

Innovative In-Situ Determination of Unsaturated Hydraulic Properties in Deep Loess Sediments in North-West Bulgaria

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Paper No. ICEM2007-7202, pp. 733-739; 7 pages

doi:10.1115/ICEM2007-7202

From: The 11th International Conference on Environmental Remediation and Radioactive Waste Management

11th International Conference on Environmental Remediation and Radioactive Waste Management, Parts A and B

Bruges, Belgium, September 2–6, 2007

Conference Sponsors: Nuclear Division and Environmental Engineering Division

ISBN: 978-0-7918-4339-0 | eISBN: 0-7918-3818-8

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ABSTRACT

abstract

In the framework of selecting a suitable site for final disposal of low- and intermediate level short-lived radioactive waste (LILW-SL) in Bulgaria, site characterization is ongoing at the Marichin Valog site, North-West Bulgaria. The site is characterized by a complex sequence of loess, clayey gravel, and clay layers, of which the first 30–40 m are unsaturated. Proper knowledge about unsaturated water flow and concomitant radionuclide transport is key input to safety assessment calculations. Constant-head infiltrometer tests were carried out at several meters below ground surface to determine the unsaturated hydraulic properties of silty loess, clayey loess, and clayey gravel layers. Individual infiltrometers were equipped with 0.5-m-long filter sections; the shallowest filter was from 2 to 2.5 m depth, whereas the deepest was from 9.5 to 10 m depth. Infiltration tests provided data on cumulative infiltration and progression of the wetting front in the initially unsaturated sediments surrounding the infiltrometer. A cylindrical time-domain reflectometry TRIME probe was used to measure water content variations with time during progression of the wetting front. Access tubes for the TRIME probe were installed at 0.3 to 0.5 m from the infiltrometer tubes. By means of an inverse optimization routine implemented in the finite element code HYDRUS-2D, field-scale soil hydraulic parameters were derived for all layers. Results show a great consistency in the optimized parameter values, although the test sites were several meters apart. Apparently the size of the affected volume of soil was large enough to reduce the effect of spatial variability and to produce average field-scale hydraulic parameters that are relevant for large-scale predictions of flow patterns and radionuclide migration pathways.

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