Determination of petrophysical properties of carbonated porous medium using a Geoelectrical-Geochemical coupling approach

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Coupled physical and chemical processes occur along the injected CO_2 pathway in a reservoir (in CCS or CO_2-based EOR) and may have consequences on the reservoir petrophysical properties. In near well-bore regions, the evaporation of the brine may lead to salt precipitation. In distal regions, fluids-rock interactions occur during the migration of CO_2 and brine by advection and/or diffusion and may result in minerals dissolution/precipitation changing the transport properties of the porous medium. Assessing the extent of petrophysical properties variations in the reservoir is crucial regarding injectivity and containment safety issues during massive CO_2 injection over decades.

We thus propose to determine the petrophysical properties changes during CO_2 injection a new combined Geoelectrical-Geochemical approach. We report here the first results on different carbonate reservoir rock-types of a new and integrated core scale experimental investigation of the absolute and relative permeability in CO_2-brine systems from the spectral induced polarization and the streaming potential coupling coefficient in saturated and unsaturated porous medium. The spectral induced polarization is realized in a large frequency range in brine saturation and CO_2-brine systems and explains the relationship between complex conductivity and the frequency domain. In the low frequency domain, the complex conductivity of saturated and unsaturated porous medium is controlled by the polarization of the Stern layer and by the grain size distribution. In the high frequency domain, the complex conductivity is controlled by the Maxwell-Wagner polarization. We compare the absolute permeability of porous medium obtained from a predective model including the main relaxation time derived from spectral induced poralization and measured absolute permeability. The streaming potential coupling coefficient is basically defined as a sensitivity coefficient between the electrical potential and the variation of capillary pressure. In unsaturated porous medium this streaming potential coupling coefficient is controlled by CO_2-brine saturation and can be related to the CO_2-brine relative permeability.