A HOLE IN THE BOTTOM OF THE SEA: DOES THE UNCLOS PART XI REGULATORY FRAMEWORK FOR DEEP SEABED MINING PROVIDE ADEQUATE PROTECTION AGAINST STRIP-MINING THE OCEAN FLOOR?

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I. INTRODUCTION

The abyssal plain—the deepest part of the ocean—is littered with polymetallic nodules: lumps of minerals deposited through accretion over the course of millions of years. The existence of these mineral deposits, although not their exact nature, has been known since at least the nineteenth century. For a century and a half, though, the engineering

challenges of collecting these nodules made them nearly as economically impracticable as asteroid mining.[1]

Nonetheless international law took into account the possibility that technological change and increasing prices for the metals contained in the nodules would eventually make such mining worthwhile. The United Nations Convention on the Law of the Sea ("UNCLOS"),[2] concluded in 1982 at the conclusion of the decade-long United Nations Conference on the Law of the Sea, contains the very lengthy Part XI—a treaty within a treaty—regulating mining and dredging of the deep seabed;[3] this was subsequently amended by the Agreement Relating to the Implementation of Part XI of the Convention, which entered into force in 1996.[4]

This attempt to create a regulatory framework for an industry that did not yet exist created a great deal of scholarly interest around the time the treaty was concluded,[5] and again in the mid-1990s, when UNCLOS entered into force and when it briefly appeared that mining the polymetallic nodules might become technologically and economically feasible.[6] A third surge of interest in the subject began recently, and the

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[1] The United States has already adopted a statute covering space resource issues including asteroid mining. U.S. Commercial Space Launch Competitiveness Act (CSLCA), Pub. L. No. 114-90, 129 Stat. 704 (2015); Section 401 *et seq.* deal specifically with asteroid mining and are codified at 51 U.S.C. §§ 51301–03. *See also* Nemitz v. United States, No. CV-N030599-HDM-RAM, 2004 WL 3167042, at *1 (D. Nev. Apr. 26, 2004), *aff'd sub nom.* Nemitz v. NASA, 126 F. App'x 343 (9th Cir. 2005); Tyler Conte, *Property Rules for Martian Resources: How the Space Act of 2015 Increases the Likelihood of a Single Entity Controlling Access to Mars*, 84 J. AIR L. & COM. 187 (2019); Matthew Feinman, *Mining the Final Frontier: Keeping Earth's Asteroid Mining Ventures From Becoming the Next Gold Rush*, 14 U. PITT. J. TECH. L. & POL'Y 202 (2014): Alison Morris, *Intergalactic Property Law: A New Regime for a New Age*, 19 VAND. J. ENT. & TECH. L. 1085 (2017); Samuel Roth, *Developing a Law of Asteroids: Constants, Variables, and Alternatives*, 54 COLUM. J. TRANSNAT'L L. 827 (2016); Lauren E. Shaw, *Asteroids, the New Western Frontier: Applying Principles of the General Mining Law of 1872 to Incentivize Asteroid Mining*, 78 J. AIR L. & COM. 121 (2013); Andrew Tingkang, *These Aren't the Asteroids You Are Looking For: Classifying Asteroids in Space as Chattels, Not Land*, 35 SEATTLE U. L. REV. 559 (2012).

[2] United Nations Convention on the Law of the Sea, U.N. Doc. A/CONF.62/122 (Dec. 10, 1982) (in force from Nov. 16, 1994) [hereinafter UNCLOS].

[3] *Id.* arts. 133–91 [hereinafter Part XI]; *see also* PROCEEDINGS OF CONFERENCE ON DEEP SEABED MINING AND FREEDOM OF THE SEAS (Frederick Tse-shyang Chen ed., 1981).

[4] Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, U.N. Doc. A/RES.48/263 (Nov. 16, 1994) (in force from July 28, 1996) [hereinafter Part XI Agreement].

[5] *See, e.g.*, Steven J. Burton, *Freedom of the Seas: International Law Applicable to Deep Seabed Mining Claims*, 29 STAN. L. REV. 1135 (1977); THEODORE G. KRONMILLER, THE LAWFULNESS OF DEEP SEABED MINING (1980); KURT MICHAEL SHUSTERICH, RESOURCE MANAGEMENT AND THE OCEANS: THE POLITICAL ECONOMY OF DEEP SEABED MINING (1982); Kathryn Surace-Smith, *United States Activity Outside of the Law of the Sea Convention: Deep Seabed Mining and Transit Passage*, 84 COLUM. L. REV. 1032 (1984); Conrad G. Welling, *Mining of the Deep Seabed in the Year 2010*, 45 LA. L. REV. 1249 (1985).

[6] *See, e.g.*, Jonathan I. Charney, *U.S. Provisional Application of the 1994 Deep Seabed Agreement*, 88 AM. J. INT'L L. 705 (1994); John Alton Duff, *UNCLOS and the New Deep Seabed*

International Seabed Authority ("ISA"; the agency charged with administering deep seabed mining under Part XI) has begun to enter into deep seabed exploratory mining contracts.[7]

This is not another article on Part XI. A great many excellent articles, books, and other works have already explored the topic thoroughly.[8] Rather, this article looks at whether Part XI still makes sense as a regulatory framework, given the enormous advances in environmental science that have taken place in the decades since it was drafted. We have recently discovered that the environment of the deep seabed is both far more diverse and far more fragile than it was understood to be at the time of UNCLOS; the UNCLOS deep seabed mining regime may be inadequate to protect that environment.

Section II of this article describes the nature and origin of deep seabed polymetallic nodules and the history of deep seabed mining, as well as the engineering challenges and current hotspots for proposed mining. Section III looks at the deep seabed mining regime, including Part XI, the precautionary principle, and other relevant law, while Section IV, the

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Mining Regime: The Risks of Refuting the Treaty, 19 SUFFOLK TRANSNAT'L L. REV. 1 (1995); Lieutenant Martin A. Harry, JAGC, USNR, *The Deep Seabed: The Common Heritage of Mankind or Arena for Unilateral Exploitation?*, 40 NAVAL L. REV. 207 (1992); Barbara Ellen Heim, Note, *Exploring the Last Frontiers for Mineral Resources: A Comparison of International Law Regarding the Deep Seabed, Outer Space, and Antarctica*, 23 VAND. J. TRANSNAT'L L. 819 (1990); David Kriebel et al., *The Precautionary Principle in Environmental Science,* 109 ENV'T. HEALTH PERSPECTIVES 871 (2001); Houston Putnam Lowry, *So Your Client Wants to Engage in Deep Seabed Mining*, 5 ILSA J. INT'L & COMP. L. 325 (1999); Arcangelo Travaglini, *Reconciling Natural Law and Legal Positivism in the Deep Seabed Mining Provisions of the Convention on the Law of the Sea*, 15 TEMP. INT'L & COMP. L.J. 313 (2001).

[7] *See, e.g.*, Luz Danielle O. Bolong, *Into the Abyss: Rationalizing Commercial Deep Seabed Mining Through Pragmatism and International Law*, 25 TUL. J. INT'L & COMP. L. 127 (2016); Ekrem Korkut & Lara B. Fowler, *Melting Ice and Deep Waters: The United States and Deep Seabed Mining in the Arctic*, 34 NAT. RES. & ENV'T 27 (Fall 2019); Kartik S. Madiraju, *Contemplating a Domestic Regulatory and Enforcement Framework for Deep Seabed Mining*, 34 NAT. RES. & ENV'T 17 (Fall 2019).

[8] In addition to the sources mentioned in the preceding three footnotes, see also, for example, LAW OF THE SEA: CARACAS AND BEYOND (Francis T. Christy, Jr. et al. eds., 1975); *Statement by Expert Panel: Deep Seabed Mining and the 1982 Convention on the Law of the Sea*, 82 AM. J. INT'L L. 363 (1988); Ian Bezpalko, *The Deep Seabed: Customary Law Codified*, 44 NAT. RES. J. 867 (2004); Katherine Dixon, *Law of the Sea—Deep Seabed Mining—United States Position in Light of Recent Agreement and Exchange of Notes with Five Countries Involved in Preparatory Commission of United Nations Convention on the Law of the Sea*, 18 GA. J. INT'L & COMP. L. 497 (1988); Jennifer Frakes, Note, *The Common Heritage of Mankind Principle and the Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?*, 21 WIS. INT'L L.J. 409 (2003); Steven J. Molitor, *The Provisional Understanding Regarding Deep Seabed Matters: An Ill-Conceived Regime for U.S. Deep Seabed Mining*, 20 CORNELL INT'L L. J. 223 (1987); John E. Noyes, *Deep Seabed Mining: The Work of the Preparatory Commission*, 82 AM. SOC'Y INT'L L. PROC. 80 (1988); MARKUS G. SCHMIDT, COMMON HERITAGE OR COMMON BURDEN?: THE UNITED STATES POSITION ON THE DEVELOPMENT OF A REGIME FOR DEEP SEA-BED MINING IN THE LAW OF THE SEA CONVENTION (1988).

conclusion, looks at the possibility of change in that regime in light of recent environmental discoveries.

