Matrix composition and community structure analysis of a novel bacterial pyrite leaching community

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Pyrite is the most abundant sulfide mineral in the earth's crust. The oxidation of pyrite leads to the release of ferric iron and - via several steps - of sulfuric acid. This causes a dramatic decrease of the pH value which in turn leads to a serious environmental problem. This process called acid mine drainage (AMD) is greatly accelerated by bacteria that catalyze the rate limiting step of pyrite oxidation, namely the reaction from ferrous to ferric iron. Here we report about a novel bacterial community that is embedded in a matrix of carbohydrates and bio/geochemical products of pyrite oxidation. This community grows in stalactite-like structures on the ceiling of an abandoned pyrite mine at pH values of 2.2-2.6. We measured sulfate concentrations of 200 mM and total iron concentrations of 60 mM in the soluble fraction of the matrix. Micro-X-ray diffraction analysis showed that jarosite is the major mineral embedded in the biofilm. X-ray absorption near-edge structure experiments at the ANKA (Karlsruhe) SUL-X beamline revealed three different sulfur species, whereby the major signal was caused by sulfate. The other two peaks might correspond to organic sulfur compounds. Arabinose was detected as the major sugar component in the extracellular polymeric substance. Via restriction fragment length polymorphism analysis, we elucidated the community structure. It consists mainly of iron oxidizing *Leptospirillum* and *Ferrovum* species but we also found microorganisms that could be involved in the dissimilatory sulfate and dissimilatory iron reduction.

Deciphering the roles of H_2O and fO_2 during calc-alkaline differentiation

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Determining the origin of tholeiitic (TH) versus calc-alkaline (CA) magmas has been clouded by issues of classification, definition, and multiple petrogenetic hypotheses. As variation in Fe is the salient feature in many TH-CA discrimination diagrams, we present a quantitative index of Fe-enrichment, the Tholeiitic Index (THI): THI = Fe4.0/Fe8.0, where Fe4.0 is the average FeO* of samples at 4±1 wt.% MgO*, and Fe8.0 is the average FeO* of samples at 8±1 wt.% MgO*. Magmas with THI>1 have become enriched in FeO* during differentiation and are TH; magmas with THI<1 are CA. Most arc magmas are CA, but the THI expresses the continuum of Fe-enrichment observed in magmatic suites of all tectonic settings.

One prominent hypothesis for CA magmas in arcs is high magmatic H_2O, which suppresses silicate crystallization relative to spinel, causing early Fe-removal and CA differentiation. However, high fO_2 also promotes early spinel (magnetite) crystallization. We explore these effects using melt inclusions (MI) from eight volcanoes in the Aleutian arc, which spans the arc global array in both H_2O and THI. We use S contents of MI as a proxy for fO_2 in the mantle wedge, and the Mg# of each suite at magnetite saturation, to deduce high- and low-fO_2 volcano groups. Within each group, H_2O strongly correlates negatively with THI. Overlapping H_2O contents between f groups suggests hydration and oxidation are not always coupled in the mantle wedge. Thus, there is a first order relationship between H_2O and THI in all tectonic settings, and a secondary relationship between THI and fO_2 in arcs.