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Potential interactions between deep-sea mining and tuna fisheries

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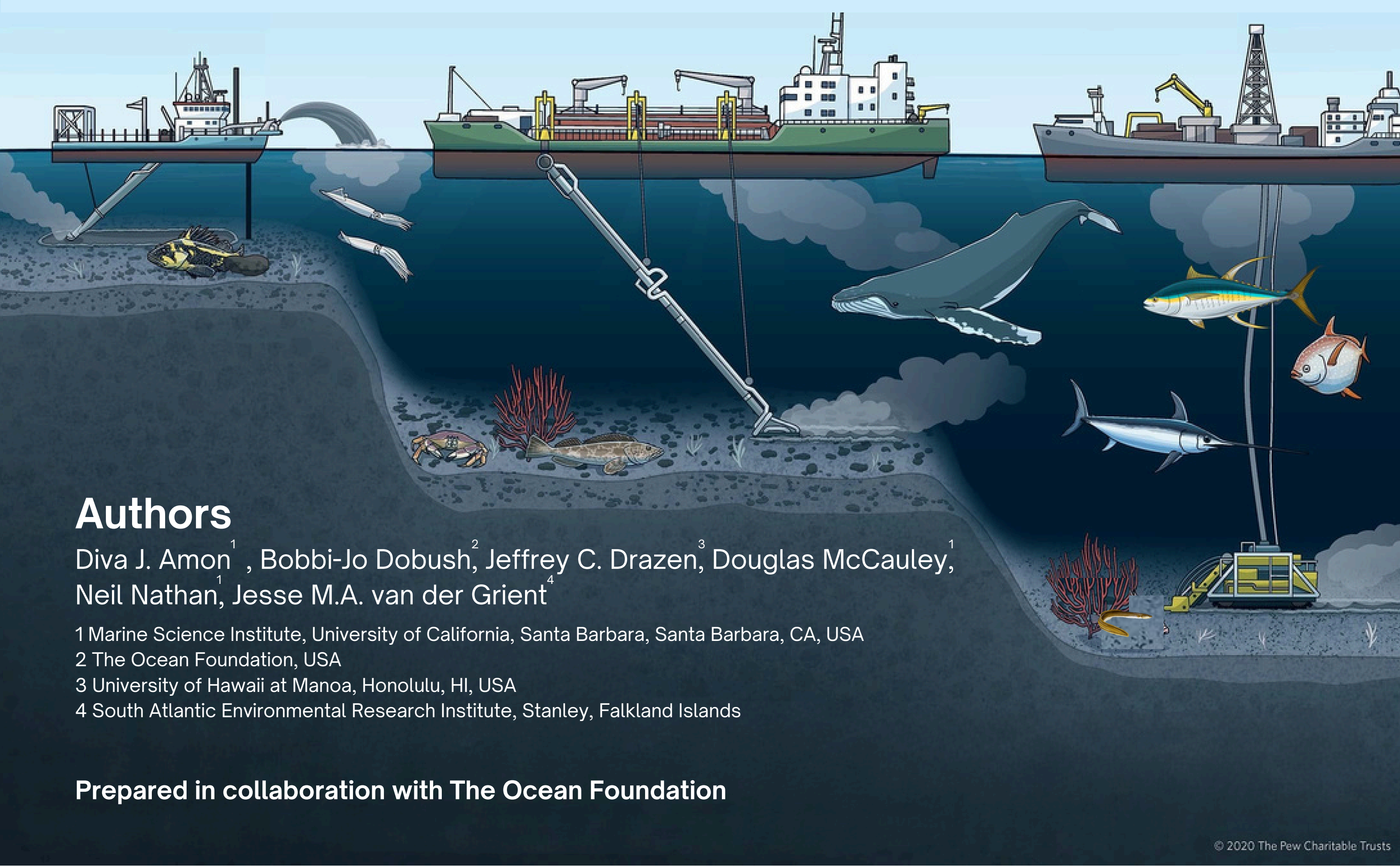

Authors

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Prepared in collaboration with The Ocean Foundation

What is deep-sea mining?

