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Vascular plant biomarkers as ancient vegetation proxies and their stratigraphic use for tracing paleoclimatic changes during Jurassic in Western Europe

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Vascular plants synthesize a large diversity of low molecular weight compounds and more particularly bioterpenoids. Many biochemical studies on extant plants have pointed out that certain bioterpenoids are specific and only occur in precise taxa (e.g. abietic acid for Pinaceae, a conifer family) while others are generic and widely distributed in plant kingdom (e.g. cadinenes) (Otto and Wilde, 2001). These bioterpenoids are finally transported in micro-particles (soot, spores, pollens, and resin grains) and macro-particles (phytoclasts, large wood fragments) both by air and rivers from land to sedimentary basins. During the transport, sedimentation and diagenesis, most of these bioterpenoids are degraded into geoterpenoids which can keep their initial chemotaxonomic value. Thus, the geoterpenoids preserved in sedimentary rocks are useful proxies of ancient vegetation developed on emerged lands close to sedimentary basins at the time of the deposition. Therefore, vascular plant biomarkers can be used as a chemostratigraphic tool for tracing paleovegetation changes on hinterlands. Because these changes are under climatic control, they can also be used for tracing climatic evolutions during geological times.

Callovo-Oxfordian claystones and limestones from Yorkshire, North and East of Paris basin have been investigated for organic geochemistry. The retene/cadalene ratio was calculated for each of the 160 samples. Retene derives from the degradation of specific

bioditerpenoids synthesized by conifers while cadalene derives from generic biosesquiterpenoids.

In the East and North of Paris basin, this ratio shows low values in claystones dated from middle Callovian to the end of *Mariae* ammonite zone then increases from *Cordatum* ammonite zone (end of lower Oxfordian) simultaneously with the progressive installation of the Oxfordian carbonate platform. The relative proportion of retene is strongly correlated with the abundance of some of its diagenetic precursors still present in the sediment. Among them, dehydroabietins and dehydroabietic acid are specific to the sole Pinaceae family. Furthermore, other markers of non-Pinaceae conifers (phenolic abietanes, phyllocladane, kaurane, beyerane) are absent. Thus, the increase of the retene/cadalene ratio reflects the rising proportion of Pinaceae on London-Brabant massif which was the nearest land from the studied locations (Dercourt et al., 2000).

In the Callovo-Oxfordian marlstones of Yorkshire, the retene/cadalene ratio also shows a similar increase starting from *Cordatum* zone. For the Oxfordian, the dehydroabietic acid/phenolic abietanes ratio shows a similar evolution than the retene/cadalene ratio which could signify that abietic acid was the major, but not the only, natural precursor of retene. Moreover, the increase of the retene/cadalene ratio indicates a growing proportion of Pinaceae on emerged lands.

As Pinaceae show many morphologic adaptations to dry climate while other conifers families preferably colonize humid environments, their increasing proportion since *Cordatum* ammonite zone should indicate a dryer climate on Western Europe. This conclusion is also supported by geochemical, paleontological, palynological, paleobotanical and mineralogical data (e.g. Abbink et al., 2001; Rees et al., 2000; Pellenard et al., 2003). A comparable increase of the relative proportion of retene was described by van Aarssen et al. (2000) in the Oxfordian of Western Australia. Similar evolution in vascular plant composition on far apart continents is an argument for a worldwide increase of aridity at the end of the lower Oxfordian. Vascular plant biomarkers appear to be excellent proxies to assess ancient vegetation. They can be used as a chemostratigraphic tool for tracing paleovegetation and climatic changes. Authors thank Andra (the French National Radioactive Waste Management Agency) for financial support and for providing samples from Paris Basin as well as BGS (British Geological Survey) for providing samples from Yorkshire.

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