Gravity Flow Units in the Nikanassin Formation, Alberta: Insights into Depositional Environments in the Early Western Canada Foreland Basin

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Summary

During the major Jurassic phase of Cordilleran uplift, the Nikanassin Formation was deposited as part of the initial coarse-grained cycle of deposition into the evolving foreland basin. The Nikanassin Formation is used in this study to describe the clastic wedge bounded by the underlying shales of the Jurassic Fernie Formation and overlying coarse clastics of the Cretaceous Cadomin Formation in the area of interest (Fig. 1). Using this informal definition of the Nikanassin Formation, an estimated 6312 $10^6 m^3$ of undiscovered gas is contained within the associated units making it an ideal interval for applied research (AEUB, 2005). Roughly 10,000 wells penetrate the Nikanassin Formation in the study area, approximately 250 of which are cored.

Limited sedimentological work has been undertaken on the Jurassic interval of interest. As facies are an important control on deep-basin reservoir distribution (Zaitlin and Moslow, 2006), this preliminary study is aimed at shedding insight into the depositional setting for the Nikanassin Formation. The lowermost portion of the formation represents the focus of this study. The strata is characterized by intervals of thin muddy (0.5-5 cm) graded beds (Facies A) and thick-bedded massive to traction-structured sandstone (Facies B).

Thin beds of Facies A are normally graded from very fine sand to shaleCommonly characterized by planar laminations and ripples. The bioturbation index of the beds is generally low, however some have been pervasively burrowed. Trace fossils are concentrated near the tops of individual beds, and syneresis cracks are found locally throughout Facies A. The trace fossil assemblage includes *Phycosiphon, Planolites*, *Cosmorhaphe* and *Cylindrichnus,* however these are diminutive compared to fully marine examples (cf. MacEachern et al., 2005).

The sandstone facies (Facies B) is locally characterized by high interstitial mud. Units are commonly structureless and normally graded, locally dominated by planar laminations, climbing ripples and oscillation ripples in the upper portions of beds. Water escape pipes, dish structures and soft sediment deformation are common. Bioturbation is extremely rare in this facies, and when present is located near the top of beds.

Thin silty graded beds and massive muddy sands with abundant water escape features from the Nikanassin Formation record rapid deposition from turbulent, depletive gravity flows (Lowe, 1988; Lowe and Guy, 2000; Mutti et al., 2003). In many instances, units were deposited above wave-base as tops of beds have been reworked. The facies described are interpreted to represent deposition from sediment gravity flows in the delta front to distal delta front/offshore transition. These facies, in association with the others present, suggest that the lowermost Nikanassin Formation was deposited in a deltaic environment with significant river influx. Low diversity trace fossil assemblages dominated by diminutive forms support this interpretation (cf. MacEachern et al., 2005).

Gravity flows in the Nikanassin Formation are postulated to have originated, in part, from hyperpycnal flows, generated when sediment-laden water from a river enters a standing body of lower density water. The higher density of the incoming flow causes it to plunge into the basin hugging the basin floor as a fully turbulent flow (Mulder and Syvitski, 1995; Wright et al., 1988; Zavala et al., 2006). Hyperpycnal conditions are known to lower salinity in deltaic settings, resulting in stressed trace fossil assemblages. The variability in facies derived from these flows are not well studied, however they have previously been interpreted to represent an important component of foreland basin fill (Mutti et al., 2003; Zavala et al., 2006). The documentation of these facies sheds insight into the depositional setting of an economically important yet understudied stratigraphic interval in the Western Canada Foreland Basin.

