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Diving to New Depths: How Green Energy Markets Can Push Mining Companies Into the Deep Sea, and Why Nations Must Balance Mineral Exploitation with Marine Conservation

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DIVING TO NEW DEPTHS: HOW GREEN ENERGY MARKETS CAN PUSH MINING COMPANIES INTO THE DEEP SEA, AND WHY NATIONS MUST BALANCE MINERAL EXPLOITATION WITH MARINE CONSERVATION

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INTRODUCTION

The deep sea is a huge, dark expanse of water that houses some of the Earth's most unique, often bizarre, creatures that inspired myths and legends.[1] It is an environment equally mysterious and unknown to human civilization, with vast areas of the deep seas still unstudied.[2] In fact, scientists have explored only 5 percent of the sea floor, even though it covers 60 percent of the Earth's surface.[3]

Nevertheless, despite the scientific knowledge gaps and technical hurdles of reaching the seabed, countries across the globe "are claiming obscure and difficult-to-reach tracts of the deep-sea floor, far from the surface and further still from land," in the hopes of extracting lucrative natural resources.[4] Massive seabed deposits of iron, cobalt, gold, silver, platinum, nickel, copper, rare earth minerals, oil, natural gas, and other resources are driving industrial development deeper into the ocean than ever before.[5] In fact, some reports estimate deep-sea minerals to be worth $150 trillion, or "nine pounds of gold for every person on earth."[6]

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[1] Emily Alder, *Sea Monsters*, *in* THE ASHGATE ENCYCLOPEDIA OF LITERARY AND CINEMATIC MONSTERS (Jeffrey Andrew Weinstock ed., 2014); Charles R. Taylor, *Fishing with a Bulldozer: Options for Unilateral Action by the United States Under Domestic and International Law to Halt Destructive Bottom Trawling Practices on the High Seas*, 34 ENVIRONS ENVTL. L. & POL'Y J. 121, 124 (2010).

[2] *See* David Hartley, *Guarding the Final Frontier: The Future Regulations of the International Seabed Authority,* 26 TEMP. INT'L & COMP. L.J. 335, 335–36 (2012); Lisa A. Levin et al., *Defining "Serious Harm" to the Marine Environment in the Context of Deep-Seabed Mining*, 74 MARINE POL'Y 245, 248 (2016).

[3] Rachel Mills, *Why are countries laying claim to the deep-sea floor?*, BBC (June 21, 2017), http://www.bbc.com/news/world-40248866 [https://perma.cc/F5KN-DE25].

[4] *Id.*

[5] *See* Sophie Cocke, *Clarion-Clipperton Fracture Zone: The New Mineral Rush*, HUFFPOST (Dec. 18, 2013), https://www.huffingtonpost.com/2013/12/18/clarion-clipperton-fracture-zone_n_4467426.html [https://perma.cc/FQ2V-4VE3].

[6] *Deep-sea Mining FAQ*, CTR. FOR BIOLOGICAL DIVERSITY, http://www.biologicaldiversity

The most advanced and promising opportunity for deep-sea mining was underway off the coast of Papua New Guinea.[7] Nautilus Minerals, a Canadian corporation,[8] obtained licenses from Papua New Guinea to mine massive sulfide deposits in the Bismarck Sea.[9] Nautilus planned to launch the world's first deep seabed mining operation, called Solwara 1, in 2019, but announced financial restructuring instead.[10]

Essentially, Nautilus planned to use three different robotic machines to conduct its mining operations, each of which are remote controlled, fifty feet in length, and outweigh a blue whale.[11] First, an auxiliary cutter grinds down the sea floor to make it level enough for the other machines, a challenge in this volcanic area covered in black smoker chimney stacks.[12] Next, the bulk cutter grinds the resulting slurry up into finer material for the collection machine to suck up before sending it up to a surface vessel.[13] Once at the surface, the ore is dewatered and loaded onto other boats for transport into ports and the wastewater is pumped back down to the sea floor.[14]

Sitting at a depth of 1,600 meters (about 5,250 feet, or almost a mile under water), the Solwara 1 deposit still offers promises of wealth: estimates calculate over one million tonnes in the deposit, with a 7 percent

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.org/campaigns/deep-sea_mining/pdfs/Deep-seaMiningFAQ.pdf [https://perma.cc/BA8U-Q8UU] (last visited Oct. 28, 2019).

[7] Randy W. Tong, *It's Time to Get Off the Bench: The U.S. Needs to Ratify the Law of the Sea Treaty Before It's Too Late*, 48 U. PAC. L. REV. 317, 318 (2017); Carol J. Clouse, *Can deep-sea mining avoid the environmental mistakes of mining on land?*, GUARDIAN (June 28, 2017), https://www.theguardian.com/sustainable-business/2017/jun/28/deep-sea-mining-environmental-mistakes [https://perma.cc/7W56-MATY].

[8] *Annual Report 2015 Corporate Information*, NAUTILUS MINERALS, http://www.nautilusminerals.com/irm/PDF/1748_0/ [https://perma.cc/YHQ6-3Z33] (last visited Oct. 28, 2019).

[9] Clouse, *supra* note 7; *see also* Tong, *supra* note 7, at 318.

[10] Tong, *supra* note 7; Clouse, *supra* note 7; Press Release Number 2017-21, Nautilus Minerals, Nautilus Provides Project Update (Oct. 12, 2017), http://www.nautilusminerals.com/irm/PDF/1930_0/Nautilusprovidesprojectupdate [https://perma.cc/9GTU-VFZN]; Benjamin Robinson-Drawbridge, *Call for PNG seabed mining licenses to be cancelled*, RADIO NEW ZEALAND (Mar. 15, 2019), https://www.radionz.co.nz/international/pacific-news/384719/call-for-png-seabed-mining-licences-to-be-cancelled [https://perma.cc/SP3H-NZHH].

[11] Clouse, *supra* note 7; Robert Ferris, *Deep sea mining company reveals new gear*, CNBC (Nov. 11, 2015), https://www.cnbc.com/2015/11/11/worlds-first-deep-sea-mining-company-reveals-new-gear.html [https://perma.cc/LCY9-L6BK].

[12] *See* Clouse, *supra* note 7; NAUTILUS MINERALS, SOLWARA 1 PROJECT: ENVIRONMENTAL IMPACT STATEMENT 3 (2008), http://www.nautilusminerals.com/irm/content/pdf/environment-reports/Environmental%20Impact%20Statement%20Executive%20Summary%20(English).pdf [https://perma.cc/ZQ9M-FL48].

[13] Ferris, *supra* note 11.

[14] *Id.*

copper grade (compared with 0.6 percent at a land-based mine) and gold grades over twenty grams/ton at some intercepts.[15] Papua New Guinea stands to greatly benefit economically from mining, as well.[16] The country owns about 30 percent interest in the project and there is an expected $142 million in direct benefits alone over the course of Solwara 1's twenty-year license.[17] Now, however, the question over the leases remains.[18] With Nautilus currently up for sale, interested investors could gain the licenses Nautilus holds in Papua New Guinea and Tonga.[19]

In addition to minerals, the seabed also contains natural gas deposits, essentially frozen in place as methane hydrates. Over the last few years, Japan has invested about $1 billion in research and development for domestic methane hydrate extraction, an abundant resource off Japan's coasts.[20] In 2013, a Japanese government-funded research group conducted the world's first extraction of natural gas from methane hydrates.[21] The process began by drilling a well, and then implementing "a submersible pump to suck water out of the sediments."[22] The pressure change from the decreased water level released the gas, which was then piped to a vessel on the ocean surface.[23] While the 2013 research team faced problems when sand got into the pipes, extraction methods continued to develop in 2017 with new polymer-coated pipes.[24] Vessels piped 235,000 cubic meters of natural gas earlier this year, and Japan hopes to launch commercial methane hydrate natural gas production between 2023 and 2027.[25] India,

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[15] Clive Schofield, *New Marine Resource Opportunities*, *Fresh Challenges*, 35 U. HAW. L. REV. 715, 728 (2013); *Fact Sheet (2015)*, NAUTILUS MINERALS, http://www.nautilusminerals.com/IRM/Company/ShowPage.aspx?CategoryId=332&CPID=1697&EID=25173525 [https://perma.cc/Z7JZ-25XR] (last visited Oct. 28, 2019); *PNG*, NAUTILUS MINERALS, http://www.nautilusminerals.com/irm/content/png.aspx?RID=258 [https://perma.cc/A43P-CM2G] (last visited Oct. 28, 2019).
[16] *See* Luz Danielle O. Bolong, *Into the Abyss: Rationalizing Deep Seabed Mining Through Pragmatism and International Law*, 25 TUL. J. INT'L & COMP. L. 127, 135–36 (2016).
[17] *Id.*
[18] *Seabed mining project in PNG moves to sell assets*, RADIO NEW ZEALAND (Feb. 26, 2019), https://www.radionz.co.nz/international/pacific-news/383392/seabed-mining-project-in-png-moves-to-sell-assets [https://perma.cc/U4S4-2GL4].
[19] *Id.*
[20] Sarah Lazarus, *Can Japan burn flammable ice for energy?*, CNN (Nov. 2, 2017), http://www.cnn.com/2017/10/31/asia/on-japan-flammable-ice/index.html [https://perma.cc/XV6T-3GL5].
[21] *Id.*
[22] *Id.*
[23] *Id.*
[24] *Id.*
[25] *Id.*; *Japan reports successful gas output test from methane hydrate*, REUTERS (May 8,

Canada, China, and the United States are also hoping to exploit their methane hydrate deposits.[26]

However, while deep-sea mining holds potential for great wealth and economic development, it risks environmental harms and diplomatic disputes on a global scale.[27] These concerns grow as energy markets and economic drivers push mining companies to the deep sea to match minerals supplies with growing demands.[28] Part I of this Article will examine the types of minerals in the seabed and the unique environments that formed those deposits. Part II will discuss the historical development of deep-sea mining and the development of legal regimes to govern the world's oceans and seabed resources. Part III will discuss the renewable energy market trends and economic incentives that are making deep-sea mining a commercial reality. Part IV will present the importance of balancing mineral exploitation with marine conservation under the United Nations Convention on the Law of the Sea ("UNCLOS III") and recommend considerations to help combat potential legal, environmental, and political challenges. This Article concludes that the increasing demands for renewable energy will drive the mineral market to new mining venues in the seabed, which holds greater mineral concentrations and quantities than terrestrial reserves,[29] but that such new mining ventures can be done in more environmentally responsible ways.

I. HARVESTING THE RESOURCES OF THE DEEP SEA

While the deep sea lacks the krakens feared by ancient sailors, it holds many other mysterious creatures that inspired both historical fish

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2017), https://www.reuters.com/article/japan-methane-hydrate/japan-reports-successful-gas-output-test-from-methane-hydrate-idUSL4N1IA35A [https://perma.cc/SR4H-W2TA].

[26] *See* REUTERS, *supra* note 25.

[27] *See* Michael W. Lodge & Philomène A. Verlaan, *Deep-Sea Mining: International Regulatory Challenges and Responses*, 14 ELEMENTS 331, 331–32 (2018); Jon Letman, *The Race Is On to Mine the Deep Sea—But Scientists Are Wary*, NAT'L GEOGRAPHIC (Aug. 29, 2018), https://www.nationalgeographic.com/environment/2018/08/news-race-to-mine-deep-sea-drones-seafloor-environmental-impact.html [https://perma.cc/L6MF-RNBM].

[28] *See* Andrew Bloodworth & Gus Gunn, *The Future of the Global Minerals and Metals Sector: Issues and Challenges out to 2050*, 15 GEOSCIENCES 90, 93 (2012).

[29] Damian Carrington, *Is deep sea mining vital for a greener future—even if it destroys ecosystems?*, GUARDIAN (June 4, 2017), https://www.theguardian.com/environment/2017/jun/04/is-deep-sea-mining-vital-for-greener-future-even-if-it-means-destroying-precious-ecosystems [https://perma.cc/X2QH-9N26]; Nicola Jones, *A Scarcity of Rare Metals Is Hindering Green Technologies*, YALE ENV'T 360 (Nov. 18, 2013), https://e360.yale.edu/features/a_scarcity_of_rare_metals_is_hindering_green_technologies [https://perma.cc/36LC-CAPA].

tales and modern works, like Jules Verne's *Twenty Thousand Leagues Under the Sea*.[30] In addition, the oil and gas deposits hold potential for energy expansions, while deep-sea minerals provide lucrative metals that are essential to modern technology, including cell phones, computers, solar panels, and wind turbines.[31] For example, rare earth minerals are a group of seventeen chemical elements with diverse, highly specialized uses, such as construction of mobile phones, advanced motors, generators, oil-refinery catalysts, and superstrong magnets.[32] Despite the name, rare earths are widely distributed in the Earth's crust, but they rarely appear in concentrated forms that can be mined at a profit.[33] Likewise, tellurium—a rare metal essential to solar panels—is three times rarer than gold and is 50,000 times more concentrated in seabed deposits than in terrestrial mines.[34]

Four main types of mineral deposits occur on the sea floor, varying in location because unique deep-sea environments form each deposit type: (a) polymetallic nodules that sit across the abyssal sea plain; (b) cobalt crusts woven into sea mounts; (c) polymetallic sulfide deposits that form at hydrothermal vent sites; and (d) methane hydrates that tend to form at the edges of continental shelves (see Figures A and B).[35] This Part will discuss each of these types of deep-sea mineral deposits in turn.

A. Abyssal Sea Plains and Polymetallic Nodules

Throughout the sea, potato-shaped polymetallic nodules litter the ocean floor.[36] These nodules range from the size of potatoes to the size of cannonballs and are the most abundant material on the seabed after clay and silica.[37] Rich in manganese, cobalt, copper, nickel, and rare earth elements—all metals essential for modern technology and clean

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[30] TONY KOSLOW, THE SILENT DEEP: THE DISCOVERY, ECOLOGY, AND CONSERVATION OF THE DEEP SEA 45 (2007); *Sea Monsters*, AM. MUSEUM NAT. HISTORY, https://www.amnh.org/exhibitions/mythic-creatures/water-creatures-of-the-deep/sea-monsters/ [https://perma.cc/H5DY-KAAN] (last visited Oct. 28, 2019).

[31] Kate Baggaley, *These Fearsome Robots Will Bring Mining to the Deep Ocean*, NBC (Feb. 27, 2017), https://www.nbcnews.com/mach/innovation/these-fearsome-robots-will-bring-mining-deep-ocean-n724901 [https://perma.cc/9ZSJ-RMY2]; Carrington, *supra* note 29.

[32] Amory Lovins, *Clean energy and rare earths: Why not to worry*, BULL. ATOMIC SCIENTISTS (May 23, 2017), https://thebulletin.org/2017/05/clean-energy-and-rare-earths-why-not-to-worry/10785 [https://perma.cc/N6D9-WFX6].

[33] *Id.*

[34] Carrington, *supra* note 29; Jones, *supra* note 29.

