
Deep sea mining: a new source of transition minerals

Introduction



The energy transition has accelerated demand for a range of minerals required for batteries and renewable energy application, and has heightened global concerns over resource security. Accordingly, accessing the rich abundance of minerals that exist within the deep sea is of increasing interest in ensuring secure mineral supply chains.

Growth in deep sea mining remains relatively slow due to technological challenges and critically, legislative gaps, but there have been important recent developments. The International Seabed Authority has published draft Exploitation Regulations which are intended to establish clear standards, notably with regard to protecting the natural environment.

Meanwhile, Norway has been working towards its first licensing round for mineral exploration rights on the Norwegian Continental Shelf, implementing the Seabed Minerals Act, which was introduced in June 2019. Again, there is a clear focus on ensuring that the environment and other interests are safeguarded.

Casting an eye on the horizon, the development of clear national and international legal frameworks for deep sea mining could unlock vital supplies of battery metals; manganese, cobalt, nickel and copper.

In this article, we consider progress so far in deep sea mineral exploration and the development of technologies for seabed mining. We then describe the developing legal framework for mineral exploitation in the international seabed area, before focussing on Norway's efforts to regulate and attract investment into mineral exploration on the Norwegian Continental Shelf.

Riches of the deep



On 21 December 1872, **HMS Challenger** set off from Portsmouth on a four-year round-the-world scientific journey of discovery, with one of its missions being to shed light on the mysteries of the murky depths of the deep sea. The discovery of manganese nodules during one of its many dredges of the ocean floor sparked fascination with the minerals that can be found on the seabed. Since then, interest in deep-sea mining has periodically surged and fallen away again, with barriers to progress including cost uncertainty and doubts regarding how abundant and rich in mineral content these nodules actually are. Furthermore, since the bulk of these minerals are located in international waters, outside of any single country's jurisdiction, the absence of a clear legal framework within which miners can operate has been a crucial barrier to progress. However, the fact that this legislation is nearly in place is starting to spur activity in the sector.

Over the years, many exploration missions have been conducted to research the minerals that exist a few kilometres beneath the surface of the ocean. One of the richest deposits that is often cited is contained in the Clarion Clipperton Zone (**CCZ**) in the middle of the Pacific, stretching from Hawaii to Mexico, which is said to contain a

wealth of polymetallic nodules. These polymetallic nodules are highly saturated in mineral content. However, they are also home to an abundance of natural life – a fact that has worried environmentalists who are concerned that mining activity will disturb this rich natural ecosystem.

Within the three main categories of these mineral nodules (detailed further below) the elements which have garnered the most interest are manganese, nickel and cobalt. As the world's focus on the global energy transition and the shift towards renewable energy and battery-operated vehicles and appliances intensifies, the importance of ensuring a steady supply of these minerals is becoming increasingly important. These minerals are crucial for the manufacture of batteries, amongst other components of different types of renewable energy.

According to the World Bank¹ *“the rapid deployment of these low-carbon technologies needed to reach a 2°C pathway, or below, will also mean that the demand for minerals needed to produce these technologies will rise.”*

Furthermore, according to the International Energy Agency², *“Our bottom-up assessment suggests that a concerted effort to reach the goals of the Paris Agreement ... would mean a quadrupling of mineral requirements for clean energy technologies by 2040. An even faster transition, to hit net-zero globally by 2050, would require six times more mineral inputs in 2040 than today.”*

It is a well-known fact that nearly all of the world's cobalt supply comes as a by-product of primarily copper and nickel mining, with over 65% of the global production concentrated in the Democratic Republic of Congo (**DRC**). The increasing ethical concerns regarding the cobalt production industry supply chains (including shocking accounts of child labour and exploitation) in the DRC, coupled with regional instability, has led to a spike in the price of cobalt on several occasions (although recently it has fallen away again due to the increase in nickel production globally). The prospect of a new stable source of cobalt (amongst other minerals) at the bottom of the sea, has led to a flurry of exploration activity to try and quantify the amounts that exist and are within (relative) reach.

