Ubiquitous Presence of Fe(II) in Aquatic Colloids and Its Association with Organic Carbon

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Abstract

Despite being thermodynamically less stable, small ferrous colloids (60 nm to 3 µm in diameter) remain an important component of the biogeochemical cycle at the Earth’s surface, yet their composition and structure and the reasons for their persistence are still poorly understood. Here we use X-ray-based Fe L-edge and carbon K-edge spectromicroscopy to address the speciation and organic–mineral associations of ferrous, ferric, and Fe-poor particles collected from sampling sites in both marine and freshwater environments. We show that Fe(II)-rich phases are prevalent throughout different aquatic regimes yet exhibit a high degree of chemical heterogeneity. Furthermore, we show that Fe-rich particles show strong associations with organic carbon. The observed association of Fe(II) particles with carboxamide functional groups suggests a possible microbial role in the preservation of Fe(II). These findings have significant implications for the behavior of Fe(II) colloids in oxygenated waters, and their role in different aquatic biogeochemical processes.