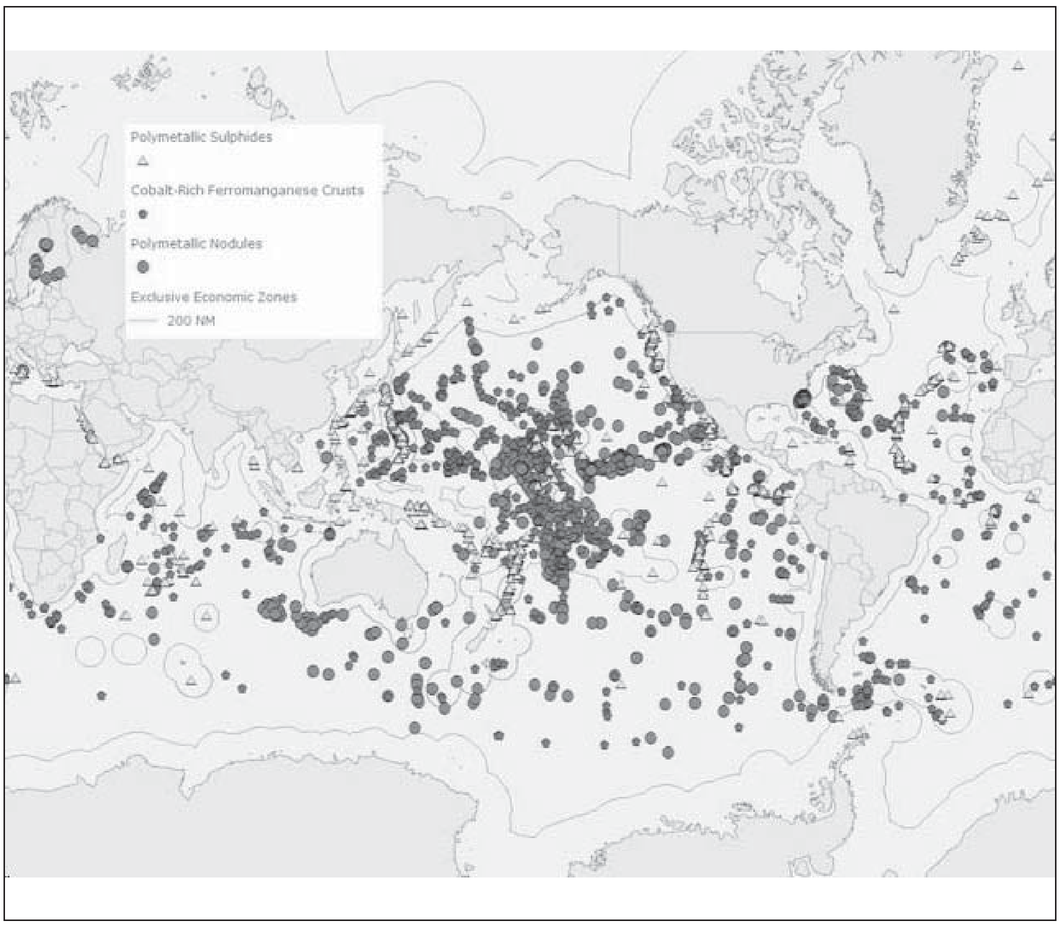
[35] Bolong, *supra* note 16, at 133; *see Gas Hydrates*, NAT'L ENERGY TECH. LABORATORY, https://www.netl.doe.gov/oil-gas/gas-hydrates [https://perma.cc/FT62-8NRA] (last visited Oct. 28, 2019).

[36] Cocke, *supra* note 5.

[37] KOSLOW, *supra* note 30, at 162.

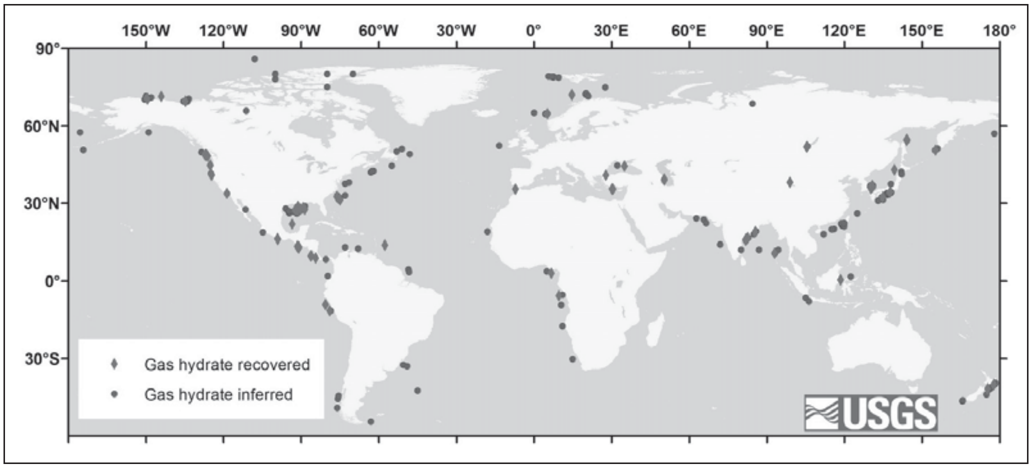
energy—these nodules offer wealth to nations willing to harvest them, especially as consumer demand for high-tech gadgets increases across the world.[38] The nodules form as layers of iron and manganese hydroxides concretions around a central core, but the exact cause of their formation remains speculative.[39] Even so, the growth of the nodules is very slow, even for geological processes, with every centimeter of the nodule taking several million years to form.[40]

Figure A: Global Distribution of Deep-Sea Minerals[41]



[38] Schofield, *supra* note 15, at 728–29; Cocke, *supra* note 5.
[39] *Polymetallic Nodules*, INT'L SEABED AUTH., https://ran-s3.s3.amazonaws.com/isa.org.jm/s3fs-public/documents/EN/Brochures/ENG7.pdf [https://perma.cc/CG9N-MS4X] (last visited Oct. 28, 2019).
[40] *Id.*
[41] *Wealth in the Oceans: Deep sea mining on the horizon?*, UNITED NATIONS ENV'T PROGRAMME (May 2014), https://na.unep.net/geas/archive/pdfs/GEAS_May2014_DeepSeaMining.pdf [https://perma.cc/C5FG-WFSC].

Figure B: Global Distribution of Methane Hydrates[42]



While polymetallic nodules litter huge sections of the globe, both in lakes and oceans, the highest concentrations occur between 4,000 and 6,000 meters under the sea.[43] To be economically viable, polymetallic nodules require concentrations of about ten kilograms of nodules per square meter of seabed, and each nodule should contain at least 27 percent manganese, about 1 percent each of copper and nickel, and 0.2 percent cobalt.[44] Therefore, only three areas in the ocean have economically viable concentrations of polymetallic nodules: between Hawaii and Central America; in the Pacific Ocean's Peru Basin; and in the northern Indian Ocean.[45] The Clarion-Clipperton Fracture Zone ("CCZ")—a seabed area the size of the United States stretching across the Equatorial North Pacific—is now home to seventeen mining claims from various nations, including Germany, Russia, Japan, France, China, the United Kingdom, Tonga, the Cook Islands, and others (see Figure C).[46] The CCZ holds over "27 billion tonnes of nodules containing . . . 7 billion tonnes of manganese, 340

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[42] *Where are gas hydrates found?*, U.S. GEOLOGICAL SURVEY, https://www.usgs.gov/faqs/where-are-gas-hydrates-found?qt-news_science_products=0#qt-news_science_products [https://perma.cc/E8JY-FJCT] (last visited Oct. 28, 2019).

[43] Hartley, *supra* note 2, at 348.

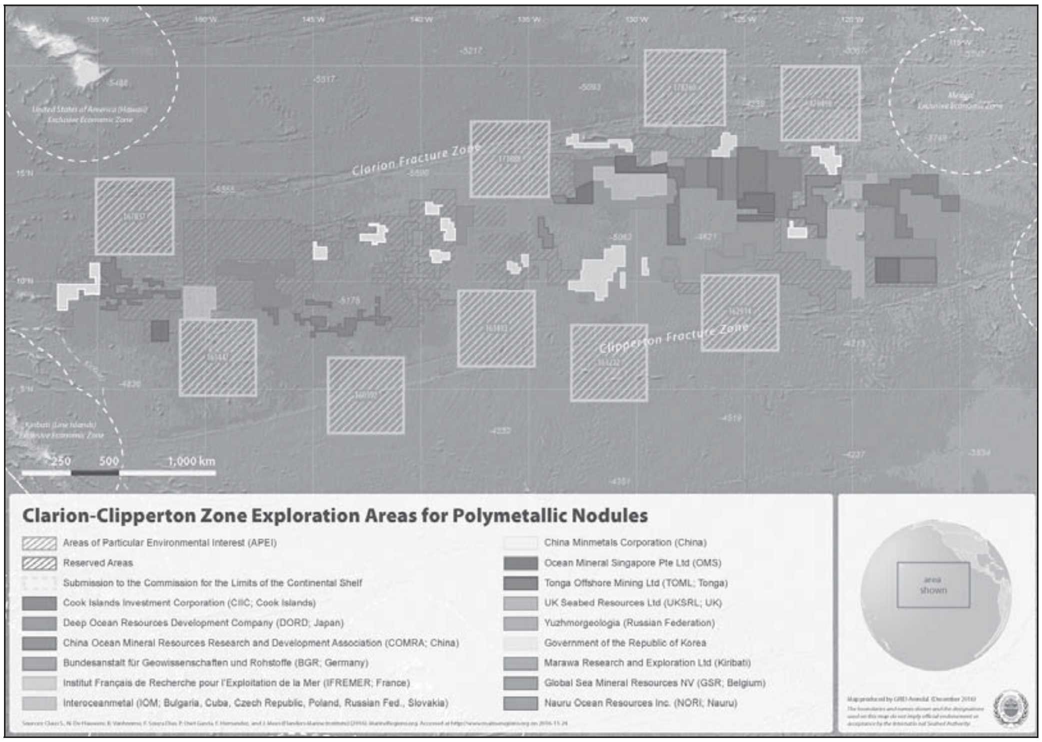
[44] *Id.*

[45] *Id.*; INT'L SEABED AUTH., *supra* note 39.

[46] Cocke, *supra* note 5; *Deep Seabed Minerals Contractors*, INT'L SEABED AUTH., https://www.isa.org.jm/deep-seabed-minerals-contractors [https://perma.cc/4L4N-69YN] (last visited Oct. 28, 2019) (As of March 2019, there are seventeen contracts for nodule exploration, seven contracts for polymetallic sulfides, and five for cobalt crusts, totaling twenty-nine exploration contracts through the ISA.).

million tonnes of nickel, 290 million tonnes of copper and 78 million tonnes of cobalt," as well as rare earth elements, making the CCZ the largest known concentration of polymetallic nodules in the world.[47]

Figure C: The Clarion-Clipperton Zone[48]



The nodules usually sit half-buried in the surrounding sediment of the abyssal plains,[49] an environment unique for its dark and slow ecology. The sea floor here is a nutrient-poor ecosystem, at least organically poor, as well as an unproductive one.[50] The unproductivity of the abyss is best displayed in a story about submarine sandwiches. When the submersible *Alvin* sank in 1968, the crew escaped but without any time to grab their lunch: bologna sandwiches, apples, and a broth-filled thermos packed in

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[47] L.M. Wedding et al., *Managing Mining of the Deep Seabed*, 349 SCI. MAG. 144, 144 (2015); *see* Schofield, *supra* note 15, at 729.
[48] The map displays contracts as of December 2016. *Exploration Areas*, INT'L SEABED AUTH., https://www.isa.org.jm/contractors/exploration-areas [https://perma.cc/7WFU-8RS2] (last visited Oct. 28, 2019).
[49] Hartley, *supra* note 2, at 348.
[50] KOSLOW, *supra* note 30, at 79.

a lunch box.[51] After recovering both the submersible and lunch box ten months later, surprised researchers found the food unspoiled and, theoretically, edible.[52] Scientific experiments later concluded that slow microbial activity preserved the food, not the cold water temperatures.[53]

Slow seems to be the abyss's primary speed, applying to sediment as well as species. For instance, larger species on the sea floor, such as fish and octopuses, tend to have long lifespans, reproduce slowly, and take years to reach sexual maturity.[54] Meanwhile, the accumulation rate of sediment in deep-sea clay amounts to only one millimeter every thousand years, with much of the seabed clay having both terrestrial and cosmic origins from periods when meteors rained down onto the earth.[55] Nevertheless, and somewhat paradoxically, the unproductive abyssal deep sea contains highly diverse species, rivaling and outpacing the biodiversity of tropical rainforests despite their dynamic growth.[56] Species in the abyssal plains include sponges, clams, mussels, corals, and xenophyphores (gigantic unicellular sponge-like organisms), with most species living in the top five to ten centimeters of sediment.[57] Moreover, about eighty to 100 different invertebrate species occupy a single square meter of sediment.[58]

The mining techniques required to harvest the nodules have been compared to "standing on top of a skyscraper on a windy day and trying to suck marbles off the street with a vacuum cleaner hose."[59] Here, hyperbole meets reality. The best methods proposed so far are hydraulic mining

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[51] *Id.* at 80.
[52] *Id.*
[53] *Id.*
[54] *See id.* at 83–84; Craig R. Smith et al., *Areas of Particular Environmental Interest (or "Protected Areas") for Ecosystem Based Management of the Clarion-Clipperton Zone: Rationale and Recommendations to the International Seabed Authority*, UNIV. OF HAW., https://ran-s3.s3.amazonaws.com/isa.org.jm/s3fs-public/documents/EN/Workshops/2010/Pres/SMITH.pdf [https://perma.cc/JY3P-8E2H] (last visited on Oct. 28, 2019).
[55] KOSLOW, *supra* note 30, at 33.
[56] Ken Stier, *Laying Waste to the Deep Sea*, TIME (Dec. 13, 2007), http://content.time.com/time/health/article/0,8599,1694495,00.html [https://perma.cc/N3W5-MKCF]; *see* KOSLOW, *supra* note 30, at 79.
[57] Levin et al., *supra* note 2, at 250–51; CTR. FOR BIOLOGICAL DIVERSITY, *supra* note 6; David Shukman, *Renewables' deep-sea mining conundrum*, BBC (Apr. 11, 2017), http://www.bbc.com/news/science-environment-39347620 [https://perma.cc/N53Z-TC5R].
[58] *See* Smith et al., *supra* note 54.
[59] Jason C. Nelson, *The Contemporary Seabed Mining Regime: A Critical Analysis of the Mining Regulations Promulgated by the International Seabed Authority*, 16 COLO. J. INT'L ENVTL. L. & POL'Y 27, 40 (2005) (citing DIVISION FOR OCEAN AFFAIRS AND LAWS OF THE SEA, UNITED NATIONS, THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (A HISTORICAL PERSPECTIVE) (1998)).

systems that essentially suck up ore crushed by a robotic device on the sea floor, pulling it thousands of meters through the water column to a floating mining platform on the surface.[60] Once there, workers dewater the ore, ship the dewatered ore to port, and pump the remaining water back down to the seabed.[61]

Environmental concerns over polymetallic mining include vehicles crushing organisms within the seabed, the resulting sediment plumes, wastewater discharge, and noise pollution.[62] More specifically, the robotic vehicles crushing ore could also crush 95 to 100 percent of organisms living along the vehicle's direct path while the sediment plumes and wastewater will impact aquatic life from the sea surface down through the water column as wastes are discharged from the surface vessel.[63] Sediment and wastewater at the surface can deplete light and oxygen, which affects photosynthesis and water temperatures.[64] In addition, noise pollution will adversely impact sound-sensitive organisms, like marine mammals, in the water column and may have unknown impacts at the seabed.[65] Noise pollution can travel 1,500 miles or more underwater,[66] and it interferes with species' communication, navigation, hunting, and predator detection.[67]

