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Novel biohopanoid molecular proxies for bacterial populations and processes

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Microbially-mediated processes at the Earth's surface and in the subsurface are fundamental controls on the global carbon and climate cycle. Bacteria and other microorganisms produce a variety of lipid biomarkers which are important for studying their activity in modern and Recent environments; however, many of these molecules (e.g. fatty acids) are not well preserved in the sedimentary record.

An alternative approach to tackle bacterial biomarkers is to apply bacteriohopanepolyols (BHPs)[1], membrane lipids biosynthesised by many, but not all bacteria, which have recently been identified in sediment samples up to 55 Ma. These compounds, consisting of a stable pentacyclic hydrocarbon skeleton with an extended, highly functionalised side chain containing at least 4 functional groups, are significant components in soils and sediments, both terrestrial and marine.

Although some BHPs have a diverse range of biological source organisms, others have more restricted origins and recently several BHPs have been proposed as novel markers for specific biogeochemical processes including aerobic methane oxidation [2] and nitrogen-fixation [3,4]. Additionally, the persistent need to understand carbon dynamics and reactions involving organic matter at the land-ocean interface has lead to a tentatively proposed new BHP based approach. We identified a group of compounds related to adenosylhopane [1] which are abundant components in soils but generally scarce or absent in lacustrine sediments and open marine systems [5]. We subsequently proposed that the relative contribution of this group of compounds to the sedimentary BHP pool may be a useful proxy for terrestrial organic matter input [6], although further development is still ongoing. As a foundation to this potential application, we have surveyed the BHP composition of over 600 soil samples from around the world and will here present a synthesis of this data, comparing terrestrial BHP fingerprints to those from a range of aquatic sediments of different ages, including new data from a large scale study of the Yangtze River-East China Sea surface sediment transect.

These novel applications will be contextualised within a summary of current knowledge of relevant source organisms and environmental factors affecting BHP biosynthesis as well as a consideration of knowledge of the fate of these molecules in the marine systems. Finally we will highlight some of the major outstanding questions currently driving this growing research area.

References

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