

## Potential products of fluid-rock interactions in the Soultz-sous-Forêts Enhanced Geothermal System

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A geochemical modelling approach of fluid-rock interactions has been applied to the potential water-rock interaction processes in the Enhanced Geothermal System (EGS) of Soultz-sous-Forêts (France) [1,2,3] which started in 2008. The aim of the study was to detect the possible risks of minerals precipitation in the circulation loop in the temperature range between 200°C at depth (5km) and 60°C in the surface power system before re-injection, in conditions reproducing those of the industrial exploitation of the site.

The major result of the simulations highlights the role of carbonates as possible products of the thermal fluids particularly in the low temperature part of the thermal loop and on short term. In the reservoir rock-forming silicates may be partially dissolved by the reinjection of fluids leading to the long term formation of clay minerals in the porosity of the rock. The modelling approach has been combined with an experimental approach of water-rock interaction under a strong thermal gradient which confirms the dynamics of silicates in these temperature conditions and with this type of saline fluid (TDS about 100g/l).

The formation of clay minerals (illites and / or chlorites) may modify the porosity and the permeability of the granitic reservoir during future exploitation.

[1] A. Baldeyrou-Bailly, F. Surma and B. Fritz (2004), *Geol. Soc. Special publ.* **236**, 355-367. [2] B. Fritz, E. Jacquot, B. Jacquemont, A. Baldeyrou-Bailly, M. Rosener, O. Vidal (2010) *CR Geoscience*, **342**, 653-667. [3] B. Fritz and A. Gérard (2010) *CR Geoscience*, **342**, 493-501,

## Composition, structure and shape of *in situ* precipitated Fe-oxide nanoparticles from a soil effluent

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Iron oxides are generally highly reactive. In nanoparticulate form, the reactivity of Fe oxides and their mobility in the aqueous phase is even increased. Thus, dispersed Fe-oxide nanoparticles are considered as key reactive components for biogeochemical processes that involve Fe. However, the majority of related investigations is based on synthetic Fe-oxide nanoparticles, the composition and properties of which may not reflect those of Fe-oxide nanoparticles actually occurring in nature.

In this study, soil columns were filled with material from a topsoil horizon. The soil columns were operated in duplicate under water-saturated conditions with a low ionic influent. The activity of soil microorganisms led to anoxic conditions and thus the reductive dissolution of pedogenic Fe oxides and the accumulation of Fe<sup>2+</sup> in the column effluent. The effluent was re-aerated after its discharge resulting in the oxidation of Fe<sup>2+</sup> and the precipitation of Fe oxides. The effluent was dialysed to separate the Fe oxides from non-particulate compounds.

X-ray diffraction and Mössbauer spectroscopy revealed the formation of short-range ordered ferrihydrite (Fh). Its crystallisation was probably disturbed by dissolved organic matter and inorganic species (e.g. As, Si) that associated with Fh. Fourier transform infrared spectroscopy pointed to mainly polysaccharides, aliphatics and carboxyls as available organic compounds to associate with the Fh particles. The aggregation intensity decreased in response to decreasing effluent ionic strengths. Dynamic light scattering revealed aggregate sizes from 50 nm to 500 nm, which was confirmed by atomic force microscopy and scanning electron microscopy. The latter approaches consistently revealed the coexistence of bulky and to a lesser extent linear-aligned nanoaggregates. Both aggregate types exhibited similar mechanical and physical properties and were composed of smaller particles (~ 10 nm).

This study demonstrated the reproducible stabilisation of nanoparticulate Fh also in complex solutions like effluents from soil. Such near-natural nanoparticles represent eligible specimen to investigate the fate and effect of nanoparticulate Fe oxides in the (soil) environment.