**MODULE ADSEA, LESSON 1**

**THE AREA: LEGAL AND SCIENTIFIC PERSPECTIVES**

**LECTURE NOTES**

**Lesson outline:**

The title of this lesson is 'The Area: Legal and Scientific Perspectives'

In the first part of the lesson, we will discuss the legal status of the Area and its resources under UNCLOS and the 1994 Agreement.

In the second part of the lesson, we will discuss the scientific aspects of the Area, including the geological setting of the deep ocean floor and the mineral resources that can be found there.

## PART I – LEGAL STATUS OF THE AREA AND ITS RESOURCES

### 1. Geographic Extent

The Area is defined in article 1, paragraph 1(1), of UNCLOS as 'the seabed and the ocean floor and the subsoil thereof, beyond the limits of national jurisdiction.'

This is an interesting way of using a negative definition to define the geographic scope of the Area. Whereas UNCLOS defines the maritime zones pertaining to the national jurisdiction of coastal States by reference to objective criteria, such as baselines or, in the case of the continental shelf, by reference to criteria set out in Article 76, it defines the extent of the Area only by reference to what it is not.

This means that the question of the limits of the Area is inextricably linked to the delineation of the outer limit of the continental shelf where it extends beyond 200 nautical miles. The only way that the boundary of the Area can be ascertained is to first establish the limits of national jurisdiction.

We know that all coastal States have the right to jurisdiction over the continental shelf up to 200 nautical miles from the baseline, whether there is a physical shelf or not.

However, coastal States may also benefit from the criteria set out in Article 76 of UNCLOS to assert jurisdiction over the continental shelf beyond 200 nautical miles. Here several problems arise.

The first problem is that UNCLOS provides that the outer limits of the continental shelf beyond 200 nautical miles established by the coastal State become 'final and binding' only if they are adopted 'on the basis of' the recommendations of the Commission on the Limits of the Continental Shelf established under Annex II of UNCLOS. Once such final and binding limits have been established, the coastal State is required to deposit information concerning such limits with the Secretary-General of the United Nations and the Secretary-General of ISA.

The reality is that the negotiators of UNCLOS vastly underestimated the scientific and technical aspects of the task of delineating the outer edge of the continental margin. Unfortunately, even forty years after the adoption of UNCLOS, only nine States have so far fulfilled their obligation under Article 84(2) to deposit charts or lists of geographical coordinates showing the outer limits of the continental shelf with the Secretary-General of ISA.

Meanwhile, as of 2020, a total of 92 submissions had been made to Commission on the Limits of the Continental Shelf, of which 35 have been dealt with. Faced with such a huge backlog of work, it is likely to be many years before the outer limits of coastal State have been established and we can have legal certainty as to the geographical extent of the Area. In the case of areas that are subject to maritime disputes, the rules of the Commission prevent it from considering submissions until the disputes are resolved, which could be an indefinite period in some cases.

Another problem concerns the extent of maritime jurisdiction of States that are not parties to the Convention. It has been argued that the entitlement to a continental shelf arises under customary international law, as reflected, for example in the Truman Declaration and the 1958 Geneva Convention on the Continental Shelf. However, this leaves quite uncertain the relationship between such claims and the provisions of UNCLOS relating to the Area and ISA.

## 2. Legal status of the Area and its resources

Under UNCLOS, the Area and its resources are the 'common heritage of mankind'.

It is worth noting that the 'common heritage' principle was regarded as so fundamental to the UNCLOS negotiators that Article 311(6) prohibits States parties from making any amendments to the basic principle relating to the common heritage or from becoming party to any agreement in derogation thereof.

In fact, this 'common heritage' status of the deep seabed had been established long before UNCLOS III started in the Declaration of Principles adopted by the UN General Assembly in 1973. Most of the principles outlined in the Declaration were simply repeated in Part XI of UNCLOS.

Articles 137, 140, and 141 of UNCLOS elaborate upon Article 136 and in so doing bring some degree of legal precision—certainly more than was contained in the Declaration of Principles—to the concept of the common heritage.

These provisions also help to clarify the similarities and differences between the regime for the deep seabed under UNCLOS and other global commons outside national jurisdiction, including, for example, the high seas, Antarctica and outer space. As a result, the deep seabed has a special status that is neither res communis nor res nullius.

The idea which underlies it is that certain interests of all humankind should be safeguarded through a special legal regime. Such a regime should recognize the overriding interest of all humanity in the preservation of the marine environment and in the rational and equitable development of natural resources. This would need to be done in such a way that it did not disregard the interests of individual States but recognized the fact that these interests could be protected only within the framework of a stable international regime of cooperation between States.

Article 137, paragraph 1, provides that no State shall claim or exercise sovereignty or sovereign rights over any part of the Area or its resources, nor shall any State or natural or juridical person appropriate any part thereof.

Article 137, paragraph 2 vests all the rights in the resources of the Area in mankind as a whole and provides that these rights are to be exercised through the International Seabed Authority, on behalf of mankind as a whole.

