



MODULE 2, LESSON 1

MINERALS, METALS, MINERAL RESOURCES AND RESERVES: BASIC DEFINITIONS

LECTURE NOTES

Hello everyone, welcome to lesson 1 of module 2 on marine mineral resources of the area. In this lesson we will explore the definition of a mineral resource, the geological meaning of mineral and its comparison with the definition given by the United Nations Convention on the Law of the Sea, the mineral resources of the area, the concept of mineral reserves and their importance to the mandates of the International Seabed Authority. The most basic definition of a mineral resource is the one expressed here.

A mineral resource is a volume of rock enriched in one or more useful materials. We can also look to the definition included in the reporting standard of the International Seabed Authority for mineral exploration. As stated in this document, a mineral resource is a concentration or occurrence of solid material of economic interest in or on the earth's crust in such form, grade, quality and quantity that there are reasonable prospects for eventual economic extraction.

So, the first mineral resources discovered by humans were rocks. Most rocks are made of minerals and the first humans found that some rocks could be worked out to develop useful tools that could help them to do work more efficiently, like cutting or hunting for example. We still use rocks today as a mineral resource, either in the construction of modern buildings or just to cook a steak on it.

I already said that most rocks are made of minerals, but what is a mineral? For geologists a mineral is usually a solid, it is inorganic and formed by natural geological process. It is chemically homogeneous, meaning that it is possible to describe the mineral with a chemical formula, since it contains the same chemical elements throughout. It has a crystalline structure, which means that the atoms of the chemical element are arranged in an orderly and repeating pattern.

So let's look to some natural examples and see if they correspond to minerals according to this definition. This is the first one. Is natural mineral water a mineral? Well, no, it is not and the main reason for it results from the fact that water is not a solid.

Thus, why do we call it mineral water? In fact, when we look to the chemical composition of a given mineral water, it does not correspond only to H₂O, which corresponds to the chemical formula of water, but also includes other elements such as magnesium, sodium, potassium and so forth, that were taken from rocks and minerals and dissolved in water during runoff from its source to the oceans. And what about these carbonate shells that are segregated from foraminifera, the small organisms living in the water column or at the bottom of the ocean? Well, despite the fact that these shells are solid, chemically homogeneous and crystalline, they are formed by organic

processes and therefore do not meet the most common mineral definition in geology. Let's take a classic example of a mineral that we can also find in the deep ocean, such as chalcopyrite.

This is a solid, inorganic and natural sample, chemically homogeneous and crystalline, meaning that the different atoms are arranged in an orderly and repeating pattern. Take note that the scale of the figures on the right is not the same of the photo on the left. The former is an image at the atomic level and the latter is an end specimen.

The chemical composition of chalcopyrite can be described by this formula that combines one atom of copper, one of iron and two of sulfur. In chalcopyrite, copper is the main metal of interest and the main responsible for considering chalcopyrite as a mineral resource. Copper is present in our life in many ways and copper wiring is certainly one of the most common and important.

However, in turn to turn copper from chalcopyrite into copper wires, we need to have a processing plant where several physicochemical processes take the copper from the chalcopyrite and make a copper concentrate. Development of civilization and societies has relied heavily on the use of mineral resources and the discovery of metals. Prehistoric men used rocks to build tools and weapons and as our knowledge on metallurgy has developed, metals have played an essential role in the progress of agriculture, transport, arts and craft.

Each step from the left to the right does not mean that a particular mineral resource was exhausted, but new advantages were learned from the use of a new metal even when the learning process was not intended at first. Nowadays, with the strong digitization and electrification of our societies, our dependence on metal resources has increased significantly. You will know more about this in future lessons.

Now, referring to past lessons in Model 1, you learned about the area and part 11 of the United Nations Convention on the Law of the Sea. The Convention also gives a definition of resource and mineral. In accordance with Article 133, resources means all solid, liquid or gaseous mineral resources in situ in the area at or beneath the seabed and resources, when recovered from the area, are referred to as minerals.

In this definition, resources such as crude oil and natural gas are included in the legal definition of minerals. As you will learn in Lesson 2 of this module, there are three different resource types that have been explored in the area. Polymetallic nodules, which are a resource mainly for nickel, copper, cobalt and manganese.

Polymetallic sulphides, which are a resource for copper, zinc, gold and silver. And cobalt-rich ferromanganese crusts, a resource mainly for cobalt, rare earth elements and copper, tellurium amongst other metals. You may have one elective lesson for each of these resources.

Despite the fact that these resources are termed minerals by the Convention, for a geologist this would be better dubbed as rocks. This map represents the sites under contracts for exploration for these minerals in the area. So far, ISA has entered into 15-year contracts for exploration with 22 different contractors.

You will learn more about these activities in Lesson 4 of this module. What are the exploration activities about? Well, one of the main objectives of a contractor is the collection of geological data, promoting the increase of knowledge on a given mineral deposit, such as its metal composition, tonnage and spatial distribution. With time, the knowledge on the mineral resource will increase from inferred, the lowest level of geological knowledge, to indicated and measured.

In order to do it, a contractor should map the area under the contract and deploy different types of equipment to collect samples and information, not only for the geological characterization of a deposit, but also for the characterization of the marine environment, which includes the seabed and the water column and its ecosystems. A good level of knowledge will allow the application of so-called modifying factors, taking into consideration the technology used for collecting the resource from the deep ocean floor, the metallurgy needed to extract the metals, the predicted impacts on the marine environment, mitigation measures, amongst others. After all these considerations, if the mining project remains economic, then the part of the resource to be exploited may be classified as a mineral reserve.

You will learn much more on resource assessment in Lesson 5 of this module. Therefore, a mineral reserve may be simply defined as the economically mineable part of a measured or indicated resource. I should add that the economic component includes allowance for environmental measures and the restriction expected as part of the permitting process.

You may also find more information on this topic in this document available in the ISA website. What is the importance of exploring mineral resources and defining mineral reserves in the area? Well, one of the great goals of the Convention is given in Article 140 by considering that the activities in the area shall be carried out for the benefit of mankind as a whole. Moreover, the Authority shall provide for the equitable sharing of financial and other economic benefits derived from activities in the area on a non-discriminatory basis.

These financial and economic benefits will mainly derive from the sustainable exploitation of minerals of the area, while a lot of knowledge from the deep ocean, also supporting marine protection initiatives, has been acquired through exploration activities. In the 40th anniversary of the adoption of the Convention, the deep-sea minerals and the role of the ISA may actively contribute for the achievement of the United Nations 2030 Agenda for Sustainable Development and its Constituent Sustainable Development Goals. For example, developing deep sea mineral resources to benefit humanity as a whole can have a direct impact on Goal 1 end poverty in all its forms everywhere and on Goal 10 reduce inequality within and among countries.

But the decisions taken collectively by the ISA may also provide significant contributions to the majority of goals considered in the 2030 Agenda for Sustainable Development. You will learn more about it in future lessons. So, I do hope that you will stay within the deep dive initiative.

Thank you.