship Noise on Marine Mammals—A Review"). For an additional overview of noise and vibration impacts on marine animals, see CRS Report R47894, *Potential Impacts of Offshore Wind on the Marine Ecosystem and Associated Species: Background and Issues for Congress*, coordinated by Caitlin Keating-Bitonti.

[164] Rob Williams et al., "Noise from Deep-Sea Mining May Span Vast Ocean Areas," *Science*, vol. 377 (2022), pp. 157-158.

[165] Erbe et al., "The Effects of Ship Noise on Marine Mammals—A Review."

[166] Erbe et al., "The Effects of Ship Noise on Marine Mammals—A Review."

[167] Sharma, "Environmental Issues."

[168] For example, ISA, *CARMU Inspection Report 01/2023*, pp. 33-34.

[169] NOAA, "Understanding Vessel Strikes," https://www.fisheries.noaa.gov/insight/understanding-vessel-strikes.

[170] For example, Pew, "Vessel Waste a Growing Challenge in the Northern Bering Sea and Bering Strait," October 10, 2018, https://www.pew.org/en/research-and-analysis/issue-briefs/2018/10/vessel-waste-a-growing-challenge—in-the-northern-bering-sea-and—bering-strait.

Processing of Seabed Mineral Resources in the United States

According to a 2019 Department of Commerce report, the United States "lacks domestic processing and manufacturing capabilities for some critical minerals,"[171] including those derived from seabed deposits. For the United States to domestically process polymetallic nodules derived from ABNJ, the ISA would need to issue exploitation contracts to companies sponsored by parties to UNCLOS and/or NOAA would need to approve commercial recovery permits pursuant to DSHMRA.

Despite China's dominance in critical mineral processing and refining, seabed mining companies reportedly "do not want to work with Chinese firms for processing" for several reasons, such as concern that these firms would require ceding too much ownership.[172] Congress has directed the Department of Defense (DOD) to provide reports about U.S. capacity to process and/or refine seabed mineral resources in the United States or on U.S.-flagged vessels. H.Rept. 118-125, the House Armed Services Committee (HASC) report that accompanied HASC's reported version of the National Defense Authorization Act for Fiscal Year 2024 (H.R. 2670), directed DOD to submit a report to the committee assessing the processing of polymetallic nodules domestically.[173] The committee report states that although the United States holds no ISA contracts, "there remains opportunity to evaluate domestic processing and refining of seafloor resources from the contracts held by allied [UNCLOS] parties and domestic partners in international waters." Similarly, H.Rept. 118-529, the HASC report accompanying the committee's reported version of the Servicemember Quality of Life Improvement and National Defense Authorization Act for Fiscal Year 2025 (H.R. 8070), authorized a DOD study to assess the feasibility of improving U.S. capabilities for refining polymetallic nodules for defense purposes.[174]

Some stakeholders have proposed Texas as a potential site for a smelting or refining facility for producing critical minerals from polymetallic nodules.[175] In 2023, some Members of Congress supported a potential seabed mineral processing facility in Texas and asked DOD to support TMC's application for funding to develop a Texas processing facility.[176]

[171] U.S. Department of Commerce, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, June 4, 2019, p. 9, https://www.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf.

[172] LaTourrette et al., *Potential Impact of Seabed Mining*, p. 9.

[173] P.L. 118-31.

[174] See Section 1724 of H.Rept. 118-529. The joint explanatory statement accompanying the Service Member Quality of Life Improvement and National Defense Authorization Act for Fiscal Year 2025 (P.L. 118-159) adopted §1724 of H.Rept. 118-529.

[175] Jabbar et al., *Polymetallic Nodules and the Critical Mineral Supply Chain*, pp. 11-12.

[176] James Osborne, "Texas Congressmen Angling to Have Deep-Sea Mined Minerals Refined on the Gulf Coast," *Houston Chronical*, December 13, 2023, https://www.houstonchronicle.com/business/energy/article/deep-sea-minerals-gulf-coast-refinery-18540332.php. TMC's U.S. subsidiary sought a $9 million grant under DOD's Defense Production Title III program (TMC, "TMC Commends U.S. House of Representatives for Allocating Defense Funding to Assess the Feasibility of Domestic Nodule Refining Capacity," May 23, 2024, https://investors.metals.co/news-releases/news-release-details/tmc-commends-us-house-representatives-allocating-defense-funding).

