Geophysical integration of deep-sea side-scan sonar and sub-bottom profiler data

*Jehyun Song[1], Seung-Sep Kim[1,2], Youngtak Ko[3]

1. Dept. of Astronomy, Space Science and Geology, Chungnam National University, 2. Dept. of Geology and Earth Environmental Sciences, Chungnam National University, 3. Deep-sea and Seabed Resources Research Division, KIOST

The seafloor documents not only topographic changes resulting from the past plate movement, but also various geological processes such as climate change and submarine volcanic activities. Also, useful mineral resources such as manganese nodules are littered on the seafloor. Since 1992, Korea Institute of Ocean Science and Technology (KIOST) has conducted multidisciplinary cruises to examine minability of deep-sea mineral resources and its environmental effects at the Clarion-Clipperton Fracture Zone, northern Pacific Ocean. With continuing scientific and technological advances, more high-resolution geophysical and geological data have been acquired and hence become available for exploratory integrated studies to better characterize a given mining area. In this study, we compare shipboard (EM120) and deep-tow side-scan sonar (MR1, IMI30, and IMI120) acoustic measurements with sub-bottom profiler (SBP) data in order to explore statistical relations, if any, between these multi-frequency data. In 2010, KIOST utilized the IMI120 deep tow system in KR5, a sub-region of Korean manganese nodule development sites. The IMI120 system was configured to collect 4-kHz SBP data along with seabed imagery. This area was mapped with the MR1 and IMI30 tow systems at different times, in addition to the multi-beam echo sounder (MBES) surveys. While deep-sea imagery data are useful for understanding acoustic characteristics of the ocean floor, SBP data image geologic stratification of the seafloor. Thus, this area is adequate to study how the vertical changes in geology contribute to the deep-sea imagery. Especially, we aim to correlate the changes in backscatter intensity of side-scan sonar with the spatial distribution of transparent layers, which can be observed when the acoustic characteristics of sediments under the seafloor are relatively uniform. In order to effectively determine transparent layers, we first enhanced the SBP data by applying a band-pass filter and manually identified their locations and thicknesses. Then, we compared the mean amplitude and thickness of the identified transparent layers with the IMI120 backscattering intensity and observed statistically insignificant correlation. This is because the 120 kHz frequency of side-scan sonar has little penetration to the sub-seafloor. Such acoustical behavior of IMI120 is consistently observed as the IMI120 data vary differently from the other backscatter data. Here we present preliminary results to characterize similarities between the various backscatter data and correlate the changes in backscatter intensity with the sub-seafloor stratification variations. As the coverage of SBP data is often limited, we will extend our analysis to estimate the spatial distribution of transparent layers based on the backscatter-SBP relation. Because previous studies have shown the seafloors with thicker transparent layer appear to have lower coverage of manganese nodules, our approach can be beneficial to both optimizing deep-sea mining efforts by deselecting these area from mining routes and minimizing its environmental impacts by disturbing less unconsolidated seafloor sediments.

Keywords: deep-sea side-scan sonar, sub-bottom profiler, deep-sea mineral resources, exploratory geophysical data analysis

