A series of papers on policy options, prepared for the third meeting of the Global Ocean Commission, November 2013

Policy Options Paper # 5:

Strengthening deep seabed mining regulation

What are the issues?

The deep ocean below 200 metres is the largest habitat for life on Earth and the most difficult to access. We remain largely ignorant of how deep-ocean ecosystems change in space and time in response to specific human activities and natural variations and the consequences of these changes. Just like the terrestrial environment, the seafloor is made up of mountain ranges, plateaus, volcanic peaks, canyons, and vast abyssal plains. It contains most of the same minerals that we find on land, often in enriched forms, as well as minerals that are unique to the deep ocean such as ferromanganese crusts and manganese nodules. The possibility of mining the deep seabed has been known for several decades and was one of the driving forces behind the Third United Nations Conference on the Law of the Sea (UNCLOS III) convened between 1972 and 1982. Prior to this, the idea that manganese nodules on the deep seabed offered the prospect of massive profits for industrialised nations with the technology to access these areas, coupled with the fear that there would be a race to colonise the seabed, led the UN General Assembly in 1970 to adopt a Declaration of Principles. This Declaration reserved the seabed beyond national jurisdiction exclusively for peaceful purposes and declared the mineral resources of the seabed as 'the common heritage of mankind', to be utilised for the benefit of mankind as a whole[1,2].

After the initial euphoria of the 1970s, a collapse in world metal prices combined with relatively easy access to minerals in the developing world dampened interest in seabed mining. However, after decades 'on hold', there is renewed interest in the potential for commercial exploitation of marine minerals from the private sector and governments alike. The principal drivers of this new interest are largely the result of a combination of technological advances in marine mining and processing, a dramatic increase in demand for metals primarily fuelled by emerging economies, leading to a rise in metal prices, a decline in the grade of land-based nickel, copper and cobalt sulphide deposits being mined and developed, and increased demand and reduced supply of rare earth minerals, which are used in modern technical applications such as renewable energy and hybrid motor vehicles[3]. Deep seabed mining must therefore be considered a significant new and emerging use of the global ocean.

Current status

Currently, there are a range of mining operations at relatively shallow water depths (up to 140 m), including diamond mining in Namibia and tin mining in Indonesia. There are also increasing numbers of exploration activities taking place in national jurisdictions. Nautilus Minerals of Canada[4], for example, currently holds more than 100 active prospecting licences in Tonga, Fiji, Solomon Islands and Vanuatu as well as a seafloor mining concession in Papua New Guinea. Exploration is also taking place in the Red Sea (Atlantis II Deep basin), Japan (Okinawa Trough, Izu-Bonin volcanic arc), New Zealand (iron sands off the North Island, Kermadec Trench, Chatham Rise), Namibia (phosphorite/phosphates), Italy (Ionian Sea), and Western Australia. Namibia has recently declared a moratorium on marine phosphate mining out of concerns at effects on the fishing industry[5].

Mineral resources of the deep seabed

Commercial interest is currently focused on four types of marine mineral deposit, which are located in four distinct environments.

Polymetallic (manganese) nodules have been known since the 1860s and were first described by the *HMS Challenger* expedition, 1872 to 1876. They occur throughout the ocean and are found lying on the seafloor in the abyssal plains, often partially buried in fine grain sediments. Nodules are potato-sized and smaller objects formed over millions of years by the accumulation of metallic particles from seawater and sediment pore water; these metals are ultimately supplied to seawater from continental run-off and volcanic, hydrothermal and atmospheric sources. Nodules contain a wide variety of metals, including manganese, iron, copper, nickel, cobalt, lead and zinc, with important but minor concentrations of molybdenum, lithium, titanium, and niobium, among others. The source of by far the richest nodules in copper and nickel, as well as the most studied area of commercial interest, is the Clarion Clipperton Zone (CCZ) in the eastern Pacific at a water depth of 3,500 to 5,500 m. It is estimated that the CCZ contains a potential (inferred) resource of 62 billion tonnes of nodules, comprising 17,500 million tonnes of manganese, 761 million tonnes of nickel, 669 million tonnes of copper and 134 million tonnes of cobalt[6]. Other areas of potential interest are the Central Indian Ocean basin and the exclusive economic zones (EEZs) of the Cook Islands, Kiribati and French Polynesia.

