Stratigraphic Architecture of the Monach Formation (Nikanassin/Minnes Group)

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The tight gas sandstones of the uppermost Minnes/Nikanassin Group in NW Alberta and NE British Columbia, referred to here as the Monach Formation, are an important reservoir target (e.g. Narraway and Chinook Ridge fields). Despite the economic potential of the high net to gross fluvial strata, relatively little published information regarding the stratigraphic architecture, paleogeography and basin history exists. This study addresses these deficiencies using primarily a subsurface dataset of over 3300 wells and 30 full diameter cores supplemented with paleocurrent measurements from outcrops near Grande Cache, Alberta (Figure 1).

Differential incision associated with the sub-Cadomin unconformity has resulted in a complex stratigraphic architecture in which the Monach Formation thins progressively from >140 m of preserved stratigraphic thickness in the fold and thrust belt to an erosional zero edge in the plains. To better constrain the basin scale-stratigraphic architecture, three lithostratigraphic units within the Monach Formation as well as two in the Beattie Peaks Formation have been identified (Figure 2). Net sandstone (<60API) maps of the lithostratigraphic units, considering an average paleocurrent direction of (027) from outcrop, provide insight into the paleogeography and sediment distribution (Figure 1). For example, in the southern portion of the study area, the Lower Monach unit is dominated by laterally extensive sheet sandstone and interpreted to have been deposited by braided rivers. The northeasterly sediment transport direction observed in the study area is consistent with sediment transport directions of the overlying Cretaceous Cadomin and Gething formations and suggests a similar paleogeographic setting during the Late Jurassic with tributaries flowing into a large axial river system (Smith et al., 1984). This hypothesis cannot be unequivocally demonstrated as only the tributary portion of the Monach Formation fluvial system is preserved due to the erosion associated with the overlying unconformity.

Utilizing the methods of Bridge and Tye (2000), insight into channel belt dimensions and channel belt scale (10-15 km) stratigraphic architecture is gained through quantitative prediction of channel belt dimensions using cross-bed thicknesses from full diameter core (Figure 3). Predicted maximum channel belt thicknesses and widths from across the basin vary from 4.1-14.9 m and 514-3005 m. These data form the basis for interpreting channel belt scale stratigraphic architecture as reflected in both maps and cross sections (Figure 1 and Figure 4). Figure 4 illustrates one possible interpretation of channel stacking based on this analysis, and demonstrates reservoir compartmentalization and stratigraphic heterogeneity inherent at the channel belt scale in the Monach Formation.

References

Bridge, J.S., and Tye, R.S., 2000, Interpreting the Dimensions of Ancient Fluvial Channel Bars, Channels, and Channel Belts from Wireline-Logs and Cores, American Association of Petroleum Geologists Bulletin, 84, 1205-1228.

Smith, D.G., Sneider R.M., Zorn, C.E., 1984, The Paleogeography of the Lower Cretaceous of Western Alberta and Northeastern British Columbia in and Adjacent to the Deep Basin of the Elmworth Area, In: Masters, J.A. (eds.). Elmworth: Case Study of a Deep Basin Gas Field.

