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Quantification of the reactions in heat storage systems in the Malm aquifer

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Combined heat and power plants (CHP) are efficient and environmentally friendly because excess heat produced during power generation is used for heating purposes. While the power demand remains rather constant throughout the year, the heat demand shows seasonal variations. In a worst-case scenario, the heat production in winter is not sufficient, and the power production in summer has to be ramped down because the excess heat cannot be released to the environment. Therefore, storage of excess heat of CHP is highly beneficial from an economic and an ecological point of view. Aquifer thermal energy storage (ATES) is considered as a promising technology for energy storage. In a typical setting, water from an aquifer is produced, heated up by excess heat from the CHP and injected through a second borehole back into the aquifer.

The carbonate rocks of the upper Jurrasic in the Molasse Basin seem to be promising sites for aquifer heat storage because of their high transmissivity combined with a typical geological setting with tight caprock. However, reactions in the aquifer cannot be neglected and may become the limiting process of the whole operation. While there have been several studies performed in clastic aquifers and for temperatures below 100 °C, the knowledge about high injection temperatures and storage into a carbonatic aquifer matrix is still limited.

Within a research project funded by the Bavarian State Ministry for Economic Affairs and the BMW Group, the storage and recuperation of excess heat energy into the Bavarian Malm aquifer with flow rates of 15 L/s and temperatures of up to 110 °C was investigated. The addition of CO_2 was used to prevent precipitations. Data from the field site was backed up by autoclave experiments and used to verify a conceptional hydrogeochemical model with PhreeqC for the heat storage operation. The model allows to parametrize the operation and to predict possible reactions in the aquifer.