Deep-sea mining is a nascent industry that seeks to mine deposits that contain commercially valuable minerals such as manganese, copper, cobalt, nickel, zinc, and rare earth minerals from the deep seafloor. Proponents of this new industry state that these metals are critical for the green transition. However, not only is this disputed, but this potential industry could also pose extensive environmental risks to the ocean ecosystem, with socio-economic repercussions.

Currently, mining for polymetallic nodules has received the greatest interest. Polymetallic nodules are potato-sized 'rocks' that lie on the abyssal seafloor (3500-5500 meters deep), and have formed over millions of years at the seawater/sediment interface. Nodules are found in high densities with high metal content in a region called the Clarion-Clipperton Zone (CCZ) that spans the waters from Hawai'i to Mexico (Lusty & Murton, 2018). The International Seabed Authority (ISA), established by the United Nations to manage deep-sea mining as well as protect the marine environment from these activities, has issued 17 exploration licenses[1] in the CCZ that together cover over 1.5 million km^2. Nodules are also being sought from the Northwest Pacific and the Central Indian Ocean Basin, as well as in Exclusive Economic Zones (EEZs) of several Pacific States.

In the Northwest Pacific, cobalt-rich ferromanganese crusts on seamounts are also being sought after for deep-sea mining. The ISA has issued four exploration licenses for cobalt-rich ferromanganese crusts.[2] Such mining activity would likely take place in shallower waters compared to the abyssal seafloor. However, the technology and commercial interest to exploit crusts are not as far advanced as those for polymetallic nodules. Additionally, polymetallic sulfides at or near hydrothermal vents are also being targeted in the EEZs of some Pacific States; in areas beyond national jurisdictions, this is so far confined to the Atlantic and Indian Oceans.

Large bamboo coral colonies on a seamount in the Pacific. Image courtesy of the NOAA Office of Ocean Exploration and Research.

1. https://www.isa.org.jm/exploration-contracts/polymetallic-nodules/
2. https://www.isa.org.jm/exploration-contracts/cobalt-rich-ferromanganese-crusts/

The potential environmental risks of deep-sea mining

Scientists are working to understand the environmental risks of deep-sea mining as there are still many unknowns (Amon et al., 2022a). Deep-sea mining involves large vehicles which will remove the resources, along with seawater and the surface layer of the seafloor. The resources will then be transported to a surface ship via a long riser pipe (Figure 1). This is projected to occur over large areas; for example, in the CCZ alone, some industry projections are to directly mine seafloor habitats over a total 500,000 km^2 (Paulikas et al. 2020; Amon et al. 2022b). Impacts will include direct habitat and biodiversity loss, as well as effects from sediment plumes, noise and light. Biodiversity (including fish) and the ecosystem services they provide, such as climate regulation, support of fisheries, and underwater cultural heritage, will likely be affected.

