

Zerovalent iron micro and nanoparticles for groundwater remediation: from laboratory to field scale

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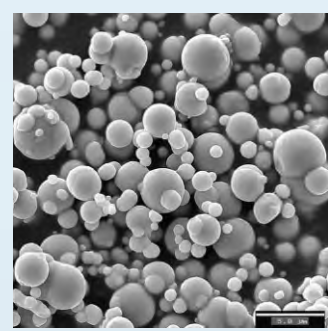
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Improving colloidal stability of MZVI and NZVI using biopolymers

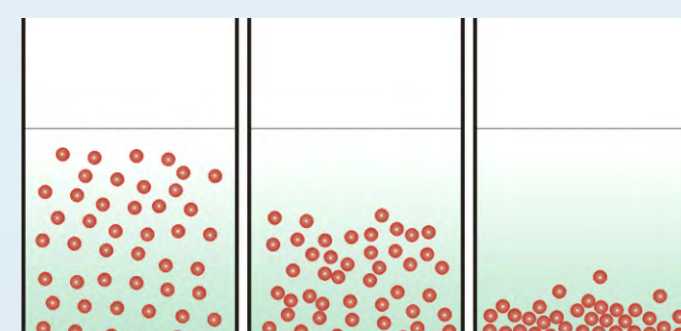
MZVI (microscale zero valent iron) and NZVI (nanoscale zero valent iron) are **not stable when dispersed in water**:

MZVI 1-5 μm

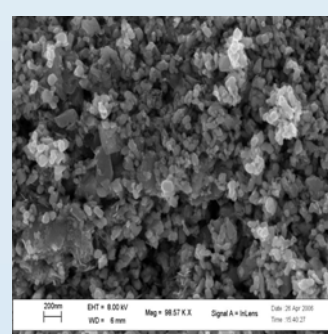


Relevant mass, high density

Gravitational sedimentation

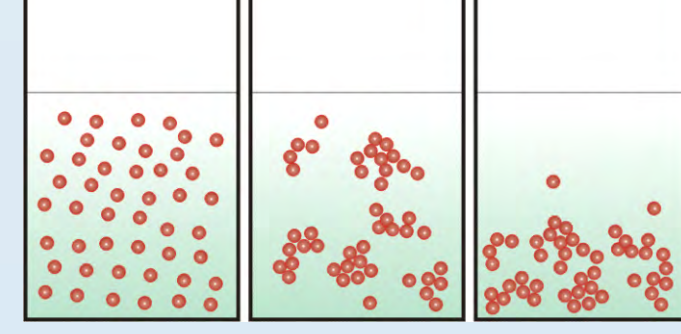


NZVI 5-100 nm

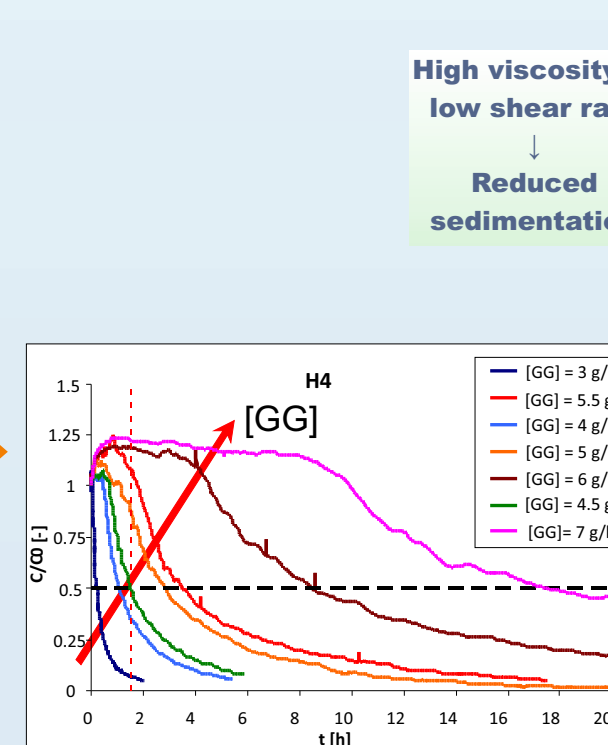


Particle-particle attraction (magnetic forces)

