

**AAPG Annual Convention
Salt Lake City, Utah
May 11-14, 2003**

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Incised Valleys Without Lowstand Deltas: Examples from the Clearwater Formation at Cold Lake, Alberta, Canada

A study of the Cold Lake heavy oil field, sponsored by Imperial Oil, revealed that it consists of multiple high-frequency valley fills incised into open-marine parasequences of the Clearwater Formation (Albian). Abundant closely spaced wells (1,057) and cores allowed investigation of fluvial to estuarine facies transitions within the valley fills, and documentation of valley terminations. Valley incision ranges up to 110 m deep and up to 10 km wide. Older valleys are poorly preserved because of subsequent incision. Later valley fills all show a basinward transition from fluvial to estuarine facies with increasing mud content and trace fossil diversity in distal portions. Fluvial facies consist of trough cross-bedded sandstone with few clay drapes. Estuarine facies range from cross-bedded sandstone with abundant clay drapes to bioturbated muddy sandstone and sandy mudstone.

In all cases valleys terminate in broad thin (under 3 m) sheets of bioturbated muddy sandstone. None of the valleys terminate in deltas or beaches. In each valley-fill deposit, brackish-water trace fossils such as *Teichichnus*, *Palaeophycus* and *Cylindrichnus* indicate that estuaries were established during transgression and flooding of the incised valleys. Distal thin muddy sheets contain open marine traces such as *Zoophycus* indicating unrestricted communication with the sea. These estuaries were sediment sinks, effectively trapping nearly all the coarse sediment that was delivered via updip fluvial systems and preventing sand delivery to the shoreline. For these types of valley fills, there are no potential downdip reservoirs. This model has been very successful at predicting and explaining reservoir distribution and compartmentalization.