Tracing land use controls on silica dynamics in the soil-vegetation continuum

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Bio-available silica (Si) is a key element in global biogeochemical cycling. In terrestrial ecosystems plants take-up dissolved silica (DSi), and form plant Si-bodies called phytoliths [1]. Upon die-off these return to the soil as amorphous silica (ASi), which dissolves far more easily than mineral silica. This dissolved Si is prone to recycling by vegetation, biological (e.g. bio-mineralisation) and/or pedogenic processes (e.g. precipitation or adsorption), but part of it is lost to aquatic systems [2]. Changes in the biological component of the Si cycle may lead to more rapid variations in the land-ocean Si transfer than previously thought [3].

The objective of this study is to contribute to understanding of the controls on temporal Si dynamics in terrestrial ecosystems, by studying Si budgets (fluxes and pools) from a small forested catchment and human disturbed catchments in central Belgium. Si is used as a tracer to determine pathways, and to assess land use control. Detailed concentrations and load patterns (2008-2010) of bio-available Si in pore-water, streams and soils made it possible to determine the different processes causing variation in kinetic equilibrium of DSi with land-use.

For the forested catchment, which is used as a reference, discharge-concentration relationships made it possible to distinguish the main processes responsible for Si dynamics during runoff events: (1) within-channel mobilization controls ASi-delivery, and (2) a dilution-flushing effect controls DSi-delivery. End-member mixing analysis showed that at up-stream catchments base-flow delivers 92.5±10% of the water, and a chemostatic behavior confirms the existence of an important kinetic equilibrium at the catchment scale.

In contrast, disturbed catchment tend to be less chemostatic, and had a significant lower kinetic Si equilibrium and bio-available Si pool (up to three times). This is explained by a perturbation of the interactions in the critical zone: a reduced Si restitution, increased Si leaching, reduced chemical weathering and conversion to less labile Si forms in severely disturbed catchments. Lower final bio-available Si delivery from disturbed catchments indicate a lower importance of subsurface delivery which is not compensated by increased overland sources. Land-use controls on Si pathways together with biological and pedological interactions were conceptualized. We show that deforestation of the catchment, as has historically taken place elsewhere in temperate regions, would drastically alter the the Si dynamics of the catchment.

[1] Watteau and Villemin (2001) *Eur. J. Soil Sci.* **52**,385-396. [2] Cornelis *et al*. (2006) *Biogeosciences* **8,** 89-112. [3] Conley. (2002) *Global Biogeochem Cy* **16**, 11-21.

Metal evolution during differentiation of calc-alkaline magmas (Hunter Ridge, SW Pacific)

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Understanding the behaviour of metals during magmatic differentiation processes helps constrain the important of parental magma composition for the potential fertility of a particular magma series, i.e. whether the association of an ore deposit with a specific magma type is due to the metal-rich parental magma, or is a consequence of later processes.

Rock samples collected from the Hunter Ridge (North Fiji Basin) include a typical island-arc calc-alkaline suite that covers a very broad range of rock MgO contents (1-14 wt.%) (Fig. 1). Phenocrysts in these samples have highly variable compositions (i.e. olivine Fo 79-95, clinopyroxene Mg# from 70-92, plagioclase An 22-92). Magnesian olivine and clinopyroxene record early, pre-eruptive stages of fractionation.

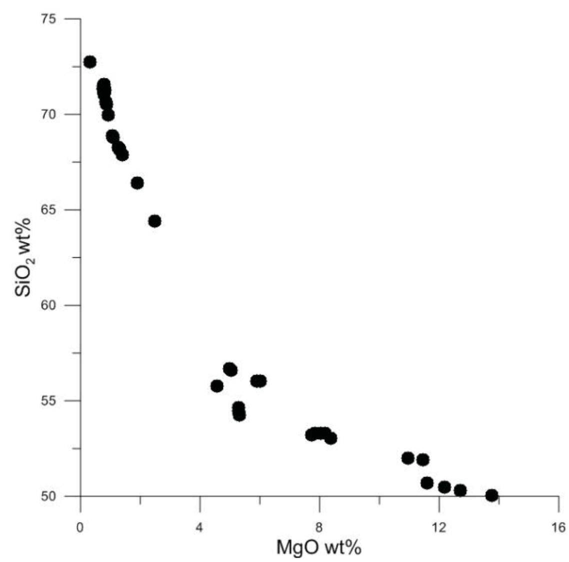

Figure1: SiO_2 wt% vs MgO wt% contents of calc-alkaline lavas from the Hunter Ridge.

In order to constrain the behaviour of metals (Cu, Zn, Pb, Co, Ni, and others) during magma fractionation, we have analysed their content in phenocrysts formed at various stages of magmatic fractionation using LA-ICPMS. A comparison of their behaviour with a wide range of lithophile elements allows for 1) a better constraint on the relative incompatibility of various metals during crystallisation processes and 2) on their distribution between immiscible phases such as fluids and sulphide melts at different stages of magma evolution.

Our results indicate that partitioning between silicate melts and water-rich fluids can affect the concentration of some metals from the earliest stages of magma evolution at crustal levels.