Geophysical Research Abstracts
Vol. 12, EGU2010-14882, 2010
EGU General Assembly 2010

Biogeochemistry of anaerobic crude oil biodegradation

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Anaerobic degradation of crude oil and petroleum hydrocarbons is widely recognized as a globally significant process both in the formation of the world's vast heavy oil deposits and for the dissipation of hydrocarbon pollution in anoxic contaminated environments. Comparative analysis of crude oil biodegradation under methanogenic and sulfate-reducing conditions has revealed differences not only in the patterns of compound class removal but also in the microbial communities responsible. Under methanogenic conditions syntrophic associations dominated by bacteria from the Syntropheaceae are prevalent and these are likely key players in the initial anaerobic degradation of crude oil alkanes to intermediates such as hydrogen and acetate. Syntrophic acetate oxidation plays an important role in these systems and often results in methanogenesis dominated by CO2 reduction by members of the Methanomicrobiales. By contrast the bacterial communities from sulfate-reducing crude oil-degrading systems were more diverse and no single taxon dominated the oil-degrading sulfate-reducing systems. All five proteobacterial subdivisions were represented with Delta- and Gammaproteobacteria being detected most consistently. In sediments which were pasteurized hydrocarbon degradation continued at a relatively low rate. Nevertheless, alkylsuccinates characteristic of anaerobic hydrocarbon degradation accumulated to high concentrations. This suggested that the sediments harbour heat resistant, possibly spore-forming alkane degrading sulfate-reducers. This is particularly interesting since it has been proposed recently, that spore-forming sulfate-reducing bacteria found in cold arctic sediments may have originated from seepage of geofluids from deep subsurface hydrocarbon reservoirs.