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BIOMARKER ASSEMBLAGES ASSOCIATED WITH THE EOCENE-OLIGOCENE TRANSITION IN LACUSTRINE DEPOSITS OF THE RENNES BASIN (FRANCE)

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The Eocene/Oligocene transition is one of the main climatic events to which more recent climate changes are often compared. Dated back to 34 Ma, it is remarkable because the Earth evolved from a greenhouse to icehouse state, permanent ice sheets appearing during the Late Eocene. In marine setting, it is marked by an increase in detrital input associated with an increase of primary productivity that resulted from well mixing of water masses (Peihzen et al., 2001). In terrestrial setting, this cooling led to major changes in animal and plant communities. For instance, palynology data show a vegetation shift from wet to dry taxa (Gregory and Chase, 1992) coincident with a large mammal turnover, the well-known "Grande coupure" (Stelhin, 1909). Although this transition is well documented in marine settings, the lack of data on lands - due to limited available outcrops - does not allow appreciating precisely its impacts on terrestrial ecosystems.

Here, we have analysed the sediment infill of the Rennes Basin that consists of 300 m of organic-rich lacustrine deposits (laminated and massive) that encompass the Middle Eocene to Oligocene series, including the Eocene-Oligocene transition, the whole fully cored (CINERGY project, BRGM). About 100 samples were collected through the core enabling us to precisely decipher environmental changes that occurred during the studied interval and to focus on the Eocene/Oligocene transition. All samples were subjected to Rock-Eval and EA-irMS to measure bulk $\delta^{13}C$. Four over the 100 samples were analysed for their molecular content so far. For a preliminary test, we have chosen representative facies (a laminated and a massive Upper Eocene sample and a laminated and a massive Lower Oligocene sample). Lipids were extracted with an Automated Solvant Extractor (ASE200®, Dionex) using DCM:MeOH (9:1). The total extract was later separated into neutrals, acidic and polar compounds. The neutral compounds were further separated into aliphatic, aromatic, ethers and esters, ketones and alcohols. After addition of 5α-cholestane, each fraction was then analysed by Gas Chromatography-Mass spectrometry on a Trace GC Ultra gas chromatograph coupled to a TSQ Quantum XLS mass spectrometer equipped with an AS 3000 autosampler.

The analysis of the different fractions of each sample revealed a high diversity of compounds that could partly be related to their source organisms or inform on the depositional environment. Hydrocarbon fraction is dominated by a series of *n*-alkanes that display a strong odd-over-even predominance, indicative of a good preservation. The dominance of long-chain homologues shows a strong higher plants contribution. This is confirmed by the presence of abundant and diversified higher plant pentacyclic triterpenes. These comprise angiosperms biomarkers such as oleanane, ursane and lupane, friedelin, onocerane I and diagenetic by-products (des-A-tritrepenes and aromatic derivatives). Fernene-type compounds could reveal an input from pteridophyts whereas tricyclic diterpenes indicate the presence of conifers. An algal influence is evidenced, for example, by the presence of 4-methylsteranes in the four samples. C_{27} to C_{32} hopanoids with α,β, β,β and β,α configurations show a substantial bacterial contribution. This is confirmed by high levels of hopane ketones in some beds.

The comparison of angiosperm-derived biomarkers with gymnosperm-derived biomarkers indicates a stronger contribution of angiosperms in Upper Eocene samples than in Lower Oligocene samples (triterpenoids, aromatic, and rearranged-triterpenoids). This result is in agreement with palynological data (Bourdillon et al., 2012) and with the well-known cooling that is coeval with the Eocene/Oligocene transition. Reversely, the comparison between the two facies (massive and laminated) does not exhibit significant differences in the molecular assemblage.

Based on this preliminary inventory of biomarkers and the richness in various biomarkers, we will proceed with the identification and quantitation on the remaining samples that cover the whole section. These preliminary results are also encouraging in the perspective of performing compound-specific isotopic analyses in order to depict, at high temporal resolution, the climatic evolution and the associated changes in plant communities during the Late Eocene and Early Oligocene and, more specifically, at the Eocene/Oligocene transition.

REFERENCES

Bourdillon, C., Chateauneuf, J.J., Lozouet, P., 2011. Le Cénozoïque du sondage CDB1, Bassin de Rennes, France. Eradata report, 64p.

Gregory, K.M., Chase, C.G., 1992. Tectonic significance of paleobotanically estimated climate and altitude of the Late Eocene Erosion Surface, Colorado. Geology 20, 581-585.

Peihzen, Z., Molnar, P., Downs, W.R., 2001. Increase sedimentation rates and grain sizes 2-4 Myr ago due to the influence of climate change on erosion rates. Nature 410, 891-897.

Stehlin, H.G., 1909. Remarques sur les faunules de Mammifères des couches éocènes et oligocènes du Bassin de Paris. Bulletin de la Société Géologique de France 4, 488-520.