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Storage capacity of CO_2 by mineral trapping in the hydrogeothermal reservoir structure at Stralsund, Germany

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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. The concept of combining hydrogeothermal energy production with geological CO_2 storage consists of converting dissolved CO_2 into the geochemically more stable form of calcite in a reaction where calcium is provided by the dissolution of sulphates (e.g. anhydrite) and alkalinity by feldspars or geothermal water treated with fly ashes. At Stralsund, situated in Northeastern Germany on the Baltic Sea, a geothermal resource was investigated and confirmed in previous studies in Buntsandstein layers at a depth of about 1520 m. We performed mass balance calculations to assess the storage capacity of the potential reservoir based on available data and plausible chemical and physical boundary conditions. The calculations assumed a common doublet installation with combined hot water production and cooled water re-injection in two wells. During an approximate life time of 65 years, suggested by preliminary reservoir simulations, with a constant production rate of 100 m^3/h, around 57 Million m^3 of geothermal water are circulated. It is assumed that the injected water is cooled from the initial formation temperature of 56°C to 25°C. The maximum stor-

age capacity of CO_2 in a geothermal reservoir by mineral trapping depends primarily on the solubility of CO_2 in the geothermal brine. This amounts to 210,000 t at a pressure of 1 MPa (maximum pressure of aboveground tubing system) for Stralsund.
However, also the solubility of anhydrite, increasing the porosity of the reservoir, is important to ensure that the reservoir permeability is not reduced over the lifetime of the geothermal plant. This is ensured if only as much calcite and secondary minerals are precipitated as newly generated pore space is available. The solubility of anhydrite in the formation water, depending on the temperature difference between the cooled water and the formation temperature and the salinity, is $3.1*10^{-3}$ mol/kg formation water. Transferred into CO_2 storage equivalents this calculates to 7,800 t. The anhydrite solubility can be increased by fractional distillation of the geothermal brine before re-injection. Avoiding precipitation of halite or other major components of the geothermal water, the maximum storable amount of CO_2 can be enhanced to 29,000 t. If it was technically feasible to remove Ca and SO_4 from the brines entirely a total of 123,000 t of CO_2 equivalents could be stored at Stralsund. Provided that not the anhydrite content but the in-situ alkalinity source is the limiting factor, 126,000 t of CO_2 equivalents can be stored in the Stralsund geothermal reservoir. Under the assumption that the rock forming minerals are not available for buffering the mineral reactions due to their low reaction rates, the surface treatment of the geothermal waters with fly ashes provides an alternative to obtain the required alkalinity. The optimized application of fly ashes results in 22,000 t of CO_2 equivalents which can be stored in the geothermal reservoir over the lifetime of the plant.
It can be concluded that the technology of transferring CO_2 into calcite in operated geothermal reservoirs is feasible but the amounts of storable CO_2 are too low to be of climatic relevance or even to increase the economic efficiency of a geothermal plant.