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[PS]Geology of Alberta's Oil Sands and Development Strategies*

Frances J. Hein[1], Travis Hurst[1], Rick A. Marsh[1], and Michael J. Boddy[1]

Search and Discovery Article #10205 (2009)
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Abstract

Alberta's bitumen is in Cretaceous Athabasca, Cold Lake, and Peace River oil sands. Bitumen reserve/resource estimates are a measure of the geologic as well as economic risk. Operators must deal with varying degrees of reservoir complexity depending on the oil sands area, bitumen deposit, and depositional environment.

For Peace River bitumen reservoirs are simple, with most of the control related to the erosional topography on the sub-Cretaceous unconformity. For Cold Lake, a deep, high-accomodation, main trunk and secondary tributary salt-dissolution valley largely focused deposition of 10+ separate fluvial-estuarine fills. At Athabasca cut-and-filling of 5+ incised valley fills occurred but within a low-accomodation area, resulting in more complex preserved stratigraphy. Preserved stratigraphy was further complicated by interactions between localized salt-dissolution tectonics and rising eustatic sea-level. In parts of Athabasca the relative base level fell, with removal of significant portions of the stratigraphy; elsewhere in Athabasca relative base level rose, with enhanced preservation of local stratigraphy. Reservoir geometries and interconnectedness is more straight forward at Peace River; increasing in complexity at Cold Lake, with extreme heterogeneity in certain portions of Athabasca.

Besides the quality, complexity, and occurrence of the bitumen reservoir, there are several factors to be considered when developing the bitumen resource. Combinations of mapping parameters such as overburden thickness, mass percent bitumen, minimum pay thickness, occurrence of bottom water, and lateral or top thief zones allow for the integration of the geologic framework with

development scenarios. In general the oil sands are shallow reservoirs. This means that confining overburden pressures are low and local Quaternary channels may compromise reservoir seals or allow communication between fresh water aquifers and underlying bitumen reservoirs. Other deeper subsurface fresh water reservoirs may also connect with bitumen reservoirs, mainly in areas adjacent to the Paleozoic highlands along the sub-Cretaceous unconformity. Ongoing salt dissolution of the underlying Prairie Evaporites has resulted in salt 'roll-over' and anticlinal structures, local faulting, and young paleokarst features. Integration of regional geologic frameworks with local depositional features of the different oil sands deposits allows for efficient development of these vast resources.

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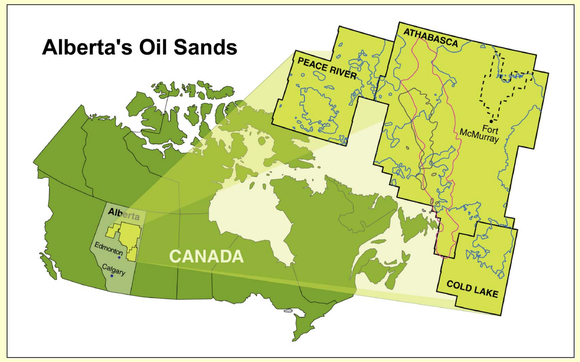

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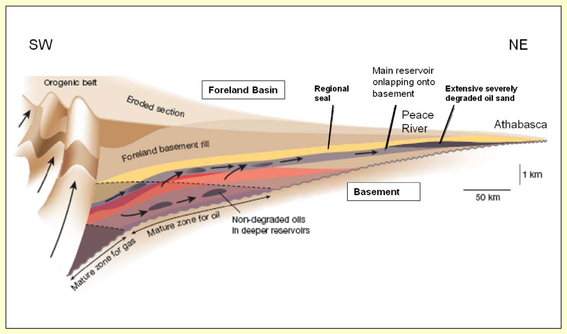
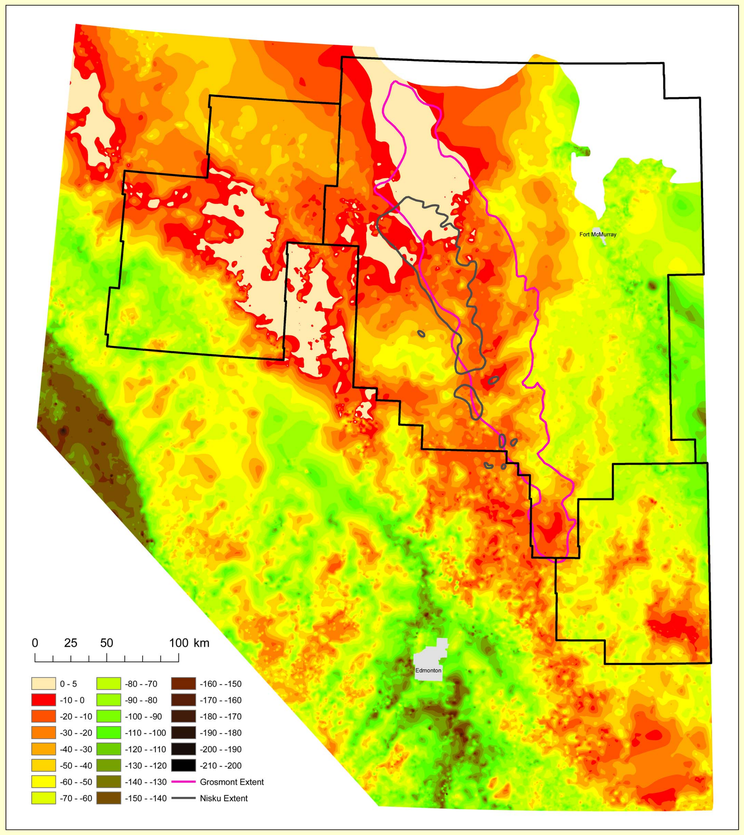


