Evidence for bacteria-mediated iron oxidation at a groundwater spring

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In an iron groundwater spring, both abiotic and biotic processes can influence iron oxidation. In a neutrophilic, oxygen-saturated system, abiotic iron oxidation can occur within minutes, potentially dominating redox processes. Alternatively, under low pO_2 conditions, biotic iron oxidation may compete with chemical processes, promoting and potentially dominating iron oxidation and precipitation. The 3.6 m fetch of Ogilvie Spring, a groundwater spring near Deep River Ontario, provided a natural field location to determine dominant iron oxidation processes. The rate of groundwater flow into the system was 0.03 m/s. Iron oxidation and precipitation within the study site was apparent according to a 56- and 30- fold decrease in the concentration of ferrous and total iron, respectively, downstream. Time-course measurements of ferrous and total iron in filtered spring water, with and without the addition of microbial mat material were recorded, using an on-site microcosm for experimentation. The bacteria-absent experiment yielded an observed maximum oxidation rate of 0.001 mg/Ls. This value agrees well with the theoretical oxidation rate (0.002 mg/Ls) calculated from rate equations for chemical iron oxidation. The bacteria-present experiment yielded a 20-fold greater observed maximum oxidation rate of 0.02 mg/Ls. The in-situ iron oxidation rate, calculated according to spring seepage velocity and ferrous iron disappearance rate, was 10-fold greater than the rate for chemical oxidation, indicating bacteria-dominated redox processes. The in-situ precipitation rate, calculated according to 30-fold decrease in total iron within the spring, was 0.03 mg/Ls. Precipitation was not observed in the bacteria-absent microcosm experiment. The bacteria-present precipitation rate (0.001 mg/Ls) was 30-fold less than that observed in-situ within the spring system. These results suggest both oxidation and precipitation are heavily dominated by microbial metabolic activity. This groundwater field and microcosm study provides further emphasis for microbial influence on freshwater geochemistry, and presents methods for quantifying the activity of iron-oxidizing bacteria within an opposing redox and chemical gradient.

Fracturing-assisted fluid migration in rocks

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Fluid migration in the Earth's crust is strongly linked to deformation. Fracturing is probably *the* most important permeability producing mechanism in the lithosphere. Large scale fracturing is in most cases linked to tectonic stresses, but large scale fluid flow may also be strongly affected by small scale forces and small scale fractures. Local fracturing may in some cases be a response to other forces than anisotropic stresses controlled by tectonics. Such forces may be related to high fluid pressure gradients, or differences between fluid pressure and load pressure, and stress perturbations caused by reactions. We present field observations and computer simulations which illustrate how fluids may propagate into initially more or less impermeable rocks driven by hydrofracturing and reactions enhanced dilation, and discuss some of the time-dependent processes coupled to fracturing and fluid migration. The effects of anisotropic external (tectonic) stresses to fluid migration driven by such forces can be very significant as revealed by simple 2D computer models. Simple modelling furthermore illustrates the importance of fluid migration for strain localization in deforming systems.