MODULE 3, LESSON 3

BIOLOGY OF POLYMETALLIC SULPHIDES

LECTURE NOTES

Good afternoon, everybody from Nigeria. I am Dr. Poopoola Samuel Olatunde, a Chief Research Officer from the Nigerian Institute for Oceanography and Marine Research. This afternoon, we are going to talk about the biology of polymetallic sulphide deposits.

From the introduction, polymetallic sulphide deposits, PMS, are most commonly found along tectonic plates boundaries, and volcanic provinces in water depths of between 500 to 5,000 meters. PMS are complex mineral deposits that contain significant amounts of metals, such as copper, zinc, lead, and gold, as well as other trace elements formed through hydrothermal processing. The interaction between the hydrothermal fluids and seawater causes the metals to precipitate out of solution and form sulphide mineral deposits.

The biology of polymetallic sulphide is also of great interest to scientists, as this deposit provides unique habitat for a variety of organisms. This picture is showing us some of the processes of formation of polymetallic sulphide mineral deposits. You can see black smoker here, active black smoker, inactive chimney of hydrothermal deposit.

Water and treatment are here, diffuse venting, focus venting. And these are all some of the metal deposits, like iron, zinc, copper, and sulphide. The deposits themselves are often colonized by bacteria and archaea that are able to use the sulphide and other minerals in a deposit as an energy source.

Also, these microbes form the base of a complex food web, a.k.a. chemoautotrophic primary production that supports a variety of other organisms, including tubeworms, snail, crabs, fish, mostly symbiotrophic invertebrates. In addition to supporting the unique biological community, polymetallic sulphide also has significant economic importance. These metals contained in this deposit are essential for a variety of industrial applications, such as electronics, construction, and transportation.

And the demand continues to grow and becomes increasingly significant. According to the ecology of man-made sediments, fauna is all the animal life present in a particular place or at a particular time. Abyssal benthic environment mostly supports the biological diverse species assembly. And belong to one of four main groups, from the smallest to the largest microfauna, meiofauna, macrofauna, and megafauna. Although ocean deeps are devoid of plant life, they are both a striking variety of ecosystem.

And all the phyla of the animal kingdom are represented on the sea floor; researchers are trying to understand them all. This extreme environment is a typical bird vessel from the underwater ecosystem used to monitor and these are microfauna, this is a typical one. Now we are going to talk about hydrothermal vents microfauna. They are the first of microscopic animals, an organism that exhibits animal-like qualities, such as nematodes, arthropods, protist kingdom, like protist ones.

And these microfauna are less than 63 microns, 64 microns. And some of them includes the thermophilic, mesophilic, and psychophilic bacteria. According to Van Dova et al, 2017A, B, and 2019.

This is a typical picture of chimney covered by dense mass, a beggiataa-like bacteria. And also, this same meiofauna, they are animals and protist kingdom that are greater than 64 micron. When we talk about hydrothermal mirofauna, they contain phyla, such as arthropoda, copepoda, cumacea, isopodo, ostracoda, and all of them.

These foraminiferans, granuloreticulosa, and other nematode communities. They are part of this hydrothermal vent meiofauna. And this endemic copepod, they represent an important taxonomic group of deep sea vents, with more than 80 described species, representing 20 families and 6 others.

The type of species, or genus, known as oncholaimus, they tolerate extreme geothermal condition and a high sulphide condition in saline water hydrothermal vents. This same hydrothermal, other hydrothermal vent macrofauna, this time around we are talking about macrofauna. They are greater than one mm. This macrofauna, they can be described as an incredible range of life forms, including isopods (sea slaters), amphipods, small gastropods, worms, bivalves, clams, oyster, cocles, mussels, and scallops. These are an example of a colony of mussels in the Lucky Strike hydrothermal site. When we talk about megafauna, hydrothermal vent megafauna, they are greater than 50 mm.

A sample of them are gastropods, barnacles, bythograeid, crabs, bresiliid, shrimps, vestimentiferans, sea anemones, and black sea snails. These are an example of Giant sea anemones, according to Charleyne et al., 2006. These are an example of scaly-foot gastropods, you can see.

And talking about hydrothermal vent communities, they play a host to other worldly species, such as giant tubeworms. At different shifts with the tectonic plates, corals can colonize and bare rock left behind. These corals provide homes for countless amphibians, such as sponges, sea urchins,

crabs, such as fish, large grouper, and shark.

The scaly-foot snail are chrysomallon, squamiferun, and unique to the Indian Ocean community. These are an example of coral and seabird communities. And also, the same hydrothermal vent community consists of others like Giant tubeworm.

This is an example of photograph from a 6,000-meter ROV, taken from the East Pacific Ridge, about 2,630 meters. Adopted to extreme, they are all adopted to extreme conditions. They are characteristic species of hydrothermal vent communities.

Sea floor massive sulphide deposits with associated communities of shrimp, crab. This is an example of them, discovered at 3,863 meters in the Mariana Black-arc in the West Pacific Ocean. You can see, this is also a black coral, about 2,227 meters in Endeavour Rift Valley in the North Pacific Ocean.

This is also another community, squat lobsters and stalked barnacles. This dominates the chimney at any high biomass in the E9 vent field in the East Coastal Ridge, Southern Ocean. This is also another one, coral reels on extinct chimney at 2,230 in the Mossback vent field in North East Pacific Ocean.

This is another one from Ridgeia piscesae tube worm communities. They likely are hosting paralvenellid worms, scale worms, limpets, and many other faunae in their push-like structures. Found near a black smoker at 2,133 meters at Endeavor segment of the Juan de Fuca Ridge in North East Pacific.

This is another one from the crinoid heliometra glacialis. They form a dense aggregation surrounding the vent speed. This is from the mid-valley ridge in the Juan de Fuca Ridge from the Antarctic sulphide chimney fragments. Most of them include stalked barnacles, brooding, octopods, coral, anemones, fungi, tunicates, fish, courtesy of Verena Tunnicliffe, from the University of Victoria.

In conclusion, majority of hydrothermal vent communities are sulphide oxidizers by using free energy heat from the oxidation of sulphide with oxygen to feed carbon dioxide. Some are found as parasites, such as copepods of the genus dirivultus.

Distribution information of hydrothermal vent community is often combined with the knowledge on the biology of elements to construct a food web and species composition of the community. And also, the biology of polymetallic sulphide is a topic that is still being explored and understood. These sulphides are formed on the seafloor and they are home to variety of unique microbial communities that have adapted to the extreme conditions of the deep ocean.

These communities play an important role in the cycling of nutrients and metals in the ecosystem. However, much more research is needed to fully understand the biology of polymetallic sulphide.