Orogeny, metamorphism and erosion: Towards a selective recycling of graphite and long-term stabilization of C in the crust

O. BEYSSAC[1], V. GALY[2], J. BOUCHEZ[3], J. GAILLARDET[3] AND C. FRANCE-LANORD[4]

[1]Laboratoire de Géologie, CNRS-ENS, Paris, France (beyssac@geologie.ens.fr)
[2]Woods Hole Oceanographic institution, USA (vgaly@whoi.edu)
[3]IPG Paris and univ. Paris Diderot, France (gaillardet@ipgp.jussieu.fr, bouchez@ipgp.jussieu.fr)
[4]CRPG, CNRS, Nancy, France (cfl@crpg.cnrs-nancy.fr)

Organic C (OC) exported by rivers is a mix of recent OC and petrogenic OC derived from erosion of rocks. Burial of petrogenic OC is a simple recycling of reduced C and has no effect on atmospheric CO_2 and O_2 levels. Conversely, its oxidation consumes O2 from and returns CO_2 to the atmosphere. Addressing the role of continental erosion on the global C cycle thus requires assessing the fate of petrogenic OC during erosion. We present a structural characterization of petrogenic OC contained in source rocks, river and marine sediments from various erosionnal systems (Himalaya, Amazon, Taiwan), using Raman Microspectrometry and High-Resolution Transmitted Electron Microscopy. We use radiocarbon dating of bulk OC to quantify the proportion of petrogenic and recent OC in river sediments. Altogether, we show that 30 to 50% of the OC contained in the Himalayan rocks appears to be preserved and recycled in the Bengal fan during the erosion cycle [1], whereas only ~10% of the petrogenic OC is preserved between Andean rivers and the Amazon floodplain. Structural investigations reveal that graphitic phases are the most resistant to oxidation. The thermal factory during orogeny thus plays a key role by transforming sedimentary OC into graphite and subtracts C from the external cycle (atmosphere-biosphere-ocean) and locks it into the geological cycle (crust-mantle). At geological timescales, graphitization thus maintains an imbalance between photosynthesis and respiration by locking reduced C into the crust.

[1] Galy V. *et al.* (2008) *Science* **322**, 943-945.

A high-resolution record of 18^{th}-20^{th} century dust emission rates from the Sahara-Sahel region of Africa

A. BHATTACHARYA AND S. MUKHOPADHYAY

Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA 02138, USA (bhattac@fas.harvard.edu, sujoy@eps.harvard.edu)

Mineral aerosols emitted from arid and semi-arid regions of North Africa are intimately linked to the hydrologic cycle. Hence, a long-term record of dust flux, close to the sources of dust, will allow us to reconstruct drought patterns in the region, and better understand future variations in precipitation patterns. Additionally, these measurements can serve as benchmarks for models that seek to predict future variations in dust emission rates. Here we present a high-resolution record of dust fluxes from the Sahara-Sahel region of North Africa from the 18^{th}-20^{th} century using Helium isotopic variations in a *Porites* coral from the Red Sea. Our previous work has shown that corals can be utilized to quantitatively reconstruct past variations in dust emission rates and precipitation patterns [1].

Spectral analysis of our dust record indicates 12-year and 50-year cycles in the dust emission rates. We find that all major variations in the hydrologic cycle of North Africa in the 20^{th} century, as captured by instrumental records of precipitation, are associated with major variations in the ^4He-based proxy record of dust. Our record indicates that modest climatic forcing can cause large variations in dust emission rates from the Sahara-Sahel region. Dust fluxes in the 19^{th} century, were, on average, a factor of 3 higher than in the 20^{th} century, with rapid and dramatic fluctuations between 1830-1880. The amplitude of the variations in the dust flux during the 19^{th} century was a factor of 3-4 higher compared to the droughts of the 1970's and 1980's. Thus, droughts during the mid-19^{th} century were more severe than those in the 2^{nd} half of the 20^{th} century. Importantly, our dust flux record indicates that, in the 18^{th} and 19^{th} century, cooler sea surface temperatures (SSTs) were associated with higher dust fluxes. However, the relationship between SST and dust emission is much more complex in the 20^{th} century, the reason for which is not apparent, but may plausibly be related to anthropogenic impacts on dust emission rates. Overall, our proxy record of dust suggests that in North Africa, the 20^{th} century was more conducive to the welfare of the human population than the 19^{th} century.

[1] Mukhopadhyay & Kreycik (2008) *GRL* **35**, L20820.