Article 137, paragraph 2, prohibits the alienation of the resources of the seabed other than in accordance with the provisions of the Convention. Article 137, paragraph 3, further underlines the fact that no claim, acquisition or exercise of rights with respect to minerals recovered from the seabed by any State (not just States Parties) or any natural or juridical person shall be recognized other than in accordance with Part XI.

It is very important to emphasize that the scope of the common heritage regime is explicitly limited to the 'resources' of the Area.

For the purposes of Part XI, 'resources' are defined as 'solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules.' This excludes living resources, including so-called marine genetic resources.

Article 140 provides that activities in the Area shall be carried out for the benefit of mankind as a whole, irrespective of the geographical location of States, whether coastal or landlocked, and taking into particular consideration the interests and needs of developing States and of people who have not yet attained full independence or other self-governing status.

A fundamental definition here is the reference to 'activities in the Area', which is defined in Article 1 of UNCLOS to mean the activities of exploration for and exploitation of the mineral resources of the Area. This will become very important later to understand the extent of the Authority's regulatory jurisdiction. The definition explicitly does not include marine scientific research in general, or other activities that are not related to exploration for and exploitation of minerals.

To give effect to this aspiration, the Authority is tasked with the development of a mechanism to provide for the equitable sharing, on a non-discriminatory basis, of financial and other economic benefits derived from deep seabed mining. This topic will be covered in more detail in another lesson.

Article 141 provides that the Area shall be open to use exclusively for peaceful purposes, by all States, whether coastal or land-locked. Article 141, as read with Article 88 relating to the high seas and Article 301, is generally understood as prohibiting the use of the seabed for acts of aggression or breaches of the non-intervention principle as reflected in Article 2 of the United Nations Charter.

**PART II – SCIENTIFIC PERSPECTIVES**

The exploration for potential seabed mineral resources began in the early 1970s. Recent renewal of interest in deep-sea minerals is driven by a substantial increase in commodity prices due to forecasts of increased future demands for these resources. Factors behind this increase include population growth, the rapidly expanding economies of countries with large populations, and the development of low-carbon footprint technologies such as wind turbines, photovoltaic cells, and batteries for electric cars as possible answers to climate variability and climate change. These new technologies require a wider range of trace metals, which are considered economically strategic to meet current and future demand.

## 1. Marine mineral resources

There are three key marine mineral resources available in the Area: polymetallic nodules or PMN, polymetallic sulphides or PMS and cobalt-rich ferromanganese crusts or CFC.

While PMN enrichments require abyssal plain conditions, PMS occur along and beside mid-ocean spreading ridges and CFC are bound to amagmatic older ridges, seamounts and guyots.

The distribution of minerals and the ore deposits they may form are quite different. Cobalt-rich ferromanganese crusts and polymetallic massive sulphides form local, 3-dimensional deposits of between 100 and 1000 whereas polymetallic nodule deposits may occupy thousands of sq.km.

Other potential future resources, including marine gas hydrates, marine metalliferous sediments, marine placers, marine evaporites and marine phosphorite deposits, are predominately found within the continental shelf environments.

Seabed mineral resources occur in all oceans at specific geological structures and under specific conditions. Generally speaking, marine minerals are not rare, although they do not form deposits everywhere. The enrichment to deposit scales is bound to very specific conditions including stable plate tectonics, lower sedimentation rates, water column redox characteristics, temporary intraplate volcanism, slow spreading rates, tectonic phases with limited magmatic activities. A significant amount of marine minerals occur within national jurisdiction.

The definition of mineable and technologically and economically interesting deposits requires very detailed knowledge of the area. Mineral resources need to occur in such form, grade, quality, quantity that there are reasonable prospects for eventual economic extraction. Their characteristics are measured with confidence to support detailed mine planning and proven mineral reserves require appropriate mining technology, infrastructure, legal, economic, environmental and other factors.

The definition of deposits and mine planning requires area knowledge at the meter level through high-resolution multi-beam echosounder measurements. – not only for a safe operation during recovery, but also for the mandatory precautionary approach.

## 2. Polymetallic nodules

The first marine mineral resource that we will cover in this lesson is polymetallic nodules. Polymetallic nodules, or PMN, can form on the seabed of any ocean and at all depths as a consequence of potential gradients in chemistry.

The largest enrichments of PMN, however, are found in abyssal plains, like the ones in the Clarion-Clipperton Zone, the Peru basin, the Central Indian Ocean Basin and the Penrhyn Basin.

Abyssal plains guarantee stable tectonic conditions, constant flow of cold, oxygen-rich bottom waters, sufficient supply of biogenetic sediments including valuable metals; organic carbon associated with the sediments have the chemical function of the most important redox reaction partner.

The formation process is two-fold. It involves metals dissolution from the sediments in pore waters and their precipitation according to surface charges and potential gradients to Fe- and Mn-oxyhydroxides (diagenetic growth), and the precipitation of dissolved metal from the ocean water (hydrogenetic growth) according to mineral surface charges.

It is important to note that PMN grow at rate of 10-100 mms per million years.

The area between the Clarion and Clipperton oceanic fracture zones, referred to as the Clarion- Clipperton Zone or CCZ, is the focus of most exploration contracts with ISA, including the first contract that was ever signed.

