Progress of weathering reactions in ultramafic rocks

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Section 7a: The Art of weathering

Chemical weathering results from a complex interaction between geochemistry, hydrology, biology, and physical erosion and is therefore site specifie [1].

Chemical weathering of dark green massive ultramafic rocks produces a distinct and remarkable yellow weathering rind when exposed to the atmosphere long enough. Crust formation on rocks from three European climates have been studied: a) Ronda Peridotite, Spain, b) Seiland Complex, Norway, c) Zermatt Ophiolite, Switzerland). Rinds from the three areas vary mineralogically and have very different thicknesses. The rind thickness depends on the mineralogy of the bedrock, atmospheric parameters and on the details of transport and kinetics of the chemical reactions.

Fig. Weathering rinds on dunite (Reinfjorden, N Norway)

The fundamental reaction "peridotite (serpentinite) + rainwater = weathering rind + runoff water" describes the crust forming process. This hydration reaction depends on the water supply from the rock surface to the reaction front. The transport mechanism is grain boundary diffusion. At the reaction front, kinetics controls the progress of the weathering reactions. The competing kinetics-diffusion control determines the rate of rind growth. The alteration zone must be wetted after a dry period and the reaction resumed at the front. The wetting-drying cycles may contribute significantly to the hydraulic properties of the weathering rind. Reaction details of the rind forming process are saved in the subtle structures of the crusts.

The propagation of the reaction front and the internal structure of the rinds have strong similarities to hydrothermal reaction veins [2]. It is evident that rind thickness development is not related to pervasive advective fluid flow.

[1] White A. F. 2008, Quantitative Approaches to Characterizing Natural Chemical Weathering Rates. In *Kinetics of Water-Rock Interaction* (ed. S. L. Brantley, J. D. Kubicki, and A. F. White), pp. 151-210. Springer.

[2] Bucher K. 1998, Growth mechanisms of metasomatic reaction veins in dolomite marbles from the Bergell Alps. Mineralogy and Petrology, 63, 151-171.

Biomineralization of selenium: proteins as the reason for altered colloidal stability of nanoparticle suspensions

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Although biomineralization of selenium has been investigated in the frame of bioremediation for decades, the molecular principles behind it remain largely unknown. Despite of its microbial origin, biogenic elemental selenium typically consists of nanosized spherical particles (Figure 1), stabilized against gravitational settling. These particular properties were suspected to be mediated by organic molecules associated to the selenium particles. In this study, organic molecules associated with high-affinity to selenium bionanominerals were isolated from such molecules with low-affinity by density-based centrifugation. The proteic fraction was characterized via capillary liquid chromatography-electrospray ionization-tandem mass spectrometry (LC-ESI-MS/MS). A plenitude of proteins was found to strongly associate to biomineralized selenium formed by physiologically different microorganisms [1]. Interestingly, one protein - a metalloid reductase - did associate strongly to both biogenic nanoselenium and synthetically produced selenium surfaces, indicating some specific recognition properties. By means of electrophoretic measurements (zeta –potential) and settling experiments it was demonstrated that, indeed, the proteic fraction considerably alters the colloidal stability of selenium bionanominerals. Furthermore, it could be demonstrated that the aqueous transport will be considerably influenced by the environmental media composition (i.e. acidic vs. neutral waters; sea vs. surface waters; waters differing in dissolved organic matter content, etc.).

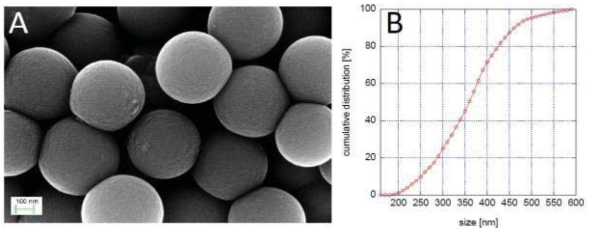

Figure 1: SEM images of purified biomineralized selenium produced by *Bacillus selenatarsenatis* (A) and corresponding cummulative particle size distribution (B)

[1] Lenz, M. et al. (2011). *Applied and Environmental Microbiology*, **77 (13)**, 4676-4680.