The influence of the flow regime on the streaming potential

Tohru Watanabe[1]

[1] Dept. Earth Sciences, Toyama Univ.

The streaming potential is one of electrokinetic phenomena caused by the ionic motion in the electric double layer. Observed surface electrical potential anomalies are often thought to be due to the streaming potential associated with subsurface fluid flows. One relation between the streaming potential and the zeta potential of the solid-fluid interface is used to estimate the fluid flow. However, this relation was derived by assuming the laminar flow through pores in rocks. It is poorly understood whether this relation is applied to the flow regime where the inertial resistance is not negligible. We experimentally investigated the influence of the flow regime on this relation.

Experiments have been conducted of brine-saturated glass-beads samples (D=19mm, L=40mm). The mean diameter of beads is varied as 200, 400 and 800 microns. The porosity is around 0.35 for all samples. The concentration of NaCl aqueous solution is 1e-5-1e-3 mol/l. We measured the fluid flux and the streaming potential with varying the pressure difference (0-12kPa).

The linear relationship known as Darcy's law between the fluid flux and the pressure difference is valid when the fluid velocity through pores is low. Darcy's law beaks down when the Reynolds number is larger than 20. The linear relationship between the streaming potential and the pressure difference is still valid for such a situation as the inertial resistance is not negligible. It suggests that the fluid flow within the electrical double layer is hardly affected by the flow regime in the bulk of pores. It implies that the relationship between the zeta potential and the streaming potential is used to characterize the subsurface fluid flow even if the flow regime is not laminar flow.