

The ambivalent promise of the abyss: Deep-seabed mining, governance gap and the race for critical minerals

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A. Introduction: the ocean's dilemma

The deep ocean, once conceived as a silent, lifeless abyss, is now recognised as the planet's largest habitable space, a realm of staggering biodiversity and critical ecosystem services.¹ It is also the Earth's final frontier for resource extraction. Beneath the crushing pressure and perpetual darkness of the abyssal plains lie vast, untapped deposits of polymetallic nodules—potato-sized concretions rich in cobalt, nickel, copper, and manganese alongside cobalt-rich crusts and polymetallic sulphides.² These are the very metals and minerals essential for the twenty-first century's clean-energy technologies, from electric-vehicle batteries to wind turbines and solar panels,³ as well as indispensable components of advanced electronics, defence

1 Samuel Georgian/Sarah Hameed/Lance Morgan/Diva J. Amon/U. Rashid Sumaila/ David Johns/William J. Ripple, 'Scientists' Warning of an Imperilled Ocean' (2022), 272 Biological Conservation, p. 1.
2 International Seabed Authority, 'Polymetallic Nodules' (2022), <https://www.isa.org.jm/exploration-contracts/polymetallic-nodules/> (last accessed: 6 October 2025).
3 Ryan Murdock, 'Deep Sea Mining and the Green Transition' (16 October 2023), <https://hir.harvard.edu/deep-sea-mining-and-the-green-transition/> (last accessed: 6 October 2025).

systems, and aerospace industries.⁴ As the world intensifies its pursuit of a low-carbon future, these deep-sea deposits are increasingly viewed as a strategic solution to the limitations and harms of land-based mining.⁵

Yet, this new frontier is not without formidable legal, ecological, and political challenges. The very notion of extracting resources from one of the planet's most pristine and poorly understood ecosystems raises difficult questions about sustainability, equity, and governance.⁶ At stake is not only the health of the ocean floor but the credibility of the international legal frameworks designed to manage humanity's shared resources.

The convergence of ecological fragility and industrial necessity has created an oceanic dilemma with profound legal, environmental, and geopolitical implications. Global decarbonisation has sharply increased demand for critical minerals, with the International Energy Agency predicting demand will triple by 2030. Yet, terrestrial mining, which currently supplies these minerals, is marked by severe environmental damage, political instability, and human rights abuses.⁷ The Democratic Republic of the Congo, for example, produces around 70 per cent of global cobalt in conditions linked to conflict and labour exploitation.⁸ Concentration of resources has also generated bottlenecks, leaving supply chains exposed to disruption and geopolitical manipulation.⁹

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- 4 European Parliament, 'Commission Must Tackle China's Export Restrictions on Rare Earth Elements' (4 July 2025), <https://www.europarl.europa.eu/news/en/press-room/20250704IPR29456/commission-must-tackle-china-s-export-restrictions-on-rare-earth-elements> (last accessed: 6 October 2025).
 - 5 United Nations Environment Programme, 'Critical Energy Transition Minerals' (2024), <https://www.unep.org/topics/energy/renewable-energy/critical-energy-transition-minerals> (last accessed: 6 October 2025).
 - 6 Lisa Depraiter/Stéphane Goutte/Thomas Porcher, 'Geopolitical risk and the global supply of rare earth permanent magnets: Insights from China's export trends' (2025), 146 *Energy Economics*, no. 108496, p. 4.
 - 7 International Peace Information Service, 'Mineral Extraction, Environmental Harm, and Conflict: The Role of EU Due Diligence in Promoting Sustainable Practices in Conflict Hotspots' (16 April 2025), <https://ipisresearch.be/weekly-briefing/mineral-extraction-environmental-harm-and-conflict-the-role-of-eu-due-diligence-in-promoting-sustainable-practices-in-conflict-hotspots/> (last accessed: 6 October 2025).
 - 8 Sasha Lezhnev, 'Testimony of Sasha Lezhnev – Democracy and Human Rights in the Democratic Republic of the Congo' (29 November 2016), <https://enoughproject.org/reports/testimony-sasha-lezhnev-democracy-and-human-rights-democratic-republic-congo> (last accessed: 6 October 2025).
 - 9 European Parliament, 'Commission Must Tackle China's Export Restrictions on Rare Earth Elements' (4 July 2025). <https://www.europarl.europa.eu/news/en/press-room/20250704IPR29456/commission-must-tackle-china-s-export-restrictions-on-rare-earth-elements>

Against this backdrop, deep-seabed mining (DSM) is promoted as a strategically less damaging alternative,¹⁰ securing minerals for renewable technologies without deforestation, child labour, or biodiversity loss in terrestrial hotspots.¹¹ Its legal foundation lies in the United Nations Convention on the Law of the Sea (UNCLOS),¹² which declares resources of “the Area” the common heritage of mankind (CHM),¹³ to be managed by the International Seabed Authority (ISA) for the benefit of all, particularly developing States, and with environmental safeguards. Properly regulated, DSM could support UN Sustainable Development Goals¹⁴ by supplying materials for climate action while reducing harmful land-based extraction.¹⁵

Yet, this rationale faces strong opposition. Scientific knowledge of the deep sea remains limited, and mining may cause irreversible biodiversity loss,¹⁶ disrupt carbon sinks, and damage ecosystems¹⁷ that recover only over millennia. This has led to a growing global chorus of scientists, governments, and corporations calling for a moratorium,¹⁸ invoking UNCLOS

0250704IPR29456/commission-must-tackle-china-s-export-restrictions-on-rare-earth-elements (last accessed: 12 February 2026).

