Chemistry of Fe^{II} and Fe^{III} in hydrothermal waters, Iceland

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Iron (Fe) is particularly important in environmental biogeochemistry, and the transformations between the dissolved, solid and colloidal Fe^{II} and Fe^{III} play a key role in the release and sequestration of many trace elements and contaminants, mineral formation and dissolution, and Fe bioavailability. The relative and absolute concentrations of aqueous Fe^{II} and Fe^{III} show a wide range in natural water depending on factors like pH and redox conditions. Transformations between the solid and dissolved Fe species occur over the entire redox state of water, with many being photochemically induced. In order to understand the chemical and biochemical reactions of Fe it is essential but non-trivial to determine its speciation.

We investigated the chemistry of Fe^{II} and Fe^{III} in natural waters in Iceland. For that purpose, samples were collected from non-thermal and geothermal surface and spring water and well discharges, and analyzed for their major elements compositions and Fe^{II} and Fe^{III} concentrations. The sampled waters had temperatures in the range of 12-99°C, pH between 2.5 and 9.8, and variable dissolved Fe and sulfide concentrations. Determination of Fe^{II} and Fe^{III} was carried out within minutes to hours of sampling using an ion chromatographic method to separate Fe^{II} and Fe^{III}, followed by post-column reaction and spectrophotometric detection. This method allows determination of both Fe^{II} and Fe^{III} within a single 15 min run and requires minimal sample treatment. On-site analysis within minutes to hours is preferred to laboratory analysis, because the concentrations of Fe^{II}, Fe^{III} and Fe^{total} were found to be affected by the filtration and acidification procedure upon sampling and the sample storage.

Iron concentrations in the <0.2 μm filtered and acidified fraction ranged from <2 μg/L to 2.3 mg/L Fe^{III} and <6 μg/L to 3.2 mg/L Fe^{II}. In waters with neutral to alkaline pH values, Fe concentrations are typically <100 ppb and only Fe^{III} was detected in alkaline waters. With decreasing pH, Fe concentrations increase and Fe^{II} becomes important at pH~6.5 and below.