

Identification of Factors and Conditions Potentially Responsible for the Buried Nodules Occurrence in the Eastern Clarion-Clipperton Zone (NE Pacific)

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ABSTRACT

Polymetallic nodules for two decades been subject to prospecting and exploration studies carried out by the Interoceanmetal Joint Organization in the eastern Clarion-Clipperton Zone where its exploration area is subsequently allocated under the contract with the International Seabed Authority. However, the phenomenon of buried nodules, occurring at 8 – 45 cm in the sediment depth was for the first time recorded during the IOM'2001 and IOM'2004 at-seagoing works within the entire sector B₂ of the exploration area. The presence of both surface and buried nodules were found at 59 stations sampling by boxcorer, which comprise about 22.6% of all sampled stations performed during that studies. This paper summarizes the distribution pattern, abundance, types, and chemical composition of buried nodules as well as defines some of the factors and conditions potentially responsible for their origin in the IOM contract area.

KEY WORDS: polymetallic nodules; buried nodules; deep-sea exploration; Interoceanmetal; Clarion-Clipperton Zone; boxcorer.

INTRODUCTION

The present knowledge on polymetallic nodules allows them to be considered as resources of economic interest that merit a particular exploration from several entities such as DORD (Japan), COMRA (China), IFREMER/AFERNORD (France), Yuzhmoregeologiya (Russia), BGR (Germany), Interoceanmetal Joint Organization (a consortium formed by Bulgaria, Cuba, Czech Republic, Poland, Russian Federation, and Slovakia), the Government of the Republic of Korea, and India. The most promising area of polymetallic resources in term of nodule abundance and high contents of the base metals nickel, copper, manganese and cobalt occur in the Clarion-Clipperton Zone (CCZ), North – East Pacific.

A deep-sea area allocated for the Interoceanmetal (IOM) exploration activity under a contract with the International Seabed Authority (ISA) covers 75 000 km² in the eastern part of CCZ and extends longitudinally over 510 km with mean width of 150 km.

This study is based on series of samples, collected by 0.25 m² boxcorer during cruises of RV YUZHMOREGEOLOGIYA to the IOM exploration area in 2001 and 2004. For the first time buried nodules

were discovered at 59 stations, located throughout the entire sector B₂ of the IOM exploration area.

The main distinctions and similarities of buried and surface polymetallic nodules collected from the eastern part of the CCZ were reported earlier (Kotlinski, Stoyanova, 2006). Based on available data and information, the objective of the present study is to understand the factors and conditions potentially responsible for the buried nodule occurrence within the eastern part of the CCZ.

MATERIALS AND DISCUSSIONS

The seafloor within the boundaries of the IOM exploration area is complex and may be visualized as undulating plain (4300 – 4400 m below sea level) intersected by a system of longitudinal ridges (3900 – 4300 m depth) and depressions (4400 – 4750 m), and sub-parallel volcanic massifs (Fig. 1). The ridges are 1.0 - 15 km wide, 5 - 70 km long, and 75 - 200 m high. The depressions (as measured along the 4500 m isobaths) are 0.8 - 25 km wide, 4.5 - 150 km long, and 70 - 200 m deep. Less common are volcanic structures (~ 30%), characterized by slopes of more than 7°.

Bottom sediments covering the seafloor consist of Marquesas (early Miocene - late Oligocene) and Clipperton (Pliocene-early Quaternary) formation deposits. Based on the origin and composition of sediments, they are divided into the following four lithofacies: calcareous and clayey-calcareous nanofossil; siliceous (radiolarian) clay, zeolitic (red deep-sea clay) and denser zeolitic crusts; and siliceous-clayed and calcareous-clayed silt (Kotlinski, Zadornov, 2002).

The seafloor sediment is topped by siliceous ooze and siliceous-clayey oozes of the geochemically active layer (2-12 cm thick) on which surface polymetallic nodules are formed and partly embedded. The IOM exploration area features all the morphological and genetic nodule types known from the Clarion-Clipperton nodule field: hydrogenetically grown type – *H*, diagenetically grown type – *D*, and intermediate type – *HD* (Kotlinski, 1999; Kotlinski, 2003). The *D*-type nodules can be clearly subdivided into two sub-types, based on their manganese content and the nickel to copper ratio. As a rule, contents of manganese, nickel, and copper for *D*-type are 30±1%, 1.4±0.1%, and 1.2±0.1%, respectively. In others, contents of manganese reach 33% and copper content is higher than that of nickel (type *D*₁).