Multi-scale aquifer characterization and groundwater flow model parameterization using direct-push technologies

Rogiers B.[1,2] ; Vienken T.[3] ; Batelaan O.[2,4,5] ; Gedeon M.[1] ; Mallants D.[6] ; Huysmans M.[2,4] ; Dassargues A.[2,7]

[1]*Institute for Environment, Health and Safety, Belgian Nuclear Research Centre (SCK•CEN), Boeretang 200, BE-2400 Mol, Belgium.* brogiers@sckcen.be; mgedeon@sckcen.be

[2]*Dept. of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200e - bus 2410, BE-3001 Heverlee, Belgium.*

[3]*Monitoring & Exploration Technologies, UFZ- Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany.* thomas.vienken@ufz.de

[4]*Dept. of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan 2, BE-1050 Brussels, Belgium.* mhuysman@vub.ac.be

[5]*School of the Environment, Flinders University, GPO Box 2100, Adelaide SA 5001, Australia.* okke.batelaan@flinders.edu.au

[6]*Groundwater Hydrology Program, CSIRO Land and Water, Waite Road - Gate 4, Glen Osmond SA 5064, Australia.* dirk.mallants@csiro.au

[7]*Hydrogeology and Environmental Geology, Dept. of Architecture, Geology, Environment and Civil Engineering (ArGEnCo) and Aquapole, Université de Liège, B.52/3 Sart-Tilman, BE-4000 Liège, Belgium.* alain.dassargues@ulg.ac.be

Keywords: maximum 5 keywords (Times New Roman, 9pt)
Conference Topics: Direct push-Technology, Flow and transport in the saturated and unsaturated zone

---

Groundwater flow and contaminant transport models are used to support decision making related to environmental impact assessment for waste disposal sites or sites contaminated by point sources, or to develop cost-effective groundwater remediation. They are influenced by different kinds of uncertainty, including spatial variability in aquifer and aquitard properties like hydraulic conductivity (*K*). However, quantifying such spatial variability, possibly observed at different spatial scales is challenging. Classical drilling techniques for shallow heterogeneous unconsolidated sedimentary deposits are very expensive and time-consuming, especially when the area of interest exceeds several tens of km².

Recent developments of direct-push technologies allow for cost-effective characterization of such deposits, even down to depths of 40 m, depending on the used tools and sediment properties. Up to now, only limited number of studies document using this type of data to parameterize regional groundwater flow models. To fill this gap, this study aims at parameterizing a regional groundwater flow model using data from various types of direct-push technologies. Such research is very much needed to demonstrate the usefulness of applying direct-push methods leading to an increased adoption in environmental industry.

This paper discussed The characterization of an area of ~60 km², near the the nuclear zone of Mol/Dessel (Belgium), using various direct-push technologies is. Most of the measurements however are concentrated on an area of 200x400 m². The data enclose 265 cone penetration tests (CPTs; both CPTE and CPTU), 113 pore pressure dissipation tests (PPDTs), 17 direct-push injection logs (DPIL), 6 hydraulic profiling tool (HPT) logs and 19 direct-push slug tests (DPST). Resulting *K* values and estimates, and the corresponding spatial variability are compared with that of borehole and outcrop studies.

The benefit of using CPT data for the parameterization of an aquitard at the studied site, has been shown before using various CPT-based *K* estimates within the groundwater flow model. This approach is now extended with the aquifer units and new direct-push data, to the total

upper ~40 m of the represented hydrogeological domain. The resulting heterogeneous hydraulic conductivity field is discussed, as well as the effect on the performance of the groundwater flow model and the value of the different direct-push technologies.