While vast and diverse, the abyssal plain's ecological consistency, slowness, and stability make it especially vulnerable to deep-sea mining impacts.[68] This expanse of the deep sea "has evolved within the most stable and least productive environment on earth"; it is a place of fragile fauna, age-old organisms, low reproduction rates, and limited dispersal rates.[69] In short, this is not an ecosystem built to handle catastrophic disturbances.[70] For instance, in the 1970s and 1980s, projects similar to deep-sea mining had monumental impacts on the abyssal environment, including

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[60] Hartley, *supra* note 2, at 348–49.
[61] Hartley, *supra* note 2, at 348–49; Ferris, *supra* note 11.
[62] Hartley, *supra* note 2, at 357–58.
[63] *Id.*
[64] *Id.* at 358; Levin et al., *supra* note 2, at 250.
[65] Christopher Clark & Brandon Southall, *Turn down the volume in the ocean*, CNN (Jan. 20, 2012), http://www.cnn.com/2012/01/19/opinion/clark-southall-marine/index.html [https://perma.cc/X3QV-PNDT].
[66] Hartley, *supra* note 2, at 359.
[67] Clark & Southall, *supra* note 65.
[68] Kathryn A. Miller et al., *An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps*, 4 FRONTIERS IN MARINE SCI. 2, 15 (2018), https://www.frontiersin.org/articles/10.3389/fmars.2017.00418/full [https://perma.cc/UE2Y-FD95].
[69] KOSLOW, *supra* note 30, at 169; Wedding et al., *supra* note 47, at 144.
[70] *See* KOSLOW, *supra* note 30, at 169; Wedding et al., *supra* note 47, at 144.

the destruction of 50 to 90 percent of macrofaunal groups after scientists ploughed eleven square kilometers off the coast of Peru.[71] However, researchers also noted that, despite evident plough marks seven years later, the fauna had returned almost completely in the otherwise undisturbed sediment.[72] Whether or not deep-sea mining will catastrophically destroy abyssal plain sea life remains a question for researchers, but some believe that some effects from mining operations could last for millennia.[73]

B. Seamounts and Cobalt Crusts

In addition to the abundance of polymetallic nodules, the deep sea also contains cobalt crusts woven into the summits of seamounts.[74] Although named for their high cobalt concentrations (up to 1.7 percent), these crusts also contain titanium, cerium, nickel, platinum, manganese, phosphorus, thallium, tellurium, zirconium, tungsten, bismuth, and molybdenum, making them a lucrative source of metals and rare earth elements.[75] The crusts form over millennia as mineral precipitation in the surrounding seawater forms a thin, accumulating layer where currents sweep areas clear of sediments.[76] Like polymetallic nodules, cobalt crusts grow slowly, accumulating an additional one to six millimeters per million years.[77]

Most of the Earth's cobalt crusts are in the Pacific Ocean, forming pavements up to twenty-five centimeters thick across many square kilometers of seamount summits and flanks, ridges, and plateaus.[78] The "thickest crusts, richest in cobalt, occur on outer-rim terraces and on broad saddles on the summits of seamounts, at depths of 800–2,500 meters,"[79] which places some of the best potential mining sites within Pacific coastal areas, including Johnston Island, Hawaii, the Marshall Islands, the Federated States of Micronesia, and international waters of the mid-Pacific.[80]

Seamounts can be enormous, with many as large as the famous mountain ranges on the continents.[81] With large mountains comes large

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[71] KOSLOW, *supra* note 30, at 169.
[72] *Id.*
[73] Levin et al., *supra* note 2, at 250.
[74] KOSLOW, *supra* note 30, at 170.
[75] *Cobalt-Rich Crusts*, INT'L SEABED AUTH., https://www.isa.org.jm/files/documents/EN/Brochures/ENG9.pdf [https://perma.cc/KZ3H-J5AR] (last visited Oct. 28, 2019).
[76] *Id.*; *see* Levin et al., *supra* note 2, at 246, 253.
[77] INT'L SEABED AUTH., *supra* note 75.
[78] *Id.*
[79] *Id.*
[80] *Id.*
[81] *Id.*

biodiversity; the seamounts often have large, sessile animals, like sponges and corals, giant protozoans called xenophyophores, and mobile fish and crabs.[82] The height and steepness of seamounts can also contribute to biomass and biological productivity, because the tallest rocky formations alter ocean currents and direct nutrients towards the sea surface.[83] Above these peaks, nutrient-rich waters result in higher concentrations of fish, marine mammals, prey organisms, and organic detritus.[84] Likewise, the seamount's depths can create diversity among the benthic and pelagic species.[85]

Nevertheless, little is known about these mountainous environments "beyond the fact that they are complex and variable; two seamounts at the same depth can have completely different biological components."[86] The ecology and formations of seamounts are "determined by a variety of factors, including current patterns, topography, seamount size, water depth, seawater oxygen content, bottom-sediment and rock types and coverage."[87] Scientists estimate that between 30,000 and 100,000 seamounts rise above the sea floor, including the longest mountain chain in the world—the Mid-Ocean Ridge—that circles the globe like the stitches on a baseball.[88] Nevertheless, researchers have explored less than 1 percent of these deep-sea mountains.[89] In fact, "[o]nly a few of the estimated 30,000 seamounts that occur in the Pacific, where the richest deposits are found, have been mapped and sampled in detail."[90]

Despite shallower waters for mineral extraction, cobalt crusts can be more difficult to mine than nodules because the crust must be removed from underlying rock.[91] Therefore, while environmental impacts on seamounts could be more localized, mining here still raises concerns over potential damage to local fauna and wildlife.[92] In order to remove the crusts, large robotic machines dig in and crush the ore, then send the slurry up to surface mining vessels through riser and lifting systems.[93] However, because the crusts are embedded in rock, it is difficult to collect the crusts

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[82] Levin et al., *supra* note 2, at 253.
[83] Taylor, *supra* note 1, at 128; INT'L SEABED AUTH., *supra* note 75.
[84] Taylor, *supra* note 1, at 128–29.
[85] *Id.*
[86] INT'L SEABED AUTH., *supra* note 75.
[87] *Id.*
[88] Taylor, *supra* note 1, at 125, 128.
[89] *Id.* at 125.
[90] INT'L SEABED AUTH., *supra* note 75.
[91] KOSLOW, *supra* note 30, at 170.
[92] *Id.*
[93] Levin et al., *supra* note 2, at 253.

without diluting the ore in too much substrate.[94] Moreover, the rugged terrain and steep summits make machinery operations difficult.[95] Inevitably, mining the crusts will cause plumes of sediment, which can bury, smother, and blind organisms, as well as disrupt the food chain and prevent species colonization.[96] Damage to the seamount ridges and summits also poses concerns regarding potentially altered current flows and biological nutrient distribution.[97]

C. Hydrothermal Vents and Polymetallic Sulfide Deposits

Like estuaries, hydrothermal vents are unique, but unstable, ecosystems that exist between two distinct environments.[98] Hydrothermal vents are often called "black smokers" because they shoot out 660°F water full of iron and metal sulfides, which turns into a black plume when it hits the frigid seawater surrounding the vents.[99] Scientists conducting underwater exploration first discovered these chimney-like structures in 1979, along with new hosts of hydrothermal vent species found nowhere else on earth.[100] As recently as the 2000 to 2010 Census of Marine Life, researchers discovered the yeti crab near vents by Easter Island, "which is not only a hairy new species, but also a new genus and a new family."[101] The species in these deep-sea ecosystems cannot rely on light, or even organic detritus, for survival like shallower ocean life does.[102] Indeed, while most life on earth depends on photosynthesis—the sunlight-based process of converting inorganic carbon into organic compounds[103]—hydrothermal

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[94] INT'L SEABED AUTH., *supra* note 75.
[95] Levin et al., *supra* note 2, at 253.
[96] *Id.*
[97] Taylor, *supra* note 1, at 128; INT'L SEABED AUTH., *supra* note 75.
[98] KOSLOW, *supra* note 30, at 101.
[99] *Id.* at 100.
[100] Hartley, *supra* note 2, at 349; *Polymetallic Sulfides*, INT'L SEABED AUTH., https://ran-s3.s3.amazonaws.com/isa.org.jm/s3fs-public/documents/EN/Brochures/ENG8.pdf [https://perma.cc/N6JR-XVVW] (last visited Oct. 28, 2019).
[101] CENSUS OF MARINE LIFE, FIRST CENSUS OF MARINE LIFE 2010: HIGHLIGHTS OF A DECADE OF DISCOVERY 13 (2010), http://www.coml.org/comlfiles/partner2010/Final%20Report%209-14%20small.pdf [https://perma.cc/VBK3-XUXF].
[102] *What conditions exist for life in the deep ocean?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://oceanexplorer.noaa.gov/facts/deep-habitat.html [https://perma.cc/4EWT-8PDB] (last visited Oct. 28, 2019).
[103] *Carbon Cycle Glossary*, SCI. EDUC. RESEARCH CTR. AT CARLETON COLLEGE, https://serc.carleton.edu/eslabs/carbon/carbon_cycle_gl.html [https://perma.cc/P33D-SQTR] (last modified Nov. 8, 2016).

vent ecosystems depend on chemosynthesis, where microbes live off chemical compounds, like hydrogen sulfide and methane.[104]

In contrast to the abyssal plains, what hydrothermal vents lack in biodiversity they make up for in productivity.[105] Around the hydrothermal vents are unique ecosystems, abundant in "extremophile" microbes and larger species such as giant clams, crabs, shrimp, barnacles, corals, sponges, octopuses, and numerous vent worms.[106] The microbes of these ecosystems are called extremophiles because they live in some of the harshest environments in the world; the extremophiles adapted to survive without light, endure high pressure and scorching temperatures, withstand lethal chemicals, and live in highly saline or acidic waters.[107] Even larger species must endure extreme conditions. For instance, the Pompeii worms living on the black smoker chimneys "are routinely bathed by vent waters at 30–70°C and may experience a 60°C range in temperature from one end of their body to the other."[108]

In addition to unique organisms, this volcanic environment also developed sulfide deposits (often called sea floor massive sulfides).[109] As magma chambers rise close to the sea floor, the hydrothermal convection system above "leaches various metals out of the deep volcanic rock—mostly iron, manganese, copper, and zinc, but also silver and gold—and precipitates them out" into seafloor chimneys and deposits.[110] In fact, one black smoker deposits approximately 250 tonnes of ore per day, while the sulfide deposits range in size from 1 to 10 million tonnes of ore.[111] Hydrothermal activity is most intense in subduction zones, where tectonic plates collide, forcing one to subduct beneath the other.[112]

Nautilus Minerals would have been the "first company to commercially explore the seafloor for massive sulphide systems, a potential source of high grade copper, gold, zinc and silver."[113] Its mining method consists of sea floor robots chopping the sulfide deposit into slurry before pumping the ore slurry to a surface mining vessel.[114] Once there, the workers

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[104] Hartley, *supra* note 2, at 360.
[105] KOSLOW, *supra* note 30, at 101.
[106] Schofield, *supra* note 15, at 730; Carrington, *supra* note 29.
[107] Schofield, *supra* note 15, at 730; INT'L SEABED AUTH., *supra* note 100.
[108] KOSLOW, *supra* note 30, at 100–01.
[109] *Id.* at 171.
[110] *Id.* at 170–71.
[111] *Id.* at 171.
[112] *Id.* at 170.
[113] *Overview*, NAUTILUS MINERALS, http://www.nautilusminerals.com/irm/content/overview.aspx?RID=252&RedirectCount=1 [https://perma.cc/DA65-8TZ8] (last visited Oct. 28, 2019).
[114] NAUTILUS MINERALS, *supra* note 12, at 5–6.

dewater the ore at the surface vessel, discharge the water and fine particles back into the ocean near the seabed, and then load the dewatered ore onto shuttle barges for transfers back to port.[115] Thus, polymetallic sulfide mining employs a process similar to nodule mining, but in a radically different environment. These mining schemes are comparable to open-pit mining on land, but they have the additional complication of getting the ore through the water column to the surface, which is located hundreds, if not thousands, of meters above the deposit.[116]

Hydrothermal sulfide mining shares many of the environmental concerns that extracting polymetallic nodules does, "including the destruction of surfaces where animals live, their burial under disturbed sediment and chemical changes due to the suspension of a particulate plume in the bottom water."[117] However, hydrothermal vents carry additional concerns of harming endemic species and vent connectivity. There are approximately 400 known active vent sites around the world,[118] each highly localized, and often occurring between 1,200 and 3,000 meters in depth across mid-ocean ridges, basins, and volcanoes.[119] Hydrothermal vents are like islands—each attracts life and develops in isolation, making each chimney home to unique species.[120] As a result, destroying one vent site may cause the extinction of a rare species.[121] Equally concerning is the knowledge that vent sites are connected, but scientists still need to find out how much connectivity exists and whether mining can impact connected sites.[122]

Despite apprehensions, some scientists estimate rapid recoveries at hydrothermal vent sites after mining cessation because some naturally disturbed sites recovered "within five to 10 years, after being completely obliterated by a single volcanic event."[123] Likewise, some researchers believe that these ecosystems developed resilience in response to volcanic disturbances.[124] Inactive vent sites are also less likely to suffer serious losses of biodiversity because the vent's iconic and endemic species tend to die off quickly after hydrothermal activity stops.[125] However, the rarity

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[115] *Id.*
[116] *See* Levin et al., *supra* note 2, at 251.
[117] INT'L SEABED AUTH., *supra* note 100.
[118] Levin et al., *supra* note 2, at 251.
[119] *Id.*
[120] Hartley, *supra* note 2, at 360.
[121] *Id.* at 361.
[122] *Id.*
[123] Carrington, *supra* note 29.
[124] INT'L SEABED AUTH., *supra* note 100.
[125] KOSLOW, *supra* note 30, at 172; Levin et al., *supra* note 2, at 252.

and endemic nature of many vent species still carries the risk of extinction if mining operations destroy the base population.[126]

D. Methane Hydrates and the Continental Shelf

The most recent discovery of deep-sea resources is the massive reserves of methane hydrate in continental slope sediments.[127] Methane hydrate is a naturally occurring clathrate—"a chemical compound in which molecules of one material (the 'host') form a solid lattice that encloses molecules of another material (the 'guest')."[128] Essentially, if buoyant natural gas seeps from the ocean floor into a "zone of hydrate stability"—an area of sufficiently cold temperatures and high pressure—the gas combines with the water such that the methane molecules become trapped in cubic ice lattices.[129] Although these frozen natural gas deposits vary in size, they are all "extremely large."[130] For example, "North and South Carolina alone contain more than 37 trillion cubic meters of methane gas, more than 70 times the US gas consumption in 1989,"[131] and seabed hydrates overall "have been estimated to contain twice the carbon in all known coal, oil and natural gas reserves."[132] Likewise, the deposits are highly concentrated, where "one cubic foot of solid methane hydrate will release about 164 cubic feet of methane gas."[133]

However, methane hydrate is also "tied to its environment—it requires very specific conditions to form and remain stable."[134] In the marine environment, methane hydrates are typically found in the Arctic Ocean and along outer continental shelves because these are "natural settings where methane and water are present, and where pressure and temperature conditions are suitable to form and sustain hydrate."[135]

Despite being the most difficult and expensive source of natural gas to recover,[136] methane hydrates still hold vast potential as an energy

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[126] INT'L SEABED AUTH., *supra* note 100.
[127] KOSLOW, *supra* note 30, at 173.
[128] NAT'L ENERGY TECH. LAB., ENERGY RESOURCE POTENTIAL OF METHANE HYDRATE: AN INTRODUCTION TO THE SCIENCE AND ENERGY POTENTIAL OF A UNIQUE RESOURCE 8 (2011).
[129] KOSLOW, *supra* note 30, at 173–74; NAT'L ENERGY TECH. LAB., *supra* note 128, at 10.
[130] KOSLOW, *supra* note 30, at 173–74.
[131] *Id.* at 173.
[132] Schofield, *supra* note 15, at 724.
[133] NAT'L ENERGY TECH. LAB., *supra* note 128, at 9.
[134] *Id.* at 8.
[135] *Id.* at 9.
[136] Schofield, *supra* note 15, at 725.