- 10 Pedro Madureira/Dale Squires/Luísa Pinto Ribeiro, ‘The International Seabed Authority and the United Nations 2030 Agenda for sustainable development’ (2023), 86 Resources Policy, no. 103166.
- 11 Ibid., pp. 4 et seq.
- 12 United Nations, Convention on the Law of the Sea, 10 December 1982, 1833 UNTS 397.
- 13 Ibid, Art. 136.
- 14 International Seabed Authority, ‘ISA’s contributions to the achievement of the 2030 Agenda’ (November 2021), <https://www.isa.org.jm/isa-and-the-2030-agenda/> (last accessed: 6 October 2025).
- 15 Madureira/Squires/Ribeiro (2023), pp. 3 et seqq.
- 16 Wenbin Ma/Kairui Zhang/Yanlian Du/Xiangwei Liu/Yijun Shen, ‘Status of Sustainability Development of Deep-Sea Mining Activities’ (2022), 10 Journal of Marine Science and Engineering, no. 1508, p. 14.
- 17 European Commission, Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Setting the Course for a Sustainable Blue Planet – Joint Communication on the EU’s International Ocean Governance Agenda, 24 June 2022, JOIN (2022) 28 final.
- 18 Matteo Bedendi/Lorenzo Schiano di Pepe, ‘A New Chapter of Ocean Governance and the European Union: Codification Efforts and Prospects of a Moratorium at the International Seabed Authority’ (2025), 40(2) The International Journal of Marine and Coastal Law, p. 403, 413.

Article 145 and the precautionary principle, or an outright ban on DSM until its consequences can be fully understood.¹⁹

Geopolitical competition compounds the issue.²⁰ Critical minerals are indispensable for defence, renewables and advanced electronics. China now controls the lion's share of rare earths,²¹ controlling over ninety per cent of certain rare earth elements²² and has used export restrictions in trade disputes,²³ revealing Western vulnerabilities and spurring a search for alternative supply chains.²⁴ This has ignited a desperate search for alternative and more secure supply chains, with DSM emerging as a potential new frontier.²⁵ Nations are investing heavily in DSM capabilities, including the U.S., which, despite not being a party to UNCLOS, has recently issued a controversial Executive Order supporting unilateral seabed mining initiatives beyond national jurisdiction.²⁶ This position, grounded in domestic law, has raised alarm about a possible breach of international law and a direct challenge to the CHM regime, undermining the legitimacy of the ISA and threatening to fracture the shared legal framework in favour of national self-interest.²⁷

At the heart of this maelstrom lies a critical legal vacuum. While the ISA has issued regulations for exploration, it has yet to finalise the comprehen-

19 United Nations, Convention on the Law of the Sea, 10 December 1982, 1833 UNTS 397.

20 Nik Martin, 'How China wields rare earths as a strategic weapon' (23 June 2025), <https://www.dw.com/en/how-china-wields-rare-earths-as-a-strategic-weapon/a-72868760> (last accessed: 6 October 2025).

21 Depraeter/Goutte/Porcher (2025).

22 John Liu/Simone McCarthy, 'US, China formalize deal on rare earth shipments in trade breakthrough', (27 June 2025), <https://edition.cnn.com/2025/06/27/business/us-china-trade-deal-agreement-signed-intl-hnk> (last accessed: 6 October 2025).

23 Depraeter/Goutte/Porcher (2025), p. 2.

24 Tiago Tecelão Martins, 'A Brief History of US-China Rare Earth Rivalry' (8 December 2023), <https://www.geopoliticalmonitor.com/a-brief-history-of-us-china-rare-earth-rivalry/> (last accessed: 6 October 2025).

25 The White House, 'Unleashing America's Offshore Critical Minerals and Resources' (24 April 2025), <https://www.whitehouse.gov/presidential-actions/2025/04/unleashing-americas-offshore-critical-minerals-and-resources/> (last accessed: 6 October 2025).

26 *ibid.*

27 Leticia Reis de Carvalho, 'Statement on the US Executive Order: "Unleashing America's Offshore Critical Minerals and Resources"' (30 April 2025), <https://www.isa.org.jm/news/statement-on-the-us-executive-order-unleashing-americas-offshore-critical-minerals-and-resources/> (last accessed: 6 October 2025).

sive 'Mining Code', the legally binding rules for commercial exploitation.²⁸ While the regulatory landscape for deep-seabed mining was evolving,²⁹ the nation of Nauru initiated a procedural step to prompt the ISA to prioritise the finalisation of comprehensive regulations.³⁰ The activation of the 'two-year rule' under the Implementation Agreement of UNCLOS put pressure on the ISA to either finalise these regulations promptly or to consider mining applications under existing provisions.³¹ This has created pressure to establish a robust framework where environmental, economic, and other impacts are thoroughly assessed to ensure sustainable development.

This article argues that deep-seabed mining governance is at a critical juncture, navigating the complex interplay of sustainability, equity, and geopolitical competition. It posits that the framework must urgently reconcile these pressures through the finalisation and robust implementation of a comprehensive, science-based, and enforceable legal framework within the Mining Code. This framework is essential to balance marine environmental protection, equitable benefit distribution as envisioned by UNCLOS, and the demands of the global resource race. Without it, the potential of the

28 International Seabed Authority, 'FAQs about the International Seabed Authority and deep-sea mining' (2025), <https://www.isa.org.jm/faq-for-media/> (last accessed: 6 October 2025).

29 International Seabed Authority, 'The Mining Code: Draft exploitation regulations' (2025), <https://isa.org.jm/the-mining-code/draft-exploitation-regulations-2/> (last accessed: 6 October 2025): ISA has undertaken work since 2014 to develop regulations for the exploitation of mineral resources in the Area. The process began with preliminary work in expert workshops, involving the preparation of a number of expert studies, discussion papers and open stakeholder consultations. It culminated in the development of draft regulations submitted by the Legal and Technical Commission for consideration by the Council in 2019.

30 Government of the Republic of Nauru, 'Nauru requests the International Seabed Authority Council to adopt rules and regulations within two years' (2021), <https://www.nauru.gov.nr/government/departments/departments-of-foreign-affairs-and-trade/faq-on-2-year-notice.aspx> (last accessed: 6 October 2025).

31 Annex Section 1(15) of the Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea (New York, 28 July 1994, in force 28 July 1996) 1836 UNTS 42. The 'two-year rule' was inserted as a pragmatic mechanism to prevent indefinite delays in the finalisation of the deep seabed mining regulatory framework. It reflects a compromise between states advocating for the rapid exploitation of resources and those prioritising the establishment of comprehensive environmental protections. Essentially, it was designed to create a definitive timeline, compelling the ISA to conclude its regulatory work or face the potential for exploitation applications to proceed under a less complete legal regime, thereby providing a pathway forward in the absence of full consensus.

deep-sea risks becoming unsustainable, undermining the common heritage for potentially short-term gains.

