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Limited karstification in soluble rocks interspersed with non-soluble rocks

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Aquifers located in terrains with soluble rocks exhibit very inhomogeneous distribution of their hydraulic conductivities. During the early stages of evolution, the bedrock (limestone, gypsum) is characterized by domains with relatively low porosity and hydraulic conductivity. These domains are separated by a system of fine fractures and fissures. Water is aggressive to limestone and gypsum rocks and is able to dissolve a certain amount of material along its way. The fine fracture system is the main pathway for the percolating water. By this way the aperture widths of the fissures are effectively widened allowing more aggressive water to penetrate deeper into the aquifer and to increase the dissolution rates there.

We present an attempt to address some of the complications that arise when modelling real aquifers. As a material example, we chose Gipskeuper from an aquifer along the Birs River in Switzerland as bedrock. This rock consists of soluble gypsum layers and insoluble clay and marls layers, with a typical layer thickness in the range of millimetres to centimetres. Depending on the location of a fracture, dissolution occurs or not, and the width of the soluble material determines the maximum amount of material, which can be removed. Aquifers with limited amount of soluble material (layers with a finite thickness between insoluble horizons), develop faster, and the karstified area of the domain is wider.

The presence of insoluble fractures (layers of insoluble material in the bedrock) leads to a significant increase of the time necessary for karstification, and also to a wider spreading of the karstified zone.