source.[137] Because natural gas "currently accounts for nearly a quarter of the U.S. energy supply," a share predicted to remain constant, domestic production must increase by 10 percent over the next twenty-five years "to keep pace with rising consumption."[138] Given these continually increasing natural gas demands, methane hydrate sources could provide abundant natural gas resources for energy independence and cheaper energy supplies, especially in nations like Japan, a country that imports over 90 percent of its energy supply.[139]

However, "[t]he potential environmental risks from methane hydrate extraction are as poorly understood as the methods that will be required to extract the gas commercially from its matrix of sediment and ice."[140] Concerns include methane losses to the atmosphere; exacerbating global warming; immediate, deadly destruction of industry vessels from explosions; and potential sea floor instability and underwater landslides after removal.[141]

II. SEABED EXPLORATION AND THE DEVELOPMENT OF UNCLOS III

A. *Historical Explorations of the Seabed*

Oceans cover three-quarters of the Earth, contain 97 percent of the planet's water, and "represent 99 percent of the living space on the planet by volume."[142] Nevertheless, throughout most of human history, civilizations viewed the seabed as a barren desert[143] and the sea as the dangerous home of lurking monsters.[144] In fact, as Socrates prepared for his death in ancient Greece, he argued that heaven would be as superior to earth as land is to the sea, because "in the sea all things are corroded by the brine, neither is there any noble or perfect growth, but caverns only, and sand, and an endless slough of mud."[145] This view of the sea persisted until the early nineteenth century, when scientists and explorers wondered if

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137 *Id.* at 725–26; *see* NAT'L ENERGY TECH. LAB., *supra* note 128, at 4.
138 NAT'L ENERGY TECH. LAB., *supra* note 128, at 4.
139 Lazarus, *supra* note 20; REUTERS, *supra* note 25.
140 KOSLOW, *supra* note 30, at 174.
141 *Id.*
142 *Goal 14: Conserve and sustainably use the oceans, seas and marine resources*, UNITED NATIONS, http://www.un.org/sustainabledevelopment/oceans/ [https://perma.cc/U87X-RLKF] (last visited Oct. 28, 2019).
143 KOSLOW, *supra* note 30, at 10.
144 Alder, *supra* note 1.
145 PLATO, DIALOGUES OF PLATO 242–43 (Cynthia Brantley Johnson ed., Benjamin Jowett trans., Simon & Schuster Paperbacks 2013).

more lay at the bottom of the deep sea than their ancient predecessors had ever realized.[146]

Explorations of the deep sea began early in the nineteenth century, including naturalist Edward Forbes's 1841 expedition on the *H.M.S. Beacon* around the Aegean Sea.[147] Other expeditions—including Captain John Ross's 1818 Northwest Passage exploration and Sir James Clark Ross's 1839 Antarctic voyage—used blacksmith-forged devices to dredge samples from up to 2000 meters beneath the water's surface.[148] Dredging pulled up numerous creatures, including shellfish, worms, crustaceans, corals, and even the rare and beautiful Medusa's head, or basket starfish.[149] Sir James Ross found the seabed to be "teeming with animal life" and concluded that "the extreme pressure at the greatest depth does not appear to affect these creatures."[150]

However, as helpful and insightful as these early expeditions were to understanding what lay beneath the sea's surface, these early explorers focused on surface exploration, not deep-sea ecology or zoological scholarship.[151] Specimens from the expeditions deteriorated without proper preservation techniques, and the explorers often failed to publish their discoveries in zoological journals.[152] In contrast, the *H.M.S. Challenger* expedition from 1872 to 1876 focused entirely on the science and geography of the deep sea floor.[153] The expedition's purposes included mapping the seabed, determining the chemistry of the oceans, and finding a global pattern of deep-water circulation.[154] By the time the *Challenger* returned to England, the ship had logged approximately 69,000 miles, crossed both the Atlantic and Pacific Oceans, and reached the edge of Antarctica (see Figure D).[155] Ultimately, the *Challenger*'s discoveries took twenty years to fully explain, filled fifty volumes of publications, and became the foundation of modern oceanography.[156]

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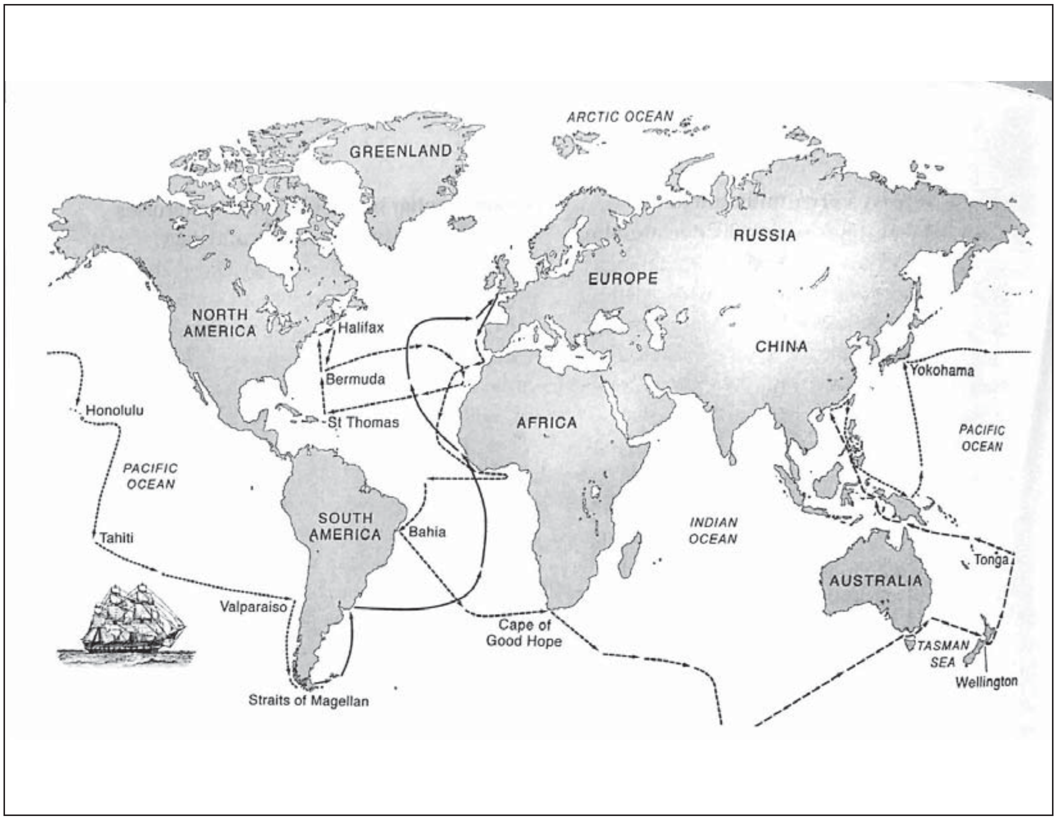
[146] KOSLOW, *supra* note 30, at 14.
[147] *Id.* at 14–15.
[148] *Id.* at 16–17.
[149] *Id.*
[150] *Id.* at 17.
[151] *See id.*
[152] KOSLOW, *supra* note 30, at 17.
[153] *Id.* at 23.
[154] *Id.* at 23.
[155] *Id.* at 30.
[156] *Id.* at 32; *Deep Seabed Mineral Resources*, INT'L SEABED AUTHORITY, https://www.isa.org.jm/mineral-resources/55 [https://perma.cc/755B-5AQ6] (last visited Oct. 28, 2019); Tina Bishop et al., *Then and Now: The HMS Challenger Expedition and the "Mountains in the Sea" Expedition*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://oceanexplorer.noaa

Perhaps the most enduring contribution of the *Challenger* is its discovery of minerals and diverse species along the sea floor, including the marvel that polymetallic nodules litter vast sections of most ocean floors.[157] These nodules, along with other mineral deposits, led nations to wonder if the sea could be mined.[158]

Figure D: Track of the H.M.S. Challenger, 1872–1876[159]



B. Historical Development of Laws over the Seas

The law of the sea dates back to ancient empires and philosophies, where the Greeks developed early maritime laws and the Romans

.gov/explorations/03mountains/background/challenger/challenger.html [https://perma.cc/PF3N-CF5Z] (last updated Dec. 18, 2017).

[157] Polymetallic nodules are also called manganese nodules. KOSLOW, *supra* note 30, at 34; INT'L SEABED AUTH., *supra* note 39.

[158] INT'L SEABED AUTH., *supra* note 39.

[159] KOSLOW*, supra* note 30, at 30.

established the "freedom of the seas" doctrine.[160] In the second century, the Roman jurist Marcianus declared the sea, fish, and coastal waters "*communis omnium naturali jure*," or "common or open to all men by the operation of *natural law*."[161] Declaring the sea *res communis* made it "incapable of being appropriated, open to the common use of all men."[162]

However, with the later (fifteenth and sixteenth centuries) escalation of European exploration, maritime conflicts broke out between competing states, especially over trade routes, fishing rights, taxes, and policing.[163] It was in this period of competition and colonization that the Dutch jurist Hugo Grotius penned *Mare Liberum*, a natural law approach that restated the Roman doctrine of the seas as *res communis* and rejected appropriation of the seas.[164] He also advocated for the freedom of the seas, a "laissez-faire philosophy" that would allow explorers, traders, and fishermen to use the sea as needed.[165] Published in 1609, Grotius's treatise laid a foundation for international law.[166]

However, modern conflicts and technological improvements led to multiple rules, conferences, and claims over the ocean throughout the twentieth century.[167] In 1911, nations began to extend claims for territorial seas out to six miles, well beyond the historic three-mile "cannon-shot doctrine," while World War I lead to assertions for a contiguous zone so nations could enforce criminal laws at sea.[168] Finally, after World War II, the United States issued two proclamations claiming fishing and regulatory authority beyond traditional marine boundaries, as well as exclusive rights to natural resources on the continental shelf along U.S. coasts.[169] Other countries soon followed suit.[170]

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[160] Peter Prows, *Tough Love: The Dramatic Birth and Looming Demise of UNCLOS Property Law (and What Is to Be Done About It)*, 42 TEX. INT'L L.J. 241, 249 (2007).
[161] *Id.*
[162] Percy Thomas Fenn, Jr., *Justinian and the Freedom of the Sea*, 19 AM. J. INT'L L. 716, 727 (1925).
[163] Prows, *supra* note 160, at 249.
[164] *Id.* at 249–50.
[165] *Id.* at 250.
[166] *See id.* at 250–51.
[167] *See id.* at 251–53.
[168] *Id.*
[169] Harry S. Truman, Presidential Proclamation 2667: Policy of the United States with Respect to the Natural Resources of the Subsoil and Seabed of the Continental Shelf, 10 Fed. Reg. 12,303 (Sept. 28, 1945); Harry S. Truman, Presidential Proclamation 2668: Policy of the United States With Respect to Coastal Fisheries in Certain Areas of the High Seas, 10 Fed. Reg. 12,303 (Sept. 28, 1945).
[170] Prows, *supra* note 160, at 253.

C. *Modern Mining Interests and the Development of UNCLOS*

While polymetallic nodules remained a simple spectacle in the nineteenth century, after World War II, nations across the globe began to speculate as to whether deep-sea mining could be economical, with "technology and international price points . . . in place to make deep seabed mining a commercial reality" as early as the 1970s.[171] However, even early on, when countries first considered mining the seabed, only the United States, France, Germany, and the Soviet Union had the capital and technology necessary to attempt nodule mining.[172] Concerns over monopolization and the fear that these minerals would enrich only a handful of nations lead to the 1967 speech by Malta's ambassador, Arvid Pardo, to the United Nations General Assembly.[173] Pardo argued that the seabed was the "common heritage of all mankind," a source of untold wealth to be exploited for the benefit of all nations.[174]

This sentiment struck a chord with many nations, both world powers and developing states, and led to the 1973 United Nations Conference on the Law of the Sea, the third international attempt to establish and codify international regulations over the sea and seabed[175] and which resulted in the comprehensive third United Nations Convention on the Law of the Sea, or UNCLOS III.[176] However, despite the United States' "substantial influence and involvement in developing UNCLOS," President Ronald Reagan declined to sign the final 1982 treaty,[177] citing a problematic provision: Part XI, which governed deep sea mining in international waters.[178] More specifically, the administration opposed the 1982 UNCLOS III provisions that declared the deep seabed to be the common heritage of humankind, requiring seabed mining technology exchanges and mining royalties,

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[171] Hartley, *supra* note 2, at 335.
[172] KOSLOW, *supra* note 30, at 167.
[173] U.N. GAOR, 22d Sess., 1515th mtg. at 14, U.N. Doc. A/C.1/PV.1515 (Nov. 1, 1967).
[174] *Id.*
[175] Hartley, *supra* note 2, at 335–36; Tong, *supra* note 7, at 321–22.
[176] Tong, *supra* note 7, at 322.
[177] *Id.*
[178] *See* Raul Pedrozo, *Arctic Climate Change and U.S. Accession to the United Nations Convention on the Law of the Sea*, 89 INT'L L. STUD. 757, 760–61 (2013); Ronald Reagan, Statement on United States Participation in the Third United Nations Conference on the Law of the Sea (Jan. 29, 1982), https://www.reaganlibrary.gov/research/speeches/12982b [https://perma.cc/5YTH-ANYM]. *See generally* United Nation Convention on the Law of the Sea, Part XI, Dec. 10, 1982, 1833 U.N.T.S. 397, 445–77 [hereinafter UNCLOS].

and expressed concerns over the lack of veto powers and creation of an international mining organization.[179]

To rectify these disputes, and ensure greater participation in and compliance with the treaty, nations renegotiated UNCLOS in 1994 to eliminate mandatory technology transfers between states, give veto powers to council member nations, limit international mining regulatory authority under UNCLOS III, and restrict the seabed mining royalties.[180] U.S. President Bill Clinton signed the amended UNCLOS treaty, but the Senate refused to ratify it.[181] Despite long-standing bipartisan support for UNCLOS III from Presidents, military leaders, and congressional representatives, the United States has never ratified UNCLOS.[182] Even after President Barack Obama's push for ratification in 2012, thirty-four conservative senators blocked the required two-thirds majority for the signed treaty to become law.[183]

Nevertheless, the United States is an outlier. Today, nations' expanded jurisdiction over the ocean has been codified in UNCLOS III,[184] and it remains a powerful treaty with 168 party countries.[185] Indeed, even the United States follows many of its rules as customary international law.[186]

The most important provisions of UNCLOS determine various boundaries of national jurisdiction out into the ocean: essentially, the first twelve nautical miles from the coast are the territorial sea, while the twenty-fourth nautical mile marks the end of the contiguous zone, and the 200th nautical mile marks the outer limit of the Exclusive Economic

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[179] *See* Tong, *supra* note 7, at 322–24.

[180] Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, title 6(a), 1836 U.N.T.S. 3; July 28, 1994; Tong, *supra* note 7, at 324; Elliot L. Richardson, *Treasure Beneath the Sea*, N.Y. TIMES (July 30, 1994), http://www.nytimes.com/1994/07/30/opinion/treasure-beneath-the-sea.html [https://perma.cc/WK3T-MF37].

