



Impacts of soil aggregation on the mobility of silicon in model variable charge soils

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Phytoliths are considered by biogeochemists and soil scientists as an important reservoir of mobile Si in the soil-plant system due to their relatively high dissolution rate. However, they are used in other disciplines as microfossils to reconstruct paleoenvironments because of their stability over millennia. Thus, on one side, phytoliths contribute massively to the continental export of dissolved silica to rivers and oceans, hence to the global silicon (Si) cycle, and, on the other side, they persist in soils and sediments. In addition to phytolith properties, soil processes can enhance their resilience, e.g., surface passivation through aluminum (Al) loading or redox-dependent iron (Fe) coating, pH buffering and aggregation.

Here, we highlight the impact of aggregation on the release of dissolved Si (DSi) from aggregates built up from assemblages including organic matter, phytolith, quartz, clay mineral and Fe oxide. The source of DSi was assessed using Al/Si and Ge/Si ratios in aqueous extracts obtained kinetically.

Aggregation significantly reduced the release of DSi particularly when variable charge components were amorphous. In this case, the source of DSi was unequivocally allophane, the dissolution of which was enhanced by pH below 5 (3.7-4.9). In contrast, in aggregates involving crystalline variable charge, DSi was released from phytoliths. In this case, Fe oxide had a significant effect on DSi release through both the aggregation process and pH control above 5 (5-8). Phytolith preservation in aggregates was effective at low oxide content (20 g kg⁻¹). Yet, the increase in pH enhanced phytolith dissolution.

Soil and sediments may thus contain two pools of phytoliths: fresh and stabilized phytoliths. The first reservoir is an important source of aqueous Si, and contributes actively to the Si soil-to-plant cycle and the DSi transfer to the hydrosystem. Yet, Si can be retrieved from the global Si cycle through phytolith entrapment in aggregates. This process contributes to the second pool of stabilized phytoliths. However, pH buffering significantly affects the impact of aggregation and the source of DSi. Indeed, acidic conditions enhance the dissolution of clay minerals while they decrease the dissolution rate of phytoliths