B. Legal foundations of deep-seabed mining

The legal architecture governing the deep seabed stands as one of the most ambitious and idealistic constructs in modern international law. Envisaged in the mid-twentieth century,³² it represents a profound vision of global co-operation and shared stewardship over areas beyond national jurisdiction.³³ The doctrine of CHM's centrepiece sought to transcend traditional notions of State sovereignty by declaring the resources of the international seabed Area as the collective property of all nations, to be managed for the common good.³⁴ The translation of this principle into a functional legal regime through UNCLOS and the establishment of the ISA represent a landmark achievement in global governance.³⁵ However, contemporary challenges highlight the difficulties of implementing such a visionary concept amid the practical realities of State interests and commercial pressures.

I. Historical development: From mare liberum to a common heritage

For centuries, the law of the sea was dominated by the Grotian doctrine of *mare liberum*—the freedom of the seas—which primarily governed navigation and fishing on the high seas.³⁶ This principle, famously expounded by Hugo Grotius in 1618 and asserted earlier by figures like Queen Elizabeth I in 1580 that the oceans and their resources were open to all and incapable of appropriation.³⁷ The deep seabed itself, however, remained

32 Sanjeet Ruhai, 'India and Global Maritime Commons', in Shashikala Gurrupur/Aakarsh Banyal (eds.), *International Law in Pursuit of Global Justice* (2025), pp. 61 et seq.

33 Ibid.

34 Yoshifumi Tanaka, *The International Law of the Sea*, 3rd ed. (2019), pp. 25 et seq.

35 International Seabed Authority, 'Secretary-General Annual Report 2024' (28 June 2024), https://www.isa.org.jm/wp-content/uploads/2024/06/ISA_Secretary_General_Annual_Report_2024.pdf (last accessed: 6 October 2025), p. 16.

36 Satya N. Nandan/Michael W. Lodge/Shabtai Rosenne, 'The Development of the Regime for Deep Seabed Mining' (11 April 2002), <https://www.isa.org.jm/wp-content/uploads/2022/06/regime-ae.pdf> (last accessed: 6 October 2025), p. 3.

37 Ibid.

largely outside the explicit scope of international law, often viewed as a *terra nullius* theoretically open to appropriation by any State with the requisite technological capacity.³⁸

This status quo was dramatically challenged in 1967 when Arvid Pardo, Malta's Ambassador to the United Nations, delivered a seminal address to the UN General Assembly.³⁹ Pardo warned of an impending technological gold rush to the seabed, foreseeing that it would benefit only a handful of wealthy, technologically advanced nations.⁴⁰ He cautioned that such unchecked exploitation could reignite colonial-style competition, lead to the militarisation of the oceans, and inflict irreversible environmental harm.⁴¹ To prevent this outcome, Pardo advanced a revolutionary proposal: that the seabed and its mineral resources beyond national jurisdiction be designated the 'common heritage of mankind.'⁴²

This was not merely a call for shared access but for collective ownership and management. Under this principle, the Area could not be subject to sovereign claims; its resources were to be managed by an international body, and the financial benefits derived from their exploitation were to be shared equitably, with a particular focus on benefiting developing countries. This vision resonated powerfully in a post-colonial era, and in 1970, the UN General Assembly adopted the Declaration of Principles Governing the Sea-Bed and the Ocean Floor (Resolution 2749 (XXV)), formally enshrining the CHM principle in international law.⁴³

II. Part XI of UNCLOS: codifying the common heritage

The CHM became the cornerstone of the protracted negotiations that ultimately culminated in Part XI of the Convention. As the longest, most complex, and politically contentious section, Part XI is devoted entirely

38 Ibid, p. 60.

39 Ruhai (2025), p. 62.

40 Ibid.

41 Nandan/Lodge/Rosenne, 'The Development of the Regime for Deep Seabed Mining' (11 April 2002), p. 17.

42 Ibid.

43 United Nations General Assembly, Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction, 17 December 1970, A_RES_2749(XXV).

to the Area and establishes the legal and institutional framework for operationalising the CHM principle.⁴⁴ Its key provisions establish:

- *Legal status of the Area and its resources*: Article 136 unequivocally states: ‘The Area and its resources are the common heritage of mankind’. Article 137 follows logically, stipulating that no State shall claim or exercise sovereignty over any part of the Area or its resources, and no State or person can appropriate any part thereof. The rights to the resources are vested in humankind as a whole, on whose behalf the International Seabed Authority shall act.⁴⁵
- *Institutional management*: The ISA is established as a treaty-based autonomous international organisation with its own legal personality, mandated to serve as a trustee for humanity. As a specialized inter-governmental body, its mandate encompasses: adopting regulations for prospecting, exploration, and exploitation in the Area; approving and overseeing mining contracts; ensuring marine environmental protection (Article 145); equitably distributing monetary and non-monetary benefits to all States, with priority given to developing nations (Article 140); and operating the Enterprise—its commercial arm intended to carry out mining on behalf of the international community. This institutional arrangement is designed to ensure non-appropriation, equitable access, and environmentally responsible resource management.
- *The parallel system of exploitation*: Reflecting the influence of the New International Economic Order (NIEO) movement of the 1970s,⁴⁶ the original Part XI envisaged a ‘parallel system’ for exploitation. Under this system, private and state-sponsored contractors seeking mining licences were required to submit two sites of equivalent commercial value. One would be allocated to the contractor; the other would be reserved for the Enterprise, which was to act on behalf of developing States. This system was coupled with provisions for mandatory technology transfer from contractors to both the Enterprise and developing countries, and financial obligations to support the Enterprise’s operations.

44 Part XI is the longest and most complex part of the Convention, consisting of 58 out of its 320 Articles and an associated Annex.

45 Art. 137(2) UNCLOS.

46 John E. Noyes, ‘The Common Heritage of Mankind: Past, Present, and Future’ (2011), 40 *Denver Journal of International Law and Policy*, p. 447, 459.

