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Original Paper

Legal Controversies and Institutional Construction of Deep-Sea Mining within the Framework of International Law of the Sea

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Abstract

Use of minerals in the international seabed area (the "Area") can be deemed one of the most important frontiers in today's modern international law by virtue of its own value of minerals from the "Area" and conflicting matter of the fragile eco-system of "Area". Following the United Nations Convention on the Law of the Sea (UNCLOS), The area and its resource were called "the common heritage of mankind", it will be necessary to create some kind of a system that is effective, fair and is with a sound premise for protecting environment in future. However, while the International Seabed Authority (ISA) is transitioning from regulating exploration to formulating the Mining Code for exploitation, deep-seated legal controversies have arisen. These disputes revolve around how to implement the precautionary principle, how to distribute the financial benefits of equitably, what the gaps in liability for environmental damage are, and what procedural pressure is caused by the so-called "two-year rule". This paper analyzes these legal controversies, and explores the conflict between the rights of the sponsors and the environmental obligations of the international community. It criticizes the current draft regulations and suggests the reform of the institutions to enhance the ISA's ability of independent surveillance and to create a tight financial mechanism. By studying in detail the legal framework and the current situation of negotiations, this study believes that a more scientific bottom line that can be legally compliant and based on the spirit of the United Nations Convention on the Law of the Sea needs to be established. The paper finishes with some very specific institutional constructions that can make sure deep sea mining will be able to add to world's collective lot, and not just its detriment.

Keywords

Deep-Sea Mining, UNCLOS, ISA, Common Heritage of Mankind, Environment Law, Code of Conduct for Mining in the Area

1. Introduction

Deep ocean floor beyond national jurisdiction possess great resources of polymetallic nodules, sulphides and crusts essential for global green energy transition. However, extraction as a legal regime is being scrutinized as never before. UNCLOS Designate the "Area" as the "common heritage of mankind" (Article 136), and the ISA is responsible for it, in the interest of all of humanity and at the same time provide effective protection of the marine environment.

Although this framework, but in the process of transition to commercial application has some flaw about the law. In 2021, Nauru invoked the "two-year rule", forcing the ISA to expedite the "Mining Code", and experts are alarmed by this without sufficient ecological knowledge to authorize industrial mining (Energy & Ecology, 2020). The main controversy is how to balance "duty to cooperate" and "due diligence" to prevent transboundary damage, and the ISA may have structural interest conflict as both regulator and beneficiary. What kind of controversy is there on these legal issue, what institution path can join the interest of current generation with environment equal benefit for next generation.

2. The Legal Framework of the Area and the Role of the ISA

As far as basic legal principle concerning to deep - sea mining system, it's more like the "common heritage of mankind" rather than the Westphalian sovereignty over resources in term of geography. Whereas freedoms such as fishing and navigation on the high seas water column, the seabed Area is within a centralized management regime in which no country can claim rights of sovereignty or sovereign rights. The ISA acts as the administrator of this regime and has the sole right to grant contracts for exploration and exploitation. Now the ISA has made many deals about finding things, it lets people look at what is under the sea and try to take stuff out, but they cannot take the minerals to make money. These contracts are sponsored by states who take on the responsibility to see to it that the sponsored entities do abide by UNCLOS and ISA. This two-tier structure of government support and international management forms a messy tangle of responsibility and control. The legal framework says that all activities in the Area should have regard for other things that happen out at sea and they should also take steps to stop, lessen, and watch out for polluting or other bad effects on the sea. How the sponsoring states domestic laws and the ISAs international rules interplay is vital to compliance being possible, if the sponsoring states have the administrative capacity and political will to make sure their contractors adhere to standards.

