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Mineral formation during production of highly saline geothermal fluids

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Geothermal solutions produced from deep wells are often highly saline and of complex composition impeding exact predictions of fluid-mineral interactions. At constant (high) temperature and flow conditions during plant operation, only little precipitation would be expected. However, during the initial phase of the operation of a geothermal plant, the testing of equipment components such as pumps and valves prevents these constant fluid flow conditions. Moreover, fluid temperatures are still relatively low and vary strongly at this stage. These inhomogeneous conditions result in the precipitation of a wide range of minerals.
The analysis of solutions composition as well as of the mineral precipitates during this initial testing phase represents a unique in-situ experiment allowing understanding the mineral formation from complex solutions under a wide range of temperatures. This experiment was possible at the geothermal in-situ laboratory in Groß Schönebeck (North German Basin). At this site, hot fluid (150 °C at 4400 m depth) is pumped out of a production well to the surface where it passes the above ground installation (e.g. 1 μm filter bags) before it would be re-injected into a second (injection) well. The temperature of the produced fluid varied between 10 and 100°C due to numerous turning on and shutdown phases.
Fluid and filter residues have been analyzed during several cycles. In the solid phase, almost no minerals of the reservoir sandstone have been identified. Instead, several compunds have been found which precipitated directly from the solution. One group, dominated mainly by barite (BaSO4), formed as consequence of the cooling effect, which affects strongly the solubility product and results in mineral precipitation. The other group of minerals (such as magnetite or several lead minerals) form due to changes in redox conditions. These changes occur possibly in the region close to the production pump, where a strong magnetic field and highly variable flow conditions exist.