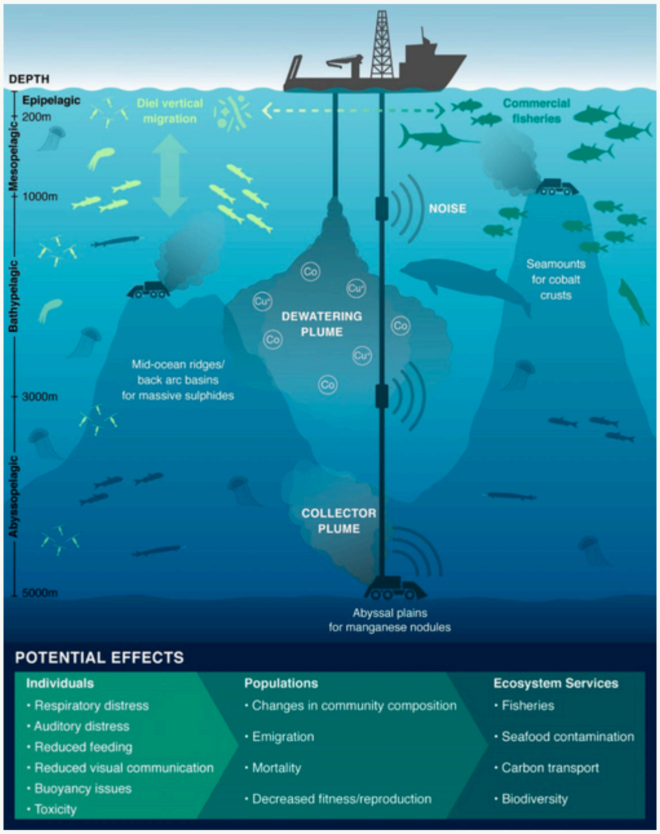

Figure 1. The potential impacts of deep-sea mining, with particular focus on pelagic taxa. Organisms and plume impacts are not to scale. Credit: Drazen et al., 2020.

On the seafloor, a significant portion of the animals, such as sponges, corals, and anemones, live directly on the resources (Amon et al. 2016; Stratmann et al. 2021). The mining activity will remove their habitat which, for nodules and crusts, cannot regrow (at least not for millions of years). Animals within the sediment will be crushed, resulting in depletion of their populations and changes to the wider community composition unlikely to recover for decades or centuries (Gollner et al. 2017; Jones et al. 2017; Simon-Lledo et al. 2019). Small-scale mining tests have shown that some fishes do not return to the impacted area for decades likely because of the lack of prey (Drazen et al. 2019). Plumes of fine mud and metal-ore particles, created by the seafloor mining vehicles (collector plumes), will raise the particle concentration in the water above the seafloor. During cobalt-rich ferromanganese crust mining, mining vehicles will operate at shallower depths (e.g., at the summit of a seamount), and the collector plumes will move away from the seamounts into the water column. Increased sediment concentrations are known to harm fish gills and respiration, interfere with the feeding of suspension feeders, and increase stress hormone levels (Wilber and Clarke 2001; Wenger et al 2018; van der Grient and Drazen 2022; Figure 1). These collector plumes are expected to drift for tens of kilometers (Aleynik et al. 2017, Ouillon et al. 2022b), settling and smothering animals beyond the mining tracks themselves (Smith et al. 2020). Collector plumes created on seamounts can increase the risk to the environment, as the physical structure of seamounts accelerate currents around them, and influence upwelling (Clark et al 2010; Leitner et al. 2020). As seamounts are hotspots for biomass and diversity in the open ocean, including for fishes (Clark et al. 2010; Morato 2010), collector plumes at these sites could pose increased risks to the marine environment and ecosystem services such as fisheries in such locations.