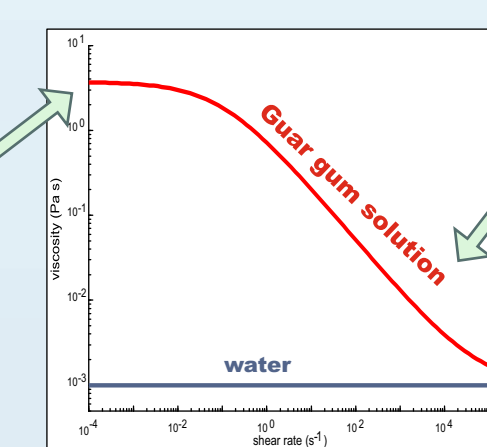
Aggregation and sedimentation



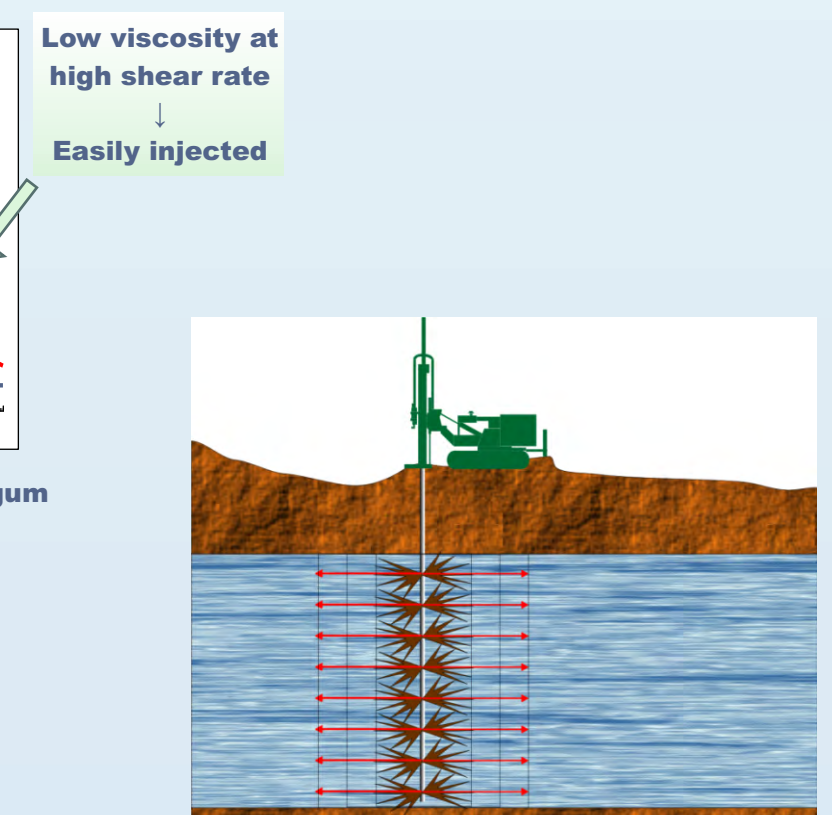
Green polymers (guar gum and xanthan gum) can improve stability via
Kinetic stabilization \rightarrow Increased fluid viscosity



Sedimentation curves of MZVI



Rheogram of water and guar gum



MZVI and NZVI injection in porous media

The mobility in porous media of MZVI and NZVI dispersed in guar gum and xanthan gum was tested in column transport tests (1-D) and a finite-differences model was developed for 1D and radial simulation of MZVI/guar gum injection:

