

Impact of atmospheric CO₂ levels on continental silicate weathering

E. BEAULIEU^{1*}, Y. GODDERIS¹, D. LABAT¹,
C. ROELANDT², P. OLIVA¹ AND B. GUERRERO¹

¹Laboratoire des Mécanismes et Transferts en Géologie,
Observatoire Midi-Pyrénées, CNRS-Université de
Toulouse, France

(*correspondence: beaulieu@lmtg.obs-mip.fr)

²Geophysical Institute, University of Bergen, Norway

Human activities are the main culprit for the CO₂ concentration increase in the atmosphere since the beginning of the industrial revolution. Here we used the B-WITCH model to quantify the impact of atmospheric CO₂ rise on CO₂ consumption by weathering of the continental surfaces. B-WITCH couples a dynamic biogeochemistry model (LPJ) and a process-based numerical model of continental weathering (WITCH). It allows the coeval calculations of the different components of the continental weathering fluxes, terrestrial vegetation dynamics, and carbon and water fluxes. The CO₂ consumption rates are estimated at four atmospheric CO₂ concentration from 280 up to 1120 ppmv for 22 sites characterized by silicated lithologies (basalt, granite or sandstones). Only the sensitivity to CO₂ is explored and temperature and rainfall are held constant. First, we show that under 355 ppmv of atmospheric CO₂, the B-WITCH is able to reproduce the global pattern of weathering rates as a function of either annual runoff, mean annual temperature or latitude for silicated lithologies. When atmospheric CO₂ rises, the evapotranspiration generally decreases owing to the progressive stomatal closure and the soil CO₂ pressure rises because of enhanced biospheric productivity. As a result, vertical drainage and soil acidity increase, promoting CO₂ consumption by mineral weathering. We calculate an increase of about 3% of the dissolution for 100 ppmv rise in CO₂. Importantly, the sensitivity of the weathering system to the CO₂ rise is not uniform, and heavily depends on the climatic, lithologic, pedologic, and biospheric settings.

Subduction-collision transition and preservation of subduction-zone geochemical history in HP/UHP metamorphic suites

G.E. BEBOUT*

Lehigh University, Bethlehem, PA 18015 USA

(*correspondence: geb0@lehigh.edu)

HP and UHP metamorphic rocks commonly preserve records of both prograde, subduction-related metamorphism and exhumation, the latter often related to collision. One example of this is in the Western Alps, where metamorphosed Jurassic ophiolite and carbonate-rich sediments (Schistes Lustrés, Cignana) record a transition from subduction to collision leading to exhumation of these rocks. The Schistes Lustrés resembles sediment sections subducting into the Banda trench [1] and contrasts with sections being subducted into most modern subduction zones. Prograde histories in UHP rocks are variably obscured by exhumation-related overprinting and relatively warm exhumation paths result in dehydration (and associated fluid flow) and partial melting.

There is growing evidence that, in relatively cool subduction zones, subducting lithologies preserve much of their volatiles and even the particularly fluid-mobile elements to depths approaching those beneath arcs [2, 3]. In less permeable rocks, geochemical heterogeneity related to surface processes is retained to such depths (e.g. seafloor alteration signatures in oceanic crust; O isotope anomalies in continental rocks [4]). More pronounced geochemical change is localized along fractures and other zones of enhanced deformation (e.g. melange zones). Subduction channel rocks (oceanic, continental) could experience interaction with large amounts of hydrous fluid from dehydrating sub-crustal ultramafic rocks in subducting slabs. Geochemical effects of subduction erosion have not yet been adequately considered.

Experimental studies point to a transition in the properties of 'fluids' at depths greater than those recorded by most HP and UHP suites [5]. It is thus difficult to investigate fluid-rock interactions beneath volcanic arcs and the compositions of oceanic and continental rocks entering the mantle beyond subarc regions (potentially contributing to mantle chemical-isotopic heterogeneity). Field-based research on UHP rocks should work to directly characterize the effects of this deeper melt removal on chemical compositions of melt residues.

- [1] Trumpy (2003) *Ear. Sci. Rev.* **16**, 19–42. [2] Bebout *et al.* (1999) *EPSL* **171**, 63–81. [3] Busigny *et al.* (2003) *EPSL* **215**, 27–42. [4] Zheng *et al.* (2003) *Ear. Sci. Rev.* **62**, 105–161. [5] Hermann *et al.* (2006) *Lithos* **92**, 399–417.