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Processes in the Vicinity of an Injection Well of a Geothermal Facility in the Malm Aquifer

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With high temperatures, high transmissivities and low salinities the Malm Aquifer in the Bavarian Molasse Basin offers ideal conditions for the exploration of geothermal energy. In 2011 the Pullach geothermal facility was extended with a third geothermal well to account for the increasing heat demand. In the course of this extension an injection well was converted to a production well. Hence, for the first time in the history of geothermal exploration of the Malm Aquifer, data became accessible from the surrounding of an injection well which has been in operation for more than 5 years. This data, together with data froma a push-pull tracer test started 9 months before the conversion, allows unique access to the processes at the injection well and sets the baseline for an assessment of the long term behavior of geothermal heat and power plants in the Molasse Basin. The development of the production temperatures went faster than expected, after 4 years of production the initial temperatures have almost been reached. This can only be explained with a vertically heterogeneous distribution of the transmissivity. In this setting, the cold water forms a thin disc which extends much further from the injection well. Thus, the effective area of the heat exchange with the matrix of the aquifer is larger than in a homogeneous setting. The breakthrough of the tracers was affected by an unexpected delay of the start of the production. The regional flow led to a shift of the injected tracer pulses with the innermost tracer pulse being entirely transposed downstream of the injection well. The recovery rates mirror the sorption coefficients of the individual tracers as determined in batch tests and column tests. It became apparent, that the stagnation phase led to a bias towards sorption with slow kinetics and diffusion-limited matrix interactions. The hydrochemical data showed a significant increase of the concentrations of calcium, magnesium, and bicarbonate indicating a dissolution of dolomite. The dissolution overcompensates the effects of the increases viscosity of the injected cold water. Modeling results indicate that lower temperatures and different lithostratigraphy are contributing to the dissolution. These processes would also occur if the water would be produced from a dolomite and injected into a limestone, which explains why most facilities in the Molasse Basin have recorded decreasing injection pressures.