

Biogeochemical weathering of serpentinite in field and laboratory studies

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Biological processes, specifically mediated by microbial communities, are closely tied to mineral weathering. Serpentinites, for example, exert strong controls on the biota that develop on them. The bulk chemistry of serpentinite rocks is high in Mg and trace elements and low in nutrients such as Ca, K, P, and N. This causes an extreme and stressful environment for plants and microbes, that has been extensively studied by ecologists [1]. However, the role that serpentine biota play in development of serpentine soils has not been examined. In order to address this question, we have observed biogeochemical weathering of serpentinite in the field, and we are conducting laboratory studies to examine how iron-oxidizing bacteria and oxalic acid influence weathering rates of serpentine minerals.

Field samples from the Trinity Ultramafic Complex in the Klamath Mountains, California were analyzed by biological activity reaction tests (BART™) to test for the presence of iron-related bacteria. The BART™ indicators tested positive for iron-related bacteria in both rock and soil cores, [2] suggesting that biological impacts on Fe cycling may be important. However, future work is needed to compare lizardite dissolution in the presence and absence of Fe-oxidizing bacteria.

Lab experiments were performed to test the effect of oxalic acid on lizardite dissolution. Oxalic acid is an exudate from many soil fungi, and is an important ligand that binds to metals in the surrounding soil. We found that oxalate in concentrations of 50 mM enhanced lizardite weathering by a factor of six [3].

We also plan to complete similar lab experiments with iron-oxidizing bacteria. We hypothesize that iron-oxidizing bacteria enhance lizardite dissolution, contributing to early serpentinite weathering in deep profiles. Crushed lizardite grains will be reacted in batch solutions with *Acidithiobacillus ferrooxidans*; a species common in acid mine drainage [4], *Ferritrophicum radicolola*; a neutrophilic species isolated from a wetland rhizosphere, and in abiotic solutions [5]. Experiments will be conducted at a range of pH values, but constrained by the survival needs of each species. Aliquots of solution will be extracted and analyzed for Mg, Si, Fe, Al, Ni, Cr, Cu, Co, and Ti using ICP-MS. Magnesium and silicon release rates will be used to calculate dissolution rates of lizardite in both biotic and abiotic experiments. Iron-oxide precipitates will be analyzed with SEM-EDS. Measured dissolution rates in the presence of microorganisms will be compared to abiotic dissolution rates, and used in reactive transport modeling of the field area.

[1] Kazakou et al. (2008) *Biological Reviews* **83**, 495-508. [2] Baumeister et al., in prep. [3] Yardley, E. (2012) M.S. Thesis. [4] Santelli et al. (2001) *Chemical Geology* **180**, 99-115. [5] Weiss et al. (2007) *Geomicrobiology Journal* **24**, 559-570.

Chemical zoning of eclogite lenses in subduction complexes: an example from the Leaota Massif, South Carpathians

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The Leaota Massif basement comprises several concordant units characterized by internal lithologic and metamorphic contrasts. Eclogite and metagabbro lenses, hosted in a semipelitic matrix, appear sandwiched between two units of pelitic/metavolcanic composition.

The eclogite lenses are chemically zoned, as best exemplified by the Bughița Albeștilor (BA) occurrence, displaying several well-defined concentric zones, from fine-grained massive phengite-free domains that grade outwards into phengite-rich zones. The mineral assemblage of the phengite-free domain is garnet + omphacite + amphibole + zoisite + quartz + rutile. The phengite-rich zone preserved a low-variance mineral assemblage of garnet - omphacite - phengite - paragonite - amphibole - kyanite - clinozoisite - quartz - rutile. Mg-rich staurolite ($X_{Mg} = 0.29 - 0.40$) was rarely identified in kyanite porphyroblasts. Whole-rock compositions approach N-MORB to E-MORB, the latter ones also displaying HFSE-depletion.

The macro- and the microscopic features of these zones, together with their trace elements patterns that resemble N-MORB except the LILE (Rb, Ba, K, U) enrichment in the rind (fig. 1, 2), support the interpretation of the phengite-rich domains as a metasomatic rind of the phengite-free inner part, ensuing interaction with subduction-zone fluids.

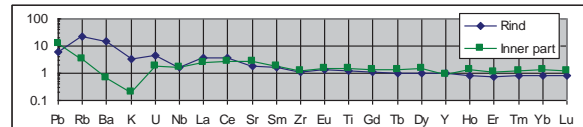


Figure 1: N-MORB-normalized [1] trace elements abundance of the inner part and its metasomatised rind of the BA-eclogites

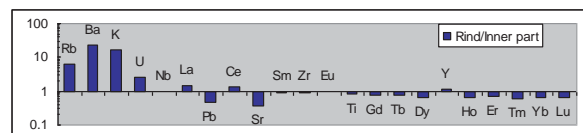


Figure 2: Chemical variation between the inner part and its metasomatised rind of the BA-eclogites

The geochemical features of the eclogite and metagabbro lenses, especially the distinctive LILE enrichment, document subduction-zone metamorphism of normal and SSZ ocean floor remnants enclosed in a subduction mélange. The LILE-metasomatism of the semipelitic matrix rocks themselves, demonstrated by high Ba contents of K-white micas [2], also support this interpretation.

[1] Sun, McDonough (1989) *Geol.Soc.Special Publications* **42**, 313-345. [2] Negulescu, Săbău (1999) *An. Univ. București XLVIII*, 55-58.