

Petrography and Microthermometry of Fluid Inclusions in Oil Sands and Heavy Oil Deposits from Western Canada Sedimentary Basin

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Understanding the hydrocarbon biodegradation processes in oil sands and heavy oil deposits is of importance both from a scientific and an economic point of view. Most studies focus on the final products of the processes, i.e., hydrocarbons in the reservoirs. In this paper, we study oil inclusions entrapped in minerals as samples of the oils in the reservoir before and during the processes of biodegradation. Preliminary petrographic and microthermometric data are presented, with an ultimate objective to better understand the thermal control on biodegradation. The data may also be useful in constraining the timing of oil charge and degradation process in the context of the basin evolution.

Preliminary petrographic studies of sandstone samples from heavy oil charged reservoirs in the Lower Cretaceous Mannville Group in the Lloydminster area indicate that the sandstones are mainly composed of quartz grains with solid bitumen and other brown materials filling interstitial space. Petroleum inclusions mainly appear isolated or in trails in quartz grains as secondary inclusions. Aqueous inclusions are abundant in detrital quartz, but most of them are likely inherited from the source rocks of the detrital grains. Some of the aqueous inclusions may have entrapped the reservoir water, but it is not straightforward to distinguish them from the inherited ones. Efforts are being made to find coexisting oil and aqueous inclusions, which can then be used to estimate the trapping temperature and pressure.

Based on the characteristics under transmitted light and UV excitation, two types of petroleum inclusions are distinguished: a brown one without fluorescence and a light-coloured one having fluorescence. The latter, with white, bluish white, and white-yellow fluorescence colours, may have recorded the petroleum in the reservoir before and during biodegradation. Preliminary microthermometric results indicate a wide range of homogenization temperatures, ranging from 29°C to over 200°C. This large variation is mostly attributed to leakage and heterogeneous trapping. Many oil inclusions show unstable homogenization temperatures, i.e., changing from one run to another, clearly indicating that the inclusions have leaked. However, some oil inclusions show stable homogenization temperatures, which mainly fall in the range from 70°C to

120°C. These temperatures are partly higher than the “pasteurization” temperature (80°C) (Head et al., 2003), beyond which biodegradation is limited. Our on-going research focuses on examining the nature of homogenization temperatures, with more data from the Athabasca and Cold Lake areas.

References

Head, I.M., Jones, D.M., and Larter, S.R., 2003, Biological activity in the deep subsurface and the origin of heavy oil: *Nature*, **426**, 344-352.