What Controls the Occurrence of Heavy Oil and Tar Sand? A Comparison Study Between the Western Canadian Sedimentary Basin and Liaohe Basin, NE China

Haiping Huang*
University of Calgary, Calgary, AB, Canada
huah@ucalgary.ca

and

Jennifer Adams, Barry Bennett and Steve R Larter
University of Calgary, Calgary, AB, Canada

Bitumen and Heavy Oil

Heavy oil and tar sand bitumen dominate the world petroleum resource and have formed via biodegradation which preferentially removes light components from conventional oil to form heavy oil and tar sands, making the oil more difficult to produce and more costly to refine. The biodegraded oils from the Western Canadian Sedimentary Basin (WCSB) and Liaohe Basin, NE China were characterized by quantitative determination of the bulk compositions, molecular component concentrations and biomarker ratios. The WCSB is a marine foreland basin, characterized by shallow stratigraphic dip, and thin, homogeneous reservoir sands, which have experienced long petroleum charge and reservoir residence time, during uplift and erosion. In contrast, the Liaohe Basin is a lacustrine rift basin, characterized by thick oil columns charged quickly into thick, heterogeneous faulted reservoirs, in a dynamic extensional tectonic depression. However, biodegradation patterns are similar in both cases despite the different geological history and dynamic evolution of petroleum systems. Variations in biodegradation and associated fluid properties along regional-scale east-west trends in the WCSB and between different fault blocks in the Lioahe Basin were controlled by the reservoir temperature and oil charge histories in each basin. Small-scale vertical variations within individual oil columns, which have significant impact on fluid properties, but are largely ignored, were developed due to interaction of biodegradation at the oil-water contact and charge mixing. The availability of essential nutrients for microbial metabolism most likely from mineral dissolution within the water leg is thought to have a significant impact upon the degree of biodegradation.

The patterns of biodegradation in these two types of basin can be explained by a consistent set of key controls, which makes levels of biodegradation and variation in the fluid viscosity within a reservoir predictable using numerical models. Even though no single parameter can be used as a quantitative tool for the pre-drilling assessment of biodegradation risk and reservoir fluid quality,

we believe that a greater understanding of the fundamental mechanisms could not only lead to predict the occurrence of heavy oil and tar sand at the prospect level but also to locate sweet-spots, optimize the placement of new wells and improve definition of completion intervals and help with production allocation from long production wells.

References

Larter, S., Huang, H., Adams, J. et al., 2006, The controls on the composition of biodegraded oils in the deep subsurface: Part II - Geological controls on subsurface biodegradation fluxes and constraints on reservoir-fluid property prediction: AAPG Bulletin, **90**, 921-938.