Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SGD24-07 Room:105 Time:May 25 10:45-11:00

Development of a gravity gradiometer system for submarine gravity prospecting 2

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Gravity surveys are useful in profiling the underground density structure. We propose a hybrid gravity survey method using gravimeters and gravity gradiometers to detect submarine ore deposits. This paper describes the development of a submersible gravity gradiometer for this purpose. As compared to a gravimeter, a gravity gradiometer is sensitive to localized density structure, and hence it is well suited to survey on concentrated source such as ore deposits. The required resolution is estimated to be finer than approximately 10E (=1x10^{-8}/s^2), considering typical dimensions of submarine ore deposits and survey altitude from the seafloor. To attain the required resolution, we newly developed a gravity gradiometer comprising two vertically-separated accelerometers with astatic reference pendulums. Because any common noise to the gravity sensors, such as translation acceleration and thermal drift, is canceled by taking the differential signal, the gravity gradiometer is preferable as an onboard instrument in the underwater vehicle.

The instrument should be installed on a gimbal to reduce rotational motion when the gradiometer is mounted in an underwater vehicle to survey around the seafloor. We have demonstrated a one-dimensional forced gimbal on which the orientation is precisely controlled to be vertical referred to both a fiber-optic gyroscope and a tiltmeter. Laboratory measurements show that the gravity gradiometer attains the required resolution and the forced gimbal reduces expected rotational disturbances to required level. By combining the gravity gradiometer with a two-dimensional gimbal based on this experiment, detectability of the typical ore deposit can be obtained.

A sea trial observation is scheduled in Suruga Bay using an AUV in September, 2012. Details of the design, the instrument performance, and the trial plan are presented.

Keywords: ore deposit, gravity survey, gravity gradiometer, gimbal, AUV