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The effects of impure CO_2 on reservoir sandstones: results from mineralogical and geomechanical experiments

H. Marbler, K.P. Erickson, M. Schmidt, Ch. Lempp, and H. Pöllmann
Martin-Luther-Universität Halle-Wittenberg, Germany (herwig.marbler@geo.uni-halle.de)

An experimental study of the behaviour of reservoir sandstones from deep saline aquifers during the injection and geological storage of CO_2 with the inherent impurities SOX and NOX is part of the German national project COORAL*. Sample materials were taken from outcrops of possible reservoir formations of Rotliegend and Bunter Sandstones from the North German Basin. A combination of mineralogical alteration experiments and geomechanical tests was carried out on these rocks to study the potential effects of the impurities within the CO_2 pore fluid. Altered rock samples after the treatment with CO_2 + SOX/NOX in an autoclave system were loaded in a triaxial cell under in-situ pressure and temperature conditions in order to estimate the modifications of the geomechanical rock properties. Mineralogical alterations were observed within the sandstones after the exposure to impure supercritical (sc)CO_2 and brine, mainly of the carbonatic, but also of the silicatic cements, as well as of single minerals. Besides the partial solution effects also secondary carbonate and minor silicate mineral precipitates were observed within the pore space of the treated sandstones. These alterations affect the grain structure of the reservoir rock. Results of geomechanical experiments with unaltered sandstones show that the rock strength is influenced by the degree of rock saturation before the experiment and the chemical composition of the pore fluid ($scCO_2$ + SOX + NOX). After long-term autoclave treatment with impure $scCO_2$, the sandstone samples exhibit modified strength parameters and elastic deformation behaviour as well as changes in porosity compared to untreated samples. Furthermore, the injected fluid volume into the pore space of sandstones from the same lithotype varies during triaxial loading depending on the chemistry of the pore fluid. CO_2 with NOX and SOX bearing fluid fills a significantly larger proportion of the sandstone pore space than brine with pure $scCO_2$.

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