Geophysical Research Abstracts
Vol. 12, EGU2010-15127, 2010
EGU General Assembly 2010

Spatial characterization of hydraulic conductivity of perialpine alluvial gravel-and-sand aquifers

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For many hydrogeological and modeling problems on a scale of the order of 10-100 m, an assessment of the spatial distribution of hydraulic conductivity is of great importance. This is one of the tasks of the RECORD project (Restored Corridor Dynamics) of CCES (Competence Center Environment and Sustainability of the ETH Domain). This project aims to understand, how river restoration measures affect river - river corridor - groundwater systems in hydrologic and ecologic terms. The river Thur and the alluvial gravel-and-sand aquifer of the perialpine Thur valley flood plain were chosen for field investigations. In this aquifer, the distribution of hydraulic conductivity at the required scale has not yet been investigated. Thus, the aim of this work is to assess the spatial distribution of hydraulic conductivity of the aquifer on a scale of the order of 10-100 m. To accomplish this, four methods were applied on different scales. Comparing the results of the different methods should lead to an optimization of future hydraulic investigations in alpine and perialpine alluvial gravel-and-sand aquifers. The different methods were applied at a test site in the central part of the valley (Widen, Felben-Wellhausen/TG), which was instrumented with a total of 18 piezometers, covering an approximately 10×20 m area (aquifer thickness, 7 m). The gravel samples of the pre-liminary core drillings were sieved and out of the grain size distributions hydraulic conductivity was calculated (decimeter scale). Further, work included the conduction and analysis of a pumping test (decameter scale), flowmeter logs and multilevel slug tests (meter scale) with appropriate methods. A statistical evaluation of the values of hydraulic conductivity from the above methods showed that the results are quite diverse. Thus, the choice of the method to assess the distribution of hydraulic conductivity has to be done according to the problem and the required level of detail.
The following recommendations are provided for future investigations. Sieve analyses should only be used to calculate hydraulic conductivity if a rough estimate with an accuracy of a factor of about 3 is acceptable. Results of pumping tests tend to correspond to the upper limit of the natural spectrum of hydraulic conductivity and are adequate for large-scale investigations. Flowmeter measurements result in vertical profiles of values of hydraulic conductivity relative to the mean hydraulic conductivity. As the calibration to absolute values can introduce more error, flowmeter logs are recommended, if the relative vertical distribution of hydraulic conductivity is of primary importance. Multilevel slug tests applied in this study resulted in the best absolute and relative representation of the distribution of hydraulic conductivity. Therefore, this method should be used if detailed information about the spatial distribution of hydraulic conductivity on a scale of the order of 10-100 m is needed. To decrease the workload required (e.g. for slug tests) and to increase the level of detail in hydraulic conductivity assessments, a combination of hydraulic testing with high-resolution geophysics and the use of tracers is recommended.