Biotic/abiotic controls on silica cycling in a grassland soil chronosequence

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A soil chronosequence (65 TO 225 kA)), exposed to a coastal Mediterranean climate near Santa Cruz, California, provides ideal conditions to quantify both short and long-term patterns in silica mobility and cycling linked to seasonal variability in hydrology, pore water chemistry and growth patterns of the grassland vegetation. Superimposed on long-term silica release rates dominated by feldspar weathering and dependent on soil ages [1, 2] are additional patterns reflecting Si cycling between pore waters and grass biomass. While the seasonal uptake and release of mineral nutrients such as K and Ca involve the incorporation into and release from relatively labile organically-bound compounds, the cycling of Si involves the incorporation and slower release from phytoliths composed of amorphous silica. Annual Si fluxes between the soil and grasses (f_{Si}) is 0.16 moles m^{-2} yr while the total phytolith soil mass (m_{phyto}), whose distribution with depth reflects both bioturbation and chemical weathering, is 85 moles m^{-3}. Assuming steady-state conditions, the phytolith residence time in the soil is $t_1 = 500$ yr

Alternatively, a phytolith residence time of $t_2 = 30$ yrs is calculated based on a 'shrinking sphere' approach incorporating recently reported experimental dissolutions rates k_r and estimates of surface roughness λ and molar volume V_o. The discrepancy in residence times ($t_1 > t_2$) either indicates non-steady-state conditions, i.e. phytoliths are currently dissolving much faster than in the past, or more likely, the natural rates are significantly slower due to the fact that pore waters are close to amorphous Si saturation. Such saturation inhibition is previously reported for silicate mineral weathering in the Santa Cruz soils [2]. Increases in amorphous Si, in excess of phytoliths with depth, and a close association with Al suggest that phytolith weathering is contributing to precursor clay formation. Addition insights are presented based on Ge/Si ratios and δ^{3o}Si distributions.

[1] White *et al*. (2008) *GCA* **72**, (36-68). [2] White *et al*. (2009) *GCA* **73**, 2804–2831.

Stable isotopic evidence of climate-driven changes in methane cycling in northern peatlands

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Boreal peatlands contain >30% of terrestrial organic carbon and are particularly vulnerable to changes in climate. Temperatures in boreal regions are predicted to increase during the 21st century which may affect soil microbial processes and plant communities. Plant community composition controls soil carbon quality, methanogenesis, methanotrophy and thus methane efflux. To date, these feedbacks have not been incorporated into carbon cycling components of GCMs. We investigated effects of soil warming and drying on methane cycling using lab incubations and field mesocosms. Bog and fen soil monoliths in northern Minnesota, received infrared heating crossed with water-table control for 6 years. Concentrations, fluxes and isotopic compositions of CH_4 were measured as well as acetate, sulfate, ammonium, plant productivity and N retention. Short-term (5-yr) perturbations in IR and water table affected CH_4 cycling through changes in soil decomposition, root productivity, and N availability. We speculate that increase in labile substrates associated with root exudates and enhanced plant transport contribute to increases in methane efflux. Porewater stable isotopes support acetate fermentation as the principal pathway of methanogenesis in bogs (mean $\delta^{13}CH_4$ = -39.3‰). Under warm, wet conditions, the majority of the methane was isotopically heavy (mean $\delta^{13}CH_4$ = -28.1‰), consistent with methanotrophic activity throughout the soil column. Increases in mineralization of organic N to ammonium in porewater may enhance methane oxidation under low water table. To further improve our understanding of the dynamics of methane cycling in response to climate forcing, soil microbial communities and their interactions with plant communities must be studied in greater detail.