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Petrographic and geochemical investigation of naturally CO_2-free and CO_2-flooded sandstones from the Central Pannonian Basin

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We investigated CO_2-free and naturally CO_2-flooded sandstone samples from a deep saline aquifers formation, which represents potential carbon storage reservoirs. A descriptive geochemical model is also coupled to the laboratory study for the better understanding of geochemical interaction between sandstone and CO_2. The studied area is located in the, Western Hungary in the Little Hungarian Plain where one of the largest CO_2-producing fields in Europe can be found. In this region, we have the opportunity to compare rocks of the same sandstone formation without CO_2 (not affected by natural CO_2 flooding) and naturally CO_2 flooded sandstone, where the CO_2 was trapped around 7-4 million years ago. As boreholes sampled not only the parts of the formation, which were flooded by CO_2 (Mihályi-Répcelak), but also the parts which were not affected at all by this flooding (Ölbő).

Besides petrographic observations, scanning electron microscopy and mineral chemistry analyses, X-ray diffraction and infrared spectroscopy were used to determine 7 CO_2-free and 6 CO_2-flooded samples textural features, mineral compositions and the presence of OH-bearing minerals. We carried out thermodynamic-batch modelling with PHREEQC geochemical modelling software and compared to the laboratory results.

The sandstone samples from the CO_2 bearing reservoirs contain quartz, mica, kaolinite, K-feldspar and carbonates such as dolomite, calcite, ankerite and siderite. The CO_2-free samples also contain chlorite, plagioclase and pyrite and all mentioned above. In the CO_2-flooded samples a carbonate phase, dawsonite ($NaAlCO_3(OH)_2$) could be also observed in significant amounts (3-16 w/w%). This is an indicator mineral of large amount of CO_2 inflow in the CO_2-water-rock system. In addition, chlorite is apparently missing in the CO_2-flooded samples. According to the petrographic observations and X-ray diffraction (XRD) results, it is clear that the plagioclase content is higher (11 w/w%) in the CO_2-free samples compared to the CO_2-flooded ones (<1 w/w%). The modal amount of K-feldspar is also lower in the CO_2 flooded reservoir rocks. The lower amount of K-feldspar and plagioclase in the CO_2-flooded samples can be explained by precipitation of dawsonite. These minerals can dissolve as a result of CO_2-flooding and serve Na^+ and/or Al^{3+} ion

for dawsonite formation. The amount of the carbonate minerals also reveal systematic differences between the CO_2-free and CO_2-flooded sandstone, the amount of ankerite is higher (from 6 to 12 w/w%) in the later ones implying that some parts of the ankerite formed after the CO_2 flooding event.

The investigation of this unique area provides opportunity to study sandstone before interaction with CO_2 and after millions of years being in contact with CO_2.

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