To know where we are in terms of deep sea mining governance, you have to see how the exploration contracts that are ongoing right now are being distributed and what they are made up of. The ISA has entered into agreements concerning three different varieties of minerals, but the main area of interest is the Clarion - Clipperton Zone in the Pacific Ocean, which is characterized by a high density of polymetallic nodules. The distribution of these contracts reveals the interests of all major economies and developing island nations in the future industry. Data on these contracts show the amount of commercial interest and administrative burden currently on the ISA. As shown in Table 1 below, the

current exploration contracts are broken down in detail according to resource type, and the diversity of the sponsoring states is reflected. This distribution illustrates that the industrial global scale and from all countries must have a regulatory framework can balance the various interests of the various nations and achieve a unified standard of environmental protection (Gao, Y., Sun, D., Huang, H. et al., 2021, pp. 2722-2737).

Table 1. Overview of ISA Exploration Contracts in Terms of Resource Type and Regional Distribution

Resource Type	Total Contracts	Primary Location(s)	Key Sponsoring States (Examples)	Estimated Resource Value (USD Trillions)
Polymetallic Nodules	19	Clarion-Clipperton Zone (Pacific), Central Indian Ocean	China, Germany, UK, Belgium, Nauru, Tonga	~16.5
Polymetallic Sulphides	7	Mid-Atlantic Ridge, Central Indian Ridge	France, Russia, China, India, Poland	~4.2
Cobalt-Rich Crusts	5	Western Pacific Ocean (Magellan Seamounts)	Japan, China, Brazil, Russia, South Korea	~2.8
Total	31	Global Deep Ocean	Diverse (Developed & Developing)	~23.5

Note. Data is an approximation of the status of the contracts as of the most recent ISA sessions. The estimation relies on global commodity price for nickel, Cobalt and Copper.

As shown in Table 1, most of the contracts are for polymetallic nodules in the Clarion-Clipperton Zone, which indicates that it is likely that this area will be the first test case for commercial mining legislation. Nauru and Tonga, developing countries, often together with private companies from the Global North, highlight the complexities of the "benefit sharing" (Hao, Y., 2022, pp. 117-130). Although these partnerships are stated to be available to developing countries for participation in the Area, legal scholars argue that they could also serve as "flags of convenience" and enable private companies to be sponsored by a State that has the capacity for less supervision, but the Advisory Opinion of the International Tribunal for the Law of the Sea (ITLOS) has already been clear that sponsoring states

have a direct duty of due diligence (Xu, X., 2022, pp. 93-102). But still the enormous economic value forecasted in the table gives strength to the pressure upon the ISA to come to terms on the exploitation rules. The legal system needs to transform from a scientific exploration framework to an industry supervision system for trillion-dollar resource extraction industry, the institutional changes and legal system innovation.

3. Environmental Controversies and the Precautionary Principle

The biggest legality issue is that there may be a long-term deep-sea mining disaster. UNCLOS Article 145 requires the ISA to make rules for the purpose of protecting the marine environment, which will follow the principle of prudence and the precautionary principle. This principle is about not using the scientific uncertainty as an excuse to stop taking the low-cost environmental measures that can be done right now. Given a lack of scientific understanding of the deep-sea ecosystems, a strict precaution approach may be required to have a moratorium on exploitation until it can be know what is the baseline biodiversity. However, the current draft regulations are criticized as a “management approach” rather than a “precaution”, which may cause damage after the start of mining.

Further pour oil on the flame of an exact set of quantifiable environmental borders that are neglected during the drafting process. While terrestrial mining regime often has particulate matter, toxicity, noise limit, but deep sea regime is still trying to define “serious damage” to marine environment. Given the special nature of the deep sea, including high pressure, low temperature and slow-growing species, it will take hundreds or thousands of years for the recovery of mining disturbance. Sediment clouds thrown up by mining vehicles could cover a large area of organisms far from the mining site. The current legal debate is on whether to use ISA as a form to create a mandatory “impact reference area” and a “preservation reference area” that will be found liable if violated (Jia, Y., Zhang, Z., Zhuo, X. et al., 2025, pp. 1-7). Country-specific environmental standards versus developing international standards creates arbitrage risk. Table 2 shows the comparison of environmental impact thresholds, and the difference between established terrestrial / coastal norms and the nascent deep-sea regime can be seen.

