

Questions to Duncan Currie for the Record

Exploring the Potential of Deep-Sea Mining to Expand American Mineral Production

House Committee on Natural Resources

Oversight and Investigations Subcommittee

1. In your oral testimony, you suggested that unilateral actions to mine the international seabed as envisioned under President Trump's recent Executive Order, "Unleashing America's Offshore Critical Minerals and Resources," will have consequences beyond the deep-sea mining regime of the United Nations Convention on the Law of the Sea. Can you elaborate?

Unilateral action to mine the deep-seabed beyond national jurisdiction (called the "Area"), as International Seabed Authority Secretary-General Leticia Carvalho [said](#), not only threatens the 1982 United Nations Convention on the Law of the Sea, and decades of successful implementation and international cooperation, but also sets a dangerous precedent that could destabilize the entire system of global ocean governance.

The 1982 Convention not only regulates activities in the Area, such as deep-sea mining, but also is central to the governance of maritime boundaries, the freedom of navigation, exclusive economic zones, the continental shelf, shipping, protection and preservation of the marine environment, and marine scientific research. It is known as the 'constitution of the oceans'. These matters are of great importance to the United States. By acting outside the Convention, the United States would weaken the Convention and may lead to other States likewise acting in contravention of the Convention.

Three legal observers to date have come to similar conclusions that unilateral mining would be unlawful: one as early as 2021, well before the current controversy. Coalter Lathrop in a [blog](#) observes that while the United States did not sign UNCLOS, it did sign the 1994 Part XI Implementing Agreement, because, as the US President [said](#) at the time, "the Agreement meets the objections the United States and other industrialized nations previously expressed to Part XI". Lathrop observes that "[t]he object and purpose of the Implementing Agreement was the creation of a common management regime for the Area and its mineral resources. Unilateral US permitting in areas beyond US jurisdiction, as contemplated in the Executive Order, would severely undermine that common management regime and would constitute a violation of US obligations as a signatory to the Implementing Agreement." This is contrary to the Vienna Convention on the Law of Treaties, whereby signatories including the United States are obliged to refrain from acts which would defeat the object and purpose of the 1994 Implementing Agreement.

The author examines recent State practice, and concludes with respect to "the prohibition against unilateral mining activities, "[i]s this prohibition a rule of customary international

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law? Almost certainly, yes.” “There is widespread state practice that subscribes to the common management of the Area and its resources, including the continuous US practice since 1994... Any attempt by the United States to characterize itself as a persistent objector to the formation of the customary rules governing the mineral resources of the Area would be made in the teeth of US practice over the last fifty-five years, which is, at best, inconsistent.” He concludes that “[t]he solution is not to destabilize the international order of the oceans that the United States has so intentionally and successfully crafted since the closing days of World War II.”

An earlier [blog](#) from April 2025 by Cavalcanti de Mello Filho came to a similar conclusion: the common heritage of humankind principle has become customary international law, and the argument that the US has been a “persistent objector” to this rule since its formation is flawed, for the US objection has not been “maintained persistently.” He goes further and suggests that in any case, the common heritage principle is arguably a peremptory norm of international law: a core principle that admits of no exception, derogation, or objection. In his view, the issuance of mining permits for The Metals Company would be a serious breach of the principle.

Joanna Dingwall’s book is particularly interesting because it dates back to 2021. She concluded that “Given that state conduct within the regime has been overwhelmingly consistent, this gives credence to the argument that elements of the UNCLOS deep seabed regime (such as the prohibition on unilateral mining activities) now have customary status. Secondly, the widespread acceptance and recognition of the regime within the broader international community also supports the conclusion that there is a customary prohibition on mining in the Area outside of the regime.” (p. 172)

In addition, acting unilaterally is accompanied by myriad legal difficulties. To name a few:

- No State or natural or juridical person shall claim, acquire or exercise rights concerning 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. (Article 137(3)). This would raise questions as to the ownership of any metals taken from the deep seabed, and very likely complications along the supply chain, including processing and including the use of the metals in products. Note that article 137 as part of the regime of the common heritage of (hu)mankind is customary international law and thus binding on the United States of America.¹ Therefore, simply stated, the United States does not own the minerals from the Area that it is purporting to licence.
- The general conduct of States in relation to the Area shall be in accordance with the provisions of Part XI, the principles embodied in the UN Charter and other rules

¹ Joanna Dingwall. *International Law and Corporate Actors in Deep Seabed Mining*. 2021. <https://doi.org/10.1093/oso/9780192898265.001.0001>). Page 162.

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of international law in the interests of maintaining peace and security and promoting international co-operation and mutual understanding (Article 138). Other States will need to avoid being party to a breach of the Convention: for instance, Allseas Group, which owns the mining vessel and equipment that The Metals Company intends to use to carry out any mining, is Swiss-based and operates in the Netherlands. Both the Netherlands and Switzerland are parties to the Convention and are prohibited from participating in any unilateral mining (see the answer to question 4).

