The Abyssal Frontier: Vertical Sovereignty and the Ethics of Ocean Governance

Paola González-Vargas
Academic Advisor and Researcher, Rectory,
Universidad Nacional de Costa Rica (UNA), Costa Rica
E-mail: paola.gonzalez.vargas@una.cr

Abstract

As the global energy transition accelerates, the seabed has emerged as a primary frontier for mineral extraction, challenging the traditional Westphalian conception of sovereignty, a topic inherent to Science Diplomacy. This article analyses the bioethical and political tensions arising from deep-sea mining, arguing that contemporary oceanic governance remains trapped in a planar, bidimensional cartography. By introducing the concept of vertical sovereignty, this paper demonstrates how the lack of material access and technological capability in the Global South constitutes a direct threat to national security. Furthermore, it examines the ontological extractivism enabled by quantum computing and Digital Sequence Information (DSI). The study concludes that effective access to the deep ocean is not a technical luxury, but a condition for epistemic justice and the protection of biospheric integrity.

The Internationalisation of the Commons

The global energy transition has triggered a technoscientific race for critical minerals located primarily in abyssal plains. While the United Nations Convention on the Law of the Sea (UNCLOS) defines these spaces as the "Common Heritage of Mankind," this legal category is facing a legitimacy crisis. The gap between nominal sovereignty and material access generates a strategic vulnerability for states in the Global South. Traditionally, International Relations have operated on a bidimensional cartography where sovereignty is limited to surface lines. This epistemic limitation ignores the volume and vertical depth of the ocean—the subsoil and abyssal trenches—as spaces for power exercise. However, the current climate crisis has shifted the geopolitical centre of gravity toward the deep ocean. The seabed is now presented as a new frontier for global extractivism, representing multidimensional challenges that cannot be analysed in isolation.

Vertical Sovereignty and the Security Gap

State sovereignty cannot remain a purely planar attribute. It becomes an inoperative abstraction if the state lacks the ontological correlate provided by technical capability for immersion and monitoring. As noted by Tilot et al. (2021)[1], the management of deep-sea resources—such as polymetallic nodules and cobalt-rich crusts—cannot be understood through bidimensional logic, given that deep-sea mining (DSM) activities operate in a tridimensional, hyper-complex manner. Furthermore, standard economic assessments often fail to capture the long-term ecological risks and structural losses associated with these operations.[2] For oceanic states like Costa Rica, the incapacity to monitor abyssal plains is not merely an industrial lag; it is a fracture in national security. Keeping this infrastructure void is equivalent to possessing terrestrial borders without institutional presence. Thus, vertical sovereignty is introduced:

sovereignty as a material capacity for exercise. If a state cannot access its own seabed, it cannot guarantee the protection of its biospheric integrity.

The Access Dilemma: Capital and Technology

The architectural framework governing contemporary oceanic spaces inherits a Westphalian matrix—a structural paradigm dating back to 1648 that privileges nation-state borders and treats territory as flat, static zones of exclusive control—that instrumentalises the law in favour of hegemonic actors. When Global North imposes the rhetoric of the commons and open access to data without transferring the technological power to process it, the framework operates as a rationalisation of asymmetric dispossession.

The current technological race has shifted the focus toward an increasingly instrumentalised science diplomacy. In this fragmented order, technical knowledge is no longer a collaborative good but a territory of strategic dispute. For countries like Costa Rica, Blue Soft Power (the strategic deployment of technical and political capabilities) acts as the bridge that translates oceanographic and biological data into legal and diplomatic mandates.

However, quantum extractivism and the dematerialisation of marine resources represent a significant threat. Through simulations of molecular interactions within chemosynthetic microbiota, hegemonic actors can patent synthetic biomimetic compounds in distant laboratories, circumventing the benefit-sharing obligations of the BBNJ Treaty (the international agreement on the conservation and sustainable use of marine Biological Diversity of Areas Beyond National Jurisdiction). This constitutes a fundamental threat to the distributive justice that the international community claims to uphold.

Science Diplomacy as a Tool for Epistemic Sovereignty

In the current geopolitical landscape, a state's capacity to influence the governance of global commons depends on its epistemic authority. For Costa Rica, the transition toward a Blue Soft Power state requires science to operate as a fundamental vector of foreign policy. Science diplomacy is often defined as the use of scientific collaboration to address common problems and build constructive international relations.[3] However, in the context of the deep-sea, it is a vital tool for sovereignty, allowing a state to engage in multilateral negotiations as a generator of situated technical evidence. As Gual Soler (2021)[4] suggests, in the 21st century, science diplomacy must be understood as the strategic direction of international relations to impel national interests in an arena of competition. This implies three essential dimensions:

1. Ensuring that the generation of oceanographic data remains a public, autonomous effort.
2. Utilising scientific evidence to challenge the Westphalian planar view of the ocean.
3. Promoting a governance model where the validation of knowledge reflects the diverse ontologies of coastal and insular nations.

By bridging the gap between university research and the Ministry of Foreign Affairs, Costa Rica transforms the technical complexity of the abyssal plains into an asset for negotiation, grounded in rigorous science and an ethical commitment to the common good.[5]

Toward Bioethical Governance

A truly reparative international policy must declare the quantum processing power applied to global commons as a transnational public good. The participation of states like Costa Rica in for a, such as the International Seabed Authority, demonstrates that legitimacy in the 21st century emanates from epistemic coherence. By advocating for a precautionary moratorium on deep-sea mining, Costa Rica exercises a transgenerational responsibility, recognising that the systemic resilience of the planet depends on our capacity to treat the ocean as a living, unitary system.

Conclusion

Consolidating vertical sovereignty and a robust Blue Soft Power is an ongoing project of political and technological recomposition. To move these principles from theoretical mandates into actionable global policy, the international community must establish clear operationalisation pathways. Ensuring the long-term integrity of the biosphere requires the implementation of specific institutional arrangements structured around three fundamental axes:

a) **Operationalising data justice via processing quotas:** Moving beyond passive data-sharing methodologies requires a binding framework within the International Seabed Authority and the BBNJ framework. This can be institutionalised through a transnational public good computing pool that legally mandates high-income nations and corporate actors to allocate a fixed percentage of their cloud-computing and quantum-processing infrastructure to scientific institutions in the Global South. In practice, oceanic states like Costa Rica would not merely receive raw digital files, but the structural capacity to run autonomous modelling and bioinformatic analyses on their own terms.

b) **Institutionalising epistemic diplomacy: States must transition from traditional, surface-bound diplomatic representation to specialised** technoscientific missions. This involves the formal integration of *Scientific and Technological Attachés* directly into maritime and diplomatic delegations. These attachés will serve as permanent institutional mediators, tasked with auditing deep-sea mining proposals, translating oceanographic data into real-time legal mandates, and defending national biospheric interests within multilateral fora.

c) **Creating regional implementation hubs:** The enforcement of the BBNJ Treaty cannot rely solely on fragmented national responses or centralised Western oversight. Instead, it must be executed through *Regional Ocean Governance Platforms*—collaborative frameworks shared by geographically contiguous coastal and insular nations. For the Central American and Pacific contexts, such platforms would standardise regulatory frameworks, coordinate shared patrol and deep-sea monitoring technologies, and establish a unified diplomatic bloc to enforce binding benefit-sharing mechanisms against algorithmic and digital biopiracy.

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