R003-06
D 会場 ： 11/25　 AM1（9:15-10:45）
10:30～10:45:00

2011 年東北地震津波の際の電場変動を用いた神津島の比抵抗構造推定

#武林 哲志 [1)], 南 拓人 [1)], 上嶋 誠 [2)]
[(1] 神戸大学大学院理学研究科, [(2] 東京大学地震研究所

Estimation of Kozushima subsurface resistivity structure using tsunami-induced electric fields from the 2011 Tohoku earthquake

#Tetsuji TAKEBAYASHI[1)], Takuto MINAMI[1)], Makoto UYESHIMA[2)]
[(1]Graduate School of Science, Kobe University, [(2]Earthquake Research Institute,The University of Tokyo

When conductive seawater moves through the geomagnetic field during a tsunami, tsunami-generated electromagnetic (TGEM) variations occur (e.g., Tyler, 2005). The TGEM variations can be observed both on land and at the seafloor (e.g., Minami et al., 2017). During the 2011 Tohoku earthquake tsunami, significant electric field variations were detected on Kozushima, a volcanic island in the Izu Islands, with the maximum occurring almost simultaneously with the tide gauge peak (Nakatani, 2015, Graduation thesis in Tokyo Gakugei University). While tsunami-generated electric (TGE) fields observed at the seafloor are little affected by the subseafloor resistivity (Shimizu and Utada, 2015), they are strongly influenced by the subsurface resistivity on islands (Minami, 2024; Shibahara, 2022, Graduation thesis in Kobe University). In this study, we estimate the subsurface resistivity structure of Kozushima using TGE variation data during the 2011 Tohoku earthquake tsunami.

On Kozushima, electric potential observations utilizing two long dipoles were conducted by Dr. Yoshiaki Orihara and Mr. Yoichi Noda as part of the “Earthquake International Frontier Research” program of the Science and Technology Agency. The two dipoles were oriented southeast-northwest (2.382km) and northeast-southwest (2.137km), providing two components of potential difference. The observed potential differences were divided by the dipole lengths to obtain two components of the electric field in the northwestward and southwestward directions. To remove variations unrelated to tsunamis from the observed data, we applied the RRRMT method using magnetic data at Changchun, China, reducing magnetic storms effect, following the method in Minami et al. (2017).

The TGE variations on Kozushima were simulated using the time-domain finite-element electromagnetic fields simulation code TMTGEM (Minami et al., 2017). The tsunami velocity field used as input was calculated with JAGURS (Baba et al., 2017), a tsunami simulation code based on linear dispersive wave theory. For the TGE simulations, a tetrahedral mesh was constructed with a minimum edge length of about 200 m around Kozushima.

As a first test, we used homogeneous resistivity structures and performed simulations with resistivity values of 10, 100, and 1000 Ω m. None of these cases reproduced the observed data. The northwest electric field variation showed a negative excursion consistent with the observation, whereas the southwestward component exhibited a positive peak for all resistivity values, in contrast to the observed data, which did not display a distinct peak. Next, we constructed a resistivity model based on geological evidence that eruption centers aligned in a southeast-northwest direction (Taniguchi, 1977), and on previous electromagnetic surveys suggesting the presence of groundwater (Orihara et al., 2010). We assumed a southeast-northwest trending low-resistivity anomaly embedded within a high-resistivity background. Specifically, the background resistivity was set to 1000 Ω m and a 10 Ω m anomaly extending from the surface down to 300 m below sea level was introduced. This model successfully reproduced the northwestward electric field variation, as in the homogeneous cases, while also improving the agreement with the observed southwestward variation. These results suggest the presence of a low-resistivity region within the central part of Kozushima, embedded in the homogeneous high-resistivity background structure.

This study demonstrates the potential of using TGE variations as a new approach for subsurface structure estimation, revealing a low-resistivity anomaly beneath Kozushima. While the structures around the dipoles have been constrained, regions farther away remain poorly resolved. Future work will focus on improving estimation accuracy by focusing on regions with higher sensitivity and by refining the tsunami simulations that provide input to the electric field calculations.