The Origin and Extent of Coarse Grained Sandstones in the Viking Formation near Dodsland, Saskatchewan*

Kain J. Michaud[1]

Search and Discovery Article #51056 (2015)
Posted January 19, 2015

*Adapted from extended abstract prepared in conjunction with presentation at CSPG/CSEG/CWLS GeoConvention 2013, (Integration: Geoscience engineering Partnership) Calgary TELUS Convention Centre & ERCB Core Research Centre, Calgary, AB, Canada, 6-12 May 2013, Datapages/CSPG © 2015

[1]Petrel Robertson Consulting Ltd., Calgary, Alberta, Canada (kmichaud@petrelrob.com)

Abstract

The Viking Formation in west-central Saskatchewan is characterized by a regional sanding-upward succession, interpreted as shoreface sandstones prograding into a shallow marine basin towards the northeast. Core analysis and production data indicate coarse-grained cherty sandstone is the most permeable lithofacies, and where present it can significantly improve production rates. Coarse-grained cherty sandstones are locally interbedded with the regional sanding-upward succession. These coarse sandstones are herein interpreted as submarine flows, namely turbidites and hyperpycnites. Periods of high river flow caused significant sand deposition at the coast during storms or river floods, and that sand avalanched down the shelf slope and was deposited as distinct event beds. Mapping the coarse-grained sandstone facies indicates trends consistent with our model as well as production curves.

Introduction

In west-central Saskatchewan, the Viking Formation is thought to be composed of shallow marine sandstones that were deposited along a NW-SE oriented shoreline. Much work has been done on the Viking Formation in Alberta, whereas Saskatchewan has had markedly less detailed work. Studies completed to date investigate individual fields, but differences in facies and their interpretations from field to field indicate the Viking is not the simple uniform shoreface succession it is often made out to be.

An especially pertinent and poorly understood facies of the Viking is a dispersed coarse-grained, often cherty, sandstone. This facies is especially important to the production of hydrocarbons, as it has the highest permeability of all lithofacies within the Viking Formation. Wilson (1970) hypothesized early on that the presence of chert sandstone was necessary for economic production of the Viking in Saskatchewan, but with the advent of recent horizontal drilling and fracturing techniques, it appears that companies no longer need to target the discontinuous chert sandstone to produce oil. That said, recent drilling activity highlights above average production from horizontal wells with horizontal legs within the chert sandstone. This performance warrants an in-depth geologic study to delineate the thickness and extent of the chert sandstone, as it appears to represent an above average target.

Methods

Sand intervals were broken down into three general facies: 1) laminated, current rippled, typically erosively based sandstones with minimal bioturbation (Figure 1A), 2) a thoroughly bioturbated muddy sandstone (Figure 1B), and 3) coarse grained cherty sandstones with variable bioturbation (Figure 1C and D). Comparing core and cuttings to their respective well logs (gamma, density, and resistivity etc), reveals a characteristic log signature for the coarse grained chert sandstone, typically low gamma, low density, high porosity and high resistivity. Mapping the log signature in over 350 well logs allowed us to identify the approximate extent and thickness of the coarse-grained sandstone throughout the area.

Examples

Coarse-grained sandstones within the Viking Formation are relatively common but are dispersed unevenly (Figure 2). In Alberta, they have been interpreted mostly as transgressive lags, essentially shoreface sandstones that have been winnowed down by waves and/or tides during periods of sea level rise (Davies and Walker, 1993; MacEachern et al., 1999). That interpretation is frequently utilized for the Viking in Saskatchewan.

However, after analyzing the core we believe the coarse-grained sandstone beds near the Fiske/Totnes Field are the result of submarine flows and not transgressive winnowing. First, only a single lag would be expected if the coarse sandstones were a transgressive lag; however, several cores contain three to five distinct coarse beds, each 5 to 50 cm thick, and some contain up to nine distinct beds. Repeated beds can be seen in Figure 1C and D. In addition, where bioturbation is minimal (Figure 1A), sedimentary structures can be discerned, and it becomes apparent that the sand beds in the area were deposited during sediment flows- either turbidites or hyperpycnites.

Conclusions

When river discharge and sedimentation rates were high in the southwest, hyperpycnal flow and slope failures occurred, feeding cherty sandstone into a WNW to ESE oriented fairway. These sands have better than average reservoir properties, and can account for production differences in the area.

Acknowledgements

I thank 3MV Energy for allowing the presentation this work, which was done on their behalf.

References Cited

Davies, S.D., and R.G. Walker, 1993, Reservoir geometry influenced by high-frequency forced regression within an overall transgression: Caroline and Garrington fields, Viking formation (Lower Cretaceous), Alberta: Bulletin of Canadian Petroleum Geology, v. 41/4, p. 407-421.