[181] Tong, *supra* note 7, at 324.

[182] *Id.* at 324–26; David Bosco, *What's the One U.N. Treaty Trump Should Love?,* FOREIGN POL'Y (Sept. 19, 2017), https://foreignpolicy.com/2017/09/19/whats-the-one-u-n-treaty-trump-should-love/ [https://perma.cc/X8B2-NK8E].

[183] U.S. CONST. art. II, § 2; Austin Wright*, Law of the Sea treaty sinks in Senate*, POLITICO (July 16, 2012), http://www.politico.com/story/2012/07/law-of-the-sea-treaty-sinks-in-senate-078568 [https://perma.cc/RV5K-5TGN].

[184] *See* UNCLOS, *supra* note 178, at 44.

[185] *Chronological Lists of Ratifications*, UNITED NATIONS, http://www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm [https://perma.cc/LS9U-CHFS] (last updated Apr. 8, 2019).

[186] *See* Tong, *supra* note 7, at 324 ("The United States has long accepted the UN Convention on the Law of the Sea as embodying international law concerning traditional uses of the oceans.").

Zone ("EEZ").[187] This 200-nautical-mile zone also gives a country inherent rights over its continental shelf,[188] which is governed by other statutory provisions.[189]

A state may apply to the United Nations Commission on the Limits of the Continental Shelf to extend its national jurisdiction over its continental shelf beyond the 200-nautical-mile mark when there is a natural prolongation of the continental shelf, up to 350 nautical miles out; however, anything beyond 200 nautical miles remains subject to the sharing rules for the Area (see below).[190] For the purposes of this Article, however, it is sufficient to know that national jurisdiction does not extend beyond the EEZ (200 nautical miles from shore) and that nations retain expansive freedoms on the high seas beyond those boundaries.[191]

D. Deep-Sea Mining Under UNCLOS III: The Area

1. The International Seabed Authority and Its General Principles

UNCLOS III governs deep-sea mining of the "Area"—"the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction."[192] "Resources" is defined as "all solid, liquid or gaseous mineral resources *in situ* in the Area at or beneath the seabed, including polymetallic nodules."[193] "[R]esources . . . are referred to as 'minerals'" after recovery from the Area.[194]

Both the international seabed and its resources are the common heritage of mankind, and therefore Area activities must be conducted for

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[187] UNCLOS, *supra* note 178, at 27, 35, 44.

[188] North Sea Continental Shelf Cases (Ger./Neth.; Ger./Den.), Judgment, 1969 I.C.J. 3, ¶ 19 (Feb. 20) ("the rights of the coastal State in respect of the area of continental shelf that constitutes a natural prolongation of its land territory into and under the sea exist *ipso facto* and *ab initio,* by virtue of its sovereignty over the land, and as an extension of it in an exercise of sovereign rights for the purpose of exploring the seabed and exploiting its natural resources. In short, there is here an inherent right.").

[189] The U.S. Congress passed the Outer Continental Shelf Lands Act (OCSLA) in 1953 to extend U.S. jurisdiction over submerged lands and control the natural resources (primarily oil and gas) found there. *OCS Lands Act History*, BUREAU OF OCEAN ENERGY MGMT., https://www.boem.gov/ocs-lands-act-history/ [https://perma.cc/J5DN-GH3U] (last visited Oct. 28, 2019).

[190] Schofield, *supra* note 15, at 718; *Commission on the Limits of the Continental Shelf (CLCS): Purpose, functions and sessions*, UNITED NATIONS, http://www.un.org/depts/los/clcs_new/clcs_home.htm [https://perma.cc/BU35-785J] (last visited Oct. 28, 2019).

[191] *See generally* UNCLOS, *supra* note 178, at 44, 57.

[192] *Id.* at 25–26.

[193] *Id.* at 69.

[194] *Id.*

the benefit of all humanity.[195] Pursuant to UNCLOS III, states that mine the deep seabed must distribute economic shares to developing states,[196] encourage and complete marine scientific research,[197] promote the transfer of technology and scientific knowledge among States,[198] and promote the participation of developing states in activities within the Area.[199] The International Seabed Authority ("ISA" or "Authority") ensures implementation of each of these requirements.[200] This regulatory authority is vested by UNCLOS III and grants the ISA powers to establish rules and procedures for mining, mineral rights, and the subsequent distribution of wealth to developing states.[201]

As the driving force behind UNCLOS III's creation, the common heritage principle remains key in seabed administration under UNCLOS III and Part XI.[202] Because UNCLOS III defines the Area as the "common heritage of mankind," the seabed and its resources cannot "[be] subject to direct claims by sovereign states."[203] In addition, this egalitarian principle is the basis for monetary redistribution of mining royalties to developing states, so that all nations may profit from these lucrative *res communis* minerals.[204]

Though some authors interpret this principle to strictly require communal environmental protection,[205] UNCLOS III's history and purpose make that interpretation unlikely:

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[195] *Id.* at 70–71.
[196] *Id.* at 71.
[197] UNCLOS, *supra* note 178, at 72.
[198] *Id.*
[199] *Id.* at 74.
[200] *Id.* at 70–71.
[201] *See id.*
[202] *See id.* at 25; Marie Bourrel et al., *The Common Heritage of Mankind as a Means to Assess and Advance Equity in Deep Sea Mining*, MARINE POL'Y 1, 2 (2016); Tong, *supra* note 7, at 321–22.
[203] Charles W. Schmidt, *Going Deep: Cautious Steps Toward Seabed Mining*, 123 ENVTL. HEALTH PERSP. A235, A236 (2015).
[204] UNCLOS III does not define developing states, but explains that the Area's resources must benefit mankind as a whole,

> irrespective of the geographical location of States, whether coastal or land-locked, and taking into particular consideration the interests and needs of developing States and of peoples who have not attained full independence or other self-governing status recognized by the United Nations in accordance with General Assembly resolution 1514 (XV) and other relevant General Assembly resolutions.

UNCLOS, *supra* note 178, at 70; *see also id.* at 71; U.N. GAOR, 22d Sess., *supra* note 173, at 14; Fenn, *supra* note 162, at 727.
[205] Hartley, *supra* note 2, at 350–51.

> Desiring by this Convention to develop the principles embodied in resolution 2749 (XXV) of 17 December 1970 in which the General Assembly of the United Nations solemnly declared inter alia 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, *the exploration and exploitation of which shall be carried out for the benefit of mankind as a whole*, irrespective of the geographical location of States, ...[206]

"Shall" implies obligation, not exemption. When reading the UNCLOS III in full—including the ISA's multiple use obligations[207] and the common heritage principle[208]—UNCLOS III instead appears to require sustainable exploitation of seabed resources.[209]

Nevertheless, environmental protection is also required under UNCLOS III. More specifically, the ISA must "ensure effective protection for the marine environment from harmful effects."[210] The ISA 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 coastline, and of interference with the ecological balance of the marine environment, [paying particular attention to mining 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.[211]

In reading these statutory provisions together, UNCLOS III requires balancing mineral development with marine conservation in a "kind of trusteeship obligation on the ISA" to respect the economic and environmental interests of future generations.[212]

2. The ISA and the International Mining Code

The ISA has three primary organs pursuant to UNCLOS III: the Assembly, Council, and Secretariat, as well as the Enterprise, which carries

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[206] UNCLOS, *supra* note 178, at 25 (emphasis added).
[207] *See id.* at 71.
[208] *Id.* at 70–71.
[209] *See id.*
[210] *Id.* at 73.
[211] *Id.*
[212] Wedding et al., *supra* note 47, at 144.

out activities in the Area.[213] The Enterprise, however, has yet to undertake any mining operations.[214] The Assembly is the "supreme organ" of the ISA, with powers to organize the budget, elect the Council and Secretary-General, and approve proposed rules and regulations.[215] As the executive organ, the Council consists of thirty-six members elected "according to a complex formula" for diverse representation.[216] The Council develops the ISA's policies, including all mining regulations, license approvals, emergency orders, and regulations to prevent environmental harm.[217] Finally, the Secretariat is the administrative body charged with "day-to-day administration."[218] As of 2019, the ISA has issued comprehensive mining rules, regulations, and procedures (known collectively as the "Mining Code") for each type of mineral deposit in the seabed: polymetallic nodules (adopted July 2000, updated July 2013), polymetallic sulfide deposits (adopted May 2010), and cobalt crusts (adopted July 2012).[219] Each deposit type requires its own specific set of regulations and procedures because both the mining methods and environmental concerns in each setting differ radically from another.[220] Nevertheless, the Mining Code universally applies the precautionary approach[221] and prohibits prospecting where "serious harm to the marine environment" can occur.[222] ISA regulations define "serious harm" as:

> any effect from activities in the Area on the marine environment which represents a significant adverse change in the

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[213] UNCLOS, *supra* note 178, at 81.
[214] Hartley, *supra* note 2, at 342.
[215] UNCLOS, *supra* note 178, at 82–83.
[216] *See id.* at 84; Hartley, *supra* note 2, at 341–42.
[217] UNCLOS, *supra* note 178, at 86; Hartley, *supra* note 2, at 342.
[218] UNCLOS, *supra* note 178, at 92; Hartley, *supra* note 2, at 342.
[219] *The Mining Code*, INT'L SEABED AUTH., https://www.isa.org.jm/mining-code [https://perma.cc/4DDP-BBZM] (last visited Oct. 28, 2019).
[220] Hartley, *supra* note 2, at 352.
[221] Int'l Seabed Auth., *Decision of the Council of the International Seabed Authority Relating to Amendments to the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area and Related Matters*, at 4, 6, ISBA/19/C/17 (July 22, 2013) [hereinafter *Nodules*]; Int'l Seabed Auth., *Decision of the Assembly of the International Seabed Authority Relating to the Regulations on Prospecting and Exploration for Cobalt-Rich Ferromanganese Crusts in the Area*, at 3, 5, ISBA/18/A/11 (Oct. 22, 2012) [hereinafter *Cobalt Crusts*]; Int'l Seabed Auth., *Decision of the Assembly of the International Seabed Authority Relating to the Regulations on Prospecting and Exploration for Polymetallic Sulfides in the Area*, at 3, 5, ISBA/16/A/12/Rev.1 (Nov. 15, 2010) [hereinafter *Sulfides*].
[222] *Nodules*, *supra* note 221, at 4; *Cobalt Crusts*, *supra* note 221, at 3; *Sulfides*, *supra* note 221, at 3.

> marine environment determined according to the rules, regulations and procedures adopted by the Authority on the basis of internationally recognized standards and practices.[223]

Because "[t]he potential for serious harm entails serious [environmental] consequences," this standard ensures the "best environmental practices and the precautionary approach."[224]

Similar standards were applied by the United Nations Food and Agricultural Organization ("FAO") to deep-sea bottom fishing on the high seas in 2009, requiring consideration of several factors to assess the existence of "significant adverse impacts" to ecosystem integrity: impact severity, spatial extent, ecosystem sensitivity, impact timing and duration, ecosystem alterations, probability of future impacts, cumulative effects, and scientific uncertainty.[225] However, the deep sea remains a complex, remote, and expansive environment; its study is filled with "major knowledge gaps" making the assessment of anthropogenic impacts problematic, including determining whether those effects are "enduring or transitory."[226]

More recently, advocates have encouraged the ISA to adopt the precautionary approach, a management concept that embraces early-stage environmental protections, even where "there is potential hazard but scientific uncertainty as to the impact."[227] Consequently, the ISA "pioneered a precautionary approach" in 2012 by adopting the deep seabed's first environmental management plan and designating nine Areas of Particular Environmental Interest ("APEIs").[228] The APEIs are effectively no-mining zones within the CCZ and they protect approximately 20 percent of the CCZ's seamounts, as well as species and habitats within several zones of the CCZ's abyssal plains.[229]

The ISA specifically designed the APEIs to conserve healthy marine environments, minimize socioeconomic impacts by exploratory license holders, protect species and habitats, create buffer zones, account

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[223] *Nodules*, *supra* note 221, at 4; *Cobalt Crusts*, *supra* note 221, at 3; *Sulfides*, *supra* note 221, at 3.
[224] Levin et al., *supra* note 2, at 246.
[225] *Id.* at 248.
[226] *Id.*
[227] Hartley, *supra* note 2, at 344; Wedding et al., *supra* note 47, at 144.
[228] Wedding et al., *supra* note 47, at 145; *Biodiversity*, INT'L SEABED AUTH., https://www.isa.org.jm/biodiversity-0 [https://perma.cc/YE86-GS97] (last visited Oct. 28, 2019).
[229] Miles Macmillan-Lawler & Peter Townsend Harris, *Multivariate Classification of Seamount Morphology: Assessing Seamount Morphotypes in Relation to Marine Jurisdictions and Bioregions*, *in* OCEAN SOLUTIONS, EARTH SOLUTIONS 329, 357 (2d ed., Dawn J. Wright ed., 2016); Wedding et al., *supra* note 47, at 145; INT'L SEABED AUTH., *supra* note 228.

for regional ecological gradients, and establish straight-line boundaries for prompt recognition and compliance.[230] Nevertheless, these APEI designations only exist within the CCZ and they remain subject to ISA modification and review, meaning they could be expanded, modified, or removed.[231]

E. *The United States and UNCLOS III*

The United States remains a "glaring absence" from the treaty it helped write, largely because of political controversies over Part XI and its common heritage principle.[232] Because Part XI requires economic benefits from mining to be shared with developing states, the United States rejected UNCLOS III under the then-new President Ronald Reagan.[233] The Reagan administration, and multiple legislators since then, have viewed Part XI as an infringement on national sovereignty and expressed concerns over the economic distributions to developing states.[234] Skeptics of UNCLOS III were especially concerned about funds going to dictators or terrorism networks, in addition to apprehension over the conflicting ISA goals to distribute royalties to developing states while protecting the marine environment.[235]

Despite long-standing bipartisan political support since the 1994 changes to UNCLOS III, the Senate still has not ratified the treaty, a critical step for the United States to be bound by the marine legal regime governing most of the world.[236] In addition, while some politicians still object to the distribution of royalties, the United States has continually upheld the common heritage principle.[237] President Johnson in 1966 and President

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[230] Wedding et al., *supra* note 47, at 145.
[231] *Id.*; *see also* Int'l Seabed Auth., *Environmental Management Plan for the Clarion-Clipperton Zone*, at 13, ISBA/17/LTC/7 (July 13, 2011).
[232] Tong, *supra* note 7, at 318–19.
[233] *Id.*
[234] Pedrozo, *supra* note 178, at 762–63; Tong, *supra* note 7, at 318–19; Steven Groves, *U.N. Convention on the Law of the Sea Erodes U.S. Sovereignty over U.S. Extended Continental Shelf*, THE HERITAGE FOUNDATION (June 7, 2011), http://www.heritage.org/report/un-convention-the-law-the-sea-erodes-us-sovereignty-over-us-extended-continental-shelf [https://perma.cc/P4BW-WC6M].
[235] James D. Brousseau, *Frozen in Time: A Fresh Look at the Law of the Sea and Why the United States Continues to Fight Against It*, 42 S.U. L. REV. 143, 161 (2014); Schmidt, *supra* note 203, at A236.
[236] Tong, *supra* note 7, at 324–25; Bosco, *supra* note 182.
[237] 30 U.S.C. § 1401(a)(7) (1980) ("on December 17, 1970, the United States supported (by affirmative vote) the United Nations General Assembly Resolution 2749 (XXV) declaring inter alia the principle that the mineral resources of the deep seabed are the common heritage of mankind"); Bourrel et al., *supra* note 202, at 2.