- Other States may be encouraged by any United States unilateral mining to follow suit. This could lead to further breakdown in the Convention, massive environmental destruction and even conflict.

In terms of national security, concern was expressed as early as 2016 about tensions over UNCLOS, maritime claims and freedom of navigation (Colin, 2016). Any failure to adhere to UNCLOS and consequent weakening of the authority of UNCLOS can have adverse consequences for United States security interests in the ocean from Asia to the Pacific and the Atlantic ocean, including freedom of navigation and claims to extended continental shelves.

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The Pacific Region

The proposed mining area in the Clarion-Clipperton Zone is in the north Pacific Ocean. If the US were to take unilateral decisions to mine or even explore for exploitation purposes in the Area, outside of the framework of UNCLOS, it would pose multiple layers of risk to the Pacific region and to the long-standing relationships between the US and Pacific States.

Such actions, contrary to international law, would be in direct conflict with Pacific regional commitments and the foundation upon which regional aspirations are built.

The '[Boe Declaration on Regional Security](#)' adopted by the Pacific Island Forum Leaders at Nauru in 2018 explicitly references the importance to regional security of adherence to international law;

“6. (vi) We reaffirm the importance of the rules-based international order founded on the UN Charter, adherence to relevant international law and resolution of international disputes by peaceful means.”

In 2022, the 18 Members of the Pacific Island Forum endorsed the '[2050 Strategy for the Blue Pacific Continent](#).' The articulated Vision places peace and security at the centre of the strategy, “As Pacific Leaders, our vision is for a resilient Pacific Region of peace, harmony, security, social inclusion and prosperity, that ensures all Pacific peoples can lead free, healthy and productive lives.”

The peace and stability that exists via the rules-based order under UNCLOS, benefits all States, not just Pacific Island States. Their collective aspirations are built on agreed rules and norms of engagement as set out in international law.

The signalled unilateral action is threatening to take resources that belong to the international community which the United States does not have the jurisdiction to take, and to persist in this effort is likely to receive responses from many States and international organizations in different forms that could be severely detrimental to US trade, international relations, and maritime security. Unilateral deep-sea mining will undermine the United States reputation and position of influence in the Pacific, which could strengthen the influence of other regional powers.

The Pacific Ocean, and the life that exists within it, has sustained Peoples of the Pacific for thousands of years. Vastly diverse Pacific cultures revolve around and are dependent upon a healthy ocean. It is well understood that deep-sea mining would negatively impact ocean health, thus potentially threatening the well-being of Pacific communities, their livelihoods and economies.

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2050 Strategy for the Blue Pacific Strategy, <https://forumsec.org/sites/default/files/2023-11/PIFS-2050-Strategy-Blue-Pacific-Continent-WEB-5Aug2022-1.pdf> Endorsed by the Pacific Island Forum Leaders at the 51st Forum Leaders Meeting at Fiji in 2022.

2. Can you clarify your concerns about the mid-water plume that would be generated by deep sea mining, especially in response to the evidence presented by Dr. Peacock during the hearing?

This is an important issue as the United States could be held liable for damage caused to the environment from deep-sea mining, including transboundary harm and impacts on commercial fisheries, all impacts which could result from the mid-water plume.

Dr Peacock said in his written testimony that in 2022 in the Clarion Clipperton Zone, his team participated in a test which included discharging sediment, metal fragments and dissolved metals at 1,200 metres depth, creating a midwater sediment plume. However, his further testimony only discussed the ‘benthic’ plume or the plume created by the collector on the seafloor. As I noted in my written testimony, plumes of wastewater, sediment, and residual metals discharged from ships during mining - expected to be discharged into 1,200-2,000 metre depths from most proposed mining methods - could flow hundreds of kilometers horizontally away from the mining sites, as well as potentially spread vertically: a finding from Dr Peacock’s own laboratory (Muñoz-Royo et al., 2021). This plume would be a long-lasting plume created throughout the duration of mining activities, with plumes from each mining contract area using the technology.

One challenge highlighted in the Muñoz-Royo et al. study is defining the limit of the plume: to what sediment concentration does a plume need to dilute to before it is no longer a plume? The study presents several scenarios whereby the plume length and height are determined based on different dilution factors, and unsurprisingly, the dilution factor (the lowest is still two times the natural background particle concentration) influences the size of the plume. More importantly, none of these sediment concentration levels are linked to biological impacts. That is, whether and to what extent sediment concentrations created across the plume will harm midwater communities.