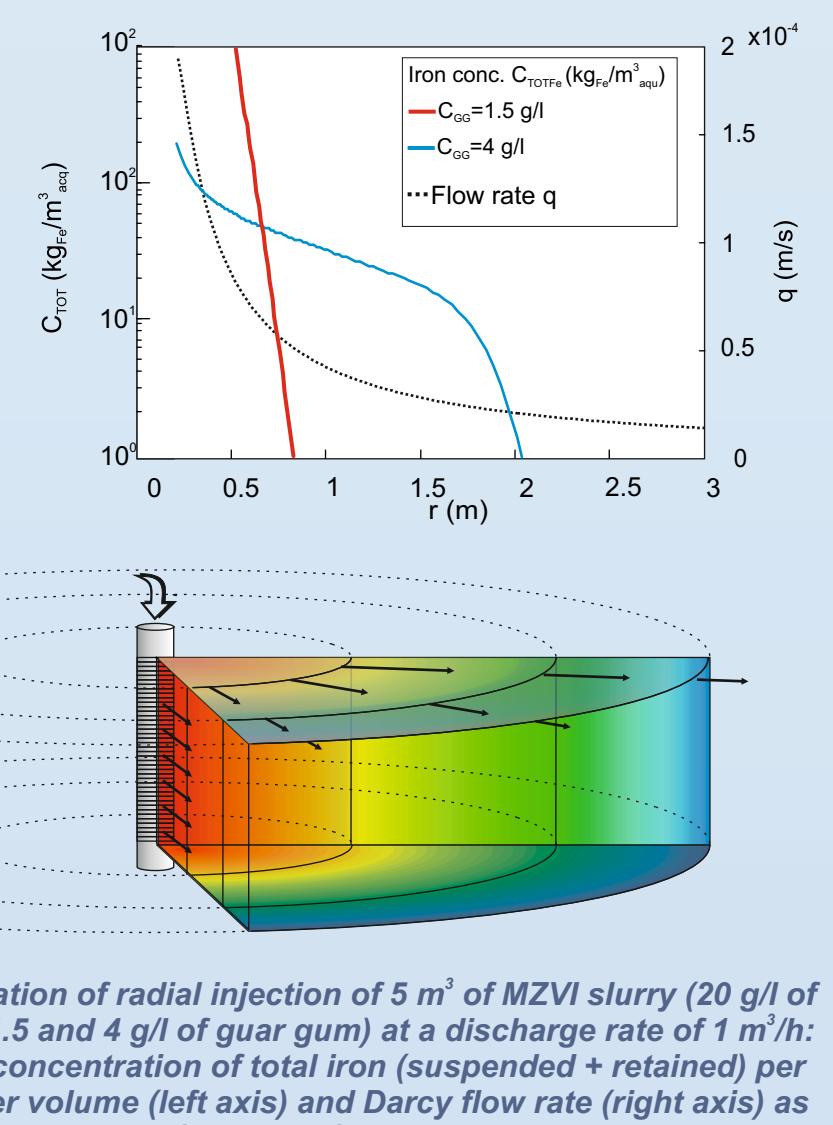
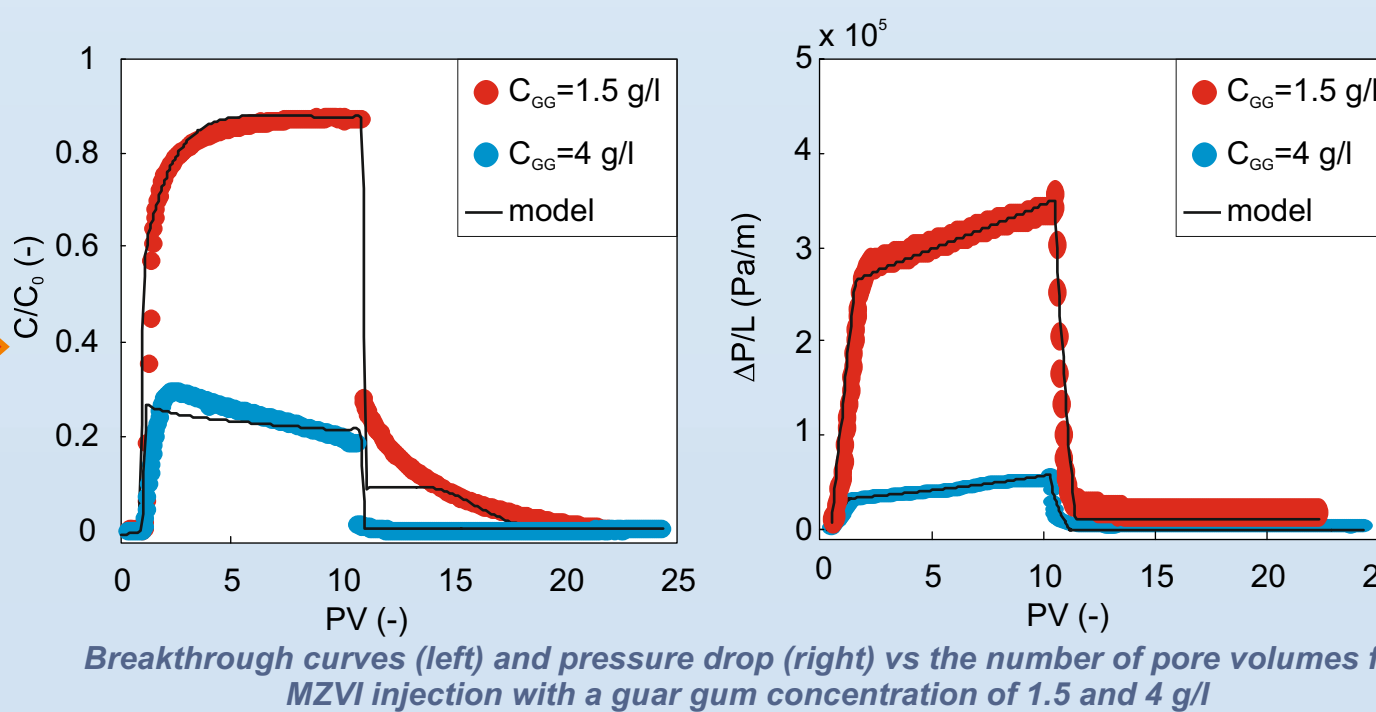