Table 2. National Vs. Environmental Impact Threshold Comparison Table

Regulatory Feature	Typical National Jurisdiction (e.g., Coastal Mining)	Draft ISA Exploitation Regulations (International Area)	Legal Status of Threshold	Risk of Ambiguity
Baseline Data Requirements	Multi-year, high-resolution temporal and spatial data often mandatory before licensing.	Baseline data required, but guidelines on duration and resolution remain flexible (e.g., 1-2 years).	Guidelines are often "recommendatory" rather than binding.	High: Insufficient baseline makes impact assessment impossible.
Sediment Plume Limits	Strict turbidity limits (e.g., mg/L) relative to background levels.	Concept of "Impact Reference Zones" exists, but specific plume concentration limits are undefined.	To be determined by "Standards and Guidelines."	Very High: Transboundary plume spread is a major liability gap.
Biodiversity Loss	"No net loss" or "Net gain" policies frequently applied (offsets).	"No serious harm" standard; offsetting deep-sea biodiversity is scientifically contested/impossible.	Article 145 mandates "effective protection."	High: "Serious harm" is a qualitative, not quantitative, legal term.
Public Consultation	Mandatory periods with legal standing for community challenges.	Limited stakeholder consultation; limited legal recourse for non-state actors to challenge decisions.	Institutional opacity remains a criticism.	Medium: Procedural justice concerns.

International regimes have a higher "risk of ambiguity" than developed national jurisdiction and as a result there is a legal void due to insufficient standard. If commercial mining goes ahead, the ISA can't apply binding criteria to make contractors responsible for non-catastrophic environmental harm. Additionally, "biodiversity offsets" are not legal and scientific in the deep sea, as unique abyssal ecosystems cannot be replicated. Therefore, legal scholars advocate for a "reverse burden of proof" in the Mining Code, that is, requiring contractors to prove the absence of serious damage before proceeding, rather than having regulators prove harm, so as to allow the precautionary principle.

4. Benefit-Sharing Mechanisms and Financial Regimes

A central pillar of the "common heritage of mankind" is equitable sharing of the financial and other requirement of UNCLOS Article 140 that activities in the Area are for the benefit of all mankind and the ISA's commitment to equitable sharing of financial gains. Making the financial regime work is complicated, and it has to balance contractor returns with the global rent from resources. Different models such as royalties, profit sharing, etc. have been put forward. The 1994 agreement was moved from technology transfers to market approach. And present disputes about the type of royalty—the structural issues—that developing countries are leaning towards more progessive royalties because it gets them revenue immediately, whereas the contractors and industrialised countries are for a lower fixed or profit-based structure. The ISA's Enterprise, which was meant to mine in developing countries, has yet to be realized.

Table 3. Financial Models for Proposed Deep-Sea Mining Royalties and Benefits Sharing

Financial Model	Mechanism Description	Advantages for "Common Heritage"	Disadvantages/Risks	Preferred By
Fixed Ad Valorem Royalty	A fixed percentage fee (e.g., 2%-6%) levied on the market value of the refined metal.	Guaranteed revenue stream from day one of production; simple to administer and audit.	May not capture "super-profits" if commodity prices spike; might be burdensome if prices crash.	Developing States; Civil Society (for transparency).

Two-Stage Ad Valorem	Lower royalty rate during the initial recovery period, increasing to a higher rate afterward.	Encourages investment by reducing early operational costs; ensures higher long-term share.	Complex to define the "recovery period"; risk of companies manipulating accounts to stay in the low bracket.	Contractors; Investors; Some Sponsoring States.
Profit-Sharing/Hybrid	Combination of royalties and a share of net profits after taxes and costs.	Theoretically captures the highest economic rent; aligns ISA interests with project success.	Extremely vulnerable to creative accounting and transfer pricing; high administrative cost for ISA.	Historically favored by initial UNCLOS drafters; less popular now.
Environmental Levy	Additional tax earmarked specifically for an Environmental Compensation Fund.	Ensures funds are available for restoration or research; internalizes environmental externalities.	Increases the total effective tax rate, potentially making projects unviable.	Environmental NGOs; Scientific Community.

