Integrated Geochemistry and Basin Modelling Study of the Bakken Formation, Williston Basin, USA

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The Mississippian-Devonian Bakken Formation of the Williston Basin is described as a low permeability continuous petroleum system with a limited loss of generated hydrocarbons to adjacent formations. We investigated the geochemical properties of the Bakken source rock members as well as the properties of produced oils using a sample set containing over 250 core samples and production data from over 600 wells from the North Dakota part of the basin. The methods used include TOC and Rock Eval analysis, Py-GC, compositional kinetic characterisation of the Bakken source rock and conventional extraction, GC and GC-MS analysis of source rock and carrier bitumens.

Analysis of extract compositions as well as mass balance calculations based on the maturity sequence studied indicate low sorption potential and excellent expulsion properties of the source rock already at comparably low transformation ratios.

The physical properties of the expelled fluids as predicted by our compositional models closely reproduce the observed natural fluid variability by a combination of continuous and instantaneous filling histories, which are generally related to the degree of structural deformation in this simple inter-cratonic basin.

In structurally undeformed areas fluid properties are reproduced assuming the cumulative accumulation of all products generated, i.e. a continuous system where migration effects are negligible. In the vicinity of structurally deformed areas such as the Nesson and Billings anticlines natural petroleum properties indicate that the bulk of early generation products has been lost, and only the latest high maturity products remain in the reservoir. In essence our data indicates that the Bakken formation behaves as a locally restricted but never the less still conventional petroleum system, where fluids expelled from the source rock are able to migrate, to a larger or lesser extent, both within the formation as well as out of it. The essence of these results is currently being integrated into a 3D basin modelling study to determine probable volumes and distances of Bakken internal migration and possible losses to adjacent formations.