

**MASSIVE SULFIDES FROM A HYDROTHERMAL FIELD HOST  
CHEMOLITHOAUTOTROPHIC COMMUNITIES WITH UNUSUAL LIPID  
BIOMARKERS**

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Mid-ocean spreading and accompanying hydrothermal activities result in huge areas with exposure of minerals rich in reduced chemical species – basaltic and peridotitic rocks as well as metal sulphide precipitates – to the oxygenated sea water. These metal sulphides harbour microorganisms able to grow chemolithoautotrophically on reduced iron and sulphur compounds (e.g. Edwards *et al.*, 2005).

Studies of the biomarker interior and their carbon isotope signatures of a massive sulphide sampled from an inactive area at the western flank of the Turtle Pits hydrothermal field (Mid-Atlantic Ridge, 5°S) revealed a unique biomarker distribution. The microbial fauna is dominated by bacteria with a lipid composition mainly comprising of hydroxylated and *iso*-branched fatty acids but especially non-isoprenoidal dialkyl glycerol diethers partially with macrocyclic cores (including methyl branched hydrocarbons with 30 to 35 carbon atoms; Fig. 1). Structural homologues with yet unknown source were recently also found in hydrothermal sinter deposits from New Zealand (Pancost *et al.*, 2006). Similar to the bacterial lipids the archaea in the sulphide predominantly consist of macrocyclic ether lipids including a common C40 isoprenoid and an uncommon compound with an additional methyl group (Fig. 1) for which structural homologues are only reported from a methanogenic archaeum (Galliker, 1990) and a Pleistocene sulphur deposit (Burhan *et al.*, 2002). Compound specific analyses of the stable isotope signatures revealed  $\delta^{13}\text{C}$  values for the majority of bacterial and archaeal lipid components of about 0‰ (versus VPDB), indicative of chemolithoautotrophs using carbon fixation pathways with only negligible isotopic fractionations. However, methanogens are also entrapped in the sulphide, demonstrated by  $^{13}\text{C}$ -depleted isoprenoidal lipids with a  $\delta^{13}\text{C}$  of about -50‰ (characteristic for  $\text{CO}_2$ -reducing archaea synthesising lipids *via* the acetyl CoA-pathway).

Our work shows that sulphides deposited at a hydrothermal field represent suitable environments for uncommon microbiological communities with mostly chemolithoautotrophic organisms. Future studies have to reveal if the widely distributed  $\epsilon$ -proteobacteria – known to be key-playing in sulphide bioleaching – are the source of the

unique glycerol diether composition, especially since recent genomic studies revealed that the  $\epsilon$ -proteobacteria are phylogenetically closer related to the deeply branching, ether-lipid containing Aquificales than to other proteobacterial lineages (Sheridan *et al.*, 2003).

Nevertheless, massive sulphides at the Mid-Atlantic Ridge contain microbial communities not known from any other milieu on Earth and thus possibly represent a window into ancient microbial communities and thus into the early evolution of life.

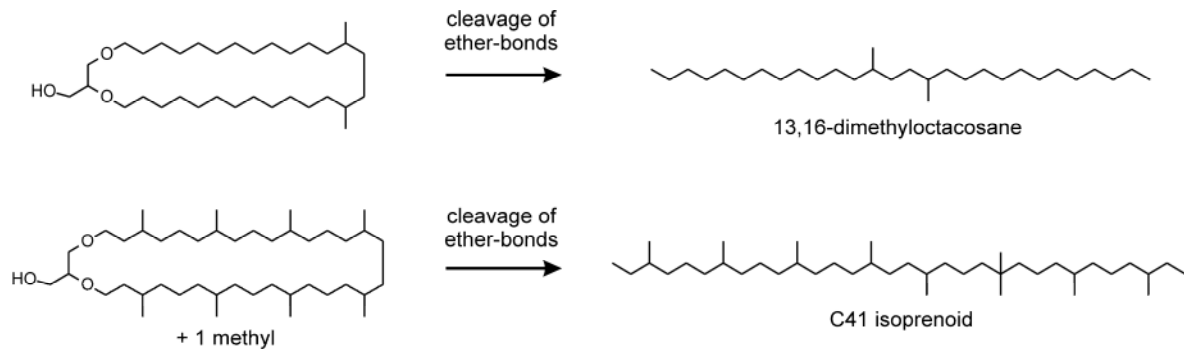


Figure 1. Examples of lipid biomarker series and their ether cleavage products present in a massive sulphide – tentatively identified from their mass spectra.

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