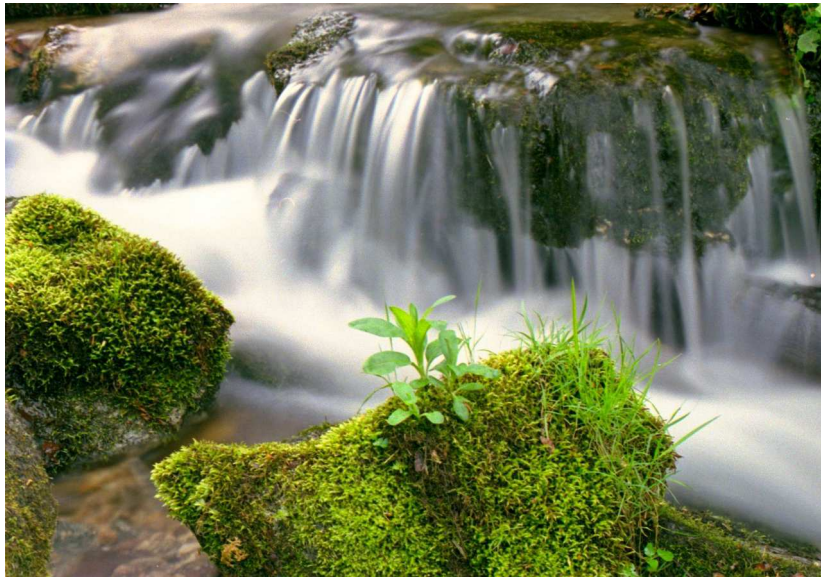
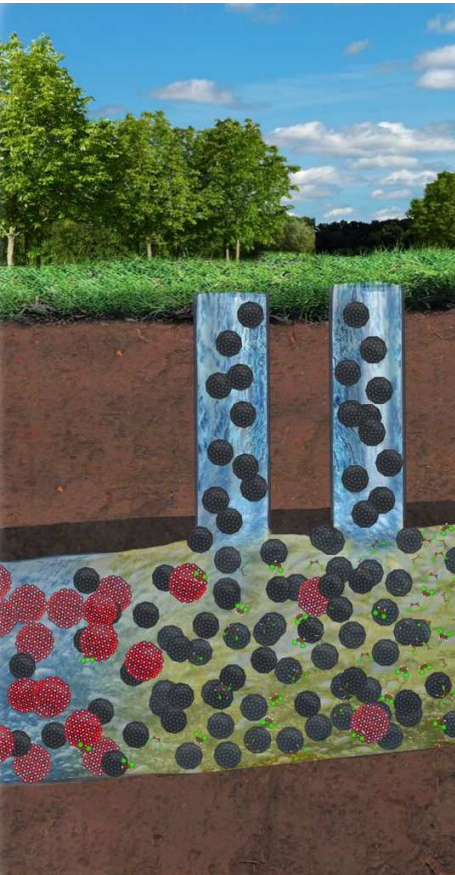
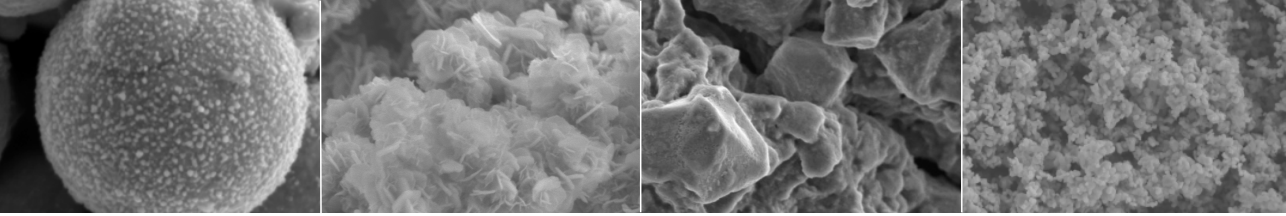


