

Collaborative Marine Scientific Research on the International Seabed

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The International Seabed Authority is responsible for organizing and controlling all mineral-related activities that take place in the international seabed area. This is an enormous task: the ocean floor in the international seabed area covers more than 50 per cent of the world's surface! It includes all the seabed areas beyond the 200-mile-limit exclusive economic zones of every country around the world.

Mineral-related activities are highly diverse. Prospecting may target polymetallic nodule deposits and sulphides on the ocean floor or minerals embedded in cobalt-rich crusts. Mining may take place in depths of up to 6,000 metres and along biologically rich ocean floor areas, such as seamounts and hydrothermal vents. The International Seabed Authority is required to manage these activities. This includes managing the environmental impacts to ensure that mining activities do not cause undue harm to ocean biodiversity as well as ensuring that all countries share the benefits from the economic value of mineral resources.

The mandate of the International Seabed Authority is sufficiently broad to address these and other issues. While the Authority aims to encourage the development of seabed mineral resources, for example, it also works to ensure that biodiversity within the marine environment

is sustained. To maintain this balance, the Authority encourages and promotes marine scientific research in the international seabed area. The Authority also requires that research and scientific knowledge gained in this area be shared amongst the international science community so scientists around the world can benefit from the findings.

This concept of 'common heritage' is an important overriding principle of the International Seabed Authority. The international seabed area and its resources are designated as the common heritage of all mankind. The Authority ensures that any economic benefits gained from extracting mineral resources in the area are shared between mining companies or entities and the international community. Any scientific understanding gained through deep-seabed research is also shared within the international scientific community.

Over the past decade, much of the Authority's efforts have focused on encouraging study of the deep-sea environment and working with scientists to analyze and disseminate the results of such research. In addition, mining enterprises and collaborations (which can include partnerships and joint ventures amongst several countries) that have entered into contracts with the Authority have led research cruises in the international area to learn more about mineral deposits and to test exploration techniques and new technologies in keeping with the Authority's environmental guidelines for exploration and mining.

The following are three examples of collaborative marine scientific research activities that were undertaken by the International Seabed Authority and its partners to predict and manage the impacts of deep-seabed mining – and increase international knowledge of the deep-seabed environment.

Kaplan Project: Analyzing Biodiversity, Species Ranges and Gene Flow in Nodule Areas of the Seabed

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. The Kaplan Project is also an excellent example of how collaborative marine scientific research is being used by the International Seabed Authority to minimize the risks of mining activities to deep-sea biodiversity in this Zone.

Abyssal sediments in the Clarion-Clipperton Zone (CCZ) are home to abundant nickel- and copper-rich nodules of increasing commercial interest. Sediments in the deep sea may also be major reservoirs of biodiversity; but before the Kaplan Project, there was very limited knowledge of the number of species residing within the

nodule-rich areas and the typical geographic ranges of these species. This made it extremely difficult to predict the threat of nodule mining to biodiversity and, in particular, the likelihood of species extinctions within areas that would potentially be perturbed by single mining operations.

During the Kaplan Project, scientists set out to evaluate

the biodiversity of three key faunal groups by determining levels of species overlap in sample areas and estimating numbers of species at 'stations' spaced out over areas across the CCZ. The sample groups represented a broad range of ecological and life-history faunal types and, combined, they constituted a high percentage of species abundance and richness in abyssal sediments.

Samples were collected by scientists using special "DNA-friendly techniques" during three major research cruises in the nodule province of the deep sea. Collected samples were then transported to laboratories in the United States, United Kingdom, Japan and France for sorting, and detailed morphological and molecular analyses.



Figure 1. International Seabed Area.

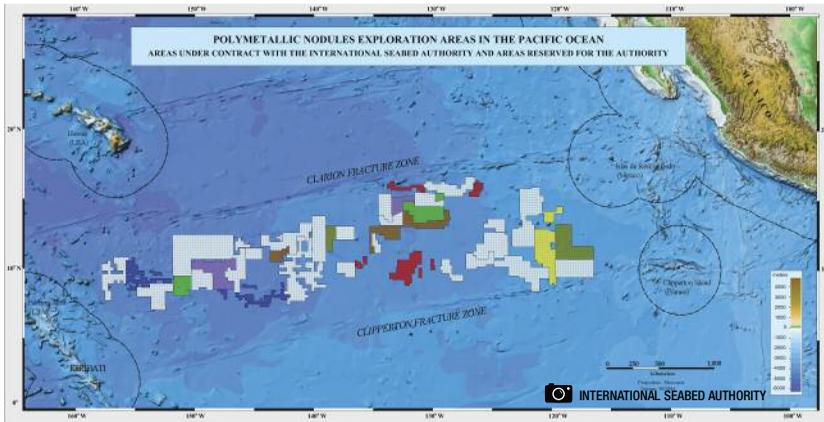


Figure 2. Exploration areas in the Clarion-Clipperton Zone.