It is estimated that the deep sea contains more minerals than from all of the world's continents combined. Some voices from the deep sea mining industry claim that the CCZ alone contains enough minerals to fulfil the world's demand for electric vehicles and battery storage production. As the world's population continues to increase and the demand for renewable energy follows suit, the shortage of these minerals on land and the pressure to locate new sources will only grow more acute.

Trapped in the abyss: slow progress to date

So why has the progress of deep sea mining been so slow? The reasons are mainly two-fold: a cost/technology barrier coupled with a historical gap in underlying legislation.

¹ Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition, 2020 report. [Y. Liang, R. Kleijn, A. Tucker, E. van der Voet, Material requirements for low-carbon energy technologies: A quantitative review, Science Direct, vol 161, June 2022; H. Miller, S. Dikau, R.Svartzman, S. Dees, The Stumbling Block in 'the Race for our Lives': Transition-critical materials, financial risks and the NGFS Climate Scenarios' Grantham Research Institute on Climate Change and the Environment, January 2023](#)

² [The Role of Critical Minerals in Clean Energy Transitions, International Energy Agency, March 2022, p.8](#)

Cost/technology barrier



Technological advances from the offshore oil and gas and wind industries, as well as scientific research, mean that we now have access to previously untouched areas of the sea floor. More autonomous underwater vehicles are being used now than ever before to explore the depths, and improving technology means that missions are becoming more cost-efficient and commercially viable.

So how will deep sea mining actually work?

