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Impact of organic matter decomposition on heavy metal distribution in mangrove sediments (French Guiana)

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From the Amapa coast (Brazil) to the Orinoco River (Venezuela), a series of migrating mudbanks originating from the huge mud discharge of the Amazon River, are colonized by mangrove forests. These forests are predominantly composed of Avicennia germinans, Rhizophora mangle and very scarce Laguncularia racemosa. The highly dynamic feature of this coastline limits mangrove lifetime to few decades.

In French Guiana studied sediments (PNEC programme), OM composition strongly depended on the developmental stages of mangrove stands. TOC ranged from 1.5% for the pioneer mangrove to 18% for the senescent forest. The sedimentary organic content of the younger mangrove swamp was mainly derived from algal mats, as highlighted by low C/N values (6 to 8), a predominance of grey amorphous organic matter in optical observations, and d13C values close to -22L'. On the opposite, the sedimentary organic content of the senescent mangrove mainly derived from higher-plant debris in the uppermost 30 cm, as indicated by d13C values close to -28L', relatively high C/N (30) and a predominance of ligno-cellulosic debris.

Redox values measured beneath young Avicennia stands showed oxic to suboxic conditions. These conditions develop thanks to the radial cable roots of this mangrove species, which is able to diffuse oxygen towards the sediment. Conversely, in the older Avicennia forests, mainly suboxic to anoxic conditions were observed. The hypothesis is that the oxygen released by the root system is insufficient to produce the decay of the large quantity of organic matter. The high sulphide concentrations associated with the occurrence of diagenetic pyrite denoted sulphate-reducing processes similar to those observed under R. mangle stands. Additionally to mangrove species and stand age,

climatic conditions play a major role on the OM decomposition by directly driving the water saturation of the sediment. During the wet season, the water table was high and mainly sulfate-reducing processes took place. Whereas during the dry season, the diffusion of oxygen from the atmosphere added its effect to that of the rhyzosphere and consequently the sediment was characterized by oxic conditions.

The total concentrations of Fe, Mn, Cr, Cu, Co, Ni, Pb, Zn and Hg were determined. The ranges of measured concentrations expressed in μmol g-1 were the following: Cu (0.06 to 0.61), Co (0.12 to 0.68), Pb (0.08 to 0.18), Ni (0.32 to 0.76), Cr (0.61 to 1.40) and Zn (1.25 to 5.94). Ranges in total Hg were between 0.15 and 2.57 nmol g-1, with mean values close to 0.41 nmol g-1, and were clearly correlated with total organic carbon. The content of mangrove sediments in heavy metals along the coastline of French Guiana is essentially the result of the continuous alternation of accumulation and transport phases occurring upstream due to the Amazon watershed run off. The sources of this heavy metal content are thus difficult to identify. However it is well known that the alluvium produced by the natural erosion of the Amazonian soils is naturally enriched in mercury. Indeed, the supply from gold mining activities is known to contribute to mercury pollution. However, heavy metal concentrations showed variations with depth linked to the diagenetic processes. The redox conditions and the organic matter decay control the Fe/Mn cycling, which in turn control the concentrations and associations of heavy metals. These results suggest that the variations in heavy metal content with depth or between mangrove areas result largely from organic decay processes variations themselves linked to variations in natural environmental conditions rather than changes in metal input resulting from local human activities.