This ambitious framework quickly became a source of major controversy. Industrialised nations—most notably the United States under the Reagan administration—criticised the original Part XI as economically impractical and ideologically incompatible with free-market principles. Their objections focused on the mandatory technology transfer regime, production controls intended to protect land-based mining, and the perceived over-representation of developing countries within ISA decision-making structures.⁴⁷ As a result, the United States refused to sign UNCLOS in 1982, citing Part XI as the principal obstacle, and instead adopted domestic legislation to govern the deep-seabed mining activities of U.S. nationals.⁴⁸

This impasse threatened the universality and effectiveness of the Convention.⁴⁹ To resolve it, a series of informal consultations, initiated by the UN Secretary-General in 1990, led to the 1994 Agreement Relating to the Implementation of Part XI.⁵⁰ The Agreement fundamentally altered the deep-seabed mining regime to make it more palatable to industrialised nations.⁵¹ It eliminated mandatory technology transfer, revised the Council's voting structure to give greater weight to States with significant economic interests, and scaled back the operational ambitions of the Enterprise, stipulating that it would initially operate through joint ventures.⁵² This compromise paved the way for near-universal ratification of UNCLOS, although the United States remains a notable outsider, having not ratified the treaty to this day.⁵³

III. The role and regulations of the International Seabed Authority

As mentioned before, the ISA's primary function is to develop the rules, regulations, and procedures—collectively known as the 'Mining Code' to

47 Nandan/Lodge/Rosenne, 'The Development of the Regime for Deep Seabed Mining' (11 April 2002), p. 2.

48 United States, Deep Seabed Hard Mineral Resources Act 1980.

49 Michael W. Lodge, 'The Deep Seabed', in Donald R. Rothwell/Alex G. Oude Elferink/Karen N. Scott/Tim Stephens (eds.), *The Oxford Handbook of the Law of the Sea* (2015), p. 277, 277.

50 Ambassador Nandan served as Special Representative of the Secretary-General and Under-Secretary-General for Oceans and the Law of the Sea from 1984 to 1993.

51 Lodge (2015), p. 227.

52 Noyes (2011), p. 464.

53 National Ocean Service, 'Deep Seabed Hard Minerals Mining' (9 August 2025), <https://oceanservice.noaa.gov/deep-seabed-mining/> (last accessed: 6 October 2025).

govern prospecting, exploration, and exploitation of deep-seabed minerals.⁵⁴ This must be done in accordance with its dual mandate: promoting the development of the Area's resources while ensuring the effective protection of the marine environment from harmful effects.⁵⁵

To date, the ISA has successfully established regulations for the first two phases of mining. The ISA has issued separate regulations for the exploration of polymetallic nodules (adopted in 2000, updated in 2013), polymetallic sulphides (2010), and cobalt-rich ferromanganese crusts (2012).⁵⁶ Under these rules, the ISA has entered into 15-year contracts for the exploration of polymetallic nodules (PMN), polymetallic sulphides (PMS) and cobalt-rich ferromanganese crusts (CFC) in the deep seabed with 22 contractors.⁵⁷ These contracts grant exclusive rights to explore vast tracts of the seabed, primarily in the Clarion-Clipperton Zone (CCZ) in the Pacific Ocean, but also in the Indian and Atlantic Oceans.

However, the crucial third piece of the Mining Code—the *exploitation regulations*—remains in draft form.⁵⁸ The finalisation of these rules has been the subject of intense and often contentious negotiations for years, delayed by the complexity of the issues and deep divisions among member States on key questions.

IV. Current legal challenges and the regulatory gap

The paramount legal challenge confronting the DSM regime remains the absence of a finalised Mining Code, perpetuating significant regulatory un-

54 Nandan/Lodge/Rosenne, 'The Development of the Regime for Deep Seabed Mining' (11 April 2002), p. 57.

55 Art. 145 UNCLOS.

56 Michael W. Lodge, 'International Seabed Authority (ISA)' (September 2020), <https://opil.ouplaw.com/display/10.1093/law:epil/9780199231690/law-9780199231690-e1180> (last accessed: 6 October 2025).

57 International Seabed Authority, Exploration Contracts (2025), <https://www.isa.org.jm/exploration-contracts/> (last accessed: 6 October 2025): Nineteen of these contracts are for the exploration for polymetallic nodules in the Clarion-Clipperton Fracture Zone (17) and Central Indian Ocean Basin (1), and Western Pacific Ocean (1). In addition, there are seven (7) contracts for exploration for polymetallic sulphides in the South West Indian Ridge, Central Indian Ridge and the Mid-Atlantic Ridge and five (5) contracts for exploration for cobalt-rich crusts in the Western Pacific Ocean.

58 International Seabed Authority, 'The Mining Code: Draft Exploitation Regulations' (2022).

certainty. Since 2014, the International Seabed Authority (ISA) has undertaken the complex task of developing this comprehensive regulatory framework.⁵⁹ Progress, however, has been consistently impeded by substantive disagreements among member States concerning requisite environmental safeguards, equitable benefit-sharing mechanisms, and appropriate fiscal terms. A critical procedural juncture was reached in June 2021 when Nauru, acting as the sponsoring State for the contractor The Metals Company (TMC), invoked the ‘two-year rule’ stipulated in Section 1(15) of the 1994 Agreement relating to the Implementation of Part XI of UNCLOS.⁶⁰ This invocation triggered a formal requirement for the ISA Council to finalise the exploitation regulations by 9 July 2023. The Council’s failure to meet this deadline activated the rule’s secondary obligation: the Council must now ‘consider and provisionally approve’ any exploitation contract application submitted to it, irrespective of the ongoing regulatory gaps. This development has substantially intensified pressure on the ISA and amplified widespread concerns regarding the potential for premature mining approvals, the influence of commercial entities within the regulatory process,⁶¹ and the attendant risk of significant and potentially irreversible harm to the marine environment due to the lack of fully operational safeguards.⁶²

The current state of the regulatory framework is embodied in the *Revised Consolidated Text* of January 2025, further advanced by the ISA Council’s second reading in July 2025.⁶³ This draft represents the most substantial progress towards codification, establishing foundational governance architecture, although numerous critical provisions remain subject to negotia-

59 Ibid.

60 Ryan Murdock, ‘Deep Sea Mining and the Green Transition’ (16 October 2023).

61 Ibid. In March 2023, Michael Lodge, then Secretary-General of ISA, faced criticism from diplomats and officials of Germany, France, and Costa Rica for allegedly exceeding his mandate as an impartial facilitator. Critics argued that Lodge advocated for expediting the regulatory drafting process, aligning with interests favouring accelerated deep-sea mining. Concurrently, discussions between the ISA and The Metals Company (TMC), a Canadian mining corporation, dating back to 2007, have raised concerns. These communications, focused on identifying optimal mining exploration areas, are permitted but have been criticised as inconsistent with the ISA’s mandate to engage directly with states rather than multinational corporations.

