

**D/H COMPOSITION OF INDIVIDUAL HYDROCARBONS FROM IN-RESERVOIR  
BIODEGRADED OILS: A LINK TO SUCCESSFUL OIL-SAND RECOVERY**

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Oil-sand deposits in the eastern part of Alberta, Canada are one of the major unconventional sources of hydrocarbons worldwide. Economic recovery of this increasingly valuable commodity is hampered by the high viscosity of hydrocarbons due to extensive biodegradation. Steam Assisted Gravity Drainage (SAGD) is a popular method for improving oil-sand recovery in Alberta. A crucial component of this process is efficient application of the injected steam in contact with in-situ bitumen. Hydrogen isotopic composition of individual hydrocarbons can provide information about the extent of interaction between the steam and bitumen. The present study investigates two factors that are important for monitoring this process: a) the extent of D/H exchange between formation waters and individual hydrocarbons during oil biodegradation, and b) the extent of D/H exchange between the injected steam and individual hydrocarbons from in-situ bitumen during the SAGD method.

The first component of this study involves compound-specific isotopic analysis of 3 sample suites of biodegraded oils that can serve as potential analogues for hydrogen isotope exchange during biodegradation of OM in Alberta oil sands. These biodegraded oils represent OM of 3 different kerogen types. The first oil suite is derived from a Cretaceous lacustrine source rock (kerogen Type I) in off-shore Brazil and experienced biodegradation levels 1 through 4 (Peters et al., 2005). The second oil suite was sourced by a terrestrial source rock (kerogen Type III) from the Niger Delta area and underwent biodegradation levels from 1 to 4. The last oil (Fig. 1) derived from a Jurassic source rock (kerogen Type II-III) in the North Atlantic. This oil went through biodegradation levels 0 to 3. We see variations in the H isotope systematics in each setting.

The second part of this project concerns investigation of D/H composition of individual hydrocarbons released during pyrolysis of biodegraded Athabasca oil sand under thermal recovery conditions like SAGD. A series of laboratory experiments were designed to simulate thermal recovery of bitumen during the SAGD method monitoring D/H exchange between the injected steam and hydrocarbons from in-situ bitumen.

Results from this work will supply new information which will be relevant to other petroleum systems containing economically important biodegraded hydrocarbons. First, we will produce much needed data concerning D/H composition of progressively degraded in-reservoir hydrocarbons. Second, we will test the applicability of compound-specific D/H methodology for improving thermal recovery of highly biodegraded oils using the SAGD procedure and tracking steam and energy fluxes in heavy oil reservoirs using the H isotope geochemistry of bitumens.

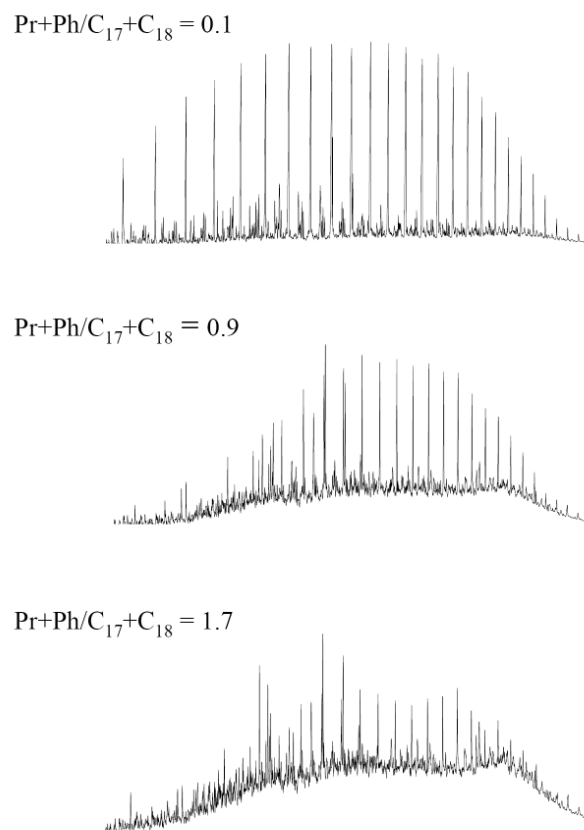


Figure 1. Three different stages of biodegradation of a North Atlantic oil derived from a Jurassic terrestrial OM source rock.

## REFERENCES

Peters, K.E., Walters, C.C., Moldowan, J.M., 2005. *The Biomarker Guide. Vol. 2: Biomarkers and Isotopes in Petroleum Exploration and Earth History.* Cambridge University Press, Cambridge.