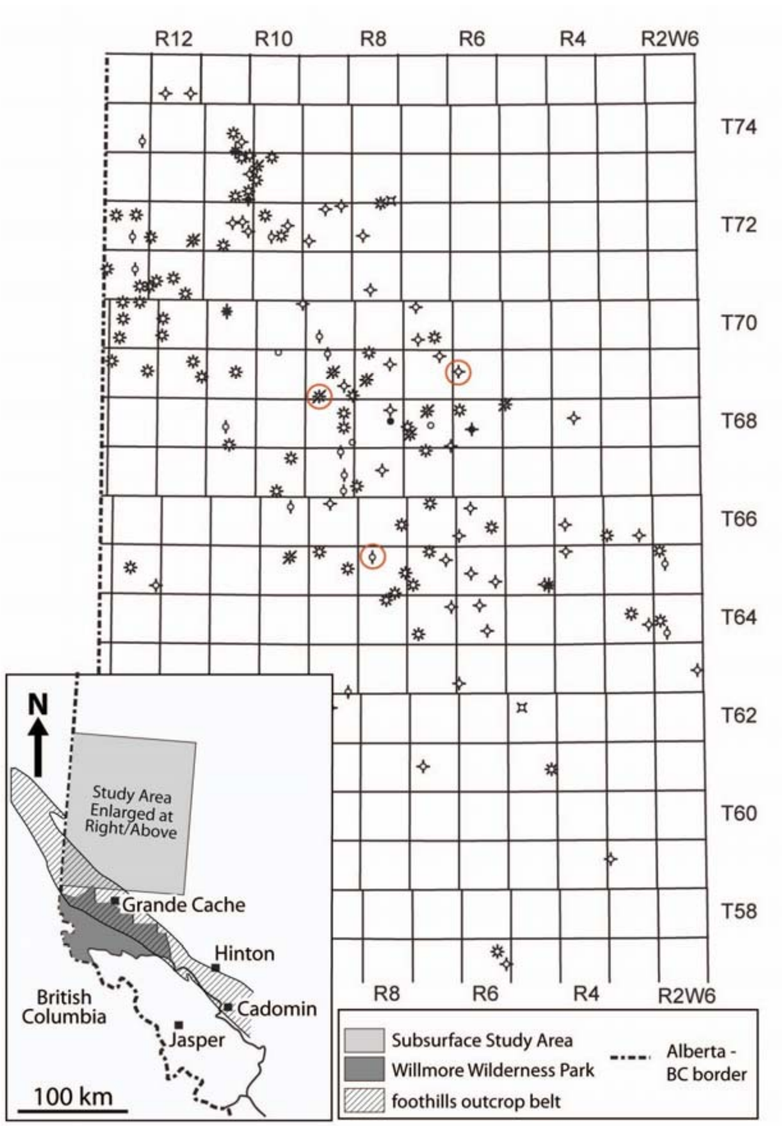

Figure 1: Location map of study area indicating wells that have core within the interval of interest. The foothills outcrop belt is indicated on the inset map, where analogous units are present that compliment the subsurface database. Core from circled wells is featured in Figures 2 and 3.