62 Georgian/Hameed/Morgan/Amon/Sumaila/Johns/Ripple (2022), p. 1.

63 International Seabed Authority, ‘Draft regulations on exploitation of Mineral resources in the Area’ (10 January 2025), <https://www.isa.org.jm/wp-content/uploads/2025/01/10012025-Revised-Consolidated-Text-2.pdf> (last accessed: 6 October 2025).

tion and refinement. On environmental protection, the draft codifies a multi-tiered framework.

Regarding liability, the draft provisions aim to clarify responsibilities across key actors: contractors, sponsoring States, and the ISA itself.⁶⁴ Contractors are expressly required to carry financial insurance sufficient to cover potential environmental risks and liabilities,⁶⁵ while sponsoring States retain their overarching due diligence obligations⁶⁶ and related jurisprudence.⁶⁷

The draft operationalizes the UNCLOS standard of preventing serious harm and requires contractors to systematically identify risks, assess scientific uncertainties, and adopt mitigation measures, underpinned by a mitigation hierarchy prioritising avoidance, minimisation, mitigation, and remediation where feasible.⁶⁸ Furthermore, an Environmental Compensa-

64 The draft regulations are designed to provide a comprehensive legal framework for mineral exploitation, clarifying the distinct responsibilities of contractors, sponsoring States, and the Authority itself. For example, specific duties of contractors are set out in Part IV, while the obligations of sponsoring States and the Authority are detailed in Part I and Part VII, respectively.

65 International Seabed Authority, 'Draft regulations on exploitation of Mineral resources in the Area' (10 January 2025), reg. 36.

66 Art. 139 UNCLOS.

67 Request for an Advisory Opinion submitted by the Commission of Small Island States on Climate Change and International Law Advisory Opinion, 21 May 2024, ITLOS Rep 2024, paras. 210–221, 233–240; Ghana/Côte d'Ivoire (Provisional Measures) (Order, 25 April 2015) ITLOS Rep 2015, p. 146, paras 84–89, 102; Responsibilities and Obligations of States Sponsoring Persons and Entities with respect to Activities in the Area (Advisory Opinion, 1 February 2011) ITLOS Rep 2011, p. 10, paras 110–122, 230–235; Land Reclamation by Singapore in and around the Straits of Johor (Malaysia v Singapore) (Provisional Measures, 8 October 2003) ITLOS Rep 2003, p. 10, paras 99–106, 121; MOX Plant (Ireland v United Kingdom) (Provisional Measures, 3 December 2001) ITLOS Rep 2001, p. 95, paras 82–89, 106; Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan) (Provisional Measures, 27 August 1999) ITLOS Rep 1999, p. 280, paras 70–77; Obligations of States in respect of Climate Change (Advisory Opinion, 23 July 2025) ICJ Rep, paras 158–170, 254–270; Pulp Mills on the River Uruguay (Argentina v Uruguay) (Judgment) [2010] ICJ Rep 14, paras 197–205, 204, South China Sea Arbitration (Philippines v China) (Award, 12 July 2016) PCA Case No 2013–19, paras 947–991, 992–1011; Guyana v Suriname (Award, 17 September 2007) PCA Case No 2004–04, 30 RIAA 1, paras 445–454, 465.

68 International Seabed Authority, 'Draft regulations on exploitation of Mineral resources in the Area' (10 January 2025), regs. 2, reg. 44, 46, 47, 49.

tion Fund is established to address irremediable residual harm, enforcing the polluter-pays principle.⁶⁹

Concurrently, the draft regulations propose key institutional reforms to improve governance and transparency. These reforms include the establishment of a Compliance Committee⁷⁰ and new inspection powers to monitor and report on activities.⁷¹ The draft also enhances transparency by mandating public access to environmental data⁷² and requiring stakeholder consultations.⁷³

The draft regulations outline the financial architecture, but key elements remain unresolved and highly contested. While proposals for royalty structures, payment mechanisms, audit requirements, and penalties for non-compliance are included, their final details, which are critical for the economic viability of projects and equitable benefit-sharing, are still under negotiation. Similarly, the specific methods for distributing financial and other benefits, a core obligation under CHM,⁷⁴ have not been finalised. Therefore, the *Revised Consolidated Text* marks a critical transition from aspirational principles to concrete rules, yet it remains incomplete.

Simultaneously, the regime faces significant external pressures challenging its universality from the non-parties of UNCLOS. Recent activities by U.S. government entities, exploring pathways to engage in DSM exploitation under the authority of domestic legislation,⁷⁵ specifically the Deep Seabed Hard Mineral Resources Act of 1980 raises substantial legal and

69 International Seabed Authority, 'Draft regulations on exploitation of Mineral resources in the Area' (10 January 2025), reg. 54 establishes the Environmental Compensation Fund as a last-resort mechanism for addressing unforeseen or unmitigated environmental damage. In alignment with the 'polluter-pays' principle, contractors are primarily responsible for financing measures to mitigate and remedy any harm caused by their activities. The fund serves as a backstop, financing these measures only when a contractor is unable to fully meet its liability for unlawful environmental damage that was not anticipated in the Plan of Work or resulted from a breach of a condition of approval.