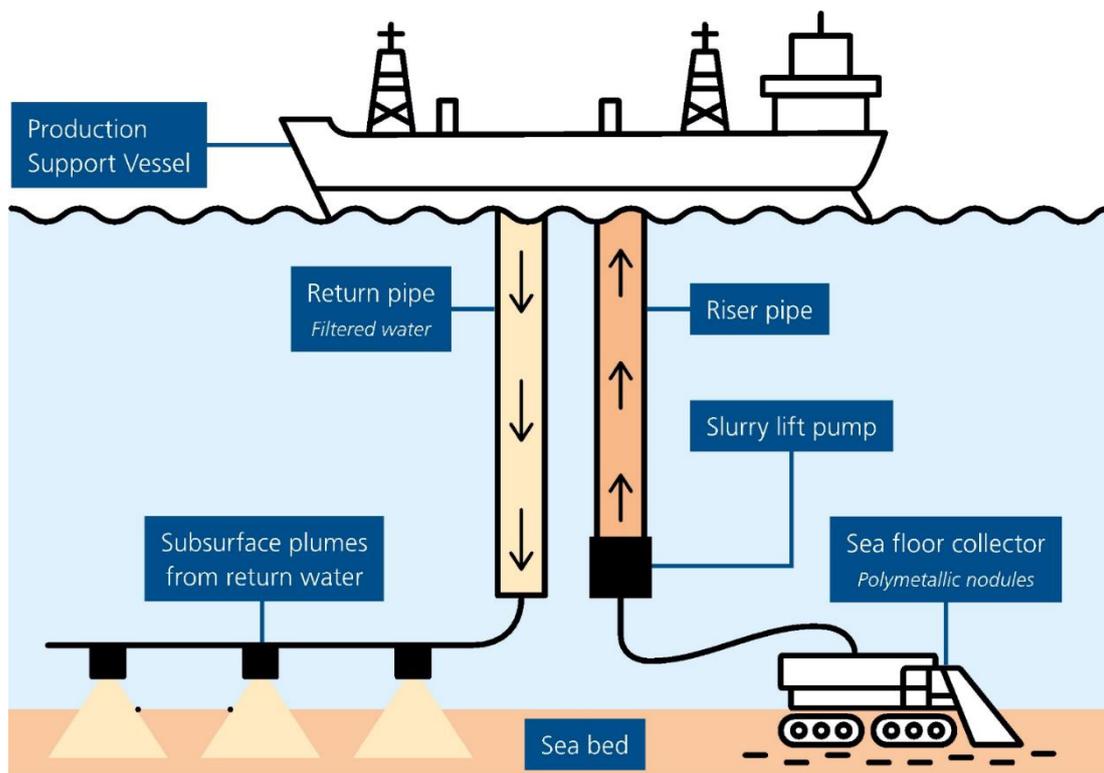


Techniques to access the nodules vary. One technique would involve using machines alike a combine harvester to move along the seabed stirring up sediment. The machine would then collect the nodules from the disturbed seabed which would then be separated from unwanted sediment, and pumped back into the sea. Alternatively, the expected process with current technology involves a Production Support Vessel (**PSV**) on the surface, with one or more smaller, submarine remote-operated vessels (**ROVs**). The abandoned **Nautilus Minerals** project, proposed to use three ROVs: an auxiliary cutter, which would prepare the seabed by creating a level working surface; a more powerful bulk cutter, to grind up the seabed; and finally, a seafloor-collecting-machine, which would move along the seafloor, sucking up the material and transferring it up to the PSV via a long 'riser' pipe. The slurry would then be dewatered in the PSV, and the resulting sediment discharged via a second 'return' pipe close to the seafloor. Each of those machines would be connected to the PSV and controlled by cable.

As seabed minerals are expected to be much more concentrated than their equivalents on land, some proponents of the industry argue that the overall process results in a more efficient and 'cleaner' extraction. The nodules are also said to contain low levels of deleterious elements (elements which are harmful when melted or vaporized as part of the refining process) compared to ores mined from the land.

However, environmental scientists are concerned about potential impacts on the previously, largely undisturbed seabed in deep waters. Many organisms are dependent on this deep sea environment, living within a complex ecosystem, which is still not fully understood. The process of grinding up the seafloor, extracting the product and re-discharging the excess will undoubtedly have very disruptive effects. Furthermore, the process will generate significant noise and vibration that may unsettle marine animals.

These impacts must, however, be weighed against the ESG concerns of traditional mining on land, which also present serious challenges in many regions.



International law framework



The main piece of international legislation governing activities within the deep sea is the 1982 United Nations Convention on the Law of the Sea (**UNCLOS**), which came into effect in 1994 and currently counts 168 countries as parties (the USA is a notable exception). UNCLOS sets out member states' rights and obligations regarding the use of the world's oceans and its resources, and the protection of the marine and coastal environment. It defined the Exclusive Economic Zones (**EEZ**) of coastal nations, which generally gives those nations rights to marine resources from the limit of their territorial waters (12 nautical miles) out to 200 nautical miles from their coast. Rights to the seabed can be further extended to up to 350 nautical miles, where the nation's continental shelf extends further.

UNCLOS created the International Seabed Authority (ISA), headquartered in Kingston, Jamaica, to organise and control activities (particularly regarding mineral resources) in the international seabed area beyond the limits of national jurisdictions (referred to as "the Area"). The Area makes up more than 50% of the world's oceans and has been placed under the ISA's authority in order for the ISA to control and supervise activities which are to be "*carried out for the benefit of mankind as a whole*".

When it comes to mining activities, the ISA has issued **Exploration Regulations**, which govern the award of exploration contracts to public and private state-sponsored entities. These contracts grant rights to carry out exploration activities in a part of the Area (similar to the award by an individual country of mining licences or concessions). To date, the ISA has published Exploration Regulations for the following:

- Polymetallic Nodules (2000, updated in 2013);
- Polymetallic Sulphides (2010);
- Cobalt Rich Ferromanganese Crusts (2012).

The Exploration Regulations set out requirements for a contractor's financial and technical capabilities as well as rules for the protection and preservation of the marine environment during exploration activities. It is notable that both UNCLOS and the Exploration Regulations require each contractor to be sponsored by a member state, which will take responsibility for ensuring that the contractor complies with Part XI of UNCLOS. Part XI sets out rules governing the Area, including, most importantly, measures for the protection of the marine environment, and principles which govern the fair exploitation of the Area's mineral resources in order to balance supply and demand, and assist developing member states.

Exploration contracts



At the time of writing, the ISA has entered into 31 15-year exploration contracts in relation to the three mineral categories outlined above. More than half of these contracts cover areas of the CCZ, with the rest relating to different areas of the Pacific, Indian and Atlantic oceans. China has sponsored the most exploration contracts (5), followed by Russia and South Korea (3 each).

