

Influence of Distribution Characteristics and Associated Seabed Features on Exploitation of Cobalt-Rich Manganese Deposits

T. Yamazaki

National Institute for Resources and Environment, Tsukuba, Japan

R. Sharma

National Institute of Oceanography, Dona Paula, Goa, India

K. Tsurusaki

National Institute for Resources and Environment, Tsukuba, Japan

ABSTRACT

Method of exploitation, selection of mine site and design of mining system of cobalt-rich manganese deposits on seamounts would be greatly influenced by the distribution characteristics as well as the associated seabed features, such as the seabed topography, surface morphology and sediment characteristics. An example detailed analysis of the distribution characteristics of crusts, nodules and sediments on a seamount is introduced. On the basis of the results, a case study of their influences on the mining system is presented.

KEY WORDS: Cobalt-rich manganese deposits, distribution characteristics, seabed features, design of mining system.

INTRODUCTION

Cobalt-rich manganese deposits on Pacific seamounts are being viewed as potential reserve for strategic metal elements, such as cobalt, nickel, platinum, etc., besides manganese and iron, as they occur at relatively shallower depths and closer to the coast than deep-sea manganese nodules (Halbach and Manheim, 1984; Manheim, 1986). Several research groups have reported the distribution of cobalt-rich manganese deposits in various areas (Halbach et al., 1982; Cronan, 1984; Hein et al., 1985a, b; Pichocki and Hoffert, 1987; Misawa et al., 1987; Yamazaki et al., 1994b). Some studies have also attempted to evolve methods for their resource evaluation (Clark, 1985; Hawaii, 1987; Morgan et al., 1988; Cronan et al., 1991; Yamazaki et al., 1992; Yamazaki, 1993; Yamazaki et al., 1994a). Miner concepts only for the crust type deposits were proposed (Halkyard, 1985; Yamazaki et al., 1995a).

A case study taken place on a mid-Pacific seamount is introduced in this paper. Influence of distribution characteristics of crusts, nodules and sediments and their morphological features, on method of the exploitation, selection of the mine site, as well as design of the suitable mining system is described.

METHODS

Results from a deep-tow survey with stereo cameras and video camera in an edge area of the seamount top during the R/V Hakurei-maru No. 2 cruise, have been analyzed to characterize the distribution and association with the different seabed features. The deep-tow path itself was described

in detail in Yamazaki et al. (1994b). The seamount is called Malony in Smoot (1989). The depth of the seamount peak is about 1,800 m and maximum thickness of the sediment layer measured by a 3.5 kHz sub-bottom profiler is 40 m on the top (Yamazaki et al., 1993b). Coverage and size of the crusts and nodules were estimated using an image analysis software and the microtopographic analysis was done on digitized stereo photos with a photogrammetric program (Yamazaki et al., 1994a). These data were used to classify physical features of the crusts, nodules and sediments, which were then correlated with seabed slope angles and geomorphic features, in order to characterize their distribution patterns.

ZONES OF DOMINANT OCCURRENCE

Distribution and concentration of the nodules, crusts and sediments in the edge of the seamount with respect to topographic variations on the seabed is classified into the following zones:

- (i) Nodule dominant zone (0-3° slopes): High nodule coverage (up to 70 %), less crust outcrop (5-30 % coverage) and marginal sediment coverage (20-30 %), dominate in the 0° to 3° slopes (Fig. 1a). The nodule size in this zone varies from small (< 4 cm) to very large (10 cm). The crust exposures occur generally very few, but occasionally scattered outcrops are observed.
- (ii) Sediment dominant zone (3-7° slopes): Sediments dominate (> 60 % coverage) in the 3° to 7° slopes, with low nodule coverage (< 20 %) and marginal crust outcrops (< 30 % coverage) in most locations (Fig. 1b). Very few nodules and crusts are observed in this zone. No nodule was developed or nodules might roll down to the other flat areas.
- (iii) Transition zone (7-15° slopes): Seafloor with slopes between 7° and 15° forms a transition zone between the nodule-rich gentle slope and crust-dominated steep seabed (Fig. 1c). In this zone, relatively few (40-50 %) locations yield nodules, their coverage ranging up to 70 %, and most of crust outcrops (64 %) have up to 60 % coverage, the nodule coverage gradually decreases while the crust coverage gradually increases with increase of gradient from 7° to 15°. This zone is also characterized by variable nodule size, and various types of crust outcrops (lineated, nodular, cobble-like and step-like). The sediments with nesting nodules cover 10-90 % of the seafloor, and occasionally underlain by buried crusts.
- (iv) Crust dominant zone (> 15° slopes): Steep slopes are mostly covered with crusts (usually 80-100 %). Very few nodules and sediments occur