Geophysical Research Abstracts, Vol. 8, 03259, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03259

Decrease of streaming current coefficient caused by turbulent flow

O. Kuwano, S. Yoshida and M. Nakatani
Earthquake Research Institute, University of Tokyo

When fluid flows through a porous medium, charges in the electric double layer are transported, resulting in streaming current. This is the representative mechanism of self-potential widely observed in the field. In the classical Helmholtz-Smoluchowski relation, the streaming current (i_s) is represented as $i_s = C_c \mathrm{grad} P_p$, where C_c is streaming current coefficient and P_p is fluid pressure. C_c depends on hydraulic property of the rock and electrochemical property called zeta potential. We examined the effect of the flow state on streaming current coefficient.

In order to measure how the flow state affects the magnitude of streaming current, measurements need to be conducted for various flow rates and various sizes of particles with the same physico-chemical surface condition. So we chose various sizes of soda-lime glass beads as samples. Grain sizes of the beads are 0.177∼0.250 mm (GB200), 0.350∼0.500 mm (GB400), and 0.710∼0.990 mm (GB800). These samples were soaked in acetone for 12 hours, washed with acetone several times, washed with distilled water and with KCl solution, which was used for background electrolyte in the experiment, and finally soaked in KCl solution for at least 24 hours before measurement. In the experiments, KCl solution was flowed through the sample column (20×15 mmϕ) inside a silica glass tube, while streaming current and flow rate were measured.

The results were as follows. Streaming current coefficient was clearly affected by the flow state; it is constant for a small Reynolds number $R_e < 1 \sim 10$ (grain diameter was adopted as the characteristic length), but it decreased with R_e when $R_e > 1 \sim 10$. This is a mechanical effect (i.e. smaller apparent permeability for turbulent flow), not a chemical effect on the zeta potential. Mutually contradicting values of zeta potential, which is calculated from measured C_c, by different authors can be due to the

effect In addition, we have found that the decreasing rate of C_c with increasing R_e is much smaller than that of permeability. This means that turbulent flow induces more streaming current per unit flow rate.