Much exploration has already taken place and the industry is now poised to begin exploiting some of these underwater mineral resources. The ISA is continuing to work on a first version of the much-awaited regulations for the exploitation of mineral resources, which could be adopted at some point in mid to late 2023. Previously expected in 2020, the timeline has been pushed back somewhat due to COVID-19.

The draft exploitation regulations



The latest draft version of the exploitation regulations (the “**Draft Regulations**”) was published in March 2019. A full analysis of the Draft Regulations is beyond the scope of this article, however some noteworthy points and themes can be drawn out at this stage:

- as with the Exploration Regulations, it is clear that the financial and technical capability of any applicant for an exploitation contract will be taken into account by the Legal and Technical Commission of the ISA ([regulation 13\(1\)\(e\)](#));
- any exploitation contract granted may provide the contractor with the possibility of joint arrangements or production sharing with the ISA's representative legal entity (named the “Enterprise”) ([regulation 19](#));
- the proposed maximum initial term of the exploitation contract is 30 years, subject to renewal for up to 10 years at a time ([regulation 20](#));
- royalties will be payable to the Secretary-General of ISA (the amount of which is yet to be determined) on the value of the metal contained in the mineral-bearing ore, calculated at the point at which the ore is first sold or transferred to a vessel transporting it from the contract area ([regulation 64](#)); and
- importantly, an anti-avoidance rule has been introduced, which is aimed at defeating any schemes which are “*carried out solely or mainly for the purposes of avoiding, postponing or reducing a liability for payment of a royalty*” ([regulation 77](#)).

ESG focus



Most importantly, considerable emphasis has been placed on the applicant's ability to meet environmental obligations. This is no doubt aimed at assuaging concerns that environmental risks are clearly addressed and will form an important part of the deep sea mining agenda going forwards.

- Regulation 26 requires the would-be contractor to lodge an environmental performance guarantee, to cover the estimated costs of activities including decommissioning and the monitoring and management of residual environmental effects. It is notable that a previous drafting suggestion included the costs of “responding to and remediating a significant environmental incident” but this has not been included in the latest version.
- Part (IV) of the Draft Regulations is dedicated to a number of ESG concerns, including:
 - the protection and preservation of the marine environment, including the development of environmental standards by the ISA after a public consultation with relevant stakeholders;
 - the requirement for the contractor (or applicant) to submit an Environmental Impact Statement (EIS) after having carried out an assessment, and the obligation to put in place and follow an Environmental Management and Monitoring Plan (EMMP);
 - obligations for the contractor to take measures to prevent, reduce and control pollution and other hazards to the marine environment, as well as restrictions on discharges that the contractor is permitted to carry out from its mining activities; and
 - the establishment of an environmental compensation fund by the ISA, the main purposes of which will be to fund the remediation of damage to the Area from mining activities and to promote research into more environmentally safe mining methods.

It is clear that protection of the marine environment is at the forefront of the ISA's mind when it comes to permitting and allowing the development of deep sea mining going forwards. This was most recently exemplified through the publication of UNCLOS' *“Draft agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction”* a.k.a. the **“High Seas Treaty”**. The treaty was published at the beginning of March 2023, and is aimed at ensuring the conservation and sustainable use of marine biological diversity of the Area.

All eyes are now turned towards the ISA as the final exploitation regulations are expected to be published in the near-term. That publication is expected to finally spur investment into the sector, as potential deep sea miners have clarity over the legal framework for their operations.

Norway: A Pioneer in National Seabed Mining

The Norwegian Continental Shelf contains a significant quantity of manganese crusts and sulphides and the country has a long and successful history of offshore natural resources development, through its petroleum industry. With the adoption of the Seabed Mineral Act (the “Act”) in June 2019, Norway now has legislation in place to facilitate commercial exploration and extraction of its deep sea minerals. The Act essentially mirrors the Norwegian Petroleum Act, with the Norwegian Ministry of Petroleum and Energy leading the ongoing process of opening up areas for potential exploration and extraction of mineral deposits.

