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Outcrop analogue studies for reservoir characterization and prediction of deep geothermal systems in the Molasse Basin, Germany

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The utilization of deep geothermal systems is based on a detailed knowledge of their distinct reservoir characteristics. In the early stages of hydrothermal reservoir exploration, the thermo-physical characterization of the reservoir is mainly accomplished by evaluation of already existing drilling data in the vicinity of the target area and in some cases seismic surveys. For reservoir predictions, the main geothermal parameters such as permeability, thermal conductivity, specific heat capacity and reservoir heat flow have to be quantified. In addition to these thermo-physical parameters in-situ stress field analysis and structural tectonic data is important to assess. Outcrop analogue studies enable the determination and correlation of the thermo-physical parameters and structural geology data with detailed facies pattern, therefore the geothermal exploration concept becomes more precise and descriptive. An outcrop analogue investigation examines the same rock formations (stratigraphy, lithology, facies) such as the potential reservoir formations from which fluids at according depth are discharged. For the economic utilization of deep geothermal reservoirs, a sufficient high flow rate of thermal waters throughout the reservoir to the production well is necessary. This flow rate is mainly controlled by the reservoir permeability. In the Molasse Basin the limestone formations of the Upper Jurassic contain the main flow paths through tectonic elements such as faults, joints and fractures, and to some extend also, typically for limestone formations, through karst phenomena. To characterize those fracture controlled reservoirs information about the structure, texture, geometry and thermo-physical properties of the reservoir formations are essential.
An outcrop analogue study of the target formation Malm of the Upper Jurassic, which is the most promising formation for deep geothermal projects in the German Molasse Basin, together with the correlation of distinct sedimentary facies and their thermo-physical parameters may contribute to establish integrated structural 3D reservoir models. The inferred predictions from the laboratory testing can be validated with actual drilling data and pump test data from recent drill sites. Due to the fact that a precise classification of facies zones in the target depth of the geothermal reservoir is not possible, the outcrop analogue study area was selected to the Swabian and Franconian Alb as well as to the transition zone of these two facies areas. The facies related characterization and prediction of geothermal reservoir parameters is also a powerful tool for the maintenance, operation and quality management of an existing geothermal reservoir. The results of this study can be used for further drilling design plans and reservoir enhancement measures. Here, we present first research results of the mechanical and thermo-physical laboratory investigations of limestone formations of the Upper Jurassic (Malm), which were sampled during a field campaign in the according outcrop areas of the Swabian und Franconian Alb in South Germany.