Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07643, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07643
EGU General Assembly 2008

Alkaline ester cleavage to examine the feedstock potential of low mature coals for deep microbial populations

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It has been stated that diverse microbial life appears to be present wherever a source of energy (substrate) is present (Kerr, 1997). In the zone of diagenetic alteration functional groups, containing oxygen, are lost from the sedimentary organic matter, partly in form of CO_2, acetic acid (acetate) or higher fatty acids. The idea is that these released products may provide a significant carbon and energy source for deep microbial populations (*Bacteria* and *Archaea)*.

The so-called New Zealand coal band contains a coal series of almost continuous maturity from Cretaceous to Tertiary age and therefore represents different feeding potentials. The collected sample set, gathered during the DEBITS (Deep Biosphere in Terrestrial Systems) project, covers a maturity range from 0.23 to 0.81 vitrinite reflectance (R_0) that is consistent with significant generation, expulsion and migration of potential substrates. To determine the amount of ester-linked compounds in the macromolecular coal matrix we developed a new analytical approach. In this method both low molecular weight (LMW) acids and high molecular weight (HMW) compounds (fatty acids and alcohols) were analysed in parallel using alkaline ester cleavage.

High numbers of LMW fatty acids such as formate, acetate, as well as oxalate and lactate were obtained from the New Zealand coal series. However, a decrease in the amounts of these compounds was observed with increasing maturity rank (to R_0 0.5-0.6), indicating a decrease in the LMW fatty acid feedstock pool linked to the coal matrix.

The HMW fatty acids showed a bimodal distribution with a first maximum at C_{16}/C_{18} and a second maximum at C_{26} carbon atoms. Long chain fatty acids from C_{24} to C_{30}, representing a terrestrial plant supply, decreased with increasing maturity and were also near the detection limit at a maturity level of R_0 0.5 to 0.6. In contrast, the maximum in the short chain range (C_{16} and C_{18}) showed an increase in this maturity range after a previous decrease between R_0 0.27 and 0.41. This implies a supply of fresh non-terrestrial biomass to the coals at this maturity level. C_{16} and C_{18} fatty acids are known to be typical membrane fatty acids of bacteria. A reason for an increase in microbial biomass might be found in restructuring processes at this maturity level as indicated by Sykes and Johansen (2007). Investigating maturity characteristics of the New Zealand Coal Band using thermal extraction- and pyrolysis-gas chromatography they showed an increase of volatile and non volatile paraffinic oil yields in thermal extracts as well as in pyrolysates of the coal samples from R_0 0.6 to 0.8. Thus, at this maturity level the thermal release of hydrocarbons might represent another feedstock pool for subsurface microbial life as known from biodegraded hydrocarbon reservoirs.

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