

## **Exploration for Polymetallic Nodules in the German License Area**

*Carsten Rühlemann, Udo Barckhausen, Stefan Ladage, Lutz Reinhardt, Michael Wiedicke*  
Bundesanstalt für Geowissenschaften und Rohstoffe  
Hannover, Germany

### **ABSTRACT**

In October/November 2008 the German Federal Institute for Geosciences and Natural Resources accomplished its first exploration cruise to the German license area in the Pacific Nodule Belt. The scientific program aboard the R/V Kilo Moana included precise bathymetric and backscatter mapping, a survey of the geographical distribution and regional abundances of the polymetallic nodules as well as the determination of their chemical composition, and a magnetic anomaly profiling along the cruise track from Honolulu (158°W) southeast to 116°W. About half of each of the two parts of the license area has been mapped and thirty-eight box core samples were taken during the six-week expedition. The first results of this data acquisition show that the license area is characterized by extensive deep-sea plains with north-south oriented horst and graben structures that originate from the mid-ocean spreading center. These plain areas are punctuated by extinct volcanoes arising 500 to 2000 m above the seafloor. The nodule size ranges between 1 and 15 cm (mean: 3 cm) with nodules >3 cm accounting for 80 % of the total nodule mass. Nodule abundances range between 1 and 27 kg m<sup>-2</sup> (mean: 13 kg m<sup>-2</sup>) in Area E1 and 1 to 25 kg m<sup>-2</sup> (mean: 8 kg m<sup>-2</sup>) in Area W1. Total concentrations of Cu, Ni and Co range between 1.9 to 2.9 wt.% (mean: 2.6) in Area E1 and 1.6 to 3.2 wt.% (mean: 2.6) in Area W1. The magnetic profiling resulted in oceanic crustal ages of 22 to 23 Ma for the eastern part of the license area (12°N/118°W) and 53 Ma for the western part (13°N/138°W). The reconstruction of the paleogeographic history of the oceanic crust underlying the license areas showed that the eastern part originated from 103°W/8°N. The western part was generated at 109°W/3°S and moved northwestward across the equatorial upwelling area during the past 53 Ma.

**KEY WORDS:** polymetallic nodules, International Seabed Authority, exploration license, magnetic anomalies, bathymetry

### **INTRODUCTION**

Germany's industry heavily depends on the continuous import of mineral commodities such as manganese, copper, nickel, and cobalt. In view of the strong increase in metal prices since 2002 Germany's federal geological survey, the Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources, hereafter called BGR) applied for a license area for the exploration of deep-sea ferro-manganese nodules in the tropical northeast Pacific Ocean between the Clarion and Clipperton fracture zones. This license

aims at securing future access of the German industry to such 'unconventional' resources, in particular, if land-based supply would falter e.g. due to political reasons or unexpectedly rising demand. The license area covers 75,000 km<sup>2</sup> and is separated in two parts, "W1" (17,000 km<sup>2</sup>) and "E1" (58,000 km<sup>2</sup>) (Fig. 1, Tab. 1). The BGR obtained initial information on the abundance and grade of nodules in the licensed area from samples collected during three cruises with R/V Valdivia and one cruise with R/V Sonne between 1976 and 1978 and furthermore by exchange of data with other pioneer investors. The four cruises were led by the German consortium "Arbeitsgemeinschaft meeresstechnisch gewinnbarer Rohstoffe" (AMR), a member of the "Ocean Management Incorporation" (OMI).

Precise information on sample locations and seafloor topography are prerequisites for possible future submarine mining for polymetallic nodules. The bathymetry maps produced during the cruises in the 1970s were derived from single beam echo sounding and the navigation used onboard the research vessels was based on satellite fixes used as reference points which were further dead reckoned by radio operation and Doppler sonar. The navigation accuracy of this system in the open ocean was on average 1600 m. The technical progress in echo sounding and navigation techniques over the past 30 years now allows to rapidly produce high quality bathymetry maps and to identify submarine topographic features that were previously invisible. Also sampling locations on the seafloor can be determined with an accuracy of several tens of meters. Because the bathymetric information was outdated and sample coverage was unevenly distributed and very low in certain parts of the license area, the BGR carried out an exploration cruise in late 2008 with the US Navy owned R/V KILO MOANA. This research vessel, based at the University of Hawaii in Honolulu, is a general purpose oceanographic research ship designed to operate in coastal and blue water areas. The SWATH (Small Waterplane Area Twin Hull) form of the vessel provides a stable platform in high sea conditions, an important quality for the hydroacoustic measurements. The MANGAN 2008 cruise, starting and ending in Honolulu, was carried out between October 13<sup>th</sup> and November 22<sup>nd</sup> 2008 with the center of activities in the eastern section of the German license area (Fig. 1). The main objectives of the campaign were

1. bathymetric mapping of the license areas to compile a digital topography model of the seafloor,
2. mapping of the backscatter data to evaluate seafloor surface characteristics,
3. compilation of sediment thickness with a 3.5 kHz echosounder,