

Deep-Sea Mineral Resources in the Northwest Pacific Ocean: Geology, Geochemistry, Origin and Exploration

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ABSTRACT

The regional patterns in distribution and composition of deep-sea mineral deposits are characterized in relation to geological setting in the NW Pacific, based on compilation of geological and geochemical data for ferromanganese crusts and nodules, massive polymetallic sulfide, and phosphorite. The mapping and simple statistics singled out some regions of possible economic interest; high Co-Ni-Pt crust/nodule deposits on seamounts of the Pacific plate, and less-grade similar type deposits over the remnant arcs of the Philippine Sea plate. Some of massive polymetallic deposits located in plate boundaries show high-precious metal contents, which await more detailed investigations in earth science and economic evaluation. This study emphasizes importance of geological consideration in exploitation and mining technology.

KEY WORDS: manganese nodule, manganese crust, massive polymetallic sulfide, NW Pacific

INTRODUCTION

Discoveries of marine metallic ore deposits during the last two decades have motivated geoscientific investigations and economic explorations in the central and eastern Pacific (Fewks et al., 1980; Halbach et al., 1988; Kohpina and Usui, in press). The manganese nodule (referred to as MnN) provinces of the northeast equatorial Pacific have been well documented in the aspects of economical evaluation and geology. Under the U.N. Law of the Sea Committee, mine sites were recently registered in the area for several pioneer investors (Shiga, 1994). Secondly, cobalt-rich manganese crusts (referred to as MnC) were first reported in the central Pacific seamount areas by the German and U.S.A. geologists group in the early 1980's (Halbach et al., 1982). The third type is the recent active massive polymetallic sulfide (referred to as MPS) deposits which was first observed by a French submersible in the spreading centers along the East Pacific Rise (e.g., Ballard et al., 1981), and similar types are being found also in the south Pacific and Atlantic Oceans (Rona and Scott, 1993).

In the northwest Pacific region little has been known of general distribution patterns of these types of deposits, since few systematic research cruises on marine minerals have been undertaken. However, significant amount of data on occurrence and composition of ferromanganese deposits has been acquired by Japanese and other organizations during geoscientific cruises and mapping cruises around the areas adjacent to the Japanese Islands over 25 years. Recently, local moderate concentration of MnN and MnC deposits is reported in seabeds of several topographic highs of geologically old seamounts and plateaus (e.g., Usui et al., 1994b). In the middle to late 1980's, precious metal-bearing MPS were found in the active submarine volcanoes and depressions on oceanic island-arc systems (Halbach et al., 1989; Watanabe and Kajumura, 1993).

We present the overview of distribution and mode of occurrence of the three types of deposits in the northwestern Pacific for the purpose of prospecting future mineral exploitation and finding target areas for marine minerals. In this report, we deal with the three types of deposits and some other deposits from deep sea floors, but not placers, sands and gravels, or hydrocarbon resources from near shores.

SOURCE OF DATA AND GEOLOGICAL SETTING

We have had an opportunity to compile all available data on marine mineral deposits from this area as a ferromanganese deposit database and a distribution map in cooperation with domestic and international colleagues (Usui et al., 1994a; Usui and Someya, in press). The database includes four types of files; Reference, Location, Description, and Analysis for the area enclosed by 15°N to 50°N latitudes and 120°E to 160°E longitudes. We obtained unpublished data through the courtesy of colleagues from U.S.A., Russia, Germany, Korea, China, Taiwan, France, and Japan. We selected some data from the public databases of NOAA, Scripps Institution of Oceanography, U.S. Geological Survey, IFREMER, and SEATAR. The total number of sample locations searched is greater than 14 000, locations of described ferromanganese deposits (MnN, MnC, and hydrothermal oxide) is about 1100, and data sets of chemical analysis is about 2600 (Table 1). The number of sample locations of ferromanganese deposits is