Supplementary Material

CRITICAL PERMEABILITY SIMULATIONS BASED ON MICRO PORE THROATS

Based on the applied Smoothed Particle Hydrodynamics (SPH) method in Balcewicz et al. (2021), it became clear that the numerical approach significantly overestimates the actual permeabilities. Cross-check calculations showed that the overestimation of permeabilities scales with lower porosities of the studied volume. At the time of this study, it is not clear why this error occurs. Nevertheless, three different pore sizes were compared to better estimate the error. Figure S1 shows in panel (A) a large pore (diameter corresponding to > 20 particles), (B) a medium pore (diameter about 12 particles) and in panel (C) a small pore (diameter corresponding to about 2 to 3 particles). In order to determine the permeability in a representative way, a parabolic arrangement of particles per pore size is mandatory. This applies to both large and medium-sized pores. However, small pore spaces are no longer occupied by a representative number of particles during the simulation. This leads to correspondingly overestimated permeabilities. The arrangement of the particles does not show a symmetrical distribution, since the pore spaces are not perfectly parallel to the direction of the driving force (in this case: $\mathbf{b} = (0, g, 0)^T$).

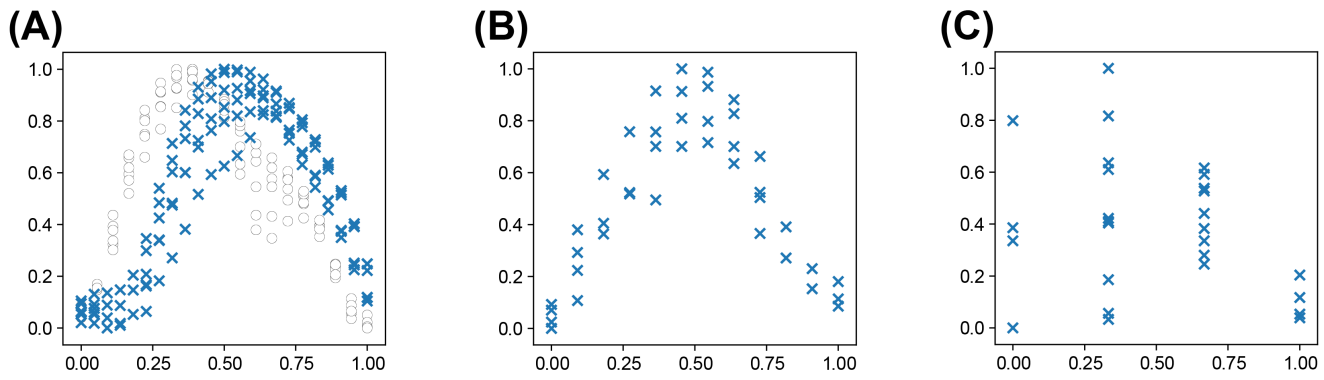

Figure S1. Visualization of particles in a (A) large pore, (B) medium pore, and a (C) small pore during applied SPH-method for Ruhr sandstone ($\phi_{\text{total}} = 8.51\,\%$ and $\phi_{\text{con}} = 6.59\,\%$). Circles and crosses indicate the relative particle's positions within the normalized pore sizes.