# Seabed Technology

- Exploration
- Mining
- Environmental protection

The development of equipment and techniques to investigate and exploit the deep seabed has been one of the great challenges to science and technology over the past half-century. As land-dwelling, air-breathing creatures, human beings have long struggled to conquer the vast, unfamiliar oceans.
For most of human history, since the first primitive rowing and sailing vessels set out for the unknown, the aim has been twofold: to extract food, and to move people and goods across the seas to other habitable lands.

This dual impetus for sustenance and transport drove industrializing societies to devise more effective means of exploring and exploiting the oceans. On ships, engines replaced oars and sails (the first steamship sailed in 1783), and radar, sonar and global positioning systems took the place of reckoning by the stars. Submersible vessels, first tested in 1620 in a river, enabled humans to move about beneath the water surface. Meanwhile, fishing vessels reached farther and deeper into the seas to feed a growing population. More recently, especially since the mid-twentieth century, the oceans have been found to be vast depositories of the minerals demanded by industry.

Ocean explorers have begun to document the riches that lie beneath the oceans: energy reserves sufficient to power the earth's factories for centuries, troves of metals and rare earth elements richer than any on land. But in many ways, these riches might as well be on the moon, so great are the obstacles to finding and retrieving them. Petroleum rigs at sea are already able to control their drill bits from up to 6 kilometres above the point where they enter the seabed. Deep-sea mining ships in the central Pacific will have to ride out the stormiest of the oceans thousands of kilometres from land, maintaining position above roving mining vehicles tethered to them thousands of metres below.
Just to explore the deep, humans must navigate a lightless environment where half a tonne of water sits atop every square centimetre.


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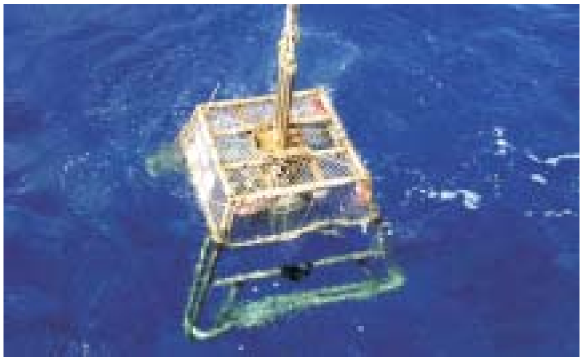

2.


3.

*1. IFREMER's research vessel L'Atalante*

*2. Sampling device (Christina Loarie)*

*3. Multiple corers take samples of sediment from the seabed, allowing scientists to observe the creatures which live there (Dr. Woong-Seo Kim, KORDI)*

# Exploration

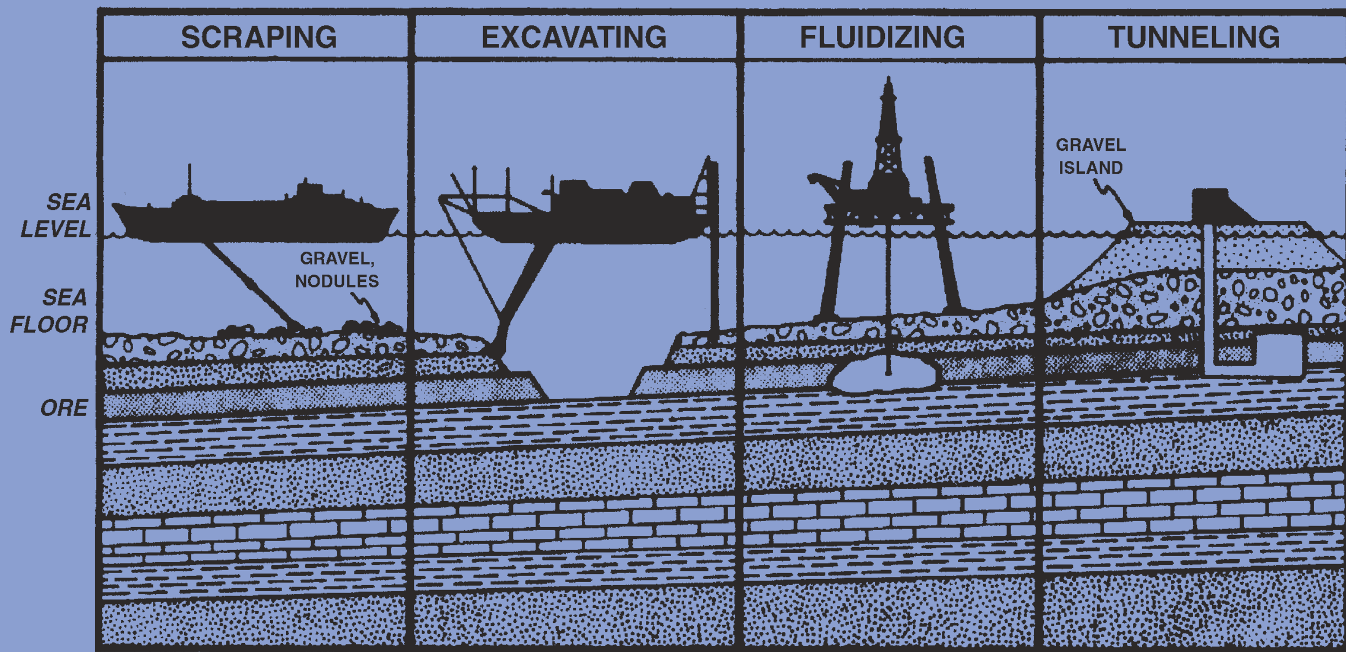
A broad range of equipment and techniques has been developed to investigate the deep seabed, useful both for finding resources and for studying the environment in which they lie. Most of these involving remote sensing, as it is far easier to send devices into these areas than to introduce the complex life-support systems that humans require in an environment for which they are totally unadapted. Consequently, remotely operated vehicles (ROVs), often self-powered while guided by their mother ships above, crawl along the bottom or sail cautiously through a jagged undersea landscape of mountains and canyons rivaling any on land.

