



Comparative study of chemical stimulation at geothermal wells in the carbonates of the upper jurassic in the Bavarian Molasse Basin

Felicitas Kaplar and Thomas Baumann

Technische Universität München, Ingenieur fakultät Bau Geo Umwelt, Lehrstuhl für Hydrogeologie, Germany

Chemical stimulation of geothermal wells to remove drilling mud and to increase the connection to the reservoir are state of the art. There is hardly any deep geothermal well in the carbonates of the upper jurassic in the pre alpine foreland basin which was not developed using one or more pulses of acid. Several tons of acid are injected into the borehole and followed by a chaser to push the acid into the reservoir. Given the wide use of chemical stimulation measures, mass balance data for the stimulation is rare. This might be due to a rather simple reaction mechanism and the assumption that there is a full stoichiometric reaction and all injected acid is recovered. The efficiency of the stimulation is assessed based on the hydraulic properties derived from the short-term pumping tests following the stimulation. This project compares the full mass balance for chemical stimulation measures and the temporal development of the concentration of relevant ions during the pumping test after stimulation. The data was collected at several sites with a temporal resolution of down to 30 mins. The data includes multiple stimulations as well as stimulation with varying acids and different setup. Using this data set we want to answer the questions whether the acid is fully recovered, whether the assumption of full stoichiometric reaction is valid, whether there is a difference in the transport of reactive and conservative ions, what additional value a hydrochemical analysis could add and whether on-site measurements could substitute costly measurements. The evaluation shows a distinct behaviour of the temporal development of the chloride concentration (after stimulation with hydrochloric acid) which can be described by a bi-exponential fit. The fitting parameters of the two exponential terms are getting closer with each stimulation indicating a reduced heterogeneity along the accessible flow paths around the borehole. A comparison of the full scale analysis with on-site sensors was sometimes not possible because the sensors showed a drift during the experiment or were poorly calibrated. As calcium, magnesium, and chloride ion concentrations showed different behaviour, electrical conductivity is not able to cover the full development. The mass balance indicates that a full recovery of the injected acid might take significantly longer than the short term pumping tests. Hydrochemical monitoring provides additional and relevant data about the reservoir in the surrounding of the borehole and allows important predictions about the long-term behaviour, especially if the borehole is used as injection well. For routine applications improved sensors and fast (and cheap) on-site analysis is required.