Fluvial Sedimentology and Stratigraphy of a Tight Gas Reservoir: The Monach Formation, Uppermost Nikanassin Group, NW Alberta

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The uppermost lithostratigraphic unit of the Nikanassin Group, the Monach Formation, is a fluvial deposit in the Mesozoic foreland basin of northwestern Alberta (Miles et al, 2009, Kukulski, 2009). Increasing interest in the Monach Formation as an unconventional tight gas reservoir in the deep basin is exemplified by the completion of associated strata in hundreds of wells during the last six years in the Chinook Ridge, Elmworth, Narraway, Red Rock, Sinclair, and Wapiti fields. Delineating the sedimentology, depositional environment, facies variability and extent of the Monach Formation provides a basis for reservoir characterization of this poorly understood and emerging tight gas resource play.

The sandstone of the Monach Formation overlies the interbedded sandstone, siltstone and coal of the Beattie Peaks Formation and is unconformably overlain by the conglomerate of the Cadomin Formation. Differential erosion associated with the incision of the sub-Cadomin unconformity creates a complex stratigraphic architecture in which the Monach Formation thins progressively from >140 m of preserved thickness basinward of the fold and thrust belt to a zero edge in the plains (Figure 1).

Detailed examination of whole diameter core properties including lithology, grain size, grain composition, and sedimentary structures allowed for the development of a detailed facies model. Five facies are identified: (1) massive appearing sandstone; (2) traction-structured sandstone; (3) very fine-grained sandstone and siltstone; (4) organic-rich siltstone and coal; and (5) chaotic and faulted sandstone and siltstone.

The sandstone intervals (Facies 1 and 2) of the Monach Formation are composed of chert and quartz sublitharenite with local mudstone and coal clasts. The grain size is dominantly upper-fine to lower-medium with rare coarse-grained sandstone, granules and conglomeratic detritus. Broadly, the sandstone dominated facies (Facies 1, 2) constitute channel body deposits and are characterized by trough cross-bedding, inclined-planar cross-bedding, ripples, climbing ripples, and massive appearing bedding. Some poorly defined laminations (Facies 1) are attributed to cryptic bioturbation, likely indicating marine influence. Porosity is consistently in the 3-9% range associated with K_{max} permeability values of <0.1 md to 1.0 md. Very fine grained sandstone, siltstone and coal (Facies 3, 4) characterize the overbank/floodplain deposits of the fluvial system with climbing ripples, starved ripples, planar- horizontal laminae, distorted laminae, thin coal beds and rootlets common. Facies 5 is dominated by major soft sediment deformation features such as high-angle syn-sedimentary faulting and sandstone intrusions, interpreted to be caused by bank collapse and liquefaction of sediment possibly associated with seismic shaking.

Facies stacking patterns and regional mapping reveal a variation from thick, amalgamated channel body deposits with high net:gross values, to smaller, vertically and horizontally isolated fining-upwards channel bodies with lower net:gross values. The variation across the basin in net:gross values may be due to changes in accommodation, sediment supply, or basin gradient; it is likely that a combination of these variables are important.

When considering the laterally continuous and compositionally homogeneous fluvial sandstones of the Monach Formation as a potential tight gas reservoir target, the presence of natural fracturing should not be overlooked. Fractures are most often observed within the fold and thrust belt, however, are also present locally within the basin and may provide important permeability conduits within the low permeability sandstone reservoirs.

References

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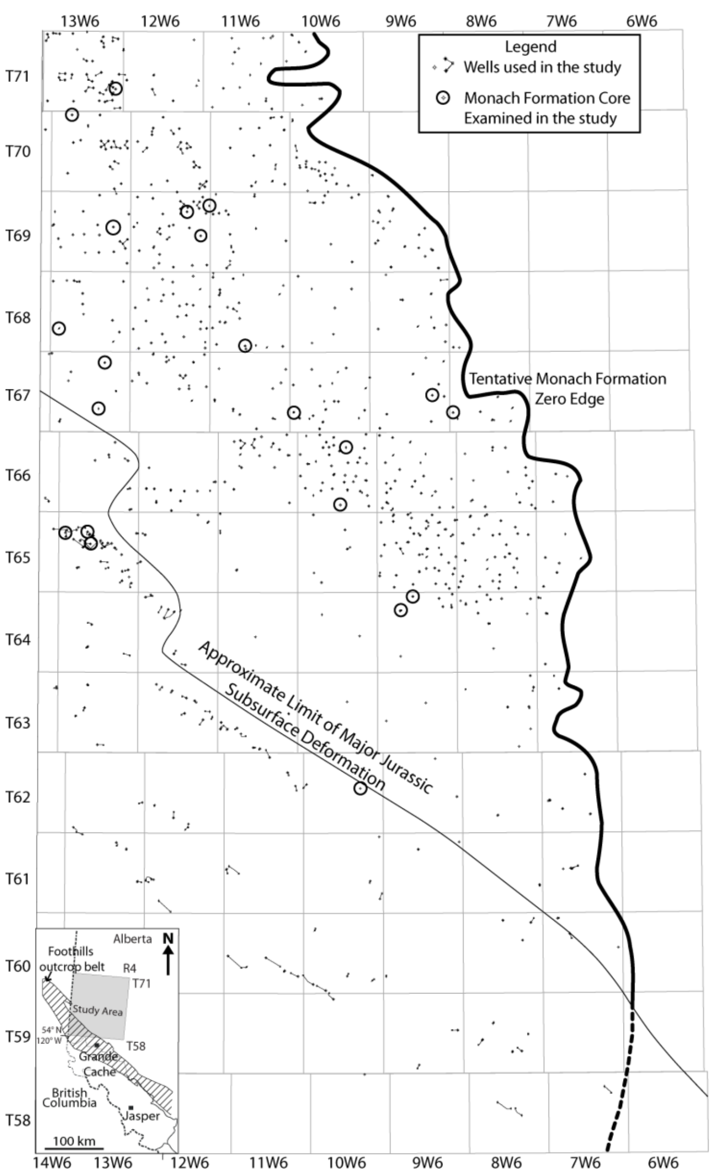

Figure 1. Study area map. Subsurface oil and gas wells utilized in mapping and the cores logged in this study are shown. Tentative Monach Formation zero edge and approximate limit of major Jurassic subsurface deformation are also displayed (Kukulski, 2009).