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A Diagenetic Study of the Mannville Group in the Lloydminster Area, Western Saskatchewan

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The Mannville Group in the Lloydminster area hosts approximately 9.5×10^9 m³ of oil-in-place. Although located along strike with Cold Lake and Athabasca oil sands, the heavy oil in Lloydminster is much less biodegraded, a condition which may be related to different charging events and thermal evolution. Petrographic and fluid-inclusion microthermometric studies were carried out in order to determine the effect of hydrocarbons in the diagenetic processes, to evaluate the relative timing of oil charging and to understand the thermal control on biodegradation. Three types of samples were studied: those with abundant hydrocarbons (oil-saturated sandstones), with minor hydrocarbons (oil-stained sandstones), and without hydrocarbons (oil-free sandstones).

The oil-saturated sandstones generally display a low degree of compaction, and contain only few diagenetic minerals such as glauconite, pyrite and siderite that formed at very shallow depths of burial. The oil-stained and oil-free sandstones (not including those massively cemented by calcite), however, contain marcasite, microquartz, feldspar overgrowth and kaolinite which formed in the later stages of diagenesis. Oil inclusions in quartz show homogenization temperatures (Th) from 29°C to more than 160°C. Although leaking and heterogeneous trapping cannot be ruled out, some of the reproducible Th values of >80°C may be valid. Based on these observations, it is proposed that the oil in the oil-saturated sandstones was charged in the early stages of diagenesis which favoured biodegradation and inhibited further diagenesis, whereas the oil in the oil-stained samples represented a secondary oil-charging event after significant burial and diagenesis, resulting in relative hot reservoirs unfavourable for further biodegradation.

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