Table 3 - Fixed Ad Valorem Royalty system is the most legal transparent system. ISA does not need to audit complex company books to minimize profit shifting and tax avoidance risks as present in global south extractive industries. There is a problem about legality for distribution on fund. UNCLOS does not have a particular formula, so there are questions about whether those funds should be given directly to states or to fund the work of the ISA or provide goods such as ocean science and conservation to the world. Also "intergenerational equity" means that the carbon pricing benefit should not only be good for the current generation but also for future generations by investing in a sovereign wealth fund. Completing the financial regime is necessary for approving any exploitation work plan, so it has become a key bottleneck in the current negotiations.

5. Institutional Gaps and Proposals for Reform

Commercial mining prospects show the structural conflicts of interest in the ISA - the ISA functions as the regulator, the licensor, and the revenue collector. The LTC is criticized for a lack of transparency and a "presumption of approval" process which is difficult to challenge. And there's also no separate inspectorate of the ISA over remote ones.

Permits should not be granted without real reform. Autonomous "Deep Sea Inspectorate" for verification and open dispute resolution procedures are key proposals. Also, there should be a clear definition of liability when the contractors are no longer accessible. Table 4 fills these gaps and proposes amendments to the ISA to make the ISA capable of enforcing Article 145.

Table 4. Main Gaps in the Draft Exploitation Regulations and Proposed Institutional Adjustments

Area of Regulation	Current Institutional/Legal Gap	Proposed Amendment/Institutional Reform	Expected Legal Outcome
Decision Making (LTC)	Closed-door meetings; "Deemed approval" of plans if Council does not vote to reject; lack of environmental expertise.	Open environmental review sessions; removal of deemed approval; mandatory independent scientists.	Increased transparency and accountability; politically legitimate decisions.
Compliance & Monitoring	No independent inspectorate; reliance on contractor self-reporting of environmental data.	Establishment of a robust "Deep Sea Inspectorate" with power to conduct unannounced audits and issue stop-work orders.	Objective verification of compliance; credible enforcement of Article 145.

Dispute Settlement	Limited scope for challenging administrative decisions of the ISA (e.g., granting a contract).	Creation of an administrative review tribunal or expanded standing for NGOs to challenge regulatory failures.	Enhanced rule of law; checks and balances on ISA discretionary power.
Liability & Compensation	Unclear "liability gap" if contractor is insolvent and state has met "due diligence"; fund size undetermined.	Mandatory insurance coverage for full potential damage; strict liability standard for environmental harm; uncapped Compensation Fund.	Full internalization of risks; protection of the "Common Heritage" financial value.

The proposals in Table 4 are related to the topics discussed in the council sessions. Set up the Deep Sea Inspectorate as the most important institutional demand. Without ocean surveillance, ISA's rules are just a bunch of hot air. It is necessary to state the legal basis for the inspection in the Mining Code to authorize boarding of ships and inspection of equipment. Reform LTC voting procedures to restore trust in ISA. At the time when mining seemed impossible, the current system was designed, and it is no longer applicable today with the demands of commercial mining. Strengthening institutions is legally bound to be trustees of mankind's common heritage for everyone, not a select few.

6. Conclusion

The UNCLOS deep-sea mining regime finds itself at a crossroads. As there is an increase in the need for important minerals, the ISA has to finish a Mining Code that balances development and preservation. This analysis points out the significant deficiencies of the draft regulations include non-mandatory environmental threshold requirements, reliance on contractor's self-monitoring, and conflict of interest of the ISA.

To establish a legal system, the international community has to expand disciplinary supervision via an independent examiner and public choices. The "two-year rule" must not be used to excuse poor regulation; due diligence demands delaying commercial mining until science is certain. In order to make sure that deep sea resources can be shared by the people of the world without damaging the ocean for the future generation.

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