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Long term effects of CO_2 on 3-D pore structure and 3-D phase distribution in reservoir sandstones from the Green River well (Utah, USA)

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Reservoir sandstones and cap rocks from the Green River area in Utah (USA) have been naturally exposed to CO_2 fluids for hundreds of thousands of years, leading to compositional and microstructural alterations of the rocks. A 300m long section of this section of these Green river reservoir and cap rocks has been cored in 2012. Here, results of a high-resolution micro X-ray tomography study of a suite of samples from the well are reported detailing the 3D pore structure and phase distribution changes due to long term CO_2 exposure. The reservoir sandstones from the Green River well (Utah) reveal the presence of various degrees of carbonate precipitation in the pores. Both reservoir sandstones (the shallower Entrada Formation and the deeper Navajo Formation) show variations in carbonate content and porosity structure. The Entrada sandstone exhibits widespread carbonate precipitation (up to 60% of infill of the original porosity), with the largest amount of carbonates at the boundary with the underlying Carmel cap rock. In an interval of a meter from the contact, carbonate precipitation decreases sharply till $\sim$20%. The porosity is significantly reduced in the lowest 1 meter. The reduction in porosity lead to a reduction in pore connectivity and thereby permeability by the long-term CO_2 exposure. On the other hand the Navajo sandstone shows predominantly only isolated spots of carbonate precipitation (up to 20% of the original porosity). Widespread carbonate precipitation is absent in the Navajo reservoir sandstone samples. Because carbonate precipitation is not present throughout, the large-scale permeability of the formation is likely not significantly affected by the CO_2 exposure. The results show how the 3D distribution of the phases and the 3D shapes of the pores are affected by long term CO_2 exposure and can be used as an example for potential changes to be expected in reservoir sandstones due to CO_2 storage in future CO_2 sequestration endeavours.