

Relative permeability and salinity dependence of the streaming potential coupling coefficient in carbonate rocks

Aurélien Cherubini (1,2), Adrian Cerepi (2), Bruno Garcia (1), Hervé Deschamps (1), and André Revil (3)

(1) IFP Energies Nouvelles – Geosciences Division, GeoFluids and Rocks dept., 92500 Rueil-Malmaison, France, (2) EA 4592 “Géoressources et Environnement”, ENSEGID-Bordeaux INP, 33607 Pessac, France, (3) ISTerre, CNRS, UMR CNRS 5275, Université de Savoie Mont-Blanc, Le Bourget du Lac, France

The seismoelectric method is showing promises to characterize both the vadose zone of the Earth and hydrocarbon reservoirs. That said, the dependence of a key parameter, the streaming coupling coefficient with the saturation remains highly debated. We explore here the relationship between the streaming potential coupling coefficient, resistivity, and permeability in saturated and unsaturated carbonate rocks together with the capillary pressure curves. Two rock samples, a limestone from the Paris basin (the Brauvilliers limestone) and a dolostone from the Aquitaine basin (Sample labeled LS2), are characterized in terms of their porosity, specific surface area, and intrinsic formation factor. A new core flooding system is used to measure simultaneously and for the first time both the relative permeability, the resistivity, and the streaming potential coupling coefficient in steady-state two phase flow conditions as a function of the saturation. The results are compared with theoretical models predicting the relationship between the streaming potential coupling coefficient, the relative permeability, and the second Archie's exponent. A good agreement is found between the model based on the van Genuchten approach and experimental data but still we could not fit all the curves with the same van Genuchten exponent. Moreover, measurements of the streaming potential coupling coefficient in intact limestones samples saturated with NaCl brines at concentrations up to 100 g/L were realised. As brine salinity increases, the coupling coefficient decreases in magnitude, but is still measurable up to the saturated concentration limit. Our results suggest that streaming potential measurements may be used to monitor flow in saline subsurface environments such as deep saline aquifers and hydrocarbon reservoirs.