Protection of the Seabed Environment

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- *Environmental Baselines*
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The 1982 United Nations Convention on the Law of the Sea places special emphasis on the critical importance of protecting and preserving the marine environment. One of the 17 major parts of the Convention (part XII) is entirely devoted to this subject, calling for global and regional cooperation, technical assistance, monitoring and environmental assessment, and the development of enforceable international rules and national legislation to prevent, reduce and control pollution affecting the oceans. With regard to the seabed, Part XI of the Convention, which defines the functions of the International Seabed Authority (ISA) in the area outside national jurisdiction, mentions the environment 19 times.

Since its establishment in 1994, in all of its activities related to the administration and regulation of deep-seabed activities, the ISA has kept environmental protection as one of its highest priorities. In 2000, the Authority adopted its Regulations on Prospecting and Exploration for Polymetallic Nodules in the "Area", in which it established a comprehensive legal regime for monitoring and protecting the marine environment in the Area. These regulations are binding on all entities that have contracted with the Authority to explore the Area for these minerals. In 2001, with input from both a workshop held by the Authority in Sanya in 1998 and one on standardization held earlier in 2001, the Authority's Legal and Technical Commission approved recommendations to guide contractors in assessing environmental impacts arising from nodule exploration. These recommendations have been followed since then by all of the contractors with the Authority.

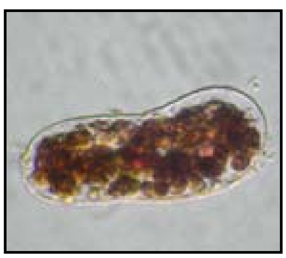
Environmental provisions are a major part of the obligations that the Authority placed on itself and on seabed contractors in its regulations on polymetallic nodules. To protect and preserve the marine environment, the Authority is obliged to establish environmental rules, regulations and procedures, while each contractor must "take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment arising from its activities in the Area as far as reasonably possible using the best technology available to it."

Also according to these regulations, in the event of serious harm to the marine environment caused by a contractor's activities, the ISA Secretary-General may take immediate temporary measures to prevent, contain and minimize the harm; the Council may follow up with emergency orders, including orders to suspend or adjust operations, and may act on its own or through others if the contractor does not comply immediately. Coastal States that have grounds for perceiving a threat to their own marine environment may notify the Secretary-General, who must give the contractor a chance to examine the evidence and submit observations. Contractors must notify the Secretary-General if they find objects of an archaeological or historical nature and must take all reasonable measures to avoid disturbing such objects.

In its work, the Authority has dealt with three practical aspects of environmental protection in relation to nodule exploration: which seabed exploration activities are likely to have environmental impacts and to what degree; what baselines should be used to measure the state of the environment prior to human activity and how should subsequent changes be monitored; and what research should be conducted into the natural and anthropogenic (human-induced) processes at work. Attention has largely been confined so far to exploration, since actual mining of these deposits has not yet commenced. Nevertheless, workshops held by the Authority also looked ahead to the possible impacts of mining, in the expectation that engineers will try to identify and limit those impacts as they design mining systems. The Authority has begun to consider two other categories of resources, polymetallic sulphides and cobalt-rich crusts, whose exploration is likely to raise different and perhaps even more acute environmental issues.

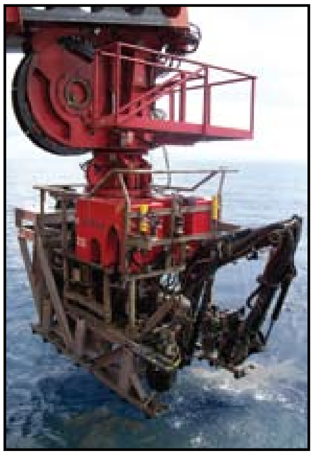
polychaete

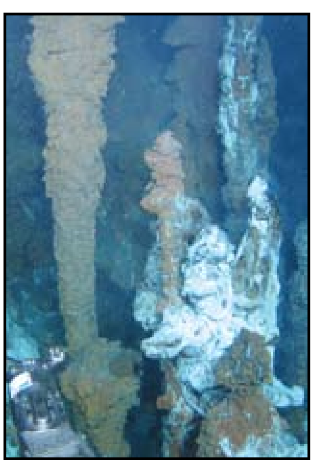
nematode



foraminiferan

Pictures of the three main fauna studied by the Kaplan Project (the first scientific collaboration between the Authority and research scientists) are provided courtesy of Nina Okhawara of JAMSTEC, Japan (foraminiferan); Adrian Glover (polychaete) and John Lambshead (nematode) both of the Natural History Museum, United Kingdom





