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How do early diagenetic processes affect the molecular composition of the sedimentary organic matter?

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Sediments represent a large reservoir of nutrients and natural organic matter (NOM) from diverse inputs in various proportions. Indeed, sedimentary OM is derived from bacteria or plankton formed in situ, but also receives allochthonous OM from the upstream catchment. Soil OM is a representative allochthonous OM source and it is easily transported into the rivers and ends up in sediments through hydrological processes (Briand et al., 2015; van der Meij et al., 2018). Sediments are also a reactive compartment where diagenetic processes occur inducing changes. Among the diagenetic processes, biodegradation plays a key role as it is one of the main processes causing changes in the amount, composition and properties of OM in sediment (Arndt et al., 2013; Guenet et al., 2014).

In this study, we decided to examine the molecular changes under early diagenesis on sedimentary OM. In this context, we designed a controlled degradation experiment at laboratory scale using organic-rich sediments artificially composed of two contrasting OM end-members (i.e., soil and algae) at known mixing ratios. The incubations were performed under oxic and anoxic conditions in the dark at 25°C for 60 days. The sediment samples were collected on day 0 (e.g., the day where the samples were inoculated) and day 60 and were directly analyzed by laser desorption/ionization Fourier transform ion cyclotron resonance mass spectrometry (LDI FT-ICR MS). LDI permits molecular analysis of the sediment to be achieved without any sample pre-treatment step and consequently limits the inherent problems related to the extraction (Aubriet and Carré, 2019).

The results allowed us, first, to identify (i) which molecules or groups of molecules are the most affected by the biodegradation processes and then, to examine (ii) the potential effect of the absence and/or occurrence of oxygen and (iii) the potential effect of the OM sources on the molecular composition during biodegradation. Finally, this study provides insights into the responding features of sedimentary OM to one of the main biogeochemical processes.

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