4.5.12

New insights on metal biogeochemistry in tropical environments: The role of vegetation in metal cycles in a small watershed

P. OLIVA, J. VIERS, B. DUPRÉ, R. GAINVILLE, J. NDAM, AND R. FREYDIER

LMTG, OMP-IRD-UPS, 38 rue des 36 ponts 31000 Toulouse, France (oliva@lmtg.ups-tlse.fr)

In tropical environments, the role of the biosphere (e.g., vegetation, organic matter) is being recognised in nutrient cycling [1-3]. Previous study [4,5] of chemical weathering at the scale of a small tropical catchment in South Cameroon (Nsimi-Zoetele) has shown organic matter and vegetation to play an important role in major element export. This study investigates micronutrient (Cu, Zn) behavior at the small catchment scale. We focus on estimates of stocks and fluxes in all watershed compartments (i.e., total humid precipitation, surface waters, soils, parental rocks, litter and vegetation).

Interpretations are based on new data (a specific mission 01 2003, to sample litters representative plants) and previous results [4-6]. A significant increase of Cu and Zn concentrations between spring waters (0.3 µg/l and 1.7 µg/l) and the waters leaving the watershed (0.9 µg/l and 4µg/l) is observed. However, in spite of this increase, the budget between i) Cu (4 g/ha/yr) and Zn (15 g/ha/yr) exports by Mengong stream water, and ii) total humid deposits of Cu (18 g/ha/yr) and Zn (298 g/ha/yr) appears to be negative (i.e., -14 g/ha/yr for Cu and -83 g/ha/yr for Zn). Thus, it seems that Cu and Zn are stored at the watershed scale. As soil cover is depleted in these elements compared to the parent rock, we suggest that Cu and Zn storage occurs in the biosphere reservoir, as litter and vegetation. Net annual biomass production does not entirely counterbalance Cu and Zn entering the forest cycle as precipitation and litter fall which suggests the litter reservoir regulates Cu and Zn cycling at the watershed scale. Stream water export represents less than 1% of the total Cu and Zn that annually moves between the ecosystem compartments.

At this stage of the study, uncertainties remain concerning litter functionning or precipitation data due to the lack of information on dry deposit or biogenic emission. Much is expected with investigations based on Cu and Zn isotopes.

References

[1] Attiwill P.M. and Adams M.A. (1993) *New Phytol*., **124**, pp.561-582.
[2] Chadwick O.A. et al. (1999) *Nature*, **397,** 491-497.
[3] Lucas Y. (2001) *An. Rev. Earth Planet. Sci*., **29,** 135-163.
[4] Viers J. et al. (1997) *Chem.Geol*., **140,** 181-206.
[5] Oliva P. et al. (1999) *GCA*, 63, 4013-4035.
[6] Freydier R. et al. (2002) *Bull.Soc.Geol.Fr.*, **173,** 129-145.
[7] Ibrahima A. et al. (2002) *Tropenbos Cam.Doc*., **9,** 44 pp.

4.5.13

Biogenic weathering of high Arctic sandstones inhabited by endolithic microorganisms

C.R. OMELON[1], W.H. POLLARD[2] AND F.G FERRIS[1]

[1] University of Toronto Geology, 22 Russell Street, Toronto, Ontario, M5S-3B1, Canada (omelon@geology.utoronto.ca; ferris@geology.utoronto.ca)
[2] McGill University Geography, 805 Sherbrooke Street West, Montréal, Québec, H3A-2K6, Canada (pollard@geog.mcgill.ca)

Endolithic microbial activity in terrestrial rock outcrops produce distinct exfoliative weathering patterns that are commonly observed in polar deserts[1]. The relative simplicity of these lithobiontic communities provides a unique opportunity to study microbe-mineral interactions that, when combined with chemical and environmental data, can identify the degree to which microorganisms play a role in weathering lithic substrates.

Both chemical and physical processes associated with endolithic microorganisms contribute to accelerated weathering of host rocks, but the degree and extent to which these factors influence rates of erosion over abiotic mechanisms can vary. Previous work on Antarctic cryptoendolithic habitats [2] show that lichen-dominated communities increase weathering rates by the production of oxalate that enhances dissolution of the sandstone cement. However, abiotic processes such as freeze-thaw cycling and physical abrasion can also erode lithic substrates in polar environments.

Here we present evidence of how both physical and chemical processes associated with cryptoendolithic microorganisms contribute to biogenic weathering of sandstone outcrops on northern Ellesmere Island, Nunavut. Examination of polished thin sections using SEM-BSE imaging with EDS analysis combined with microenvironmental data suggests weathering is enhanced by dissolution of the carbonate cement resulting from prolonged moisture retention within the microbial biofilm. In contrast to the prevalence of lichen populations in the Antarctic, cyanobacteria dominate endolithic habitats in this region; these microorganisms produce polysaccharides to reduce desiccation, which effectively retain moisture. Examples of rocks colonized by similar microbial populations that show little degree of this erosional patterning suggests that the cementing agent is a major control on the degree of biogenic weathering in this high Arctic desert environment.

References

[1] Friedmann E.I. (1982) *Science* **215,** 1045-1053.
[2] Johnston C.G., and Vestal, J.R. (1993) *Microb. Ecol.* **25,** 305-319.