Polymetallic sulphides (or Seafloor Massive Sulphides or SMS) are rich in copper, iron, zinc, silver and gold. Deposits are found at tectonic plate boundaries along the mid-ocean ridges, back-arc ridges and active volcanic arcs, typically at water depths of around 2,000 m for mid-ocean ridges. These deposits formed over thousands of years through hydrothermal activity, which is when metals precipitate from water discharged from the Earth's crust through hot springs at temperatures of up to 400°C. Because of the black plumes formed by the activity, these hydrothermal vents are often referred to as 'black smokers'. In 1977 scientists discovered hydrothermal vents and associated ecosystems composed of an extraordinary array of animal life. Chemosynthetic bacteria, which use hydrogen sulphide as their energy source, form the basis of the vent food web, which is comprised of a variety of giant tubeworms, crustaceans, molluscs and other species, with composition depending on the location of the vent sites. Many vent species are considered endemic to vent sites and hydrothermal vent habitats are thus considered to hold intrinsic scientific value. Over 500 vent species have been described so far, although fewer than 100 sites have been investigated to any degree. The International Seabed Authority database contains locations for about 350 known sites of hydrothermal activity, but it is estimated that vents are likely to occur at approximately 100-kilometre intervals along the 60,000 km mid-oceanic ridge system that encircles the globe, including in some EEZs[7].

Cobalt crusts accumulate at water depths of between 400 and 7,000 m on the flanks and tops of seamounts. They are formed through precipitation of minerals from seawater and contain iron, manganese, nickel, cobalt, copper and various rare metals, including rare earth elements. Globally, it is estimated that there may be as many as 100,000 seamounts higher than 1,000 m, although relatively few of these will be prospective for cobalt crust extraction. The most prospective area for cobalt crusts is the Magellan seamounts in the Pacific Ocean, east of Japan and the Mariana islands. Water currents are enhanced around seamounts, delivering nutrients that promote primary productivity in surface waters, which in turn may promote the growth of fish and animals such as corals, anemones, stars and sponges, but also creates an oxygen-minimum zone that inhibits the growth of some organisms. The most well-known threat to seamount diversity has been deep sea bottom trawling, which has been shown to have caused serious and long-lasting damage to seamount habitats. At this point, little is known about the potential impact of removing cobalt crusts from seamounts or the factors that influence community structure and ecosystem functioning around seamounts[8].

Phosphorite (or phosphates) are cumulations of calcium phosphates, a commodity that is used as fertiliser in agriculture throughout the world. Phosphorites form at water depths of 2 to 600 m. They are formed by chemical reactions in sediments promoted by strong upwelling and high biological primary productivity in surface waters. They are most common off the western margin of continents and on plateaus. The two areas that have been the focus of activities have been off Namibia and on Chatham Rise southeast of New Zealand.

Environmental impacts of mining

Although there will be technological variations in the mining equipment required for each type of mineral deposit, the basic concept and methodology for recovery is similar. In each case, a collector vehicle will make contact with the seafloor and collect the mineral deposits. In the case of SMS, and cobalt crusts, this will require cutting or breaking the mineral deposits from the substrate. The mined materials, combined with seawater, will be brought to the surface (most likely through hydraulics) by a riser system and transported to a surface support vessel. There the ore will be separated from the seawater and transported to processing plants on land; in the case of sulphides and cobalt crusts, the (treated) seawater will then be pumped back down to the water depth of the mine site. In the case of nodules, various methods have been proposed, including continuous line buckets, suction dredges, and picking up nodules from the seabed[9].