Potential Environmental Impacts

The task of the ISA is to regulate activities by contractors exploring for, and eventually exploiting, deep-lying deposits of polymetallic nodules and other mineral deposits in the international seabed area. It has identified three types of activities with potential for environmental impacts: (1) exploration for commercial deposits; (2) small-scale and prototype tests of commercial recovery mining systems; and (3) metallurgical processing, if it occurs in the Area. Exploration is not expected to cause serious environmental harm. Mining-system tests and commercial mining are not anticipated for many years, and metallurgical processing is unlikely to take place in the Area in the foreseeable future.

Nevertheless, it is critical in any environmental evaluation to consider the implications of an activity as well as the activity itself. Actions taken in the near future by explorers, their collection of baseline data and their choice of technology all have implications for the ultimate characteristics of the seabed-mining industry and its environmental impacts. Thus, it is not premature to initiate environmental assessment in parallel with exploration activities and in anticipation of future mining-system tests and commercial mining itself, especially as valid environmental studies usually take many years to complete.

Prospecting and Exploration

Prospecting and exploration are similar in many ways to oceanographic research, though with a focus on potential exploitation. Although explorers for polymetallic nodules have refined and modified many procedures to fit their particular goals, their basic methods and backgrounds stem directly from the well-developed disciplines of geological, physical and biological oceanography. These techniques are initially employed to find the best mine sites and to map their extent. Such activities would probably continue until mining commences. After the mineral resources are mapped, the same techniques would be used in concentrated seabed areas holding the greatest promise, to delineate the actual path to be traversed by the mining device. In line with conclusions reached by the USA Government's evaluation of seabed mining environmental impacts, the Legal and Technical Commission has determined that these activities are not expected to cause serious environmental harm, at least so long as they do not involve dredging.

Seabed mining exploration images: drill ship, corer, ROV copper sulphide sampling and sulphide chimneys. Photos © courtesy of Nautilus Minerals Inc.,

Small-Scale and Prototype Mining Tests

Prior to commercial operation, it is likely that at least five years of testing of a prototype mining system would be necessary to develop adequate operational control, to demonstrate system reliability and to acquire sufficient ore for pilot scale metallurgical processing tests. This estimate is based on projections made by prospective deep-seabed mining consortia and filed with the USA Department of Commerce. The mining systems for these tests are assumed to be similar to commercial systems, but would operate for much shorter periods. Because these tests would be of short duration, they are not expected to cause substantial environmental harm. However, these test operations would provide the first opportunity for the accurate assessment of environmental impacts from long-term, commercial mining.

Commercial Recovery

Several private and government-subsidized international consortia have been active during the past three decades in the development of systems to recover polymetallic nodules from the deep seabed. Nodule mining will differ from land-based mineral extraction, not only because it involves lifting the ore through 4,500 to 5,000 metres of seawater but also because these surface deposits are essentially two-dimensional, with no overburden. Mining nodules is more like harvesting potatoes than strip-mining or open-pit operations for ores in the earth.

Mining will consist of removing nodules from the seabed surface of fine-grained pelagic sediments (mud) and conveying them to the ocean surface, where they will be taken aboard "mother ships". Many strategies have been tested to accomplish these two tasks, ranging from simple, towed dredges to self-propelled, highly manoeuverable systems. As the environmental consequences of these different systems are likely to be dissimilar, impact assessment will vary according to the particular design utilized. Systems already subjected to scale-model tests in the deep seabed include various kinds of hydraulic systems, which pick up the nodules with a towed or self-propelled harvester and then lift them to the surface with simple hydraulic or air-assisted lift systems, and a continuous-line bucket system that employs dragline buckets connected in a loop. Other more speculative systems have been conceived, but have not been developed or tested.

