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Observation of self-potential (SP) variations induced by periodic pumping tests

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We measured the variations of the self-potential (SP) during periodic pumping tests performed in a vacated sandstone quarry, at the northwestern border of an artificial freshwater reservoir (Kemnader See) of the River Ruhr, at the southern city limits of Bochum, Germany. Successions of injection and production intervals were applied in a borehole penetrating the jointed sandstone aquifer (Renner & Messar, *Geophys. J. Int.* 167, 2006). Here we present and discuss some SP responses observed during experiments, with periods ranging between 10 and 60 min and flow rates comprised between 10 and 30 L / min.

Our results indicate that combining periodic pumping tests with SP measurements at the surface may yield densely spaced information on the hydraulic properties of the subsurface. General problems encountered while measuring weak and noisy SP signals are reduced because of the benefits of the spectral analysis. The characteristics of the observed SP signals clearly correlate with the pressure/flow field in the subsurface. They are periodic, attenuated and phase-shifted with distance. Nevertheless, the relationship between hydraulics and electrics is not simple. The SP responses seem to depend significantly on the characteristic of the layer above the aquifer. In particular, the shape of the SP curves is non-harmonic: the Fourier amplitude spectra contain two main components (at the period and half the period), suggesting that non-linear processes were acting.