Shale weathering turning mountains into CO_2 sources

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As sedimentary rocks crop out over a large fraction of the Earth continental surface, their weathering has a major impact on global biogeochemical cycles, solutes and particulate fluxes to the oceans, and evolution of atmospheric CO_2 [1]. The Bolivian Andes are a perfect setting to study the global effect of this process, as they are almost solely underlain by sedimentary rocks, feature high erosion rates, and are drained by the largest river system in the world, the Amazon. Based on an extensive sampling of the dissolved load of more than 20 rivers draining the Bolivian Andes and the associated foreland and lowland areas of the Madeira Basin, we quantify the rates and characterize the chemical pathways of sedimentary rock weathering and erosion. We use an inverse method to solve a novel set of mass budget equations and estimate the contribution of the various rock and acidity sources to the solute load. The results of the inversion are checked against independent isotope data on dissolved sulfate ($\delta^{18}O$ and $\delta^{34}S$).

Silicate weathering contributes to around 70% of the chemical denudation in the Upper Beni Basin, while the contribution of carbonate weathering attains 50% in some Andean rivers. In addition, sulfuric acid (derived from the oxidation of sedimentary sulfides) is the major proton supplier in the upper Bolivian Andes, and is much less significant at lowland sites. We find that the rate of sulfide oxidation at the basin scale is correlated with the erosion rate, indicating that this process is limited by the supply of sulfide to the Earth surface. In the Andean area, weathering reactions comsume only a limited amount of acidity derived from atmospheric CO_2, while in the lowland area of the Madeira Basin, weathering reactions represent a net sink of atmospheric CO_2. In particular, we find that the net atmospheric CO_2 sink related to weathering in the whole Madeira Basin is around 40.10^4 mol y^{-1}, i.e. three times lower than previously suggested [2,3]. Following these results, a reconsideration of the role of mountain building on the long-term evolution of atmospheric CO_2 is warranted.

[1] Dellinger *et al.*, *EPSL* **401**:359-372, 2014. [2] Gaillardet *et al.*, *Chem. Geol.* **142**:141-173, 1997 [3] Moquet *et al.*, *Chem. Geol.* **287**:1-26, 2011