Fe(II) oxidation in aqueous solution under freezing conditions

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Abstract

Fe(II) oxidation has been extensively studied under a wide range of aqueous conditions since iron plays a major role in the various (bio)geochemical processes, and its redox speciation heavily participates in controlling the fate and transport of other inorganic and organic substances. Recently, a few studies have investigated redox behaviors of Fe (e.g., dissolution of Iron oxides) under freezing conditions and showed that the reaction rates were considerably enhanced. Study about geochemical reactions under freezing conditions is necessary to understand a wide range of environments. As some chemical reactions can follow different pathways under freezing conditions, the rate and extent of Fe(II) oxidation may also be far from those under the normal aqueous conditions.

This study examined cryogenic Fe(II) oxidation under dark and acidic conditions (pH 2.0 – 5.0), where its abiotic reaction without any catalyst is known to be sluggish. The solution pH was adjusted with or without a buffer. For each ice sample, 10 mL of 50 μM Fe(II) solution was placed in an ethanol bath at -20 ℃ and rapidly thawed in lukewarm water after predetermined reaction time. Preliminary results showed that Fe(II) oxidation was significantly accelerated upon freezing conditions in the presence of acetate at pH 4.5. The rate and extent of cryogenic Fe(II) oxidation were affected by the type of acid for adjusting the solution pH. We will investigate the freezing effect on Fe(II) oxidation under the pH conditions prevail in the environment (pH 5.0 - 9.0).