Relationship between Polymetallic Nodule Genesis and Sediment Distribution in the KODOS (Korea Deep Ocean Study) Area, Northeastern Pacific

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Abstract – Polymetallic nodule and sediment characteristics were investigated for two blocks (KR2 and KR5) in the Korea Deep Ocean Study (KODOS) area in order to better understand nodule distribution and the potential effects of sediments on nodule genesis. The northern block (KR2) is dominated by hydrogenetic nodules, whereas the southern block (KR5) is dominated by diagenetic nodules. Sediments in the study area are assigned to three major lithologic units which are distinctive in color and texture. The northern block is characterized by a thick, metal-poor Unit 1 sediment, which is thin in the southern block, where metal-rich Units 2b and 3 occur close to the surface. The distribution of different nodule genetic types in the northern and southern blocks can be attributed to topographic variations (topographic high near seamounts in KR2 and abyssal plain in KR5) and different sedimentation rates (0.1 and 0.32 mm/kyr in blocks KR2 and KR5, respectively). The southern block has a geologic setting more conducive to diagenetic nodule formation, such as flat topography and sediment composition. Nodule distribution in the studied blocks might also be explained by the distribution of the sediment units of different metal contents. The northern block, in which Unit 1 is thicker, has more abundant hydrogenetic nodules, possibly because Unit 1 prevents metals that are remobilized from the underlying sediments from reaching the seabed where the nodules are forming.

Key words – polymetallic nodule, deep-sea sediment, nodule genesis, CCZ (Clarion–Clipperton Zone), northeastern Pacific

1. Introduction

Polymetallic nodule genesis and growth are affected by many environmental factors; (1) the supply of biogenic, terrigenous, and hydrogenetic material; (2) the deposition and reworking of sediments related to seafloor morphology; (3) the composition and dynamics of bottom waters; and (4) intensity and type of bioturbation (Piper and Blueford 1982; Usui et al. 1987; von Stackelberg and Beiersdorf 1991). These factors are related partly or entirely to sediment supply rates and composition, which are important in nodule genesis.

Two nodule facies—(1) a high abundance and high-grade diagenetic facies rich in Cu, Ni, and Co, and (2) a low abundance and low-grade hydrogenetic facies—are well-known from the Clarion–Clipperton Fracture Zone (CCZ), which has been the focus of much international research for many years (Mero 1965; McKelvey et al. 1979; Bernhard and Blissenbach 1988). The differences between the nodule facies are generally attributed to difference in sedimentary environment, resulting from the northwestward motion of the Pacific plate. The high-grade diagenetic nodules started forming in a zone of high productivity with a high supply of organic matter, whereas the low-grade hydrogenetic nodules formed outside the zone of high productivity (von Stackelberg and Beiersdorf 1991).

Although changes in organic matter supply caused by plate movements might be important in controlling variations in nodule facies at a regional scale, such a model neglects many other environmental factors that might affect nodule growth. In this paper, we investigated nodule occurrence (i.e., abundance, shape, surface texture, and metal content), the chemical and mineral composition of sediments, sedimentation rates, and sediment distribution patterns, in order to better understand the potential effects of sediments on nodule genesis.

2. Materials and Methods

We selected two blocks (KR2 and KR5) of the Korea...
Deep Ocean Study (KODOS) Area for studying the genetic relationship between nodules and sediments. KR2 in the northern (16°–17°N) part and KR5 located in the southern (9°–11°N) part of the CCZ with similar longitudes, between 130° and 133°W (Fig. 1). They show different bathymetric characteristics. KR2 is characterized by the presence of small-scale seamounts and, as a consequence, has a highly variable bathymetry. KR5 has a relatively flat bathymetry and is characterized by the repetitive occurrence of abyssal hills and valleys oriented in a NNW–SSE direction. This bathymetric trend has been interpreted as either the trace of a rift structure of the East Pacific Rise, or as due to plate extension and contraction during westward migration of the CCZ (Kennet 1982; Macdonald et al. 1996). Water depth in the KR5 ranges from 4,628 to 5,278 m, with the eastern and western parts being 150–200 m shallower than the central region. KR2 shows larger variations of water depth (4,138 to 5,411 m) compared to KR5, which can be attributed to location of seamounts in the north of KR2 block (Fig. 1).