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2D dual permeability modeling of flow and transport in a two-scale structured lignitic mine soil

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Two-dimensional single- and dual-permeability simulations are used to analyze water and solute fluxes in heterogeneous lignitic mine soil at a forest-reclaimed mine spoil heap. The soil heterogeneity on this experimental site "Bärenbrücker Höhe" resulted from inclined dumping structures and sediment mixtures that consist of sand with lignitic dust and embedded lignitic fragments. Observations on undisturbed field suction-cell lysimeters including tracer experiments revealed funneling-type preferential flow with lateral water and bromide movement along inclined sediment structures. The spatial distribution of soil structures and fragment distributions was acquired by a digital camera and identified by a supervised classification of the digital profile image. First, a classical single-domain modeling approach was used, with spatially variable scaling factors inferred from image analyses. In the next step, a two-continuum scenario was constructed to examine additional effects of nonequilibrium on the flow regime. The scaling factors used for the preferential flow domain are here obtained from the gradient of the grayscale images. So far, the single domain scenarios failed to predict the bromide leaching patterns although water effluent could be described. Dual-permeability model allows the incorporation of structural effects and can be used as a tool to further testing other approaches that account for structure effects. The numerical study suggests that additional experiments are required to obtain better understanding of the highly complex transport processes on this experimental site.