II. DEEP SEABED MINING: SCIENCE, HISTORY, ENGINEERING, AND CURRENT DEEP SEABED MINING HOTSPOTS

A. The Nature and Origin of Deep Seabed Polymetallic Nodules and Related Mineral Deposits

In 1878 the Swedish scientist and Arctic explorer A.E. Nordenskjöld set out in search of a Northeast Passage—a navigable sea route between Europe and Asia over the northern coast of both continents.[9] On this trip, or possibly on an earlier expedition, he pulled up from the floor of the Kara Sea, the body of water lying east of Novaya Zemlya, a polymetallic nodule.[10] Other sources date the discovery of the first nodule to 1868, without elaboration, while still claiming the Kara Sea as the site.[11] While Nordenskjöld was in the Arctic in 1868, he was not in the Kara Sea; he was leading the *Sofia* expedition to explore the waters around Svalbard, hundreds of miles to the west, although it is quite possible that he pulled up his polymetallic nodule from there instead.[12] Regardless of the exact date and location, Nordenskjöld was almost certainly not the first to see such a nodule; dredges and trawlers must have been pulling them up for centuries. Nordenskjöld may have been the first, however, to realize what the nodule was, and to see the potential in it. Or that discovery might first have been made by the research crew of the *HMS Challenger* on its legendary 80,000 mile expedition from 1872 to 1876.[13] John Murray,

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[9] Nordenskjöld, also spelled Nordenskiöld (the Finnish spelling) was born in the Grand Duchy of Finland, which throughout his life was part of the Russian Empire, but his anti-Czarist sentiments, and the attention they brought, eventually forced him to flee to Sweden. *See Nordenskiöld, Nils Adolf Erik*, *in* ENCYC. BRITANNICA (1911), *available at* https://en.wikisource.org/wiki/1911_Encyclop%C3%A6dia_Britannica/Nordenski%C3%B6ld,_Nils_Adolf_Erik [https://perma.cc/2YCX-S2SW] (last visited Feb. 1, 2022).

[10] *See* Oleg S. Vereshchagin et al., *Ferro-Manganese Nodules from the Kara Sea: Mineralogy, Geochemistry and Genesis*, 106 ORE GEOLOGY REVS. 192, 192 (2019), https://doi.org/10.1016/j.oregeorev.2019.01.023 [https://perma.cc/M59E-7TSE].

[11] *Nodules*, METALS CO., https://metals.co/nodules/ [https://perma.cc/W8XL-RYLQ] (last visited Feb. 1, 2022); INT'L SEABED AUTH., POLYMETALLIC NODULES 1, https://isa.org.jm/files/files/documents/eng7.pdf (last visited Feb. 1, 2022).

[12] *Nordenskjöld's Arctic Voyages*, 20 NATURE 631 (1879), https://www.nature.com/articles/020631a0.pdf [https://perma.cc/R82H-7C2N] (serialized summary of THE ARCTIC VOYAGES OF ADOLF ERIC NORDENSKJÖLD, 1858–79 (1879)); *see also* the previous week's summary at *Nordenskjöld's Arctic Voyages*, 20 NATURE 606 (1879).

[13] Richard Fisher, The Unseen Man-made 'Tracks' on the Deep Ocean Floor, BBC FUTURE (Dec. 3, 2020), https://www.bbc.com/future/article/20201202-deep-sea-mining-tracks-on-the-ocean-floor [https://perma.cc/V58P-CX69]; James R. Hein, Andrea Koschinsky & Thomas Kuhn, *Deep-Ocean Polymetallic Nodules as a Resource for Critical Materials*, 1 NATURE REVS. EARTH & ENV'T 158, 158 (2020); *see also* Stephen Dowling, *The Quest that Discovered Thousands of*

Charles Wyville Thompson, and the other Challenger scientists also analyzed the content of the nodules.

High above the ocean floor in the upper ocean, tiny organisms thrive in the sunlight. Diatoms, unicellular microalgae, build shells of silica, as do radiolarians and acantharians, protista often living in symbiotic relationships with algae. (Some of the latter also build shells of strontium.) Foraminiferans build shells of calcium carbonate, like mollusks, while dinoflagellates, with an exterior body armor of cellulose thecal plates, sometimes include internal silica structures.[14] These and other plankton live their lives in the upper ocean; eventually they die, and their microskeletons sink to the ocean floor far below. Some are consumed by larger creatures, which in turn also eventually die, leaving their skeletons, internal or external, to sink to the ocean floor as well.[15]

These plankton and other phytoplankton are an irreplaceable cornerstone of all life on Earth, not only providing the basis of the oceanic food chain and playing a vital role in the carbon cycle, but also producing most of the world's oxygen.[16] Yet most of the time we pay them little heed, except to marvel at bioluminescent waves or decry a red tide (both caused by dinoflagellates), or to mine diatomaceous earth, deposited over hundreds of millions of years and later lifted above sea level by plate tectonics, for use in water filters and abrasives. The endless rain of these tiny skeletons has shaped our atmosphere, our ecosphere, our history, and our geology, largely unnoticed.

It has also created the polymetallic nodules. Each nodule has at its core some small fragment of hard material such as a shark's tooth or the shell of a diatom.[17] The nodules are the result of countless eons of remains of deceased animals and plankton from the upper ocean, slowly raining down on the ocean floor, where over yet more eons mineral deposits formed upon them, eventually accreting nodules far larger than the original core. These mineral deposits may include elements such as

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New Species, BBC FUTURE (Feb. 5, 2021), https://www.bbc.com/future/article/20210204-the-quest-that-discovered-thousands-of-new-species [https://perma.cc/4NE8-8RNP].

[14] *See, e.g.*, *Protists 2: Radiolarians, Acantharians and Foraminiferans,* PLANKTON CHRONS., http://planktonchronicles.org/en/episode/protists-2-radiolarians-acantharians-and-foraminiferans/ [https://perma.cc/D9QH-64AE] (last visited Feb. 1, 2022).

[15] *See generally* Sophie Yeo, *How Whales Help Cool the Earth*, BBC FUTURE (Jan. 19, 2021), https://www.bbc.com/future/article/20210119-why-saving-whales-can-help-fight-climate-change [https://perma.cc/W8YD-TG6D].

[16] Sarah Witman, *World's Biggest Oxygen Producers Living in Swirling Ocean Waters*, EOS (Sept. 13, 2017), https://eos.org/research-spotlights/worlds-biggest-oxygen-producers-living-in-swirling-ocean-waters [https://perma.cc/NY5S-H9BW] ("[P]hytoplankton . . . are responsible for producing an estimated 80% of the world's oxygen.").

[17] *See* INT'L SEABED AUTH., POLYMETALLIC NODULES, *supra* note 11, at 1.

copper and nickel, concentrated in the bodies of plankton.[18] While the composition of the nodules varies widely, the typical nodule is about half metal, and contains a variety of metals including currently commercially valuable nickel, copper, and cobalt.[19]

In other words, the nodules are themselves the result of a biological process; they are part of the ecosystem (as are many other mineral resources), and thus affected by and conceivably affecting other ecological processes. Their accessibility is the result of biological processes as well. As the ISA notes:

> Even for residual radiolarian ooze, the average rate of sedimentation is in the order of several millimetres per thousand years. Accordingly, the nodules should be buried under several metres of sediment. It is assumed that deposit-feeding benthic organisms (polychaete or echiurian worms) clean the recently settled particles atop the nodules and eject them on the sides or even below the nodules, thus preventing their burial.[20]

Thus not only the formation of the nodules, but also their continued presence on the surface of the ocean floor, and thus their continued growth, is the result of a poorly understood ecological process. The nodules, whose formation begins at the end of the life processes of plankton and nekton, provide a habitat for benthos. It seems unlikely that the process simply stops there—that is, that these benthic organisms die and play no further part in whatever complex cycle is involved in the formation and maintenance of the nodules, in a process that will continue until the entire ocean floor is plated with manganese mixed with other metals.

Nor are deep seabed polymetallic nodules the only undersea resource targeted for commercial exploitation. Underwater hydrothermal vents result from seawater or subsurface water coming into contact with magma, releasing mineral-laden, superheated water and supporting ecosystems that may have been the origin of life on Earth. As this water cools on contact with surrounding seawater, the minerals drop out of solution, forming polymetallic sulfide deposits.[21] And on the sides and tops of some undersea mountains are cobalt-rich ferromanganese crusts up to ten inches thick, formed by a slow process of deposition that is not

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[18] *Id.* at 2.

