Effects of Reservoir Compartmentalization on Bitumen Quality in the Athabasca Oil Sands Deposits, NE Alberta

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Recent studies have demonstrated that the bitumen residing in the Athabasca Oil Sands Deposit (AOSD) shows large variation in hydrocarbon composition and bitumen quality based on physical properties (e.g., API gravity ranges 6-11). The compositional variations are observed on both lateral scales as well as vertically. In general, the bitumen located towards the base of an oil column, in close proximity to a basal oil-water contact, is usually of a higher viscosity compared to the bitumen form higher up in the reservoir. The variation in physical and chemical properties of bitumen observed as compositional gradients has been attributed to the effects of biodegradation. Detailed compositional analysis of a number of petroleum columns have shown that physical and chemical property variation in various areas may show anomalous inverse gradients, and even off-sets in compositional trends coinciding with geological features.

A suite of methods have been employed to characterise the bitumen composition of samples obtained from AOSD in terms of viscosity (at 20°C), weight percentage (%) bitumen determined by the Dean Stark method, level of biodegradation (employing molecular markers determined by GC-MS), and bulk molecular composition measured by Iatroscan. A detailed description of reservoir geology has been compiled from core descriptions, geophysical logs and sedimentological analysis. The integration of geological data and bitumen properties shows that where compositional gradients appeared anomalous they may be attributed to compartmentalization of the reservoir (i.e. the bitumen is not in communication). The results obtained indicate that even very closely spaced compartments (<5 m) may contain not only bitumen with very different properties, but also that bitumen composition may be used to define the presence and effectiveness of barriers between the compartments. Although biodegradation appears to be recognised as the dominant alteration process in the AOSB, we suggest the following geological factors should be considered:

- Petroleum charging and mixing histories;
- reservoir rock properties (facies);
- Local variations in conditions (e.g. water composition, lithology) that may lead to different biodegradation pathways. For example, in the AOSD, 25-norhopane formation has been observed synonymous with hopane degradation, sometimes hopane degradation occurs without the formation of 25-norhopanes.

This information is useful for indicating the range of chemical and physical property variations, laterally and vertically, that may be encountered in oil sands reservoirs. The information may be used to assist in prospect evaluation and exploitation, and can indicate where potential recovery problems may occur when a resource is evaluated for *InSitu* operations and/or discrepancies in recoveries from different reservoir zones.