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Experimental investigation into effect of gas capillary trapping to hydraulic conductivity of coarse sands

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The relationship between gas residual saturation (Sgr) and corresponding hydraulic conductivity (K), was studied experimentally for two coarse sands. Air entrapping was achieved by drainage-imbibition cycles done on columns of packed sand. The value of K was determined using a constant head infiltration experiment and evaluated using Darcy's law from measured steady-state flux. The Sgr was determined gravimetrically after each infiltration run. One point of K(Sgr) relationship was determined from each infiltration experiment that followed the drainage-imbibition cycle. The sample was fully saturated at the beginning and drainage was done using a tension imposed at the bottom of the sample.
Four samples (two replicated sample for each sand) were used to obtain the K(Sgr) relationship. Additionally, air bubbles were visualized by micro-computed X-ray tomography (CT) for selected runs to obtain information on entrapped air cluster sizes, shapes and distribution. CT revealed that fractures occurred in the lower part of the sample as result of deformation of insufficiently rigid supporting textile mesh at the bottom of the sample. Therefore, an experimental setup with more rigid support, formed by thin carbon rods, was designed. The fractures then weren't detected with used of improved set-up. The spatial distribution of air bubbles within the sample, the histogram of air bubble sizes and residual air content were obtained from binarized CT images.
The resulting K(Sgr) relationship confirmed the trend of decreasing K with increasing Sgr. The highest amount of the entrapped air content and the largest air bubbles were detected in the upper half of sample. The results confirmed that the trend of the K(Sgr) relationship was a consequence of changes in entrapped air bubbles distribution.