[19] *Id.*

[20] *Id.*

[21] Michael Lodge, *The International Seabed Authority and Deep Seabed Mining,* UN CHRON., https://www.un.org/en/chronicle/article/international-seabed-authority-and-deep-seabed-mining [https://perma.cc/44YG-U9M8] (last visited Feb. 1, 2022).

yet well understood but is probably the result of a biological process.[22] Sedimentation apparently interferes with or prevents the formation of these crusts, meaning they are not found on the level ocean bottom surfaces more conducive to the growth of polymetallic nodules, but on steeper mountainsides where sediment does not accumulate.[23]

B. A Brief History of Deep Seabed Mining

Even before the discovery of the nodules, the possibility of mining mineral resources from the seabed had captivated the imagination of the public and the cupidity of corporations. Jules Verne wrote that "at the bottom of the sea there exist veins of zinc, iron, silver, and gold whose mining would quite certainly be feasible."[24] Feasible it may have been, but there is often a wide gap between technological feasibility and economic practicability. The nodules are far richer than terrestrially mined ores, and have the unusual quality of offering many valuable metals instead of merely one or, in a few cases, two. Where nodules lie in shallow water, exploitation is easier, and has already begun:

> On the west coast of Africa, the De Beers Group is using a fleet of specialized ships to drag machinery across the seabed in search of diamonds. In 2018, those ships extracted 1.4 million carats from the coastal waters of Namibia; in 2019, De Beers commissioned a new ship that will scrape the bottom twice as quickly as any other vessel. Another company, Nautilus Minerals, is working in the territorial waters of Papua New Guinea to

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[22] INT'L SEABED AUTH., COBALT-RICH CRUSTS 1, https://isa.org.jm/files/files/documents/eng9.pdf [https://perma.cc/8R8C-XB8U] (last visited Feb. 1, 2022).

[23] *See id.* at 2–3.

[24] JULES VERNE, *Pt. 1, Ch. 12: Everything through Electricity*, *in* 20,000 LEAGUES UNDER THE SEA (1872) (Frederick P. Walter trans., 1999), https://www.gutenberg.org/files/2488/2488-h/2488-h.htm [https://perma.cc/9JX2-5NY9]. Verne's *Pt. 2, Ch. 10, The Underwater Coalfields*, *in id.*, foreshadowed the exploitation of undersea fossil fuel resources, although today fossil fuel companies extract oil and natural gas, rather than coal, from beneath the ocean. *See also, e.g.*, Annie Banerji, *Race to the Bottom? India Plans Deep Dive for Seabed Minerals*, REUTERS (Dec. 4, 2018), https://www.reuters.com/article/us-oceans-rights-india/race-to-the-bottom-india-plans-deep-dive-for-seabed-minerals-idUSKBN1O403M [https://perma.cc/U2NM-YHMD] ("In the 1870 Jules Verne classic '20,000 Leagues Under the Sea', underwater explorer Captain Nemo predicted the mining of the ocean floor's mineral bounty—zinc, iron, silver and gold."); Lodge, *supra* note 21 ("In Jules Verne's *20,000 Leagues Under the Sea*, Captain Nemo announced that 'in the depths of the ocean, there are mines of zinc, iron, silver and gold that would be quite easy to exploit', predicting that the abundance of marine resources could satisfy human need. Although he was right about the abundance of the resources, he was most certainly wrong about how easy it would be to exploit them."). Michael Lodge is the Secretary-General of the International Seabed Authority.

> shatter a field of underwater hot springs lined with precious metals[.][25]

Neither of these is aimed at harvesting deep-seabed nodules. De Beers has known for some time that the diamonds were there; the alluvial diamond fields of Namibia inevitably contain only a portion of those diamonds that have, over millions of years, washed down to the coast and into the sea. The existence of undersea hydrothermal vents, with their high mineral concentrations and resultant mineral deposits, has been known for far less time than has the existence of the diamonds or the nodules; the first were discovered in 1977.[26] Since their discovery, they have radically revised our understanding of the nature and origin of life on Earth—an understanding too recent to have found its way into Part XI.

C. The Situation Today: Deep Seabed Areas Currently Targeted for Mining

The nodules are unusually rich in comparison to terrestrially mined ores. While nodules vary, it is not unusual for nodules to be about half metal by weight; using commercially valuable copper as an example, the nodules may contain 1.3% copper, placing them at the high end of the copper-content ore spectrum.[27] Better yet, harvesting the nodules does not require the removal of huge amounts of overburden or the excavation of large amounts of non-ore-bearing rock, as terrestrial mining does. The nodules contain so many different metals that there will be less waste, and there will be no tailing dumps or other visible and immediately dangerous side effects.[28] Instead, any environmental harm will happen in

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[25] Wil S. Hylton, *History's Largest Mining Operation Is About to Begin*, THE ATLANTIC (Jan–Feb. 2020), https://www.theatlantic.com/magazine/archive/2020/01/20000-feet-under-the-sea/603040/ [https://perma.cc/35K3-MQVB].

[26] *What is a Hydrothermal Vent?*, NOAA (Feb. 26, 2021), https://oceanservice.noaa.gov/facts/vents.html [https://perma.cc/YWZ3-JNKH].

[27] *See* INT'L SEABED AUTH., POLYMETALLIC NODULES, *supra* note 11, at 2. In comparison, "[c]urrently mined or under development IOCG [iron oxide, copper, gold] deposits have an average of 6 million tons of valuable metal at an average ore grade of approximately 0.9% Cu, sediment-hosted deposits contain 4.5 million tons at about 1.9%, and porphyry deposits contain about 3 million tons at about 0.5%." Nadine Rötzer & Mario Schmidt, *Decreasing Metal Ore Grades—Is the Fear of Resource Depletion Justified?*, 7 RESOURCES 88, at *4 (2018).

[28] Tailings dam disasters causing catastrophic toxic flooding have occurred with dismal frequency. Recent incidents include Ajka, Hungary; Stava, Italy; Baia Mare, Romania; Aznalcóllar, Spain; and Gällivare, Sweden. *See generally, e.g.*, Pavel Danihelka, Presentation at UNECE Tailings: TMF Management and Accidents in the UNECE Region, Including in a Transboundary Context (2018), https://unece.org/fileadmin/DAM/env/documents/2016/TEIA/Inception/Presentations/Session2/1_ENG___Tailing_Dams_Astana_2018_Pavel_Danihelka_ENG.pdf [https://perma.cc/U4U7-YLB6]. For a more in-depth look at one of these incidents, *see* Aaron Schwabach, *From Schweizerhalle to Baia Mare: The Continuing Failure of International Law to Protect Europe's Rivers*, 19 VA. ENV'T L.J. 431 (2000).

absolute darkness and crushing pressure under miles of water, making it much harder to detect.

As long as terrestrial mining companies are able to externalize some of the costs of pollution and land destruction, terrestrial mining has a cost advantage over the extraction of nodules from the ocean floor. As the price of metals rises, however, deep seabed mining becomes more attractive. Cobalt, for example, an essential ingredient in batteries used for everything from electric cars to mobile phones, is mined mostly in the Democratic Republic of the Congo (DRC), often with child labor and in unsafe working conditions.[29] The DRC's history of political instability and poor infrastructure create additional difficulties in bringing the cobalt to market, creating a fairly volatile market for a non-precious metal. Between 2016 and 2018, for example, the world price of cobalt spiked to over four times its initial price, eventually subsiding—but it spiked again beginning in December of 2020, with the price on the London Metal Exchange increasing from $32,190/ton on December 25, 2020 to $51,800/ton on February 26, 2021, an increase of 61% in just two months.[30]

This intersection with international human rights law adds a non-quantifiable human rights aspect to the problem. The minerals obtained via deep seabed mining would supplement or substitute for resources often located in poor countries with political and economic difficulties, notably but not only the DRC. These minerals are then used to produce expensive computer goods such as tablets and cell phones.[31] Deep seabed mining, if successful, will lower the cost of these minerals, depressing the economies of those countries still further and increasing the suffering of the people living and working there. The same amount of ingenuity and effort, if directed toward the goal of ensuring that the economic benefit of the extracted resources reaches the inhabitants of the countries from which they are extracted, could not only avoid an environmental harm of unknown magnitude but could also improve not only the economy of the countries in which the resources are extracted, but consequently of the world as a whole.