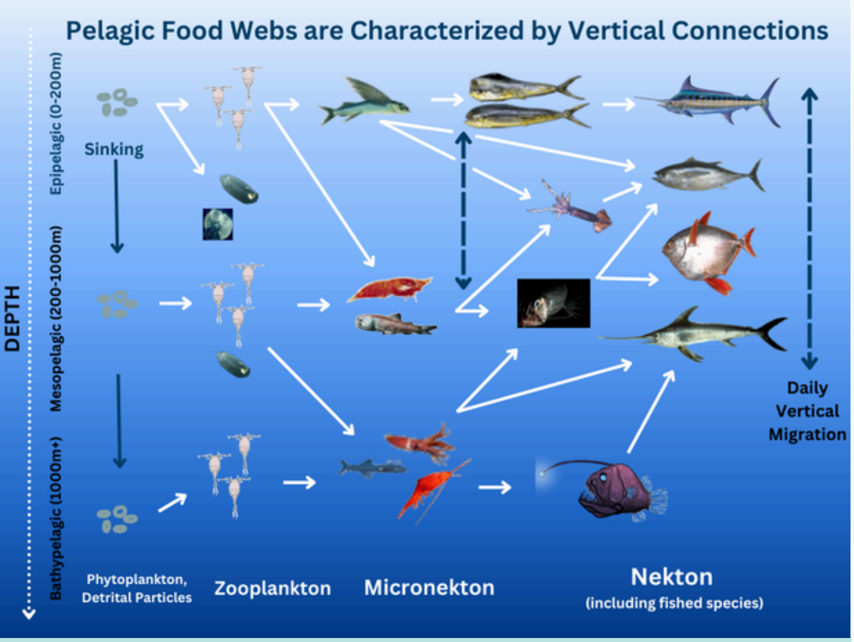

Figure 2. A simplified oceanic food web from primary producers to commercially exploited fish species. Credit: Jeff Drazen

Much of the work assessing mining risks has focused on the potential deep seafloor impacts, however it is likely that the ocean's sea surface and midwater could be affected as well (Drazen et al. 2020; Figure 1). Once ore and associated mud and seawater are transported from the seafloor collector vehicle to a ship, the ore will be retained and the sediment, mineral fines and water pumped back into the ocean. A rate of about 50,000m^3 per day (roughly the volume of a freight train) per mining operation is anticipated, which will likely create plumes that extend for tens of kilometers and affect very large volumes of the ocean (Muñoz-Royo et al. 2021; Ouillon et al. 2022a; Amon et al., 2022b). Similar to the collector plume, the discharge plume will raise the particle concentration in the water column, interfering and harming filter feeding apparatuses and gills of fishes and their suspension feeding prey (Figure 2), reducing visual communication, and increasing stress hormone levels (van der Grient & Drazen 2022; Stenvers et al. 2023). In addition, the discharge plume is expected to contain elevated concentrations of metals (Xiang et al. 2024). As minerals are collected, they will likely fragment with some dissolving into seawater and some adhering to sediment or organic particles that could be ingested and incorporated into deep-sea food webs. The discharge depth of the secondary or dewatering plume has not been regulated, nor is there an industry standard, but toxic metals could enter and bioaccumulate in our seafood supply (Drazen et al. 2020). Finally, mining noise could also be extensive and cause animals, from sea surface to deep seafloor, to alter their feeding and/or reproductive migrations (Williams et al. 2022) (Figure 1).

Increasing overlap between deep-sea mining and tuna fisheries

If deep-sea mining moves to exploitation, chances of conflict between fisheries and deep-sea mining will increase, especially given the existing spatial overlap between the two industries. Note also that impacts, including sediment plumes, noise and light, are expected to travel outside of the zones of direct impact. The WCPFC countries that obtained the highest average annual tuna catches (in tonnes) in the water column over the licensed cobalt-rich ferromanganese crust areas in the Northwest Pacific are Republic of Korea, Philippines, Japan, Ecuador, Chinese Taipei, China and Vanuatu (van der Grient & Drazen, 2021). Overlap can be determined by the percentage catch of the WCPFC derived from within and around the cobalt-rich ferromanganese crust areas in the Northwest Pacific targeted for mining (van der Grient and Drazen, 2021) (Figure 3). The spatial overlap of WCPFC tuna catches in this area varies between States. Ecuador, for example, obtains 6% or less of their tuna in the mining areas, while the other four States obtain between 1-3% of their tuna in mining areas. Nations that may not fish the most in the licensed mining areas may still derive a moderate proportion of their RFMO tuna catches from mining areas. For example, and depending on the zone of influence of mining, Belize may obtain between 35-45% of their tuna in the Northwest Pacific cobalt-rich ferromanganese crust areas. This overlap may change in the future given historic expansion of fishing but also as tunas and billfishes change their distribution in response to climate change (Coulter et al. 2020; Bell et al. 2021, Amon et al., 2023).

