Extended hydrologic impacts of karst discharge zone confinement - a modeling study

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Abstract

Karst springs are the natural outflow of karst water to the surface. These springs occur where the water table can reach the surface unimpeded. This study examines the effect of alluvial deposits with varying thickness and permeability, covering the main outlet (karst spring) of a karst network on karst drainage (e.g., development of the karst water, drainage patterns, conduit-matrix interaction) as a result of a positive base level shift. This was realized with a numerical conceptual model (FEFLOW) of a hypothetical karst aquifer with 6 model configurations (inactive vs. active conduit flow, free vs. confined spring conditions with 20 m and 50 m sediment cover, respectively, with low and high hydraulic conductivity). Conduit flow and coupled conduit-matrix interactions were incorporated into the model with one-dimensional discrete feature elements. The results show that the permeability of the sediments has a more distinctive effect on conduit discharge than their thickness. The conduit network significantly contributes to the drainage even with a fully confined spring outlet. The conduit system acts as a water collector from the matrix in the recharge zone. The buried outlet increases the hydrostatic pressure farther along the conduit, and water is pushed upwards back into the matrix in the vicinity of the stratigraphic contact. Depending on the depositional setting, this results in the evolution of one to multiple new flow systems towards new potential spring sites. The results obtained here provide insight into the likely responses of natural karst systems.

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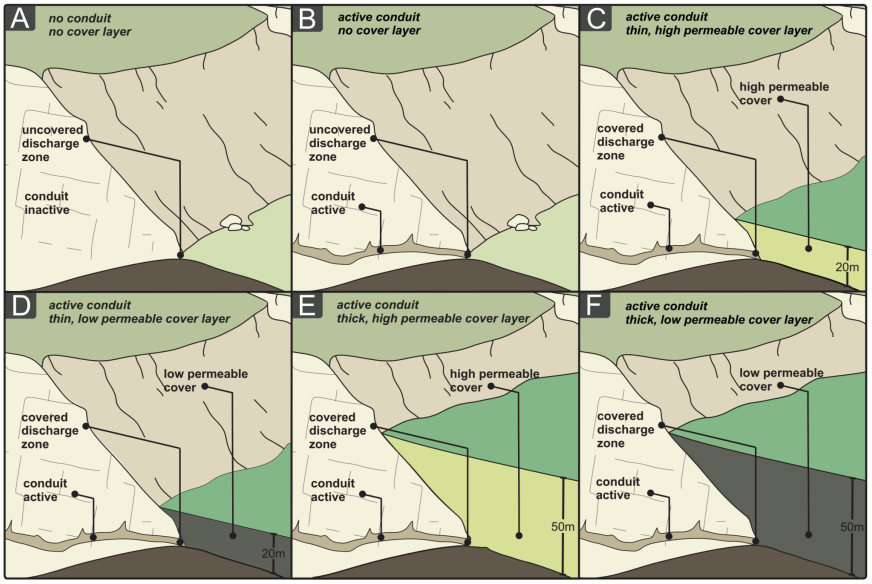

