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A 3D Integrated Model of Porous Media and Fractured Rock for Interpretation of Subsurface DNAPLs Migration

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Dense non-aqueous phase liquids (DNAPLs) are common organic contaminants for soil and groundwater systems, originated from industrial waste. Once disposed of incautiously, the DNAPLs migrate into the deep subsurface through different geological media. Therefore, the prediction of DNAPL migration requires specialized methods depending on the media. In this study, an integrated model that considers the different geological media including unconsolidated soil (US), weathered rock (WR), and fractured rock (FR) was developed from a detailed field investigation at a testbed in the Republic of Korea. At the testbed, various techniques of pumping tests, groundwater monitoring, and geophysical loggings and seismic surveys were implemented to represent the distinguishing feature of each geological media in the model. For example, the results of the neutron porosity logging and core loggings were utilized for the realization of a 3D heterogeneous porosity field; the fracture properties such as orientation and aperture size were utilized to generate discrete fracture network (DFN) planes; Hydraulic connectivities of major permeable fractures detected by a series of image loggings and pumping tests were fully reflected into the model. After the process of building the integrated site characterization (ISC) model, hypothetic DNAPL transport was simulated for 100 years. The DNAPL transport and fate during the simulation time were quantitatively evaluated with the 1st and 2nd spatial moments, an indicator that assesses the spatial distribution of DNAPL mass. Additional to the base case, the evaluation for tens of cases varying the parameter in association with WR and FR conditions was conducted to perform a sensitivity analysis. As a result, the permeability anisotropy and structural differences in WR, where the greatest part of DNAPLs resided, were the most influencing factors on DNAPLs migration. They governed the location of the main fracture entrance that most DNAPLs entered, then, dramatically changes the vertical and horizontal distribution of DNAPLs in FR. In the future, the importance of each factor will be quantified and ranked by adopting a global sensitivity analysis.

Participation

In-Person

References

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Primary author: Mr KIM, Taehoon (Yonsei University)

Co-authors: Prof. HAN, Weon Shik (Yonsei University); Dr YOON, Seonkyoo (University of Minnesota); Prof. KANG, Peter (University of Minnesota); Dr SHIN, Jehyun (Korea Institute of Geoscience and Mineral Resources); YUN, Tae Kwon (Yonsei University)

Presenter: Mr KIM, Taehoon (Yonsei University)

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