The interactions with tuna fisheries will be mostly influenced by the depth of the release of discharge. That is, the shallower the release depth, the greater the chance that sediment and toxic metals will enter food webs and affect commercially important species (Figure 2). The mesopelagic zone (200-1000 meters depth) hosts many diurnal vertical migrators, which are important prey species for deep-diving tuna (e.g., bigeye tuna) (Musyl et al., 2003; Dagorn et al., 2000; Young et al., 2010; Josse et al., 1998; Sutton 2013; Drazen et al., 2020; Perelman et al., 2021).

School of yellowfin tuna. Credit: Jeff Muir

Future challenges and considerations

Scientific knowledge gaps

There are critical unresolved questions about the deep sea and how it will be impacted by deep-sea mining. This includes mining technology, the depth of discharge, and cumulative or synergistic impacts between deep-sea mining, fisheries and climate change. These knowledge gaps greatly limit the effective management of this industry (Amon et al. 2022a; 2023).

The Mining Code is not yet finalized

Significant work is still needed to develop robust rules, regulations and procedures that encapsulate the Mining Code.

Fisheries excluded thus far from ISA negotiations

Fishing nations, industries, and/or RFMOs have not been adequately considered, engaged or consulted with by the ISA thus far.

Lack of holistic approach to ocean management

The fragmented patchwork of sectoral management bodies currently lack the capacity to embrace a holistic, cooperative and ecosystem-based approach to managing human activities, especially with regard to shifting stocks.

Unresolved equity issues

For example, mining by large developed States could lead to Small Island Developing States and other developing coastal States losing food security and income from tuna fisheries.

Seafood statement calling for a precautionary pause

Downstream users of fisheries are beginning to voice their concerns about deep-sea mining and the impact it may have on the quality and quantity of global seafood supply. The health and safety of seafood is of paramount importance to consumers, with levels of toxins (e.g., mercury, cadmium, lead) already closely monitored (Bosch et. al 2016). The possibility of deep-sea mining releasing large concentrations of heavy metals that may increase bioaccumulation of toxins in economically-important species has led seafood market groups to issue a statement calling for a precautionary pause on deep-sea mining until there is a clear understanding of the impacts the industry may have on the marine environment, its living resources, and those dependent on them. Signatories include seafood wholesalers, sustainable seafood NGOs, and large industry groups such as the Global Tuna Alliance, with more expected in the coming months.

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Appendix

State delegates from WCPFC member countries and co-operating non-member countries who attended the 29th Council Session of the International Seabed Authority.

ISA Member States

- Australia
    - Representative
        - Mr. James Larsen
    - Alternate Representatives
        - Ms. Robyn Frost
        - Ms. Loretta Benson
        - Ms. Alexandra Borthwick
        - Mr. Heath Synnott
        - Mr. Jamie Cooper
        - Ms. Alexandra Hutchinson
        - Mr. Harry Aitken
        - Ms. Laura Mcilhenny
    - Adviser
        - Mr. Mark Alcock
- Canada
    - Representatives
        - Dr. Carole St-Louis, Deputy Director, Oceans Law, Oceans, Environment and Aerospace Law Division, Global Affairs Canada, Government of Canada (Head of Delegation)
        - Ms. Emina Tudakovic, High Commissioner of Canada in Jamaica and The Bahamas and Non-resident Consul General to the Turks and Caicos Islands and the Cayman Islands, High Commission of Canada in Jamaica
        - Mr. José Benchetrit, Senior Policy Adviser, International Affairs and Trade Division, Policy and Economics Branch, Lands and Minerals Sector, Natural Resources Canada
        - Mr. Richard Vaughan, Policy Adviser, International Oceans Policy, Fisheries and Oceans Canada, Government of Canada
- China
    - Representative
        - H.E. Mr. Daojiang Chen
    - Alternate Representative
        - Mr. Haibo Gou
    - Adviser
        - Mr. Xiangyang Li,
        - Mr. Xianming Deng
        - Ms. Wenting Zhao
        - Mr. Dongsheng Zhang
        - Mr. Dan Zhang
        - Mr. Chunqing Hu
        - Ms. Yuwei Liu
        - Mr. Yuntian Pang
        - Ms. Zhaoyu Chen
        - Mr. Duojin Yin
        - Mr. Ximu Shi
- Cook Islands
    - Representative
        - Mr. Te-Ara Henderson, Senior Policy and Legal Officer, Cook Islands Seabed Minerals Authority (Head of delegation)