A contract allows for the exploration and resource assessment of an area of 75,000 sq.km for a period of 15 years. Pre-explored areas are reserved for developing countries. Thirteen Areas of Particular Environmental Interest, or APEIs, representing particular ecological subregions are entirely protected from exploration and future exploitation. They cover approximately 1,97 million $km^2$ of the CCZ.

In addition, natural geological characteristics like seamounts, slopes and nodule distribution limit the actual prospective areas to about 30% of each contract area.

Exploration activities aimed at identifying ore deposits and assessing their potential for future exploitation. As an example, the model area in red provides an average PMN coverage of 7-10 kg/sq. M in three defined deposits with sizes of 1,000, 1,200 and 2,000 sq.km. The combined deposit carries a total of 56 Mio. t of PMN in 4,200 sq.km representing only 5.6% of the total license area and allows for 14 years of mining at a production of 4 Mio t per year. The resulting metals that are Cu-Co-Ni-Mn and other traces could have a significant impact on the metal markets.

Potential mining technology for the recovery of PMN by collector vehicles was successfully tested in the late 1970s and recently by Belgian contractor GSR in two contractor's areas. Testing of the technology itself was complemented by mandatory detailed environmental monitoring programmes to better understand impacts and improve industry practice in line with the precautionary approach.

## 3. Polymetallic sulphides

PMS are associated with very prominent features on the seabed called "black smokers". Black smokers result from the leakage of vast amounts of so-called hydrothermal fluids originating from seawater circulation in the oceanic crust and emanating eventually from the seabed at oceanic spreading centres and rift zones. These smokers form fascinating precipitates that are host to special chemosynthetic habitats – but do not represent 'ore'. The oldest examples of smokers in Earth history have an age of 3.2 Gyres but only represent a so-called 'exhalite horizon' without any economic significance. However, these 'exhalites' are indicators for processes deeper in the oceanic crust and therefore provide evidence for possible PMS deposits at depth.

The formation process of PMS consists of capturing heat and sometimes components of magmatic bodies in the lower oceanic crust, taken up by circulating seawater as deep as 4-5 km in the crust. The seawater tuns into an aggressive hot acid solution remobilizing metals from the volcanic rocks, transporting, precipitating and eventually enriching these metals as massive sulphide bodies. These bodies may reach tonnages of more than 200 Mio tonnes on land and an open scientific question remains regarding the actual size of marine PMS deposits.

PMS deposits have a diameter of up to 300 m on the seabed and are identified by a three-dimensional conical funnel shape. They usually narrow towards the base. The deeper portions of the deposit are considered high-temperature during formation and are therefore Cu-(Au)-rich. Potential mining down to 250 m may account for 10s of million tonnes of base and precious metal sulphide ores even though the spatial footprint on the seabed is minor.

Based on geological evidence, the metal endowment, localization, size, shape and tonnages of PMS occurrences can be assessed by remote high-resolution techniques including robotic AUV/ROV technologies and electromagnetic measurements on the seabed.

Any mining of PMS from seafloor subsurface will involve mining activities towards depth. As a consequence, and similar to land-based deposits, an open pit mining strategy was adopted by Nautilus for its SOLWARA deposit in Papua New Guinea. This resulted in the development of mining machines including continuous miner, bulk cutter, collecting machine and lift pumps.

ISA contractor JOGMEC of Japan performed the world's first ore-lifting pilot test for polymetallic sulphides in August/September 2017 at a water depth of about 1,600 m within the Okinawa Trough.

JOGMEC's concept was similar to that of Nautilus but was carried out as a multi-ship operation.

Vertical concepts adopt trench cutter operations that are in use for marine diamond exploitation. Available techniques can possibly accommodate the particular shape of narrow three-dimensional and conical geological bodies better than the traditional open pit mining approach developed for land-based deposits.

## 4. Cobalt-rich crusts

Finally, the third marine mineral resource that we will cover in this lesson is cobalt-rich ferromanganese crusts, or CFC.

CFC form blankets on seabed structures like ridges and seamounts. They make mineral formations and metal enrichments due to chemical potential gradients and metals precipitate from the seawater to form crusts.

During the formation process of CFC, elements with variations in surface and component charges are captured by Fe-Mn-oxides and –hydroxides over time. The growth rates for CFC are very slow, with 1 to 4mm per million years.

CFC form cm-thick crusts on the hard rock substrate on the summits of seamounts, ridges, plateaus, and abyssal hills, either attached to the top and flanks of the bedrock or as broken pieces on the seabed.
They commonly form in areas where volcanic rocks have been swept clean of sediments by bottom currents at water depths between 400 and 4,000 meters, with highest thickness in between 500 and 1,500 meters, which mostly encompasses the zone of lower oxygen concentration.

Ore deposit assessment requires the measurement of crust thickness and abrasive milling technologies for separation. Their occurrence on steeper walls of seamounts complicates the use of crawler technologies and the combination with vertical-to-laterally drilling techniques may allow for well-defined recovery of the crusts. Artificial intelligence and sensor-based mineral recovery have the potential to avoid critical habitats – as they identify and avoid natural morphological irregularities disrupting the mining process.