Steady-state streaming potential coefficient measurements and modelling of sandstones as a function of pore fluid salinity and pH

Emilie Walker (1) and Paul W.J. Glover (2)

(1) Department of Geology and Engineering Geology, Université Laval, Quebec, Canada., (2) University of Leeds, School of Earth and Environment, Leeds, United Kingdom (p.w.j.glover@leeds.ac.uk)

The last twenty years has seen the steady increase in the quality and quantity of streaming potential coefficient and zeta potential determinations in the laboratory. More recently (Glover et al., 2012), a model has been developed that allows both the zeta potential and streaming potential coefficient of a porous rock to be calculated theoretically. We have carried out high quality streaming potential coupling coefficient measurements using a newly designed cell with both a steady-state methodology and a new pressure transient approach. We have shown the pressure transient approach to be particularly good in providing high quality streaming potential coefficient measurements as it allows thousands of measurements to be made at different pressures to which a good linear regression can be fitted. Nevertheless, the method is approximately five times as fast as the conventional measurement approaches. Measurements of streaming potential coefficient have been carried out on seven samples of Berea, Boise and Lochaline sandstones as a function of salinity (approximately 18 salinities between 10^{-5} M and 2 M) and pH (approximately 11 pHs between 8 and 2). The data have been inverted to obtain the zeta potential. The streaming potential coefficient becomes greater (more negative) for fluids with lower salinities and higher pHs, which is consistent with the corpus of existing measurements. Our measurements are also consistent with the high salinity streaming potential coefficient measurements made by Vinogradov et al. (2010). The streaming potential and zeta potential tend to zero as the pH approaches the point of zero net surface charge for quartz (approximately 3), which was 2.8±0.2 in our measurements. Both the streaming potential coefficient and the zeta potential have also been modelled using the theoretical approach of Glover et al. (2012). This modelling allows the microstructural, electrochemical and fluid properties of the saturated rock to be taken into account in order that the theoretical model provides a relationship that is unique to the particular rock sample. In all cases, we found that the experimental data was a good match to the theoretical models, but only if we used the actual salinity and pH of the fluid in the rock rather than that of the bulk fluid, as might be expected.