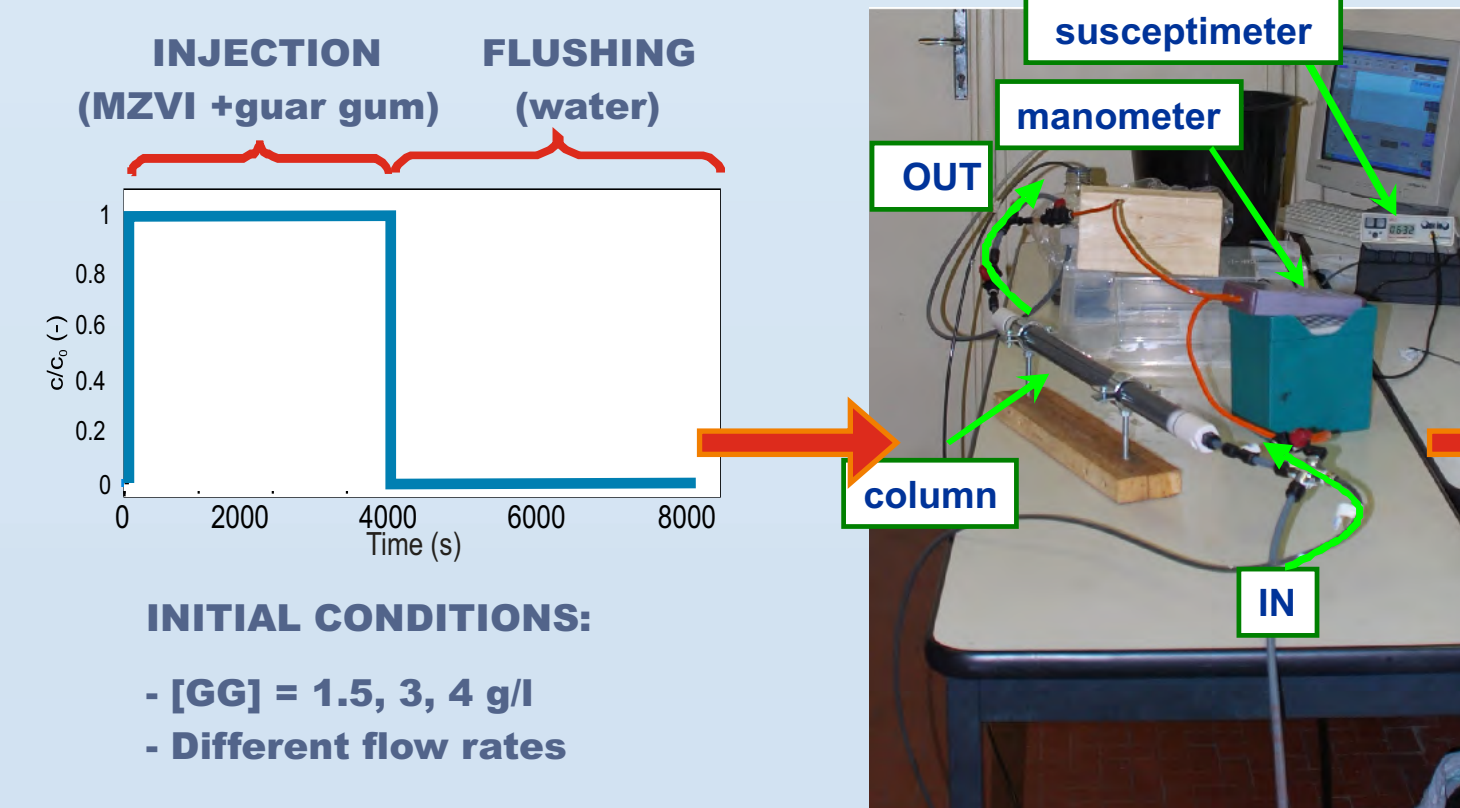
Column tests provide information on:

