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Centimeter-scale secondary information on hydraulic conductivity using a hand-held air permeameter on borehole cores.

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Saturated hydraulic conductivity (Ks) is one of the most important parameters determining groundwater flow and contaminant transport in both unsaturated and saturated porous media. Determining the small-scale variability of this parameter is key to evaluate implications on effective parameters at the larger scale. Moreover, for stochastic simulations of groundwater flow and contaminant transport, accurate models on the spatial variability of Ks are very much needed. While several well-established laboratory methods exist for determining Ks, investigating the small-scale variability remains a challenge. If several tens to hundreds of metres of borehole core has to be hydraulically characterised at the centimetre to decimetre scale, several hundreds to thousands of Ks measurements are required, which makes it very costly and time-consuming should traditional methods be used.
With reliable air permeameters becoming increasingly available from the late 80's, a fast and effective indirect method exists to determine Ks. Therefore, the use of hand-held air permeameter measurements for determining very accurate small-scale heterogeneity about Ks is very appealing. Very little is known, however, on its applicability for borehole cores that typically carry a small sediment volume. Therefore, the method was tested on several borehole cores of different size, originating from the Campine basin, Northern Belgium. The studied sediments are of Miocene to Pleistocene age, with a marine to continental origin, and consist of sand to clayey sand with distinct clay lenses, resulting in a Ks range of 7 orders of magnitude. During previous studies, two samples were taken from borehole cores each two meters for performing constant head lab permeameter tests. This data is now used as a reference for the air permeameter measurements that are performed with a resolution of 5 centimetres.
Preliminary results indicate a very good correlation between the previously gathered constant head Ks data and the air permeability measurements, but a systematic bias seems to exist. A geostatistical analysis with cross-validation is performed to assess the predictive uncertainty on Ks, using both types of data.
We conclude that performing hand-held air permeameter measurements on undisturbed borehole cores provides a very cost-effective way to obtain very detailed information in the framework of stochastic simulation and conditioning of heterogeneous hydraulic conductivity fields.