New proposal on mechanism of electromagnetic anomaly

Koichi Nakagawa[1]

[1] Graduate School of Sci., Osaka City Univ.

It is well known that an electromagnetic anomaly is often associated with large earthquake occurrences. However, the detailed mechanism of the anomaly has not yet been clarified. Electrical polarizations were observed in specimens of some kind of the saturated soils, such as those in fault gouge in shear deformation tests conducted in a laboratory setting. This electric potential is called SIP (Shear-induced Potential). The SIP can be interpreted as the physicochemical interaction between the surface of the fine particles and the interstitial water resulted from the kinetics of the electric double layer. Accordingly, the SIP almost could not be detected in the remolded craft clay materials, which were possibly treated with not water but electrically non-dipole oil.

A plane strain shear test under the un-drained condition was carried out in order to reveal the characteristics of the polarization accompanying deformation, and especially, to clarify the relationships between the polarity of electric charges induced and the stress distribution. The sieved gouge material was remolded with salt water and consolidated axially with K-zero condition. Many electrodes were attached to each surface of the parallelepiped specimen. The electrode for the reference potential was embedded in the center of the specimen. The potential levels induced during deformation were up to the order of several tens of millivolts. The polarities of the electric potential on the maximum, medium and minimum strain axial surfaces indicated to positive, neutral and negative charges, respectively. These potential changes of the electrodes increased with the strain level. The detailed mechanism of polarization associated with the shear deformation was not clear. However, it was hypothesized that breaking the inter-particle bonding by deformation disturbs the electric equilibrium near the particle contacts and subsequently releases cations from the adsorbed layer into the free pore water.

We applied the results obtained from the laboratory to the field and examined the electrodynamic behaviors resulting from the fault sliding at actual landslide sites. Three active sites were selected for measurements of spontaneous potential: the belt of Atotsugawa active fault at Kamioka mine, Central Japan; the Busuno landslide block in Niigata Prefecture, Northeast Japan; and the Nuta-Yohne landslide block in Kochi Prefecture, Southwest Japan. In this paper, the latter two sites are described. In many cases, the precipitation produced rapid changes of the spontaneous potential. A manner of the potential variation with time showed good agreement with that of the relative landslide displacement in both of the field and laboratory experiments. Therefore, the polarity pattern of the spontaneous potential generated in the field can be explained by the hypothesis deduced from physicochemical particle bonding model.