



MODULE 5, LESSON 6

METHODS, TOOLS AND SCOPE FOR EXPLORATION OF COBALT-RICH FERROMANGANESE CRUSTS

LECTURE NOTES

Hello everybody. My name is Akira Usui. I'm a marine geologist working for ferromanganese deposits for more than 40 years and I have experience on board observations in total probably three years today, I'd like to share my experiences and ideas with you in the world of marine ferromanganese crust in the northwestern Pacific.

As you should know, already the ferromanganese crusts are important elements as well as metallic ores, but in my opinion, we should accumulate more and more facts and ideas on the nature and origin of the deposits. I like the words of ISA Secretary General and MS Home pages, Deep sea Marine science is the key and we need prudent development for including all aspects of scientific knowledge. Let's start with the schedule of today's lecture. We have 3 topics. First is - what metallic ore deposits on; secondly what are the sedimentary rocks? And I'll show you some examples of exploration, including the geophysical methods and mapping geochemical mapping tools.

This is a common scenery of the deep seafloors, almost all sieved substrates or such as volcanic rocks and limestones are covered with maximum 10 centimeter per manganese oxide layers. As you can see, the left-hand blue photos shows typical morphology of seamount. Thousands of seamounts in the northwestern Pacific and this is one example of variable nature of occurrence and morphology and thickness along with the straight line from the bottom of the seamount to the top. You can see the various colored substrates, variation of thickness most importantly the nature of the crust, variability of thickness and variability of compositions on various scales from microscopical to global.

This is an example of microscopical analysis of ferromanganese. As you can see this is 7 centimeter thick thermal class and this shows a very strong large variability in composition in chemistry and mineralogy. The age of the surface is almost 0 modern time on the bottom of the crust is about 18,000,000 years old now. This slide shows that manganese crusts are polymetallic and polygenetic and modern growing sedimentary rocks, these kinds of metallic ores have never been found from the deposits on land, this is unique to the oceans only. As shown by the earlier slide, there is no evidence of volcanic inference, but the crusts are totally hydrogenic. Hydrogenic means originated from the normal sea water, so that means this crusts have been affected by the change, in the conditions of ancient ocean that means, history of the ocean are closely related to the microscopic change in composition within the crust.

So now we have the common understanding that ferromanganese crusts have been forming been as the interface between the bottom water and substrate. That means the substrate is very important as a platform of ferromanganese crusts growth. This showed the very simple ideas of formation or the flat top seamount starting from the volcanic eruption on the sea level and the wave cut on the reef building and significant subsidence of the seamount. Most probably the position of ferromanganese crusts started after subsidence and the stable limestones and volcanic rocks can be a very nice platforms ferromanganese crusts deposition. This is the third topic on the field, we have two types of tools to search for the deposit one is the physical method, including acoustic method and secondary on site sampling and on site observations. Acoustic remote sensing an cover wide areas but very low resolution. On the other hand, one side observation or bottom sampling can give you a very exact points, nice data and samples, facts and realities, but it covers only several meters or 10s of meters. We should use both types of tools.

These photos show the innovation results of innovation for the last 40 years. As you can see that we have already have the nice machines for mapping and sampling and imaging. We have higher resolution, bathymetric map and more delicate samples and bigger data which can visualize our real world of the deep sea at this moment.

This is a summary of exploration. The most important parameters in the great abundance and accessibility is divided into 4. Points. The final goal is to apply the geological model to the resource potential estimation. We need the geological structure, versions history, and sedimental condition as a platform of ferromanganese crusts and secondary, we need to know the surprise source and the environmental data including with the water column structures and sea water bottom contact and substrate natures. Then finally these data are combined with the correlated with the ferromanganese crusts natures without any remote sensing data and on-site data we cannot get more scientific conclusions.

This is the final slide showing the example of our on-site exploration. The point of this exploration is that the combination of the history of evaluation of the seamount with the micro stratigraphy of thermal crust we tried. To compare with the diversity of sickness and composition to the history of the seamount. We assume that the start of the class formation started after subsidence. Another decay of the substrate has caused another negative anomaly or less abundant crust. Such an interpretation is not always the final one. But it could be applicable to another new areas for more reasonable, more practical estimation of the potential of the resources. So, this is the summary of my talk, there are three points is concluded:

1. is that we need to consider all aspects of the deposit including the structures below the deposit sub-bottom structure and above the deposit overlying seawaters in order to establish a geological model, we need such an environmental factors
2. Secondly - We try to combine with the mapping data and sampling data of ferromanganese crust this is also necessary for established and geological model as well as the more prudent way of estimation and realistic mining in the future.
3. Finally, as pointed at the first of my talk, we need a better scientific background for future

deep sea mining, which is just exactly the same as the message from ISA.

Thank you very much.