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# Toward Optimal Thermal Recovery by Testing Geology With Engineering Data; The Pressure is On!

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**ABSTRACT**

The Clearwater Formation (Upper Cretaceous) in the Cold Lake area, east-central Alberta, contains bitumen which is produced by thermal recovery. There are a variety of thermal schemes which are used commercially including vertical/deviated cyclic steam stimulation (CSS) and horizontal well (HW) CSS. Although steam-assisted gravity drainage (SAGD) is not yet commercially used in the area, it is being tested and proposed. Other schemes have been piloted but have not proven to be efficient as the primary thermal scheme, however they may yet prove to be effective processes as follow-up to CSS.

A major challenge for all schemes is to overcome the heterogeneities inherent in the Clearwater Formation which can impact the effectiveness of recovery schemes. Mud beds that may be continuous on the scale of meters, as in the case of toesets and foresets on subtidal bars, may behave as baffles to flow and only marginally impact recovery, whereas more laterally continuous mud beds may be barriers to steam and bitumen flow. These latter beds may actually define the boundaries of flow units. In addition, geological interpretation of mud thickness and lateral continuity always carries the uncertainty of interpolating between wells. However, engineering data such as measured pressures can serve as an invaluable test of such geological interpretations.

A combined drive drainage (CDD) scheme was piloted in the Primrose area (northwest of Cold Lake) which is currently produced by HW CSS. Combined drive drainage consists of multiple parallel horizontal wells alternately used as injectors and producers with injectors placed stratigraphically above the producers. The geology in the area of the CDD pilot consists of two stacked stratigraphic sequences. The upper sequence contains a lower muddy non-reservoir facies assemblage which separates the sandy reservoir of the lower sequence from that in the upper sequence. The mud-rich facies was interpreted to be tidally influenced delta front deposits and therefore laterally continuous enough to be a barrier to thermal recovery. This model was consistent with the poor performance of the CDD scheme which showed little recovery. Further information was available from a vertical observation well, drilled as part of the CDD pilot, and instrumented with two piezometers, one in the upper and one in the lower sequence. The lower CDD production well was subjected to CSS thereby undergoing cyclic pressure increases. Within days, the piezometer lateral to the lower well registered the pressure transient, whereas there was no response in the piezometer in the upper sequence reservoir even after months.

Intervening mud-rich facies prevented communication between the sand-rich reservoirs providing additional, compelling support for the geological interpretation and illustrating the power of testing models by integrating data sets. Results of these findings lead to abandoning the CDD recovery scheme in favour of high pressure CSS.