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## Iron minerals as catalytic activators for persulfate for PFAS degradation

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Increasing environmental awareness and still countless cases of polluted environmental compartments have led to a wide range of publications on chemical remediation methods in recent years. Many of them are devoted to advanced oxidation processes (AOPs) in water, with increasing attention for the remediation of persistent pollutants in surface-, ground- and waste waters with sulfate radicals. Processes based on activation of the oxidants peroxydisulfate (PS) and peroxymonosulfate (PMS) are becoming more and more popular especially for *in-situ* remediation strategies for aquifers contaminated with perfluorinated alkyl substances (PFAS).

In contrast to hydroxyl radicals, sulfate radicals are able to attack the carboxylate group in many PFAS. Our main focus of attention lies on the heterogeneous activation of PS for sulfate-radical generation in order to exploit pollutant enrichment at active surfaces. In the present study, the activation of PS with various iron minerals was investigated. From the pool of iron minerals tested, iron(II)-sulfide (FeS) proved to be a powerful activator for PS. A more detailed investigation of the FeS/PS system (e.g. pH dependence of the reaction, long-term performance of FeS as activator for PS and determination of radical yield and activation energy) led to the hypothesis of an activation mechanism via homolytic bond cleavage and to the assumption that FeS acts as a true catalyst with a considerable lifetime and not, as would be expected, as a reagent.

Based on the experiences made, the FeS/PS system was optimized and specifically designed for degradation of PFOA (perfluorooctanoic acid), one of the most prominent PFAS representatives being in the focus of regulatory attention. Due to surface-mediated processes, the target reaction, PFOA degradation, can be carried out even in real groundwater samples, even additionally doped with typical water constituents, such as humic acid. These results are remarkable, as it is known that not only dissolved iron, but also chloride and dissolved organic matter (DOM) effectively quench free sulfate radicals. The presentation will inform about reaction products, yields and pathways under various reaction conditions. By mechanistic insight into the activation of PS via heterogeneous activation, this work breaks new ground for novel remediation approaches using PS for *in-situ* and *ex-situ* water treatment.

Based on the promising lab results, a field test of the FeS/PS system, as a part of the Intraplex<sup>®</sup> technology, was conducted at a contaminated site in western Germany. The main contaminants were the perfluorinated carboxylic acids with a total concentration of 0.6 µg/L. Using a

combination of permanent injection points and direct push injections, an injection transects was carried out to apply the material across the main downstream direction of the PFAS plume. The effects of the pilot test were studied by an intensive monitoring program which determined the concentration of pollutants, transformation products and hydrogeochemical parameters. Preliminary results will be presented.