Figure 1 (A-D) Study area and net sandstone maps for the Upper Beattie Peaks, Lower Monach, Middle Monach and Upper Monach units showing a general sediment transport direction from southwest to northeast. Zero edges of members are shown as a solid black line, the deformation edge is shown as a thin dashed line and line of cross section is labeled. (E) Cadomin Formation isopach map with thick trends oriented SW-NE. Zero edges of Monach Formation units are shown as a solid black line, the deformation edge is shown as a thin dashed line and lines of cross sections are labeled.
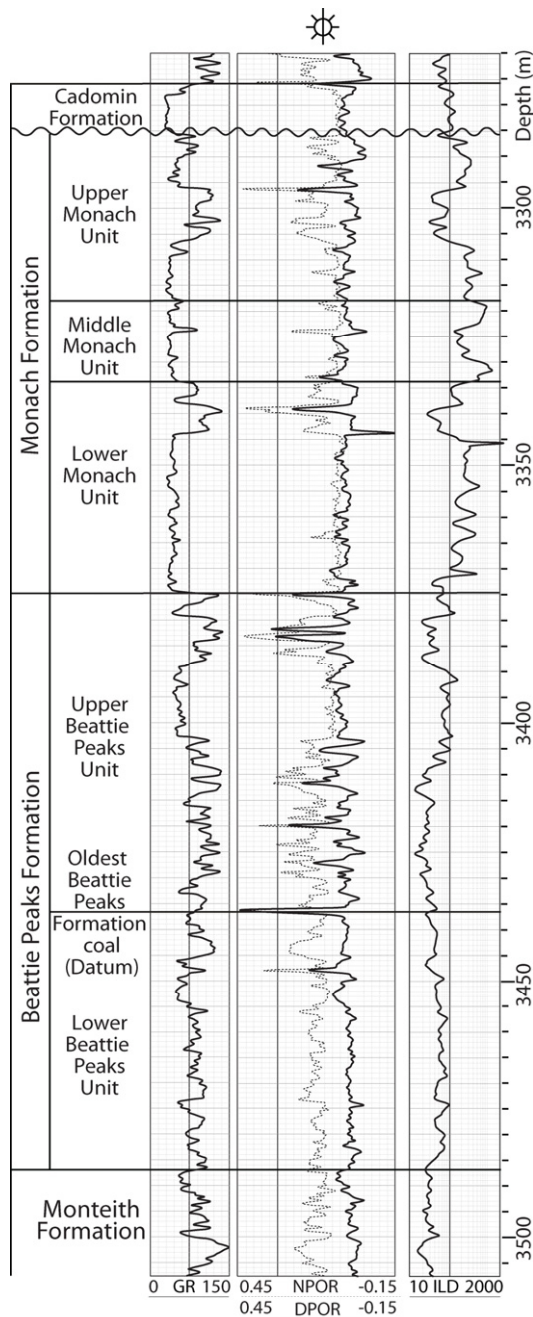
Figure 2. Example log from well 13-03-066-12W6 demonstrating a typical log response across each of the surfaces used to define units
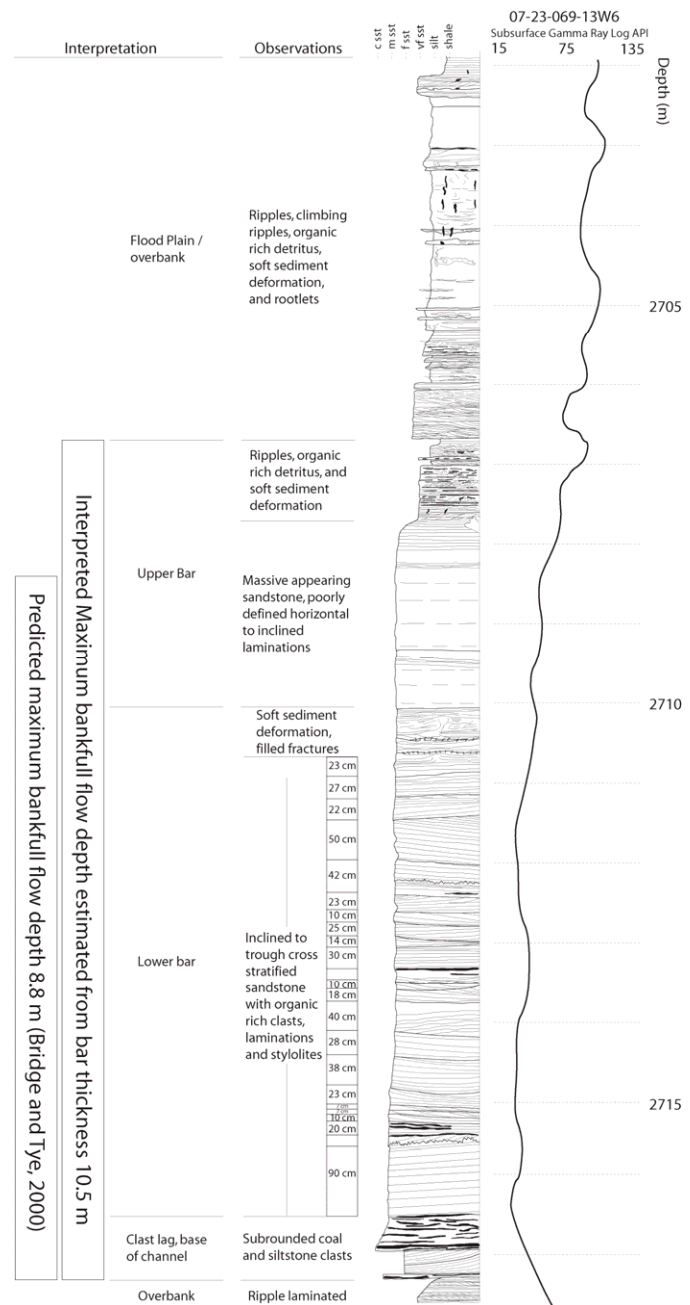
Figure 3. Wireline log, core description and interpretation demonstrating a typical fining upwards succession in the Monach Formation (07-23-069-13W6, 2718 m- 2702 m). The succession is interpreted to be a complete channel fill with associated overbank material. Also shown are the cross-set thickness measurements used to calculate the maximum bankfull flow depth (8.8 m) and the channel belt width (1456 m) associated with this sandstone body.

Figure 4. (Following page) (A) 2.9 km long cross section oriented approximately perpendicular to paleoflow utilizing the first Beattie Peaks Formation coal as a datum. The 60 API gamma radiation line used as a sandstone cutoff is shown as a vertical line through each gamma radiation log. Stratigraphic divisions and net to gross values in the Upper Beattie Peaks and Monach units are shown. (B) Cross section from (A) with interpreted channel belts using width and thickness calculated in the study. (C) Cross section from (B) with predicted channel belts between wells using measured net to gross as a guide. The legend depicts the range of channel belt dimensions calculated for each lithostratigraphic unit and used in the cross section (Bridge and Tye, 2000).

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