Abstract

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Preferential flow paths in a karstified spring catchment: A study of fault zones as conduits to rapid groundwater flow

In this study we model saturated and unsaturated flow in the karstified Weendespring catchment, located within the Leinetal graben in Goettingen, Germany. We employ the finite element COMSOL Multiphysics modeling software to model variably saturated flow using the Richards equation with a van Genuchten type parameterization. As part of the graben structure, the Weende spring catchment is intersected by seven fault zones along the main flow path of the 7400 m cross section of the catchment. As the Weende spring is part of the drinking water supply in Goettingen, it is particularly important to understand the vulnerability of the catchment and effect of fault zones on rapid transport of contaminants. Nitrate signals have been monitored at the spring only a few days after the application of fertilizers within the catchment at a distance of approximately 2km. As the underlying layers are known to be highly impermeable, fault zones within the area are likely to create rapid flow paths to the water table and the spring. The model conceptualizes the catchment as containing three hydrogeological limestone units with varying degrees of karstification: the lower Muschelkalk limestone as a highly conductive layer, the middle Muschelkalk as an aquitard, and the upper Muschelkalk as another conductive layer. The fault zones are parameterized based on a combination of field data from quarries, remote sensing and literary data. The fault zone is modeled considering the fracture core as well as the surrounding damage zone with separate, specific hydraulic properties. The 2D conceptual model was implemented in COMSOL to study unsaturated flow at the catchment scale using van Genuchten parameters. The study demonstrates the importance of fault zones for preferential flow within the catchment and its effect on the spatial distribution of vulnerability