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Mineral trapping of CO_2 in operated geothermal reservoirs – Numerical simulations on various scales

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A novel approach to store CO_2 not only by hydrodynamic trapping within a reservoir, but to convert dissolved CO_2 into the geochemically more stable form of calcite in a reaction with calcium obtained from dissolution of sulphates and alkalinity from feldspars or fly ashes is described here. The presentation gives answers to the key questions:
• Where are potential geothermal reservoirs with anhydrite abundant?
• Does the transfer of anhydrite into calcite work at all and what are the reaction rates?
• What are probable alkalinity sources and how fast are they available?

Numerical simulation is a means to quantify the entire process of CO_2 storage and to deepen the understanding of the detailed chemical processes. We performed numerical simulations on multiple scales. The relevant scales reach from the micro or thin section scale (ca. 1 cm) to the reservoir scale (ca. 10 km). The idea is to provide constraints for smaller scale models from the larger scale and derive functionality from smaller scale models of processes which cannot be resolved in larger scale models, due to restrictions of discretization of the applied numerical mesh.

With regard to the 3 questions above we can conclude that the combination of CO_2 storage and geothermal energy production is generally feasible because candidate sites are available, anhydrite is transformable into calcite and alkalinity can be provided by fly ashes (Back et al. 2010) or even in-situ (Kühn and Clauser 2006). Based on our laboratory investigations and numerical studies we are able to estimate the storage potential for mineral trapping of CO_2 in geothermal reservoirs (Kühn et al. 2009). On the one hand the maximum is unfortunately less than a million tons over the life time of a geothermal heating plant. On the other hand significant storage capacities are available in geological formations with regard to hydrodynamic trapping for millions of tonnes of carbon dioxide. This is why under the current circumstances the combination of geothermal energy production and CO_2 storage is not economical.

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