The world's economy is not, unfortunately, geared toward alleviating human suffering; it is paradoxically easier to extract small lumps of metal from the floor of the Pacific Ocean than to guarantee safe working

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[29] Fisher, *supra* note 13; Hylton, *supra* note 25.

[30] *Cobalt: 2010-2021 Data*, TRADING ECON., https://tradingeconomics.com/commodity/cobalt [https://perma.cc/N8XR-6AE4] (interactive chart) (last visited Feb. 27, 2021).

[31] *See Phones, Electric Cars and Human Rights Abuses—5 Things You Need to Know*, AMNESTY INT'L (May 1, 2018), https://www.amnesty.org/en/latest/news/2018/05/phones-electric-cars-and-human-rights-abuses-5-things-you-need-to-know/ [https://perma.cc/X64U-HPYH].

conditions and decent wages for workers in the DRC and elsewhere. The possibility of permanently high prices for cobalt and other metals has reawakened interest in the polymetallic nodules that have lain undisturbed for a century and a half since their discovery, as well as in the more recently discovered cobalt crusts and polymetallic sulfide deposits around hydrothermal vents. Since 2010, the ISA has granted exploration contracts to multiple private companies as well as to the national governments that were previously the sole holders of such contracts.[32]

Twenty-two contractors currently hold a total of thirty-one exploration contracts with the ISA for the Part XI Area.[33] Three of these are national governments (India, Poland, and South Korea), and several others are entities closely associated with governments, but the majority are private or semi-private companies.[34] Of the twenty-two contractors, two (the South Korean government and China Ocean Mineral Resources Research and Development Association) hold exploration contracts for all three types of resources (polymetallic nodules, cobalt crusts, and polymetallic sulfide deposits).[35] Including those two, a total of nineteen hold contracts for polymetallic nodules; three others (the Indian government, the Institut français de recherche pour l'exploitation de la mer, and the German Federal Institute for Geosciences and Natural Resources) also hold contracts for polymetallic sulfides.[36] Four entities hold only contracts for polymetallic sulfides (the government of Poland), cobalt crusts (Japan Oil, Gas and Metals National Corporation and Companhia de Pesquisa de Recursos Minerais S.A.; the latter is a joint stock company, linked to Brazil's Ministry of Mines and Energy[37]), or both (Russia's Ministry of Natural Resources and Environment).[38]

These exploration contracts do not cover all of the Area; each is for a specifically delineated smaller area on the ocean floor. Seventeen—just over half—are for exploration for polymetallic nodules in the Clarion-Clipperton Fracture Zone, which covers an area roughly half the size of the United States stretching for 4,500 miles along the Pacific Ocean floor slightly north of the equator, very roughly defined at its eastern end by Clipperton Island (France) and Clarion Island (Mexico) and at the

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[32] *Exploration Contracts*, INT'L SEABED AUTH., https://www.isa.org.jm/exploration-contracts [https://perma.cc/NT9H-HQ39] (last visited Feb. 1, 2022).

[33] *Id.*

[34] *Id.*

[35] *Id.*

[36] *Id.*

[37] Lei No. 8.970, de 28 de Dezembro de 1994, COL. LEIS REP. FED. BRASIL, 186 (12, t.2): 4850, Dezembro 1994 (Braz.).

[38] *See Exploration Contracts*, *supra* note 32.

western end near the Line Islands (Kiribati and U.S.).[39] Another two contracts are for polymetallic nodules in the Central Indian Ocean Basin and in the Western Pacific Ocean.[40] The seven polymetallic sulfide contracts are in the Central Indian Ridge, South West Indian Ridge (which runs from the Indian Ocean to the Atlantic, passing south of South Africa), and the Mid-Atlantic Ridge, while the five cobalt crust contracts are all in the Western Pacific Ocean.[41] The exploratory mining contracts are thus spread out fairly widely across the Earth's oceans, with the potential to affect even wider areas as ocean currents carry tailings plumes long distances before they eventually fall back to the ocean floor.

D. The Current Problem: Known Fragility and Unknown Importance of the Deep Seabed Ecosystem

At first glance deep-seabed mining seems like an opportunity to continue to fuel the global consumer economy's boundless appetite for metals and to rein in carbon emissions through making electric vehicles cheaper, without destroying indigenous cultures and their homelands[42] or, presumably, exploiting the labor of children.[43] The act of extracting minerals from ores buried under the surface of the Earth is inevitably destructive; extracting those same minerals from deep below the ocean floor will spare the human lands of the surface world from destruction.

Sadly, things are not so simple. The polymetallic nodules are not merely the accretion of minerals around the final remnants of once-living things; they are islands of life on the sea floor, both supporting and maintained by an incredibly diverse ecosystem. The hydrothermal vents around which polymetallic sulfide deposits are found support different, yet similarly diverse, ecosystems. And cobalt-rich ferromanganese crusts are possibly the result of a slow biological process still poorly understood; as with the other areas targeted for deep-seabed mining, the seamounts on which the crusts form also support highly varied and diverse ecosystems.[44]

What we have learned about deep-seabed ecosystems in the few decades since their discovery is that they are fragile and slow to recuperate from anthropogenic damage. The first experimental attempts

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[39] *Id.*; *Clipperton Fracture Zone*, ENCYC. BRITANNICA, https://www.britannica.com/place/Clipperton-Fracture-Zone [https://perma.cc/V4VQ-ZPCL] (last visited Feb. 1, 2022).

[40] The contracts for polymetallic nodules add to 19 rather than 18 because one entity, UK Seabed Resources Ltd., holds two contracts. *See Exploration Contracts*, *supra* note 32.

[41] *Id.*

[42] *See, e.g.*, Beanal v. Freeport-McMoran, Inc., 197 F.3d 161, 163 (5th Cir. 1999).

[43] *See, e.g.*, Hylton, *supra* note 25; Fisher, *supra* note 13 (noting that cobalt mining in the DRC uses child labor).

[44] *See* INT'L SEABED AUTH., COBALT-RICH CRUSTS, *supra* note 22.

at dredging the deep seabed for polymetallic nodules in the 1970s left tracks on the ocean floor that provide an opportunity to study the long-term effects of human activity on the abyssal and bathyal benthic zones. The results of these studies are not encouraging: even after three or four years, the tracks gouged by human dredging remain lifeless desert areas.[45] These early dredges were often simple metal rakes, less disruptive than the complex hydraulic mining and continuous line bucket systems, with their sediment plumes, planned for commercial mining use.[46]

From what little is now known, the animal phylum whose members make up the most numerous inhabitants of the deep seabed are nematodes; thus, in determining the impact of human activity on biodiversity in this environment, many researchers have focused on nematode species.[47] The results have not been encouraging:

> Natural physical and smothering disturbance, such as that resulting from turbidites and benthic storms, has been associated with a small but statistically significant reduction in North Atlantic deep-sea nematode diversity. However, it was noteworthy that the effect of disturbance [from deep seabed mining] could be prolonged (e.g., lasting for decades to centuries), possibly through changes in sediment composition.[48]

In a study of impacts on seven sites over periods of up to 26 years, "very few faunal groups return to baseline or control conditions after two decades. The effects of polymetallic nodule mining are likely to be long term."[49] A similar follow-up study of an experimental mining site in the Clarion-Clipperton Fracture Zone found that 26 years after the initial dredging, nematode biomass, density, and biodiversity remained significantly lower than outside the dredged area.[50]

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[45] *See* Fisher, *supra* note 13.

[46] *Id*. For a description of these mining systems, *see* INT'L SEABED AUTH., POLYMETALLIC NODULES, *supra* note 11, at 4–7.

[47] *See, e.g.*, Lara Macheriotou, Annelien Rigaux, Sofie Derycke & Ann Vanreusel, *Phylogenetic Clustering and Rarity Imply Risk of Local Species Extinction in Prospective Deep-Sea Mining Areas of the Clarion–Clipperton Fracture Zone*, 287 PROC. ROYAL SOC'Y B 1 (2020), https://doi.org/10.1098/rspb.2019.2666 [https://perma.cc/3L9D-7XAH]; P. John D. Lambshead et al., *Biodiversity of Nematode Assemblages from the Region of the Clarion-Clipperton Fracture Zone, an Area of Commercial Mining Interest*, 3 BMC ECOLOGY 1 (2003).

[48] *See* Lambshead et al., *supra* note 47, at 3.

[49] Daniel O. B. Jones et al., *Biological Responses to Disturbance from Simulated Deep-Sea Polymetallic Nodule Mining*, PLOS One, Feb. 8, 2017 (abstract), https://doi.org/10.1371/journal.pone.0171750 [https://perma.cc/9UKY-F5AF].

