

Chemical and structural imaging of fossilized tissues at the nanoscale and assessment of their taphonomy

M.E. GALVEZ^{1,2}, K. BENZERARA², O. BEYSSAC¹
AND S. BERNARD¹

¹Laboratoire de Géologie, CNRS-Ecole Normale Supérieure, Paris, France (mgalvez@ens.fr, beyssac@geologie.ens.fr, bernard@geologie.ens.fr)

²Institut de Minéralogie et de Physique des Milieux Condensés, CNRS, Paris 6 and IPGP, Paris, France (karim.benzerara@impmc.jussieu.fr)

Geological preservation of molecular fossils from the cell membrane of organisms (i.e. biomarkers) may be a precious record of ancient life and ecosystems. However, such organic fossils may be transformed, altered and/or react with the mineral matrix during diagenesis or metamorphism and assessment of these processes is required to better understand the fossil record. Here, we report the geochemical and structural characterization of remarkably well preserved plant fossil from Austria and New Zealand. Although not relating to microbes, our study explore the capabilities and limitations of new microscopy and spectroscopy tools that are of importance to geomicrobiologists. A petrological study suggests that the New Zealand samples experienced a blueschist facies metamorphic peak (~ 300°C, 8 kbar) and the austrian samples an amphibolite facies (~ 525°C, 7,5 kbar). Despite such high-grade metamorphic conditions, the morphology of these carbonaceous fossils is remarkably well preserved.

We have investigated the structure and chemistry of the organic remains at the 25nm scale using STXM at the C and O K-edges and at the μm scale using Raman and IR spectroscopy. These analyses show the high aromatic content of all the carbon phases composing these samples. Some spectroscopic heterogeneities are observed and interpreted in terms of polarization effects. TEM investigations evidenced the presence of ~100nm Ti oxide rods within the carbonaceous matrix as well as Fe-bearing oxides developed at the interface between carbon phases and the mineral matrix. The chemistry and the texture of these oxides with respect to carbon phases will be presented and discussed in terms of redox processes that affected these rocks. Such study highlights the difficulty of deciphering the taphonomy of fossils with a complex geologic history, but also demonstrates that a systematic multiscale and multitechnique sample characterization is required to address these issues.

The Nd isotopic signature of Himalayan chemical weathering

A. GALY

Department of Earth Sciences, University of Cambridge, UK
(albert00@esc.cam.ac.uk)

Temporal variations in the $^{143}\text{Nd}/^{144}\text{Nd}$ ratio (expressed as ϵ_{Nd}) of marine authigenic phases such as oxides have been used to reconstruct past oceanic circulation and riverine input [1-4]. In the case of the Northern Indian Ocean, the ϵ_{Nd} variations during the Neogene have been interpreted as being primarily controlled by the input of dissolved Nd released by rivers and hence as a record of the weathering fluxes associated with the buildup of the Himalayan orogen [4-6]. Unfortunately direct measurement of the ϵ_{Nd} in the dissolved load of rivers are rather sparse and it is often assumed to be identical to the suspended or bed-load material transported by those rivers. For instance, the Ganges-Brahmaputra input is estimated to have an $\epsilon_{\text{Nd}} = -16.0$ based on suspended sediment material [5].

In order to assess the validity of this value, the leaching and the silicate fraction of suspended and bed-load sediment from the Ganges and the Brahmaputra sampled in Bangladesh have been analysed. The ϵ_{Nd} of the silicate fraction and the bulk sediment range from -17.7 to -13.6, in good agreement with literature data. The leaching has been done in 10% acetic acid, at room temperature and its $^{87}\text{Sr}/^{86}\text{Sr}$ and Rb/Sr ratios are characteristic of detrital carbonate [7]. The ϵ_{Nd} of the leaching ranges from -15.1 to -12.2 and the difference between the ϵ_{Nd} of the silicate and of the leaching is positively correlated with the amount of detrital carbonate with a y-intersect of +2 ϵ_{Nd} units. [Nd] of the leaching (expressed as weight proportion of the dry mass of the material dissolved by the leaching) range from 14.7 to 71.4 ppm and therefore are far too high to be solely representative of the carbonate and suggest that terrestrial authigenic phases are also leached in 10% acetic acid. When corrected for carbonate contribution, the ϵ_{Nd} of the leaching is close to -14.0, a value likely to be more representative of the true modern day Himalayan input of dissolved Nd into the Bay of Bengal. A rise by 2 ϵ_{Nd} units of the Himalayan end-member value will reduce the himalayan contribution by 1/4 to 1/3 when reconstructing Ganges-Brahmaputra outflow into the Eastern Indian Ocean.

[1] O'Nions *et al.* (1978) *Nature* **273**, 435-438. [2] Piegras & Wasserburg (1980) *EPSL* **50**,128-138. [3] Elderfield *et al.* (1981) *GCA* **45**, 513-528. [4] Frank (2002) *Rev. Geophys.* **40**, ARTN 1001. [5] Stoll *et al.* (2007) *EPSL* **255**, 213-228. [6] Gourlan *et al.* (2008) *EPSL* **267**, 353-364. [7] Galy *et al.* (1999) *GCA* **63**, 1905-1925.