There is currently limited empirical evidence available for deep-sea animals exposed to suspended sediment concentrations (there are 15 peer-reviewed studies), and all but one study focus entirely on benthic environments. The one peer-reviewed study for the midwater (Stenvers et al., 2023) focused on a jellyfish and showed negative acute and energetically costly responses when exposed to sediment concentrations of at least 17 mg/l. This jellyfish was obtained from a Norwegian fjord, which is a naturally more turbid area compared to the deep waters of the Clarion Clipperton Zone. This is important as organisms’ sensitivity to increased suspended sediment concentrations are affected by the level of naturally occurring sediment concentrations. That is, for example, organisms that occur in naturally turbid areas (e.g., estuaries) are less sensitive to sediments than organisms from naturally clear waters (e.g., lakes), as shown by van der Grient & Drazen (2022). Meaning, it is highly possible that animals from the Clarion Clipperton Zone are more sensitive than the ones from the Norwegian fjord, and would respond in negative ways at much lower sediment concentrations (only a few mg/l) - and therefore also

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respond across a larger part of the plume -, as modelled by van der Grient & Drazen (2022).

The midwater plume can elicit a range of responses (van der Grient & Drazen 2022); a plume could disrupt feeding, breathing, communication and buoyancy of deep pelagic species. As the deep pelagic and shallow water (epipelagic) food webs are connected via diurnal vertical migration, impacts in the deep can be transferred via prey-predator interactions to shallower-occurring species, including commercially-important species, as well as whales and species currently ranked as endangered (Martin, 2021, Chin and Hari 2020; Thompson et al., 2023; Drazen et al., 2020).

A paper (Dowd, preliminary results presented at a [scientific conference](#)) is expected to show that zooplankton could be negatively impacted as they could (i) get confused and ingest sediment particles instead (and starve even feeling full), (ii) reject sediment particles but this comes with an increased energetic cost (iii) have their food source diluted - which is a problem as it is already an oligotrophic region , and food availability can affect the strength of animal responses to suspended sediments, with lower food availability resulting in stronger negative responses (Kang, 2012).

The midwater plume is also expected to contain elevated concentrations of toxic metals, which could be incorporated and bioaccumulate into ocean food webs, with impacts on the health of marine ecosystems and humans via our seafood supply (Hauton et al., 2017; Drazen et al., 2020). Additionally, independent monitoring of the BGR/GSR trials by the Mining Impact consortium found that dissolved metals were also released from benthic plumes. In [presenting](#) this research, it was noted that these generally exhibit a higher toxicity than solid metals (Haeckal et al., 2024). Last, sediments from the Clarion Clipperton Zone contain persistent organic pollutants (POPs), which accumulate in the food web (Sacket et al., 2024). Discharging such sediments in the midwater could introduce these POPs into the water column and the pelagic food web.

Many commercially important species are highly migratory, such as tuna, and any contamination of fishes through the food chain could percolate through the wider stock distribution. Climate change is driving increasing overlap between eastern Pacific tuna fisheries and deep-sea mining. Climate models suggest that tuna distributions will shift in the coming decades, increasing the potential overlap between fishing and mining activities within and around the CCZ, which could represent substantial economic and health risks for nations fishing in the region (van der Grient & Drazen, 2021; Amon et al., 2023). The full Committee's Ranking Member, Rep. Huffman, and Subcommittee Ranking Member, Rep. Dexter, observed that toxic plumes could travel hundreds, even 100s of miles.

Note that this is estimated from a point - mining operations will move in space, so the spread of plumes will increase because of changes in mining operations as well. How such operations affect spread of plumes have not been modelled for either type of

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plume, and instead we only have estimates for a plume released from a stationary point.

If discharged too shallow, they could disrupt pelagic food webs, including tuna, whales and other species that support our economy. The Global Tuna Alliance and other seafood industry groups have called for a halt to deep-sea mining because of the risk that such plumes could pose to disrupting feeding, breeding and migration patterns for tuna. The Global Tuna Alliance's 48 industry partners account for 32% of the global tuna trade. The effect on economically valuable tunas will depend on the depth of the discharge plume. This depth is not, for example, currently taken up in the ISA draft regulations on exploitation, and instead will rely on the decisions of a mining contractor. Their choice of discharge depth may depend on financial, technological and logistical constraints, factors which are at this moment unclear in how they may influence a mining operation. Intentions can be clarified by the industry, but given the potential high risk of this factor, an intention or promise may not be sufficient, as market forces could result in the shallowing of a discharge if it is cheaper. It must be properly considered whether this unregulated factor is acceptable in the management of the Blue Economy. In addition, it is important to understand that different depths have different oceanographic dynamics, such as the direction, seasonal positioning and strength of currents and the effect of passing eddies, and these factors can influence the spread of a plume. For example, the seasonal shifts in the North Equatorial Current and North Equatorial Countercurrent and presence of eddies have not been taken up in any of the plume models investigating midwater discharges thus far (Fiedler & Talley 2006; Perelman et al., 2023).

