Porosity and permeability of fractured Triassic carbonates forming the main ground water reservoirs of the 1st Vienna Water Main in the Schneeberg Massif (Lower Austria)

Theyer, Mario[1]; Prandstätter, Lukas[1]; Kuschnig, Gerhard[2]; Decker, Kurt[1]

1 Institute of Geology, University of Vienna, Josef-Holaubek-Platz 2, A-1090 Vienna, Austria; 2 Municipal Department 31 of the City of Vienna, Vienna, Austria.

Fractured, faulted and karstified carbonates are the most important aquifers providing tap water for the city of Vienna. Such hydrogeological reservoirs may be characterized by modified dual porosity-dual permeability models with karstic features forming the part of the model which is characterized by very high permeability and low total storage capacity. Fractured carbonate rocks with generally low permeability and low to moderate porosity constitute the second part of the model. Due to the large volume of fractured rock (several km³) the second part of the model provides most of the pore space for groundwater storage. While, by its high permeability and short groundwater transit times, the first part of the model is critical to the vulnerability of the aquifer, the second part determines the long-term storage capacity of the reservoir and the base flow of the tapped karstic springs. In this contribution we focus on the second part of the dual model by investigating the hydro-geologically important parameters porosity and permeability of fractured Triassic carbonates of the Kuhschneeberg in the catchment of the 1st Vienna Water Main (I. Wiener Hochquellenleitung). Analyses build on the structural-geological characterization of fractures of different origin, type and size. Fracture density, which is the key parameter governing both porosity and permeability of the aquifers, is assessed by a field-based semi-quantitative classification technique estimating the range of P32 values and in thin sections from flourolstained samples analyzed under UV-light. Porosity was measured by immersion techniques and an automated Vinci 700 Gas Porosi Permeameter. The latter was also used to determine Klinkenberg permeabilities from plug samples at confining pressures between 400 and 6,500 psi. Measurements of porosity/permeability were conducted to assess the reduction of porosity/permeability with increasing overburden of the aquifers, which is an important effect in the analyzed catchments where springs emerge at altitudes about 1–1.5 km below the elevation of the karst plateaus. The results of our analyses reveal porosity values between about 0.5 and 7 % and a wide range of Klinkenberg permeabilities between about 0.001 to 2 mD. Data further show that the reduction of porosity and permeability by overburden is a relevant effect even at low confining stress/overburden. The largest reduction applies to rocks with high fracture density and high fracture porosity. Rocks in which porosity is carried by other types of pores (e.g., cataclasite) suffer much less porosity/permeability reduction. Porosity-permeability (Phi-K) correlations show no apparent influence of increasing confining stress.