# ADVANCED WATER TREATMENT TECHNOLOGIES



**NANOMATERIALS**  
IN ENVIRONMENTAL APPLICATIONS



REGIONAL CENTRE  
OF ADVANCED TECHNOLOGIES  
AND MATERIALS



Palacký University  
Olomouc



# GROUNDWATER REMEDIATION

## REDUCTIVE TECHNOLOGIES BASED ON NANOSCALE ZERO-VALENT IRON

### HIGHLY EFFICIENT IN REMOVAL OF

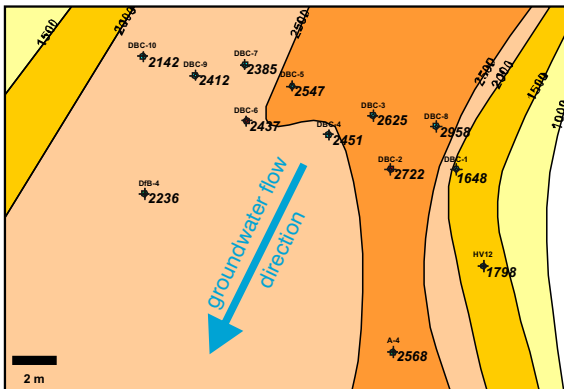
- > Inorganic compounds like Arsenic, Barium, Chromium, Selenium, Uranium, Copper, Lead, Cadmium, Mercury, Nickel (and many other heavy metals), sulphates, nitrates, perchlorates, etc.
- > Organic compounds like polychlorinated methanes, ethanes, ethenes, benzenes, etc.

### PROPERTIES OF $Fe^0$ NANOPARTICLES

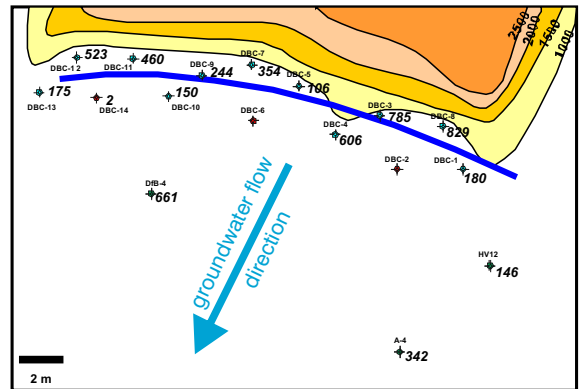
- > High redox potential (electron donor)
- > High surface area (20-25  $m^2/g$ )
- > Narrow particle size distribution (average of 50 nm) allowing the particles to migrate in groundwater conditions
- > Pyrophoric or air-stable character (powder or aqueous dispersion)
- > Magnetically separable
- > High-reactivity and long-term performance
- > Possibility to combine various properties in composite materials
- > Ideal for remediation of large areas or for construction of permeable reactive barriers
- > Environmentally friendly material
- > Low cost comparing to conventional technologies

## APPLICATION EXAMPLE

IN FIELD APPLICATION OF THE REDUCTIVE BARRIER AT MARS SVRATKA (CZECH REPUBLIC) IN 2012-2014)



CONCENTRATION OF CIE DAY 0



CONCENTRATION OF CIE DAY 180



# SURFACE AND DRINKING WATER TREATMENT

## OXIDATIVE TECHNOLOGIES BASED ON IRON IN HIGH VALENCE STATE (FERRATES IV,V,VI)



### HIGHLY EFFICIENT IN REMOVAL OF

- > Inorganic compounds such as Arsenic, Uranium, Zinc, Copper, Nickel (and many other heavy metals), metal cyanides, phosphates, sulfates, etc.
- > Organic compounds such as hormones, pesticides, pharmaceutical compounds, etc.
- > Biological pollutants such as Cyanobacteria

### PROPERTIES OF FERRATE MATERIALS

- > High oxidative potential (electron acceptor) due to Fe in high valence state
- > Highly effective against wide spectrum of pollutants
- > Disinfecting effect against various microorganisms (Cryptosporidium, Coliforms, Salmonella, etc.)
- > Coagulation and flocculation capacity
- > Increasing pH value
- > High reactivity and low reagent consumption
- > Reaction products are benign iron oxides with high surface area which is advantageously useful for additional sorption
- > Environmentally friendly material
- > Low cost comparing to conventional technologies

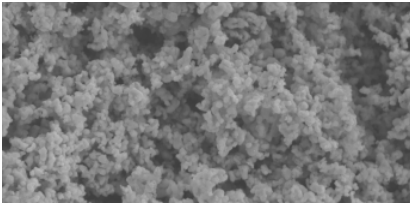


# AVAILABLE PRODUCTS



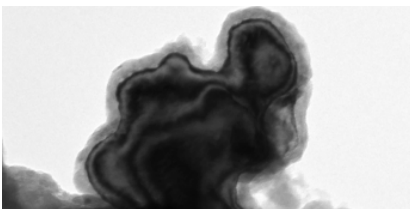
## NANOFER 25P

- > Fe<sup>0</sup> nanoparticles (powder) without surface modification
- > Highly reactive and pyrophoric Fe<sup>0</sup> nanoparticles



