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海底探査用重力偏差計システムの開発 3
Development of a gravity gradiometer system for submarine gravity prospecting 3

新谷 昌人 [1*], 篠原 雅尚 [1], 金沢 敏彦 [2], 藤本 博己 [3], 山田 知朗 [1], 飯笹 幸吉 [4], 石原 丈実 [5], 月岡 哲 [6]
Akito Araya[1*], Masanao Shinohara[1], Toshihiko Kanazawa[2], Hiromi Fujimoto[3], Tomoaki Yamada[1], Kokichi Iizasa[4], Takemi Ishihara[5], Satoshi Tsukioka[6]

[1] 東大地震研, [2] 防災科研, [3] 東北大災害科学国際研, [4] 東大新領域, [5] 産総研地質情報, [6] 海洋研究開発機構
[1]ERI, Univ. Tokyo, [2]NIED, [3]IRIDeS, Tohoku Univ., [4]GSFS, Univ. Tokyo, [5]Inst. Geol. Geoinf., AIST, [6]JAMSTEC

Gravity surveys are extensively conducted for profiling the underground density structure on land, while their application to sea area has been difficult because of either wide-area seafloor observation or poor accuracy caused by instability of the platform such as ships and airplanes. We propose a hybrid gravity survey method using an autonomous underwater vehicle (AUV) containing both a gravimeter and a gravity gradiometer. This paper describes the development of the submersible gravity gradiometer for this purpose.

As compared to a gravimeter, a gravity gradiometer is sensitive to localized density structure as a spatial derivative of its gravitational field, and hence it is suited to survey on concentrated sources such as submarine ore deposits. In addition, any common noise to the gravity sensors, such as translation acceleration of the platform, has little effect on gravity gradiometer as the differential gravity acceleration, and therefore a gravity gradiometers is preferable as an on-board instrument in the underwater vehicle.

We operated the developed gradiometer at a quiet site on land and estimated its self-noise to be 6 E (=6×10^{-9} /s^2) in (2-50) mHz where gravity gradient signal is expected to be dominant when an AUV passes above a typical ore deposit. To reduce centrifugal error associated with rotation of the underwater vehicle, the gravity gradiometer was mounted on a two-dimensional forced gimbal controlled to be vertical with reference to fiber-optic gyroscopes and tiltmeters.

A sea trial observation was carried out on 7-9 September, 2012, in Sagami Bay at a depth of about 1,300 m using the AUV Urashima (JAMSTEC). The gravity gradiometer and the forced gimbal operated stably onboard the moving platform unless it involves large motions during turning and pitching. Design and resulted resolution, as well as discussion for improvements, will be presented.

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