[50] Dmitry M. Miljutin, Maria A. Miljutina, Pedro Martinez Arbizu & Joëlle Galeron, *Deep-Sea Nematode Assemblage Has Not Recovered 26 Years After Experimental Mining of Polymetallic Nodules (Clarion-Clipperton Fracture Zone, Tropical Eastern Pacific)*, 58 DEEP SEA RSCH. PART I: OCEANOGRAPHIC RSCH. PAPERS 885 (2011), abstract available at

Some species, especially those unable to migrate away from the disturbance, were even more heavily affected. In a study of the DISturbance and reCOLonization experiment (DISCOL) site, where experimental dredging had been conducted in the Peru Basin in 1989, "Some faunal groups showed no evidence of recovery. . . . [S]essile megafauna did not show any evidence of recovery. The total macrofaunal density at BIE-II decreased greatly between 1 month and 1 year after disturbance."[51] Another study of the DISCOL site found that "[a]lthough megafaunal taxon richness may now show signs of recovery within [plough tracks] for the first time since the original disturbance, the impacts of the DISCOL ploughing are still very evident in the composition of the fauna."[52] While some species had recovered, others, especially suspension feeders, were greatly diminished.[53] The ecology of the dredged area had been altered, perhaps permanently. Life at the bottom the ocean, in the cold and dark and enormous pressure, moves at a slower pace than life on the surface; it repairs damage more slowly as well.

III. THE DEEP SEABED MINING REGIME: UNCLOS PART XI, CUSTOMARY INTERNATIONAL ENVIRONMENTAL LAW, AND THE PRECAUTIONARY PRINCIPLE

A. Sources of International Environmental Law: Conventional and Customary

International law is, at the risk of oversimplification, conventional (as positively consented to by states through treaties and other international agreements) and customary (a set of normative expectations drawn from the practice of states undertaken out of a sense of legal obligation (*opinio juris*)).[54] In determining the law applicable to deep seabed mining, both

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https://www.sciencedirect.com/science/article/pii/S0967063711001063 [https://perma.cc/KF96-65ZT].

[51] *See* Jones et al., *supra* note 49, at 16.

[52] Erik Simon-Lledó et al., *Biological Effects 26 Years After Simulated Deep-Sea Mining*, 9 SCI. REPS. 8040, 8046 (2019), https://doi.org/10.1038/s41598-019-44492-w [https://perma.cc/2KTT-FX3T].

[53] *Id.* at 8044.

[54] *See* Statute of the International Court of Justice, 1976 Y.B.U.N. 1052, 59 Stat. 1031, T.S. No. 993. Article 38(1) of the Statute, setting out the Court's rules of decision in cases other than those decided *ex aequo et bono*, is a frequent starting point for discussion of the sources of public international law. Art. 38(1) includes in its list:

> a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states;
>
> b. international custom, as evidence of a general practice accepted as law;
>
> c. the general principles of law recognized by civilized nations;

conventional law and customary law need to be taken into account. The former is embodied in Part XI; however, not all countries with the capacity to enter into deep seabed mining activities—and notably not the United States—are parties to UNCLOS. Thus, the first customary law question is whether UNCLOS in general, and Part XI in particular, have attained the status of customary international law; for the most part it seems safe to say that they have. The second is whether two other principles of international law have attained the same status. The first of these is the duty to do no harm to areas beyond national jurisdiction, as embodied in Principle 21 of the Stockholm Declaration on the Human Environment.[55] As with UNCLOS, it seems safe to say that Principle 21 has entered into customary international law through its observance in the practice of states, undertaken out of an apparent sense of legal obligation. The second of these is the precautionary principle, as embodied in, inter alia, Principle 15 of the Rio Declaration on Environment and Development.[56] In this case, it is less clear that the principle has become a part of customary international law.

B. The UNCLOS Part XI Regime and the Role of the International Seabed Authority

A great deal of research and scholarship has already addressed the details of UNCLOS Part XI and Annex III, and it is not the purpose of this article to re-examine them.[57] For our purposes it will suffice to observe that the Area (UNCLOS capitalizes the word in this context) we are concerned with is that which UNCLOS defines as "the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction[.]"[58] Note that this excludes areas of the seabed that are within the jurisdiction of a state, which, because of relatively shallower water and easier access to shore, may often be easier to exploit commercially. The De Beers mining operation off the coast of Namibia and the Nautilus mining operation off the coast of Papua New Guinea, mentioned above,

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> d. subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law.

See also RESTATEMENT (THIRD) OF THE FOREIGN RELATIONS LAW OF THE UNITED STATES: SOURCES OF INTERNATIONAL LAW § 102 (AM. L. INST. 1987).

55 U.N. Conference on the Human Environment, *Report of the United Nations Stockholm Conference on the Human Environment*, U.N. Doc. A/CONF.48/14/Rev. 1, princ. 21 (1973) [hereinafter Stockholm Declaration].

56 U.N. Conference on Environment and Development, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26 (vol. I), annex I, princ. 15 (June 14, 1992) [hereinafter Rio Declaration].

57 *See supra* notes 5–8, and accompanying text.

58 *See* UNCLOS, *supra* note 2, art 1(1).

both fall into this category.[59] In addition, many of the seamounts on which cobalt-rich crusts form lie within the territorial waters of states.[60]

The bulk of the Clarion-Clipperton Fracture Zone, however, and other areas slated for exploration for polymetallic nodules, lies within the Area. Mining within the area is subject to the authority of the International Seabed Authority.[61] Notionally it is carried out by the ISA's Enterprise,[62] although as a practical matter this can only be done through contracts with national governments, private companies, and other contractors.[63]

The UNCLOS preamble acknowledges "that the area of the seabed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction, as well as its resources, are the common heritage of mankind[.]"[64] This is reiterated in Article 136 near the outset of Part XI: "The Area and its resources are the common heritage of mankind."[65] Thus all property rights in the resources of the Area belong to humanity as a whole, and no state or person can claim, acquire or exercise rights in connection to resources in the Area except in accordance with Part XI. In other words, assignment and disposition of those rights is exercised solely by the ISA from its headquarters in Jamaica, and only the ISA may authorize alienation of those rights or of minerals recovered under those rights, at least in the first instance.[66]

An equitable distribution of resources, rather than protection of the natural environment, seems to have been at the forefront of the minds of the drafters of Part XI. Part XI includes only a single environmental article: Article 145, titled "Protection of the Marine Environment,"[67] although Article 147.1 does contain the additional proviso that "[a]ctivities in the Area shall be carried out with reasonable regard for other activities in the marine environment."[68] The laws of the

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[59] *See supra* note 25, and accompanying text.

[60] INT'L SEABED AUTH., COBALT-RICH CRUSTS, *supra* note 22 ("Based on grade, tonnage and oceanographic conditions, the central equatorial Pacific region offers the best potential for crust mining, particularly the exclusive economic zones around Johnston Island and Hawaii (United States), the Marshall Islands, the Federated States of Micronesia and international waters of the mid-Pacific. Moreover, crusts from shallow waters contain the greatest concentration of minerals, an important factor for exploitation.").

[61] *See* UNCLOS, *supra* note 2, arts. 156, 160, 170.

[62] UNCLOS, *supra* note 2, art. 170; Part XI Agreement, *supra* note 4, annex § 2.

[63] *See* Part XI Agreement, *supra* note 4, Annex § 2.2.

[64] UNCLOS, *supra* note 2, pmbl. Note that the wording is nearly identical to that of Article 1.1(1).

[65] *See* UNCLOS, *supra* note 2, art. 136.

[66] *See generally* UNCLOS, *supra* note 2, arts. 137–142, especially 140; *see also The International Legal Framework for Deep Sea Mining: A Primer*, MIDAS, https://www.eu-midas.net/legal_framework [https://perma.cc/LZ75-67F4] (last visited Feb. 1, 2022).

[67] UNCLOS, *supra* note 2, art. 145.

[68] UNCLOS, *supra* note 2, art. 147.1.

participating states might provide some protection if they apply extraterritorially,[69] and Part XII of UNCLOS ("Protection and Preservation of the Marine Environment") applies as well.[70] Note, though, that within Part XII, Article 209.2 requires that "States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by vessels, installations, structures and other devices flying their flag or of their registry or operating under their authority[.]"[71] At the same time "[i]nternational rules, regulations and procedures shall be established . . . to prevent, reduce and control pollution of the marine environment from activities in the Area."[72] The national laws and regulations adopted in accordance with Article 209.2 "shall be no less effective than the international rules, regulations and procedures" adopted in accordance with 209.1.[73] States have similar duties with regard to activities within areas under their jurisdiction,[74] as well as a more general obligation "to protect and preserve the marine environment"[75] and to take measures "necessary to protect and preserve rare or fragile ecosystems."[76] This includes the abyssal benthic ecosystem centered on the polymetallic nodules, as well as the hydrothermal vent ecosystems, of which the drafters of UNCLOS were not yet aware.