70 Ibid., reg. 102.

71 Ibid., regs. 96 et seqq.

72 Ibid., reg. 92 bis.

73 Ibid., regs. 93 bis, 93 ter.

74 Art. 140 UNCLOS.

75 United States Congress, 'Seabed Mining in Areas Beyond National Jurisdiction: Issues for Congress' (15 July 2025), <https://www.congress.gov/crs-product/R47324> (last accessed: 6 October 2025).

political concerns.⁷⁶ Any unilateral move by the U.S. to authorize exploitation outside the ISA framework would constitute a direct challenge to the Authority's exclusive mandate under UNCLOS and the foundational CHM principle.⁷⁷ Such action risks triggering broader disregard for the international regime, potentially leading to uncoordinated exploitation by other States, thereby undermining decades of multilateral efforts dedicated to ensuring environmental protection and the equitable sharing of benefits from the international seabed.⁷⁸

C. DSM: necessities v. uncertainties

The debate over deep-seabed mining (DSM) is ultimately a contest between necessity and uncertainty. On one side, proponents emphasise the indispensable role of DSM in securing the critical minerals required for the global energy transition. On the other, critics highlight the profound environmental risks and economic doubts that continue to shadow the industry. This tension has come to define one of the most significant natural resource debates of the twenty-first century.

Proponents of DSM advance three principal arguments. First, they point to the mineral demands of decarbonisation.⁷⁹ The technologies underpinning the transition to renewable energy—electric vehicles, batteries, wind turbines, and solar panels—are intensely mineral-dependent.⁸⁰ Global demand for nickel, cobalt, copper, and manganese is projected to rise sharply over the coming decades.⁸¹ At present, the supply chains for these minerals

76 United States, Deep Seabed Hard Mineral Resources Act, 28 June 1980, Pub. L. No. 96–283, 94 Stat. 553.

77 United States Congress, 'Seabed Mining in Areas Beyond National Jurisdiction: Issues for Congress' (15 July 2025) <https://www.congress.gov/crs-product/R47324> (last accessed: 12 February 2026).

78 Leticia Carvalho, 'Thirty-Fifth Meeting of States Parties to the United Nations Convention on the Law of the Sea: Agenda item 9: Information reported by the Secretary-General of the International Seabed Authority' (23 June 2025), https://www.isa.org.jm/wp-content/uploads/2025/06/SG_Statement-Thirty-fifth-meeting-of-State-Parties-to-UNCLOS_Agenda-Item-9.pdf (last accessed: 6 October 2025).

79 Oliver Ashford/Jonathan Baines/Melissa Barbanell/Ke Wang, 'What We Know About Deep-Sea Mining — and What We Don't' (23 July 2025), <https://www.wri.org/insights/deep-sea-mining-explained> (last accessed: 6 October 2025).

80 Ibid.

81 Kirsten Hund/Daniele La Porta/Thao P. Fabregas/Tim Laing/John Drexhage, 'Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition' (2020),

are highly concentrated, with over 70 per cent of cobalt production located in the Democratic Republic of Congo,⁸² nearly 40 per cent of copper output concentrated in Chile and Peru,⁸³ and the refining of rare earths and other critical minerals dominated by China.⁸⁴ This geographical concentration creates acute supply risks, exposing importing States to political instability and, in the case of China, to the potential for deliberate supply-chain manipulation.⁸⁵ DSM, its advocates contend, could mitigate such vulnerabilities by providing access to resources located in the international seabed,⁸⁶ thereby diversifying supply away from terrestrial chokepoints.

Second, the terrestrial mining industry carries with it significant social and environmental costs.⁸⁷ Land-based mining has been closely linked with deforestation, water pollution, biodiversity loss, displacement of local communities, and in some cases, child labour and other human rights violations.⁸⁸ By contrast, DSM would occur thousands of metres below the ocean surface and far from human settlements, eliminating risks of deforestation and displacement. It is argued that, if properly regulated, DSM could be designed to avoid the most egregious social harms associated with terrestrial mining, offering a cleaner and more ethically acceptable alternative.⁸⁹

Third, terrestrial deposits are increasingly of lower grade, meaning that more earth, water, and energy must be expended to yield the same amount

<https://documents1.worldbank.org/curated/en/099052423172525564/pdf/P16627806f5aa400508f8c0bdcb0878a3e.pdf> (last accessed: 6 October 2025), pp. 71 et seqq.

82 Natural Resources Canada, 'Cobalt Facts' (2023), <https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/cobalt-facts> (last accessed: 6 October 2025).

83 Carla Selman/Veronica Retamales Burford/Johanna Marris, 'Chile and Peru's copper for energy transition' (5 April 2023), <https://www.spglobal.com/sustainable/en/insights/special-editorial/chile-and-peru-s-copper-for-energy-transition> (last accessed: 6 October 2025).

84 International Energy Agency, 'Executive summary: the role of critical minerals in clean energy transitions' (5 May 2021), <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary> (last accessed: 6 October 2025).

85 Depraiter/Goutte/Porcher (2025), p. 2.

86 Murdock, 'Deep Sea Mining and the Green Transition' (16 October 2023).

87 Madureira/Squires/Ribeiro (2023), pp. 3 et seqq.

88 Ibid.

89 Ibid.

of metal.⁹⁰ By comparison, polymetallic nodules on the abyssal plains contain high concentrations of multiple metals within a single ore body.⁹¹ This, proponents argue, provides efficiencies unavailable on land. Industry projections suggest that a single DSM operation could supply a substantial share of annual cobalt demand, thereby reducing pressure on terrestrial sources.

Yet, these claims are strongly contested. Critics argue that DSM carries environmental and economic uncertainties of a scale that cannot be ignored. The deep seabed is not barren, but rather the largest and least explored biome on Earth, hosting fragile ecosystems adapted to conditions of extreme pressure, darkness, and low temperatures.⁹² Polymetallic nodules themselves are slow-forming substrates that provide habitat for unique organisms, many of which have only recently been discovered. Mining would entail the direct removal of nodules, along with the organisms attached to or inhabiting them, resulting in irreversible habitat destruction. Sediment plumes generated by seabed vehicles and discharge from surface vessels could spread for tens or even hundreds of kilometres, smothering benthic communities, releasing toxic metals, and disrupting filter-feeding species.⁹³ In addition, DSM operations would introduce light and noise pollution into an environment evolved in silence and darkness,⁹⁴ with potential impacts on deep-sea fauna and even on migratory megafauna such as whales. Perhaps most troubling, disturbing deep-sea sediments could interfere with

90 Daina Paulikas/Steven Katona/Erika Ilves/Saleem H. Ali, 'Deep-sea Nodules versus Land Ores: A Comparative Systems Analysis of Mining and Processing Wastes for Battery-metal Supply Chains' (2022), 26 *Journal of Industrial Ecology*, p. 2154, 2155 et seq.: The study suggests nodule exploitation may yield less waste with lower severities, potentially alleviating terrestrial mining's intensification, but caveats include uncertain plume effects and the need for comprehensive life-cycle assessments. It advocates balanced policymaking under the International Seabed Authority, emphasising scientific safeguards to minimise ecological harm while meeting sustainable development goals.

