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Characterization of a binary karst aquifer using process time scales

Steffen Birk and Thomas Wagner
Institute for Earth Sciences, University of Graz, Graz, Austria (steffen.birk@uni-graz.at)

Within "a theoretical framework for the interpretation of karst spring signals" (Covington, EGU2012-853-1) process length scales that characterize the travel distances required for damping pulses of physicochemical parameters of spring waters such as electrical conductivity and temperature were derived (Covington et al., J. Geophys. Res., 2012). These length scales can be converted to corresponding process time scales characterizing the travel times needed for damping the pulses. This is particularly convenient if the travel distance is unknown. In this case the time lag between the increase of spring discharge and subsequent physicochemical responses at the spring may provide an estimate of the travel time. In binary karst aquifers with localized recharge from a sinking stream, the recharge pulse can be directly observed and thus travel times are readily obtained from the time delay of the physicochemical spring responses. If the spring response is strongly damped travel times can be inferred from artificial tracer testing. In this work, time scales for carbonate dissolution and heat transport were used for characterizing the binary Lurbach-Tanneben karst aquifer (Austria). This aquifer receives allogenic recharge from the sinking stream Lurbach and is drained by two springs, namely the Hammerbach and the Schmelzbach. The two springs show different thermal responses to two recharge events in December 2008: Whereas the temperature of the Schmelzbach responds within one day after the flood pulse in the Lurbach, the temperature signal is strongly damped at the Hammerbach. The evaluation based on the thermal time scale thus suggests that the Schmelzbach spring is fed by conduits with hydraulic diameters at least in the order of decimetres. In contrast, the damping of the thermal responses at the Hammerbach may be due to lower hydraulic diameters and/or longer residence times. Interestingly, the Hammerbach did show thermal responses in the time before a flood event in August 2005. This suggests that this flood event may have caused a change of the properties of the Hammerbach aquifer such that temperature pulses are more strongly damped than before. As opposed to the thermal responses the electrical conductivity appears to be less affected by this change, which suggests that the hydraulic diameters are still sufficiently large to permit the propagation of chemical signals.