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Geothermal field development in foreland basins: Case study Mauerstetten, Bavarian Molasse Basin (Germany)

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Foreland basins with their increasing depth towards the orogenic front are ideal geologic systems for geothermal resources. The Bavarian Molasse Basin is an example where geothermal energy is being successfully developed mainly by industry. However, the predicted productivity is not achieved in all project sites because either temperature or flow rate or both are lower than expected.
The case study Mauerstetten in the southwestern Bavarian Molasse Basin is one of the industry triggered projects where high temperature of over 150°C but insufficient flow rate dragged the overall project performance down. As research project, Mauerstetten is revived aiming to gain the relevant knowledge to develop a strategy to increase reservoir productivity. Within this framework structural geological and biostratigraphical analysis were combined with geomechanical tests. The structural geological analysis on 2D seismic sections revealed fossil normal faults in a strike slip to transpressional stress regime. Biostratigraphical analysis was undertaken on thin sections from wellbore cuttings to delineate appropriate analog outcrops for geomechanical tests to predict reservoir behavior under injection and production. Remarkably, the upper Jurassic Malm formation exhibits extremely high rock strength if Tubiphytes dominate the carbonate rock. Tubiphytes are encrusting and branching organisms associated with shallow-water sponge reefs rimmed along the continental margin of Laurasia towards the Tethys during Upper Jurassic. Other than coral dominated reef limestone, Tubiphyte-dominated limestone is expected to trigger a high self-propping effect along shear fractures due to its brittleness, and a low reactivation potential due to its high rock strength. Natural and artificial shear fractures are expected to be preferential flow pathways. Abnormal high injection pressure is necessary to induce slip in Tubiphytes limestone in the present-day stress field. Our study exemplifies that exploration of geothermal reservoirs is site-specific with distinct selection of appropriate methods as in this case structural geology, biostratigraphy and geomechanics. This approach should be considered for geothermal field development in foreland basins where facies and fractures control geoenergy systems in general.