[Modeling](#) independent of the DSM industry [predicts](#) that it could take only three months for sediment particles discharged in The Metals Company (TMC)'s subsidiary TOML's (Tonga) licence area to reach the waters of Kiribati and Hawaii with unknown consequences (@ 11-13.30 min). As described in the associated [technical paper](#), this prediction is derived from accredited oceanographic models utilising the most rigorous data available as of 2022, and references the 2022 publications from Dr Peacock's laboratory.

Dr Peacock also indicated that during prototype trials by GSR that in-situ monitoring of the benthic plume showed that 2-8% of the sediment plume generated was suspended up to around 15 feet above the seabed. The fate of this lighter portion is unknown, however research (Gazis et al., 2025) highlights variability in sediment deposition in the CCZ due to site-specific currents and physical processes. This 2-8% portion of the sediment plume could be significant taking into the potential high sensitivity of deep-sea animals to suspended sediments given the naturally clear waters, and accounting for the cumulative impacts over the multiple 30 year plus licence periods and the employment of multiple commercial-scale machines, which as noted by Dr Peacock are 3 times larger than tested prototypes.

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It is worth repeating that the benthic (seafloor) plume is separate from the midwater (discharge) plume. Impossible Metals' technology proposes not to create a midwater discharge plume, but the benthic plume remains a significant concern. It is also worth noting that Impossible Metals proposes a yet-to-be proven mining method which, in theory, would reduce sediment plumes relative to other proposed seafloor mining machines. However, the resulting benthic plume as predicted by modeling commissioned by IM (DHI, 2024) could be sufficient to create a coating of the seabed and a cloud of suspended sediment. Even small sediment loads are sufficient to interfere with the function of, reduce viability, and kill deep-sea organisms, including microorganisms (Mevenkamp et al., 2017).

With these potentially significant risks to marine life, as well as substantial knowledge gaps (Amon et al., 2022), there is a critical need for more independent scientific data to inform decision making. This includes data on site-specific oceanographic and sediment studies to understand the sediment dispersion patterns of plumes in the changing oceanographic dynamics present in the Clarion Clipperton Zone, and the impacts of various elements of the plume (sediment, wastewater, as well as particulate and dissolved metals) on marine animals and how this translates to impacts to biodiversity and the wide-ranging food-web effects including for commercially important species. This will require site-specific *in situ* testing with the technology to be used in commercial mining, as well as laboratory experiments and appropriate modelling efforts.

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3. Can you please expand on your comments about the role of polymetallic nodules in the deep-sea ecosystem and the consequences of removing them?

It is important to note that considerable scientific uncertainties exist: we only learned that nodules were radioactive two years ago, and only last year that they may be involved in oxygen production (Sweetman et al., 2024).

Polymetallic nodules form a critical part of the habitat in abyssal ecosystems by providing hard substrate in a soft-sediment environment. This hard substrate provides an anchor, attachment surface or shelter for a multitude of deep-sea animals (Vanreusel et al., 2016; Amon et al., 2016; Simon-Lledó, et al., 2019). In fact, more than 50% of deep-sea megafaunal species, such as corals, anemones, and sponges, in the Clarion-Clipperton Zone depend on nodules as an attachment surface, anchor, or shelter (Vanreusel et al., 2016; Amon et al., 2016; Simon-Lledó, et al., 2019; Uhlenkott et al., 2022). The nodules also harbour diverse microbial communities that are distinct from those on neighbouring sediment and in the surrounding water (Shulse et al., 2017).

Nodules also play a critical role in maintaining deep-sea food-web integrity and their removal, even at the rates proposed by Impossible Metals, will likely result in lower abundance and diversity of seafloor life, which could directly affect ecosystem function and even services (Stratmann et al., 2021). Just a few months ago, the nodules were also found to be creating oxygen in the Clarion-Clipperton Zone (Sweetman et al., 2024). This was the first time oxygen was observed being created in the absence of sunlight, which challenges the previously held scientific consensus that oxygen is produced solely from light through photosynthesis. While the biological relevance has not been confirmed yet, the oxygen that is being produced may contribute to sustenance of life in the deep sea or life on Earth more generally. This recent discovery is an example of how poor our understanding is of the functioning of the CCZ ecosystem, the deep sea generally, and the planet, and is a canary in the coal mine for irreversibly damaging ecosystems, losing these types of mechanisms, before we know about them or understand their significance.

Without the presence of nodules, recolonisation of a significant portion of the inhabiting fauna will not be possible. For example, “Due to the slow growth rates of nodules (ca. 10 mm/My) and overall very low sedimentation rates, short-term recovery is unlikely; the nodules and nodule dependent fauna may take millions of years to recover, and even the partial recovery of the motile sediment-dwelling fauna may take hundreds to thousands of years” (Kaiser et al., 2017). As such, there will be severe and likely irreversible effects on seafloor communities from any type of polymetallic-nodule mining (Simon-Lledo et al., 2019).

