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Characterizing and modelling 'ghost-rock' weathered limestones

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'Ghost-rock' karst aquifer has recently been highlighted. In this particular type of aquifer, the karst is not expressed as open conduits but consists in zones where the limestone is weathered. The in-situ weathering of limestone leaves a soft porous material called 'alterite'.

The hydro-mechanical properties of this material differs significantly from those of the host rock: the weathering enhances the storage capacity and the conductivity of the rock. This type of weathered karst aquifer has never been studied from a hydrogeological point of view. In this study, we present the hydraulic characterization of such weathered zones. We also present a modelling approach derived from the common Equivalent Porous Medium (EPM) approach, but including the spatial distribution of hydrogeological properties through the weathered features, from the hard rock to the alterite, according to a weathering index. Unlike the Discrete Fracture Network (DFN) approaches, which enable to take into account a limited number of fractures, this new approach allows creating models including thousands of weathered features.

As the properties of the alterite have to be considered at a centimeter scale, it is necessary to upscale these properties to carry out simulations over large areas. Therefore, an upscaling method was developed, taking into account the anisotropy of the weathered features. Synthetic models are built, upscaled and different hydrogeological simulations are run to validate the method. This methodology is finally tested on a real case study: the modelling of the dewatering drainage flow of an exploited quarry in a weathered karst aquifer in Belgium.