

## Streaming potentials at high salinity and partial saturation: Application to characterization and monitoring of subsurface fluid flow

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The spontaneous (or self) potential (SP) in fluid saturated rocks acts to maintain electroneutrality when a separation of electrical charge occurs in response to gradients in (i) pressure (relative to hydrostatic), which gives rise to streaming potentials, (ii) chemical composition, which gives rise to electrochemical potentials, or (iii) temperature, which gives rise to thermoelectric potentials. Borehole logging of the SP has long been used to characterize rock properties such as permeable bed boundaries. However, this presentation will focus on the application of SP measurements to characterize and monitor fluid flow in the subsurface. The results of new experimental and modelling work will be presented, that aims to understand the streaming potential component of the SP (1) at the high salinity conditions that pertain to many oil and gas fields, during saline water influx into freshwater aquifers, and to deep saline aquifers during CO<sub>2</sub> sequestration, and (2) during the flow of multiple immiscible fluid phases, that occurs in the vadose zone, in oil and gas fields, and during CO<sub>2</sub> sequestration.

SP measurements could make a unique and valuable contribution to monitoring flow in these environments. However, the streaming potential is widely believed to be negligibly small in rocks saturated with highly saline brine, owing to collapse of the diffuse part of the electrical double layer at mineral-brine interfaces. We present experimental results in the high salinity domain, that demonstrate non-zero streaming potential in sandstones up to the saturation limit of NaCl at laboratory conditions, and in both sandstone and carbonate rocks saturated with seawater. It is hypothesized that collapse of the diffuse layer at high salinity is prevented by the finite size of the hydrated ions. Streaming potentials during the flow of multiple immiscible phases (such as air-water, oil-water and supercritical CO<sub>2</sub>-water) are still poorly understood, with contrasting experimental results from different groups that are difficult to reconcile. We present results from experimental measurements and simple pore-scale models, and discuss the differences between these and other studies. Suggestions for a consistent model that can reconcile these differences are welcome.