It should also be noted that Impossible Metals intends to leave 60% of nodules by number and 30% by mass. So the 40% of the nodules taken will comprise 70% of the mass. This could only be achieved by selectively targeting large nodules and leaving

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small nodules: the relatively low surface area and mass of which will support less life through the provision of anchors, attachment surfaces or shelter. It appears that this proposal is not validated by peer-reviewed science. This proposed mining strategy is unlikely to maintain ecosystem viability and function – a consequence that would only be understood through long-term studies. Impossible Metals also proposes to use AI technology and video imagery to selectively choose nodules with less fauna. This has not yet been proven and further lacks independent scientific verification. It remains to be seen what species and size of species the technology will actually be able to identify, especially in a seascape where >88% of species have not yet been formally described or have not yet been discovered (Rabone et al., 2023).

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4. In your evidence you raised the potential legal problems regarding companies operating on a U.S. license in international waters. Could you elaborate on what the impacts may be, specifically for The Metals Company given their application?

The Metals Company themselves have said in a [filing to the United States Securities and Exchange Commission](#) dated May 12, 2025 that:

“The announcement or implementation of this strategy may cause additional regulatory and political tensions, delay ISA decision-making, or impair our ability to secure or maintain exploration contracts or an exploitation contract under the ISA framework and may result in our need to engage in costly and time-consuming litigation to enforce our rights. In addition, **UNCLOS parties and the ISA are under a legal obligation, under UNCLOS, not to recognize any commercial recovery permit issued to us under DSHMRA; many UNCLOS parties and the ISA are likely to regard such a permit as a violation of international law, including UNCLOS, which could affect international perceptions of the project, and could have implications for logistics, processing, and market access in UNCLOS parties for seabed minerals extracted under a U.S. license and for downstream products containing them, or for partnerships involving foreign entities, and could also result in actions, pursuant to UNCLOS, against TMC under the national laws of UNCLOS parties**, any or all of which could have a material adverse affect on our business, financial condition, liquidity, results of operations and prospects”. (emphasis added)

Note that 169 countries, including the top US trading partners, are parties to UNCLOS.

Article 137 of the 1982 United Nations Convention on the Law of the Sea (the “Convention” or “UNCLOS”) provides that:

1. No State shall claim or exercise sovereignty or sovereign rights over any part of the Area or its resources, nor shall any State or natural or juridical person appropriate any part thereof. No such claim or exercise of sovereignty or sovereign rights nor such appropriation shall be recognized.
2. All rights in the resources of the Area are vested in mankind as a whole on whose behalf the Authority shall act. These resources are not subject to alienation. The minerals recovered from the Area, however, may only be alienated in accordance with this Part and the rules, regulations and procedures of the Authority.
3. 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 this Part. Otherwise, no such claim, acquisition or exercise of such rights shall be recognized.

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Joanna Dingwall examined article 137 obligations and concluded that, as a matter of treaty law (i.e. for parties to UNCLOS), “there are sufficient grounds to argue that Article 137 binds corporate actors, including nationals of NSPs [non-State Parties, such as the United States], directly, as a matter of treaty law.” (page 189) And as regards non-Parties, “the customary prohibition on unilateral deep seabed mining activities constitutes an international law rule which is directly binding upon corporate actors. ... if a corporate actor began mining the deep seabed unilaterally, that actor would violate the customary norm prohibiting this activity and, consequently, would be responsible, as a matter of international law, for this violation.” (page 194)

Paragraph 3 of article 137 is in my view particularly problematic for The Metals Company. No party to the Convention may recognize any claim with respect to minerals recovered from the Area otherwise in accordance with Part XI (refer The Metals Company in the extract above). In sum, no rights shall be acquired or exercised with respect to the minerals. This provision could make it very problematic to process the nodules, and even to sell any metal such as nickel, cobalt, copper or manganese recovered from the metals to any party to UNCLOS. At this stage it cannot be said how far down the supply chain this would apply. Would products including such metals also be unable to be bought by any party to UNCLOS or their nationals?

In addition, to the downstream supply chain difficulties, suppliers will also be constrained. Firstly, UNCLOS Parties are obliged to both comply with Part XI, which addresses deep-sea mining (Arts. 139, 154, etc) to act in accordance with Part XI (Article 138) and are obliged not to aid or assist another State in the commission of an internationally wrongful act (Articles on Responsibility of States for Internationally Wrongful Acts adopted by the International Law Commission, Article 16). These, and potentially other measures, could hinder The Metals Company in its reliance on its suppliers of technology and expertise, for instance.

The terms of The Metals Company’s subsidiary NORI’s contract with the International Seabed Authority and with its sponsoring States Nauru and Tonga Offshore Mining Ltd (TOML), particularly in relation to NORI’s obligations with respect to the International Seabed Authority, also need to be raised in this context. The ostensible unlawfulness of any DSHMRA permit exposes the operation to risk of litigation that could be costly to the company, the Government, and the taxpayer.