Article 145 provides that:

> Necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities. To this end the Authority shall adopt appropriate rules, regulations and procedures for *inter alia*:
>
> > (a) the prevention, reduction and control of pollution and other hazards to the marine environment, including the

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69 On the hit-and-miss nature of extraterritorial application of U.S. environmental law, see, for example, Environmental Defense Fund, Inc. v. Massey, 986 F.2d 528 (D.C. Cir. 1993); Beanal v. Freeport-McMoran, Inc., 969 F. Supp. 362 (E.D. La. 1997), *aff'd*, 197 F.3d 161 (5th Cir. 1999); Amlon Metals, Inc. v. FMC, 775 F. Supp. 668 (S.D.N.Y. 1991); Hirt v. Richardson, 127 F. Supp. 2d 849 (W.D. Mich. 2001); NEPA Coalition of Japan v. Aspin, 837 F. Supp. 466 (D.D.C. 1993). Of these, an argument could be made that deep-seabed mining most resembles the situation in Massey, which involved activities in Antarctica—also an area beyond national jurisdiction. *See Massey*, 986 F.2d at 533–34, 536.

70 UNCLOS, *supra* note 2, arts. 192–237.

71 *Id.* art. 209.2.

72 *Id.* art. 209.1.

73 *Id.* art. 209.2.

74 *Id.* art. 208.

75 *Id.* art. 192.

76 *Id.* art. 194.5.

> coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities;
>
> (b) the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment.[77]

The existence of highly complex "rock garden" ecosystems centered around the polymetallic nodules was unknown when these words were drafted; thus the article refers to the "marine environment" more generally. The marine environment above the ocean floor is also at risk of harm from mining operations, whether through tailings (sediment plumes, in the case of ocean mining) drifting for miles or hundreds of miles, or through noise, chemical leakage, introduced species, or any of the other possible by-products of human industrial activity. Now that we know of these rock garden ecosystems, however, it might seem impossible to carry out Article 145: the rock gardens won't survive if the rocks are removed. However, the situation may be more analogous to logging: while clear-cutting old-growth forests may be environmentally disastrous, selective logging, ensuring that the forest as a whole remains intact, is possible with far less harm. In the same way Article 145 might be observed by selective mining, rather than clearing vast swathes of ocean floor of nodules, although the increased costs of doing so might be sufficiently high to render the entire enterprise unprofitable.

C. Customary International Law

The formation of a norm of customary international law, as noted above, requires both state practice and *opinio juris*. While at times the parameters of the rule sought to be established as one of customary international law may be difficult to establish with specificity, in this case all of our potential rules come from written documents: UNCLOS, the Stockholm Declaration, and the Rio Declaration.

1. UNCLOS as customary international law in the practice of the United States

UNCLOS has 168 parties. Of these, 164 are United Nations member states. Non-members Cook Islands, Niue, and Palestine are also parties,

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[77] *Id.* art. 145.

as is the European Union.[78] Of the states that are non-parties, some are landlocked (including the five Central Asian republics formerly part of the Soviet Union and now collectively colloquially known as "the Stans"); the largest non-party, and the non-party with the longest coastline, is the United States.[79] There are 151 parties to the 1994 Part XI Agreement, including 147 United Nations member states plus, once again, the Cook Islands, Niue, and Palestine.[80] Once again, the United States is not a party.

Whether UNCLOS is a statement of customary international law with regard to the United States and other non-parties requires a sort of depeçage. On the one hand, the U.S. has frequently treated parts of UNCLOS as definitive statements of international law and has followed them, apparently out of a sense of legal obligation.[81] On the other, the main reason the U.S. has not ratified UNCLOS is Part XI.[82] (The U.S. also objected to provisions on marine mammals, fisheries, and the continental shelf.[83]) U.S. objection to Part XI led to its amendment via the Part XI Agreement; however, while this satisfied then-President Clinton, it failed to satisfy the Senate, and the U.S. remains a party to neither agreement.[84]

Within Part XI, however, the concerns of the United States were not environmental but were economic and administrative; and, as we have seen above, much of the environmental protection against damage from deep-seabed mining comes not from Part XI but from Part XII, from which the U.S. did not dissent. However, the mere absence of dissent may not be enough, by itself, to establish that the environmental provisions of

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[78] *Chronological Lists of Ratifications of Accessions and Successions to the Convention and the Related Agreements*, U.N. DIV. FOR OCEAN AFFS. & L. SEA (May 28, 2021), https://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm [https://perma.cc/N7KT-6B6V].

[79] *See id.*; *Countries with the Longest Coastline*, WORLD ATLAS https://www.worldatlas.com/articles/countries-with-the-most-coastline.html [https://perma.cc/M2EA-6XJR] (last visited Feb. 1, 2022).

[80] *Id.*

[81] See President Reagan's Statement on United States Ocean Policy, Mar. 10, 1983, https://www.reaganlibrary.gov/archives/speech/statement-united-states-oceans-policy [https://perma.cc/HE84-6WLQ] (accepting UNCLOS as international law on topics other than deep seabed mining), and his National Security Decision: Directive 83, United States Oceans Policy, Law of the Sea and Exclusive Economic Zone (C), issued on the same day and available at https://www.reaganlibrary.gov/public/archives/reference/scanned-nsdds/nsdd83.pdf [https://perma.cc/8GGR-325B] [hereinafter Directive 83].

[82] *See* Roncevert Ganan Almond, *U.S. Ratification of the Law of the Sea Convention: Measuring the Raison d'État in the Trump Era*, THE DIPLOMAT (May 24, 2017), https://thediplomat.com/2017/05/u-s-ratification-of-the-law-of-the-sea-convention/ [https://perma.cc/2T67-CWFZ].

[83] *See* Directive 83, *supra* note 81.

[84] Almond, *supra* note 82.

UNCLOS Article 145 have become accepted in U.S. practice as a legal obligation (although apparently Articles 192, 194.5, 208, and 209 have).[85]

2. The Stockholm Declaration

If any principle of international environmental law can be unequivocally said to have attained the status of customary international law, it is Principle 21 of the Declaration of the United Nations Conference on the Human Environment adopted at the first United Nations Conference on the Human Environment, held in Stockholm, Sweden in 1972:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[86]

Principle 21 expresses two strands of customary international law that had been evolving throughout the twentieth century, beginning with the *Trail Smelter*[87] and *Corfu Channel*[88] principles of territorial integrity—the idea that a state has the duty not to allow its territory to be used in a way that causes harm to the territory of other states—and limited or modified by the sovereignty of states over natural resources within their territory and the consequent right to exploit those resources.[89] To these two strands the Stockholm Declaration added a new principle: that the duty to do no environmental harm to territory beyond a state's borders extended not only to other states but also to areas beyond national jurisdiction, including the high seas, the deep seabed, and Antarctica. While this seems sensible enough environmentally, as important parts of ecosystems lie beyond national jurisdiction, it was radical from an

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[85] On the question of whether the United States can or should proceed unilaterally in harvesting deep seabed resources under the Deep Seabed Hard Mineral Resources Act of 1980, without the authority of the ISA, see the discussion at *U.S. Can Mine the Deep Seabed Without Ratifying UNCLOS*, UNCLOS DEBATE, https://www.unclosdebate.org/argument/1213/us-can-mine-deep-seabed-without-ratifying-unclos [https://perma.cc/YB5A-CJBY] (last visited Feb. 1, 2022).

[86] Stockholm Declaration, *supra* note 55, princ. 21.

[87] Trail Smelter Case (U.S. v. Can.), 3 R.I.A.A. 1905, 1965 (1941), *reprinted in* 35 AM. J. INT'L L. 684 (1941).

[88] Corfu Channel Case (U.K. v. Alb.), Judgment, 1949 I.C.J. 4, 22 (Apr. 9).

