

The contribution of phytoliths in improving the understanding of Si cycling

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The Si cycle is remarkably affected by biomineralisation processes through the formation of diatoms and other microorganisms in aquatic systems, and through the formation of phytoliths that constitute the main form of Si storage in terrestrial plants. After translocation from the roots to the shoots as silicic acid, the main form of Si in soil solutions, Si is polymerized through the elimination of water by evaporation and the formation of phytoliths occurs. Phytoliths are composed of opal A (XRD-amorphous phase) particles although some authors have suggested the presence of crystalline silica. Contrary to many nutrients, Si cannot be subsequently redistributed within the plant because the phytoliths remain insoluble until the litter falls and decomposes. The beneficial effects of Si have been demonstrated by many studies using pots, hydroponic and field experiments and are particularly remarkable in plants exposed to biotic or abiotic stresses.

During litter decomposition phytoliths are either dissolved and constitute a source of recycled Si for plants or preserved from weathering and their morphoscopy may then be helpful for reconstructing the past vegetation. After presenting some evidences that phytoliths can control the biogeochemical cycle of Si at ecosystem or watershed levels, several issues concerning phytolith research are discussed. A few recent studies have provided some evidences that agriculture practices can deplete ASi pools of soil. Because phytoliths constitute one of the most rapidly bio available source of Si for crops, the consequence of soil erosion and straw exportation on crop yield should be more studied in cultivated areas. In order to better integrate the phytoliths in the global models of Si cycling there is a need for a better quantification of soil phytolith pool (ASi). Extraction using gravimetric methods are time consuming and poorly correlated with extractions using alkaline dissolution protocols such as the DeMaster's (1981), initially used for diatom test quantification in aquatic systems. We have recently shown that alkaline extraction may not be strong enough to dissolve aged phytoliths, and may underestimate ASi by a factor of 4.

Laboratory Study of Nitrate Photolysis in Antarctic Snow: Quantum Yield, Mechanism, Isotope Effects and Wavelength Dependence

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Post-depositional processes alter the nitrate concentration and isotopic composition at low accumulation sites. Available nitrate ice core records can only provide input for studying past atmospheres and climate if such processes are fully understood. Reported quantum yields for the main reaction differ by orders of magnitude. The experimental system included a Xe lamp with optional UV filters, an environmental chamber with temperature control and a N₂ flow system to flush gas phase products and used natural snow from Dome C, Antarctica. Irradiated snow was sampled in 1 cm sections and analyzed for nitrate concentration and isotopic composition ($\delta^{15}\text{N}$, $\delta^{18}\text{O}$ and $\Delta^{17}\text{O}$). Observed values for the quantum yield lie in the middle of the range of previously reported values and can be explained using two types of nitrate: one easily accessible (photolabile) and one of trapped or buried nitrate. The quantum yield changes from 0.45 to 0.05 within what corresponds to weeks of UV exposure in Antarctica. An average photolytic isotopic fractionation of $^{15}\epsilon = -15 \pm 0.01 \text{‰}$ was found for the experiments without a wavelength filter. These results are ascribed to excitation of the intense absorption band of nitrate around 200 nm. No fractionation was observed in the oxygen isotopes. An experiment with the 305 nm UV filter, close to the actinic flux spectrum in Dome C, showed a photolytic isotopic fractionation of $^{15}\epsilon = -38 \pm 2.2 \text{‰}$ slightly more positive than the fractionation determined in the field (-40 to -74.3‰, Erbland *et al.*, In review). We demonstrate that the photolytic fractionation of nitrate isotopes in snow is very sensitive to the actinic flux spectrum, leading to the reinterpretation of previous laboratory studies. In order to directly apply results from laboratory studies to ambient conditions the wavelength of irradiation has to match that in the field, as the photolytic fractionation changes significantly depending on the impinging spectrum.