ENVIRONMENTAL BASELINES

The Sanya workshop identified three effects from nodule mining that are likely to harm benthic (seabed) life to varying degrees and these are likely to be similar for the new resources being considered. The effects were the crushing of organisms in the path of the mining vehicle, the burial of nearby organisms under sediments stirred up and redistributed, and chemical and physical changes in the water column caused by losses from the lift system and discharge of waste from the surface vessel. These potential impacts and their relationship to a hydraulic mining concept are sketched in Figure 1.

Regulation 31 of the ISA prospecting and exploration regulations requires seabed explorers to establish environmental baselines in the areas explored. The ISA recognizes that exploration itself does not generally have significant environmental impacts. However, it is critical that the contractors, while conducting exploration cruises in their prospective mining areas, should take the opportunity to gather as much environmental information as possible in advance of mining, to provide baselines that will allow comparison with conditions after mining has begun. Much of the discussions at the various workshops held by the ISA has focused on what is known about the environments where mineral resources are found, what is currently unknown, and how can these knowledge gaps be filled. This has enabled the Legal and Technical Commission to specify a list of parameters to guide contractors in their environmental studies.

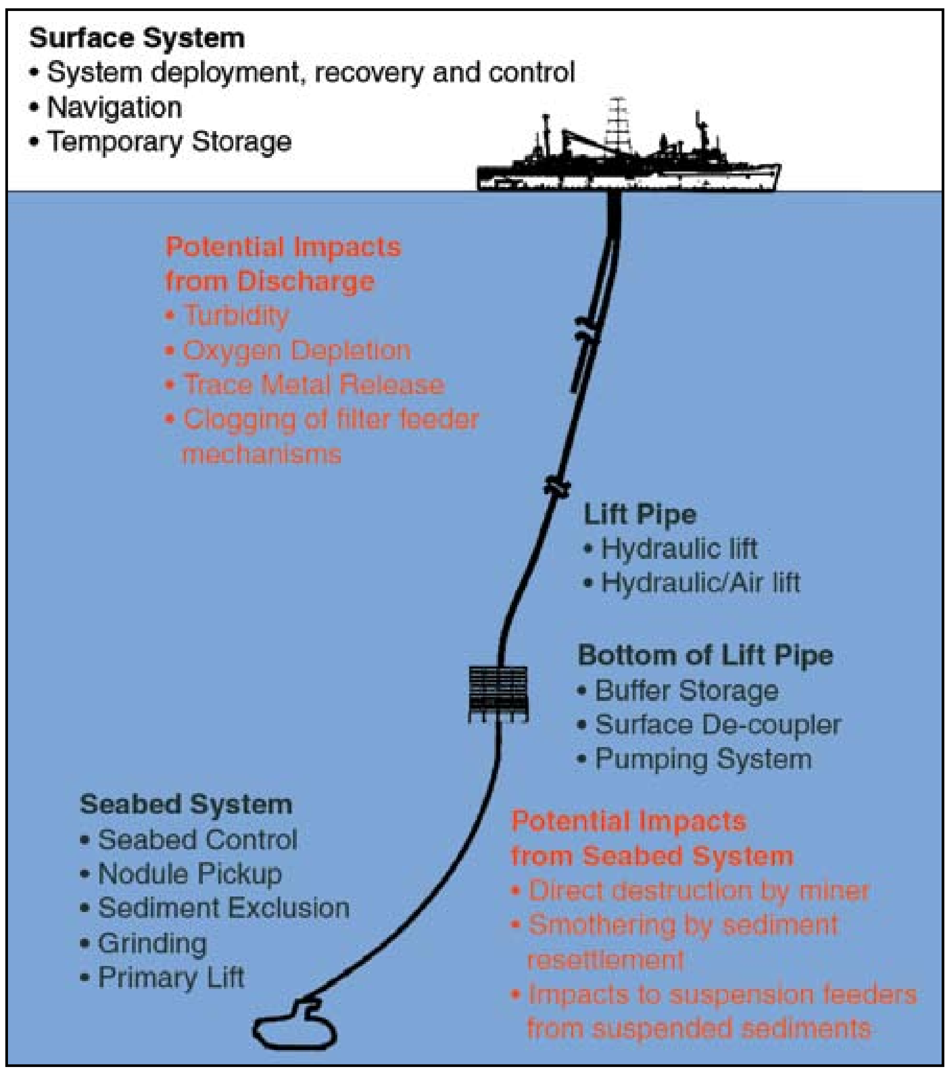
The ISA has allocated two regions in the deep seabed to contractors in response to the claims they had advanced to these sites. An area in the south central Indian Ocean between 10º and 17º south latitude and 72-82° east longitude has been assigned to the Government of India, and portions of the northeastern tropical Pacific Ocean (in the Clarion-Clipperton Fracture Zone south and southeast of Hawaii) between 7° and 18° north latitude and 157-118° west longitude have been assigned to seven groups from various countries Though these regions are more than 13,000 kilometres apart and must be considered separately in any site-specific environmental analyses, they share key similarities that have resulted in both regions containing nodule deposits of relatively high abundance and high metal content.

