

## Geological Model Project:

### Metals of Commercial Interest in Polymetallic Nodule Deposits of the Clarion-Clipperton Zone

*Project dates: May 2003 – December 2008*

*Funded by: International Seabed Authority*

*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 potatoes that have a core primarily made up of a rock piece or 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 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 Clarion-Clipperton Zone of up to 75,000 km<sup>2</sup>. In March 2001 the Authority and representatives of these contractors met to discuss ways to better assess the mineral resources of the Clarion-Clipperton Zone. 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 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 (of 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 Clarion-Clipperton Zone. Tested 'proxy data' included: chlorophyll concentration depth; distance from the East Pacific Rise and islands in the West; and carbonate compensation depth; seafloor topography; tectonic and volcanic framework; sediment character; among others. For example, nodule abundance did not appear to have any relation to carbonate compensation depth, while nodule grade towards the West of the Zone was affected by this variable. Statistical analysis showed that the highest grade nodules occur between -250m and +250m of the carbonate compensation depth.

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.