

Estuaries, deltas and underground estuaries: Continent-ocean transfer

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Les estuaires et deltas sont des zones de transfert de sédiments, matière organique, nutriments, métaux traces entre le continent et l'océan. La forte hétérogénéité spatiale et temporelle des processus sédimentaires, géochimiques et biologiques qui s'y passent nécessite des projets multidisciplinaires pour appréhender l'importance des flux et le rôle de ces zones de transfert comme réacteurs biogéochimiques (jouant le rôle de source ou de puits pour certains composés chimiques comme les métaux ou les sels nutritifs), mais aussi l'impact de ces processus sur l'écologie benthique.

1. The Rhône prodelta, a river-dominated system

As part of the ANR project CHACCRA, benthic foraminiferal faunas were studied in the Rhône prodelta [1,2]. It appears that the river outflow has a major impact on the spatial distribution of the faunas. Close to the river mouth, monospecific *Leptohalysis scotti* assemblages occur where the combination of very shallow sedimentary oxygen penetration and intense hydrodynamic processes create stressful conditions. With increasing distance from the river mouth, sedimentary oxygen penetration increases, organic matter becomes increasingly of marine origin, and foraminiferal biodiversity increases [3,4]. Along this gradient, a clear succession of three assemblages is found. A comparison of the faunas sampled in September 2006 with those sampled in June 2005, shortly after the yearly spring runoff maximum, shows a strong opportunistic response of taxa, which are particularly favored by organic supplies due to river runoff (Fig.1).

The objectives of the ANR project EXTREMA, coordinated by IRSN, were to record the flow of materials and contaminants across the Gulf of Lions during extreme weather conditions. The transfer processes associated with these extreme events are better understood and

allow the development, validation and use of hydro-sedimentary models at different temporal and spatial scales [5]. The major phenomena highlighted by this project were contaminant transfer processes from river to marine sediments and influence of extreme events (floods, storms) on the supply and the erosion of the continental shelf sedimentary cover [6,7].

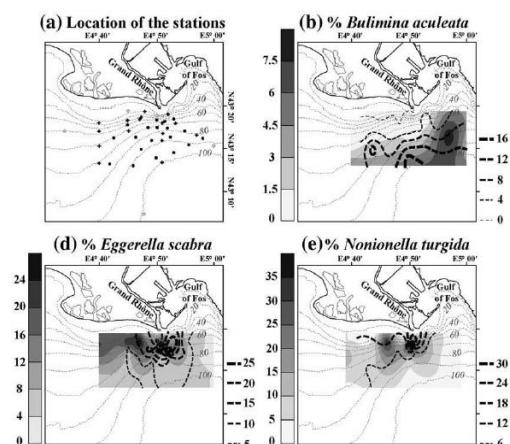


Fig. 1 : Relative abundance of major species in June 2005 (black dotted lines, Mojtahid et al., 2009) and September 2006 (grey areas) in the Rhône prodelta [1].

2. Loire estuary

The Loire is the longest river in France. Paradoxically its estuary was poorly studied by the laboratories of its region for many years. The projects RS2E and

SEMHABEL aim to fill this gap. One project aims to characterize the geochemistry of suspended matter and surface waters along the salinity gradient of the estuary and the sedimentary features of the river bed. The second aims

to characterize the variability of the nature of the deposited sediment in terms of granulometry, chemical composition and meiofaunal ecology. Preliminary results show complex patterns resulting in a mosaic of ecosystems (Fig. 2).

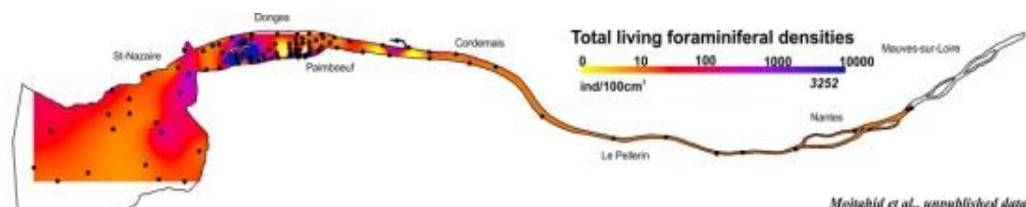


Fig. 2 : Densities of benthic foraminifera of surface sediment (1st cm) in the Loire Estuary.

3. Underground estuaries, a non-negligible continent-ocean transfer

Underground estuaries are a new research field of our laboratory. We studied the temporal and spatial dynamics of pore water biogeochemistry for sandy beaches on the Atlantic coast (EC2CO ESTAFET). Sandy beaches act as biogeochemical reactors with a complex circulation inside the permeable sediment, where freshwater from coastal aquifers mixes with seawater. Our results highlighted that pore water composition is progressively modified along the tidal cross-shore transect because of production and consumption of chemical components due to organic matter mineralization by organisms such as bacteria. Biogeochemical fluxes from such estuaries to the coastal ocean have to be considered and future studies should be conducted to evaluate their role in the coastal budgets.

Collaborations

EPOC (P.Lecroart, P.Anschutz, A.Coyne); IFREMER Nantes (J.Knoery); SUBATECH (O.Peron); MMS (L.Barillé, V.Méléder, C.Mouneyrac); LETG-LEESA (A.Jadas-Hécart); CEREGE (C.Vella, O.Radakovitch); IFREMER Brest (J.F.Cadiou, S.Berné, D.Cossa); IPGP-LGE (E.Viollier); LSCE (C.Rabouille); LOBB (J.M.Amouroux, A.Pruski); CEFREM (R.Buscaill, P.Kerhervé.); IRSN (F.Eyrolle, M.Arnaud); POC (C.Estournel)

Associated publications

- 1- **A Goineau, C Fontanier, E Metzger, FJ Jorissen et al.** (2011) Live (stained) benthic foraminifera from the Rhône prodelta (Gulf of Lion, NW Mediterranean): Environmental controls on a river-dominated shelf, *J. Sea Res.* (65), 58-75.
- 2- **A Goineau, C Fontanier, E Metzger, FJ Jorissen et al.** (2012) Temporal variability of live (stained) benthic foraminiferal faunas in a river-dominated shelf - Faunal response to rapid changes of the river influence (Rhône prodelta, NW Med.), *Biogeosc.* 9, 1367-1388.
- 3- L Pastor, **E Metzger et al.** (2011) Influence of the organic matter composition on benthic oxygen demand in the Rhône prodelta (NW Med.), *Cont. Shelf Res.*, 31, 1008-1019
- 4- L Pastor, C Cathalot, B Deflandre, E Viollier, K Soetaert, FJR Meysman, C Ulses, **E Metzger, C Rabouille** (2011) Modeling biogeochemical processes in sediments from the Rhône River prodelta area (NW Med. Sea), *Biogeosc.*, 8, 1351-1366.
- 5- **GM Maillet, C Vella, F Sabatier, E Poizot, Y Mear** (2011). Sediment transport pattern in a microtidal river mouth using geostatistical sediment trend analysis (GSTA). The case of the Grand Rhone River, France, *J. Sed. Res.*, 81, 138-152.
- 6- AS Fanget, **GM Maillet, et al.** (2013) Historical evolution and extreme climate events during the last 400 years on the Rhone prodelta (NW Mediterranean), *Mar. Geol.*, 346, 375-391.
- 7- AS Fanget, S Berné, G Jouet, MA Bassetti, B Dennielou, **GM Maillet, M Tondut** (2014) Impact of relative sea level and rapid climate changes on the architecture and lithofacies of the Holocene Rhone subaqueous delta (Western Med. sea), *Sedimentary Geology* (in press).