Ecologically, these areas consist entirely of deep (more than 4,000 m) seabed communities that exist and evolve beneath a host of marine ecosystems in the water column above. The deep seabed comprises about half of the Earth's surface.

In general, it is cold (around 4° Celsius) and poor in nutrients. Very low densities of highly diverse organisms, mostly invertebrates, inhabit this environment. These communities have developed ways of surviving on the meagre fare of detritus descending from the pelagic populations above them.

The recommendations for guidance of contractors identify various biological, chemical and physical characteristics that contractors should gather during their exploration activities and include the following list of baseline parameters for investigation by seabed explorers:

1. Physical oceanographic data, including current, temperature and turbidity (suspended sediment) data, on the seafloor and in the water column where mining discharges are contemplated.
2. Chemical oceanographic data on the water-column.
3. Sediment properties from prospective mine sites, including soil mechanics that will determine how mining is likely to redistribute the sediment.
4. Biological communities at and above the seabed, including samples from the differing topography, sediment types and nodule distribution patterns in which the organisms live, with records of any trace metals in dominant species. Animals of all sizes down to the microscopic are to be covered, including fauna living in, on and around nodules, demersal (bottom-dwelling) scavengers, pelagic organisms and sightings of marine mammals, as well as temporal variations.
5. Bioturbation, as animals mix sediments by moving about.
6. The flow of solid materials from the upper waters to the deep sea.



The Sanya workshop identified three effects from mining that are likely to harm benthic (deep seabed) life to varying degrees: the crushing of organisms in the path of the mining vehicle, the burial of nearby organisms under sediments stirred up and redistributed, and chemical and physical changes in the water column cause by losses from the lift system and discharge of waste from the surface vessel. These potential impacts and their relationship to a hydraulic mining concept are sketched in this diagram.

The ISA is in the unique position of being able to obtain baseline conditions in a pristine environment prior to any anthropogenic impacts. This means that it will be possible to monitor any changes in the environment as a result of mineral activity and puts the Authority in a better position to mitigate any changes to the environment.