[89] *See, e.g.*, Donauversinkung Case (Wurttemberg & Prussia v. Baden), 4 Ann. Dig. 128, 131 (RGZ 1927); J. G. LAMMERS, POLLUTION OF INTERNATIONAL WATERCOURSES: A SEARCH FOR SUBSTANTIVE RULES & PRINCIPLES OF LAW 433–36 (1984) (discussing the *Donauversingkung* case in detail); *see also* Affaire du Lac Lanoux (Spain v. Fr.), 12 REPS. INT'L ARBITRAL AWARDS 281 (1957), *digested in* 53 AM. J. INT'L L. 30 (1959).

international law perspective, as it imposed responsibility for actions that did not cause direct harm (or perhaps any harm) to another state. In the five ensuing decades, however, this too has become, through state practice undertaken out of a sense of legal obligation, a generally accepted rule of customary international law. The Rio Declaration attempted a retrenchment by adding two words (shown in bold below):

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental **and developmental** policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[90]

These two words were added to reflect the concerns of developing nations. In the twenty years between the 1972 Stockholm Conference and the 1992 United Nations Conference on Environment and Development at Rio de Janeiro, Brazil, both environmental understanding and the nature of international discourse changed considerably. Advances in human understanding of environmental systems and processes was balanced against an increased ability on the part of developing countries to express their concerns. Countries that had been barely a decade old in 1972 were far more established and ready to steer the discourse, and were aided by the recent end of the Cold War that had overshadowed all previous international discourse since World War II.

The Rio Declaration reflects these changes. Its Principles are more unequivocally human-centric than those of the Stockholm Declaration. In addition to the foregrounding of the importance of development in Principle 2, Principle 1 begins with the words, "Human beings are at the centre of concerns for sustainable development."[91] The importance of development is again emphasized in several of the Principles, including Principles 4, 5, 6, 12, and 25. To the extent that Principle 2 of the Rio Declaration is a statement of customary international law, it seems to weaken environmental protection of the marine environment from harm caused by deep seabed mining undertaken by states not parties to UNCLOS.[92]

If Part XI has not attained the status of customary international law, and if no other rule of customary international law prohibits exploitation of deep-seabed mineral resources by the United States, Peru, and other

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[90] Rio Declaration, *supra* note 56, princ. 2 (emphasis added).

[91] *Id.* princ. 1.

[92] *See generally* Bezpalko, *supra* note 8; Bolong, *supra* note 7.

UNCLOS non-party states, the Part XI protective regime, as inadequate as it is, falls apart completely; mining ventures will simply operate out of non-party states. The participation of these states in the development of international environmental regulation of the impacts of deep seabed mining, whether as parties or non-parties, is essential if those regulations are to succeed.[93] As all of these states apparently act, or try to act, in accordance with a perceived customary international legal obligation not to cause harm to the territory of other states or areas beyond national jurisdiction, agreement on at least this basic principle should be possible.

However, a 1970s understanding of what it means to do no harm to areas beyond national jurisdiction may be insufficient to prevent global catastrophe; this is where the precautionary principle comes in.

3. The precautionary principle

Simply stated, the precautionary principle holds that some forms of environmental damage are potentially so severe that measures that might prevent them may have to be taken even before the efficacy of and necessity for those measures can be determined.[94] Although a precise definition of the precautionary principle is difficult to pin down, a useful starting point can be found in the second sentence of Principle 15 of the Rio Declaration on Environment and Development: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[95] In other words, even though traditional cost/benefit risk analysis might permit the activity to go forward, where there is an unknown risk of extremely high-magnitude harm, the activity should be delayed until the risk can be assessed more accurately.

Situations like this are the reason the precautionary principle exists. We now know that polymetallic nodules are not just lifeless mineral lumps sitting around on the ocean floor waiting for someone to come pick them up. Rather, they support immensely complex, diverse, and fragile ecosystems. We also know that the damage done by early dredging experiments has not healed after several decades; the dredged areas

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[93] *See U.S. Ratification of UNCLOS Key to Development of Deep Seabed Mining Industry*, UNCLOS DEBATE, https://www.unclosdebate.org/argument/396/us-ratification-unclos-key-development-deep-seabed-mining-industry [https://perma.cc/V933-RY64] (last visited Feb. 1, 2022).

[94] *See generally, e.g.*, U.N. Conference on Environment and Development, *Agenda 21*, U.N. Doc. A/CONF.151/26 (June 13, 1992); World Comm. on Env't & Dev., Rep. to the Comm. of the Experts Group on Environmental Law, U.N. Doc. WCED/86/23/Add.1, at 6–12 (Aug. 1986) (describing "Legal Principles for Environmental Protection and Sustainable Development").

[95] Rio Declaration, *supra* note 56, princ. 15.

remain lifeless deserts where (judging from similar areas that were not dredged) must once have been thriving ecosystems.

What we do not know is how these deep-seabed ecosystems interact with our own. The decades since the drafting of Part XI have seen advances in our understanding of the biosphere in many areas, and a corresponding understanding of humanity's fragile place within it. At the time of the drafting or Part XI we did not know how important airborne bacteria are to rainfall and snowfall; through sheer good luck, anthropogenic release of antibiotics into the water cycle from activities such as cattle farming did not result in a global drought.[96] We did not know how much of the Earth's biomass consisted of slow living deep subterranean archaea and bacteria, and we still do not understand the importance of that huge chthonic biomass in the carbon cycle.[97]

A change in environmental understanding alone may not be enough to modify a party's duties under Part XI or any state's duties under customary international law. The Vienna Convention on the Law of Treaties provides that changed circumstances can be grounds for terminating or withdrawing from a treaty only in very narrow circumstances, stating in relevant part:

> 1. A fundamental change of circumstances which has occurred with regard to those existing at the time of the conclusion of a treaty, and which was not foreseen by the parties, may not be invoked as a ground for terminating or withdrawing from the treaty unless:
>
> > (a) the existence of those circumstances constituted an essential basis of the consent of the parties to be bound by the treaty; and
> >
> > (b) the effect of the change is radically to transform the extent of obligations still to be performed under the treaty.[98]

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[96] Quirin Schiermeier, *'Rain-Making' Bacteria Found Around the World,* NATURE (Feb. 28, 2008), https://www.nature.com/news/2008/080228/full/news.2008.632.html [https://perma.cc/38UD-VVC5].

[97] Terry Collins & Katie Pratt, *Life in Deep Earth Totals 15 to 23 Billion Tonnes of Carbon—Hundreds of Times More than Humans,* RESONANCE SCI. FOUND. (Dec. 13, 2018), https://www.resonancescience.org/blog/Life-in-Deep-Earth-Totals-15-to-23-Billion-Tonnes-of-Carbon-Hundreds-of-Times-More-than-Humans [https://perma.cc/5D9N-6BE6].

[98] Vienna Convention on the Law of Treaties art. 62(1), May 23, 1969 (in force Jan. 27, 1980), 1155 U.N.T.S. 331. The United States is a signatory to the Convention but not a party, although it consistently acts in accordance with the Convention out of an apparent sense of legal obligation. *See, e.g.*, RESTATEMENT (FOURTH) OF THE FOREIGN RELATIONS LAW OF THE UNITED STATES: CAPACITY AND AUTHORITY TO CONCLUDE INTERNATIONAL AGREEMENTS § 302 cmt. b, rptr.'s notes 1–8 (AM. L. INST. 2018).

In the Gabčíkovo-Nagymaros dispute, a case also involving a changed understanding of the environmental consequences of a development project (as well as a changed political situation), the court found that:

> The changed circumstances advanced by Hungary are, in the Court's view, not of such a nature, either individually or collectively, that their effect would radically transform the extent of the obligations still to be performed in order to accomplish the Project. A fundamental change of circumstances must have been unforeseen; the existence of the circumstances at the time of the Treaty's conclusion must have constituted an essential basis of the consent of the parties to be bound by the Treaty. The negative and conditional wording of Article 62 of the Vienna Convention on the Law of Treaties is a clear indication moreover that the stability of treaty relations requires that the plea of fundamental change of circumstances be applied only in exceptional cases.[99]

The acknowledged fact that the environmental destruction from the Gabčíkovo-Nagymaros project would be far worse than had originally been understood did not justify deviation or derogation from the treaty. Nor, despite the arguments of the Court's Vice-President, did the (arguable) emergence of sustainable development as a norm of customary international law since the conclusion of the treaty.[100]

However, the treaty and the ISA's regulations provide more environmental protection than customary international law alone. There is little reason to seek to avoid the treaty unless the treaty prevents the application of the precautionary principle.

Destruction of the deep seabed ecosystem, in all its biodiversity, would be regrettable for its own sake. It also has the potential for unanticipated, and currently unknowable, environmental effects in the human areas of the biosphere. One reporter's interview with controversial geneticist Craig Venter neatly summed up the problem:

> Venter has been accused of trying to privatize the human genome, and many of his critics believe his effort to create new organisms is akin to playing God. He clearly doesn't have an aversion to profit-driven science, and he's not afraid to mess with nature—yet when I asked him about the prospect of mining in deep water, he flared with alarm. "We should be very careful about mining in the ocean," he said. "These companies should be doing rigorous microbial surveys before they do anything else. We only know a fraction of the microbes down there, and it's a terrible idea to

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[99] Case Concerning the Gabčíkovo-Nagymaros Project (Slovk. v. Hung.), Judgment, 1997 I.C.J. 7, ¶ 104 (Sept. 25).

