Variability and Accuracy of Polymetallic Nodules Abundance Estimations in the IOM Area – Statistical and Geostatistical Approach

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ABSTRACT
Paper summarizes results of statistical and geostatistical analysis of polymetallic nodules abundance variability in Interoceanmetal Joint Organization (IOM) claim area (Kotliński et al., 2008; Kotliński et al., 2011; Mucha et al., 2011). Nodule abundance is characterized by high variability and very significant contribution of random component variability, being part of the total parameter variability. On the current stage of geological recognition, with sampling points distance about 11 − 15 km, satisfactory nodule resources estimation was obtained only for the largest seafloor areas (> 400 km²). For the proper ore fields border delimitation and improving accuracy of resources estimation, authors suggest broader and more systematic use of underwater TV surveying and multibeam acoustics systems and implementation of advanced geostatistical methods.

KEY WORDS: Nodules; abundance; variability; resources; accuracy; statistics; geostatistics; Clarion − Clipperton

INTRODUCTION
The main subject of prepared study was statistical and geostatistical analysis of polymetallic nodules abundance using data collected from IOM area. An intergovernmental contractor Interoceanmetal Joint Organization (IOM), in accordance with UNCLOS convention, has exclusive rights to deepsea exploration of polymetallic nodule deposits (Kotliński, 2010). IOM exploration area (75000 km²) is located in Clarion – Clipperton Fracture Zone (Eastern Pacific Ocean), about 1000 nautical miles from Mexico (Fig. 1). It consists of two minor fields: north (B1 − 12000 km²) and south (B2 − 63000 km²). Polymetallic nodules comprise mainly iron and manganese oxide and hydroxide minerals. They are covering large seafloor spaces at depths greater than 3500 m. Additionally, they consist of several valuable metals such as cobalt, copper, nickel, manganese, REEs and other (Morgan, 2000). Nodule abundance is characterized by density of seafloor coverage calculated as average weight of wet/dry nodules per 1 m² of seafloor surface (nodule abundance index K).

Presented nodule abundance estimations were made on basis of 0.125 m³ (0.5 m x 0.5 m x 0.5 m) box corer sampling results from IOM 2006 and 2009 expeditions. Total number of 623 samples (B1 − 54, B2 − 569) had been collected with average 14.9 km distance between sampling stations in the B1 area and 10.5 km in the B2. Their territorial distribution is quite irregular, nevertheless they are covering the entire study area in some uniform way. The most promising N11(5300 km²) deposit area (Fig. 1) is part of the IOM B2 exploration area, within seafloor sampling made into two major stages. At the N11 total number of 101 samples had been collected with an average 7.3 km spacing. Sampling results were supplemented by the underwater photo and TV surveying.

Nodule abundance variability studies were made using classical statistics (histograms, arithmetic means, coefficients of variation). Nodule abundance variability structure was analyzed using Matheron geostatistics (Journel and Huijbregts, 1978). It included variability analysis with use of directional and omnidirectional semivariograms, determination, and finally their modeling and verification by cross-validation procedure (Isaaks and Srivastava, 1989). Isotropic semivariogram models were used into nodule abundance contour map construction process with implementation of block/polygon kriging procedure. Due to unwanted smoothing effect for kriging estimation procedure, results were corrected by Yamamoto algorithm (Yamamoto, 2005). One of the most important task of presented studies was nodule abundance accuracy estimations for various sizes of calculation blocks. All of them were made using Geovariances ISATIS geostatistical software.