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Effects of Microtopography on Mining Possibility of Cobalt-rich Manganese Crusts

Koji Goto, Tetsuo Yamazaki, Rei Arai, Naoki Nakatani
Osaka Prefecture University
Sakai, Japan

ABSTRACT

The importance of cobalt-rich manganese crusts on the Pacific seamounts for future rare metal and rare earth element resources has currently been recognized. The thin layer-type deposit characteristics affect recovery efficiency of the deposit, degradation of the mined ore, and the economy of the mining venture, when the microtopographic undulation is severe. Assuming some ideal distributions of cobalt-rich manganese crusts with respect to microtopography, the recovery efficiency, degradation, and economy under existing mining technologies are examined. The important role of utilization of rare metals and rare earth elements in the crusts for the better economy of the mining is introduced.

Keywords: Cobalt-rich manganese crust; economic feasibility; microtopography; mining operation; substrate rock.

INTRODUCTION

Cobalt-rich manganese crusts on seamounts have received attention as potential sources for strategic metals such as Co, Ni, Cu, and Mn, due to their vast distribution and higher cobalt concentration than manganese nodules (Cronan, 1980; Halbach, 1982; Manheim, 1986). The geological information on potential areas was reported (Cronan, 1984; Clark et al., 1984; Misawa et al., 1987; Pichocki and Hoffert, 1987). A systematic feasibility study for the mining was published (Hawaii DPED, 1987).

From the end of 1980s, Japan has undertaken many survey cruises for cobalt-rich manganese crusts in and around the Mid-Pacific Mountains (Yamazaki et al., 1994; Usui and Someya, 1997; Yamazaki and Sharma, 1998; MMAJ, 2001). Some key technological studies for the mining and the processing also have been studied (Aso et.al, 1992; Yamazaki et al., 1995; Rokukawa, 1995; Yamazaki et al., 1996; DOMA 1998). On the basis of these studies and referring some economic evaluation results of manganese nodule mining (Andrews et al., 1983; Hillman and Gosling, 1985; Charles et al., 1990; Soreide et al., 2001), the economic potential of mining cobalt-rich manganese crusts was preliminary evaluated (Yamazaki et al., 2002).

Because the importance of cobalt-rich manganese crusts for future rare metal and rare earth element resources has currently been recognized, the effects of microtopography on recovery efficiency of the crusts and degradation of the mined ore are examined here in this study under ideal deposit and assumed mining conditions. The economy of the mining venture is also evaluated.

PREVIOUS RESEARCH

Geological information of cobalt-rich manganese crusts in potential mining areas was available through the earlier studies (Halbach et al., 1982; Hein et al., 1985a; Hein et al., 1985b; Cronan et al., 1991; Cronan and Hodkinson, 1991; Cronan and Hodkinson, 1993). For the economic evaluation was insufficient; only one systematic feasibility study was published (Hawaii DPED, 1987). The reason lies in the scarcity of published research on the engineering distribution characteristics (Morgan et al., 1988), the mining technologies (Halkyard, 1985; Latimer and Kaufman, 1985), and the ore processing technologies (Haynes et al., 1987; Hirt et al., 1988).

In addition to the geological information, some engineering distribution characteristics necessary for designing seafloor miner (Yamazaki et al., 1990; Yamazaki et al., 1993; Yamazaki et al., 1994; Yamazaki et al., 1996; Yamazaki and Sharma, 1998; Yamazaki and Sharma, 2000), some fundamental technologies for mining systems (Aso et.al, 1992; Aso et.al, 1994; DOMA, 1995; Yamazaki et al., 1995; Chung, 1996; Chung, 1998), and ore dressing technologies for processing (DOMA, 1998) became available for the feasibility study for mining cobalt-rich manganese crusts. According to these information, a preliminary study to compare the technical and economic advantages and disadvantages of mining cobalt-rich manganese crusts with those of manganese nodules was conducted (Yamazaki et al., 2002).

Contents of rare earth elements in on-land ferromanganese oxide samples formed on seafloor old days were evaluated and the potential for the future resources was highlighted (AIST website). From the reviewed analytical data of ferromanganese oxide samples obtained from ocean floor, currently formed deposits, showed high contents in rare earth elements (Hein, 2004). Especially the values in the western Pacific cobalt-rich manganese crusts were higher in many cases.