91 Aurora Cato/Philippe Evoy, 'Exploring plausible future scenarios of deep seabed mining in international waters' (2025), 24 *Earth System Governance*, no. 100249.

92 Ashford/Baines/Barbanell/Wang, 'What We Know About Deep-Sea Mining — and What We Don't' (23 July 2025).

93 Lamjahao Sithou/Parthasarathi Chakraborty, 'Comparing deep-sea polymetallic nodule mining technologies and evaluating their probable impacts on deep-sea pollution' (2024), 206 *Marine Pollution Bulletin*, no. 116762, pp. 13 et seqq.

94 Kathryn A. Miller/Kirsten F. Thompson/Paul Johnston/David Santillo, 'An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps' (2018), 4 *frontiers in Marine Science*, no. 418, p. 15.

the ocean's role as a carbon sink, undermining global climate regulation and creating a paradox where mining undertaken to advance the energy transition may in fact exacerbate climate risks.⁹⁵

The critics also highlight that economic viability adds another layer of uncertainty.⁹⁶ The costs of seabed metals are unlikely to be competitive given market fluctuations and the rapid evolution of battery technology, which increasingly favours lithium, iron, phosphorus, and sodium over cobalt, nickel, copper, and manganese—the very minerals targeted by DSM.⁹⁷

DSM technologies designed for large-scale seabed mining have yet to demonstrate their feasibility in the harsh deep-sea environment. The collapse of Nautilus Minerals' Solwara 1 project in Papua New Guinea, which ended in bankruptcy before extraction began, illustrates the significant financial risks for both investors and host States.⁹⁸ Investor scepticism has only grown, as major early participants, including Lockheed Martin and Maersk, have exited the sector, citing market volatility and regulatory risk.

Furthermore, DSM's economic case is weakened by the rapid rise of alternatives. The circular economy promises significant reductions in demand for virgin minerals, with the International Energy Agency estimating that recycling could meet a quarter of cobalt demand and nearly 40 per cent of copper and nickel demand by 2050.⁹⁹ At the same time, technological innovation is shifting markets away from cobalt and nickel altogether, as evidenced by the widespread adoption of lithium iron phosphate (LFP) batteries and the development of sodium-ion technologies.¹⁰⁰ In light of these competing trends, DSM's necessity for the energy transition may be less compelling than its advocates suggest.

95 *Ibid.*, pp. 15 et seq.

96 Bobbi-Jo Dobush/Maddie Warner, 'Deep Seabed Mining Isn't Worth the Financial Risk' (2024), <https://oceanfdn.org/wp-content/uploads/2024/02/dsm-finance-brief-2024.pdf> (last accessed: 6 October 2025), p. 1: The report highlights that DSM remains an unproven industrial venture, marked by profound technological, financial, and regulatory uncertainties. Its business cases often rely on unrealistic assumptions about future metal demand and ignore the volatility of mineral markets; for instance, cobalt prices fell by 10 per cent between 2016 and 2023 despite a 2,000 per cent increase in electric vehicle production.

97 *Ibid.*, p. 2.

98 Justin Alger/Jessica F. Green/Kate J. Neville/Susan Park/Stacy D. VanDeveer/D. G. Webster, 'The false promise of deep-sea mining' (2025), 4 *njp ocean sustainability*, no. 21, p. 2.

99 Ashford/Baines/Barbanell/Wang, 'What We Know About Deep-Sea Mining — and What We Don't' (23 July 2025).

100 Dobush/Warner, 'Deep Seabed Mining Isn't Worth the Financial Risk' (2024), p. 19.

D. Geopolitics as the new battleground

Although framed primarily in environmental and economic terms, the DSM debate is increasingly geopolitical. The race for critical minerals has transformed supply chains into arenas of strategic competition, with access to resources now equated with national power. The most striking precedent lies in China's dominance of rare earth elements.¹⁰¹ Controlling roughly 70 per cent of global production and over 90 per cent of processing, Beijing has repeatedly demonstrated its willingness to use resource leverage as a geopolitical tool,¹⁰² most notably during a dispute with Japan in 2010¹⁰³ and in the context of trade tensions with the United States.¹⁰⁴ This pattern has spurred Western States to diversify supply through domestic mining, recycling, and partnerships, but rebuilding supply chains is costly and slow. Against this backdrop, the deep seabed is increasingly perceived as a potential buffer against Chinese dominance.¹⁰⁵

This resource geopolitics is producing fractures in the multilateral regime. Although the United States is not a Party to UNCLOS, the prohibition on unilateral mining activities in the Area is widely accepted, binding upon all States. The issuance of the Executive Order,¹⁰⁶ coupled with The Metals Company's submission of applications to the National Oceanic and Atmospheric Administration (NOAA) for deep-sea mining licences,¹⁰⁷

101 Tom LaTourrette/Fabian Villalobos/Elisa Yoshiara/Zohan Hasan Tariq, 'The Potential Impact of Seabed Mining on Critical Mineral Supply Chains and Global Geopolitics' (9 April 2025), https://www.rand.org/content/dam/rand/pubs/research_reports/RR43500/RR43560-1/RAND_RRA3560-1.pdf (last accessed: 6 October 2025), pp. 1 et seq.

102 Ibid.

103 Martin, 'How China wields rare earths as a strategic weapon' (23 June 2025).

104 Reuters, 'Trump Says China Will Supply Rare Earths, US to Allow Students' (11 June 2025), <https://www.reuters.com/world/china/trump-says-china-will-supply-rare-earth-us-allow-students-2025-06-11/> (last accessed: 6 October 2025).

