

# Mineral Mining on the Mid-Atlantic Ridge

Sensing the environment before and during operations

## NEWSFLASH

At the Mid-Atlantic Ridge, the European and African continents are separating from the Americas with some centimeters per year. Here new crust is formed that is rich in rare minerals which are needed in the on-going transition from fossil fuels to cleaner energy.

**EMINENT** - Energy MINerals for the NEtzero Transition is a Norwegian project that aims to quantify the available amounts of minerals and to develop automatized extraction methods, accompanied by extensive environmental monitoring before, during and after extraction. If these operations are found economically and environmentally viable the goal is to create mining operations that have a significantly lower environmental impact than today's land-based rare mineral mining.

*Sensing the environment before and during operations is essential to reduce environmental impact and make practices more sustainable.*

In 2023 a key part of the project was a spring expedition to the Mid-Atlantic Ridge. Despite rough weather, multiple operations were carried out, often in parallel, from an offshore supply vessel named **Dina Star**. A **tractor** (Figure 1) carried a new coring and drilling device, FlexiCore, teaming up with an ROV (Remote Operated Vehicle) to collect rock and sediment samples. Another ROV was used to run biological video transects, to deploy instruments on the seafloor, (Figure 2) and to sense the environment.

For this an Aanderaa **SeaGuard II** logger with cable-connected sensors was installed to measure **speed**, **tilt**, **heading**, **acoustic backscatter**, **pressure**, **salinity**, **temperature**, **oxygen** and **turbidity** at 2 seconds intervals (Figure 3).

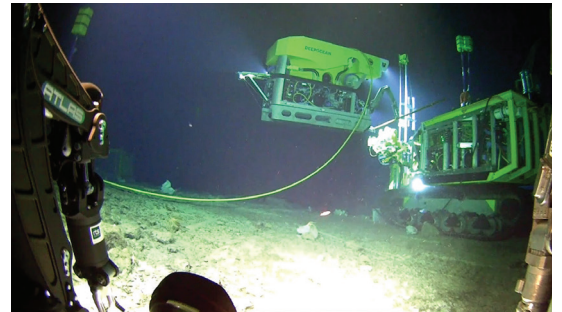


Figure 1: Subsea excavator with new FlexiCore and ROV in seafloor operation at the Mid-Atlantic Ridge.

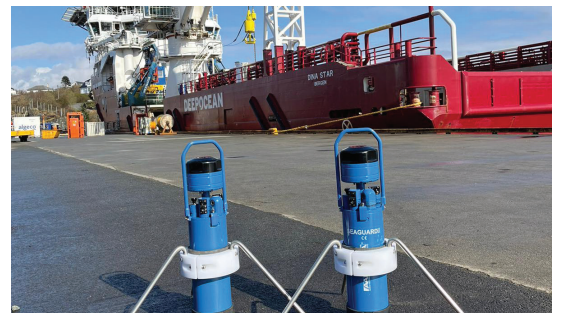


Figure 2: ROV deployed SeaGuard II instruments, to collect background information at the bottom for +1 year at 10 min interval. Measured information includes: bottom currents & particles, mm seafloor movements, salinity, temperature, oxygen and turbidity. The expedition vessel Dina Star is in the background.

The instrument offers a flexible sensor hub to which additional sensors, e.g. pH, pCO<sub>2</sub> and [acoustic profiling](#), to measure currents above or below the ROV, can be connected. Examples of data from a ROV transect along the bottom is presented in Figure 4 and water column profiles during descent in Figure 5.

The instruments placed on the seabed will record background information, for at least one year, of natural changes in bottom currents, sediment re-suspension, oxygen, salinity, temperature and millimetre movements of the seafloor.

During a possible operational phase the deployed systems can be expanded to perform continuous monitoring in and around the area of mineral extractions. The water column will be monitored by using a combination of [acoustic profiling sensors](#) and [sensor strings](#). The acoustic profiling sensors will remotely measure currents, particle clouds and mixing in up to 150 levels above the seafloor. Sensor strings attached to the same instruments will provide water quality information at multiple levels in the same volume of water. Important information to be included is e.g. oxygen, turbidity, salinity, temperature and pH.

Communication between underwater nodes, vehicles and the surface will be enabled by underwater acoustic networks, such as used in [wireless sensor applications in aquaculture](#), achieving real-time operations coordination and live environmental monitoring.

