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Sorption of organic matter on clay minerals in aquatic system and influence on sedimentary organic preservation.

An example of lacustrine environment (Lac Pavin, France)

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Sorption of organic molecules on clay surfaces in aquatic environment influence organic sedimentation fluxes. It is well known that mineral sorption affects transport of natural organic matter to bottom water and to sediments. These physical and chemical interactions produce a flocculation of organo-mineral complexes and then increase weight of sedimentary fractions. The resulting sedimentation rate reduces risks of bacterial recycling and/or oxidation. Other studies revealed that sorption also influences the fate of organic matters in sediments ([1]). Direct contacts between clay minerals and organic molecules allow creation of organo-mineral assemblages in sediments, and influence organic molecules availability to benthic fauna and bacteria ([2]). Many studies concluded that mineral sorption and chemical linkage created can be considered as one of preservation mechanism, leading incorporation of organic matter in sediments.

Many questions in this topic remain unresolved. Does sorption of organic molecules on clay minerals can occur in the water column (before sedimentation)? What is the behaviour of clay/organic matter complexes in the deep water? Does this sorption really protect organic molecules from bacteria recycling and oxidation in the water column?

The aims of this work are to test the possible *in situ* sorption of natural organic molecules in lacustrine environment, in different fresh and bottom water and for various interaction times. In this respect, the behaviour of natural organic matter in presence of synthetic saponites (high and low charge Na-smectites) has been studied in oxic and anoxic levels of an oligotrophic meromictic crater lake (Lac Pavin, Massif Central, France). Six clay samples positioned in the oxic layer and four clay samples in the anoxic deep layer have interacted with lake water during 3, 10 and 21 days. Clays were positioned in traps, closed by two hydrophilic 0.45µm Durapore[®] membranes, allowing only circulation of dissolved organic matters and there interaction with clays. After runs, interactions were interrupted on the spot by centrifugation, and clays were separated from water immediately.

Rock-Eval analysis shows the presence of organic carbon associated with clays after interaction in Lac Pavin. Failure of extractions by classical organic solvents suggests a very stable bonding between organic matters and clay particles. The molecular Pyro-GC/MS investigation, performed on these clays, reveals the presence of n- and iso- alcohols, n-alkanes, iso-alkanes and fatty acids, in significant amounts (Fig. 1).

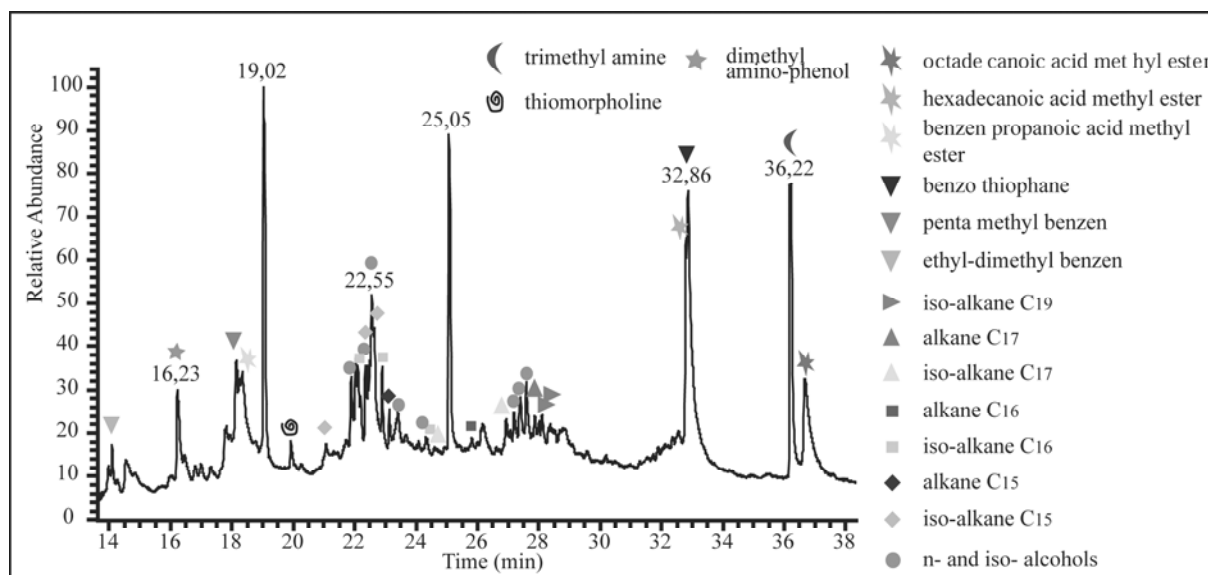


Fig. 1 - Spectral response of molecular analysis on low charge saponite by pyro-GC/MS (21 interaction days at 65 meters, in anoxic deep layer)

The same molecular GC/MS analysis of organic extracts carried out on waters, macrophytes algae (developed in the border between 2 and 7m depth), and phytoplanktonic fractions developed in the water column were performed in order to characterise the type and origin of organic clay-adsorbed fractions (see Boussafir et al., this meeting). These molecular investigations revealed that the same molecular fractions are present in macrophytes and phytoplankton lipid extracts.

ESCA analysis reveal a loss of sodium in the interlayer space of the two saponites, and its possible substitution by divalent iron in anoxic deep layer. This suggests the predominance of cation bridge mechanism, involving divalent iron, to explain the adsorption of organic molecules on clays.

References

- [1] Keil R.G., Montluçon D.B., Prahl F.G., Hedges J.I., 1994 - Sorption preservation of labile organic matter in marine sediments - Nature, Vol. 370, 549-551.
- [2] Sugai S.F., Henrichs S.M., 1992 - Rates of amino-acid uptake and mineralization on Resurrection Bay sediments - Ecol. Prog. Ser., 88, 129-141.