Geophysical Research Abstracts
Vol. 19, EGU2017-582, 2017
EGU General Assembly 2017

How much CO_2 is trapped in carbonate minerals of a natural CO_2 occurrence?

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Carbon Capture and Storage (CCS) is a transitional technology to decrease CO_2 emissions from human fossil fuel usage and, therefore, to mitigate climate change. The most important criteria of a CO_2 geological storage reservoir is that it must hold the injected CO_2 for geological time scales without its significant seepage. The injected CO_2 undergoes physical and chemical reactions in the reservoir rocks such as structural-stratigraphic, residual, dissolution or mineral trapping mechanisms. Among these, the safest is the mineral trapping, when carbonate minerals such as calcite, ankerite, siderite, dolomite and dawsonite build the CO_2 into their crystal structures. The study of natural CO_2 occurrences may help to understand the processes in CO_2 reservoirs on geological time scales. This is the reason why the selected, the Mihályi-Répcelak natural CO_2 occurrence as our research area, which is able to provide particular and highly significant information for the future of CO_2 storage. The area is one of the best known CO_2 fields in Central Europe. The main aim of this study is to estimate the amount of CO_2 trapped in the mineral phase at Mihályi-Répcelak CO_2 reservoirs. For gaining the suitable data, we apply petrographic, major and trace element (microprobe and LA-ICP-MS) and stable isotope analysis (mass spectrometry) and thermodynamic and kinetic geochemical models coded in PHREEQC.
Rock and pore water compositions of the same formation, representing the pre-CO_2 flooding stages of the Mihályi-Répcelak natural CO_2 reservoirs are used in the models. Kinetic rate parameters are derived from the USGS report of Palandri and Kharaka (2004). The results of petrographic analysis show that a significant amount of dawsonite ($NaAlCO_3(OH)2$, max. 16 m/m%) precipitated in the rock due to its reactions with CO_2 which flooded the reservoir. This carbonate mineral alone traps about 10-30 kg/m3 of the reservoir rock from the CO_2 at Mihályi-Répcelak area, which is an unexpectedly high proportion of total amount of CO_2. Further results enlightened that other carbonates, ankerite, calcite and siderite have precipitated in two generations, the first before and the second after the CO_2 flooding. Further laboratory analysis and geochemical models allow us to estimate the ratio of these two generations and also to understand how far the reservoir rock is in the CO_2 mineral trapping process.