Issues for Congress

Deep-seabed mining in ABNJ could help diversify U.S. critical mineral supply chains. New technologies in defense and energy may continue to drive demand for some critical minerals, including those sourced from seabed deposits.[177] However, some stakeholders contend that by the time deep-seabed mining becomes operational at a commercial scale, future technologies may not depend as much on critical minerals commonly found in ABNJ.[178] At issue for Congress is weighing the advantages of mining critical minerals from the deep seabed against how that process may deleteriously affect deep-sea habitats, along with concerns about the potential geopolitical consequences of permitting exploration and commercial recovery outside the ISA framework. As previously discussed, an original U.S. objection to ratifying UNCLOS was over the convention's deep-seabed mining provisions. Given the changes in geopolitical incentives for securing critical minerals—such as expanding diversity of critical mineral supply chains away from those dependent on China—the factors under congressional consideration over whether to ratify UNCLOS may be different now than they were in the 1980s.

On April 24, 2025, President Trump issued E.O. 14285, "Unleashing America's Offshore Critical Minerals and Resources," which, among other things, directed the Administrator of NOAA, in consultation with the Secretary of State and the Secretary of the Interior (acting through the BOEM Director) to "expedite the process for reviewing and issuing seabed mineral exploration licenses and commercial recovery permits" in ABNJ under DSHMRA.[179] In the 119th Congress, H.R. 3803 and H.R. 4018 would codify and/or adapt E.O. 14285. In addition, NOAA's FY2026 budget request identified "expedit[ing] NOAA review and support for the advancement of deep seabed mining" as an objective for FY2026-FY2030.[180] How this executive branch activity may be implemented under current U.S. and international law is not clear. Namely, whether and how U.S. policies, as expressed in E.O. 14285, may conflict with the ISA framework for seabed mining or the policies of UNCLOS signatories is uncertain within the statutory authority provided by DSHMRA.[181]

E.O. 14285 also directed the Secretary of Commerce, in coordination with the Secretaries of the Interior and Energy and in consultation with other federal entities, to provide a report about private sector interest and opportunities for seabed mineral processing capacity in the United States or on U.S.-flagged vessels.[182] In addition, the executive order directed other department and agency heads, including the Secretary of Defense, to support domestic processing capabilities for seabed mineral resources.[183] As previously discussed, the United States currently lacks domestic seabed mineral processing capacity.[184] Furthermore, seabed mining companies may be

[177] For example, NOAA, "Deep Seabed Hard Minerals Mining," https://oceanservice.noaa.gov/deep-seabed-mining/.

[178] For example, LaTourrette et al., *Potential Impact of Seabed Mining*, p. 14.

[179] E.O. 14285.

[180] NOAA, *Budget Estimates: Fiscal Year 2026*, NOS-19.

[181] Chronological lists of ratifications of, accessions and successions to the convention and the related agreements as of July 23, 2024, accessed April 25, 2025, http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm. UNCLOS has a 170 signatories, with San Marino becoming the most recent party to join the treaty in July 2024.

[182] See §3(a)(ii)(B) of E.O. 14285.

[183] See §§3(d)(ii) and 3(e) of E.O. 14285.

[184] See "Processing of Seabed Mineral Resources in the United States," above.

primarily focused on exploration activities and technology developments rather than processing.[185]

Another issue for Congress is where to process seabed minerals resources. Congress may weigh the tradeoffs of incentivizing the U.S. private sector to invest in processing capabilities in the United States versus seeking out partnerships with allied and partner nations that have existing processing capabilities (e.g., South Korea). For example, some Members of Congress have noted that it can take 10 to 20 years for new processing and refining plants to become operational in the United States.[186] At the same time, Korea Zinc, the world's largest zinc smelter and one of the few sources of zinc independent of China, is evaluating polymetallic nodules provided by TMC to validate processing and refining pathways.[187] Korea Zinc also is considering establishing processing and refining operations in the United States, reportedly.[188]

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[185] For example, *Exploring the Potential of Deep-Sea Mining*, hearing, 119th Congress; and LaTourrette et al., *Potential Impact of Seabed Mining*, p. 8.

[186] See Rep. Gary Palmer, Chairman of the Subcommittee on Oversight and Investigation, opening statement in U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Oversight and Investigation, *Examining Ways to Enhance Our Domestic Critical Mineral Supply Chains*, hearing, 119th Congress, 1st sess., May 21, 2025, https://www.congress.gov/119/meeting/house/118291/documents/HHRG-119-IF02-MState-P000609-20250521.pdf.

[187] TMC, "TMC Announces Strategic Investment from Korea Zinc—a World-Leader in Non-Ferrous Metal Refining and pCAM Technology—to Advance Development of Deep-Seabed Critical Minerals in the U.S.," June 16, 2025, https://investors.metals.co/news-releases/news-release-details/tmc-announces-strategic-investment-korea-zinc-world-leader-non.

[188] Yusuf Khan, "Korea Zinc Backs Trump Plan for Deep Sea Mining," *Wall Street Journal*, updated June 16, 2025.