

Combined Analysis of Ecology and Economy of Manganese Nodule Mining

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ABSTRACT

Manganese nodules on deep ocean floor have received continuous attention as future resources for Co, Ni, Cu and Mn last five decades. The mining is a large-scale and long term venture. However, very few ecological assessments have been reported for it, due to the lack of a suitable assessment method. In this paper, the authors have applied an evaluation method named the Total Materials Requirement (TMR) for the ecological assessment of manganese nodule mining venture. Comparing the result with an economic evaluation, the authors propose an advanced method for a combined analysis of ecology and economy of deep-sea mining.

Keywords: Ecology; economic feasibility; manganese nodule; mining venture; Total Materials Requirement.

INTRODUCTION

Manganese nodules on deep ocean floors have continuously received attention as potential sources for strategic metals such as Co, Ni, Cu, and Mn, due to their vast distribution and relatively higher metal concentrations (Mero, 1965; Cronan, 1980).

Several registered Pioneer Investors have already identified promising sites in deep-sea regions for manganese nodule mining (ISA, 1998), and appropriate mining technologies have been developed during the last thirty years by the international consortium and several nations (Welling, 1981; Kaufman et al., 1985; Bath, 1989; Charles et al., 1990; Yang and Wang, 1997; Yamada and Yamazaki, 1998; Hong and Kim, 1999; Muthunayagam and Das, 1999). The mining feasibility for manganese nodules, including an economic evaluation, has been examined in detail by some researchers (Andrews et al., 1983; Hillman and Gosling, 1985; Charles et al., 1990; Soreide et al., 2001).

Owing to growing concern for the environmental impact of manganese nodule mining, multi-disciplinary environmental studies (oceanography, geology, geochemistry, ecology and geotechnical engineering) have been undertaken in many countries (Ozturgut et al. 1978; Ozturgut et al.

1980; Burns et al., 1980; Schriever et al., 1997; Trueblood et al., 1997; Radziejewska, 1997; Yamazaki and Kajitani, 1999; Sharma et al., 2003). Baseline survey of the background conditions, and the monitoring during and after an artificial disturbance has been the accepted method for quantifying the impacts on deep-sea ecosystem.

However, no ecological viewpoint has been presented as yet, as no actual mining has been carried out for manganese nodules in these three decades. As a result of higher metal market prices from 2006 to early 2008, the possibility of mining has been greatly recognized once again and an economic re-evaluation of the mining venture showed highly attractive results under economic condition in 2007 (<http://www.isa.org.jm>). In this study, application of an ecological management method named the Total Materials Requirement (TMR) for the first ecological assessment of manganese nodule mining and its comparison with the economic analysis are presented.

PREVIOUS RESEARCH FOR MANGANESE NODULES

Geological distribution characteristics of manganese nodules were studied in depth by numerous researchers (Craig and Andrews, 1978; Andrews and Friedrich, 1979; Friedrich et al., 1983; von Stackelberg and Beiersdorf, 1991; Morgan et al., 1992; ISA, 1999). Some international consortia claimed their mining sites under US domestic law (Padan, 1990), whereas several Pioneer Investors were allotted 'exploration' areas by ISA (1998) in the Clarion-Clipperton Fracture Zones (CCFZ) in the Pacific as well as Central Indian Ocean Basin (CIOB) in the Indian Ocean.

Following the R&D activities by the international consortia in the 1960s and 1970s (Clauss, 1978; Burns and Suh, 1979; Grote and Burns, 1981; Chung et al., 1981; Kollwenz, 1990), mining technologies for manganese nodules were developed by several national projects and other studies, such as seafloor nodule miner design and operation (Li and Zhang, 1997; Yasukawa et al., 1999; Hong et al., 1999; Yamazaki et al., 1999; Deepak et al., 2001), the hydraulic lifting characteristics of nodules in pipeline (Bernard et al., 1987; Saito et al., 1991; Xia et al., 1997; Yoon et al., 2000; Chung et al., 2001), and the hydro-dynamics of