The potential environmental impacts of deep seabed mining may be summarised as follows. The mining collector at the seafloor will cause localised damage, including crushing living organisms, removal of substrate habitat and disturbance of sediment. The consequences of this damage may be significant. In the case of manganese nodules, sediment disturbance will create a sediment plume of as yet unknown size that could bury seafloor organisms or clog the siphons of filter-feeding organisms. There is also the possibility of other environmental damage through malfunctions in the riser and transportation system, hydraulic leaks, noise pollution and light. Once ore is brought to the surface, there is then the problem of de-watering, or removal of water from recovered minerals, which can be a source of significant pollution. If discharged, deliberately or accidentally, in the near-surface water column, de-watering could impact plankton and fish stocks. On the other hand, discharging near the seabed may create additional sediment plumes as well as possible geochemical changes due to changes in oxidation/reduction (redox) conditions. Much remains unknown, particularly with regard to local species composition and distributions. It is nevertheless reasonable to assume that recovery periods are likely to be decadal and that, at least in localised areas, community structures may never recover, as is the case on land when a city, road, school, farm, power plant, etc. is built. Impacts on endemic species may be more profound, although vent ecosystems may recover as a result of new volcanic activity[10].

Current policy landscape

Deep seabed mining beyond national jurisdiction (referred to in UNCLOS as 'the Area') is regulated by the International Seabed Authority (ISA), an international organisation established by UNCLOS[11]. All States Parties to UNCLOS are automatically members of ISA. In accordance with UNCLOS, the mineral resources of the deep seabed are the 'common heritage of mankind'. The current regime under which these resources are administered may be described briefly as follows. Scientific research short of prospecting is largely free of restrictions. Prospecting may be conducted only after the ISA has received a satisfactory written undertaking that the proposed prospector will comply with UNCLOS and the ISA rules, regulations and procedures and will accept verification of compliance by ISA.

Exploration and exploitation may only be carried out under a contract with ISA and are subject to its rules, regulations and procedures. Contracts may be issued to both public and private mining enterprises provided they are sponsored by a State Party to UNCLOS and meet certain standards of technological and financial capacity. ISA has developed regulations, including provisions relating to environmental protection, to govern exploration, but has not yet agreed on a regulatory system for exploitation. The concept behind the ISA regime is that economic benefits from deep seabed mining, possibly in the form of royalty payments, are to be shared for the 'benefit of mankind as a whole', with particular emphasis on the developing countries that lack the technology and capital to carry out seabed mining for themselves[12].

Status of current activities

To date, ISA has approved 19 contracts for seabed exploration, with a further four in the pipeline. Twelve of these contracts are in the CCZ, three in the Indian Ocean and two in the Atlantic (see Table 1). Contracts are held by States Parties to UNCLOS and by companies sponsored by States Parties. National government participants include those from South Korea, India, France, Japan, Germany, Russia, China, and the Interoceanmetal Joint Organization (a consortium of Bulgaria, Cuba, Czech Republic, Poland, Russia and Slovakia). Countries that have sponsored companies to explore include UK, Kiribati, Tonga, Nauru and Belgium. Compared to exploration areas granted in national jurisdiction, the areas granted by ISA in the Area are typically large. Contracts for polymetallic nodules, for example, typically cover 150,000 km^2, half of which is relinquished over a period of years down to 75,000 km^2. The total seabed area covered by mining licences or exploration contracts in national jurisdiction and the Area is currently 1,843,350 km^2 [13].