Overall results indicated high, unanticipated and still poorly sampled levels of species diversity for all three sample faunal groups. For example, of the more than 250 morphospecies of foraminifera recognised from one of the sampling sites, only 17 were shared by the other two sites.

The DNA-friendly techniques, which entail using the unique genetic code found in an organism's DNA to determine the species, helped researchers find evidence of abyssal species radiation in all the animal groups studied, which means that species have been able to evolve in the deep sea and adapt as required.

In addition, use of these techniques revealed to the scientists that what had been previously identified as single species were in fact complexes of multiple species with very similar morphological characteristics. This is not only useful information for the Kaplan project; it also serves to enhance taxonomic knowledge in an understudied environment.

Based on data collection and analysis, the researchers recommended that the International Seabed Authority establish marine protected areas at multiple locations across the zone to safeguard biodiversity that could be affected by mining activities.

Next Steps

Based on the results of the Kaplan project, the International Seabed Authority is in discussion with the Global Census of Marine Life on Seamounts (CenSeam)

reference zones in the Clarion-Clipperton Zone. To that end, in October 2007 a group of scientists, funded with the support of Pew Foundation, developed a set of recommendations for determining the size and location of a network of representative preservation zones. The draft recommendations will be presented to members of the Authority at their 2008 annual meeting.

CenSeam Project: Assessing Biodiversity Patterns on Seamounts to Identify Knowledge Gaps

The International Seabed Authority is partnering with CenSeam (Census of Marine Life on Seamounts, which is part of the Census of Marine Life programme) to assess the patterns of biodiversity on seamounts and the factors that determine these patterns, in order to identify the gaps in current knowledge and encourage collaborative research initiatives that will address them. The results of this project will also be used by the Authority to minimize the risks of mining activities on deep-sea seamounts.

Seamounts are undersea mountains, often of volcanic origin, that feature prominently in the world's underwater topography.



Figure 3. Seabed resources.

Seamounts may be hotspots of biodiversity and play an important role in patterns of marine biogeography. Often highly productive ecosystems for fish, marine mammals,

to conduct a similar study of the genetic make-up of plant and animal life found on seamounts.

The Authority is also engaging with scientists, contractors and its Legal and Technical Commission in the development of a comprehensive proposal to establish preservation

and seabirds, seamounts are also of potential interest for deep-seabed mining. The long-term effects of prospecting and potential impacts of mining, however, are vastly understudied.

The lack of marine scientific research in seamount areas can be blamed in part on the sheer enormity of the task. The number of seamounts over 1 kilometre high has been estimated at more than 100,000 and there are many more with smaller elevation. Relatively few seamounts have been studied; about 350 have been sampled, and less than 200 of these have been sampled in any detail. As a result, the biodiversity of most seamounts on a global scale is poorly known.

In March 2006, the International Seabed Authority held a workshop to determine how exploration and mining activities on cobalt-rich crusts may impact seamount biodiversity and the biogeography of seamount species. This knowledge, combined with the results of other workshops, is being used by the Authority to develop environmental baselines for exploration and future mining of cobalt-rich crusts.

Through presentations and discussions over the three-day workshop, participants examined gaps in the current knowledge of seamount fauna, patterns of diversity and the degree to which species are restricted or isolated to the seamount or the immediate seamount area. Workshop participants also discussed opportunities for future collaboration through marine scientific research to close the knowledge gaps.

CenSeam was one participant in this workshop. CenSeam aims to strategically guide future sampling in seamount areas to fill critical knowledge gaps and target understudied regions and types of seamounts. CenSeam is undertaking these tasks to make progress towards achieving global understanding of how seamount ecosystems are structured and function to form a global census of marine life on seamounts.

