The fate of organic matter in mangrove sediments subject to variable environmental conditions (French Guiana).

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The fate of organic matter in mangrove sediments subject to variable environmental conditions (French Guiana)

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During the four last years, a National research Programme for Coastal Environment (PNEC) was partly devoted to the littoral of French Guiana. Several field trips allowed to sample twinned sedimentary cores from both the mangroves and the unvegetated sediments, and various vascular plants specific to these swamps. An elemental, pyrolytic and optical study of total sedimentary organic matter (OM), completed with stable isotope and molecular analyses, was carried out on these sets of samples and coupled with a study of pore waters (physico-chemical properties and dissolved organic content) collected in the mean time, during contrasted seasons. The development and age of mangrove marshes and forests was assessed by parallel studies performed by ecologists.

The main purpose of this study was to assess the origin of the sedimentary OM and its fate (Hedges et al. 1997) considering the various diagenetic processes present in brackish to hypersaline mangrove sediments characterised by great changes in the redox conditions. Several specific results have already been published i.e.: the physico-chemical conditions of such environments during wet and dry seasons, the composition of bulk OM, the organic content of pore-waters linked to degradation processes and finally the behaviour of carbohydrates and lignin during early diagenesis (Marchand et al., 2003; 2004; 2005; in press). Here, we propose to present an integrated conceptual model for organic sedimentation and diagenesis in French Guiana mangroves, taking into account as far as possible, the whole range of results.

The mangroves studied are located: i) on the right bank of the Sinnamary River, near Kourou, ii) at the mouth of the Kaw River, near Cayenne. They develop on the upper

intertidal zone of 30 km long mud banks that can reach up to 5 km in width and that move upwards to the North West due to the huge discharge of Amazone River. This moving occurs with a 50 yrs cyclicity, which is a quite critical point for economical development of Guianas.

We demonstrate that the OM composition depends on both the topography of formations and the age of ecosystems, which will directly determine the origin of OM. Close to the sea, algal mats develop on the top of just accreting littoral deposits. Along a sea-land transect, the forest is the dominant organic source, it becomes more and more dense with increasing age, inducing litters and soils with increased thickness. The underlying fine-grained clay sediment only contains minute refractory debris of higher plants supplied with clay minerals by the Amazonian current.

Based on the study of both pore-waters and sediments, we determined very different bio-geochemical processes depending on the locations studied. We showed that these processes are clearly linked to interacting parameters among them: climate, forest and soil development, mangrove species, tides and bioturbation intensity.

The climate plays a main role on the establishment of environmental conditions by directly influencing the water-saturation of the sediments, which depth varies through the year depending on the season. Consecutively, an oxidation front affects the sediment once a year in the most seaside locations. Moreover, these places are also submitted to the daily running off of the uppermost sediments due to tides and to the bioturbation effects. Far from the littoral, where tides and crabs are without effects, the sediments stay always saturated involving stable conditions. The succession of seasons leads to a stratification of redox processes (oxic-suboxic-anoxic) and to strong variations of surface sediments salinity. In older wet sediments, pyrite framboids assess the occurrence of marked sulfate reduction conditions.

The mangrove vegetation is the major organic source in these environments. Its distribution is the other main parameter determining the environmental conditions and OM evolution. It supplies organic carbon into the sediment, via the litters, under the form of fresh ligno-cellulosic debris. We characterized the OM evolution by the following markers: 1) palynofacies constituants %, 2) TOC%, IH, C/N and $^{13}\partial$C values, 3) total sugars and phenols %, 4) $(Ad/Al)_v$ and S/V ratios, 5) fucose and rhamnose contents. Their distribution obeys to a combined vertical/horizontal trend revealing that the sedimentary OM is degraded through the succession of oxic-suboxic-anoxic processes depending on the location and age of mangroves. Additionnally, it has been shown that locally, the vegetation is also able to increase the salinity of pore waters due to evaporation-transpiration process. More particularly, *A.*

germinans specific from young littoral mangroves may also enter O_2 into the sediment through its very specific root system, which may induce oxidative conditions.

Moreover, this study illustrates that both lignin and cellulose, derived from vascular plants, can be rapidly degraded (10 yrs scaled) in waterlogged, brackish to hypersaline sediments. Long term preservation of such molecules requires much larger organic delivery.

References

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