WORKSHOPS

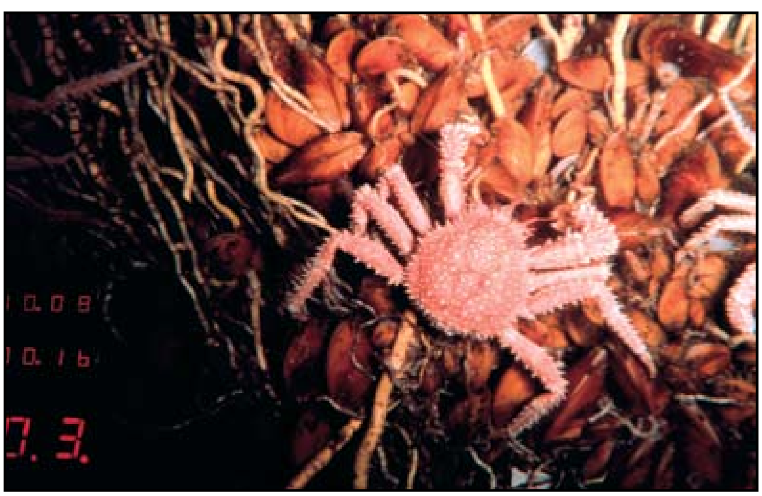
As well as its responsibility to ensure effective protection of the marine environment from the harmful effects of mining, the ISA also has a responsibility to promote and encourage the conduct of marine scientific research in the international area. The most immediate and practical way in which the Authority has begun to implement this responsibility is through its programme of technical workshops. Since 1998, the Authority has established a pattern of workshops and seminars on specific issues related to deep seabed mining, with participation by internationally recognized scientists, experts, and members of the Legal and Technical Commission as well as representatives of contractors, the offshore mining industry and member States. Proceedings from the workshops are available direct from the Authority. Of the nine workshops that have been held, five have been directly concerned with the environment. The outcomes of these workshops have included:

Draft guidelines for the assessment of the environmental impacts from exploration for polymetallic nodules (China, 1998).

Technical recommendations designed to ensure that the results from environmental sampling conducted by different contractors at different locations can be compared. These involve specifications for the equipment and procedures used, including the types of devices and laboratory analyses for each kind of biological, chemical and physical evaluation to be undertaken. (2001)

Recommendations on possible scientific research collaborations in four areas by outlining specific collaborative projects, compiling a list of resources currently available for the projects, identifying potential sources of additional support needed, and specific plans for capacity enhancement. (2002)

Draft guidelines for the assessment of the environmental impacts from exploration for polymetallic sulphides and cobalt-rich ferromanganese crusts (2004).



Hydrothermal vent fauna (NOAA)

Most recently (2006), a workshop was convened to address the current state of knowledge with regard to seamounts, the environments where cobalt-rich crusts are found. This workshop identified certain regions where knowledge was lacking and as a result the ISA has formed a collaboration with Census of Marine Life programme Censeam.

SCIENTIFIC COLLABORATION

An international workshop in Kingston in 2002, called specifically to develop collaborative research, suggested four types of project that would investigate:

1. Biodiversity, species ranges and rates of gene flow in potential mining areas.
2. Burial sensitivity of deep-sea animals and their response to the type of disturbance caused during commercial activity, as well as the recovery of animal communities over space and time.
3. Impacts on the ocean layers above a mine site caused by unwanted materials that could be released from a mining operation as bottom water, sediment and waste are raised to the surface.
4. Natural variability in deep-ocean ecosystems over space and time.

The first major scientific collaboration between the Authority and research scientists was the Kaplan Project. The Kaplan Project was the first and most successful attempt to analyze species composition and rates of gene flow of living organisms across the abyssal plains of the Clarion-Clipperton Zone in the Central Pacific Ocean. During the Kaplan Project, scientists evaluated the biodiversity of three key faunal groups at different locations in the Clarion-Clipperton Zone. Samples were collected by scientists using special "DNA-friendly techniques" during three major research cruises and transported to laboratories in the United States, United Kingdom, Japan and France for sorting, and detailed morphological and molecular analyses. Based on results of the project, the researchers recommended that the ISA establish marine protected areas at multiple locations across the zone to safeguard biodiversity that could be affected by mining activities.

Another scientific collaboration that has been created is the joint project between the Authority and CenSeam. With support from the Authority, CenSeam aims to determine the role of seamounts in the biogeography, biodiversity, productivity and evolution of marine organisms, and to evaluate the effects of human activity. The intention of the project is to assess patterns of community composition and diversity of fauna on seamounts (with and without cobalt-rich crusts) and the factors that determine these patterns; and to examining gaps in current knowledge of these patterns to support future collaborative research to address them. As a result, the Authority will be provided with recommendations to input into the development of environmental guidelines for future mining contractors.

The ISA is actively conforming to its function with regard to both the promotion and encouragement of marine scientific research in the Area and the protection of the marine environment beyond national jurisdiction and will continue to do so for the benefit of mankind.