The Geobiology of Weathering: The 13th Hypothesis

D.W. SCHWARTZMAN[1]* AND S. BRANTLEY[2]

[1]Department of Biology, Howard Univ., Washington DC 20059, USA (*correspondence: dschwartzman@gmail.com)

[2]Department of Geosciences, Pennsylvania State Univ., University Park, State College, PA 16802, USA (sxb7@psu.edu)

The magnitude of the biotic enhancement of weathering (BEW) has profound implications for the long-term carbon cycle [1, 2]. The BEW ratio is defined as how much faster the silicate weathering carbon sink is under biotic conditions than under abiotic conditions at the same atmospheric pCO_2 level and surface temperature. Thus, a 13th hypothesis could be added to the 12 outlined by Brantley *et al.* [3] regarding the geobiology of weathering: The BEW factor and its evolution over geological time can be inferred from "meta-analysis" of empirical and theoretical weathering studies. We present estimates of the global magnitude of the BEW drawing from lab, field, watershed and models of the long-term carbon cycle, with values ranging from one to two orders of magnitude.

[1] Schwartzman and Volk (1989) *Nature* **340**, 457-460. [2] Schwartzman (1999 2002) *Life, Temperature, and the Earth: The Self-Organizing Biosphere*. Columbia Univ. Press. [3] Brantley *et al*. (2011) *Geobiology* **9(2)**, 140-165.

Serpentinization history of the Santa Elena complex peridotites, Costa Rica

ESTHER M. SCHWARZENBACH[1]* AND ESTEBAN GAZEL[2]

Department of Geosciences, Virginia Tech, Blacksburg, VA, United States
([1]*correspondence: esther11@vt.edu; [2]egazel@vt.edu)

Serpentinization is a widespread process where ultramafic rocks react with water or fluids along oceanic ridges or within subduction zones. On the Santa Elena peninsula (Costa Rica) variably serpentinized peridotites outcrop together with layered and pegmatitic gabbros and are intruded by mafic dikes. However, the original tectonic setting of the Santa Elena complex and the origin of the peridotites has not yet conclusively been determined and interpretations range from a supra-subduction zone to an oceanic ridge setting. In this study we identify the alteration history and the sources of the hydrothermal fluids that affected these peridotites by studying the petrology and sulfur geochemistry. Our goal is to contribute to the understanding of the tectonic evolution of Central America.

The Santa Elena ultramafic complex includes lherzolites, cpx-bearing harzburgites and minor dunites. Extent of serpentinization varies between 30 and 100%. Locally clinopyroxene is replaced by amphibole (tremolite, Mg-hornblende, edenite, and pargasite). The peridotites preserve opaque mineral assemblages including pentlandite, awaruite, pyrrhotite, heazlewoodite, magnetite, and locally violarite and smythite. Additionally, most samples contain native Cu and a chemically wide range of Cu-sulfide assemblages including chalcocite, cubanite, bornite chalcopyrite, samaniite [$Cu(Fe,Ni)_8S_8$], and sugakite [$Cu_2(Fe,Ni)_7S_8$]. Elemental mapping revealed that native copper abundantly forms dendritic rims around pentlandite, while pentlandite is variably replaced by Cu-sulfides.

The mineralogical observations and the opaque mineral assemblages of the peridotites generally reflect i) highly reducing conditions during serpentinization and very low water rock ratios (<< 1), ii) that both formation of amphibole and Cu-alteration occurred subsequent to serpentinization, and iii) that serpentinization occurred at ≤250°C, but that locally fluid temperatures exceeded 300-350°C. Thus, our new data indicates that the peridotites of the Santa Elena complex experienced several stages of hydrothermal alteration and that serpentinization was likely overprinted by a later high temperature hydrothermal event.

DOI:10.1180/minmag.2013.077.5.19