Tectonostratigraphy, Water-Source and Water-Injection Potential of the Clearwater Formation, Athabasca Oilsands (*in situ*) Area, Alberta.

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The Lower Cretaceous Clearwater Formation of northeastern Alberta is a heterogeneous package of marine clastic sediments. It can be generally described as a series of offlapping, coarsening- upward cyclic sequences of shelf shales and siltstones capped by low to middle shoreface sandstones, punctuated by the occasional lowstand channel or estuarine complex. It is well explored and well documented as a host formation for natural gas, oil, and bitumen. Much less well known is the regional potential of Clearwater sandstones to be water-source or water-disposal zones at in-situ bitumen production facilities in the Athabasca Oil Sand Area.

The starting point for a regional hydrogeological characterization of the Clearwater Formation is to establish a hydrostratigraphic architecture of flow units mappable at a one-well per township scale. This is done through the use of familiar and common subsurface mapping techniques based on the principles of sequence or genetic-unit stratigraphy. However, for the purpose of hydrogeological characterization there are two aspects that receive more emphasis than in conventional subsurface mapping for oil and gas.

First, there is a greater emphasis on the tracking of local subsidence history. This tracking is done through the use of multiple stratigraphic datums in cross-sectioning and the paying of close attention to mappable linear trends in isopachs and facies belts, a process sometimes referred to as tectonostratigraphy. The reason for this extra attention is that such linear trends in the Clearwater could be associated with activation of basement-related fault systems during Lower Cretaceous subsidence. Careful mapping of these trends may reveal significant linear zones characterized by a local concentration of fractures, faults, breccias, or unusual degrees of alteration and cementation. While the degree of hydraulic heterogeneity along these zones may be insufficient to capture the attention of explorationists, it can impart significant horizontal and vertical anisotropies to the regional hydraulic fabric. Such anisotropies would have significant effects on the long-term behaviour of groundwater withdrawal or injection near these zones.

Second, there is a greater emphasis on the characterization of hydraulic properties of lithofacies within each genetic unit and the careful agglomeration of these components into regional hydrostratigraphic units. Observations and data from core study, thin-sections, core analyses, DSTs, and mini-permeameter measurements are used to characterize hydraulic structures of each component at various scales. These results are generalized or upscaled into a hydrogeologically meaningful architecture at the regional scale. To do this, the components are amalgamated into bodies of physically contiguous and alike hydraulic properties. The resultant maps and cross-sections will look like simple lithostratigraphic maps, but with two major differences. One difference is that amalgamated hydrostratigraphic units will have hydraulic properties controlled by the fabric of their components rather than being assigned an arbitrary bulk value. Another difference is that there will be cases in which the hydraulic anisotropies of otherwise alike and adjoining components may be sufficiently different to warrant not grouping them at all, whereas under simple lithostratigraphy they would otherwise be grouped.

This poster will demonstrate the applicability and results of this approach to subsurface hydrostratigraphic characterization of the Clearwater Formation in the southwest Athabasca Oil Sands area.