Seasonal stream water chemistry at the Damma Glacier, Switzerland

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In the past few years a number of catchment-based studies have focused on the role of glaciers and have come to conflicting conclusions regarding the effect of the glacier on chemical weathering rates and resulting CO_2 consumption. Gaining a clear picture of weathering processes in glacial regions is difficult due to dilute meltwaters, the truncated field sampling season and the influence of daily melt cycles.

This work forms part of the multi-disciplinary BigLink Project which is investigating the 10.7 km^2 granitic Damma catchment (Switzerland). The glacier has retreated rapidly, exposing fresh mineral surfaces, allowing the initial stages of granite weathering to be studied. Stream waters were sampled for six months in five different locations, in conjunction with high-resolution hydrological and meteorological measurements. Selected isotope ratios were analysed in addition to the overall chemical composition to characterise spatial and temporal variations in stream water chemistry.

After correction for atmospheric inputs, daily and seasonal cycles were clearly observed in the cation concentrations. These trends were independent of dilution and indicated the mixing of at least two distinct water sources whose relative proportions changed over seasonal and daily timescales. These sources reflected differing water-rock interaction times as evinced by variable elemental ratios (e.g. Na/Ca) which were offset from bulk rock ratios.

The $\delta^{44/42}$Ca isotope ratios (measured by TIMS using a ^{43}Ca-^{46}Ca double spike) were uniform and indistinguishable from bedrock samples. Thus, the dissolved Ca isotopic signature of the catchment output is that of the granitic bedrock and this indicates that Ca isotopes are not fractionated during the initial stages of granite weathering.

The calculated cationic and silica fluxes are among the lowest reported from alpine glaciers and are at the low end of the range reported for non-glaciated granitic catchments.

Further analyses will help to provide better constraints and improve our understanding of the chemical weathering and mixing processes that occur in glacial, granitic catchments.

Short and long-term denudation rates at the Altiplano margin, La Paz region, Bolivia

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Erosional unloading by focused incision causing flexural rebound has been proposed for the Rio La Paz drainage system, Bolivia [1]. However, relief, landscape morphologies and processes, as well as tectonics and precipitation rates contrast sharply across the drainage divide. This results in high denudation rates towards the east where precipitation rates are highest, landsliding processes dominate [2,3] and flexural rebound is focused down-valley [1]. Denudation rates in the Rio La Paz drainage realm are temporally variable with present day rates of 0.6-6 mm/yr (sediment yield data [4]), millennial rates of 0.1-0.6 mm/yr (cosmogenic nuclides [2]) and long-term (my) sediment budget rates of ~ 0.23 mm/yr [2]. Assuming rebound to be constant since the initiation of the Rio La Paz system (~ 2.8 My [1]), the denudation rates would be several times higher than the modelled rebound, but could also point towards rebound rates increasing with time.
Here we quantify denudation rates and the effects of a suggested flexural rebound due to erosional unloading by the Rio La Paz drainage system on the Altiplano side. Precipitation rates are relatively low and the landscape exhibits smooth hillslopes and diffusive hillslope processes. For catchments bordering the Rio La Paz drainage divide but draining towards the Altiplano we have determined catchment wide denudation rates based on cosmogenic ^{10}Be in river sediments. Preliminary denudation rates vary between 0.005 to 0.025 mm/yr, with higher rates in catchments affected by partial glacial modifications. Modern sediment yield rates [5] are similar to the cosmogenic nuclide-derived values, although the latter integrate over >30-200 ky. Therefore, on the Altiplano side, the proposed rebound appears to be in steady state with denudation. Nevertheless, ongoing headward capture of the Rio La Paz into the Altiplano seems yet to be the dominant process at the eastern margin of the Altiplano.

[1] Zeilinger & Schlunegger (2007), *Terra Nova* **19**, 373-380. [2] Zeilinger *et al*. (2009), *EGU*. [3] Safran *et al*. (2005), *ESPL* **30**, 1007-1024. [4] Bourges *et al*. (1990), *IHAS* **193**, 351-356. [5] Guyot *et al*. (1992), *Lake Titicaca* 113-119.