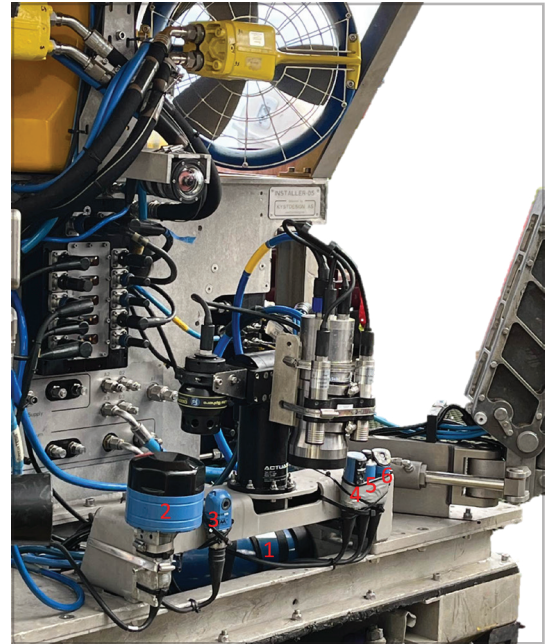


Figure 3: ROV installed SeaGuard II sensor hub (1) with cable-connected sensors: Doppler Current (2), Salinity/Temp (3), Turbidity/Temp (4), Pressure/Temp (5) and Oxygen/Temp(6).

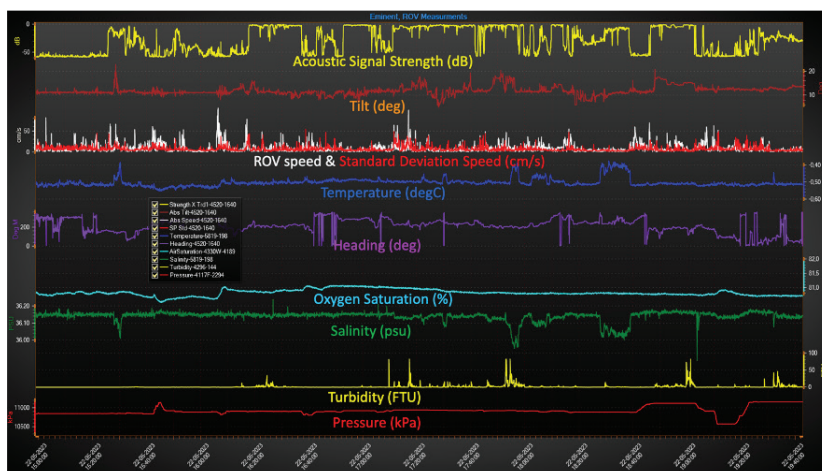


Figure 4: Example of dive data produced by SeaGuard II sensor hub with cable connected sensors that measure at 2 s interval.

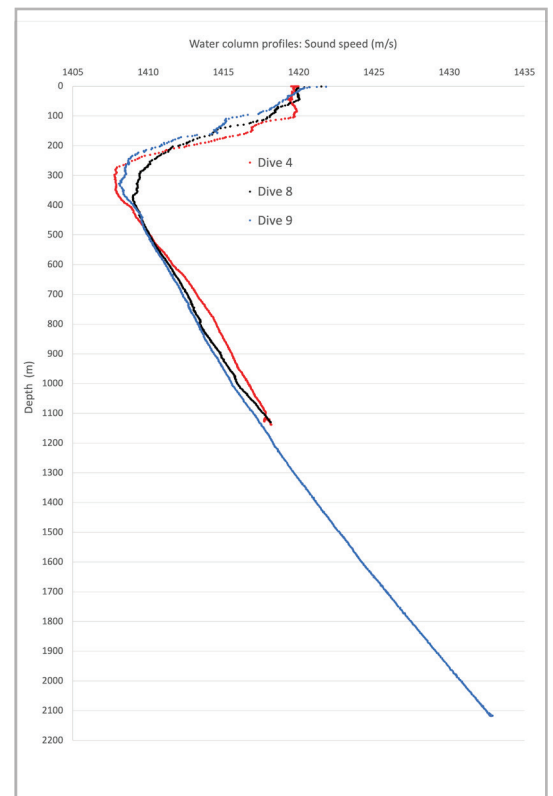


Figure 5: Examples of water column profiles of sound speed measured during the ROV descent.