- porous medium clogging
- pressure build up during Injection
- interactions among iron particles and porous medium

Transport modelling

1D transport tests performed at different flow rates and polymer concentration were fitted using MNMs (www.polito.it/groundwater/software).

Results were used to develop a radial transport model.



Field applications

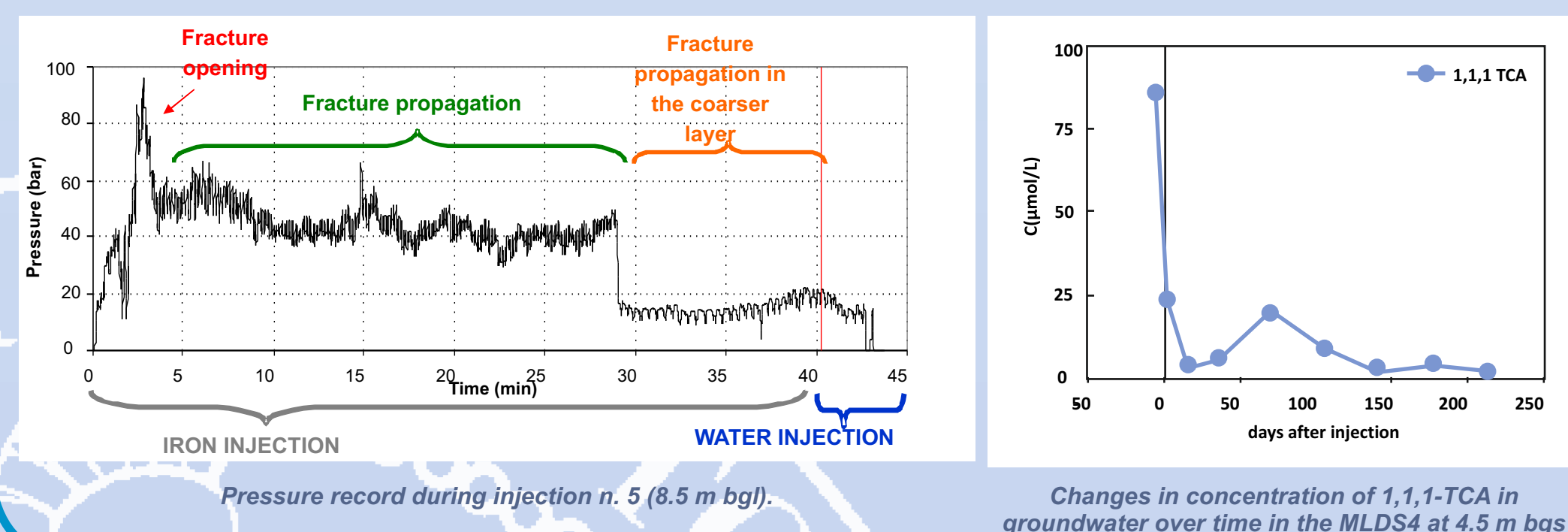
Pilot field injection via fracturing

Delivery: Direct push systems
(high pressure & discharge rates)

