

TEM investigations of bacterial effects on biotite dissolution

J. HOPF, F. LANGENHORST AND D. MERTEN

Institute of Geosciences, University of Jena, Burgweg 11,
D-07749 Jena, Germany (JulianeHopf@web.de)

Introduction

In natural environments minerals and rocks are not only weathered by chemical and physical processes but also by biological activity. In order to understand the role and interaction between alteration processes, the interface between minerals and bacteria must be investigated at the microscopic to nanometer scale.

Methods and results

In batch culture experiments three different bacteria strains (*Bacillus subtilis spizizenii*, *Shewanella putrefaciens* and *Streptomyces acidiscabies E13*) were grown for 35 days with ground biotite as main nutrient source. The release of major and minor elements (Al, Fe, K, Mg, Mn, Si, Ti) was measured using inductively coupled plasma-optical emission spectrometry (ICP-OES). In comparison with an abiotic control the sample with *Bacillus subtilis spizizenii* showed an increase in the dissolution of Al and Mg. Compared to the control, the dissolution rates of Al and Mg in experiments with *Shewanella putrefaciens* and *Streptomyces acidiscabies E13* are however slightly decreased. These first results demonstrate that bacteria have a diverse control on the dissolution behaviour of biotite.

To understand this diversity in dissolution behaviour of biotite, we have employed transmission electron microscopy (TEM) and energy dispersive X-ray microanalysis (EDX). These techniques were used to detect changes in structure, morphology, and element chemistry of the untreated and biologically treated biotite. Pure visual TEM observations of the bacteria treated specimens provide clear evidence for intense degradation. The small bacteria treated biotite flakes show frayed rims and etch pits on surfaces, whereas untreated biotite from the control experiment displays the normal shape of unaltered starting biotite with unaffected crystal edges and surfaces. Crystal-chemical changes have been detected in experiments with *Bacillus subtilis spizizenii*, which show a K-Na cation exchange in biotite interlayers. The Na is thereby provided by the liquid media. Additionally, we found small crystals of a secondary phase, which is currently under identification.

Conclusion

Bacteria are able to influence the dissolution processes of biotite in various ways. Especially the gram-positive soil bacteria *Bacillus subtilis spizizenii* increases the dissolution of certain elements and triggers the precipitation of a secondary phase.

An evaluation of He, Ne and Ar isotope and element systematics of oceanic mantle sources

JENS HOPP AND MARIO TRIELOFF

Mineralogisches Institut, Universität Heidelberg, Im
Neuenheimer Feld 236, D-69120 Heidelberg
(jhopp@min.uni-heidelberg.de)

The more radiogenic character of Mid Ocean Ridge Basalts (MORB), i.e. higher air corrected mantle ratios of $^4\text{He}/^3\text{He}$, $^{21}\text{Ne}/^{22}\text{Ne}$, $^{40}\text{Ar}/^{36}\text{Ar}$ compared to many Ocean Island Basalts (OIB), is commonly attributed to a higher degree of depletion of primordial noble gases within the MORB source. In addition, He/Ne and He/Ar elemental ratios found in MORB glasses are higher relative to OIBs. This had been considered as evidence for solubility controlled elemental fractionation during gas - melt partitioning. However, the generally lower He concentrations in OIBs compared to a presumed degassed MORB source appears in contradiction with this conclusion.

To resolve this issue in terms of a two-stage fractionation and binary mixing model we evaluated literature data from MORB and Loihi-Kilauea glasses and used their He, Ne and Ar isotope and element systematics and concentrations. We can describe mantle $^{21}\text{Ne}/^{22}\text{Ne}$ - $^4\text{He}/^3\text{He}$ isotope systematics by a simple binary mixing process between a MORB and a 'plume' endmember that differ in their $^3\text{He}/^{22}\text{Ne}$ ratios at time of admixing. The 'plume' endmember is a postulated component, basing on the premise that both endmembers shared a common radiogenic evolution history, i.e. the same initial $^3\text{He}/^{22}\text{Ne}$ ratio, but a different time integrated accumulation of radiogenic isotopes. Within this model a primary fractionation process must have occurred before admixing of both subcomponents. We performed a back calculation of this mixing process and extended this procedure to the Ar system assuming a linear relationship of mantle $^{21}\text{Ne}/^{22}\text{Ne}$ and $^{40}\text{Ar}/^{36}\text{Ar}$ ratios. With the implicit assumption that the composition of basalt glasses represents the melt phase and that the initial He/Ne, He/Ar compositions of the melt will only evolve towards higher values in course of solubility controlled secondary fractionation during magmatic degassing we derive upper limits for the $^3\text{He}/^{22}\text{Ne}$, $^4\text{He}^*/^{21}\text{Ne}^*$ and $^4\text{He}^*/^{40}\text{Ar}^*$ ratios of both mixing endmembers. The MORB component appears not or weakly fractionated, in opposite to the 'plume' component displaying a significant He deficit. A simple calculation of unfractonated initial 'plume' $^3\text{He}/^{22}\text{Ne}$, $^4\text{He}^*/^{21}\text{Ne}^*$ and $^4\text{He}^*/^{40}\text{Ar}^*$ ratios and He concentrations are in broad agreement with observed MORB data. A more compatible behaviour of He relative to Ne and Ar during crystal - melt partitioning could explain the data: OIB melt could represent low degree melts from an isotopically different source region that admixes with higher degree MORB melts at shallow depths. Alternatively, a more complex magmatic fractionation scenario is addressed.