Geophysical Research Abstracts
Vol. 18, EGU2016-14911, 2016
EGU General Assembly 2016

Badlands and the Carbon cycle: a significant source of petrogenic organic carbon in rivers and marine environments?

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A key issue in the study of carbon biogeochemical cycle is to well constrain each carbon origin in term of fluxes between all C-reservoirs. From continental surfaces to oceans, rivers convey particulate organic carbon originate from the biomass (biospheric OC) and /or from the sedimentary rocks (petrogenic OC). Existence and importance of this petrogenic OC export to oceans was debated for several decades (see Copard et al., 2007 and ref.), but it is now assumed that 20% of the global carbon export to ocean has a geological origin (Galy et al., 2015). The main current challenge is to constrain the major contributors to this petrogenic OC flux. Amongst the expected sedimentary sources of petrogenic OC in rivers, sedimentary rocks forming badlands can be rightly considered as some viable candidates. Indeed these rocks show a strong erosion rate, may exceed 50 kt km–2 y–1 and in addition, shales, marls and argillaceous rocks, frequently forming badlands (see Nadal-Romero et al., 2011 for the Mediterranean area), contain a significant amount of petrogenic OC (frequently over 0.50 wt. %, Ronov and Yaroshevsky 1976).

Our work illustrates the contribution of badlands, mainly distributed within the Durance catchment (a main tributary of the Rhône river), in the petrogenic OC export to the Mediterranean Sea. The approach is based on (i) the use of previous and new data on radiogenic carbon, (ii) bulk organic geochemistry (Rock-Eval pyrolysis), (iii) optical quantification of particulate OM (palynofacies), performed on suspended sediments from the Durance, the Rhône rivers and from small rivers draining the badlands. A mean erosion rate of badlands, previously calculated for instrumented catchments (SOERE Draix-Bléone, Graz et al., 2012) was also applied to the badlands disseminated within the Durance catchment.

These different methodologies converge to a petrogenic contribution of the OC export to the Mediterranean Sea close to 30 %. Badlands from the Durance catchment, which represent less than 0.25 % of the Rhône surface, may yield 15 % of the POC annually delivered to the sea. In other words, 50% of the petrogenic OC would have a badlands origin. At a global scale, we assume that badlands could significantly contribute to the delivery of petrogenic OC to the marine environments.

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