



MODULE 3, LESSON 4

BIOLOGY OF COBALT-BEARING FERROMANGANESE CRUSTS

LECTURE NOTES

Hello everyone. I'm Tomohiko Fukushima . A member of Legal Technical Commission LTC. One of the order of International Seabed Authority, ISA, today's lecture is about biology of cobalt-bearing ferromanganese crust. Biology includes molecular biology, taxonomy, evolutionary biology, biological geography, ecology, ethology, embryology, etc. So please understand in advance, this lecture covers only a part of biology, even though limited content, I hope you can enjoy this lecture.

So let's begin. In the beginning, I would like to explain cobalt rich ferromanganese crust. cobalt rich ferromanganese crust is the name of the mineral deposit, hereafter, called crusts in this lecture. Crusts are manganese oxide that typically formed on hard substrate and distributed on deep seabed with significant topographic relief such as seamount ridges. ISA identified crusts as one of the important development target, as well, polymetallic sulfide and polymetric nodules. This slide shows seamount. There are isolated topographic features in deep sea with significant height above the seafloor. Among them, those with relative height more than 1000 meters are called seamount and less than 1000 meters are called sea knolls. In general, current around the seamount is complicated because the raised topography becomes obstacle to water flow and the complicated water flow makes seafloors a complex feature. Complex feature of seafloor lead to heterogeneity in contents of organic material and resulting in highly localized biomass. Seamount ecosystem have such a characteristic.

This slide explains the sinking process of organic material in the water column. In the ocean organic materials are produced in the upper layer by photosynthesis. A part of organic material remains there and the rest of organic materials are transported to the basic layer. In other words, organic materials that are incorporated into regeneration production cycle remains in the upper layer and and those do not directly contribute to the benthic ecosystem. On the other hand, other organic materials are incorporated into new generation cycle. Those are quickly transported to the seafloor through a biological pump, mainly by micronekton. Otherwise, many slowly settled down to the bottom as a marine snow. Freight of marine snow is affected by water movement. Not only during the sinking process in the water camp, but also during the deposition process on the seafloor.

In the place with rise you water movement marine snow cannot reach the seafloor in such a place, bedrock is exposed. On the other hand, marine snow can accumulate on the seafloor with a smaller water movement. Such seafloor are overlaid by clay and ooze.

This is why I mentioned earlier in that that, movement of water is one of the factors that create complex feature of seafloor. These photographs showed the seabed features on seamount at the South Pacific Ocean, among them, clay and ooze are area where water movement are weak and rocky and cobble and crust area are where water movement is strong. Next, the topographic diversity in seamount is explained. In general, variety of types of features can be found in deep seabed. The upper figure shows geological heterogeneity of seamount and the areas in jurisdiction of Micronesia, Samoa, and Marshall Island. You can see that there are large differences between the area, in addition, there is diversity within the areas. On the other hand, lower figure shows that geological heterogeneity of abyssal plane in Cook Island, Kiribati and Tuvalu. You can see that abyssal plane has a relatively uniform comparing between abyssal plane where the polymetallic nodule is distributed and seamount, where the crust distributed, significant difference in diversity of seabed can be found.

As I mentioned in the previous slide, the diversity of seafloor sediment led to diversity of organic material distributions. Which in turn led to the localization of basic community. Next, the relationship between the seabed future and benthic organisms are explained. Benthic organisms can be classified as various ways. For example, taxonomic classification, size classification, trophic levels, classification, etc.

Focus on feeding types classification.

Basic organisms living on seafloor Seamount are mainly divided into deposit feeder and suspension feeder. Deposit feeders depend on organic materials in the sediment for their food, but the sediment does not move. They need to move by their own to obtain their food, so the most of them are motile fauna. However, there are exceptions, some organisms create the burrows in the sediment and the extend proboscis from there to take organic matter. Such organisms exist on seafloor, covered by clay. Typical deposit feeders is holothurians and echiurid. Deposit feeders are distributing the place where the place is rich with organic material. Such areas are areas with low water movement that allow marine snow to settle down. In addition, it is a place covered for covered with clay and ooze.

Suspension feeders are basic organisms that food organic material in water color. Their foods are carried along with water flow. So they don't need to move by themselves. But they need a solid substrate to support their body against the water flow. Typical, that's when your feeders are sponge, sea pens, sea fans and deep sea corals etc. By the way, ISA has made our environmental research guidance for contract. The name of the document is "Recommendations for the guidance of contractors for the assessment of the possible environmental impact arising from exploration for the mineral marine minerals in the area". The environment guideline reflects the characteristic of seamount organism as mentioned so far. In particular, ISA emphasized that highly localized, benthic community observed in seafloormount. And close linkage between the benthic community and the substrate.

Actual ecosystem as a more complicated. So I would like to supplement this with a physiological optimum range and ecological optimum range. Needless to say, all organism exist within the range that is physiologically possible for them to live in short, within a habitable range. Among the habitual range, the range weather especially suitable for living is physiological optimal. However, in reality the physiological optimum and actual distribution range do not match, because there is an interaction between individuals and species. This is the ecological optimum.

In other words, organism does not live in the place where they are most likely to live. This suggests that if there is anthropogenic disturbance in the area; the balance of interaction between the individuals and the species may be disrupted, leading to replacement of dominant species or changes in faunal composition. What I want to say is - for sustainable development of seabed mineral resources, it is necessary to keep in mind that ecosystem is building on the delicate balance of biological interaction.

ISA identify cobalt rich ferromanganese crust as important development target as well, polymetallic nodules and polymetallic sulfide seamount where crust is distributed, changes the water flow by its topography. The complicated water flow makes seafloor a complex feature. In addition, complex feature of seafloor led to the heterogeneity in organic materials contents. And resulting in highly localized content, biomass. Deposit feeder tends to be distributed in clay or ooze where the water movement is small while suspension feeder tend to distribute in the area where the water movement is large and there is a hard substrate.

ISA issue of environmental guideline that reflects the characteristics of organisms in the crust. For example, highly localized distribution and close relationship between their distribution and substrate. In order to proceed sustainable development, it is important to pay attention to delicate deep sea environment.

Thank you very much for your kind attention.