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Are electro-kinetic methods useful in the development of tight gas and shale gas resources?

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The development of unconventional reservoirs provides new challenges to the petrophysicist; challenges that might be overcome with new techniques and approaches. The application of electro-kinetics to hydrocarbon reservoirs is relatively recent. In fact, up until 2012 there was no theoretical model that was capable of predicting the streaming potential coefficient of a rock with given petrophysical properties (Glover et al., 2012). Here, we use that model to ask the question whether the measurement of electro-kinetic properties of tight gas sands and gas shales could be useful in the development of these resources. We have calculated the streaming potential coefficient for gas shales with typical values of porosity, cementation exponent and grain size as a function of pore fluid salinity (10^{-5} to 2 mol/dm^3) and pH (pH 5-9) at the temperatures and pressures encountered in shale gas reservoirs. For typical gas shales such as the Barnett shale (grain diameter 0.1 μm, porosity 2.5 % and 5 μD, respectively) the streaming potential coefficient is less than 2×10^{-10} V/Pa for all the modelled salinities and pHs. This is extremely small, and would only result in a streaming potential of the order of millivolts even during hydraulic fracturing at 10 kpsi, while deep monitoring of fluid flow would be impossible. Similar modelling of typical tight gas sands (grain diameter 3 μm, porosity 5 %, permeability 0.1 mD) provides a higher streaming potential coefficients, reaching 10^{-7} V/Pa at low salinities (<10^{-3} mol/dm^3) but significantly lower for higher salinity pore fluids. These values are probably still too low to be used to monitor fluid flow in tight gas reservoirs. By contrast, however, there may very well be an application of electro-kinetics in the monitoring of near-surface aquifers for accidental flooding by either thermogenic gas from a faulty casing or biogenic gas that has been mobilised by drilling in shale gas and tight gas sand wells. At shallow depths the aquifer grain size, cementation exponent, porosity and fluid properties provide streaming potential coefficients of the order of 10^{-4} V/Pa at aquifer salinities, which makes it possible to use electrical measurements to warn of the encroachment of gas into the aquifer and to monitor flood fronts.