It is manganese crusts and sulphides that have been found on the Norwegian Continental Shelf, rather than manganese nodules. The Norwegian Petroleum Directorate (NPD) (in cooperation with scientific institutions) has carried out several data acquisition projects in deep sea areas in the Norwegian Sea and the Greenland Sea since 2011. According to a report by Rystad Energy³ the majority (67%) of the world’s active spreading ridges are in international waters, where massive sulfides originate. For the remaining resources, the report estimates that Norway holds as much as 5.5% of the world’s active spreading ridges. Only Fiji has a higher proportion (8%).

A focus on prudence



With the Act in place, the Norwegian Ministry of Petroleum and Energy kicked off the process for the opening of areas for exploration and extraction of mineral deposits in January 2020. The process consists of two main parts: (1) an impact assessment and (2) a resources assessment.

The Ministry sent its impact assessment to public hearing in December 2022, which included a proposal of areas to be opened⁴. In January 2023 the resource assessment was completed⁵ and concluded that resources in place are significant, but that the volume of recoverable resources will largely depend on technology and economics. Licences under the Act would only be awarded after the opening of an area, and on 20 June 2023 the government put forward a white paper recommending the opening of parts of the Norwegian Continental Shelf for commercial seabed mineral activities.

When issuing the impact assessment, the Ministry highlighted the Norwegian tradition of prudent resource management, which would weigh up the dual interests of harvesting natural resources while ensuring that environmental values and other related interests are safeguarded. It mentioned that knowledge of the area included for assessment is limited, so it would be crucial to take a cautious approach. The Act’s first section contains a wide-reaching purpose statement, which emphasizes that any mineral activity is to be carried out in a prudent manner. When issuing the white paper in June 2023, the Minister stated that “(t)o acquire more knowledge, we need to gather expertise and open for commercial mapping, exploration and extraction of seabed minerals. Therefore, we are proposing to open an area on the Norwegian continental shelf for mineral activities”.

³ <https://offshoreenergy.no/contentassets/f7a40b81236149ea898b87ff2e43a0e3/20201120-marine-minerals---norwegian-value-creation-potential.pdf>

⁴ <https://www.regjeringen.no/contentassets/dbf5144d0fbc42b5a4db5fc7eb4fa312/kart-over-forslag-til-apningsomrade.pdf>

⁵ <https://www.npd.no/globalassets/1-npd/fakta/havbunnsmineraler/publikasjoner/2023/resource-assessment-summary.pdf>

Licensing process



Exploration (survey) licences may be issued to companies of any nationality for up to five years, with obligatory work commitments enshrined within the licence. The Act specifies that such licences are non-exclusive and do not contain preferential rights for later receiving any extraction licences. In particular, the Act confirms that extraction licences may be granted to holders covering an area that is subject to other survey licences, which also do not preclude petroleum activity, scientific research, or other activities from taking place within the licence area.

An **extraction** licence however, will provide an exclusive right to produce minerals deposits and to conduct further exploration activities in the area covered by the licence for a period up to ten years. Unlike exploration licences, extraction licences may only be awarded to legal entities incorporated under the laws of Norway. That may be a single company or a group of co-venturers, as is common in the petroleum industry. However, the Act's preparatory works commented that it is too early to say what the normal business model for deep sea mining activities would be.

An application for an extraction licence must contain a proposed work program covering the period up to submission of a plan for extraction. The application must also demonstrate the applicant's financial capacity, as well as its technological expertise and technical capacity. If the licensees decide to proceed to the production phase, after award of the extraction licence, a production plan will need to be approved by the Ministry and must be accompanied by a project-specific impact assessment.

Conclusion



With increasing concerns over securing mineral supply chains, global interest in deep sea mining is growing. The need for rapid expansion of the supply of transition minerals, and advances in regulation of the sector present an unprecedented window of opportunity for companies at the forefront of this emerging technology to mature their development plans and progress to production. While the draft Exploitation Regulations for mining in international waters are keenly awaited, those countries who are able to regulate the commercial exploration and extraction of their own deep sea minerals may benefit from first mover advantage.

In opening up this new mining frontier, environmental protection and the preservation of biodiversity should be paramount, and will underpin deep sea miners' licence to operate. Global cooperation should be promoted in order to accelerate the development of technology, best operating practices and acceptance of deep sea mining by society.

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