Silica fractionation and reactivity in soils

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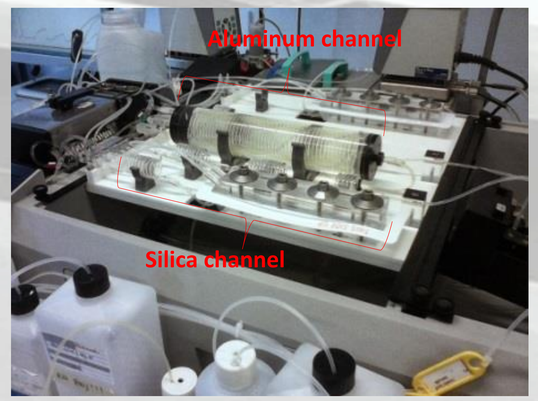
1. Aim of the phD! Although silica cycle plays an important role in soil acidification control, carbon dioxide regulation and nutrition of plants and microorganisms, is still a very poorly known biogeochemical cycle. Different silica fractions can be found in soils, therefore a good characterization of these fractions is crucial to move forward knowledge on soil Si cycling.
How many fractions are there? How these fractions vary along the global silica cycle? How humans affect the silica fractionation?

2. Why is this interesting?
Different fractions have different reactivity - how fast they can dissolve and hence the facility to be taken up by plants. We can distinguish between: biogenic silica (BSi) that comes from the degradation of living organisms which consists mostly on phytoliths (protection structures from plants) and is highly reactive due to its amorphous structure; silicate minerals that come from the bedrock dissolution and are less reactive; and a whole set of secondary non-biogenic fractions, that can also have a high reactivity (adsorbed Si, reactive secondary minerals…).
Silica and carbon cycle are strongly connected. Silica is taken up by diatoms, the strongest carbon storage organism and the basic producer of the oceanic food web. The characterization of silica fractionation could contribute to understand how much and what kind of silica reaches the ocean.
These characterization can also help better to understand weathering processes related to silica.



New Method

3. New method. Using a continuous extraction of silica and aluminum in 0.5M NaOH, biogenic and non-biogenic fractions can be distinguished. (Adapted by Barão, 2013 from Koning, 2002).

4. How does it work? The ratios between silica and aluminum concentrations tell us the character of the fraction.
Si/Al ratio:
>4: Biogenic silica fraction (BSi). High Si content.
1-4: Clay minerals. Because of the clay's proportions itself.
< 1: Silica absorbed to Fe and Mg oxides. More Al than Si.

5. What are we testing?

Fertilizers effects

Olivine (silicate mineral) fertilization of two crops (barley and wheat), at two rain application regimes (daily rain and weekly heavy rain) and with two different fertilizer grain sizes.

How crops and soil respond to olivine fertilization?
Is silica cycle affected by an increase of the intensity of rainy events – as expected due to climate change?

Fire effects

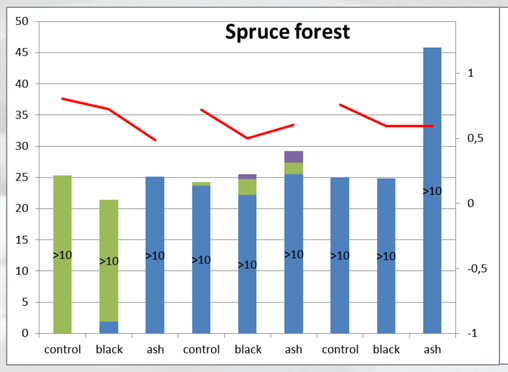
Litter from spruce and beech forest and peat soils at two burning levels, after 350°C and 550°C burnings.

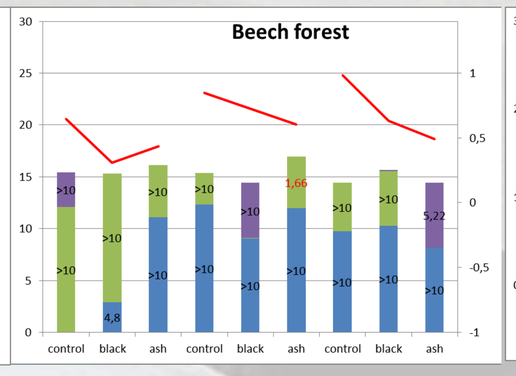
First results

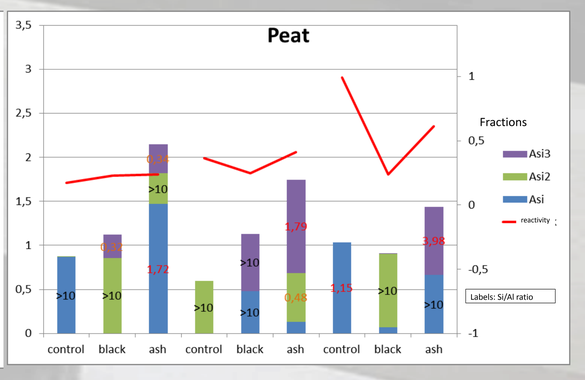
- Spruce BSi content was higher than beech litter content (phytolith Si content). No strong differences in fractionation.
- No evident changes in reactivity among all samples.
- In peat, Si mineralizes and becomes extractable after burning!

Land use effects

Comparison between highly disturbed and 'pristine' soils.
Brazil fieldwork: Crop fields (strong and less degraded soils) under crop rotation and forest soils almost undisturbed.
Is the silica fractionation affected by the land use?







References: - Koning E., Epping E. and van Raaphorst W. (2002) Determining biogenic silica in marine samples by racking silicate and aluminium concentrarions in alkaline leaching solutions. Aquatic Geochemistry 8, 37-67.
- Barão, L., Clymans, W., Vandevenne, F., Meire, P., Conley, D.J. and Struyf, E. Pedogenic and biogenic amorphous Si distribution along a temperate land use gradient. Submitted, European Journal of Soil Science, 2013.