## NANOFER 25S

- > Aqueous dispersion of Fe<sup>0</sup> nanoparticles modified by biodegradable organic stabilizer
- > Highly reactive with large scale of pollutants
- > Excellent migration properties

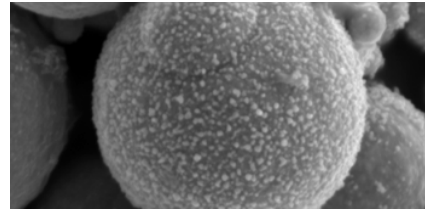


## NANOFER STAR

- > Surface-stabilized Fe<sup>0</sup> nanoparticles (powder)
- > Safe storage, transport, handling and applications compared to non-stabilized Fe<sup>0</sup> nanoparticles
- > When activated, the Fe<sup>0</sup> nanoparticles are highly reactive with reducible pollutants
- > Possibility to combine with biodegradable organic stabilizer for better migration performance

## Fe<sup>0</sup>-BASED COMPOSITES

- > Micro-Fe<sup>0</sup> & nano-Fe<sup>0</sup> composite material combining long-term reactivity of microparticles with rapid effect of nanoparticles
- > Nano-Fe<sup>0</sup> & carbon composite material combining reductive/magnetic properties of Fe<sup>0</sup> nanoparticles with sorption properties of carbon (active carbon, carbon black, nanotubes, biochar etc.)



## ENVIFER

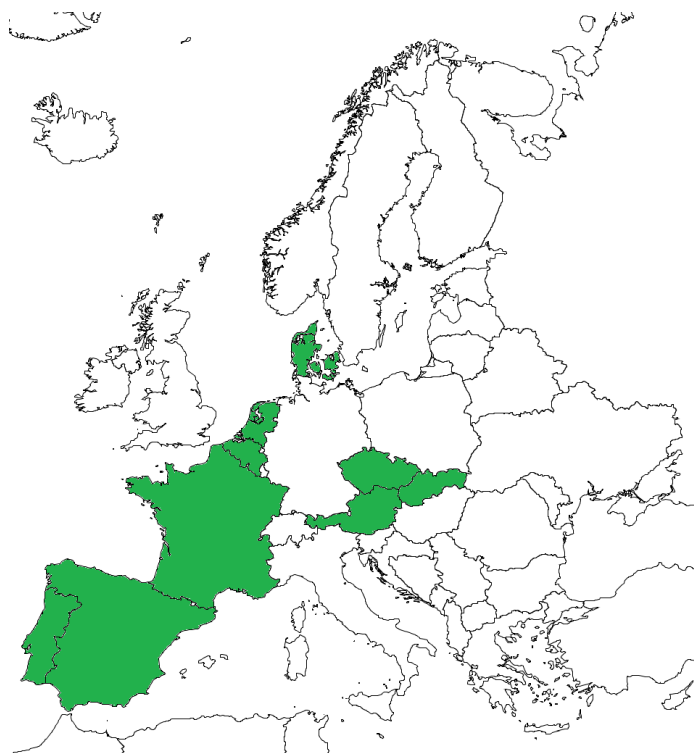
- > Product based on Ferrate (IV, V or VI, or their combination) with outstanding oxidation capacity
- > Oxidation/disinfection properties are accompanied with high sorption capacity of reaction products
- > Soluble material stable in solutions at high pH
- > Stable in solid form at dry conditions



## AND MUCH MORE...

- > We are able to offer custom modified Fe-based nanomaterials
- > Any additional information on request

# APPLICATION REFERENCES



1 site in Austria



4 sites in Benelux



15 sites in Czech Republic



3 sites in Denmark



2 sites in France



1 site in Portugal



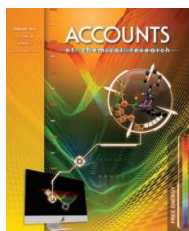
1 site in Slovakia



2 sites in Spain

and others, like USA, Canada, South Korea,...

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