Geophysical Research Abstracts
Vol. 13, EGU2011-3970, 2011
EGU General Assembly 2011

Measurements of spontaneous potential in chalk with application to aquifer characterization in the southern UK

Jan Vinogradov (1), Matthew Jackson (1), and Adrian Butler (2)

(1) Imperial College London, Earth Science and Engineering, United Kingdom (j.vinogradov@imperial.ac.uk), (2) Imperial College London, Civil and Environmental Engineering, United Kingdom

We report the first measured values of the streaming potential coupling coefficient in chalk samples saturated with natural groundwater from the Berkshire Chalk aquifer in the southern UK. We investigate the pH dependence of the coupling coefficient, by modifying the natural groundwater composition via the addition of HCl or Ca(OH)2. We also report preliminary results from field measurements of the spontaneous potential at both ambient and pumped conditions at a test site in the Berkshire Chalk aquifer. The ultimate aim of the work is to use measurements of spontaneous potential, in conjunction with borehole measurements, to characterize groundwater flow and aquifer properties. Flow models based only on borehole measurements can be limited by sparse data, particularly where there are significant lateral variations in hydraulic properties or where the number of boreholes is limited for economic or environmental reasons. Furthermore, the presence of numerous boreholes and/or large pressure gradients during pumping tests may modify interpreted aquifer properties. Spontaneous potential measurements complement conventional borehole methods, because they can be implemented over large regions with dense sampling in both space and time. Moreover, they can be obtained from the surface at ambient conditions, so are non-intrusive and do not require pumping tests

We find that the streaming potential coupling coefficient for the chalk saturated with natural groundwater is -59.5 mV•MPa-1. Its value increases in magnitude with increasing pH, but remains negative over the range pH 3-11. The chalk acts as a buffer for pH alteration, with water pH returning to the natural groundwater value of 7.5 after passing through the sample several times. The concentration of Na+ and Cl- ions in the water decreases with any deviation from the natural pH level, but the concentration of Ca2+ ions increases with increasing pH. The corresponding zeta potential is also negative and its magnitude increases with pH. Preliminary field results show that voltages measured at the ground surface and in monitoring boreholes respond well to pressure drawdown and build-up induced by the abstraction of water. The change in measured voltage is negative during pressure build-up and positive during pressure drawdown, suggesting a negative coupling coefficient consistent with the laboratory results. Moreover, the magnitude of the change in voltage is similar to that predicted using the measured value of streaming potential coupling coefficient. This suggests that the spontaneous potential changes during abstraction are dominated by the streaming component induced by pressure variations. Future work will investigate the origin of temporal and spatial changes in the spontaneous potential observed at ambient conditions. Our results indicate that measurements of spontaneous potential may make a valuable contribution to characterizing groundwater flow in the UK Chalk aquifer, which is one of the UK's most significant groundwater resources.