Appendix

- European Union
  - Representative
    - H.E. Ms. Marianne Van Steen, Ambassador, Permanent Representative of the European Union to Jamaica, Belize, The Bahamas, Turks and Caicos and the Cayman Islands to the International Seabed Authority (Head of delegation)
  - Alternate Representative
    - Mr. Piotr Byczkowski, Deputy Head of Delegation of the European Union to Jamaica, Belize, The Bahamas, Turks and Caicos and the Cayman Islands
    - Mr. Aniceto Rodríguez Ruiz, Head of Cooperation of the Delegation of the European Union to Jamaica, Belize, The Bahamas, Turks and Caicos and The Cayman Islands
- Federated States of Micronesia
  - Representatives
    - H.E. Mr. Jeem Lippwe, Ambassador, Permanent Representative, Permanent Mission of the Federated States of Micronesia to the United Nations (Head of delegation)
    - Mr. Clement Yow Mulalap, Adviser (Legal), Permanent Mission of the Federated States of Micronesia to the United Nations
- Fiji
  - Representatives
    - Dr. Raijeli Taga, Permanent Secretary, Ministry of Lands and Mineral Resources (Head of delegation)
    - Dr. Apete Soro, Director for Mineral Resources, Ministry of Lands and Mineral Resources
- France
  - Representatives
    - M. Olivier Guyonvarch, Ambassadeur, Représentant permanent de la France auprès de l'Autorité internationale des fonds marins (Chef de délégation)
    - Mme Anne-Sophie Roux, Conseillère société civile et relations internationales au cabinet du secrétaire d'Etat chargé de la mer at de la mer biodiversité
    - Mme Caroline Krajka, Sous-directrice du droit de la mer, du droit fluvial et des pôles, Ministère de l'Europe et des Affaires étrangères
    - Mme Alexia Pognonec, Conseillère juridique à la sous-direction du droit de la mer, du droit fluvial et des pôles à la direction des Affairs juridiques, Ministère de l'Europe et des Affaires étrangères
- Indonesia
  - Representatives
    - H.E. Mr. Arrmanatha Christiawan Nasir, Ambassador Extraordinary and Plenipotentiary, Permanent Representative of the Republic of Indonesia to the United Nations and International Seabed Authority, New York (Head of delegation)
    - H.E. Mr. Hari Prabowo, Ambassador, Deputy Permanent Representative of the Republic of Indonesia to the United Nations, New York (Alternate Head of delegation)
    - Mr. Andy Aron, Minister Counsellor, Legal Advisor, Permanent Mission of the Republic of Indonesia to the United Nations, New York
    - Ms. Sherley Mega Sandiori, Third Secretary, Permanent Mission of the Republic of Indonesia to the United Nations, New York
- Japan
  - Representative
    - H.E. Mr. Yasuhiro Atsumi, Permanent Representative of Japan to the International Seabed Authority, Ambassador Extraordinary and Plenipotentiary of Japan to Jamaica (Head of delegation)
    - Alternate Representatives
    - Ms. Ryoko Shinohara, Director, Law of the Sea Division, International Legal Affairs Bureau, Ministry of Foreign Affairs
    - Mr. Ichiro Shimogaite, Negotiator, Law of the Sea Division, International Legal Affairs Bureau, Ministry of Foreign Affairs
    - Mr. Hiroaki Ishihara, Assistant Director, Law of the Sea Division, International Legal Affairs Bureau, Ministry of Foreign Affairs
    - Ms. Shoko Fujimoto, First Secretary, Embassy of Japan in Cambodia
    - Mr. Yoshihito Doi, Deputy Director, Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry

