

TRACKING SOIL ORGANIC CARBON TRANSPORT TO CONTINENTAL MARGIN SEDIMENTS USING SOIL SPECIFIC BACTERIOHOPANEPOLYOL BIOMARKERS

Martin P. COOKE¹, Helen M. TALBOT¹, Olubunmi ENIOLA¹, Thomas WAGNER¹,
Roselyne BUSCAIL² and Serge HEUSSNER²

1. *School of Civil Engineering and Geosciences, Devonshire Building, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK. M.P.Cooke@ncl.ac.uk.*

2. *Centre de Formation et de Recherche sur l'Environnement Marin (CEFREM), Université de Perpignan, 66860 Perpignan Cedex, France*

The transport and subsequent deposition of terrestrially derived organic matter into the ocean is an important but poorly constrained aspect of the modern global carbon cycle. In regions associated with large river systems it is likely that the terrestrial input of organic carbon is much more complex than commonly considered and very difficult to trace based on established geochemical proxies. It is therefore important to develop proxies that target the movement and fate of this terrestrial organic material.

The identification of bacteriohopanepolyol (BHP) biomarkers unique to soil derived organic carbon (SOC) has enabled the transport of SOC into aquatic sediments to be traced. The extreme recalcitrance of BHPs enables these source specific compounds to be used on recent and ancient sediments to identify periods of high and low SOC input into sediments.

BHPs are bacterial membrane compounds with a high degree of structural variability. They are analogous to steroids in eukaryotes and have been identified in over half of all bacteria studied for their presence. BHPs have a wide range of over 40 functional groups on the side chain, with up to 6 functional groups in each structure, and with methylation and unsaturation over 100 total structures have been identified¹.

During the BHP analysis of a wide range of soils from around the world consistently high levels adenosyl hopane (m/z 788; Fig. 1), known to originate from purple non-sulphur, nitrogen fixing and ammonia oxidising bacteria and 2-methyl adenosyl hopane (m/z 802; Fig. 1)², from nitrogen fixing bacteria were identified. Only 2 lacustrine sediments with large SOC supply from their catchments areas have been found to contain these markers in a survey of over 40 different recent marine and non-marine settings.

The Rhone River is the major freshwater input into the Mediterranean with sediment accumulation rates of 20 cm^y⁻¹ and an annual discharge of 7-10 10⁶ tonnes³. First analysis of surface samples taken from a core transect across the shelf confirms the presence of both adenosyl and 2-methyl adenosyl hopane in the sediment. The concentrations of both BHPs decrease with distance from the coast, suggesting progressive dilution of the terrestrial

organic signal with marine sources. These first results from the Gulf of Lions are supported by recent results on non-isoprenoidal glycerol dialkyl glycerol tetraethers (GDGTs) in the same area, more specifically the branched and isoprenoid (BIT) index³.

Recent studies on Late Quaternary sediments from the Congo deep sea fan (OPD site 1075, ~2 km water depth) provide a strong case to expect markers for SOC⁴. An initial analysis of the core samples confirms the presence of soil specific BHP markers in each sample analyzed down to 89 m depth in addition to the presence of common sediment associated BHPs (see Fig. 1). Concentrations of soil markers are high in the upper sediment section down to about 49 m supporting the case for these molecular markers as novel proxies for SOC supply and burial. Distinct peaks of adenosyl and 2 methyl adenosyl hopane at about 200, 300 and 550 kyrs tentatively imply that the rate of terrestrial organic matter discharge from tropical Africa significantly increased at these times, possibly associated with periods of reduced soil stability in the Congo catchment.

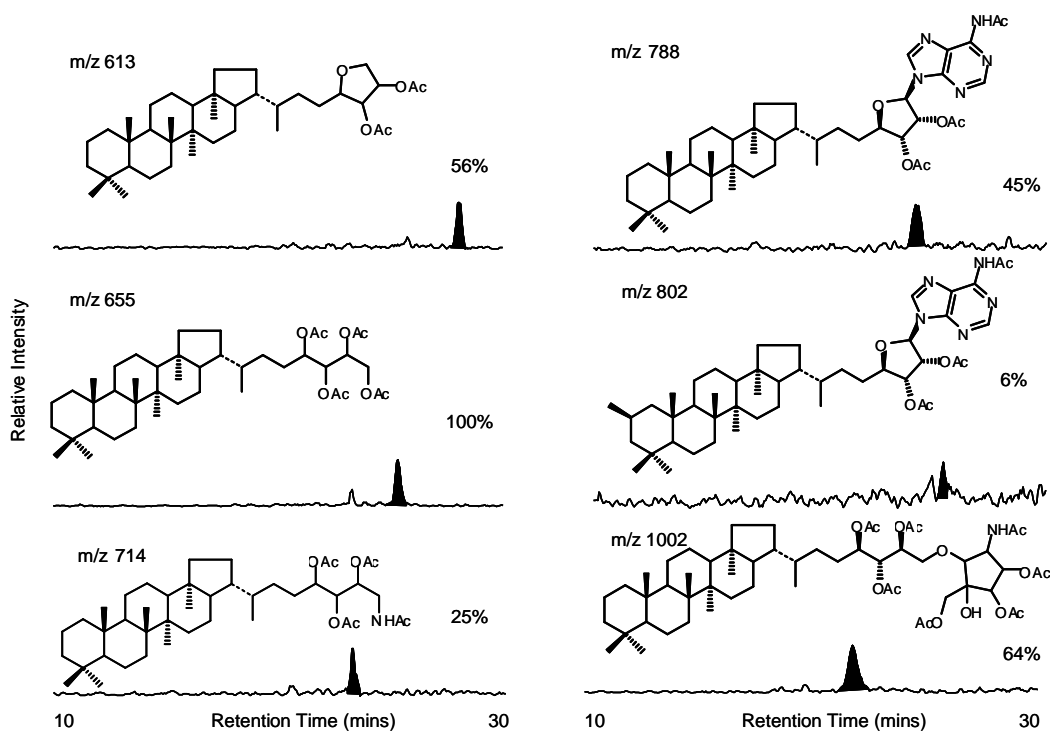


Figure 1. APCI mass chromatograms and relative intensity of the major BHPs found in Congo fan sediment age approximately 300 kyrs. (BHPs analysed as peracetate derivatives; Ac = COCH₃)

REFERENCES

- [1] Rohmer, M. 1993. *Pure and Applied Chemistry* 65, 1293-1298.
- [2] Talbot, H.M., Rohmer, M., Farrimond, P., 2007. *Rapid Communications in Mass Spectrometry* (In press).
- [3] Kim, J. H., Scouten, S., Buscail, R., Ludwig, W., Bonnin, J., Sinnighe Damsté, J.S. Bourrin, F. 2006. *Geochemistry, Geophysics, Geosystems*, 7, Q11017, doi:11010.11029/12006GC001306.
- [4] Holtvoeth, J., Wagner, T., Kolonic, S., 2005. *Geochimica et Cosmochimica Acta*, 69, 2031-2041.