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Multiple tracer tests for assessing fracture properties of sedimentary hard rocks

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Current studies apply to the characterisation of fractured carboniferous sandstones in the vicinity of the city of Bochum (Germany). In this context, dual-tracer experiments within the scope of push-pull-tests will be carried out in shallow observation wells. Preliminary studies focused on the acquisition of tracer properties. Batch tests were used to determine adsorption coefficients for the sandstones. Measurements in diffusion cells provide diffusion coefficients. Cumulative information about matrix-diffusion, dispersion and sorption properties will be obtained by flow tests through a block of sedimentary rock with a definite artificial fracture.

In the following, field tests at single wells and between boreholes connected by a fracture network will be carried out. First results from slug-and-bail and pumping tests show transmissivity values around 10^{-4} m^2/s for these 20 – 30 m deep boreholes. As the next step push-pull-tests will be carried out. By injecting water containing a tracer cocktail and subsequent extraction in the same borehole the resulting breakthrough curve can be used to specify the dimension of the fracture plain.

All results from the laboratory and the field as well as stratigraphical data will be used to a) build up a conceptual model of the study area, b) convert it into a numerical model and c) define the parameters for flow and transport. The dual-tracer tests will be reproduced by this model. Beside this numerical solution the field data will be analysed using the SFDM-approach (single fissure dispersion model).

This research work contributes to investigations within the framework of a project dealing with the realisation of a geothermal doublet in 4 km deep sedimentary hard rocks. Therefore, it will be analysed how modelled results can be applied to a deep geothermal reservoir consisting of comparable lithological units. Especially the question of feasibility of a continuum approach as assumption for this application has to

be proofed. An additional issue is how the flow has to be reduced due to less open fractures and decreased porosity (to be evaluated by hydraulic tests in an about 4 km deep borehole). Furthermore, due to forecasted water density of 1.3 kg/m^3 a density-dependant flow has to be accounted for. Finally, the model for the geothermal reservoir should be used to depict the flow between two boreholes as well as the heat flux caused by extending cold water injected into one of the boreholes.