Differential Entrapment of Charged Oil - New Insights on McMurray Formation Oil Trapping Mechanisms

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The Lower Cretaceous McMurray Formation is the primary host of the Athabasca oil sands deposit, one of the largest petroleum deposits in the word. Regional studies shows that bitumen saturated reservoir sands are encountered within the central and western part of the basin, while the eastern part of the basin has never been charged by petroleum. The lateral contact between petroleum and water saturated reservoir sands is characterized by rapid changes in bitumen saturation even between closely spaced wells and different petroleum entrapment schemes have been employed to explain the trapping mechanism of this vast resource, but they still remain a matter of great debate.

In this work integration of a reservoir charging and an inter-compartmental reservoir charging and spilling-mixing petroleum geochemical model combined with the detailed knowledge of reservoir architecture allows us to look at petroleum “fill and spill” among lateral reservoir compartments separated by mud filled channel sections as part of the trapping mechanism. Classical molecular maturity parameters measured by gas chromatography - mass spectrometry of bitumen from neighboring reservoir compartments show notable changes confirming that compartments at the eastern edge of the Athabasca oil sands are sometimes filled by separate petroleum charges. Implications for reservoir development are immense, including using the principles and geochemical gradients as a tool for defining the presence and the extent of individual compartments as an aid to well placements. The results also suggest oil charge was very limited locally and individual compartments may not have seen the multiple charges evident in the oil sands to the west. The concepts presented should be applicable to other meandering fluvial belt reservoirs worldwide and suggests a necessity to revise existing stratigraphic trap schemes by including stratigraphic trap compartmentalization as one of the trapping mechanisms.