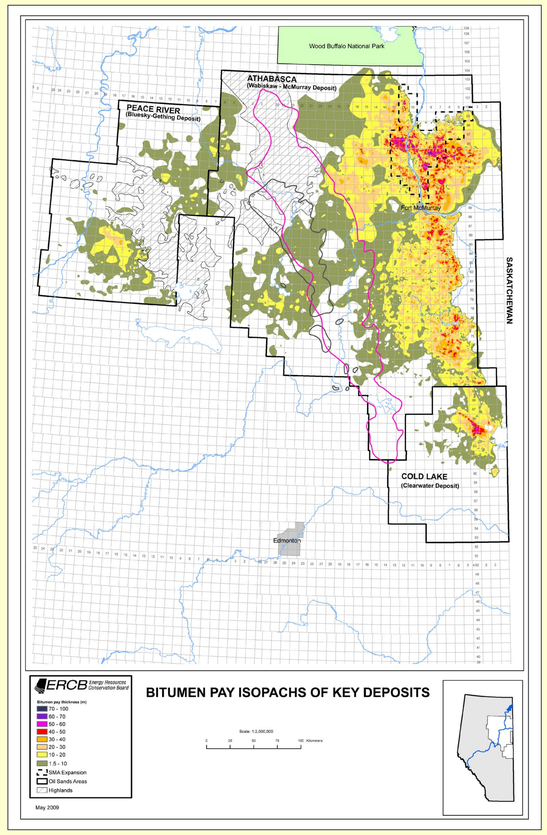
Schematic cross section showing emplacement of conventional reservoirs and biodegradation of oil into bitumen in the Alberta foreland basin (modified from Head et al., 2003).

Paleozoic Topography at Pre-McMurray Time



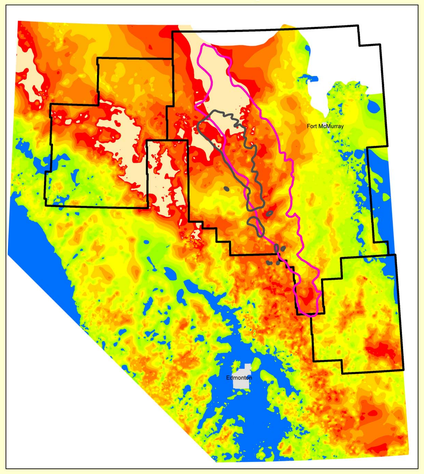
Paleozoic topography controls Oil Sands deposition

Alberta Oil Sands Net Pay

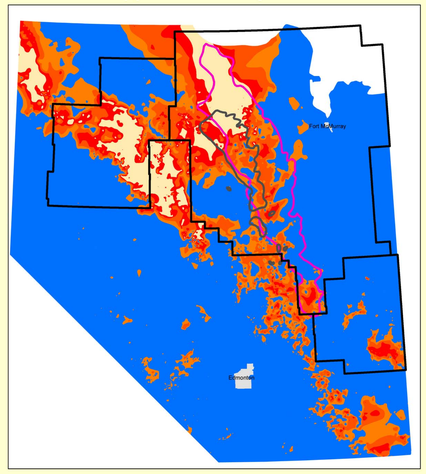


Bitumen of 6% weight tar or greater

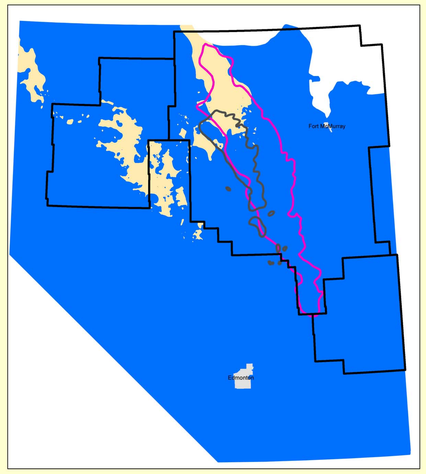
Accommodation Space Lower McMurray Time



Accommodation Space Upper McMurray Time



Accommodation Space End of Wabiskaw Time



Reference

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