Nixon in 1970, for example, "expressly recognised the principle as being at the core of the common regime of utilisation for the resources of the seabed."[238] Opposition to UNCLOS III should also recognize that Part XI of UNCLOS was meant to evolve and develop in tandem with expanding technical expertise and scientific knowledge of the deep sea.[239] Thus, Part XI primarily imposes obligations on the ISA and grants it broad authority to develop appropriate mining regulations.[240]

III. SEABED MINING IN THE LATE 20TH AND 21ST CENTURIES

Even during the renegotiation of UNCLOS III, industries never fully developed any actual deep-sea mining interests because it proved expensive and politically controversial and because new mineral deposits were discovered on land.[241] Ultimately, while nodule mining was "generally considered technically feasible, it [was not] economically viable, largely due to depressed global metal prices since the early 1980s."[242] Only in the last several years has deep-sea mining gained ground as an economically viable mining method to meet increasing natural resource demands.[243]

A. *Increasing Interests in Seabed Minerals: Economic and Technological Changes*

1. Global Terrestrial Mineral Reserves: Bleak Trends and Forecasts

Forecasts predict declines in the long-term supplies of minerals from terrestrial reserves over the next century, while mineral demand should steadily rise and outpace supplies.[244] Copper production, for example, will

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[238] Bourrel et al., *supra* note 202, at 2.
[239] *See* UNCLOS, *supra* note 178, at 71–73 (ISA shall provide equitable sharing of economic benefits derived from Area activities, ISA shall adopt rules to promote marine scientific research, ISA shall adopt rules to protect marine environment, ISA shall adopt rules to protect human life); Tong, *supra* note 7, at 326–27.
[240] *See* UNCLOS, *supra* note 178, at 71–73 (ISA shall provide equitable sharing of economic benefits derived from Area activities, ISA shall adopt rules to promote marine scientific research, ISA shall adopt rules to protect marine environment, ISA shall adopt rules to protect human life); Tong, *supra* note 7, at 326–27.
[241] Hartley, *supra* note 2, at 336.
[242] KOSLOW, *supra* note 30, at 166–67.
[243] *Deep-Sea Mining Remains Out of Reach, For Now*, STRATFOR (May 13, 2016), https://worldview.stratfor.com/article/deep-sea-mining-remains-out-reach-now [https://perma.cc/VD5A-827D].
[244] Bolong, *supra* note 16, at 128, 130–31.

start to decline as early as 2030, and by 2100 "the 1.7 billion tons demand will far exceed the 1.6 billion tons of cumulative reserves."[245] Likewise, the United States faces declines in mining and exploration investment, including the huge 35 percent drop in 2015.[246] The U.S. Geological Survey has reported that "[o]ne consequence of the decline in early-stage exploration in the last decade is that the number of viable, large-scale assets available for potential development has declined."[247]

These declining supplies create major problems for economic and technological development because minerals—especially rare earth elements—are required for a variety of modern and green energy technologies critical to the United States and other nations, including photovoltaic solar cells, solar energy storage, computer chips, cell phones, hybrid and electric car batteries, high-temperature superalloys and superconductors, energy-saving lighting, wind turbines, nuclear energy, and hydrogen fuel cells.[248] For example, an electricity-generating solar (photovoltaic) cell uses minerals like cadmium, gallium, germanium, indium, selenium, and tellurium to construct the semiconductor films that produce positive and negative charges.[249] These minerals are typically "recovered as byproducts" from other metal productions, but are "critical to varying extents for the efficient operation of photovoltaic cells."[250] Meanwhile, the front and back

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[245] *Id.* at 131.

[246] *U.S. mining and exploration investment declined 35% in 2015*, U.S. ENERGY INFO. ADMIN. (Feb. 10, 2016), https://www.eia.gov/todayinenergy/detail.php?id=24912 [https://perma.cc/87S3-AFMM] ("Mining and exploration investment declined 35% in 2015, the second largest year-over-year decline since the U.S. Bureau of Economic Analysis (BEA) began reporting the series in 1948. Most mining and exploration investment reflects petroleum exploration and development, but the category also includes natural gas, coal, and other minerals. Mining and exploration investment declined from $135 billion in 2014 to $87.7 billion in 2015, weighing down investment growth more than any other segment of nonresidential investment. Total private fixed investment, of which mining and exploration is a small subset, grew 4% in 2015 to $2.7 trillion. Low commodity prices remain a significant factor in U.S. firms' investment decisions.").

[247] D.R. Wilburn & N.A. Karl, *Annual Review 2015: Exploration Review*, MINING ENGINEERING MAG. 30, 34 (2016).

[248] *See* Bolong, *supra* note 16, at 132 n.21; *Critical Minerals for the EU Economy: Foresight to 2030*, EUROPEAN COMM'N, https://www2.warwick.ac.uk/fac/soc/pais/research/researchcentres/csgr/green/foresight/economy/2013_ec_critical_minerals_for_the_eu_economy_-_foresight_to_2030.pdf [https://perma.cc/47TY-QA4H] (last visited Oct. 28, 2019).

[249] Donald I. Bleiwas, *Byproduct Mineral Commodities Used For the Production of Photovoltaic Cells*, U.S. GEOLOGICAL SURVEY 2 (2010), https://pubs.usgs.gov/circ/1365/Circ1365.pdf [https://perma.cc/7CFY-R9LQ].

[250] *Id.*

contacts of the cell are made of conductive metals, like aluminum, copper, gold, molybdenum, and silver.[251]

The United States depends heavily on foreign imports for several commodities, including manganese, cobalt, and platinum.[252] For example, in 2016 "imports made up more than one-half of the U.S. apparent consumption of 50 nonfuel mineral commodities, and the United States was 100% import reliant for 20 of those."[253] These numbers have increased "from 47 and 19 nonfuel mineral commodities, respectively, in 2015."[254] In addition, the United States relied on imports for another thirty mineral commodities, and exported only sixteen nonfuel mineral commodities.[255] In fact, in 2016 the United States relied on imports for 100 percent of its manganese, 100 percent of its rare earth minerals, 91 percent of titanium (mineral concentrates), 74 percent of its cobalt, 67 percent of its silver, and 34 percent of its copper consumption.[256]

Rare earth minerals are particularly important for use in communications, computing, and weaponry; however, most of the globe's rare earth minerals come from China, which forces other nations to consider the "security of supply."[257] The seabed offers potential deposits to U.S. mining companies, and reaching into the abyss for those minerals may increase supplies such as to prevent international monopolies over reserves.[258] For example, from 2010 to 2015, China imposed strict exportation limits on rare earth elements, of which China produces 96 percent of the global supply.[259] China's exportation limits were reportedly "an economic weapon" used in retaliation against Japan over the nations' longstanding territorial dispute over the Senkaku/Diaoyu Islands.[260]

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[251] *Id.*

[252] *See Mineral Commodity Summaries 2017*, U.S. GEOLOGICAL SURVEY 6 (2017), https://minerals.usgs.gov/minerals/pubs/mcs/2017/mcs2017.pdf [https://perma.cc/B786-WX4P].

[253] *Id.* at 7.

[254] *Id.*

[255] *Id.*

[256] *Id.* at 6.

[257] Carrington, *supra* note 29; *see also Rare Earth Elements*, BRITISH GEOLOGICAL SURVEY 22 (2011), https://pdfs.semanticscholar.org/6b7d/727a84f4cae48c032799a46cf6a688f512aa.pdf [https://perma.cc/9RHJ-LXN2].

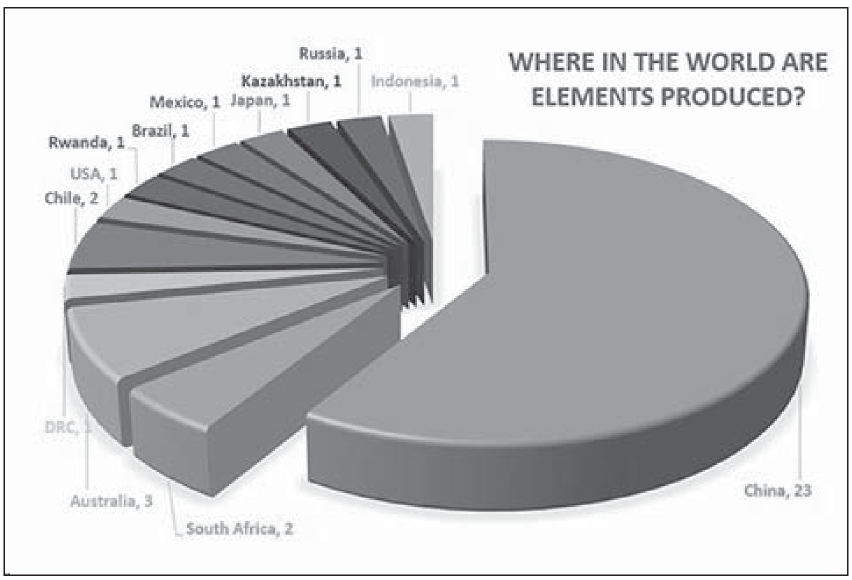
[258] Bolong, *supra* note 16, at 134–35.

[259] *Id.*

[260] Known as the Senkaku Islands in Japan and the Diaoyu Islands in China, these disputed uninhabited islands offer rich fishing grounds, oil and gas deposits, and a strategic location near shipping lanes. Bolong, *supra* note 16, at 134–35; *How uninhabited islands soured China-Japan ties*, BBC (Nov. 10, 2014), http://www.bbc.com/news/world-asia-pacific-11341139 [https://perma.cc/4WG3-GMSN].

Despite concerns over mineral supplies and monopoly,[261] China remains the leading global producer of twenty-three mineral commodities of economic value (see Figure E), and it provided approximately 72 percent of the rare earth minerals that the United States imported in 2016.[262] Based on current market trends, China should continue to play a leading role in production and reserves for metals essential for green technology.[263] In addition, Chile, Peru, and Bolivia should remain key suppliers of copper and lithium; India remains dominant in iron, steel, and titanium; and South Africa and Guinea "will be vital in the effort to meet growing demand for platinum, manganese, bauxite, and chromium."[264] Therefore the United States dramatically lags internationally in production of these increasingly important minerals, making deep-seabed mining more attractive, both economically and politically.

Figure E: Leading Global Producers of Elements or Elemental Groups[265]



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[261] Carrington, *supra* note 29; *see also* BRITISH GEOLOGICAL SURVEY, *supra* note 257, at 24.
[262] U.S. GEOLOGICAL SURVEY, *supra* note 252, at 134.
[263] Press Release, The World Bank, Clean Energy Transition Will Increase Demand for Minerals, Says New World Bank Report (July 18, 2017), http://www.worldbank.org/en/news/press-release/2017/07/18/clean-energy-transition-will-increase-demand-for-minerals-says-new-world-bank-report [https://perma.cc/E9LA-EG7M].
[264] *Id.*
[265] *Risk list 2015,* MINERALSUK, https://www.bgs.ac.uk/mineralsuk/statistics/risklist.html [https://perma.cc/2AN5-TLCT] (last visited Oct. 28, 2019).

2. Increasing Green Energy Markets and Consumer Demand

Another factor in the increasing attractiveness of deep-seabed mining is the increasing demand for green energy, such as wind and solar. As "[c]oncerns regarding the negative impact of climate change [drive] a major effort to develop and introduce low carbon technologies," metals critical to those technologies "will grow rapidly from what is currently a low base."[266] Much of that demand will stem from the earth's growing population, which is expected to exceed nine billion by 2050 and provide millions of new consumers in emerging technology markets.[267] Even though the relevant terrestrial metal deposits are unlikely to be exhausted, growing demands and limited supplies force mining companies to search out either lower grade deposits or deposits in extreme environments to meet mounting demands, even if that means diving the depths of the ocean.[268]

Renewable energy now accounts for approximately 17 percent of global energy consumption, and global renewable energy generation should increase to between 18 and 44 percent by 2050.[269] Likewise, global investments in clean energy grew by more than 4 percent in 2015, totaling $329 billion.[270] In the United States, renewable energy produces about 14 percent of domestic electricity, and states are increasingly turning to renewable energy technologies: in 2015, for example, Texas installed 3,600 megawatts of new wind capacity, Rocky Mountain states deployed geothermal technology, and California had about 11,987 megawatts of photovoltaic solar capacity installed.[271] In addition, solar power increased by about 50 percent worldwide in 2016, with the United States and China each doubling its solar capacity.[272]

Nevertheless, while cleaner in terms of carbon emissions, renewable energy sources—wind, solar, and hydrogen in particular—tend to be more material intensive, with their respective technologies requiring more metals

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[266] Bloodworth & Gunn, *supra* note 28, at 97.
[267] *See id.* at 90.
[268] *See id.* at 93.
[269] THE GROWING ROLE OF MINERALS AND METALS FOR A LOW CARBON FUTURE, WORLD BANK GROUP (2017), http://documents.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf [https://perma.cc/2DUC-J6AN].
[270] *4 Charts That Show Renewable Energy is on the Rise in America*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY (Nov. 14, 2016), https://www.energy.gov/eere/articles/4-charts-show-renewable-energy-rise-america [https://perma.cc/8WH5-BWPS].
[271] *Id.*
[272] Adam Vaughan, *Solar power growth leaps by 50% worldwide thanks to US and China*, GUARDIAN (Mar. 7, 2017), https://www.theguardian.com/environment/2017/mar/07/solar-power-growth-worldwide-us-china-uk-europe [https://perma.cc/7GK5-SJ39].

and minerals than fossil-fuel-based energy systems.[273] In fact, "[w]ind turbines require up to fourteen times the iron needed for fossil fuel power generation, and solar photovoltaics require up to forty times the copper than traditional coal, oil or natural gas-fired power plants . . . ."[274] Likewise, "the permanent magnets used to manufacture a 3-megawatt turbine contain some two tons of rare earth."[275]

While some commenters believe that shortages of rare minerals will encourage industries to produce technology with smarter designs and more plentiful materials,[276] even common metals and minerals are essential in much greater quantities than was true in the past to meet consumer demands.[277] For instance, solar cells tend to be constructed from one of four technologies: crystalline silicon cells, copper indium gallium selenide ("CIGS") "thin film," cadmium telluride film, or amorphous silicon, with each requiring varying combinations of aluminum, copper, indium, iron, lead, nickel, silver, and zinc.[278] Similarly, wind turbines require either significant amounts of copper for coil-driven generators or rare earth magnets in direct-drive models.[279] Increased use of storage batteries will also create a growing demand for aluminum, copper, lead, lithium, manganese, nickel, silver, steel, zinc, and rare earths (including indium, molybdenum, and neodymium).[280]

Recycling metals critical to green energy, and other advanced technologies, assists future availability, "but is unlikely to be sufficient to satisfy all demand."[281] For example, "[o]ver [90 percent] of the gold, lead, silver, titanium, and vanadium in recyclable products is currently recycled, but this only provides [30 to 70 percent] of the necessary supply of these metals."[282] Meanwhile, there is still very little rare earths recycling around