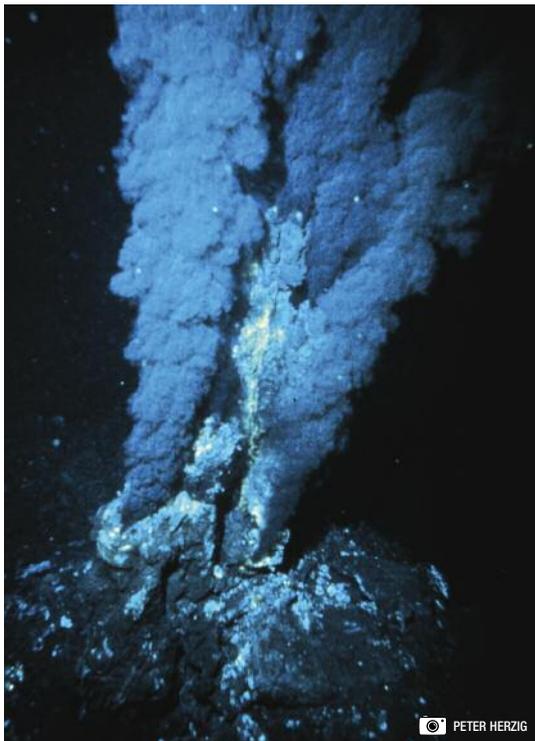
It became clear at the 2006 workshop that very little was known about the biodiversity of seamounts that are

located in the most likely region for commercial mining activity. CenSeam thus began to prioritize seamount surveys to describe biodiversity. As a result of their participation in the workshop, CenSeam and the International Seabed Authority began to outline a collaborative research initiative that has three main activities:

- assessing patterns of community composition and diversity of fauna on seamounts (with and without cobalt-rich crusts) and the factors that determine these patterns;
- examining gaps in current knowledge of these patterns to support future collaborative research to address them; and
- providing the Authority with recommendations to input into the development of environmental guidelines for future mining contractors.

Participants in this collaboration include scientists who have contributed to the Authority's workshops, as well as their colleagues in the wider international scientific

Figure 4. Black smoker in the Lau Basin.



community. Data collected from this research will be extremely valuable for both seamount science and the future management of seamount resources.

Geological Model Project: Metals of Commercial Interest in Polymetallic Nodule Deposits of the Clarion-Clipperton Zone

The Geological Model is a comprehensive representation of the quantity, distribution and metal content of polymetallic nodule deposits in the Clarion-Clipperton Zone. It provides exploration entities under contract with the International Seabed Authority and future mining prospectors with a detailed mineral resource assessment in the Zone. It also contributes to scientific knowledge of how these deposits form and the marine variables that may contribute to nodule formation and abundance. The project includes a prospectors' guide that lists the proxy indicators for nodule distribution along the seabed for use by prospectors and explorers in future seabed mining exploration.

Polymetallic nodules are rounded rock formations about the size of a potato that have a core primarily made up of a rock piece or perhaps a shark tooth. Around this core are concentric layers of minerals that contain metals such as nickel, copper, cobalt and manganese. While no one is entirely certain how these nodules are formed, it is agreed that nodule growth is one of the slowest of all geological phenomena: about one centimetre in diameter over several million years!

While nodules have been found in all the world's oceans, and even in some lakes, their abundance and distribution in certain areas of the ocean are more economically interesting to mining prospectors. The Clarion-Clipperton Zone in the Pacific Ocean, for example, has the largest known deposits of deep-seabed polymetallic nodules. Here, nodule distribution can be compared to a carpet along the seabed; covering more than 70 per cent of the Zone, with some nodules touching one another.

Seven seabed entities are presently under 15-year contracts with the International Seabed Authority to conduct exploratory work, environmental studies and develop mining technology in an exclusive area of the CCZ of up to 75,000 km². The Authority's regulations on prospecting and exploration for polymetallic nodules in the international seabed area outline the responsibilities of these contractors. This includes a requirement to collect baseline data that establishes the natural conditions of the environment before any human activities take place. The data are then added to a central data repository that is maintained by the Authority.

In March, 2001 the Authority and representatives of these contractors met to discuss ways to better assess the mineral resources of the CCZ. As a result, they decided to develop a geological model of the polymetallic nodule deposits in the Zone. This collaborative project was led by a group of technical experts, in partnership

Figure 5. Polymetallic nodules.



with the Secretariat of the International Seabed Authority, and scientists and other representatives from each of the Authority's contractors.

The resulting model predicts the geographical distributions of nodule metal content (manganese, cobalt, nickel and copper) as well as abundance (kilograms of nodules per square metre of the seafloor), using data of other known variables on the seabed and in the water column of the CCZ.

