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Degradation of emerging micropollutants in lentic ecosystem sediments through natural aphotic Fenton reaction

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Sediments of freshwater lentic ecosystems accumulate pollutants from human activities. While priority pollutants are regulated due to their toxicity, emerging pollutants, like pharmaceuticals and personal care products, remain largely unmonitored despite evidence of their persistence and risks to ecosystems and human health. Along accumulation, micropollutants can be degraded by several natural processes such as biodegradation, photodegradation or other abiotic pathways. This study focuses on the degradation potential of pollutants by aphotic Fenton reaction occurring in sediments. Fenton reaction occurs when dioxygen is reduced by mixing with the anoxic layer of the sediments. This reduction of O_2 by Fe^{II} produces $O_2^{\cdot -}$, H_2O_2 and – the Fenton reaction – HO·. Hydroxyl radical is one of the most powerful oxidizers in water ($E^0 = 2.8$ *V*) and this study aims to evaluate its capacity to oxidize organic pollutants. Different families of organic contaminants have been studied : pesticides, organophosphorous flame retardants, commonly found pharmaceuticals and personal care products.

Laboratory experimentations were conducted to evaluate the degradation of micropollutants in presence of Fe^{II} and dioxygen to simulate Fenton reaction. First, experimentations using synthetic media, ultrapure water buffered with ammonium acetate and 10 to 5000 nM of pollutants, were performed to evaluate the degradation of the targeted pollutants when 1 mM Fe^{II} solution complexed with 10 mM of citrate were added in presence of oxygen. Degradation rate constants were determined and compared to ROS production rate constants. For metolachlor family, 0.033 min^{-1} of HO· production was measured while degradation rate was 0.013 min^{-1}. Secondly, to better understand the effect on the ROS production and contaminants degradation, experiments were conducted with real porewater samples. Porewaters were collected from sediments from lentic ecosystems to evaluate the differential ROS production. Samples were spiked with a mixture of targeted contaminants (100 nM) and Fe^{II} (1 mM). Key parameters such as pH, organic matter, sulfurs and major ions were monitored to evaluate their influence on the ROS production et pollutants degradation rates. These results aim to evaluate the contribution of aphotic Fenton reaction in degrading micropollutants in sediments and predicting the natural resilience of such ecosystems would be permit.