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Carbon supported Nano-Iron for environmental remediation: Transport observations using column tests, magnet resonance imaging and synchrotron tomography.

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The use of nano-zerovalent iron (nZVI) for environmental remediation is a promising new technique for in situ remediation of contaminated groundwater. Due to its high surface area and high reactivity, nZVI is able to dechlorinate organic contaminants and render them harmless. Limited mobility, however, due to fast aggregation and sedimentation of nZVI, restricts the practical applicability for source and plume remediation. Carbo-Iron is a newly developed composite material consisting of activated carbon particles (d50 about 500 nm) that act as carrier for nZVI particles. Together with a polyanionic stabilizer (CMC) Carbo-Iron is able to form a stable injectable suspension. These particles are designed to combine the mobility of activated carbon and the reactivity of nZVI.

Various methods were used to observe and describe transport properties, with a focus on column tests and tomographic methods: Column tests were performed in chromatography columns of 40 and 60 cm length, filled with sand grains or glass beads. Results indicate high mobility and breakthrough after addition of CMC, but changing transport properties at different pH and ionic strength.

Magnet Resonance Imaging (MRI) and Synchrotron Imaging are technologies of growing interest in observing flow and transport in porous media. Even though both methods are based on different physical principles, both are sensible to iron loads in colloids and allow two- and three-dimensional reconstruction and visualization. Therefore both methods may principally be suitable for observing Carbo-Iron in porous media and might give information complementary to other experimental investigations. A suitable MRI method was developed using a medical MRI. The method based on T1 weighted measurement with short repetition time (TR = 7.0 ms) and echo time (TE = 2.95 ms) can detect different particle concentrations in a porous medium. The synchrotron tomography method used an energy rich (13 keV) parallel X-ray beam to collect (micro-) tomographic images, which were reconstructed to yield three dimensional images afterwards. Both, individual sand grains vs. Pore space, and Carbo-Iron agglomerations can be visualized and are distinct from each other. Results indicate particle agglomeration occurring at pore throats. In comparison to column tests, these tomographic methods can add a spatially three-dimensional distribution of Carbo-Iron in the porous medium and a localization of agglomerates in the pore space network, both also for different times.