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Fire effects on silica fractionation

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Fire events are expected to increase due to climate change, both in number and intensity Effects range from changes in soil biogeochemistry up to the whole ecosystem functioning and morphology. While N, P and C cycling have received quite some attention, little attention was paid to fire effects on the biogeochemical Si cycle and the consequences after a fire event. The Si cycle is a globally important biogeochemical cycle, with strong connections to other biogeochemical cycles, including C. Dissolved silica is taken up by plants to form protective structures called phytoliths, which become a part of the soil and contribute strongly to soil Si cycling upon litter burial. Different silica fractions are found in soils, with phytoliths among the most easily soluble, especially compared to silicate minerals. A whole set of secondary non-biogenic fractions exist, that also have a high reactivity (adsorbed Si, reactive secondary minerals…). Biogenic and other pedogenic secondary Si stocks form an important filter between weathering of mineral silicates and eventual transport of dissolved Si to rivers and the coastal zone.

We used a new method to analyze the different reactive fractions of silica in the litter layer of 3 ecosystems after different fire treatments. Using a continuous extraction of Si and Al in 0.5M NaOH at 85°C, biogenic and non-biogenic alkaline reactive Si fractions can be separated based on their Si/Al ratios and their reactivity. We analyzed the silica fractionation after two burning treatments (no heating, 350°C and 550°C) from three types of litter (spruce forest, beech forest and Sphagnum peat). Reactive Si from litter of spruce and beech forest was purely biogenic, based on the observed Si/Al ratio. Beech litter (∼2.2 % BSi) had two different biogenic silica pools, one reactive and one more refractory. Spruce litter (∼1.5% BSi) showed only one fraction of biogenic Si. There was negligible biogenic Si present in the peat samples (<0.1%). While a fairly large fraction of crystalline Si (analyzed using x-ray diffraction) was present in the beech forest and the peat samples, it was much smaller in the spruce forest samples. Biogenic Si content (relative to original mass) did not change for the forest samples after both burning treatments. However, based on Si/Al ratios, we observed that the 550°C treatment caused a crystallization of the BSi in the beech samples. Then, we performed a dissolution experiment in rain water. Spruce and beech litter had similar solubility after 24 h (about 0.3% of BSi dissolved) and intermediate burning (10-13% of BSi dissolved). BSi solubility increased with more intense burning, with highest solubility observed in the spruce ash (550°C) samples (90% of BSi dissolved). In the beech ash samples, solubility increased to 20% of the BSi. Our results emphasize that biogenic Si solubility is apparently affected by the degree of burning, and the presence of mineral Si in the litter layer can affect the crystallization of the BSi.