Exploration involves the ability to look around, measure, record, and retrieve samples. Still cameras and television extend human vision into the depths, using light-enhancing electronics to penetrate murky waters. Photographic libraries of life forms are being created, with pictures disseminated through the Internet so that scientists worldwide can compare observations. Maps of the ocean bottom are computer-generated by reconstructing sonic images from sonar and seismic sounding equipment. Side-scan sonar can be towed over a preset course for days to map a broad swath of seabed, or can be used to investigate details of the terrain around individual potential mine sites. Seismic profiling can disclose information about the kinds of rock and the depths of layers at and beneath the ocean floor. Sound is the preferred medium, as radio waves, like light, do not propagate far in water, while sounds can be detected hundreds and even thousands of kilometres from their source. Sensors and sediment traps are hung from mooring cables at various levels to detect currents, oxygen content and other chemical composition, and turbidity (the density of sediment in the water).
At the surface, oceanographic research vessels can record their exact location within a metre through the satellite-based Global Positioning System (GPS), available anywhere on earth.

Remote sensing must be supplemented by the direct study of samples brought up to the research vessel and often analysed by laboratories ashore. Draglines, grabs and box corers are dropped to the seabed to capture biological and geological specimens at the surface and just above and below it. They must be specially designed and handled so that animal specimens do not disintegrate when brought to the surface. Deeper sampling may be carried out by coning, probing or drilling. So far, no device has been developed that can drill 50 or 100 metres into hard rock, a capacity that geologists need to investigate such deposits as methyl hydrates – immense basins of frozen natural gas.
Biological research, and especially the identification of species, has been greatly aided in the past decade by the development of genetic testing, which enables scientists to identify and compare specimens many times faster than when they had to rely on painstaking examination of each sample under the microscope.

*Remotely operated submersibles allow scientists to control sampling in areas they cannot go (West Coast NURP)*

# FOUR BASIC METHODS OF MARINE MINING




## Mining

Whether on land or in the oceans, there are only four basic ways to mine, or recover mineral deposits: scraping them from the surface, excavating them from a hole, tunneling to a deposit beneath the surface, or drilling into the deposit and fluidizing it. Mining is essentially a materials moving process: once the deposit material is gathered or collected, it must be transported elsewhere for concentration or processing and then refined into a marketable product for sale.

Deep-seabed mining differs from its land-based counterpart because it must be carried out underwater by remote methods, controlled from a floating platform at the sea surface. At each stage of the process, depending on the nature of the deposit, the bulk of material being handled is reduced and tailings (waste) are discarded. In a polymetallic nodule deposit, for example, three of the constituent metals – nickel, copper and cobalt – make up less than 3% of the deposit, excluding sediment. Counting manganese, the metals represent about 30% of the bulk. By contrast, a deposit of aggregates – gravel and sand – may have little waste material. Every deposit is different and many variations in technology may be applied.

To date no sustained operations have taken place for the commercial recovery of solid minerals in water depths greater than 200 metres. However, testing of systems for the recovery of polymetallic nodules at depths of 5,000 metres – where they can be readily lifted off the seabed – have indicated that there are no technical reasons that will prevent mining of these or similar deposits.

On the other hand, the configuration of mining technology for deposits that require the fragmentation or penetration of hard materials is a matter of conjecture. Several systems have been proposed for mining sulphide crusts and surface deposits of hydrothermal sulphides but until more details are gathered about individual deposits, the efficiency of these systems will be speculative. Advances in drilling capability, pipeline trenching and production from deep petroleum basins have added significantly to the technical capabilities available for mining but significant adaptations will be required to conform to the more selective extraction processes required for hard mineral deposits. This will surely happen, however.

With the notable exception of nodule extraction, most technology for exploration and exploitation of the seabed has been developed for use at shallower depths and its use extended as the need arises. In the future, therefore, it is likely that existing gaps in deep-seabed mining technology will be filled by advancing the technology of conventional systems, many from other industries. New drilling systems, improved transfer of energy for exploitation, more processing of the raw materials on the seabed, and differential recovery of selected metals through boreholes by hydrometallurgical processes (such as leaching) are likely outcomes.

# Environmental Protection

In workshops conducted by the International Seabed Authority, a trend has been noted for engineers to have more regard for environmental consequences when they design deep-sea mining equipment. To meet environmental standards being developed by the Authority, miners will have to minimize the effects of the disturbance that their operations will inevitably cause as they crawl over or dig into the seabed, raising clouds of sediment that will bury animals in their path and surroundings, and changing the chemical characteristics of the ambient water. Thus, efforts will be made to minimize the amount of sediment disturbed as nodules are gathered, not only for environmental reasons but also because the sediment is a waste material that dilutes the proportion of metals in the product to be processed. In addition, studies will be carried out to determine the best depth to discard the sediment that will inevitably be included as nodules are brought up, whether at the surface or some intermediate level where it might cause less harm to the surrounding life.

*Deep seabed organisms and fauna around hydrothermal vents*