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5. Would deep sea mining eliminate extractive mining on land?

No. Any deep-sea mining would be in addition to terrestrial mining and mines would not close. There are no academic studies that prove that DSM will reduce terrestrial mining of metals in rainforests. Terrestrial mining would continue even if deep-sea mining increases the impact of mining on the globe.

The World Economic Forum found that DSM “will not necessarily lead to mine closures or to planned new mines being abandoned. Nor would it selectively eliminate land-mining operations with the lowest environmental or social performance since pressure on land-based mines would correlate to their production costs rather than their sustainability attributes.” (World Economic Forum (2022)). A study commissioned by the ISA found that DSM will not cause overproduction of minerals globally (Lapteva et al., 2020). Rather, mining both the deep sea and on land could drive down mineral prices, reducing neither’s destructive practices and lowering prices (Lapteva et al., 2020). To use nickel as an example, TMC’s maximum production rate year, according to its March 2021 forecast, will be 119,000 tons (TMC 2021). World production in 2030 is projected to be 5,090,000 tons (and, thus, in 2031 will be at least that number). Therefore, TMC would produce only 2.34% of world’s production in 2031. To use nickel as an example, TMC’s maximum production rate year, according to its March 2021 forecast, will be 119,000 tons (TMC 2021). World production in 2030 is projected to be 5,090,000 tons (and, thus, in 2031 will be at least that number). Therefore, TMC would produce only 2.34% of world’s production in 2031.

Damage to biodiversity on land cannot be compared to damage to biodiversity from deep-sea mining, which is currently unknown. TMC’s own reports² acknowledge that a

² The Metals Company: Life Cycle Analysis: Where Should Metals for the Green Transition Come From? Comparing Environmental, Social, and Economic Impacts of Supplying Base Metals from Land Ores and Seafloor Polymetallic Nodules. At https://metals.co/wp-content/uploads/2023/03/TMC_NORI-D_LCA_Final_Report_March2023.pdf

“An effort was made through endpoint analysis to assess the impact on ecosystems and some level of biodiversity analysis. However, this method is still very limited as it does not account for the ocean fauna, neither the type of vegetation and terrestrial land type.”

And see Daina Paulikas, Dr. Steven Katona, Erika Ilves, Dr. Greg Stone, Anthony O’Sullivan.

Where should metals for the green transition come from? 2020.

https://www.fullertreacymoney.com/system/data/files/PDFs/2020/May/22nd/LCA-White-Paper_Where-Should-Metals-for-the-Green-Transition-Come-From.pdf

“Biodiversity is acknowledged in the paper as the most significant impact of nodule collection and is treated qualitatively in the paper. Because biodiversity impacts are treated qualitatively, it is difficult to say with certainty that biodiversity and species impacts from deep-sea nodule collection would be less significant than those observed and measured on land.”

TMC’s own financial filings repeat this: “it may also not be possible to definitively say whether the impact of nodule collection on global biodiversity will be less significant than those estimated for land-based mining.” Annual Report for 2021 Form 10-K, p 41-2.

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biodiversity comparison of the impacts on species and biodiversity from deep-sea mining versus terrestrial mining can't be done. A December 2023 report found that “the results of the three current studies comparing the cradle-to-gate (nodule-to-commodity) climate impact of deep sea and terrestrial mining vary hugely, estimating that polymetallic nodules could have a higher or lower climate impact than land ores.” (Amadi 2023). The report noted that two of the three studies were funded and supported by DSM companies (Amadi 2023). The European Academies Sciences Advisory Council evaluated claims that DSM is the “lesser of two evils when compared with terrestrial mining” and found those claims misleading: “We discuss the validity of such claims and find them misleading, and note also that deep-sea mining lacks the mitigation and remedial measures available to terrestrial mining.” (EASAC 2023).

Deep-sea mining currently lacks the mitigation and remedial measures available to terrestrial mining. In terrestrial mining, a four-tier mitigation hierarchy is used to protect biodiversity: (i) loss avoidance; (ii) minimisation; (iii) remediation; and, as a last resort, biodiversity offsets (Van Dover et al., 2017). When comparing this to DSM, avoidance of biodiversity loss is not possible as the habitat will be destroyed and biodiversity may also be lost in the water column and areas affected by sediment plumes. With a lack of physical boundaries in the marine environment, impact minimisation is constrained, in contrast to terrestrial mining, where engineering design can limit impacts to the mining site. Similarly, remediation of deep-sea ecosystems is likely to be ineffective owing to the slowness of deep-sea recolonisation of disturbed habitats, the large areas affected, and the irreversibility of some habitat loss ([see results from DSM on the Blake Plateau 50 years on](#)) (Planet Tracker, 2023). Lastly, offsets to compensate for biodiversity loss over hundreds of thousands of kilometres of seabed is next to impossible.