Appendix

        - Mr. Yusuke Kawahara, Chief, Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry
        - Mr. Yusuke Otani, Chief, Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry
        - Mr. Ken Nakamura, Counsellor, Embassy of Japan in Jamaica 8/25
        - Ms. Noriko Oshima, First Secretary, Embassy of Japan in Jamaica
    - Advisers
        - Ms. Maki Sekimoto, Japan Organization for Metals and Energy Security
        - Dr. Tomohiko Fukushima, Japan Organization for Metals and Energy Security
        - Ms. Saeko Shukuwa, Japan Organization for Metals and Energy Security
        - Mr. Kunihito Yamamoto, Japan Organization for Metals and Energy Security
        - Ms. Eri Suzuki, Japan Organization for Metals and Energy Security
        - Mr. Seiya Kawano, Japan Organization for Metals and Energy Security
        - Ms. Yumiko Arai, Japan Organization for Metals and Energy Security
        - Ms. Hiroko Kamoshida, Japan Organization for Metals and Energy Security
        - Mr. Kiyotaka Orita, Japan Organization for Metals and Energy Security
        - Mr. Kazuhiro Kojima, Deep Ocean Resources Development Co. Ltd.
        - Dr. Nobuyuki Okamoto, Deep Ocean Resources Development Co. Ltd.
        - Mr. Tadayuki Ishiyama, Deep Ocean Resources Development Co. Ltd.
        - Dr. Akira Tsune, Deep Ocean Resources Development Co. Ltd.
        - Mr. Akira Koizumi, Deep Ocean Resources Development Co. Ltd.
        - Dr. Chisato Yoshizawa, Deep Ocean Resources Development Co. Ltd.
        - Dr. Keisuke Nishi, Deep Ocean Resources Development Co. Ltd.
        - Mr. Takanori Ishizuka, E&E Solutions Inc.
        - Ms. Mayumi Sudo, E&E Solutions Inc.
        - Ms. Sakiko Kinoshita, E&E Solutions Inc.
- Kiribati (28th session)
    - Representatives
        - Mrs. Josephine Moote, Deputy Permanent Representative of the Kiribati Mission to the United Nations
        - Ms. Joyce Maria Uan, Senior Mineral Compliance Officer
- Republic of Korea
    - Representative
        - Mr. Kim Jin-wook, Permanent Representative of the Republic of Korea to the International Seabed Authority (Head of delegation)
    - Alternate Representatives
        - Ms. Lee Yuseong, Second Scretary, International Legal Affairs Division, Ministry of Foreign Affairs
        - Ms. Kim Jeeyoung, Third Secretary, Embassy of the Republic of Korea in Jamaica
        - Mr. Kim Sang Yeob, Senior Researcher, Embassy of the Republic of Korea in Jamaica
    - Advisers
        - Dr. Lee Changyoul, Principal Research Scientist, Ocean Law Research Center, Korea Institute of Ocean Science and Technology
        - Dr. Moh Youngdawng, Senior Research Scientist, Ocean Law Research Center, Korea Institute of Ocean Science and Technology
        - Mr. Ju Sejong, Principal Research Scientist, Korea Institute of Ocean Science and Technology
- Republic of Marshall Islands
    - Not present
- Nauru
    - Representatives
        - H.E. Ms. Margo Deiye, Ambassador, Permanent Representative of the Republic of Nauru to the International Seabed Authority (Head of delegation)
        - Mrs. Francilia Adire, Legal Adviser
        - Mr. Chris Brown, Adviser
        - Mr. Corey McLachlan, Nauru Ocean Resources Incorporated
        - Mr. Nathan Eastwood, Nauru Ocean Resources Incorporated
        - Mr. Ryan Coombes, Nauru Ocean Resources Incorporated

