Fluid-rock interaction of kimberlites on the base of their noble gas composition

T. WIERSBERG, S. NIEDERMANN AND J. ERZINGER

GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany (wiers@gfz-potsdam.de, nied@gfz-potsdam.de, erz@gfz-potsdam.de)

In order to obtain new information on the fluid composition of the earth´s mantle beneath old and thick continental lithospheric crust, we have determined noble gas concentrations and isotopic compositions of three whole rock kimberlite samples as well as two separated phlogopites. The samples originate from the locations Poria Guba and Kandalaksha in the eastern Baltic Shield. The kimberlitic magmatism in that region occurred 400 Ma ago. Noble gases in whole rock samples were extracted by both stepwise heating and crushing; noble gases of phlogopites were released by stepwise heating only.

Thermally released noble gases show $^{3}He/^{4}He$ ratios from 0.02 to 0.5 times the atmospheric value (R_a). $^{3}He/^{4}He$ ratios determined in crushing experiments are in average higher (up to 0.8 R_a). A significant contribution of cosmogenic helium is not likely, because cosmic rays cause production of helium in the crystal lattice and would result in higher $^{3}He/^{4}He$ ratios in the rock matrix than in the fluid inclusions, opposite to what we observe. Contamination with atmospheric helium is negligible as well: the He/Ne ratios of all samples are more than three orders of magnitude higher than that of air. In addition, the $^{3}He/^{4}He$ ratios of the kimberlites are considerably higher than the calculated production ratio. Thus we conclude that the elevated $^{3}He/^{4}He$ ratios are most likely caused by interaction of the kimberlitic magma with a mantle derived fluid phase.

Mechanically and sometimes thermally ($T < 600°C$) released gas fractions show $^{20}Ne/^{22}Ne$ and $^{21}Ne/^{22}Ne$ ratios which are higher than atmospheric values and positively correlated in the 3-isotope diagram. Assuming a $^{20}Ne/^{22}Ne$ ratio of 12.5 for the mantle endmember, a $^{21}Ne/^{22}Ne$ ratio of 0.073 ± 0.011 can be calculated indicating, a mantle domain which is more severely affected by nucleogenic neon than a MORB mantle. The isotopic composition of neon released at high temperatures is mainly dominated by in situ produced ^{21}Ne and ^{22}Ne.

In the $^{3}He/^{4}He$ versus $^{20}Ne/^{22}Ne$ diagram the data form a hyperbolic mixing line. Extrapolation to the $^{20}Ne/^{22}Ne$ mantle endmember value of 12.5 yields a $^{3}He/^{4}He$ ratio of ~ 2.5 R_a. The contribution of radiogenic He in the magma source of the kimberlites is thus higher than in both the MORB mantle (8 Ra) and the average subcontinental mantle (~ 6 R_a; Dunai and Baur, 1995), reflecting higher amounts of uran and thorium in the magma source of the kimberlites.

References

Dunai, T. J. and Baur, H. (1995), *Geochim. Cosmochim. Acta* **59**, 2767-2783

Adsorption and Precipitation of Iron by *Bacillus subtilis* Bacterial Cell Walls

PETER G. WIGHTMAN[1] AND JEREMY B. FEIN[2]

[1] University of Notre Dame, Civil Engineering & Geological Sciences, 156 Fitzpatrick, Notre Dame, IN, 46556, (wightman.1@nd.edu)
[2] (fein.1@nd.edu)

Hydrous ferric oxides (HFOs) are widespread minerals whose high capacity for adsorbing aqueous cations can significantly affect the distribution and transport of metals in the environment. HFOs are often found in close association with bacterial cells, and a number of studies suggest that the presence of bacteria, even non-redox active bacteria, can facilitate the precipitation of HFO. It is unclear whether this precipitation enhancement is a kinetic or a thermodynamic effect. That is, is the association caused because the bacteria speed precipitation of the HFO in systems that are over-saturated with respect to Fe-oxides, or is the bacteria-HFO association caused by the creation of a micro-environment around the bacteria that allows for precipitation at undersaturated conditions? In either case, the Fe adsorption must be quantified in order to isolate precipitation mechanisms. Adsorption of Fe to the bacteria surface is known to occur and is a necessary pre-cursor to Fe-precipitation, however the extent of adsorption and the resulting effect on saturation conditions in the presence of bacteria has not been adequately explored.

We conduct two types of experiments: 1) Kinetic precipitation-type experiments with and without bacteria at starting Fe concentrations of 1, 2.5, and 5 ppm at a constant pH of 3. 2) Batch adsorption experiments at low pH (<3) with 1ppm Fe and 2 g/l bacteria.

The results of precipitation experiments clearly demonstrate that bacteria significantly enhance the rate and extent of Fe sorption relative to the bacteria-free controls. However, the steady-state endpoints of kinetic experiments at the 3 different Fe concentrations do not converge to a single equilibrium solubility value, suggesting that the difference between the biotic and abiotic experiments may be dominated by adsorption-related effects. The results of the batch adsorption experiments are used to determine stability constants for Fe-bacteria surface complexes assuming zero precipitation at these low Fe, low pH conditions. We use the results of these adsorption experiments to evaluate the observed bacteria enhancement of HFO formation. The possible effects of experimental procedures on the results is also addressed.