105 Craig Hart, 'Mapping China's strategy for rare earths dominance' (13 June 2025), <https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/mapping-chinas-strategy-for-rare-earths-dominance/> (last accessed: 6 October 2025).

106 The White House, 'Unleashing America's Offshore Critical Minerals and Resources' (24 April 2025).

107 The Metals Company, 'The Metals Company to Apply for Permits under Existing U.S. Mining Code for Deep-Sea Minerals in the High Seas in Second Quarter of 2025' (27 March 2025), <https://investors.metals.co/news-releases/news-release-details/metals-company-apply-permits-under-existing-us-mining-code-deep/> (last accessed: 6 October 2025).

under the Deep Seabed Hard Mineral Resources Act of 1980,¹⁰⁸ has intensified concerns that the U.S. may seek to circumvent the ISA framework. However, the U.S. cannot credibly claim persistent objector status, as it has consistently acknowledged the core principles of the seabed regime and even signed the 1994 Implementing Agreement.¹⁰⁹ These developments have led the ISA to reaffirm that the Area's resources form part of the common heritage of mankind and that no State may unilaterally exploit them.¹¹⁰

Within the ISA, divisions are equally stark. Over twenty States, including Germany, France, Spain, Canada, Brazil, and numerous Pacific Island nations, support a precautionary pause or moratorium.¹¹¹ They are opposed by a pro-mining bloc including China, Russia, and small island States sponsoring contractors such as Nauru and Tonga. This polarisation has slowed consensus-building within the Council and highlights the fragility of the cooperative vision underpinning UNCLOS.

Equity remains another unresolved fault line. The promise of the common heritage principle was that seabed resources would be managed and shared equitably, especially for the benefit of developing countries. Yet, proposals for payment regimes have been criticised for disproportionately benefiting contractors and sponsoring States, leaving minimal returns for distribution among the wider membership. Practices of 'sponsorships of

108 United States, Deep Seabed Hard Mineral Resources Act, 28 June 1980, Pub. L. No. 96-283, 94 Stat. 553.

109 Vienna Convention on the Law of Treaties, 23 May 1969, 1155 UNTS 331, art. 18(a). By signing the 1994 supplementary agreement to the United Nations Convention on the Law of the Sea (UNCLOS), the United States incurred a legal obligation under Article 18(a) of the Vienna Convention on the Law of Treaties (VCLT) to refrain from acts that would defeat the object and purpose of the treaty. Although the U.S. is not a party to the VCLT, this principle is widely considered customary international law. The core purpose of the UNCLOS deep-seabed mining framework is to regulate activities in 'the Area' as the 'common heritage of mankind' through the International Seabed Authority (ISA). Therefore, the U.S. remains under an international obligation to not undermine the ISA or the principle that the seabed is a global commons.

110 Eileen Travers, 'Deep-sea must not turn into 'Wild West' of rare minerals exploitation, agency head says' (24 July 2025), <https://news.un.org/en/story/2025/07/1165482> (last accessed: 6 October 2025).

111 Kathy-Ann Brown, 'The Draft Regulations on Exploitation of Mineral Resources in the Area: "A Work in Progress"', in Alfonso Ascencio-Herrera/Myron H. Nordquist (eds.), *The United Nations Convention on the Law of the Sea, Part XI Regime and the International Seabed Authority: A Twenty-Five Year Journey* (2022), p. 328.

convenience', where companies based in developed economies operate under the sponsorship of small, economically vulnerable island States, have drawn sharp criticism.¹¹² These arrangements risk exposing developing States to liability without corresponding benefits, replicating extractive patterns familiar from terrestrial mining.

The geopolitics of deep-seabed mining is thus a complex tapestry of strategic anxiety, national ambition, and systemic inequity. The race for rare earths and critical minerals has not only created the impetus for DSM but is also shaping its development in ways that threaten to undermine the cooperative, equitable vision upon which its legal framework was built. The seabed, far from being a peaceful commons, is becoming a new frontier where the enduring struggles over resources, power, and justice are being played out in the dark depths of the ocean.

E. Conclusion: Charting a sustainable course

The prospect of deep-seabed mining has brought the international community to a critical juncture, one defined by the intersecting pressures of resource demand, ecological vulnerability, and geopolitical rivalry. At the heart of this debate lies the principle of the *common heritage of mankind*, originally envisioned as a framework for multilateral cooperation and equitable benefit-sharing. Yet, that principle is now under strain, threatened by the accelerating push to commercialise the seabed. At the same time, the deep ocean is emerging as a theatre of strategic competition among States, amplifying the danger that short-term geopolitical imperatives will override both ecological prudence and international legal commitments.

Therefore, the governance gap for deep-seabed mining is now the decisive legal issue. The Mining Code remains unfinished, scientific knowledge of deep-sea impacts is incomplete, and geopolitical pressures are increasing the risk of unilateral action. These facts create a clear legal and policy choice: either complete a robust multilateral framework before any commercial exploitation proceeds or accept the likelihood of fragmented practice that will weaken the authority of the international regime.

A practical roadmap follows from this assessment. First, finalise the exploitation rules in the Mining Code on the basis of the precautionary approach, with clear thresholds and mandatory, peer-reviewed environmental

112 Cato/Evoy (2025), p. 6.

assessments. Second, require continuous, independent monitoring and a liability and compensation mechanism based on strict liability and an operational compensation fund. Third, maintain a pause on the grant and exercise of exploitation licences until these safeguards are in place and key scientific uncertainties are narrowed. Fourth, reform ISA governance to improve transparency, wider stakeholder participation, and equitable benefit-sharing so that sponsorship arrangements cannot be used to evade obligations. These measures are necessary to reconcile resource needs with environmental protection and distributive fairness.

If States adopt this course, the international regime can remain the primary vehicle for managing the Area and for distributing benefits in an orderly way. If not, the result will be legal fragmentation, reduced investment security, and a higher risk of irreversible harm to a unique global ecosystem. The choice is therefore institutional and legal rather than purely technical: it requires States to align short-term interests with a rules-based approach to a shared global resource.

