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A 3D geological model of a karstic aquifer and its relevance for groundwater flow

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Groundwater flow modeling in fissured and karstic aquifers is typically approached using deterministic methods for aquifer parameterization, especially in regional scale studies. Geological discontinuities such as stratigraphic horizons and faults play a key role in controlling groundwater flow within fissured and karstic aquifers. Commonly used graphical user interfaces for groundwater simulation offer only limited possibilities for mapping geological settings with more complex tectonic structures. This is because (1) geological and geophysical data from different sources cannot be adequately imported and compared, (2) 3D structures such as faults and faulted stratigraphic horizons are very difficult to model accurately, (3) the consistency of a geological model of faulted horizons cannot be thoroughly reviewed, and (4) automated discretization of hydrologeological properties in such a setting is often not manageable by the graphical user interface. In this study we present a new approach of integrating geological data into a hydrogeological model. Firstly, in order to integrate as much of the existing geologic information as possible, we constructed a 3D geological model of the area, which is based on the existing geological information (borehole descriptions, geological maps, geological cross-sections) that is consistent with the regional geological setting. The geological 3D model was constructed using a software package capable of modeling complex geological objects. The model includes 47 faults and four faulted horizons in order to derive structural maps of the main aquifers-aquitards boundaries. Secondly, we integrated the faulted horizons of the 3D geological model into the groundwater modeling software package and simulated the groundwater flow within the main relevant aquifers using a finite difference approach. The results of this research forms the basis for model developments including subsurface salt dissolution and groundwater solute transport in the area, and may ultimately help to provide predictions on widespread land subsidence risks.