野島断層の層状断層岩の電磁波伝搬特性

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Electromagnetic Wave Propagation of Layered Gouges in Nojima Fault, Japan

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The attenuation and scattering of electromagnetic (EM) wave propagating through geological media are represented by skin depth which is the penetration length decaying to 1/e from the initial intensity of EM wave. The transmission and reflection of EM waves depend on continuous internal structures beneath the ground, such as changes in density (Robin et al. 1969, Ono et al. 2009), conductivity (Paren and Robin 1975) and changes in crystal orientation fabric (Harrison 1973, Muto and Nagahama, 2005). Given the appropriate frequencies of EM waves, the magnetotelluric exploration and the ground-probing radar detect the underground structures in the Earth's crust. Some researchers have reported, prior to earthquake, the detection of low frequency electromagnetic waves (Loma-Prieta earthquake: Fraser-Smith et al. 1990) as well as direct currents (Hyogo-ken Nanbu earthquake: Enomoto and Zhang 1998). If these detections are evident, the EM waves should be transmitted from an in-depth focal region or nearby stressed region through the bianisotropic geological structures such as beddings, faults and folds. However, Takahara et al. (2010) revealed from fractal skin depth theory that the skin depth decreases as the crustal media is fractured in a homogeneous crust, suggesting that highly damaged fault zones heavily attenuate the EM waves from hypocenter or nearby deep stressed region. We think this contradiction is solved by considering the internal structure of fault zones. Here we report the anisotropic dielectric constant of bianisotropic layered Nojima fault rocks, parallel to and perpendicular to the fault foliation. The Nojima fault is an active fault and is separating the Osaka formation of silt and protolith granite. The fault caused the Hyogo-ken Nanbu earthquake. The fault rocks consist of bianisotropic layered structures of comminuted silt, granitic gouge and pseudotachylyte. The measurements show that samples of the silt layer have the highest dielectric constant of the real part. Moreover, based on Maxwell equations with complex dielectric constants, we found that the skin depth of layered silt is the shortest, about one fifth as long as others. This bianisotropic transmission of EM waves explains why some earthquakes have accompanied EM wave radiations at the surface and others don't have done.