

New evidence of the degradability and lability of riverine organic matter in coastal ecosystems : the case of the Rhône prodelta

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1- Scientific background and aim of the study

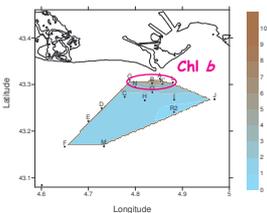
Deltaic environments are the depocenters of large amounts of terrigenous compounds, which are considered to be relatively refractory to decomposition due to the presence of lignin structures. Nevertheless, this paradigm has been recently questioned by several studies which suggest that riverine inputs of POM are sufficiently labile to have an impact on biological communities and biogeochemical cycling [1,2,3].

2- What do we know about the distribution & reactivity of terrigenous OM in the sediments of the Rhône prodelta?

- High contribution of Rhodanian inputs → estimation of the terrestrial contribution based on $\delta^{13}\text{C}$ signatures of surface sediments : 80 to 99% in April 2007 [Kerhervé, pers. com.]
- Rapid deposition of the river inputs along a preferential SW gradient
- Intensive remineralization of OM in the sediments of the prodelta [4]
- Exploitation of terrestrial POM by benthic organisms [3]

5- Results : Origin and quality of surface sediments

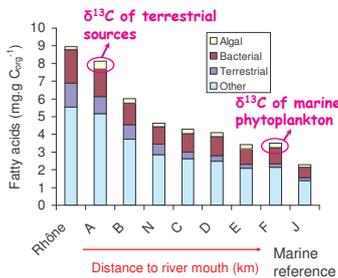
Phytopigment distribution



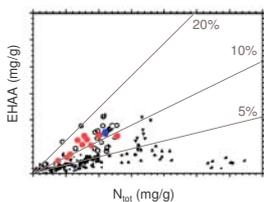
- High inputs of terrestrial phytodetritus (chl a & b) in the vicinity of the Rhône mouth
- Rapid decrease of terrestrial inputs offshore
- Pigment degradation is inversely correlated to phytodetritus inputs (unshown data)

- High lability of the FA fraction: rapid decrease offshore
- Contribution of land-derived detritus nearshore
- Occurrence of essential components (PUFAs)
- Positive correlation between bacterial FA and chl a contents ⇒ coupling between riverine OM inputs & the intensity of microbial activity!

FA concentrations and composition



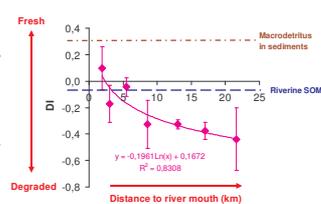
Relation between EHAA & Total Nitrogen contents in coastal sediments [2]



- In surface sediments of the Rhône prodelta, EHAA accounts for up to 15% of N_{tot} (upper ranged of values reported for coastal sediments) ⇒ Delivery of some nutritionally rich OM by the Rhône to the coastal zone!

○ Mississippi coast, ▼ Gulf of Maine, ■ Antarctica, ▲ Cape Hatteras, ▲ North sea, ▲ California basin, ● San Francisco bay, ● Rhône prodelta, ● Rhône river

Degradation index [5] of riverine SOM, macrodetritus and surface sediments



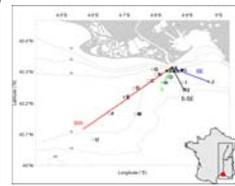
- Degradation : macrodetritus << nearshore sediments << riverine SOM
- Degradation state increases seaward
- Sedimentary OM is moderately degraded compared to coastal sediments from other areas

3- What remains to clarify ?

Our objective within the CHACCRA "Climate and Human-induced Alterations in Carbon Cycling at the River-seA connection" project was to study the provenance, distribution and reactivity of sedimentary OM in the sediments off the Rhône river using molecular-level proxies.



4- Study area and biochemical analyses



- Collection of sediment cores in a radius of 15 miles off the Rhône river in April 2007

Surface sediments:

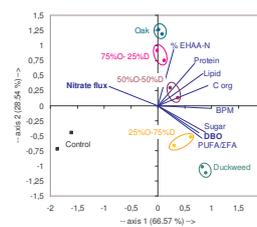
- Pigments
- Fatty acids (FA)
- Total & Enzymatically hydrolysable amino acids (THAA & EHAA)

From Cathalot et al. 2010

6- Results : Experimental evidence of the reactivity of land-derived detritus

The potential reactivity of land-derived phytodetritus was tested using *ex situ* core-incubations of spiked sediments. Muddy coastal sediments were collected in the bay of Banyuls and enriched with land-derived phytodetritus to reach a final content of 1.5% C_{org} equivalent to values found in the Rhône prodelta. Sediment oxygen demand (SOD) and nitrate/nitrite fluxes were then measured in sealed sediment cores.

Exploratory analysis (PCA) showing relationships between benthic fluxes & the lability of sedimentary OM



- SOD is enhanced by the addition of oak leaves and duckweeds, alone or in combination

- SOD increase is positively correlated with the proportion of labile OM (fatty acids, sugars as starch), but not % EHAAN

7- Conclusions

The Rhône delivers large amounts of particulate OM to the coastal sediments. The close linking between bulk descriptors of quantity and degradation proxies suggests the ongoing degradation of riverine POM inputs by pre- and post-depositional processes.

The riverine material is sufficiently labile to promote a strong microbial activity of remineralisation within the sediments.

Enrichment experiments show that the response of the microbial compartment to a pulse of terrestrial phytodetritus depends on the lability of the added material.

For the benthic fauna, the Rhône inputs represent a relatively rich source of OM with a high proportion of bioavailable proteaceous matter and essential PUFAs.

8- References

- Keil et al., *Geochim. Cosmochim. Acta* 1997
- Mayer et al., *Estuaries & Coasts* 2008
- Darnaude et al., *MEPS* 2004
- Cathalot et al., *Biogeosciences* 2010
- Dauwe & Middelburg, *L&O* 1998

9- Acknowledgements

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