The geological model was developed using information from the central data repository and additional samples and information acquired by the Authority's contractors. The contractors also provided expertise to complete various implementation aspects. For example:

- China Ocean Mineral Resources Research and Development Association provided two scientists to assist with the resource assessment component, and large amount of data on nodule grade, abundance, sediments, and bathymetry.
- Korea Ocean Research and Development Institute contributed several consultants to help process and interpret data sets for nodule grade and abundance, type and sedimentation.
- *Institut Français de Recherche pour l'Exploitation de la Mer* (IFREMER), France provided data on different sediments for the preparation of sediment distribution maps.
- Data from *Yuhzorgeologiya* was used to analyze the interrelationships between nodule grade and abundance with tectonic and volcanic frameworks.
- Interoceanmetal Joint Organization provided a substantial amount of data on bathymetry, abundance and metal content, sedimentation, nodule types, water column, tectonic and volcanic activity observed in the Zone, as well as underwater photographs.
- Deep Ocean Resources Development Company Ltd. of Japan also provided some data on nodule abundance and grade.

The development of the geological model and prospectors' guide is a valuable example of implementation of the

Authority's mandate; particularly its responsibility to encourage collaborative scientific research in the international seabed area for the benefit of all mankind. The model provides the international scientific community with a better understanding of how and where economically interesting polymetallic nodule deposits have formed. For deep-sea mining entities, the model also provides a detailed resource assessment of the metals of economic value in nodules found in the Clarion-Clipperton Zone. Finally, the model facilitates future mineral prospecting in other international seabed areas through its prospectors' guide.

Endowment Fund for Collaborative Marine Scientific Research

Encouraging marine scientific research in the international seabed area has been a key pillar of the International Seabed Authority's mandate since it was established in 1994. This includes encouraging the participation of scientists, researchers and technical personnel from developing countries in research programmes. All exploration contracts issued by the Authority, for example, require prospectors to organize and provide training programmes for personnel from developing countries. Scientists from developing countries have also been active participants in the technical workshops held annually by the International Seabed Authority in order to disseminate the results of collaborative scientific research conducted in the international seabed area and to identify initiatives for future collaboration.

In many cases, however, financial costs to conduct marine scientific research in the deep seabed have prohibited the involvement of developing nations' scientists and other personnel. Lack of technology and expertise in a field that remains on the cutting edge of science may have also contributed to fewer researchers from developing countries being involved in deep-sea research initiatives.

As a global resource, scientific study in the international seabed area should include, wherever possible, scientists and researchers from both developing and developed countries. To achieve this objective, the member States of

the International Seabed Authority established an endowment fund in 2006.

The *International Seabed Authority Endowment Fund* promotes and encourages the conduct of collaborative marine scientific research in the international seabed area through two main activities:

- By supporting the participation of qualified scientists and technical personnel from developing countries in marine scientific research programmes and activities.
- By providing opportunities to these scientists to participate in relevant initiatives.

The Secretariat of the International Seabed Authority is facilitating these activities by creating and maintaining an ongoing list of opportunities for scientific collaboration, including research cruises, deep-sea sample analysis, and training and internship programmes. This entails building a network of cooperating groups interested in (or

presently undertaking) these types of activities and programmes, such as universities, institutions, contractors with the Authority and other entities.

The Secretariat is also actively seeking applications from scientists and other technical personnel from developing nations to be considered for assistance under the Fund. Application guidelines have been prepared for potential recipients to participate in marine scientific research programmes or other scientific co-operation activity, to enrol in training programmes, and to qualify for technical assistance. An advisory panel will evaluate all incoming applications and make recommendations to the Secretary-General of the International Seabed Authority so successful applicants may be awarded with Fund assistance.

To maximize opportunities for and participation in the Fund, the Secretariat is also seeking donations and in-kind contributions to build on the initial investment of US\$3 million. This entails raising awareness of the Fund, reporting on its successes and encouraging new activities and participants. ~

Figure 6. Multicore on deck.



The International Seabed Authority is an autonomous international organization established under the 1982 United Nations Convention on the Law of the Sea (UNCLOS) and the 1994 Agreement relating to the Implementation of Part XI of UNCLOS. The responsibilities of the International Seabed Authority are also outlined in UNCLOS and its 1994 Agreement. For more information, visit www.isa.org/jm/en/efund.



Michael Lodge is Legal Counsel to the International Seabed Authority. He was responsible for drafting the first set of international regulations on prospecting and exploring for seabed minerals to be adopted under the 1982 United Nations Convention on the Law of the Sea. He also negotiated and prepared contracts between the Authority and the first group of investors to be granted contracts for exploration of the deep seabed. Mr. Lodge has a degree in law from the University of East Anglia, UK (1980) and a Master's degree from the London School of Economics (1995).