Effect of cyanide-mineral interactions on granite weathering in a glacier forefield

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In alpine regions weathering processes are of particular interest with respect to the effects of climate change. Large areas of bare rock will be exposed as glaciers retreat. Dissolution of most primary rock-forming minerals is limited by slow kinetics of the reactions at the mineral-water interfaces. Dissolution rates depends on extrinsic factors (T, pH, Eh, and exudates from microbes and plant roots) and on intrinsic factors (mineral surface properties and weathering state). Microorganisms can act as geological agents affecting biogeochemical processes through metal speciation as well as metal immobilization and solubilisation.

As part of an interdisciplinary project for the investigation of a glacier forefield (Damma glacier in Central Switzerland), we examined the significance of cyanide as a ligand for the nutrient mobilization for microorganisms. Typically, cyanide is produced during bacterial growth for a short time period only (early stationary phase) as secondary metabolite. From a chemical point of view, it has been proposed that cyanide formed in the prebiotic soup acted as lixiviant on rocks. So, cyanide can be considered as the oldest complexing agent. However, until now cyanide has not been investigated with respect to mineral weathering and initial soil formation.

Rock samples from the glacier forefield (granite) were crushed (63-250 µm) and treated (up to 24 h) in batch reactors purged with HCN gas (0.84 ± 0.1 mM HCN in solution) at different pH (5.5-7). The dissolved elements were analyzed with ICP-OES. A significant effect of cyanide on the dissolution rates of the granite was observed. Cyanide generally leads to a faster dissolution. However, for iron and manganese lower concentrations in the solutions were measured in the presence of cyanide (iron concentrations after 5 hours at pH 6: 6 ppm without cyanide but 0.3 ppm with cyanide). Modelling of chemical speciation has shown that the iron in the solution mainly occurs as ferrocyanide, and subsequently a ferrocyanide solid phase was precipitated (most likely Prussian blue). Cyanide seems to have two functions for the microorganisms: Increase of nutrients' availability, and regulation of individual element concentrations in the solution.

A reactive hydrothermal flow model for the Endeavour Segment, Juan de Fuca Ridge

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The two-dimensional finite element code RST2D [1] is being used to study the geohydrology and geochemistry of recharge zones in seafloor hydrothermal systems such as the Endeavour Segment of the Juan de Fuca Ridge. Relative to vents and other discharge features, submarine recharge zones are understudied. Numerical calculations are being made to quantify likely rates of recharge zone flow and relevant geochemical water-rock reactions, including mineral precipitation and dissolution, using a fully-coupled, 2-D, reactive flow approach. In particular the reactive flow model is being used to predict the formation and likely spatial distribution/preservation of anhydrite in the hydrothermal recharge zone, and its influence on fluid flow and heat transport. We are focusing on the effects/controls of off-ridge crustal geology and geometry, permeability, fault location, and thermal boundary conditions on the predicted size and extent of the recharge zone, and whether hydrothermal recharge is focused along extensional faults or diffused across broad areas of the seafloor. Hydrothermal flow systems located along the Endeavour Segment are being used as a representative field application because it has been the setting of numerous earlier studies of heat flow and hydrothermal circulation, which help provide constraints on the mathematical modeling.

[1] Raffensperger, J.P. (1996) *Advances in Porous Media* **3**, 185–305.