Fe(II) and Mn(II) oxidation and biomineralization within basalt-hosted lithoautotrophic biofilms

A. TEMPLETON[1], B. TEBO[1], H. STAUDIGEL[1], B. BAILEY[1], L. HAUCKE[1], AND T. TRAINOR[2]

[1]Scripps Institution of Oceanography, La Jolla, CA 92093, USA
[2]University of Alaska, Fairbanks, AK 99775-6160, USA

The metabolic activity of epilithic and endolithic microbial organisms can exert a major influence on the rates of chemical weathering of geological materials. We are particularly interested in the activity of lithoautotrophic microorganisms that can grow using reduced metals in rocks and glasses as an energy source for growth under oxic conditions. Our current work is focused on elucidating the mechanisms whereby neutrophilic Fe(II) and Mn(II) oxidizing bacteria influence the rates of Fe and Mn transfer and oxidation from basaltic glasses, and the chemical signatures of their activity retained at the basalt/biofilm interface. We will discuss biomineralization processes within natural epilithic biofilms formed on the glassy margins of pillow basalts collected from Loihi Seamount, an active submarine volcano adjacent to the island of Hawaii. This will be directly compared to laboratory-based biofilm experiments with novel Fe(II) and Mn(II) oxidizing isolates. Our data will show how Fe(II) oxidizing bacteria accelerate the oxidative alteration of basaltic glasses, whereas Mn(II) oxidizing bacteria passivate the surfaces unless integrated into a cooperative microbial consortia.

Role of the cell surface in calcite precipitation on picocyanobacteria

M. DITTRICH AND M. OBST

EAWAG, Limnological Research Center, CH-6047 Kastanienbaum, Switzerland (dittrich@eawag.ch, martin.obst@eawag.ch)

Picocyanobacteria and Calcite Precipitation

Recent research has shown that seasonal calcite concentration peaks in oligotrophic lakes may be explained by the activity of unicellular autotrophic picocyanobacteria (Dittrich et al., 2004). Picocyanobacteria often dominate total phytoplankton biomass in oligotrophic lakes. Because of the small cell size and its high abundance, picoplankton provides large surface areas. Thus, it may play a key role for calcite formation. However, detailed studies on the potential of picoplankton to induce calcite precipitation are still rare and the mechanisms of calcite precipitation are not yet well understood.

In a pre-study we investigated the cell mineral interface by analytical Transmission Microscopy (TEM) (Obst et al., 2005). For this analysis samples were prepared using a Focused Ion Beam (FIB)-milling. From these experiments we conclude that the composition of the cell surface seems to play a crucial role in the nucleation process.

Characterization of Cell Surface

In the most recent study, the surface properties of two picocyanobacteria strains were examined by measurements of zeta potential, potentiomentric titration, and infrared spectroscopy (IR). The results demonstrated that the deprotonation of picocyanobacterial cells surfaces is a reversible process. Modelling results, data on zeta potential and IR spectra are consistent with the presence of three surface sites, corresponding to carboxyl, phosphate, and amine groups. The carboxyl group slightly dominates the surface sites in both strains with 37% and 44%, the amine groups represent 36% and 29%. The smaller fraction of phosphate was similar in both strains with 27% and 26%.

During the picocyanobacterial bloom in oligotrophic lakes the concentration of functional groups amounts to ca. 0.35 mmol/ml. The zeta potential measurements have shown that picocyanobacteria are negatively charged at pH between 6 and 7, which is typical for natural surface water. Calcium cations can therefore be easily attracted. On the other hand, the presence of amine groups on the cell surface influences the carbonate anions. Both reactions are important in the nucleation of calcite on the cell and may be key processes for the calcite precipitation in lakes.

References

Dittrich M., Kurz P., and Wehrli B. (2004) *Geomicrobiology* **21**, 45-53.

Obst M., Gasser P., Mavrocodatos D., and Dittrich M. (2005) *American Mineralogist* in press.