Long-term effect of a seasonal thermal storage on the subsurface: a case study from the Upper Muschelkalk, SW Germany


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The thermal effect on the subsurface of a solar-coupled district heating system with a borehole heat exchanger system as a seasonal thermal storage located in Crailsheim, Baden-Württemberg, Germany. (Fig. 1) has been simulated over a time span of 30 years using a FEFLOW model. The thermal storage is loaded from April to September and discharged from October to March.

The borehole thermal storage system (BTES) consists of 80 borehole heat exchangers (BHE) arranged in squared raster model within a circle of 30 m in diameter (Fig. 3). The BHE have a depth of 55 m and are located predominantly in Middle Triassic carbonates (Upper Muschelkalk). The BTES intersects multiple aquitards located in the Erfurt Formation (Lower Kupfer) and the Meißner Formation (Upper Muschelkalk) and penetrates into an aquifer at about 71 m depth.

The model is based on three 80 m core sections (GWM2 to 4) drilled at the project site (Upper Muschelkalk). The BTES intersects multiple aquitards located in the Erfurt Formation (Lower Kupfer) and the Meißner Formation (Upper Muschelkalk) and penetrates into an aquifer at about 71 m depth. The model is based on three 80 m core sections (GWM2 to 4) drilled at the project site (Upper Muschelkalk). The BTES intersects multiple aquitards located in the Erfurt Formation (Lower Kupfer) and the Meißner Formation (Upper Muschelkalk) and penetrates into an aquifer at about 71 m depth.

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The model is based on three 80 m core sections (GWM2 to 4) drilled at the project site (Fig. 3). Each core has been analysed in detail with respect to lithology, facies and stratigraphy. The thermal conductivity, specific heat capacity, and permeability have been measured on 76 representative samples from well GWM3 using pointwise measurement techniques. Additionally, the main joint directions have been recorded in two reference outcrop sections (Fig. 2) and have been incorporated into the model.

Fig. 4 shows the BTES after 30 years at the end of the seasonal heat extraction phase. Clearly visible is a heat plume in the aquifer that migrates in flow direction. Additionally, a significantly hotter zone develops below the BTES, whose heat can not be extracted by the BHEs.