Geophysical Research Abstracts
Vol. 19, EGU2017-18622-1, 2017
EGU General Assembly 2017

A case study on changes of petrophysical properties of Werkendam well-cores due to interaction with supercritical carbon dioxide

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Changes of porosity, permeability, electrical conductivity and E-modul were studied on sandstones from the Werkendam drillings WED2 (CO_2-free) and WED3 (CO_2-rich) (The Netherlands). WED2 and WED3 are separated by a fault. Porosities of the untreated samples range from <0.3% up to 16.5%, permeabilities from<0.01 mD up to >160 mD. Significant differences of samples from the WED2 and WED3 well were not detected. The petrophysical properties of the whole set of samples was measured prior to any experiment, then in total 8 samples from WED2 and WED3 were selected for the following experiments with supercritical CO_2 ($scCO_2$). These were performed at pressures of 10-12 MPa and temperatures ranging from 100 up to 120°C. The pores were partially saturated with brine (0.1 M NaCl). In a first step the autoclave experiments lasted about 45 days and were then extended in a second series up to 120 days total reaction time. An increase in porosity, permeability and electrical conductivity was measured after each experimental series with $scCO_2$. Two of the samples failed along fractures due to dissolution and thereby caused loss of stability. The frequency dependent complex conductivity was measured in the frequency range 10-3 Hz up to 45 kHz thus having access to fluid/solid interactions at the inner surface of the pores.
In a final sequence the uniaxial compressive strength and E-modul were measured on untreated and processed samples. Thus we could get an estimate on weakening of the mechanical stability caused by $scCO_2$-treatment.