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New life in old reservoirs – the microbial conversion of oil to methane

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Since almost 20 years it is known from stable isotope studies that large amounts of biogenic methane are formed in oil reservoirs. The investigation of this degradation process and of the underlying biogeochemical controls are of economical and social importance, since even under optimal conditions, not more than 30-40 % of the oil in a reservoir is actually recovered. The conversion of parts of this non-recoverable oil via an appropriate biotechnological treatment into easily recoverable methane would provide an extensive and ecologically sound energy resource.
Laboratory mesocosm as well as high pressure autoclave experiments with samples from different geosystems showed high methane production rates after the addition of oils, single hydrocarbons or coals. The variation of parameters, like temperature, pressure or salinity, showed a broad tolerance to environmental conditions. The fingerprinting of the microbial enrichments with DGGE showed a large bacterial diversity while that of Archaea was limited to three to four dominant species.
The Q-PCR results showed the presence of high numbers of Archaea and Bacteria. To analyse their function, we measured the abundances of genes indicative of metal reduction (16S rRNA gene for Geobacteraceae), sulphate reduction (sulphate reductase, dsr), and methanogenesis (methyl coenzyme M-reductase, mcrA).
The methanogenic consortia will be further characterised to determine enzymatic pathways and the individual role of each partner. Degradation pathways for different compounds will be studied using 13C-labelled substrates and molecular techniques. Our stable isotope data from both, methane produced in our incubations with samples from various ecosystems and field studies, implies a common methanogenic biodegradation mechanism, resulting in consistent patterns of hydrocarbon alteration.