DSM will undermine the shift towards a circular economy (EJF, 2024). Recycling would help to increase resilience and supply chain security, while reducing primary extraction of raw materials and its associated environmental and social impacts. High recovery rates of above 90% are feasible for all four DSM Metals (Dominish et al., 2021).

Recoverable minerals from polymetallic nodules, the source which is the current focus of deep-sea mining, are cobalt, nickel, manganese and copper. The first three are a small proportion of the 50 minerals on the US Critical Minerals List, which does not feature copper (which is available only as an effective by-product in polymetallic nodules. (US Congress, 2025). Note that rare earth elements (RREs) are not being targeted as a saleable product from the nodules.

Nickel

USGS in 2024 estimated global reserves of over 130 million tons (with seabed resources not counted in the figures), with 26 million tonnes being in the friendly jurisdictions of Australia and Canada (USGS, 2025)

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An extensive global assessment of nickel mines shows that, given current data, land-based reserves and resources are sufficient to meet demand for over 100 years (at 2018 mining rates) (Mudd, 2022). Diversity of supply is provided by six countries holding 80% of global terrestrial nickel, and recent overproduction has led to a recent drop in historical five year prices (USGS, 2025). Action is needed, including improved management and biodiversity protection, to prevent ecological degradation and habitat loss accelerating (Tunncliffe et al., 2025). In 2022, recycled nickel in all forms accounted for approximately 54% of apparent consumption (USGS, 2025).

Cobalt

USGS estimates there are over 11 million tonnes of cobalt in reserves, and the International Energy Agency (2021) estimated that supply can meet projected demand through 2040 with current reserves and moderate investment (USGS, 2025).

Most cobalt is sourced from the Democratic Republic of Congo (DRC) and is mostly a by-product of copper mining. Social conditions and environmental degradation need to be addressed (Earle, 2022; Tunncliffe et al., 2025) but recycling could cut primary demand for cobalt by 35% by 2040 (Dominish et al., 2021). While other terrestrial sources expand, cobalt supply will remain tied to copper and nickel mining from which most cobalt is produced as a by-product. Solutions to address cobalt supply include increased efficiency and sustainability in metal extraction from mines, re-mining of tailings, new technologies in battery chemistry, and recycling and urban mining (Tunncliffe et al., 2025).

Manganese

Manganese reserve estimates are 1.7 million tonnes, with significant reserves in friendly jurisdictions, including 500,000 tonnes in Australia (USGS, 2025). There are significant reserves in non-Russian occupied Ukraine, alongside two shuttered mines which as part of any US-Ukraine deal would significantly add to global and US production. (USGS, 2021). TMC themselves have noted “We will be producing a novel manganese silicate product which does not yet have recognition in the marketplace with customers ... manganese silicate is not a conventional mineral product and may require additional approvals for export and import from our processing facilities to our future customers.” (The Metals Company, 2025).

Copper

Global copper reserves in 2024 were estimated to be 980 million tons of copper - over 3.5 times those in 1970, despite the depletion by mining since then (USGC, 2025).

In conclusion:

- Terrestrial reserves of the metals and minerals that are currently targeted for seabed mining - notably cobalt, copper, nickel and manganese - are already extensive.

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- There is no evidence to suggest that deep-sea mining will be cost-competitive with terrestrial mining given such deep-water environments.
- Deep-sea mining will add a new, environmentally destructive, mining industry where there is no evidence it can be managed sustainably, particularly given current lack of knowledge, and copious evidence of the damage that we know it will cause.
- Better governance of terrestrial mining, a circular economy, including more reuse, recycling and repurposing, and technological advances are all well-known routes to meet the needs of the foreseeable future.
- Deep-sea mining is not a substitute for terrestrial mining; it will simply add to the biodiversity loss and challenges faced by the globe.
- For the most part, the large terrestrial mining industry is not involved in deep-sea mining. Instead, the industry is led by untested start-up companies, and has faced considerable economic challenges. Nautilus [entered into liquidation](#) in 2019 and Lockheed Martin [sold](#) its interests in nodules 2023 to [Loke Minerals](#), which entered into bankruptcy this year.

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6. Would mining minerals from the seafloor provide critical minerals supply chain security to the United States?

No. Deep-sea mining is too speculative and unproven, too slow and too expensive, to alter mineral supply chain economics. Instead of a new, speculative and damaging industry, stockpiling metals from existing sources would provide some security of supply, as is recognized in the [Strategic and Critical Minerals Stock Piling Act](#) of 1939.

A recent article published in Nature (Alger et al., 2025) shows that

1. We already have sufficient terrestrial deposits of the metals and mineral required for energy transitions and we do not to augment supplies through deep-sea mining.
2. The argument that deep-sea mining will avoid negative social effects of terrestrial mining is false because deep-sea mining will not replace terrestrial mining, and
3. Deep-sea mining is a risky and unprofitable investment.

