P41-MO

USING HETEROCOMPOUNDS AND STABLE ISOTOPES TO QUANTIFY AND PREDICT ALTERATION PROCESSES IN PETROLEUM RESERVOIRS

Raingard M. HABERER, Andrea VIETH, Heinz WILKES, Rolando DI PRIMIO and Brian HORSFIELD

GeoForschungsZentrum Potsdam, Section 4.3: Organic Geochemistry, Telegrafenberg, 14473Potsdam, Germany.

Post-filling alteration through biotic and abiotic effects is a major risk in many shallow petroleum prospects. Once petroleum is trapped in a structure, these processes (e.g. biodegradation and –synthesis, water washing, gas stripping and gravity segregation) generally have strong economic consequences since they lead to a decrease in oil quality and reduce the total volume of petroleum in place. The overall goal of our new Industry-Partnership-Program project "**I**n **R**eservoir **A**lteration **D**ynamics (INRAD)", which started in December 2006, is to develop integrated models for predicting and quantifying the extent of such post-filling alteration processes in shallow prospects. Therefore the vertical and lateral variability of petroleum composition within different reservoirs e.g. in the Norwegian Sea, the Gulf of Mexico and offshore Brazil will be characterised, evaluated and interpreted at high resolution. In this context the reservoir architecture, its compartmentalisation and filling history through geological time as well as the timing, rate and extent of alteration processes are important elements.

In the three-phase system rock-water-petroleum one of the basic controls on compositional alteration during migration is the variable partitioning behaviour of various petroleum constituents. The qualitative and quantitative deconvolution of physicochemical processes influencing the compositional heterogeneity of petroleum on the reservoir scale is one part of this project. To achieve this, a combination of advanced techniques will be employed for the geochemical characterisation of crude oils and reservoir cores.

Currently we started with investigations of crude oil samples with regard to their hydrocarbon and polar non-hydrocarbon content using whole-oil-GC and GC-MS-analysis. Thereby specific attention is paid to the distribution of polar non-hydrocarbon constituents, containing nitrogen, sulphur and oxygen, such as carbazoles, fluorenones and xanthones which are expected to provide suitable insights into the role of partitioning processes on the reservoir scale. Xanthones for example have been identified in a former study as a new class of petroleum constituents and it has been shown that the physicochemical properties of different isomers control their respective susceptibility to fractionation during migration and to sequential biodegradation (Oldenburg et al., 2002). In this context, molecular modelling of

physicochemical properties of selected oil constituents will be used to assist the interpretation of geochemical analysis. Overall, these investigations will provide new insights into the distribution of different petroleum constituents on the reservoir scale. The underlying transport processes will be better constrained yielding an improved understanding of compound-specific bioavailability and the specific degradation rates of individual petroleum constituents.

As a further tool to deconvolute various alteration processes we will use the compound specific stable carbon and hydrogen isotopic signatures of selected petroleum constituents. Biodegradation of light hydrocarbons is well-known to cause an enrichment of ^{13}C and D in the residual fraction of the substrate. Thus, the use of carbon and hydrogen isotope ratios of hydrocarbons and other organic compounds has become a sensitive tool in identification and quantification of biodegradation processes in sedimentary systems (Vieth and Wilkes, 2006). In this study carbon and hydrogen isotopic signatures of petroleum hydrocarbons will be determined as quantitative tracers of alteration processes in the investigated reservoirs. Using these results the individual compound losses will be calculated via mass balance. Moreover, this data evaluation will result in a conceptual framework for implementing secondary alteration processes into petroleum compositional modelling. Preliminary findings from one of the three study areas will be presented.

REFERENCES

Oldenburg, T.B.P., Wilkes, H., Horsfield, B., van Duin, A.C.T., Stoddart, D., Wilhelms, A., (2002) Xanthones - novel aromatic oxygen-containing compounds in crude oils. *Organic Geochemistry*, 33(5), 595-609.

Vieth, A., Wilkes, H., (2006) Deciphering biodegradation effects on light hydrocarbons in crude oils using their stable carbon isotopic composition: A case study from the Gullfaks oil field, offshore Norway. *Geochimica et Cosmochimica Acta*, 70(3), 651-665.