Research report for ERI Visit

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During my five-month visit in ERI, I worked with Dr. Makoto Uyeshima conducting study on the coseismic electromagnetic (EM) signals observed during the April 15th, 2016 Kumamoto, Japan earthquake of M7 based on comparison with theoretical numerical simulations. A M5.4 aftershock occurring about 20 minutes after the main shock of the 2016 Kumamoto earthquake was taken as our main research target since the data were very good. The observation result in either Cartesian or Cylindrical coordinate systems evidently showed the coseismic EM signals. Both the seismic and EM signals started to show up from the P arrival. Our numerical simulations were performed by considering the electrokinetic effect (Pride, 1994) as the generation mechanism. At first, we adopted a half-space model consisting of a water-saturated porous medium. The simulation result for a receiver with depth of 0.1 m failed to well explain the observation, because there is no magnetic signal before the S arrival. The reason was revealed by theoretical analysis. For the used half-space model, the magnetic-inducing-capacity of SH wave is much stronger than those of SV and fast P waves. The difference is several orders of magnitude. Thereafter, further simulations were conducted on a seven-layer model, where the second layer between the depths of 20 and 200 m is saturated by water while the other six layers are saturated by air. The simulation results with or without surface-charge assumption Ren et al. (2015) also failed to well explain the observation. Given that the stations were located in a volcanic area, we thought the scattering effect may have played some role. Therefore, we tried to introduce an artificial scattering effect into our simulations. We assumed additional PSV-to-SH and SH-to-PSV conversions occur at the ground surface. In addition to the seismic waves from the source, there should be some contributions from other directions due to the existence of scattering bodies. We roughly consider this effect by rotating the horizontal components of the total wave-fields. The new simulation result showed no signal missing in all components whether the Cartesian or the Cylindrical coordinate system is used. Therefore, the combination of electrokinetic effect and scattering effect is a plausible explanation to the coseismic EM signals. The effect of the scattering coefficient on the total wave-field amplitudes was investigated. It was found the amplitudes of the coseismic magnetic signals generally increased for greater scattering coefficient. This probably means, the coseismic magnetic signals observed during earthquakes may have some information on the scattering effect in the observation area. Two talks related to this work were presented at ERI (the 964th Danwakai) and Kyoto University (2017 SGEPSS Fall Meeting). I thank the colleagues in and out of ERI for the helpful comments and discussion.

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