Consideration of Seafloor Ore Separation by Slurry Flushing for Seafloor Massive Sulfide Mining

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ABSTRACT

Seafloor massive sulfides (SMS) which contain Au, Ag, Cu, Zn, and Pb have been interested in as a target of commercial mining these 15 years. Japan has large potential of SMS and a national R&D project for the mining has been active these 5 years. However, the economy of SMS mining is very bad, because the waste tailing disposal cost is very expensive in Japan. A slurry flushing method is experimentally examined in this study for the improvement of the economy. During the flushing, because of density difference between the metal-rich ore and the waste rock, a kind of gravity separation is possible. The results suggest a possibility of the actual application.

KEY WORDS: Gravity separation on seafloor; Seafloor massive sulfides (SMS); Slurry flushing.

INTRODUCTION

Seafloor massive sulfides (SMS) in the western Pacific have received much attention as resources for gold, silver, copper, zinc, and lead (Lenoble, 2000). Since the end of the 1980s, SMS have been found in the back-arc basin and on oceanic island-arc areas in the western Pacific. The typical representatives found are in the Okinawa Trough and on the Izu-Ogasawara Arc near Japan (Halbach et al., 1989; Iizasa et al., 1999), in the Lau Basin and the North Fiji Basin near Fiji (Fouquet et al., 1991; Bendel et al., 1993), and in the East Manus Basin near Papua New Guinea (PNG) (Kia and Lasark, 1999). The higher gold, silver, and copper contents in one of the areas increased the chance for profitable mining operation (Smith, 2010). Japan has large potential of SMS in the exclusive economic zones (EEZ). However, there are many problems on the mining SMS in Japan. One of the problems is waste rocks and sediments excavated together with SMS ores during the seafloor mining. If large amount of the rocks and sediments are collected with the ores and lifted up to surface vessel, it causes not only increase the costs of mining system construction but also operation. In addition, the waste disposal cost in the downstream processes becomes much expensive. In Japan, the final economy becomes negative, because the disposal cost is very much higher than PNG (Yamazaki et al., 2013). In order to overcome the problem, it is proposed to adapt a primary ore separation on the seafloor prior to the lift-up.

GRAVITY SEPARATION

Outline

In the primary ore separation on the seafloor, one of practical and realistic methods is a gravity separation. No chemical agent is acceptable for the separation to avoid environmental damage on seafloor ecosystem. Magnetic and electro-magnetic methods are not good at in underwater condition. The gravity separation leaves less attractive part of excavated ore beside the mining site. Among many gravity separation methods, only one considered for the application to deep underwater condition is a hydrocyclone for cobalt-rich manganese crusts in an earlier feasibility study (Hawaii DPED, 1987). An outline of the separation flowsheet is introduced in Fig. 1. It uses the density difference between the substrate rock, 2,500 kg/m³, and crust, 2,000 kg/cm³. The heavier part comes out at the bottom of the hydrocyclone. Crush and sizing are necessary prior to the separation in hydrocyclone as shown in the figure. The size of ore separation unit was expected 10-20 m wide, 10-20 m long, and 10-20 m high, respectively depending on the production rate. It looks like a small plant unit. In the previous feasibility study (Hawaii DPED, 1987), the hydrocyclone was designed to install on the seafloor miner. However, it means the miner size becomes very large and has little reality for actual use.

Fig. 1 Flowsheet of ore separation by hydrocyclone for cobalt-rich manganese crusts

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