The World of Minerals
by Vivien Gornitz

Part I of this series described the ocean floor as the new aquatic frontier—ripe for exploitation of its potentially vast underwater mineral wealth. Part II briefly reviewed some of the technology and machinery designed for seafloor mining. Part III examined consequences of disturbing the fragile ocean bottom environment. Part I-III were posted in Bulletins of the New York Mineralogical Club earlier this year.
In Part IV below, we investigate the geopolitical fallout as the five major Arctic nations[1] race to stake a claim to their piece of the seafloor. Part V takes a closer look at the potential ecological disruptions arising from sea bed mining activities.

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Part IV—Deep Sea Bonanza

Race to the Arctic

As the Arctic thaws, the competition for control of its natural resources intensifies. On August 2, 2007, Russia planted a flag 4,300 meters (14,110 ft) deep on the seafloor, under thick sea ice at the North Pole. A symbolic gesture that marks the beginning of the race for control of the Arctic Ocean's great potential mineral wealth.

The United Nations Convention on the Law of the Sea (UNCLOS) gives a country a 10-year period following ratification of the Convention in which to file a claim to an extended continental shelf beyond the 200 nautical mile (230 mi) exclusive economic zone (EEZ). The nation holds all rights to resources in and under the water within its EEZ. Russia presented its original claim to UNCLOS in 2001[2], followed by Norway in 2006, and Denmark in 2014. It laid claim to 895,000 km^2 (345,600 mi^2) going from Greenland, past the North Pole, up to the limits of the Russian EEZ. In 2013, Canada declared its intent to file a claim and in May, 2019, it submitted a 2100-page report, including detailed scientific data, to the Convention on the Limits to the Continental Shelf (CLCS), claiming 1.1 million km^2 of seabed. Parts of this territory overlaps competing claims by Russia and Denmark. The United States, although it abides by UNCLOS, has yet to ratify the Convention and therefore, in principle, still has time to submit its claim. Meanwhile, the U.S. has conducted extensive research to map the extent of the continental shelf north of Alaska, which should help strengthen its case in future negotiations.

The UNCLOS contains several loopholes: to obtain an extension beyond the EEZ limit, the country must prove that its continental shelf extends beyond the EEZ. Article 76 provides a complex, somewhat ambiguous formula for determining the outer boundary of this extension. Furthermore, a nation can claim a broad swath of seabed around a submerged ridge, without precisely defining what is meant by "ridge." The greatest bone of contention has been the Lomonosov Ridge, which extends some 1,800 km across the Arctic Ocean from Russia to near Ellesmere Island in Canada. Once thought to be an inactive mid-ocean ridge, it is now recognized as an ancient piece of continent crust formed tens of millions of years ago when parts of the North American and Eurasian plates separated, opening up the Arctic Ocean floor. Denmark (through Greenland), Russia, and Canada all claim parts of the Lomonosov Ridge, believed to be rich in oil and gas deposits.

The Lomonosov Ridge roughly divides the Arctic Ocean into two distinct basins: an older Amerasian Basin of late Mesozoic age and a younger Eurasian Basin formed during the Cenozoic Era. The Eurasian Basin margin consists of a suite of rotated fault blocks that step

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[1] Russia, Canada, Norway, Denmark, and the United States.
[2] A revised claim was filed in 2015.
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down to the basin. Earlier studies on the origin of the Amerasian Basin were inconclusive, but more recent detailed mapping suggests a somewhat analogous origin for the American Basin. Unresolved ambiguities in the language of Article 76 and in ridge geology are not slowing down Russia, Canada, and Denmark in mapping out their respective (and sometimes overlapping) claimed sections of the ridge.

To complicate matters further, political tensions between the U.S. and Russia only serve to underscore the growing strategic importance of the Arctic, particularly as climate warming makes the Arctic Ocean more accessible to shipping and mineral extraction. Furthermore, Greenland, already a semi-autonomous part of Denmark, may eventually gain full independence, with complete control over its natural resources on land and under water. And China, which is already building multiple giant development projects around the globe, is eying a "Polar Silk Road" to enhance its trade and shipping routes across the Arctic.

Climate change and advanced technology are rapidly opening up the North and the ocean depths to increased mining and natural resource exploitation, but these emerging opportunities are also fraught with environmental hazards.

Further reading

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Part V

A fragile undersea environment under threat

In 1989, scientists devised a simple experiment to access the impacts of deep-sea mining. The DISCOL experiment consisted of scraping a roughly 11 km^2 (4.25 mi^2) area of the Pacific Ocean floor with an 8 m (26 ft) rake. The activity stirred up a plume of ocean sediment that rained down and smothered most bottom-dwelling creatures over the test area that couldn't crawl or swim away, without even removing any rocks off the sea bed. Several repeat visits, the latest in 2015, showed that site had still not recovered. Scars of the ploughing still remained and the former sea life—sponges, sea anemones, soft corals—had not yet returned.

DISCOL is still considered the largest, most extensive test of deep-sea environmental impacts to date. Other more recent attempts have been stymied by technical or financial difficulties. Nautilus Minerals, based in Toronto, Canada, had conducted some environmental assessments on its planned mining site—Solwara I, off Papua New Guinea—and was all set to begin mining in spring 2019. But financial reversals and local opposition forced last-minute cancellation of the operation.
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Unlike Solwara I—a deep sea hydrothermal site—the Clarion-Clipperton Zone (CCZ) on the ocean floor in the Pacific Ocean is littered with millions of tons of Fe-Mn nodules. These metal-rich mineral concretions of Fe oxyhydroxides and Mn oxides are rich in metals such as Ni, Cu, Co, Mo, Zr and rare earth elements. The CCZ is estimated to hold greater reserves of certain metals, such as cobalt, nickel, manganese, and thallium, than on land. However, the potato-sized concretions grow extremely slowly around a hard nucleus on the sea floor over millions of years. Unlike some deep-sea hydrothermal vents which can continue to build up metal sulfide-rich mounds as long as the vent remains active, Fe-Mn are not a renewable resource. In this ink-black, quiet ocean realm, fine sediment settles down at a leisurely rate of 1 mm per century and nodules grow very much slower.

Nevertheless, the CCZ abyssal plain hosts a surprisingly varied ecosystem. Larger creatures include corals, sea urchins, starfish, anemones, sponges; also crustaceans, sea cucumbers, and fishes. Other organisms live on the nodules themselves and on the abyssal sediments—nematodes, worms, starfish, and single-celled foraminifera. Although CCZ biodiversity is high, overall population densities are low. Disturbance of the sedimentary substrate by mining could severely upset the stable but delicate biogeochemical equilibrium and harm the smaller or slower creatures that could not escape in time. Furthermore, deep-sea mining would generate large clouds of sediment that would spread out over broad swaths of ocean before gradually re-settling. Clearly, much more information on the ecological impacts would be needed before large-scale mining begins.

However, as of 2019, the United Nations-sponsored International Seabed Authority (ISA), which both promotes and regulates sea floor mining, has granted 29 exploration licenses and is rushing to complete its regulatory framework by 2020. Although scientists' advice is taken into consideration, the final decisions are made behind closed doors. Once mining begins, the ISA claims, so will monitoring. Standards can be tightened as needed, they argue. The problem lies in the contradictory roles played by the ISA. It is like letting the wolf guard the henhouse. ISA faces a tough battle in even persuading its 168-nation membership to agree on a draft mining code that would include environmental as well as mining regulations. Meanwhile the race to the sea bed continues and we still have much to learn of how best to balance the competing needs of sea floor mining and environmental protection.

Further reading

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