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Tracing fossil particulate organic carbon from bedrocks to river and marine sediments: implications for the geological carbon cycle

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Organic C (OC) exported by rivers is a mix of recent OC and fossil OC derived from erosion of rocks. Burial of fossil OC is a simple recycling of reduced carbon and has no effect on atmospheric CO_2 and O_2 levels. Conversely, its oxidation consumes O_2 from and returns CO_2 to the atmosphere. Addressing the role of continental erosion on the global carbon cycle thus requires assessing the fate of petrogenic OC during erosion. In large scale erosionnal systems (Himalaya, Amazon), it has been shown that only graphite resists to oxidation during river transport.
We present new structural and geochemical data on marine (Taiwan) and river (New-Zealand) sediments for two small-scale and extremely active erosionnal systems in which OC is massively and rapidly transferred to the ocean. The in situ structural characterization of fossil OC by Raman spectroscopy shows that all forms of fossil OC, from very disordered (kerogen-like) to graphite, are transported and preserved from the bedrocks to the marine sediments. Such small scale active systems therefore act as major carbon sinks on geological timescale. In turn, the Raman spectra of fossil OC may be used as a powerful tool for the provenance study of detrital sediments.
The fate of fossil OC during erosion is a complex interplay between the burial history (diagenesis/metamorphism) of the OC-bearing source rock, the nature of the erosionnal system (transport, erosion dynamics, biological activity, climate...) and the sedimentation processes. Assessing the interactions of OC between the lithosphere and the atmosphere on geological timescale requires studies in various geological contexts to quantify the fluxes of fossil OC during erosion, but also studies dedicated to the processes controlling oxidation or preservation (role of biological activity).