Geophysical Research Abstracts
Vol. 19, EGU2017-13894, 2017
EGU General Assembly 2017

Chemical weathering of flat continents

Pierre Maffre (1), Yves Goddéris (1), Jean-Baptiste Ladant (2), Sébastien Carretier (1), Jean-Sébastien Moquet (1), Yannick Donnadieu (2,3), David Labat (1), and Nathalie Vigier (4)

(1) Geosciences Environnement Toulouse, CNRS-IRD-UPS, Toulouse, France (pierre.maffre@get.omp.eu), (2) Laboratoire des Sciences du Climat et de l'Environnement, CNRS-CEA-UVSQ, Gif-sur-Yvette, France, (3) Aix Marseille Université, CNRS, IRD, Collège de France, CEREGE, Aix-en-Provence, France, (4) Laboratoire d'Océanographie de Villefranche, CNRS, Sorbonne Universités, UPMC, France

Mountain uplift is often cited as the main trigger of the end Cenozoic glacial state. Conversely, the absence of major uplift is invoked to explain the early Eocene warmth. This hypothesis relies on the fact that mountain uplift increases the supply of "fresh" silicate rocks through enhanced physical erosion, and boosts CO_2 consumption by chemical weathering. Atmospheric CO_2 —and therefore climate— then adjust to compensate for the changes in weatherability and keep the geological carbon cycle balanced (Walker's feedback).
Yet, orography also strongly influences the global atmospheric and oceanic circulation. Consequently, building mountains does not only change the weathering regime in the restricted area of the orogen, but also modifies the worldwide distribution of the weathering flux.
We conduct a numerical experiment in which we simulate the climate of the present day world, with all mountain ranges being removed. Up-to-date weathering and erosion laws (West, 2012; Carretier et al., 2014) are then used to quantify the global weathering for a "flat world". Specifically, the parameters of the weathering law are first carefully calculated such that the present day distribution of the weathering fluxes matches the riverine geochemical data. When removing mountains, we predict a warmer and wetter climate, especially in geographic spots located in the equatorial band. The calculated response of the global weathering flux ranges from an increase by 50% to a decrease by 70% (relative to the present day with mountains). These contrasted responses are pending on the parameterisation of the weathering model, that makes it more sensitive to reaction rate (kinetically-limited mode) or to rock supply by erosion (supply-limited mode). The most likely parameterisation —based on data-model comparison— predicts a decrease of CO_2 consumption by weathering by $\sim$40% when mountains are removed.
These results show that (1) the behaviour of the weathering engine depends on the continental relief, but also on the continental configuration through global climatic connexions. Results obtained for the present day world are not valid for other continental configurations of the geological past. (2) The available estimates of the silicate weathering from river geochemical data are still too few to allow a precise calibration of parametric laws. We are currently working on introducing to the model additional proxies of continental weathering such as lithium isotopes.

Carretier, S., Goddéris, Y., Delannoy, T. and Rouby, D. (2013) Mean bedrock-to-saprolite conversion and erosion rates during mountain growth and decline. Geomorphology 209:39–52.
West, A.J., (2012) Thickness of the chemical weathering zone and implications for erosional and climatic drivers of weathering and for carbon-cycle feedbacks. Geology 40(9):811–814