Site: Aarschot (Belgium)
Contamination: 1,1-DCA, 1,1,1-TCA, TCE, cis-1,2-DCE
MZVI: H2O (d50=56 μm , Hoganas)
Guar gum: 5 g/l
Slurry: 1.5 m³, iron conc. 66 g/l
Injection design: 5 injections:
10.5 - 8.5 m bgl, 0.5 m spacing
Q=0.55 m³/h



Field injection via direct push (cortesy of Carsico S.r.l., left) and scheme of stratigraphy and injection points (right)



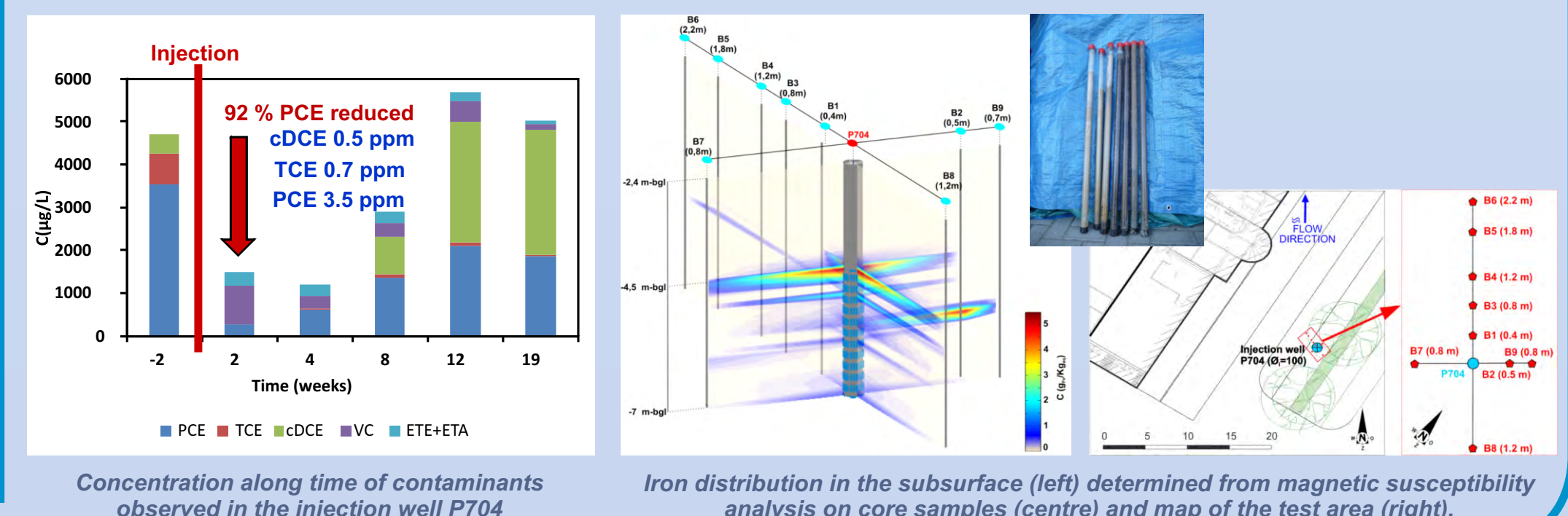
Pilot field injection via permeation

Delivery: low-pressure injection
through a well

Site: Site P (Belgium)
Contamination: PCE @ 8.1-72.6 mg/l
MZVI: HQ (d50=1.2 μm , BASF)
Guar gum: 2 g/l
Slurry: 5 m³, iron conc. 10 g/l
Injection design: pressurized well
Screen: 4.5-7 m bgl
Q=1.5 m³/h



IMZVI field injection at Site P: (1) tank for slurry preparation (2) dispersion and recirculation unit, (3) tank for slurry storage, (4) cation pump, (5) injection well, (A) discharge rate measurement, (B) magnetic susceptibility sensor, (C) pressure sensor.



Acknowledgements and References

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