[100] *Id.* at 88 (separate opinion by Vice-President Weeramantry).

> screw with them before we know what they are and what they do."[101]

Granting that the precautionary principle would weigh against large-scale commercial exploitation of deep seabed resources until the deep seabed ecology is more fully understood, is the precautionary principle a rule of customary international law? It has found acceptance in a wide variety of aspirational documents, including Principle 15 of the Rio Declaration and the even more far-reaching Wingspread Statement on the Precautionary Principle. The Wingspread Statement does not require "serious or irreversible damage," as Principle 15 does: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."[102] This would prove almost impossible to put into practice, the more so as "the proponent of an activity, rather than the public, should bear the burden of proof."[103]

Less extreme statements of the precautionary principle, more akin to that in Rio Principle 15, have found their way into multiple treaties, including the Cartagena Protocol on Biosafety to the Convention on Biological Diversity,[104] the Espoo Convention on Environmental Impact Assessment in a Transboundary Context,[105] and the Stockholm Convention on Implementing International Action on Certain Persistent Organic Pollutants.[106] The United States is not a party to any of these treaties, although it is a signatory to the Espoo and Stockholm conventions.

The precautionary principle's finest hour was the ozone depletion crisis. The ozone depletion treaties—the Vienna Ozone Convention[107] and the Montreal Protocol[108]—required precautionary measures at a time when the scientific necessity for those measures had not yet been established; these measures were adopted and followed, and successfully reversed the depletion of the Earth's ozone layer. (The United States is a

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101 Hylton, *supra* note 25.

102 Wingspread Statement on the Precautionary Principle, WHO (Jan. 20, 1998), http://www.who.int/ifcs/documents/forums/forum5/wingspread.doc [https://perma.cc/C438-LQ77].

103 *Id.*

104 Cartagena Protocol on Biosafety to the Convention on Biological Diversity art. 1, Jan. 29, 2000, 39 I.L.M. 1027.

105 Espoo Convention on Environmental Impact Assessment in a Transboundary Context art. 2, Feb. 25, 1991, 30 I.L.M. 800.

106 Stockholm Convention on Implementing International Action on Certain Persistent Organic Pollutants art. 1, May 22, 2001, 40 I.L.M. 532.

107 Vienna Convention for the Protection of the Ozone Layer, pmbl., Mar. 22, 1985, UNEP Document IG.53/5, 26 I.L.M. 1529.

108 Montreal Protocol on Substances that Deplete the Ozone Layer, pmbl., Sept. 16, 1987, 26 I.L.M. 1550.

party to both agreements, as well as to the London, Copenhagen, Montreal, and Beijing Amendments.[109]) It was only after the fact that scientific evidence revealed both that the danger was real and that the protective measures were necessary and apparently effective;[110] a civilization-ending catastrophe had been averted.

From an economic perspective, the precautionary principle may lead to inefficient allocation of resources.[111] If the precautions turn out to have been unnecessary, a great deal of effort, money, and time may have been expended unnecessarily. But when the magnitude of the potential harm rises to the level of a global catastrophe (as was the case with ozone depletion), precautionary measures, including avoidance of the potentially harmful activity, may be necessary.[112]

The precautionary principle seems to find its greatest acceptance in the practice of states when, as in the case of the ozone regime, there is buy-in by major economic actors, including the United States; when the magnitude of the harm is potentially catastrophic; and when, as in the case of ozone depletion, there is a small number of actors whose actions need to be controlled. The last of these criteria is met here; the costly, complex, and labor-intensive nature of deep seabed mining guarantees that there will never be very many actors involved. (At the other extreme, consider climate change; every person on Earth contributes to carbon emissions in some way, even if only by breathing and eating.) The potential magnitude of the harm is presently unknown, but not unknowable; scientific research into the deep-seabed ecology is ongoing. If the current U.S. administration and the parties to Part XI have the environmental commitment to apply the precautionary principle to deep seabed mining, it will be in the best interests of mining companies and entities to fund further research in order to speed up the process of ascertaining the potential harm, if any, and its magnitude, so that steps

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109 *Country Data: All Ratifications*, UNEP OZONE SECRETARIAT, https://ozone.unep.org/all-ratifications [https://perma.cc/JM2Z-7PG8] (Jan. 20, 2022).

110 *See Large Ozone Hole Recorded Over Antarctic for 2020, But Montreal Protocol Efforts Have Minimized the Damage,* UNEP OZONE SECRETARIAT (Oct. 30, 2020), https://ozone.unep.org/large-ozone-hole-recorded-over-antarctic-2020-montreal-protocol-efforts-have-minimized-damage [https://perma.cc/34N5-HGPE].

111 This is eloquently expressed by Cole, the distraught Australian bulldozer driver in Werner Herzog's Wo die grünen Ameisen träumen (Where the Green Ants Dream (1984)), on being told that the mining company's project will destroy the place where the titular dreaming takes place: "Ants? *Green* ants? Dreaming here? Why the f*** can't they dream somewhere else?" (What the green ants are dreaming is, of course, the world and everything in it; disturbing their dreams will be the end of humanity.) The film is very loosely based on the Gove land rights case, *Milirrpum v. Nabalco Pty. Ltd.* (1971) 17 FLR 141 (Austl.).

112 For an environmental health perspective, see, for example, David Kriebel et al., *The Precautionary Principle in Environmental Science,* 109 ENV'T HEALTH PERSPS. 871 (2001).

can be taken to avoid and mitigate that harm and mining can begin. And at least some mining companies may be on board with the idea. The Metals Company, for example, touts the idea that deep seabed mining is environmentally preferable to terrestrial mining, with a much smaller carbon footprint.[113] The company's CEO, Gerard Barron, "advocates for [ISA] regulations to mandate low-impact discharge," saying "We need to be doing things that have a low impact environmentally."[114]

IV. CONCLUSION

The human-habitable environment—that complex web of environmental processes that maintains an environment allowing humans to exist on the biosphere—is on the brink of collapse from numerous causes, including climate change, biodiversity loss, and toxic pollution. Tampering with recently discovered, poorly understood environmental processes in pursuit of further consumer goods seems unwise at present. Nonetheless, it will happen. It would be naïve to think that the precautionary principle will be applied absent international agreement involving not only the states parties to Part XI but also the United States and other non-parties.

As we have seen, conventional law, especially in the form of UNCLOS Article 145 and of UNCLOS Part XII, provides some protection, although it does not incorporate the precautionary principle. While the United States is a significant non-party and thus not bound by Article 145, it takes the position that it is bound by the more generally stated protections in Part XII. This leads to the question of whether UNCLOS has attained the status of customary international law for those states that are not parties. President Reagan's statements and actions,[115] and those of his successors, affirm that it has—with the exception of Part XI.

Even in the absence of Part XII, a similar though less clearly defined duty to cause no environmental harm to areas beyond national jurisdiction can be found in customary international law, most clearly stated in Principle 21 of the Stockholm Declaration on the Human Environment.[116] While Principle 21 might provide protection roughly co-extensive with Part XII, more may be needed to prevent environmental catastrophe.

The precautionary principle, as embodied in Principle 15 of the Rio Declaration on Environment and Development, may provide the extra needed protection.[117] It is not yet clear that the principle is a rule of

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113 INT'L SEABED AUTH., POLYMETALLIC NODULES, *supra* note 11.

114 Hylton, *supra* note 25.

115 *See supra* note 81 and accompanying text.

116 Stockholm Declaration, *supra* note 55, princ. 21.

117 Rio Declaration, *supra* note 56, princ. 15.

customary international law; to make it so will require commitment to the principle as a legal obligation by the states involved or potentially involved in deep seabed exploration and mining, and the honoring of that obligation in their practice. Alternatively, were the United States and other non-members to become parties to either UNCLOS or otherwise subject themselves to the regulatory authority of the ISA, the precautionary principle might be incorporated into the ISA's regulations.

Barring some other environmental catastrophe befalling the human race first, it is inevitable that the relentless hunger of the consumer economy will eventually loot the ocean floors, as soon as it becomes profitable to do so. Law, or in this case regulation, is a way of making the looting less profitable and thus restraining it, ideally until the risks can be assessed and minimized. Without such delay, environmental damage is unavoidable, and the only question is whether it will affect the surface world. At best, we destroy a strange and eerily beautiful ecosystem that has existed in the darkness, but not in isolation, at the bottom of the ocean for billions of years. At worst, the ocean-floor ecosystem turns out to be inextricably linked in some as yet unknown way to our continued viability as a species, and we pull out the last supporting block in the Jenga tower that sustains humanity's precarious place in the biosphere.