

# Researchers explore opportunities to extract precious metals that lie several thousand metres deep

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A large NTNU pilot project, Deep Sea Mining, explores underwater volcanoes and mineral deposits. Credit: NTNU

"There are large unexplored ocean areas, and there is an enormous amount we do not know about them. We actually know more about the moon than the seafloor," says Steinar Ellefmo, an Associate Professor in NTNU's Department of Geology and Mineral Resources Engineering.

Just over 70 per cent of the Earth's surface is covered by water. We know a little about what is hidden below the water's surface, but far from

everything. And we know even less about what is to be found in the seabed. But we know there are undersea volcanoes that form near where the continental plates meet and create fissures into the Earth's interior.

Submarine volcanoes, or hydrothermal vents, were first discovered in 1977 in the Pacific Ocean. They are also called black smoker chimneys because of the apparent black smoke that flows out of them. They spew out minerals and metals from rocks deep in the earth's crust and deposit them on the seabed.

These metalliferous minerals are known to exist along the Mid-Atlantic ridge. This is a huge underwater mountain range that runs the length of the Atlantic Ocean. The part of the mountain range that runs from Jan Mayen northward and up along the west coast of Svalbard is within Norwegian jurisdiction and part of the Norwegian extended continental shelf.

A research project led by Ellefmo in 2013 charted a gross value estimate of marine minerals within this zone at nearly NOK 1,000 billion.

Now Ellefmo is leading a large interdisciplinary research project that will take mineral mapping of the ocean floor to a new level. The pilot project is called Deep Sea Mining.

"We need a geomap of the ocean floor. There aren't any as yet – and this type of map is quite difficult to make. But we want to draw on what data and indicators we have to create a map that shows zones and a model of the relevant seabed areas. The map will help us conduct a more targeted search for this type of deposit," Ellefmo says.

He adds that academia was responsible for the few findings of black smokers that we know of today. For starters, we need a decent map to work towards a better understanding of the resources in a systematic

fashion, and to gain a better overview of the resource potential and possible future industrial development.

Underwater Robots (AUVs or ROVs) will probably be used in mapping the seabed. The underwater vehicles can take highly detailed images and a high-resolution video of the seafloor and provide scientists with valuable information.



Credit: Wikimedia Commons

## Researching ethics

Deep Sea Mining is a multidisciplinary pilot project in NTNU's Ocean Science and Technology strategic research area. Ten doctoral students are involved in the project, and the researchers come from both technology fields and the humanities.

An important part of the research is related to ethics and the

environmental consequences of extracting mineral resources on the seafloor.

"How do we think about the social and environmental responsibilities when we develop new technology – and don't know the consequences of it yet? An old-fashioned way of thinking is to develop the technology first and consider the consequences afterwards," says Siri Granum Carson, an Associate Professor in NTNU's Programme for Applied Ethics. She is responsible for guiding one of the Applied Ethics PhD candidates who will help create reflection within the pilot project.

"We have to integrate thinking about social responsibility throughout the process. Technologists do this too, but someone who comes from the ethics field will be able to systematize and thematize thinking in a different way than technologists. We'll help to weigh the environmental impacts against the socioeconomic benefit," says Carson.

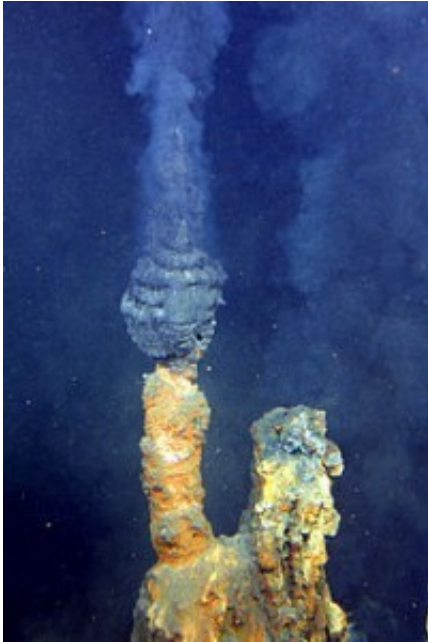
She says, "This is techno-development under highly uncertain conditions, and if we look at the EU Horizon 2020 Initiative, Responsible Research and Innovation (RRI) is a big theme."

The reason that difficult-to-access minerals and metals on the seabed have become so interesting, is that the mines on land are becoming depleted, yet the world demand for minerals and metals is ever growing. Copper and zinc, which are used in the consumer electronics that we are surrounded by in daily life, are in especially high demand.

## **Who has jurisdiction over the oceans?**

The United Nations Law of the Sea is the theme for the project's second doctoral position in the humanities. Regulations are complicated in international waters, and conflicts around the right to resources can easily arise. Countries like China, Russia, Japan, France and India have

begun to adopt strategic positions to secure resource-rich areas in international waters for themselves.



Minerals and metals are deposited on the seabed around the black smoker chimney when the scorching water that has been down in the earth's interior is forced up to the seafloor and into the ocean waters. Credit: National Oceanic and Atmospheric Administration, NOAA

Norway is fortunate to have deposits that lie in Norwegian territorial waters. Nonetheless, many obstacles may exist.

"The rules governing the rights to these deposits are unclear. Relevant ministries are collaborating to develop a common basis for the regulations. We don't know yet when this will be completed," says Ellefmo.

## **Creating a dictionary to understand each other**

"The thematic focus areas are facilitating more committed cross-discipline work. It's rewarding, and it's challenging," says Ellefmo. The people involved have different areas of expertise, which also means that they operate with different terminology. Arriving at a common conceptual understanding is important. Carson and Ellefmo think the research team needs to create its own dictionary to ensure good dialogue.

## **Connects many fields**

Doctoral scholars from various disciplines and institutions are linked to the Deep Sea Mining [pilot project](#) through the following projects:

- Increased understanding of the ore forming processes under the seafloor and how they affect the grade, tonnages and ore-metal distribution of marine deposits containing copper, zinc and gold. This project will be implemented with the Department of Geology and Mineral Resources Engineering.
- Exploration for marine mineral resources using advanced geophysical methods developed for the exploration of oil and gas deposits. This project will be implemented with the Department of Petroleum Engineering and Applied Geophysics.
- Development of new sensors that can "sniff" their way to black smokers. This project will be implemented with the Department of Marine Technology.
- Assessment of normative issues related to the development of new technologies in general, and technology related to the extraction of marine minerals in particular. This may, for example, relate to social responsibility and ethics. This project will be implemented with the Department of Philosophy and Religious Studies.
- A study of the historical development of international rules relating to exploitation of marine minerals. This project will be

implemented with the Department of Historical Studies.

Provided by Norwegian University of Science and Technology

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