Contribution ID: **17** Type: **not specified**

Magnetic resonance and neutron imaging of infiltration into heterogeneous soil

Monday, April 16, 2012 3:21 PM (3 minutes)

The subject of the contribution is to show the possibilities of combining the three-dimensional magnetic resonance imaging (MRI) and neutron imaging (NI) to investigate the complex water flow dynamics in natural soil. The infiltration outflow experiment was conducted on undisturbed soil samples with concurrent imaging by i) MRI and ii) NI. Despite the experiment was conducted on two different samples, the experimental concept, type of soil and observed behaviour was the same. Additionally, both NI and MRI were used to image selected soil samples at various static water saturations.

MRI of porous system and of soils in particular, is specific due to many issues related to the complex internal structure, varying pore sizes, interface interaction, etc. In small pores, due to very fast relaxation of hydrogen spins on solid-liquid interfaces, the MRI signal is difficult or impossible to detect with use of current MR scanners. On the other hand, the relaxation properties can be used to increase the image contrast between water contained in different pore size classes or distinguish between the water and tracer. The acquisition time increases with the image resolution, therefore, depending on the process dynamics the image resolution can be sometimes sacrificed in favour of capturing fast processes.

During repeated ponded infiltration (RPI) experiment on undisturbed soil sample of coarse sandy loam (dia. 5.5 cm, height 11.2 cm) the process of infiltration and nickel nitrate transport was investigated combining MR imaging and MR relaxometry measurements. The RPI experiment consisted of two consecutive infiltration runs separated by drainage phase and differed in initial water content. Fast processes were imaged by a fast, low resolution MR sequence. The wetting, steady state flow and drainage phases as well as the nickel tracer breakthrough of each experimental run were monitored by multi-echo multi-slice magnetic resonance sequence. Mapping of relaxation parameters, which is substantially time consuming, was performed during steady state conditions. The RPI experiment reveals complicated water regime and flow instability characterized by a decrease of the steady state flow rates between the first infiltration run conducted into drier soil and the second infiltration run into wet soil. It was hypothesized that the discrete air phase entrapped in large pores causes substantial decrease of inflow/outflow flux density in the case of the second infiltration run. The spatial distribution and the volume of the entrapped air were extracted from MR image. The tracer breakthrough patterns showed significantly different flow trajectories during first and second infiltration run. In highly heterogeneous soil under study the pathways which conducted the dominant portion of the water/solute during the first infiltration run were the ones strongly affected by trapped air bubbles during the second run.

Undisturbed samples (dia. 36 mm, height 100 mm) of the same soil type were investigated by NI likewise. Particular phases of ponded infiltration were imaged by neutron radiography (fast processes) to image fast processes in 2D and by neutron tomography to monitor slow processes in 3D. Identically to MRI the NI was able to detect the increase of the trapped air volume between first and second infiltration run and to identify the distribution of individual bubbles; however these air structures could be identified only in the voids larger than the voxels size. The study shows strengths of each of imaging methods and the potential of combining these two non-invasive methods for investigation of water phenomena in natural porous media.

Primary author: Ms JELINKOVA, Vladimira (Faculty of Civil Engineering, Czech Technical Univ. in Prague, Czech Republic)

Co-authors: Dr POHLMEIER, Andreas (Forschungszentrum Jülich GmbH, IBG-3, Agrosphere, Jülich, Germany); Ms SOBOTKOVA, Martina (Faculty of Civil Engineering, Czech Technical Univ. in Prague, Czech Republic); Dr SNEHOTA, Michal (Faculty of Civil Engineering, Czech Technical Univ. in Prague, Czech Republic); Prof. CISLEROVA, Milena (Faculty of Civil Engineering, Czech Technical Univ. in Prague, Czech Republic)

Presenter: Ms JELINKOVA, Vladimira (Faculty of Civil Engineering, Czech Technical Univ. in Prague, Czech Republic)

Session Classification: Short presentations (Poster session)