Geophysical Research Abstracts,
Vol. 11, EGU2009-5533, 2009
EGU General Assembly 2009

Aminopentol, a possible novel biomarker tracer for methane hydrate stability in sedimentary records

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The Congo Fan is a region of important methane (CH_4) storage and seepage: large gas hydrate reservoirs at and just below the sediment surface occur alongside deeply-buried reservoirs of thermogenic methane linked with hydrocarbon source rocks. Methane release from both reservoirs has the potential to drive or respond to changes in local and global climate, thus causing changes in ocean chemical properties and biotic responses. Understanding these mechanisms of methane emission and reconstructing the history of past emissions in the Congo Fan (ODP Site 1075) is the main focus of this study.

Bacteriohopanepolyols (BHPs) are lipid membrane constituents of bacteria and occur with a wide range of structural and functional variability. Amino-BHPs are produced by methane-oxidising bacteria and the 35-aminobacteriohopane-30,31,32,33,34-pentol (aminopentol) is a highly specific biomarker for aerobic methane oxidation. Aminopentol abundance varies significantly throughout the studied section with a suspected precession-driven cyclical variability superimposed on longer-term short eccentricity cycles. Compound-specific stable carbon isotope analyses confirm that the amino-BHPs are of methanotrophic origin. A period of sustained greater concentrations and inferred emissions occurs from ca. 500 and 600 ka during which soil organic matter input, as recorded by soil BHP concentrations and the BIT index, is consistently low. Unsaturated Δ^6-bacteriohopanetetrol cyclitol ether, which is interpreted as a biomarker for nitrogen-fixing marine *Tricodesmium* cyanobacteria, was also found in this interval and is absent from the remainder of the section. This interval could therefore reflect a period of low terrigenous organic matter and associated nutrient input during which nitrogen-fixing bacteria may have flourished in the resultant nutrient-, in particular nitrate, poor water. Ongoing sea surface temperature reconstruction, using the TEX_{86} proxy, seeks to investigate potential perturbations in local climate with relation to these previously unrecognized methane emission events.

The aerobic oxidation of methane is thought to be intrinsically linked with methane gas hydrate dissolution. Thus, the variability in amino-BHP abundance could provide an indicator for past methane emission events, directly linking key aspects of structural geology with gas hydrate stability, deep ocean processes, and methane cycling.