

Laboratory approach for the 3D visualization of the generation of an in-situ reactive zone for aquifer remediation

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The application of zero-valent iron nanoparticles for groundwater remediation is currently hindered by their lack of stability that determines low mobility in the porous medium and very poor migration performances. The evaluation of the particles transport and deposition in large-scale 3D experiments is usually achieved by means of indirect measurements, for example by electric tomography or magnetic susceptibility. In the present work an approach based on layer excavation is tested for a medium scale 3D setup, using digital imaging to perform a volume reconstruction. The test was performed in a 3D tank of size 65x45x45 cm (LxHxW) filled with a quartz sand. The nanoparticle suspension was injected from a well with a 20cm screening, with a designed on ModFlow to obtain a 32 L deposition volume. At the end of the experiment the sand was excavated in layers of 3cm each and for each layer a photo was taken from above. Once the images were aligned and rescaled, the ImageJ software was used to interpolate between the different layers and obtain a volume reconstruction, which provides information on the spatial distribution of the nanoparticles. The deposited particles are very well localized in the tank and extends vertically by abt. 23cm which is in good accord with the well screening. From the analysis performed at the end of the injection protocol it was also possible to measure that the deposition of the particle occurred in a 39 L volume, validating the injection design. It is also possible to notice that the method allow to visualize the transformation of the particles, in terms of their color (for iron black indicates zerovalent iron and red its oxidized forms). In conclusion, with a limited experimental effort, the method presented allow for a direct investigation of the particle deposition in the porous medium, to gather information on their chemical transformation and also allow for an evidenced based sampling for further analysis (e.g., ICP, XRD, etc.).