Table 1: Status of exploration contracts issued by ISA

Contractor	**Sponsoring State**	**Date of contract**	**Date of expiration**	**Location**	**Size of area (in km^2)**
Government of India		25 March 2002	24 March 2017	Central Indian Ocean Basin	75,000
Institut Français de Recherche pour l'Exploitation de la Mer	France	20 June 2001	19 June 2016	CCZ	75,000
Deep Ocean Resources Development Co. Ltd	Japan	20 June 2001	19 June 2016	CCZ	75,000
Yuzhmorgeologiya	Russian Federation	29 March 2001	28 March 2016	CCZ	75,000
China Ocean Mineral Resources Research and Development Association	China	22 May 2001	21 May 2016	CCZ	75,000
Interoceanmetal Joint Organization	Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia	29 March 2001	28 March 2016	CCZ	75,000
Government of the Republic of Korea		27 April 2001	26 April 2016	CCZ	75,000

Federal Institute of Geosciences and Natural Resources of Germany	Germany	19 July 2006	18 July 2021	CCZ	75,000
Nauru Ocean Resources Inc.	Nauru	22 July 2011	21 July 2026	CCZ-Reserved Area	75,000
Tonga Offshore Mining Limited	Tonga	11 January 2012	10 January 2027	CCZ-Reserved Area	75,000
China Ocean Mineral Resources Research and Development Association	China	18 November 2011	17 November 2026	Southwest Indian Ridge	10,000
Government of the Russian Federation		29 October 2012	28 October 2027	Mid-Atlantic Ridge	10,000
UK Seabed Resources Ltd	United Kingdom	8 February 2013	7 February 2028	CCZ	58,600
Marawa Research and Exploration Ltd	Kiribati	To be signed		CCZ-Reserved Area	75,000
G-TEC Sea Mineral Resources NV	Belgium	14 January 2013	13 January 2028	CCZ	75,000
Government of the Republic of Korea		To be signed		Indian Ocean	10,000
Institut Français de Recherche pour l'Exploitation de la Mer	France	To be signed		Mid-Atlantic Ridge	10,000
China Ocean Mineral Resources Research and Development Association	China	To be signed		Western Pacific Ocean	3,000
Japan Oil, Gas and Metals National Corporation	Japan	To be signed		Western Pacific Ocean	3,000

Issues for the Global Ocean Commission

The deep seabed, far from being a marine desert as was once commonly – and incorrectly – thought, supports a surprising diversity of marine life. Although biomass at such great depth is dominated by bacteria and meiofauna, these organisms are specially adapted to this environment and particularly diverse. A study carried out between 2002 and 2007 estimated that there may be more than 1,000 species at a single site within the CCZ[14]. Very little is known about large-scale habitat configuration and other elements of deep-sea ecology in the deep seabed, largely because deep-sea research has been severely spatially limited due largely to lack of funding.

Although important environmental management work aimed at better understanding the impact of deep seabed mining has already been undertaken and is ongoing (particularly through the ISA and the Secretariat of the Pacific Community), there is a need for better understanding of the effects of multiple anthropogenic stressors for deep-sea ecosystems and an integrated management strategy that balances future mineral extraction with a sustainable, productive and healthy marine environment[15]. Elements of such a strategy would include the need for regional-scale planning for specific mineral resources as well as consideration of sampling, data and taxonomic standards; connectivity within and across ecosystems; cumulative impacts on biodiversity and ecosystem services (including from non-mining activities); economic incentives for green industrial practices; management of resource use conflicts; development of new technologies to serve environmental management; compliance, monitoring and enforcement strategies; and the design of networks of protected areas[16].

There is also a need to fill governance gaps that have emerged as the regimes for deep seabed mining in areas within national jurisdiction and areas beyond national jurisdiction have developed. ISA has made a start at developing a regulatory regime for deep seabed mining beyond national jurisdiction that addresses environmental matters and allows for cost effective exploration for marine minerals. However, the regime is at present primarily focused on exploration and many elements require further development, including, for example, operational guidelines for the application of the precautionary approach, compliance and monitoring measures, a network of representative marine protected areas, risk assessment methodologies, mechanisms to address risks and the application of best environmental practices. These need to be developed in an effective, efficient, transparent and flexible manner. Furthermore, while in many ways the ISA regime was very forward thinking, it was established with the notion that the seafloor could be considered separately from the water column – legally convenient, but ignoring the ecological connectivity between the two.