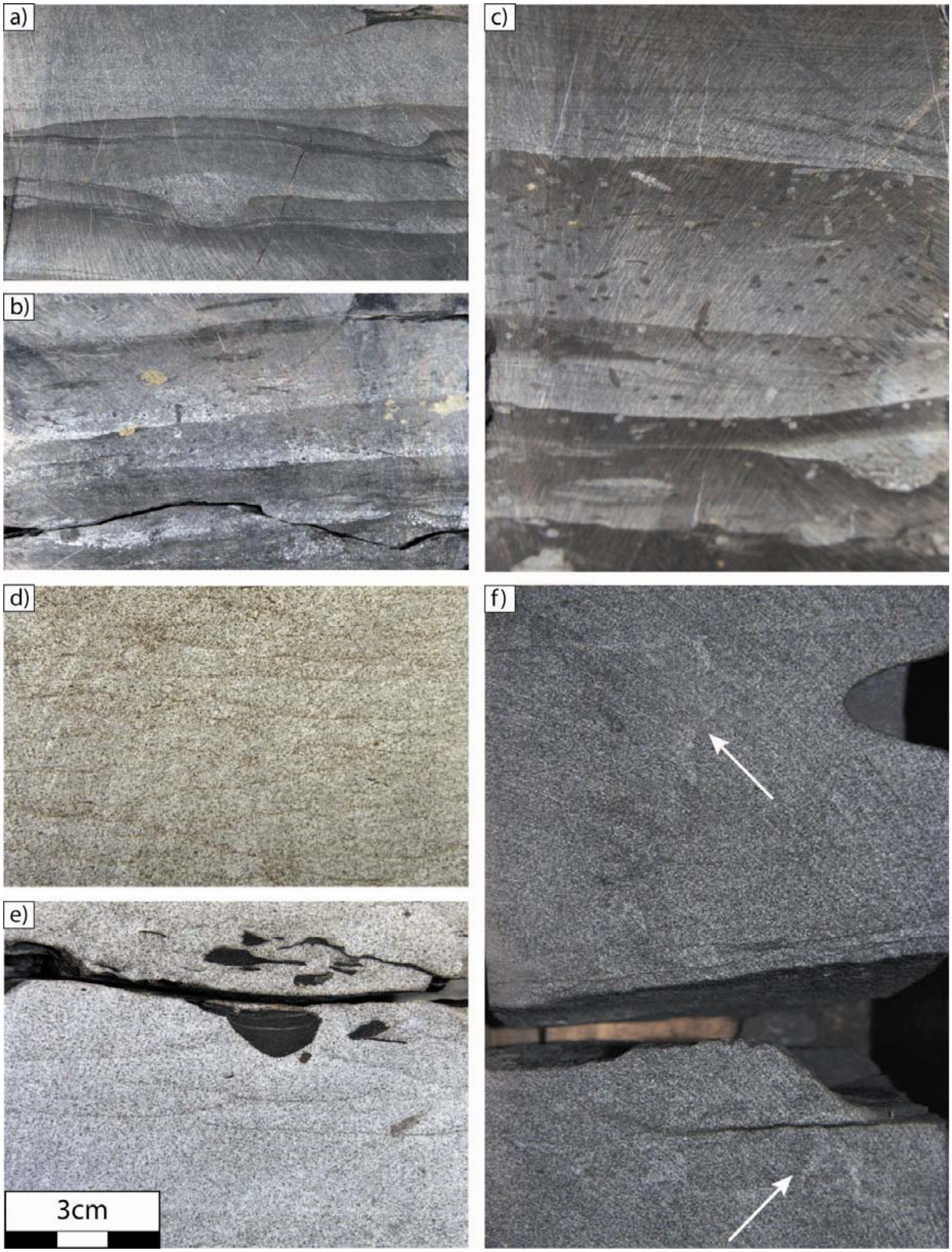

Figure 2: Sedimentological characteristics of Facies A and Facies B. Location of wells are highlighted in Figure 1. The scale in the lower left is applicable to all images. **a)** Scour surfaces on the base of thin graded beds of Facies A (02/07-05-069-09W6; 2516.75 m). **b)** Bioturbated deposits within Facies A; in some instances bioturbation obscures bedding completely (02/07-05-069-09W6; 2521.25 m). **c)** Fine thin graded beds characteristic of Facies A; bioturbation is dominated by *Phycosiphon* and *Chondrites* (02/07-05-069-09W6; 2495.75 m). **d)** Dish structures characteristic of Facies B. Dish structures are indicative of rapid deposition (06-19-069-06W6; 2169.8 m). **e)** Well developed dish structures within sands of Facies B (06-19-069-06W6; 2169.5 m). **f)** Subtle water escape pipes within a muddy sand. The water escape pipes are highlighted by faint sorting of light coloured grains (see white arrows) (10-29-065-08W6; 3090.75 m).

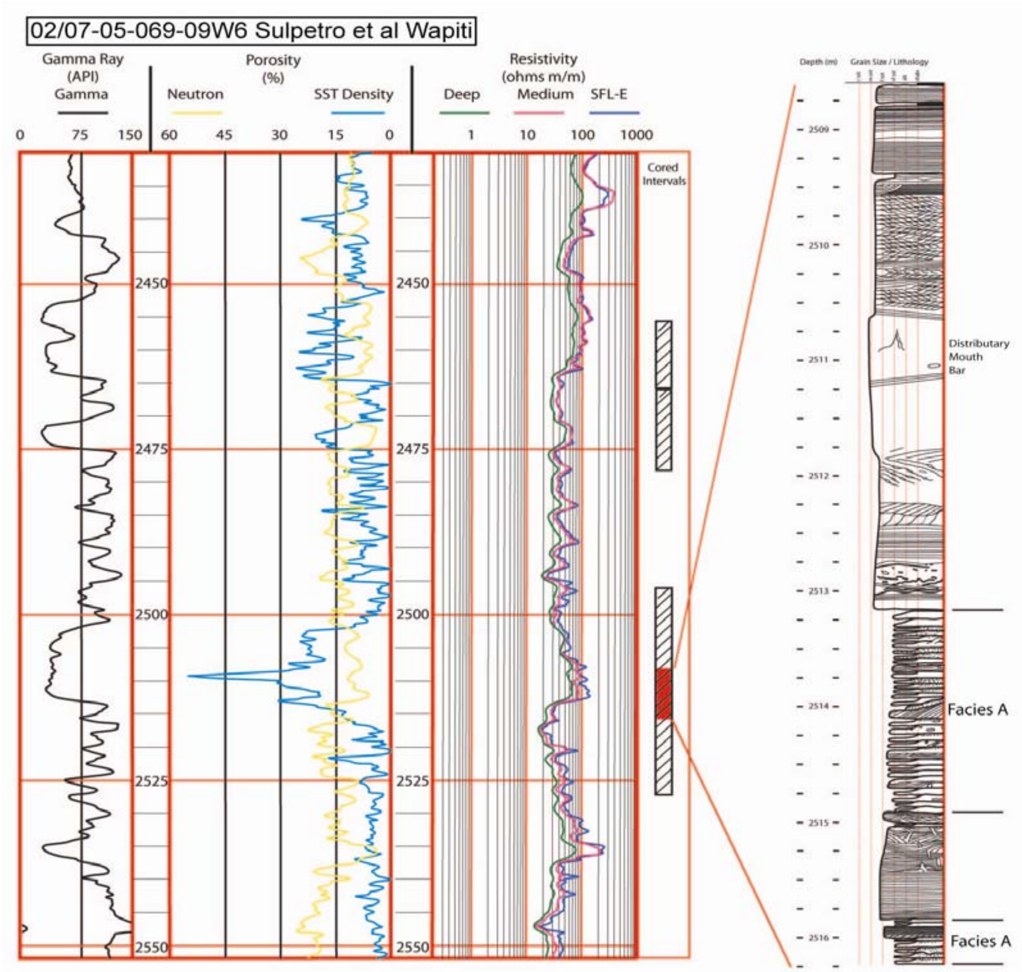

Figure 3: Detailed core description and wireline log suite for well 02/07-05-069-09W6 Sulpetro et al Wapiti. The portion of core described is indicated by the red portion of the core interval. All depths are reported in meters. Location of well is circled in Figure 1.

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