Going further, the [European Academies Science Advisory Council](#) concluded in 2023 that “The argument that deep-sea mining is essential to meet the demands for critical materials is thus contested and does not support the urgency with which exploitation of deep-sea minerals is being pursued. There remains much potential for policy to prioritise a circular economy, support innovation, and minimise continued dependence on the linear economy’s focus on extracting virgin materials from nature.”

Note that current deep-sea mining will not provide rare earth metals, which is the key critical mineral resource most frequently cited. (IEA, 2022)

The main battleground in the global competition for critical minerals is not so much raw materials as midstream processing, an area where China dominates. (Zhou & Månberger, 2024). If security of supply is the key concern then the focus should be on ensuring the on-shoring or friend-shoring of processing capabilities.

The Metals Company has [claimed](#) that NORI-D has a measured resource of 4 Mt of 1.4% nickel and 0.13% cobalt. If that translates to 56,000 tonnes of nickel and 5,200 tonnes of cobalt, that pales into the comparison of 8 million tonnes of cobalt and 100 million tonnes of nickel in terrestrial sources. Deep-seabed mining at full scale is an untested technology. Deep sea explorer and entrepreneur Victor Vescovo has [expressed](#) skepticism about the prospects of deep-sea mining from a practical perspective: “It is an act of God to do anything at 4,000 meters. Everything breaks. Everything is difficult...You’re talking about sustained heavy mining operations in depths that exceed the depth of the Titanic.” He has [observed](#) that “There are major technical risks mining 5,000 meters down with massive, rotating machinery under 5,000 psi in freezing cold, corrosive saltwater. The technical difficulties of 24/7 commercial mining of the seafloor are massively underestimated. Deep-sea mining is also based on wildly over-optimistic financial assumptions made five years ago which no longer reflect current cost levels, interest rates, or likely revenue. Even at full production rates, The Metals Company, for example, will only produce less than three percent of worldwide nickel production. Deep-

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sea mining will not materially affect terrestrial mining at all, as they would have their backers believe.”

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7. Would mining minerals from the seafloor provide us with the minerals we need for national security?

No: please see the response to question 6. The United States [Executive Order](#) of July 2025³ defined critical minerals to mean minerals included in the “Critical Minerals List” published by the United States Geological Survey (USGS) pursuant to section 7002(c) of the Energy Act of 2020 (30 U.S.C. 1606) at 87 FR 10381, or any subsequent such list. Of the [2022](#) list of 50 minerals,⁴ only cobalt, nickel and manganese will be obtained from polymetallic nodules. Copper and manganese being relatively low value, deep-sea mining of polymetallic nodules largely is directed at obtaining cobalt and nickel.

Rare earth minerals are not present in significant amounts in polymetallic nodules. For security and defence purposes the minerals in nodules would not be the most critical, where rare earth elements are prioritised, and are far less accessible by recycling (DoD, 2022; Vivoda *et al.*, 2025).

No country or company has successfully conducted large-scale commercial deep-sea mining. While deep-sea mining will have a ‘huge impact’ in the marine environment, technologies like seafloor nodule collectors and riser systems are still experimental and unproven at scale (Zhang *et al.*, 2024).

It is naive to believe that even if successful, The Metals Company and similar companies would only provide minerals mined from the sea floor to the United States. They have already in 2021 [announced](#) that they concluded an offtake agreement with Glencore, a multinational commodity trading company [headquartered in Switzerland](#) for half of their nickel and copper production.

There is no guarantee that minerals collected will be processed in the United States. For example, regarding minerals collected under DSHMRA, as The Metals Company is proposing, The Metals Company stated on their May 14, 2025 investor call that they will not be processing in the United States, nor do they have a timeline to do so. TMC’s CFO Craig Shesky stated that both TMC and NOAA understand the “reality that processing will occur outside the US for some time.”

³ The White House. Ensuring National Security and Economic Resilience Through Section 232 Actions on Processed Critical Minerals and Derivative Products July 15, 2025. <https://www.whitehouse.gov/presidential-actions/2025/04/ensuring-national-security-and-economic-resilience-through-section-232-actions-on-processed-critical-minerals-and-derivative-products/>

⁴ Includes the following 50 minerals: Aluminum, antimony, arsenic, barite, beryllium, bismuth, cerium, cesium, chromium, cobalt, dysprosium, erbium, europium, fluorspar, gadolinium, gallium, germanium, graphite, hafnium, holmium, indium, iridium, lanthanum, lithium, lutetium, magnesium, manganese, neodymium, nickel, niobium, palladium, platinum, praseodymium, rhodium, rubidium, ruthenium, samarium, scandium, tantalum, tellurium, terbium, thulium, tin, titanium, tungsten, vanadium, ytterbium, yttrium, zinc, and zirconium.

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The answers above and to Question 6 explain why deep-sea mining is not an economic or reliable source of deep-sea minerals, far less one on which the United States can rely for its national security.

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