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[273] *See* WORLD BANK GROUP, *supra* 269, at xii.
[274] Bobby Magill, *Renewables Are as Green as You'd Expect*, SCI. AM. (Oct. 8, 2014), https://www.scientificamerican.com/article/renewables-are-as-green-as-you-d-expect/ [https://perma.cc/E2VP-QQ4Z].
[275] Lindsey Hilsum, *Are Rare Earth Minerals Too Costly for Environment?*, PBS (Dec. 14, 2009), https://www.pbs.org/newshour/show/are-rare-earth-minerals-too-costly-for-environ ment [https://perma.cc/AS9B-KV54].
[276] Lovins, *supra* note 32.
[277] *See* Olivier Vidal et al., *Metals For a Low-Carbon Society*, 6 NATURE GEOSCIENCE 894, 894–95 (2013).
[278] WORLD BANK GROUP, *supra* 269, at 9.
[279] *Id.* at 8.
[280] The World Bank, *supra* note 263.
[281] WORLD BANK GROUP, *supra* 269, at 63.
[282] Ben Mander, *Recycling as a source of mineral commodities*, AM. GEOSCIENCES INST., https://www.americangeosciences.org/sites/default/files/CI_Factsheet_2017_1_recycling _170331_0.pdf [https://perma.cc/NEL2-UQLX] (last updated Mar. 17, 2017).

the globe because the expensive processing and purification costs under current technology exceed the value of recycled rare earths.[283] Reusing minerals also depends on the recyclability of technology and materials. For example, magnets with plating are trickier to recycle, as magnets are more subject to corrosion.[284] Similarly, the co-mingling of waste batteries can affect the quantity and quality of producible secondary materials from recycling, and battery recycling overall tends to focus on recovery of valuable metals, like cobalt or nickel.[285]

In short, because both rare and common minerals are necessary for modern technological advancements—and are needed in far greater quantities than ever before—mining companies will have to pursue new mineral deposits to keep pace with the expansion of renewable energy demands.[286] This point is illustrated by recent challenges to green energy developments: in 2009, when the Department of Energy tried to enforce a switch to the doubly efficient next generation florescent light bulbs, General Electric and other companies "cried foul," arguing that they could not produce enough bulbs because of rare earth mineral scarcity.[287] Likewise, the "hopes of both battery and vehicle manufacturers hang on the mining sector finding more deposits" of precious minerals like cobalt and lithium.[288] Many car and battery companies are rushing to lock in metal supply agreements as consumer demand for electric vehicles rises and terrestrial supplies become unreliable.[289]

International progress towards a low carbon future, based on low carbon electricity generation and energy-efficient energy-using technologies, "has huge potential to shift both the scale and composition of the

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[283] *See* THOMAS G. GOONAN, RARE EARTH ELEMENTS—END USE AND RECYCLABILITY, U.S. GEOLOGICAL SURVEY 2 (2011), https://pubs.usgs.gov/sir/2011/5094/pdf/sir2011-5094.pdf [https://perma.cc/7LD8-LCJB]; *Rare Earth Recycling*, U.S. DEP'T OF ENERGY (Jan. 1, 2017), https://science.energy.gov/bes/highlights/2017/bes-2017-03-c/ [https://perma.cc/NGE8-TYKM].
[284] GOONAN, *supra* note 283, at 9.
[285] Bálint Simon et al., *Potential Metal Requirement of Active Materials in Lithium-Ion Battery Cells of Electric Vehicles and Its Impact on Reserves: Focus on Europe*, 104 RESOURCES, CONSERVATION & RECYCLING 300, 304 (2015).
[286] *See* Bloodworth & Gunn, *supra* note 28, at 93; Vidal et al., *supra* note 277, at 895.
[287] Jones, *supra* note 29.
[288] Karl West, *Carmakers' electric dreams depend on supplies of rare minerals*, GUARDIAN (July 29, 2017), https://www.theguardian.com/environment/2017/jul/29/electric-cars-battery-manufacturing-cobalt-mining [https://perma.cc/56SE-SN3S].
[289] *Id.* (indicating that rising consumer demand and the recent political struggles in the Democratic Republic of Congo—which produces 65 percent of the global cobalt supply—could cause a four-year cobalt shortage); *see also* Henry Sanderson, *Electric vehicle ambitions spark race for raw materials*, FIN. TIMES (Oct. 23, 2017), https://www.ft.com/content/44af43da-a1d6-11e7-8d56-98a09be71849 [https://perma.cc/YY6X-UUBS].

demand for minerals and metals."[290] As such, demand for the following minerals and metals should increase as renewable technologies become more important to energy supplies: manganese, iron, titanium, zinc, lead, aluminum (including bauxite), lithium, silver, steel, cobalt, copper, nickel, platinum metals, and rare earth minerals including cadmium, molybdenum, neodymium, and indium.[291] However, intra-technology choices will also drive mineral commodity markets.[292] Alternative vehicles, for instance, create different metal demands: lithium in electric vehicles, lead in hybrid cars, and platinum in hydrogen-powered vehicles.[293]

Of course, the economic benefits of deep-sea mining are not restricted to green energy markets alone. The United Kingdom, for example, stands to gain £40 billion over a thirty-year period, while Papua New Guinea's forty-seven deep-sea mining exploration licenses could generate as much as half of the nation's 2014 gross domestic product.[294] Ultimately, therefore, deep-sea mining holds the potential to diversify and strengthen the economies of both developed and developing nations, as well as turn poorer nations into the world's richest countries.[295]

B. Mining the Area: Current Contracts with the ISA

As of September 2019, the ISA has entered into twenty-nine deep-seabed exploration contracts across the Area: seventeen contracts for nodule exploration, seven contracts for polymetallic sulfides, and five for cobalt crusts.[296] For instance, China has multiple contracts within the Area, including exploratory licenses for polymetallic nodules in the CCZ, sulfide deposits in the Southwest Indian Ridge, and cobalt crusts in the Western Pacific Ocean.[297] Brazil, India, Russia, Poland, Japan, the United Kingdom, France, Germany, Belgium, Singapore, the Republic of Korea, Kiribati, Nauru, Tonga, and the Cook Islands all hold contracts with the

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[290] WORLD BANK GROUP, *supra* note 269, at xvi.
[291] *Id.* at xii.
[292] *See* The World Bank, *supra* note 263.
[293] *Id.*
[294] Bolong, *supra* note 16, at 135–36.
[295] Rupert Neate, *Seabed mining could earn Cook Islands 'tens of billions of dollars,'* GUARDIAN (Aug. 5, 2013), https://www.theguardian.com/business/2013/aug/05/seabed-mining-cook-islands-billions [https://perma.cc/6BD3-7FHK].
[296] INT'L SEABED AUTH., *supra* note 46.
[297] *China Minmetals Corporation Signs Exploration Contract With the International Seabed Authority*, INT'L SEABED AUTH. (June 2017), https://www.isa.org.jm/news/china-minmetals-corporation-signs-exploration-contract-international-seabed-authority [https://perma.cc/9CDD-EBYR].

ISA for various exploratory licenses.[298] Some nations have even partnered together to obtain contracts, such as the Interoceanmetal Joint Organization, sponsored jointly by Bulgaria, Cuba, the Czech Republic, Poland, Russia, and Slovakia.[299] With increasing interest in the deep seabed, some coastal nations are even turning to deep-sea mining opportunities within jurisdictional waters. Saudi Arabia and Sudan, for example, revived their Atlantis II project for deep-sea mining in the Red Sea (a project dating back to 1974) and expect to begin exploration phases by 2020.[300] Likewise, Japan recovered ore off the coast of Okinawa in 2017.[301]

C. Deep-Seabed Mining for the United States

The United States remains absent amongst ISA contracts because it is not a party to UNCLOS III. Instead of treaty ratification, however, the United States crafted its own licensing authority over deep-sea mining in 1980 through the Deep Seabed Hard Minerals Resource Act ("DSHMRA").[302] This statute vests licensing authority to the National Oceanic and Atmospheric Association ("NOAA").[303] While DSHMRA was "to provide an interim legal framework . . . to facilitate the continued development of deep seabed mining in an orderly and environmentally sensitive manner,"[304] the act was only meant to govern deep-sea mining in the Area until UNCLOS III's ratification.[305]

Four multinational mining consortia leapt onboard DSHMRA's licensing scheme in 1984, with NOAA issuing ten-year exploration licenses to Ocean Minerals Company ("OMCO"), Ocean Management, Inc. ("OMI"), Ocean Mining Associates ("OMA"), and Kennecott Consortium ("KCON").[306]

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[298] Cocke, *supra* note 5; INT'L SEABED AUTHORITY, *supra* note 46.
[299] INT'L SEABED AUTH., *supra* note 46.
[300] STRATFOR, *supra* note 243.
[301] *Japan successfully undertakes large-scale deep-sea mineral extraction*, JAPAN TIMES (Sept. 26, 2017), https://www.japantimes.co.jp/news/2017/09/26/national/japan-successfully-undertakes-large-scale-deep-sea-mineral-extraction/#.WeUhvEzMzVo [https://perma.cc/C76T-GNRU].
[302] 30 U.S.C. § 1401-73 (1980); U.S. DEP'T OF COM., DEEP SEABED MINING REPORT TO CONGRESS 1 (1981), http://www.gc.noaa.gov/documents/gcil_dsm_1981_report.pdf [https://perma.cc/M82P-WBH3].
[303] 30 U.S.C. § 1401-73.
[304] U.S. DEP'T OF COM., *supra* note 302, at 1.
[305] *See* 30 U.S.C. § 1401(a)(13) (stating the Act's purpose as an interim legal framework "pending a Law of the Sea Treaty"); *see also* 30 U.S.C. § 1401(a)(7)–(12).
[306] Steven Groves, *The U.S. Can Mine the Deep Seabed Without Joining the U.N. Convention on the Law of the Sea*, HERITAGE FOUND. (Dec. 4, 2012), http://www.heritage.org

Today, Lockheed Martin is the only U.S. entity with active claims in the CCZ, but it still lacks the insurance and stability of the ISA's mining regime.[307] Eager to pursue minerals with internationally recognized mineral and property rights, Lockheed Martin urged the U.S. Senate to ratify UNCLOS III in 2012.[308] These ratification attempts failed.[309] Consequently, Lockheed Martin's forty-year interest in polymetallic nodules—generating "more than 80 patents and invest[ing] more than $500 million in exploration" of the deep seabed, primarily in the CCZ—pushed the company to utilizing its British subsidiary (UK Seabed Resources) to gain legal access to the Area.[310] Lockheed Martin is a key example of the potential economic and mineral losses the United States faces as it continues to refuse to ratify UNCLOS III. Effectively, the political blockade prohibits domestic companies from pursuing mineral rights in the Area, forcing many U.S. companies to turn to their foreign subsidiaries "to the detriment of the United States."[311]

IV. LOOKING FORWARD: BALANCING MARINE CONSERVATION AND SEABED MINING

Despite regulatory, political, and financial roadblocks to deep-sea mining over the last few decades, nations and corporations have pursued deep-sea mining opportunities as a means of mineral independence, energy development, and ample wealth.[312] Mineral demands, a developing legal framework, and attainable mining technology all make deep-sea mining increasingly likely, even if metal markets slump again.[313] Ultimately, the

/report/the-us-can-mine-the-deep-seabed-without-joining-the-un-convention-the-law-the-sea [https://perma.cc/YU7A-ZBWV].

[307] Daisy R. Khalifa, *Law of the Sea Goes Public*, 55 SEAPOWER 16, 17–18 (2012).

[308] *See* Stewart M. Patrick, *(Almost) Everyone Agrees: The U.S. Should Ratify the Law of the Sea Treaty*, ATLANTIC (June 10, 2012), https://www.theatlantic.com/international/archive/2012/06/-almost-everyone-agrees-the-us-should-ratify-the-law-of-the-sea-treaty/258301/ [https://perma.cc/2FFS-S767].

[309] Wright, *supra* note 183.

[310] Khalifa, *supra* note 307, at 18; Neate, *supra* note 295.

[311] Tong, *supra* note 7, at 341.

[312] *See* JAPAN TIMES, *supra* note 301; NAUTILUS MINERALS, *supra* note 113; STRATFOR, *supra* note 243.

[313] *Compare* STRATFOR, *supra* note 243 ("[T]he viability of deep-sea mining has been increasingly called into question. And as commodity prices dip low once again, the momentum behind such projects is slowing."), *and* JAPAN TIMES, *supra* note 301 ("The [Japanese] ministry expects more ore deposits to be found in the area and is planning to commercialize mining at the sites around the middle of 2020 following an economic evaluation

likely question is not *if* mining will occur, but *when*, especially if global mineral demands outpace terrestrial production.[314] The bigger issue is how to protect deep-sea marine environments at the same time. From the perspective of the United States, these balancing issues resolve into three questions: First, is it in the United States' best interest to ratify UNCLOS III? Second, how can the ISA regime for the Area better protect deep-sea marine environments? Finally, what about deep-seabed mining that occurs within particular nations' EEZs and continental shelves? This Part addresses each of these issues in turn.

A. Ratifying UNCLOS III

If the United States wants to improve renewable energy developments, remain competitive in the global mineral and technology markets, have a voice on deep-sea mining regulations, or encourage U.S. entities to mine in the Area, it must ratify UNCLOS III.[315] The United States' ratification of UNCLOS is equally necessary and valuable to this country because it would further legitimatize the treaty and give the United States a leadership role over ocean governance, as well as benefit both national economic interests and international diplomacy.

First and foremost, ratification grants the United States a council position within the ISA, a voice on the regulatory framework, and a veto power over administrative decisions like royalty distributions.[316] So far, the United States' long absence from UNCLOS III has kept the country from representing its interests as the ISA's mining framework evolved and developed.[317] In 2012, former U.S. Army General Martin Dempsey commented on the importance of ratifying UNCLOS:

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scheduled for fiscal 2018, which starts next April. Japan relies heavily on mineral imports" and "could possibly become a resource-producing nation if abundant quantities of deposits were confirmed"), *with* Carrington, *supra* note 29 ("The special metals found in rich deposits [at the seabed] are critical for smart electronics and crucial green technologies, such as solar power and electric cars. But as the world's population rises, demand is now outstripping the production from mines on land for some important elements.") *and* Patrick, *supra* note 308 (When UNCLOS came before the U.S. Senate for ratification again in 2012, "Lockheed Martin sent a strongly worded letter to the Senate saying his company wanted to join the race for undersea riches, but could not assume investment risks until it was clear that it would have a clear legal title to its findings.").

[314] *See* Carrington, *supra* note 29.

[315] *See* Tong, *supra* note 7, at 338–41.

[316] Khalifa, *supra* note 307, at 19; Tong, *supra* note 7, at 338.

[317] Tong, *supra* note 7, at 335.

> The Convention offers an opportunity to exercise global security leadership. Over 160 nations are party to it, including every Arctic nation and permanent U.N. Security Council member. Even so, the world looks to us for leadership. We have the world's largest and most capable Navy, the world's largest economy and the largest Exclusive Economic Zone [EEZ]. We will become the leader within the Convention as soon as we enter it, and that's never been more important.[318]

Thus, second, the diplomatic benefits of ratification include recognition of international relations and global interdependence,[319] as well as a firmer foundation against China's island building in the South China Sea and unsustainable fishing practices.[320] In other words, "[r]atifying the convention would allow the United States to be a leader, rather than an observer, on the new frontiers of mining."[321] While staunch political opposition makes ratification an unlikely result in the coming years,[322] ratification remains a fundamental step for the United States to take.

Third, the economic advantages to the United States from ratifying UNCLOS would be monumental, especially because U.S. entities are reluctant to pursue deep-sea mining claims without the legal insurance of treaty ratification.[323] Lockheed Martin and other major U.S. entities want the United States to ratify UNCLOS III so that they can pursue Area exploratory licenses through the ISA, in conformity with international

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[318] Khalifa, *supra* note 307, at 17.

[319] Tong, *supra* note 7, at 332 (citing 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. 224, 239 (1987)).