An Environmental Management Plan for the CCZ was adopted by ISA in 2012, but is partial, outdated already and needs review, and only applies to the CCZ. Its main immediate effect is in protecting defined areas of particular environmental interest (APEIs) from exploration and potential development. The Code for Environmental Management of Marine Mining adopted by the International Marine Minerals Society sets out some general principles and benchmark standards for marine mining, including practices relating to mitigation and habitat restoration[17].

When the international regime on the dumping of wastes at sea from ships, aircraft, platform and other man-made structures at sea, was negotiated at the beginning of the 1970s (London Convention, 1972)[18] and modernised in the 1990s (1996 Protocol)[19], governments excluded offshore minerals exploitation and seabed mining from the scope of these instruments, presumably on the basis that these issues would be covered by the emerging regime for seabed mining (Article III.1[c] of the London Convention [LC] and Article 1.4.3 of the London Protocol [LP]). However the exception was not limited to the Area and thus also excludes national offshore activities, such as those on continental shelves. With regard to the Area, Article 209 of UNCLOS specifically provides for the protection of the marine environment from pollution from activities in the Area and requires, without exception or qualification, that both international and national measures are to be taken accordingly, with the latter being no less stringent than the former. The ISA is the responsible body here and the LC-LP Parties are exploring liaison with the ISA.

With the offshore and mining industry now expanding into the global ocean in remote areas, a case can be made that it is time for the London Convention and Protocol to be amended in order to fill the gap in governance that would otherwise become evident in the event of incidents involving pollution from seabed mining in areas within national jurisdiction. This would have the merit of creating incentives to develop advanced technical solutions to the problem of pollution resulting from offshore installations and seabed mining, and would potentially also resolve gaps in civil liability for environmental damage arising from these activities. (See Policy Options Paper # 3 on Pollution, including its Option # 2.)

In relation to the latter, suggestions have been made that ISA may consider the establishment of a trust fund to compensate for damage to the marine environment that cannot otherwise be compensated, similar to the fund for oil pollution damage established under the International Oil Pollution Compensation Funds 1971 and 1992. In this regard, Article 304 of UNCLOS allows for the further development of rules of international law regarding responsibility and liability[20]. Article 235 allows for the possibility of such a fund[21].

Conclusions

Deep seabed mining is rapidly emerging as a significant new use of the global ocean. Although mining is confined at present to national waters, exploration is increasingly taking place in areas beyond national jurisdiction. Overall, deep seabed mining is tightly regulated by an international body established for that specific purpose. Nevertheless, there are important gaps in the regime, which was largely negotiated in the 1970s and 1980s before the 1992 Earth Summit and without the benefit of vastly improved scientific understanding of deep-sea ecosystems. There are also concerns that a more strategic approach needs to be taken when addressing the protection and conservation of the deep-sea environment that takes into account other stressors and the possibility of cumulative and synergistic impacts.

References

[1] Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, Beyond the Limits of National Jurisdiction, GA Resolution 2749 (XXV), (17 December 1970; http://www.un-documents.net/a25r2749.htm).

[2] Michael W. Lodge, The Common Heritage of Mankind. *International Journal of Marine & Coastal Law*, 27 (4), 733–742 (2012). DOI: 10.1163/15718085-12341248.

[3] International Seabed Authority. Towards the development of a regulatory framework for polymetallic nodule exploitation in the Area: Technical Study No. 11 (2013), http://www.isa.org.jm/files/documents/EN/Pubs/TStudy11.pdf. Hein, J., 2012, Prospects for rare earth elements from marine minerals, ISA Briefing Paper 02/12, International Seabed Authority, Kingston Jamaica, (2012) http://www.isa.org.jm/files/documents/EN/Pubs/BP2.pdf.

