Third-Generation Commercial Mining System Development for Manganese Nodules: Direct-to- vs. Incremental-to-5,000-m Approach

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ABSTRACT
This paper assesses two different approaches in developing deep ocean mining systems and technology: Incremental and direct to reach the 5,000-m ocean floor for manganese nodule and crust mining or production. The paper reviews rather the slow technological developments made among the newcomers using an incremental approach since the early 1990s and presents an idea likely to speed up the technological progress: Namely, adopting the use of a direct approach.

KEY WORDS: Ocean mining systems, technology, incremental-to-5,000-m depth approach, direct-to-5,000-m depth approach.

INTRODUCTION
In the 1970s, the four international consortia based in the United States and Canada started deep-ocean mining R & D from “zero-base knowledge on 5,000-m-range deep ocean floor,” when 100-m depth was called “deep water.” Among the four consortia, Ocean Minerals Company (OMCO) started its deep ocean mining program in 1975. The operating company was Lockheed Missiles & Space Co. Inc. (“Lockheed”). OMCO successfully deployed the world’s most advanced deep ocean mining system from the Hughes Glomar Explorer (“Explorer”) with a 5,000-m steel pipe, a buffer at its bottom end, buffer-link-(remotely controlled) oceanfloor miner with Archimedean-screw propulsion and collector in the North Pacific Ocean. Adopting a direct approach, OMCO further initiated in 1975 and developed a more advanced commercial mining system and technology (Fig. 1) which was completed in 1981. Active projects by all the consortia ended by 1981.

Newcomers International Seabed Authority (ISA) (“contractors”) joined later and started their ocean mining R&D program in the early 1990’s. Most of the newcomers’ mining systems were modeled after the ocean mining system of OMCO. Recently some have started to wonder how much progress the contractors have made in technology development in the past 20+ years.

Although limited information of the 1970s concepts and basic knowledge were made available, most late-comer countries took the incremental step-by-step approach. They are still in the 100-m depth range, a rather long learning cycle.

Can they scale the test data taken in 100-m depth range, perhaps aiming to scale-up the data to a 5,000-m depth commercial system? As the 100-m technology may not directly apply, how many incremental depths for additional tests will be needed before the 5,000-m system test? How many more years until a real 5,000-m depth commercial mining system development?

FIRST-GENERATION, SECOND-GENERATION AND THIRD-GENERATION MINING SYSTEM DEVELOPMENT: A BRIEF