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Characterisation of reservoir fluid conditions at geothermal well Gross Buchholz Gt1

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In 2009 an approximately 4 km deep geothermal well was drilled in Hannover, Germany. The intention of the project is to provide thermal energy for the Geocentre in Hannover (office complex with a heat demand equivalent to 2 MW) It is intended to produce energy out of tight sediments of the northern German basin from a single well. As the target formation (Bunter Sandstone) has only a marginal porosity, an underground heat exchanger had to be created by a hydraulic frac operation. The frac was generated by injecting 20.000 m^3 of fresh water into the well. After six month of enclosure the water was recovered from the formation. While producing the fluid was sampled several times to analyse dissolved mineral content, gases and possibly particles. The geochemistry of the reservoir is of particular interest for the use and maintenance of the future geothermal system. Only a good understanding of the underground conditions allows a successful operation of the heat supply system.
In this study, the chemical composition of the water and the nature of the gas phase are presented. In addition, the chemical and mineralogical composition of scales, which developed during the test, is addressed. The radioactivity of water, gas, and scale were also studied for occupational safety reasons.
The obtained water at the well head became oversaturated with respect to NaCl at surface conditions. Therefore massive scaling occurred on the surface equipment. After a few days of production the test had to be stopped. The water is a very hard Na-Ca-Cl-brine (total dissolved solids (TDS) 340 g/L). Concentrations at the bottom of the well were probably even higher as cooling-induced precipitation occurs during passage to the surface. If the formation water were in equilibrium with halite, the TDS should be ca. 370 g/L at 160 °C. The pH value ranges between 5 and 6 at surface conditions after partial degassing. The redox conditions are anoxic with high concentrations of Fe(II), Mn(II) and NH4+. The gas phase mostly consists of nitrogen (90 Vol%) and carbon dioxide (10 Vol%). A normal geogenic content of 222Rn in the gas phase was detected, corresponding to relatively low radioactivity (50 Bq/L). In both, water and scale, concentrations of radioactive compounds were well below threshold values. In order to characterise mixing and dissolution processes the stable isotopes of the injected water and the reproduced water were also analysed.
The recovered water reflects the signature of deep formation water. This result along with the high salt content shows a high percentage of formation fluid. Its composition is most likely dominated by a mixture of reservoir fluid and dissolution of some cementation minerals, like halite and anhydrite.
It remains to be shown, if oversaturated water occurs at any production test or if a state of subsaturation can be achieved by repeated injection of fresh water. More tests are needed to answer this question.