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Self-potential and induced-polarization response to saturation-desaturation cycles: testing a new laboratory set-up.

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In a recent paper (Maineult et al., JGR 113, 2008), we reported an unexpected behaviour of surface self-potential (SP) recorded during harmonic pumping tests. During these tests, a quasi-sinusoidal variation is imposed to the water level inside an injection well. The SP field in surface (with respect to an undisturbed reference electrode) was periodic but not sinusoidal, with strong amplitude peaks at the main period and at the half-period, whereas the SP recorded in monitoring wells, inside water, was sinudoidal. We suspected that this non-linear behaviour could result from the forced saturation and desaturation cycles occurring in the vadose zone over the water table. Indeed, these processes are known to be asymmetric.

To study the possible physical explanations of the energy splitting observed in the SP spectra, and also verify the theoretical assessment by *Linde et al.* (*GRL 34, 2007)* and *Revil et al.* (JCIS 313, 2007) that predicts a hysteretic response of SP to saturation-desaturation cycles, we devised a new experimental set-up. A 20-cm high and 10-cm in diameter sand-column is connected to a reservoir, in which the water level is controlled by an outlet fixed to a vertical worm screw. The rotation of the worm screw is driven by a miniature rotor numerically controlled, so saturation and desaturation cycles can be applied to the sand-column in a perfectly reproducible way. This device is currently in test phase, but preliminary measurements of SP and also of induced-polarization responses seem to be promising.