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# A fractal model to describe the evolution of multiphase hydraulic properties during mineral dissolution

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In this study we present a physically-based theoretical model for describing the temporal evolution of porosity, saturated and relative permeability, water content relation and diffusion coefficient during rock dissolution by reactive fluids. These processes play an important role in many vadose zone and multiphase flow processes, such as the geological storage of carbon dioxide, enhanced oil or gas recovery, flow and transport in unsaturated soil, geothermal systems, etc. The derivation of the model is based on the assumption that the porosity of the rock can be represented by a group of parallel capillary tubes with a fractal cumulative size distribution. Using this fractal description and known physical properties we obtain analytical expressions that depend only on the minimum and maximum pore radii, the size of the representative elemental volume and the fractal dimensions of porosity and tortuosity, but do not need any other fitting parameters. By assuming periodic fluctuations in the radius of the pores, it is possible to represent hysteresis in the water content relation and in the relative permeability function.
Finally, assuming a constant dissolution reaction it is possible to derive closed-form analytical expressions for porosity, water content relation, saturated and relative permeability and diffusion that depend explicitly on time.
The temporal evolution predicted by the proposed model is compared with laboratory data obtained on calcite and dolomite rocks.