[4] Nautilus Minerals of Canada: http://www.nautilusminerals.com/s/CorporateDirectory.asp

[5] "Namibia imposes moratorium on coastal phosphate mining," September 19, 2013, at http://www.mining.com/namibia-imposes-moratorium-on-coastal-phosphate-mining-41520.

[6] Morgan, C., A Geological Model of Polymetallic Nodule Deposits in the Clarion-Clipperton Fracture Zone, ISA Briefing Paper 01/12 (2012; http://www.isa.org.jm/files/documents/EN/Pubs/BP1.pdf).

[7] Patrick Colman Collins *et al*., A Primer for the Environmental Impact Assessment of Mining at Seafloor Massive Sulfide Deposits. *Marine Policy* 42, 198–209 (November 2013).

[8] Van Dover *et al.,* Environmental Management of Deep Sea Chemosynthetic Ecosystems: Justification of and Considerations for a Spatially-based Approach. ISA Technical Study No. 9 (2011; http://hal.archives-ouvertes.fr/docs/00/66/78/38/PDF/ISA_Tech_Report_9.pdf).

[9] See ISA, Polymetallic Nodules Brochure, at http://www.isa.org.jm/files/documents/EN/Brochures/ENG7.pdf.

[10] International Seabed Authority. Environmental Management Needs for Exploration and Exploitation of Deep Sea Minerals, Report of a Workshop held by the International Seabed Authority in collaboration with the SOPAC Division of the Pacific Community, Nadi, Fiji (2011. ISA Technical Study No. 10 (2012; http://www.isa.org.jm/files/documents/EN/Pubs/TS10/TS10-Final.pdf).

[11] International Seabed Authority: http://www.isa.org.jm

[12] Wylie Spicer. Commentary: Seabed mining still lacks ground rules, The Northern Miner: The Global Mining Newsletter, 2013-01-16 and 2013-01-23. (http://www.northernminer.com/news/commentary-seabed-mining-still-lacks-ground-rules/1001995484/)

[13] Hein *et al*., Deep-ocean mineral deposits as a source of critical metals for high-and green-technology applications: Comparison with land-based resources. *Ore Geology Reviews* 51: 1–14 (2013; http://www.researchgate.net/publication/235350121_Author's_personal_copy_Deep-ocean_mineral_deposits_as_a_source_of_critical_metals_for_high-and_green-technology_applications_Comparison_with_land-based_resources/file/32bfe5112ea4f8ccc7.pdf).

[14] International Seabed Authority. Biodiversity, Species Ranges and Gene Flow in the Abyssal Pacific Nodule Province: Predicting and Managing the Impacts of Deep Seabed Mining. ISA Technical Study No.3 (2006; http://www.isa.org.jm/files/documents/EN/Pubs/TechStudy3.pdf).

[15] Michael W Lodge, Current Legal Developments: International Seabed Authority. *The International Journal of Marine and Coastal Law*, 26 (3), 2011, 463–480. DOI: 10.1163/157180811X576929.

[16] Van Dover *et al.,* Brief to the Global Ocean Commission on behalf of the Deep Ocean Stewardship Initiative, 17 May 2013.

[17] IMMS Code, adopted by the International Marine Minerals Society on 16 November 2011: http://www.immsoc.org/IMMS_downloads/2011_SEPT_16_IMMS_Code.pdf

[18] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972): http://www.gc.noaa.gov/documents/gcil_lc.pdf

[19] 1996 Protocol to the London Convention: http://cil.nus.edu.sg/1996/1996-protocol-to-the-1972-convention-on-prevention-of-marine-pollution-by-dumping-of-wastes-and-other-matter/

[20] Duncan French, From the Depths: Rich Pickings of Principles of Sustainable Development and General International Law on the Ocean Floor the Seabed Disputes Chamber's 2011 Advisory Opinion. *International Journal of Marine & Coastal Law*, 26 (4), October 2011, 525–568. DOI: 10.1163/157180811X598691.

[21] Case No. 17, Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area (2010), para. 205. At. http://www.itlos.org/index.php?id=109.