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# Assessment of biogeochemical processes in petroleum systems using the carbon and hydrogen isotopic composition of hydrocarbons

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Hydrocarbons are among the most abundant naturally occurring low-molecular-weight substrates for heterotrophic microorganisms in subsurface sedimentary systems. Specific microbial communities inhabit petroleum reservoirs where biodegradation of hydrocarbons has a major impact on the quality and economic value of crude oil and natural gas. Limitations of microbial activity in petroleum reservoirs are poorly understood and are subject of ongoing investigations. It has become more widely accepted in recent years that any volumetrically significant degradation of hydrocarbons in such reservoirs has to proceed under anoxic conditions. This contribution explores the potential of the carbon and hydrogen isotopic composition of individual hydrocarbons as a tool for the assessment of biogeochemical processes in petroleum systems.

Occurrence, composition and properties of petroleum are controlled by a complex interplay of geological, physical, chemical and biological processes influencing both the generation of fossil fuels as well as their secondary alteration after the accumulation in reservoirs. Importantly, all these processes take place on geological time scales (hundred thousand to many million years). This must be taken into account when using compound-specific stable isotopes as tracers of biogeochemical processes in such ecosystems compared to e.g. anthropogenic petroleum contamination in natural environments where processes take place on much shorter time scales. Another important aspect is the differentiation of various alteration mechanisms that may play a role in addition to biodegradation such as water washing, cap rock leakage, evaporative fractionation, deasphalting, gas stripping or gravity segregation. Recently we have demonstrated that carbon isotopic compositions of light hydrocarbons are well-suited to trace

biodegradation effects in a North Sea oil field where other possible influences on the compound-specific isotopic signatures are well-constrained (Vieth and Wilkes, 2006). Here we will compare carbon and hydrogen isotopic data for hydrocarbons from various petroleum systems in which biodegradation is well-established as one important control on the occurrence and composition of hydrocarbon fluids. A general approach to quantify the extent of biodegradation for individual petroleum hydrocarbons using their carbon isotopic composition will be discussed on the basis of our field data and the known mechanisms of anaerobic hydrocarbon degradation (e.g. Wilkes et al., 2002).

**References**

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