Appendix

- New Zealand (28th session)
  - Representatives
    - Ms. Charlotte Skerten, Lead Adviser, Ministry of Foreign Affairs and Trade, Wellington
    - Mr. Yusuke Otani, Chief, Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry
    - Ms. Zoe Russell, Second Secretary, New Zealand Permanent Mission to the United Nations, New York
    - Ms. Abby Hutchison, Legal Adviser, Ministry of Foreign Affairs and Trade, Wellington
    - Mr. Finbar Kiddle, Senior Adviser, Ministry of Foreign Affairs and Trade, Wellington
    - Ms. Sarah Ireland, Unit Manager, Ministry of Foreign Affairs and Trade, Wellington
    - Mr. Simon Lamping, Senior Policy Analyst, Ministry for the Environment, Wellington
    - Ms. Danica Stent, International Manager, Department of Conservation, Wellingston
    - Ms. Mathilde Richer de Forges, Marine Science Adviser, Department of Conservation, Wellington
- Niue
  - Not present
- Palau (28th session)
  - Representatives
    - H.E. Ilana Victorya Seid, Ambassador, Permanent Representative of Palau to the United Nations (Head of delegation)
    - Mr. Charles Reklai Mitchell, Counsellor, Permanent Mission of Palau to the United Nations
- Papua New Guinea
  - Not present
- Philippines
  - Representative
    - Ms. Azela Arumpac-Marte, First Secretary, Legal Adviser, Permanent Mission of the Republic of the Philippines to the United Nations, New York (Head of delegation)
- Samoa
  - Not present
- Solomon Islands
  - Not present
- Tonga
  - Representatives
    - Ms. Jeanett Vea, First Secretary, Permanent Mission of the Kingdom of Tonga to the United Nations (Head of delegation)
    - Mr. Pupunu Tukuafu, Assistant Geologist, Ministry of Lands and Natural Resources
- Tuvalu
  - Not present
- Vanuatu (28th session)
  - Representatives
    - H.E. Mr. Odo Tevi, Ambassador, Permanent Representative of Vanuatu to the United Nations, New York
    - Mr. Sylvain Kalsakau, Head, United Nations Division, Department of Foreign Affairs and International Cooperation, Ministry of Foreign Affairs, International Cooperation and External Trade
    - Mr. Sanlan William, Deputy Permanent Representative, Permanent Mission of Vanuatu to the United Nations, New York
    - Ms. Majorie Wells, Desk Officer, Treaties and Convention Division, Department of Foreign Affairs and International Cooperation
    - Mr. Siddharth Shekhar Yadav, Adviser to the Ambassador on Climate and Ocean Affairs, Permanent Mission of Vanuatu to the United Nations, New York

Appendix

ISA Observer States

- United States of America
  - Representatives
    - Mr. Gregory O'Brien, Senior Oceans Policy Adviser, Office of Ocean and Polar Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State (Head of delegation)
    - Mr. James Gresser, Attorney-Adviser, Office of the Legal Adviser, U.S. Department of State (Alternate Head of delegation)
    - Ms. Sheila Bialias, International Affairs Advisor, Office of International Affairs, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
    - Ms. Juliette Lee International Affairs Specialist, Office of Strategic Policy and International Affairs, Bureau of Ocean Energy Management, U.S. Department of Interior
    - Ms. Kira Mizell, Research Oceanographer, Office of Global Marine Science Center, U.S. Geological Survey, U.S. Department of the Interior
    - Ms. Nicole Weber, Counselor for Political and Economic Affairs, Political and Economic Section, United States Embassy Kingston, U.S. Department of State
    - Mr. Charles Clatanoff, Economic and Commercial Officer, Political and Economic Section, United States Embassy Kingston, U.S. Department of State