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Hydraulic characterization of a fractured carbonatic aquifer using pumping test data - an example from the Eastern Alps (Austria)

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Water flow in fractured aquifers is strongly influenced by heterogenities including lithological and structural (fracture network) variability at various scales. This causes a dependency of the hydraulic properties on the investigation scale. Different hydraulic testing methods, such as pumping tests or packer tests, provide averaged hydraulic properties at larger scale or at local scale in the vicinity of the well. To investigate scale effects in a fractured, carbonatic aquifer piezometers with different distances to the pumping wells were used for monitoring the hydraulic head, the electric conductivity, and the water temperature.

The investigated aquifer is built up by permomesozoic dolo-/ limestones of the Semmering – Wechsel complex in the Eastern Alps (Austria) belonging to the Lower Austro-Alpine. The carbonatic hard rocks show a distinctive fracture network with only a slight corrosive enlargement of the fractures. The fracture network of the dolo-/limestones can be recorded and characterized at exposures on the surface, where the formation strikes out. The test site is situated within an infrastructural pilot tunnel gallery having two niches with pumping wells at tunnel station 2340 m and 3240 m, pumping since August 1997 and June 1998, respectively. Additionally several observation wells exist at distances between approximately 100 meters to over 1 km to the pumping wells. The data base consists of long term monitoring data, daily water level measurements from 1997 to 2008. Additionally four data loggers were installed in observation wells at tunnel stations 2485m, 2785m, 3400m, and 3500m measuring the piezometric head and the water temperature at intervals of 15 minutes since summer 2008. In a first step the hydraulic properties were calculated from transient pumping test data using the analytic solution by Theis 1935 and Cooper Jacob 1946 for a rough estimation of the hydraulic properties. For these analyses time periods were selected in which only the first pumping niche was operating. The transmissivities calculated at several observation wells with various distances range from 3.7E-03 m^2/s to 7.8E-03 m^2/s. With an aquifer thickness of 150 m, hydraulic conductivities range from 2.5E-05 m/s to 5.2E-05 m/s are obtained. Considering that the aquifer includes both fracture and matrix porosity, the analytical solution by Moench 1984 was also used to evaluate the pumping test data, yielding slightly lower transmissivities from 3.2E-03 m^2/s to 5.7E-03 m^2/s.

In a next step, hydraulic pulses through the aquifer stimulated by varying the pumping rates will be monitored and interpreted in terms of hydraulic aquifer properties. The outcome of these analyses will be compared to the earlier results of packer tests within the same tectonic and lithological formation. At a later stage it is planned that the results will be integrated into a numerical model to evaluate the superposition of the two pumping niches and the relationship between recharge processes and the variability of the flow. Additionally, it will be possible to assess the scale dependency of hydraulic properties in this type of carbonatic formation.