Contrasting on- and off-axis melt delivery: a Sr and Nd isotopic study of the Moho transition zone of the Oman ophiolite

MARIE NICOLLE[1]*, DELPHINE BOSCH[2], LAURIE REISBERG[1], DAVID JOUSSELIN[1] AND AURORE STEPHANT[1]

[1]Université de Lorraine, CRPG-CNRS, Vandoeuvre les Nancy, France, mnicolle@crpg.cnrs-nancy.fr (* presenting author)
[2]Université Montpellier 2, Géosciences Montpellier, Montpellier, France

Recent tomographic images from the East Pacific Rise [1] indicate that nearly 50% of the melt is delivered off-axis instead of beneath the ridge axis. The consequences of this process can be studied on land in the Oman ophiolite, where structural mapping has shown the existence of both on- and off-axis melt delivery systems [2]. Off-axis diapirs impinge directly on hydrothermally-altered lithosphere and may be contaminated by this material. Petrologically, off-axis melt delivery results in the development of an unusually thick Moho Transition Zone (MTZ) composed largely of clinopyroxenite, whereas on-axis MTZ contains troctolite and gabbro lenses. We are analyzing the Sr and Nd isotopic compositions of pyroxenites, gabbros, diorites, and dunites, from an on-axis (Maqsad) and an off-axis (Mansah) diapir in the Semail massif of the Oman ophiolite to explore the geochemical consequences of these contrasting settings. Leached and unleached whole rocks, as well as clinopyroxene (cpx) separates are being studied, to allow us to investigate both magmatic and later hydrothermal processes. Initial Nd isotopic compositions from unleached whole rock powders are comparable for the two diapirs (ε_{Nd} = 8.5-9.2 on-axis; ε_{Nd} = 5.6-10.3 off-axis), although off-axis rocks display a larger range of variation. In contrast, whole rock Sr isotopic ratios differ markedly, with on-axis samples displaying a limited range of enriched MORB-like compositions ($^{87}Sr/^{86}Sr$ = 0.703010 - 0.703438) whereas off-axis samples have more radiogenic and highly heterogeneous compositions ($^{87}Sr/^{86}Sr$ = 0.703277 - 0.706192). We attribute this difference to the presence of a magma chamber above the on-axis diapir, which protects the MTZ from the effects of hydrothermal circulation. Separated cpx and leached whole rocks from off-axis pyroxenites have less radiogenic compositions ($^{87}Sr/^{86}Sr$ = 0.703218 - 0.703576) than the corresponding unleached whole rocks. Nevertheless, several of these samples have $^{87}Sr/^{86}Sr$ ratios that approach the upper limit of the Indian MORB field. In outcrop, a mixing zone is observed between pyroxenites and crustal gabbros in the MTZ overlying the off-axis diapir. Samples from this mixing zone have more radiogenic cpx compositions than samples collected further from the Moho, suggesting magmatic contamination of the pyroxenites by incorporation of hydrated material rich in seawater-derived Sr.

[1] Toomey et al. (2007) *Nature* **446**, 409-414. [2] Jousselin and Nicolas (2000) *Marine Geophysical Researches* **21,** 243-257

Weathering in the Rhizosphere Analyzed with Transmission Electron Microscopy

S.M. NIEDZIELA[1]*, A. DOHNALKOVA[2,3], K.A. GREENBERG[1], B.W. AREY[2], Z. BALOGH-BRUNSTAD[1], Z. SHI[3], AND C. K. KELLER[3]

[1] Hartwick College, Oneonta, NY, 13820 USA (*correspondence: balogh_brunz@hartwick.edu)
[2]Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, WA, USA
[3]School of the Environment, Washington State University, Pullman, WA, USA

Introduction and Methods

It is generally accepted that bacteria and mycorrhizal fungi enhance mineral weathering and nutrient translocation to their host plants. The role of biofilm in rhizosphere (root zone), on the other hand, is not well known and poorly characterized. The goal of our study was to examine the mineral-fungus-biofilm interface under conditions of calcium and potassium limitation, using transmission electron microscopy. We hypothesized that tree-fungus-bacteria association increases biofilm formation under calcium and potassium limitation, and enhances mineral weathering that will be indicated by distinct depletion profiles of elements under fungal and biofilm cover [1].

Red pine (*Pinus resinosa* Ait.) trees were grown in leach tubes filled with quartz sand amended with 0.5 wt% biotite and 1 wt% anorthite. Half of the trees were inoculated with *Suillus tomentosus* and a group of forest soil bacteria, and the other half were left without microbial inoculation. Additional columns without any biology served as controls. Calcium and potassium were supplied in irrigation water at 0, 10, 30 and 100% of rates for healthy tree growth. A subset of the columns were destructively sampled after three months. Whole mount transmission electron microscopy (TEM) grids were prepared from root-system wash solutions used to collect the rhizospheric microbial community. Anorthite and biotite grains were also collected from the rhizosphere to prepare thin sections using focused ion beam – scanning electron microscopy (FIB-SEM). Thin sections of the 0% treatment and a control were analyzed with high resolution TEM coupled with energy dispersive x-ray spectoscopy to test our hypothesis. Multiple chemical profiles were analyzed on the FIB sections under the fungal cover of anorthite and biofilm cover of biotite.

Results and Discussion

Whole mount TEM shows that the 0% treatment has the greatest species diversity, but all treatments have one or two types of bacteria. The overall bacterial population by number is the largest in the 100% treatment. Fungal hyphae are only oberserved with SEM. On the anorthite FIB sections, a slight decrease of Ca is seen under the fungus compared to the control. The same slight depletion is seen for K, Mg and Fe in biotite under biofilm cover, compared to the control. However, these chemical profile differences between treatments and controls are not significant after 3 months reaction time. Further work after 6, 9 and 12 months is planned to further explore our hypothesis.

[1] Bonneville et al. (2011) *Geochim. Cosmochim. Acta* **75**, 6988-7005.