Detecting Sub-Surface Groundwater Flow in Fractured Rock Using Self-Potential (SP) Methods

Fritjof Fagerlund[1,2] and Graham Heinson[2]

[1]Department of Earth Sciences, Geophysics, Uppsala University, Geocentrum, Villavägen 16, SE-752 36 Uppsala, Sweden
[2]Department of Geology and Geophysics, University of Adelaide, Adelaide, SA 5005, Australia

ABSTRACT

In the wine district of Clare Valley in South Australia, the natural-voltage SP-signal generated by fluid flow in fractured rock during a pumping test was carefully monitored over time. From ten electrode-locations surrounding the pumping well logged every 15 s, the drawdown cone produced by pumping was determined on basis of the SP measurements together with laboratory measurements of the grain-boundary ζ (zeta) potential. Such measurements allowed calculation of the fractured-rock aquifer's transmissivity and average permeability. Results were confirmed by piezometer measurements to the extent that data were available.

The study has revealed that SP-signals generated during pumping tests are of complex nature. However, if the pumping test is sufficiently long to allow the signal to stabilise, and careful field procedures are in place, then SP-measurements have the potential to add significant hydrogeological information. SP-measurements are relatively easy and cheap, and are, contrary to traditional hydrogeological methods, not restricted to the locations of existing piezometers, which is particularly useful in fractured-rock aquifers.