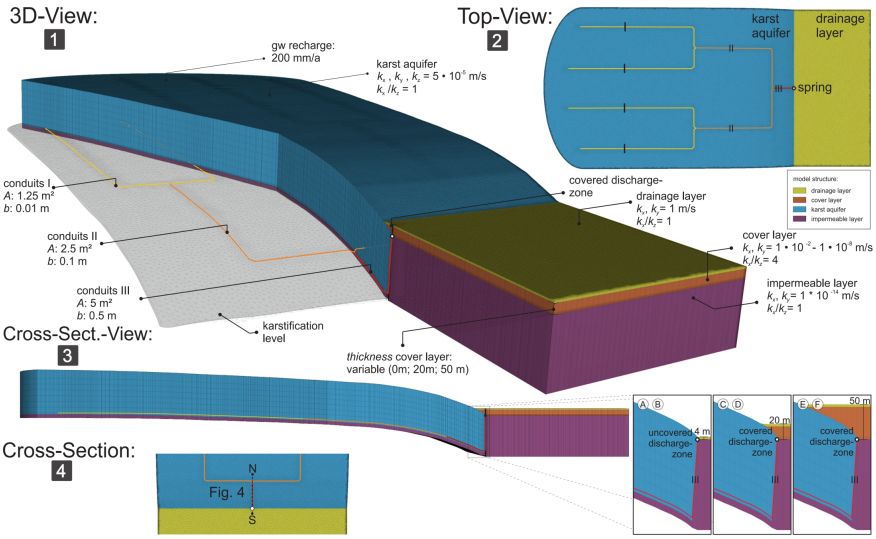

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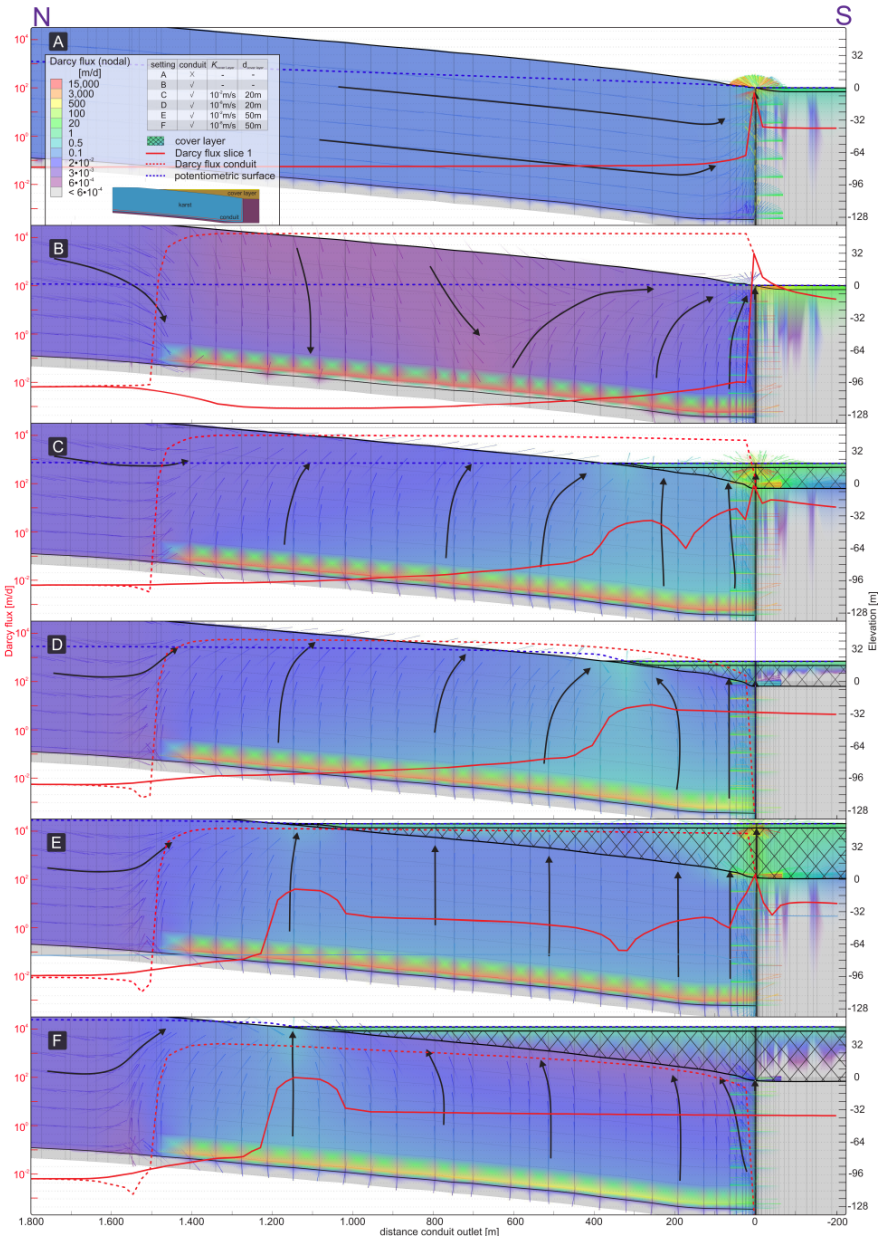

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