Seafloor Electromagnetic Station with Differential Pressure Gauge

Hiroaki Toh[1]; Takuto Minami[2]; Hiroko Sugioka[3]; Yozo Hamano[4]
[1] DACGSM, Kyoto Univ.; [2] Geophysics, Kyoto Univ.; [3] IFREE, JAMSTEC; [4] JAMSTEC

Recently, it has been found that tsunamis can induce significant electromagnetic (EM) fields on the seafloor (Toh et al., 2011). This is because of the dynamo action caused by the conductive seawater moving through the weak but significant magnetic field of our planet, as the tsunamis propagate all over the ocean. It was further revealed by the seafloor vector geomagnetic data at the time of the 2011 off the Pacific coast of Tohoku Earthquake (Minami et al., 2012) that waveforms the tsunami-induced vertical magnetic component pretty much resembles those of ocean bottom pressure. This strongly suggests that the vertical geomagnetic component induced by tsunamis can be a very good proxy of tsunami wave height. It, however, was impossible to clarify the amplitude ratio and phase difference between the two totally different physical quantities because the simultaneous seafloor observations at the time of the Mw9.0 earthquake were not collocated at the same site.

In order to determine the complex conversion factors, that may possibly be frequency-dependent, from the tsunami-induced vertical magnetic component to the tsunami wave height, we have developed a SeaFloor EM Station (SFEMS) with a precise Differential Pressure Gauge (DPG). Although the SFEMS itself has already been completed and applied to real observation at the seafloor since August, 2001 (Toh et al., 2004), addition of DPG to SFEMS was a major innovation on and after the discovery of the aforementioned tsunami dynamo effect. Here we report an overview of the new seafloor instrument that includes the principle of the DPG, details of the total architecture, specification of both SFEMS and DPG and so on.

Another intent of this paper is to describe newly acquired seafloor EM data by the SFEMSs. The SFEMSs are now deployed at two sites in the northwest Pacific: one is on the NorthWest Pacific Basin (Site NWP) and the other is on the West Philippine Basin (Site WPB) since June, 2006. The new seafloor EM data are results from a series of our recent research cruises over the western Pacific. As a result, the seafloor vector EM time-series have been accumulated for more than 5 years at Site WPB and more than 10 years at Site NWP, which includes the tsunami-induced magnetic field at the time of the 2011 off the Pacific coast of Tohoku Earthquake as well. We will further report results from those long enough time-series such as the detected vector geomagnetic secular variations and the deep electrical structure of the mantle transition zones with and without the effect of stagnant slab. The very last topic is important in the sense that the water supply from the surface by the subducting slab can affect the deep mantle dynamics significantly. In conclusion, it is stressed here that long-term seafloor observations are essential not only to identify geophysical phenomena such as the tsunami dynamo effect and the geomagnetic secular variation but also to delineate deep electrical structures that are robust irrespective to the solar activity.