[320] Tong, *supra* note 7, at 336 ("The U.S.'s stance on the South China Sea debate is fully supported by UNCLOS, although the U.S.'s challenges are empty without its accession."); Patrick, *supra* note 308 ("China, a party to UNCLOS, rejects U.S. interpretations of the treaty's freedom of navigation provisions, and continues to assert outlandish claims to control over virtually the entire South Sea."); *see also Testing the Rule of Law in the South China Sea*, N.Y. TIMES (July 12, 2016), https://www.nytimes.com/2016/07/13/opinion/testing-the-rule-of-law-in-the-south-china-sea.html [https://perma.cc/83DA-LSRT] (explaining that the Obama administration wanted to handle the international dispute over China's island building in the South China Sea through international law and peaceful diplomacy; however, the United States remains a neutral bystander, and is not party to UNCLOS); Andrew Jacobs, *China's Appetite Pushes Fisheries to the Brink*, N.Y. TIMES (Apr. 30, 2017), https://nytimes.com/2017/04/30/world/asia/chinas-appetite-pushes-fisheries-to-the-brink.html [https://perma.cc/TC9G-7KTY].

[321] Bosco, *supra* note 182.

[322] *See* Tong, *supra* note 7, at 326; Bosco, *supra* note 182.

[323] *See* Patrick, *supra* note 308.

law.[324] Not only does ratification of UNCLOS III grant the United States access to mineral exploration licensing in the Area, but it also provides potential access to shared technology and information with UNCLOS III member states.[325] The minerals, in turn, provide needed resources for technology developments and renewable energy expansions.[326]

In addition to Area access for hydrothermal sulfide deposits, polymetallic nodules, and cobalt crusts, UNCLOS III also provides natural resource opportunities for oil and gas on the extended continental shelf, which could be especially important to the United States in the Arctic Ocean.[327] Since 2004, the "U.S. Coast Guard and National Oceanic and Atmospheric Administration vessels . . . have logged hundreds of hours at sea scanning and mapping the seabed to bolster U.S. claims."[328] With that work now complete, the United States could claim rights to almost 400,000 square miles of extended continental shelf areas under UNCLOS III,[329] including a huge extended shelf off of Alaska.[330]

In contrast, so long as the United States fails to ratify UNCLOS III, it may face "an obstacle to full enjoyment of its potential maritime rights."[331] Without international recognition and legal security, "oil and gas companies will be reluctant to invest in drilling operations in these areas."[332] Losing continental shelf resources is a huge economic loss,[333] especially in the Arctic, which "could hold up to 12 percent of the world's undiscovered oil and 30 percent of its natural gas resources."[334] Furthermore, because claims for extended continental shelves are time consuming and often overlap with other international claims, the United States is put at a severe disadvantage by remaining outside of UNCLOS III[335]—especially considering that the other four Arctic nations have already filed

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[324] Tong, *supra* note 7, at 338–40.
[325] *Id.* at 330.
[326] *See Deep Sea Mining*, INT'L UNION FOR CONSERVATION NATURE (July 2018), https://www.iucn.org/sites/dev/files/deep-sea_mining_issues_brief.pdf [https://perma.cc/X44H-YEQF].
[327] *See* Tong, *supra* note 7, at 319, 325; *see also* Brent Carpenter, *Warm is the New Cold: Global Warming, Oil, UNCLOS Article 76, and How an Arctic Treaty Might Stop a New Cold War*, 39 ENVTL. L. 215, 222 (2009).
[328] Bosco, *supra* note 182.
[329] *Id.*
[330] Khalifa, *supra* note 307, at 19.
[331] Bosco, *supra* note 182.
[332] *Id.*
[333] *See* Khalifa, *supra* note 307, at 19.
[334] *Id.*
[335] *Id.*

their claims for extended continental shelves in that increasingly accessible ocean.[336] Thus, ratification offers the United States several competitive advantages in mineral development and energy markets.

While the United States might be able to mine deep-sea minerals without ratifying UNCLOS III—an argument some UNCLOS opponents suggest is more in line with U.S. interests—such conduct risks diplomatic grievances and conflicts.[337] In addition, the United States' domestic law regime for leasing the CCZ could interfere with international mining claims established through the ISA regime, which are legally recognized by UNCLOS III's 168 member states.[338] Such behavior would render the United States a rogue nation in international law and policy. These risks extend to the commercial realm, where U.S. companies refuse to pursue deep-sea mining without the legal stability and insurance of UNCLOS.[339]

B. Establishing Marine Protected Areas

Although each resource extraction method poses risks to various environments and species, all deep-sea mining techniques can affect deep-sea habitats across the globe: slope environments are at risk from oil and gas development, seamounts could be damaged by cobalt crust extraction, and nodule mining threatens the age-old stability of the vast abyssal plains.[340] One author commented that although deep-sea mineral interests have "lain dormant for this past half-century . . . if the slumbering dragon should awake, perhaps driven by the rising resource hunger of the emerging Asian market, how long will it pause to consider the fate of . . . deep-sea fauna?"[341]

Ultimately, although mining techniques and deposit environments vary radically, seabed mining at each deposit type can cause habitat destruction, substrate and geochemistry alterations, sedimentation shifts, food web disruptions, noise and light pollution, flow regime changes, sediment plumes, heavy metal contamination, and chemical releases.[342] All of these concerns are exacerbated by the fact that "major knowledge gaps" exist throughout scientific understanding of the deep sea.[343] In

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[336] *Id.* at 18–19.
[337] Groves, *supra* note 306.
[338] Tong, *supra* note 7, at 331–33; UNITED NATIONS, *supra* note 185.
[339] Tong, *supra* note 7, at 340.
[340] KOSLOW, *supra* note 30, at 174–75.
[341] *Id.* at 175.
[342] Levin et al., *supra* note 2, at 256.
[343] *See id.*

addition, these deep-sea benthic ecosystems provide vital ecological functions on a global scale, including carbon sequestration, nutrient cycling, and provision of diverse habitats to a range of species.[344]

Nautilus Minerals insisted that deep-sea mining can balance environmental concerns with economic benefits, avoiding terrestrial mining's long history of social and environmental mistakes.[345] Likewise, some scientists argue that deep-sea mining, while harmful to some degree to deep-sea ecosystems, is the lesser evil compared to land-based mining because of its reduced environmental impacts.[346] Higher mineral concentrations in the seabed allow for less extraction overall, while the extracted minerals provide the raw components of green technology—solar panels, wind turbines, and electric cars, to name a few—that make modern life more sustainable.[347] For instance, tellurium "is a key metal for high performance solar panels and is 50,000 times more concentrated in deep sea deposits than in land ores."[348]

As essential as UNCLOS III ratification is to the United States' economic and diplomatic well-being with respect to deep-sea mining, it is equally vital that the United States collaborate internationally to protect marine ecosystems on and near the Area. While UNCLOS III and ISA regulations require environmental protections and considerations,[349] international efforts should focus on establishing marine protected areas ("MPAs") to conserve ecosystems, preserve wildlife, and aid fisheries.[350] For example, in October 2016, the international commission over Antarctic waters (the Commission for the Conservation of Antarctic Marine Living Resources) voted unanimously to designate the Ross Sea as a marine reserve.[351] The Ross Sea instantly became the world's largest marine reserve, and it now protects 598,000 square miles of ocean teeming with plankton,

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[344] Wedding et al., *supra* note 47, at 144.
[345] Carrington, *supra* note 29.
[346] *Id.*
[347] *Id.*
[348] *Id.*
[349] *Nodules*, *supra* note 221, at 4; *Cobalt Crusts*, *supra* note 221, at 3; *Sulfides*, *supra* note 221, at 3.
[350] Erik Olsen, *Protected Reef Offers Model For Conservation*, N.Y. TIMES (Apr. 26, 2010), http://www.nytimes.com/2010/04/27/science/earth/27reef.html?rref=collection%2Ftimes topic%2FFish%20and%20Other%20Marine%20Life&action=click&contentCollection=science&region=stream&module=stream_unit&version=search&contentPlacement=9&pgtype=collection [https://perma.cc/D4CW-YGGK].
[351] Brian Clark Howard, *World's Largest Marine Reserve Created Off Antarctica*, NAT'L GEOGRAPHIC (Oct. 27, 2016), http://news.nationalgeographic.com/2016/10/ross-sea-marine-protected-area-antarctica/ [https://perma.cc/WXQ4-2LRG].

fish, seals, penguins, and whales.[352] The designation "shows that the world can successfully cooperate on global environmental issues."[353]

However, preexisting and new mining claims, which can be up to 75,000 square kilometers for nodule exploration, "can erode the effectiveness of protected-area networks by preempting protection of critical habitats and by limiting population connectivity by causing excessive spacing between MPAs."[354] Likewise, determining baseline knowledge of the deep sea and its ecological variability can take years of research.[355] For example, the ten-year Census of Marine Life (2000 to 2010) underscored how little is known about the ocean, with about 20 percent of the ocean's volume remaining completely unrecorded and unknown.[356] Thus, the ISA and international community should strive to establish MPAs *before* establishing additional deep-seabed mining areas. Likewise, marine scientific research should be conducted on an ongoing basis to evaluate the efficacy of the protected areas, enhance scientific knowledge about the deep sea, and adaptively manage the MPAs and APEIs as needed.[357] Such actions will "reduce uncertainty about future mining activities . . . while safeguarding deep-sea biodiversity and ecosystem function at relevant geographical scales."[358]

While countries are already considering the need for more MPAs in international waters,[359] efforts must expand and accelerate. The common heritage principle supports the protection of deep-sea environments just as it authorizes mineral activity and royalty distributions.[360] If mining can be conducted in ways that minimize environmental impacts, allow economic growth, and supply the growing demand for renewable energy technology, deep-sea mining efforts may provide the most practicable sustainable future.

However, as always in mining, the risks remain high and warrant prudence.[361] Ultimately, in a world that depends on oceans for climate,

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[352] *Id.*
[353] *Id.*
[354] Wedding et al., *supra* note 47, at 145.
[355] Levin et al., *supra* note 2, at 248.
[356] CENSUS OF MARINE LIFE, *supra* note 101, at 3.
[357] *See* Wedding et al., *supra* note 47, at 145.
[358] *Id.*
[359] Somini Sengupta, *Nations Will Start Talks to Protect Fish of High Seas*, N.Y. TIMES (Aug. 2, 2017), https://www.nytimes.com/2017/08/02/climate/nations-will-start-talks-to-protect-fish-of-the-high-seas.html [https://perma.cc/HH3B-F4MM].
[360] *See* Wedding et al., *supra* note 47, at 144.
[361] *See* Press Release, Deep Sea Mining Campaign, Seeing is Believing: Nautilus Giant Seabed Mining Machines Will Wreak Havoc (Sept. 29, 2017), http://www.deepseamining

sustenance, and natural resources, nations must take a balanced approach to harvesting and utilizing the seas. Many countries already recognize the importance of establishing marine protected areas, and some international efforts to designate marine protections are underway.[362]

C. Encouraging National Seabed Mining Regulations

To date, most companies have preferred to pursue deep-seabed mining within the marine boundaries of individual nations, rather than on the Area.[363] However, UNCLOS III protects only the deep seabed beyond national jurisdiction, and other aspects of international law protect only against transboundary environmental harms; impacts within a nation's EEZ waters and continental shelf remain an issue of national law.[364] Therefore, it is vital that nations collaborate on, and encourage, mineral nations to enact appropriate seabed mining regulations for their own continental shelves, extending ISA-like protections closer to shore.

Liability and environmental justice concerns surround the Solwara 1 project, as well as other EEZ based mining projects, and demonstrate why improved regulation in coastal mineral states is needed. In most of these operations, foreign corporations can place the burdens of unknown environmental impacts and ocean stressors on the poorer island nations hosting the mineral activity.[365] Various local communities are concerned with Solwara 1's significant risks to the environment and marine resources, with some calling for a halt on all Pacific deep-sea mining plans.[366] At one community forum, Father Vincent Takin of the Diocese of Kavieng, explained,

> In order, for any development to take place, the people must be the object of development and not subject to it. The people

outofourdepth.org/nautilus-giant-seabed-mining-machines-will-wreak-havoc/ [https://perma.cc/JWS2-KYN7].

[362] Sengupta, *supra* note 359.

[363] Kathryn A. Miller, et al., *An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps*, FRONTIERS MARINE SCI. 2, 15 (2018), https://www.frontiersin.org/articles/10.3389/fmars.2017.00418/full [https://perma.cc/62RP-K2Q4].

[364] James E. Bailey, III, *The Exclusive Economic Zone: Its Development and Future in International and Domestic Law*, 45 LA. L. REV. 1269, 1285 (1985).

[365] *See* Deep Sea Mining Campaign, *supra* note 361.

[366] Peter Neill, *Deep Sea Mining and the Controversial Solwara 1 Project in Papua New Guinea*, HUFFPOST (July 11, 2017), https://www.huffingtonpost.com/entry/deep-sea-mining-and-the-controversial-solwara-1-in_us_5964dbe9e4b0deab7c646bb5 [https://perma.cc/9776-SR98].

> have not been fully informed about the impacts of Solwara 1 on the social, cultural, physical and spiritual aspects of their lives. Therefore they cannot give their consent.[367]

As such, mineral rich nations (with encouragement from the entire international community) should seek to protect their multiple uses and resources of the sea, including fisheries, navigation, conservation, and tourism. These uses benefit local uses and traditions and provide revenue to the state. One starting point may be to model regulations on the ISA regulations, or look to other coastal nations that have sufficient environmental protections in place. Either way, coastal nations should craft the new regulations to fit the needs of its unique ocean uses, ecosystems, and mineral types. Marine spatial planning should also be considered "to address specific ocean management challenges and advance [the country's] goals for economic development and conservation."[368]

CONCLUSION

Mining has been critical to technological development throughout human history, and past experiences on land demonstrated that it can be incredibly environmentally destructive.[369] Nevertheless, the global economy has grown dependent on a number of technologies that require rare and depleting minerals, including the ever-important renewable energy technologies.[370] At the same time, global communities are trying to decarbonize our energy supply and combat the effects of climate change.[371] Remote and poor quality deposits on land make terrestrial mining expansion increasingly unlikely, especially as pursuit of terrestrial minerals becomes increasingly uneconomic.[372]

Meanwhile, the seabed offers high quality deposits in concentrated areas, giving us a unique potential to develop mining techniques with far less environmental impact than on land while obtaining the minerals necessary for clean energy production. Therefore, the choices open to nations

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[367] *Id.*
[368] *Regional Activities*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://cmsp.noaa.gov/activities/ [https://perma.cc/3DZE-86VU] (last visited Oct. 28, 2019).
[369] Clouse, *supra* note 7.
[370] *See* Clouse, *supra* note 7.
[371] *See* Coral Davenport, *Nations Approve Landmark Climate Accord in Paris*, N.Y. TIMES (Dec. 12, 2015), https://www.nytimes.com/2015/12/13/world/europe/climate-change-accord-paris.html [https://perma.cc/JM7N-2ATA].
[372] *See* Schofield, *supra* note 15, at 728; Clouse, *supra* note 7.

seeking sustainability dwindles down to relinquishing new technologies or pursuing deep-sea mining in the most environmentally protective way possible. The difficulty of these choices cannot be understated, but the conversation over our dependence on minerals needs to start addressing our current, essential, drive towards renewable energy. Pilot projects just may show the world if the deep sea can provide a small environmental footprint, handsome profits, and, hopefully, quality minerals to help us reach a renewable energy sector.[373]

[373] *See* Clouse, *supra* note 7.