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Mineral trapping of CO2 in operated hydrogeothermal reservoirs

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Storage of carbon dioxide by precipitation of carbon-bearing minerals in geological formations is, on the long run, more stable and therefore much safer than direct storage or solution trapping. Among available options for CO2 sequestration those are particularly attractive which offer additional economic benefits besides the primary positive effect for the atmosphere, such as the novel approach of storing dissolved CO2 as calcite in managed geothermal aquifers. Hydrogeothermal energy in Germany is mainly provided from deep sandstone aquifers by a so called “doublet” installation consisting of one well for hot water production and one well for injection of the cooled water. When cold brines are enriched with CO2 and injected into an anhydrite bearing reservoir this mineral dissolves. As a result, the water becomes enriched in calcium ions. Numerical simulations demonstrate that dissolved Ca and CO2 react to form and precipitate calcium carbonate provided that alkaline buffering capacity is supplied from plagioclase in the reservoir rock or by surface water treatment with fly ashes. We show that anhydrite dissolution with concurrent pore space increase is important to balance pore space reduction by precipitation of calcite and secondary silicates. Laboratory experiments prove the feasibility of transforming anhydrite into calcite and provide necessary kinetic input data for the modelling. Suitable geothermal reservoirs exist, which contain sufficient anhydrite as matrix mineral and plagioclase for supplying alkalinity. Mass balance calculations performed with respect to the anhydrite and feldspar content show, that for an assumed operation time of 30 years, the theoretical storage capacity is significant: millions of tons of CO2 can be trapped as calcite in geological formations used by geothermal heating plants.