Methoxy-serratenes as discriminant biomarkers for soils developed under conifer forests

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IMOG Abstract Template

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The evolution of landscapes through time constitutes a challenge for both archaeologists and paleoenvironmentalists. For example, human deforestation (for cultivation and building) strongly affected the shape of continental surfaces with supposed impacts on the global carbon cycle of which the timing and extent remains controversial.

Molecular biomarkers detected in soils can provide clue information on the past local vegetation, and thus on past land uses. In addition, if these biomarkers are transferred from soils to sedimentary archives, they can be used to reconstruct the evolution of ecosystems through time. Higher plant pentacyclic triterpenes are commonly associated with angiosperms and are increasingly used in environmental reconstructions. Due to their wide diversity of structures, functions and configurations, they constitute valuable chemo-taxonomic targets, considering that a restricted number of organisms are able to synthesize specific structures. For example, pentacyclic triterpene methyl ethers can be related to Gramineae [1], [2] whereas triterpenyl acetates are mainly produced by Asteraceae [3]. Both reflect the development of open vegetation, either under the influence of climate or due to human activities.

In order to search for such compounds, we have analysed the lipid content of soils developed under conifer forest (spruces and pines) in the catchment of Lake Aydat (Massif Central, France). Lipids were extracted by ASE with DCM:MeOH 9:1 and then separated into classes by flash chromatography with solvents of increasing polarity before being analysed by GC-MS.

Apart from *n*-alkanes and diterpenoids, a series of 11 original compounds were detected in the ketone and alcohol fractions (Figure 1). These compounds are unsaturated pentacyclic triterpenes with a serratane structure, a methoxy group and various additional oxygenated functions (methoxy, acetoxy, ketone or alcohol). Their concentrations range from 1 to 20 µg/g of soil.

Serratane compounds are biosynthesized by many plants such as pines, spruces, ferns and club mosses. Reversely, serratane triterpenes bearing a methoxy group have, up to now, only been reported in Pinaceae.

Methoxy-serratenes constitute novel tracers of conifers that are far more specific than classical diterpenoids. In addition, considering their lower volatility, they are likely to be preserved in lacustrine archives, although their resistance to early diagenetic processes remains to be documented. If resistant, there are likely to

provide crucial information on the evolution of pine and spruce forests over decadal to millennial timescales.

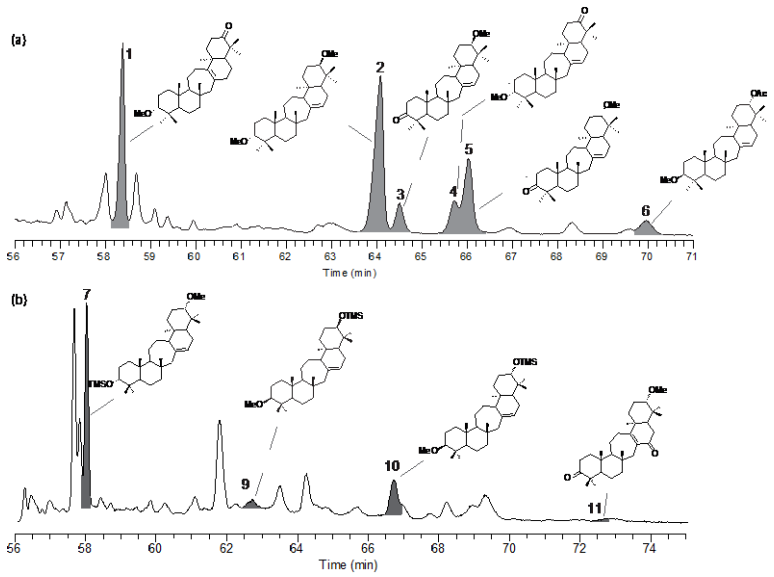

Figure 1: GC-MS Total Ion Chromatogram (TIC) of (a) the ketone fraction and (b) the alcohol fraction from the lipid extract of a soil developed under a conifer forest : 1: 3α-methoxyserrat-13-en-21-one; 2: 3α,21β-dimethoxyserrat-14-ene; 3: 21β-methoxyserrat-14-en-3-one; 4: 3α-methoxyserrat-14-en-21-one; 5: 21α-methoxyserrat-14-en-3-one; 6: 3β-methoxyserrat-14-en-21-yle acetate; 7: 21α-methoxyserrat-14-en-3α-ol; 9: 3β-methoxyserrat-14-en-21β-ol; 10: 3β-methoxyserrat-14-en-21α-ol; 11: 21α-methoxyserrat-13-en-3,15-dione.

References:

[1] Jacob J., Disnar J.R., Boussafir M., Albuquerque A.L.S., Siffedine A., Turcq B., 2005. Pentacyclic triterpene methyl ethers in recent lacustrine sediments (Lagoa do Caço, Brazil). Organic Geochemistry, 36, 449-461.

[2] Zocatelli R., Jacob J., Turcq B., Boussafir M., Siffedine A., Bernades M.C., 2010. Biomarker evidence for recent turf cultivation in Northeast Brazil (Lagoa do Boqueirao, RN State). Organic Geochemistry, 41, 427-430.

[3] Lavrieux M., Jacob J., Le Milbeau C., Disnar J.R., Zocatelli R., Bréheret J.G., Masuda K., 2011. First detection of triterpenyl acetates in soils: sources and potential as new palaeo-environmental biomarkers. 25th IMOG. Interlaken (Switzerland)