MacEachern, J.A., B.A. Zaitlin, and S.G. Pemberton, 1999, A sharp-based sandstone of the Viking formation, Joffre Field, Alberta, Canada: Criteria for recognition of transgressively incised shoreface complexes: Journal of Sedimentary Research, v. 69/4, p. 876-892.

Wilson, W.W., 1970, The geology and development history of Plato Field, Saskatchewan: Mesozoic Core Conference, Regina, Saskatchewan, October 30, 1970, 11 p.

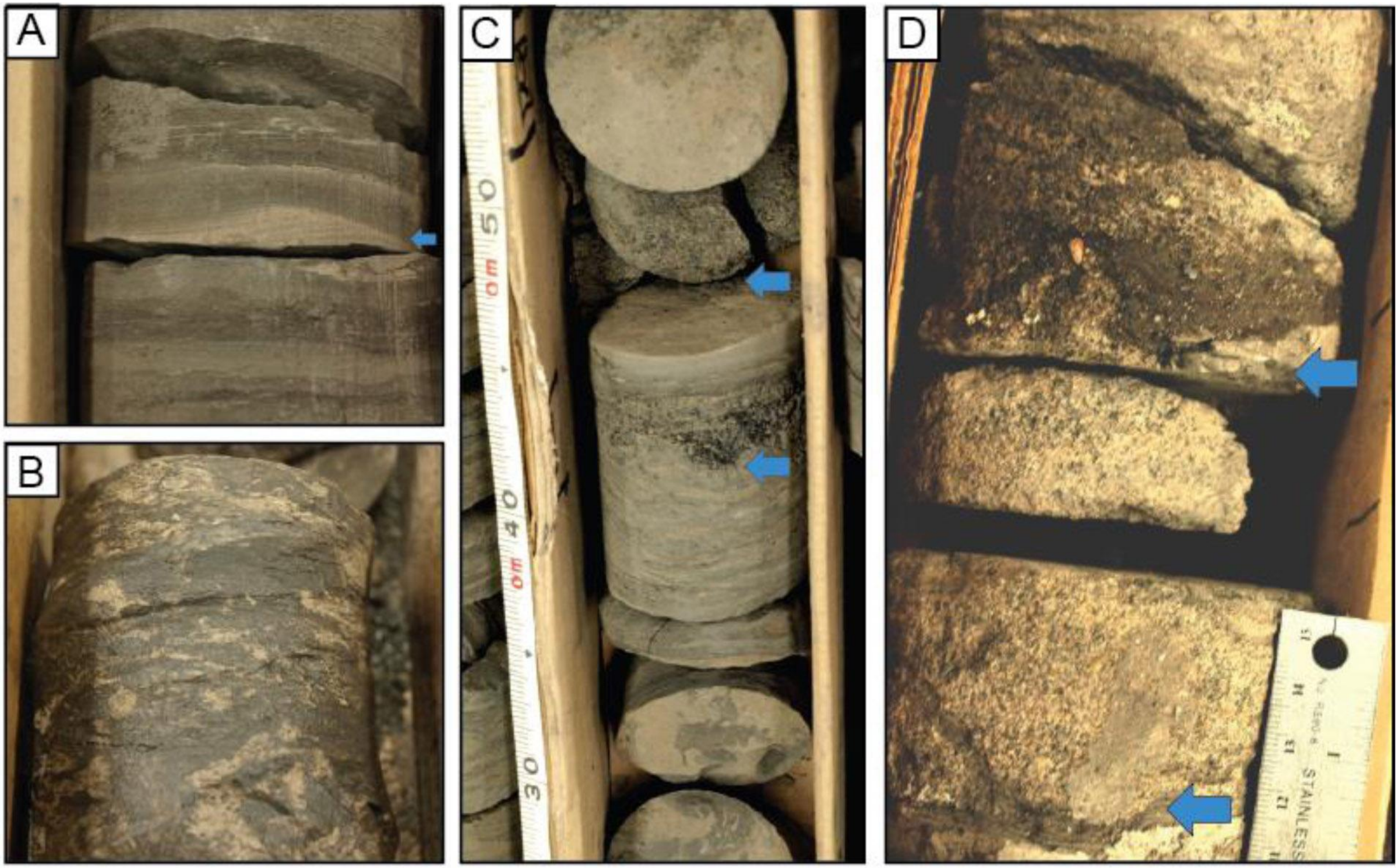

Figure 1. (A) Facies 1 contains current rippled (arrow) event beds with minimal bioturbation. (B) Facies 2 is composed of thoroughly bioturbated sandstones with a bioturbation index of 4-6. Burrows are typically *Cruziana* ichnofacies and often include *Helminthopsis*, *Paleophycus*, *Planolites*, *Chondrites*, *Phycosiphon*, *Thalassinoides*, *Fugichnia*, *Scolicia*, and *Teichichnus*. Coarse-grained cherty sands are often found at the base of event deposits (C). Multiple event beds are commonly separated by muds- see arrows in (C) and (D).

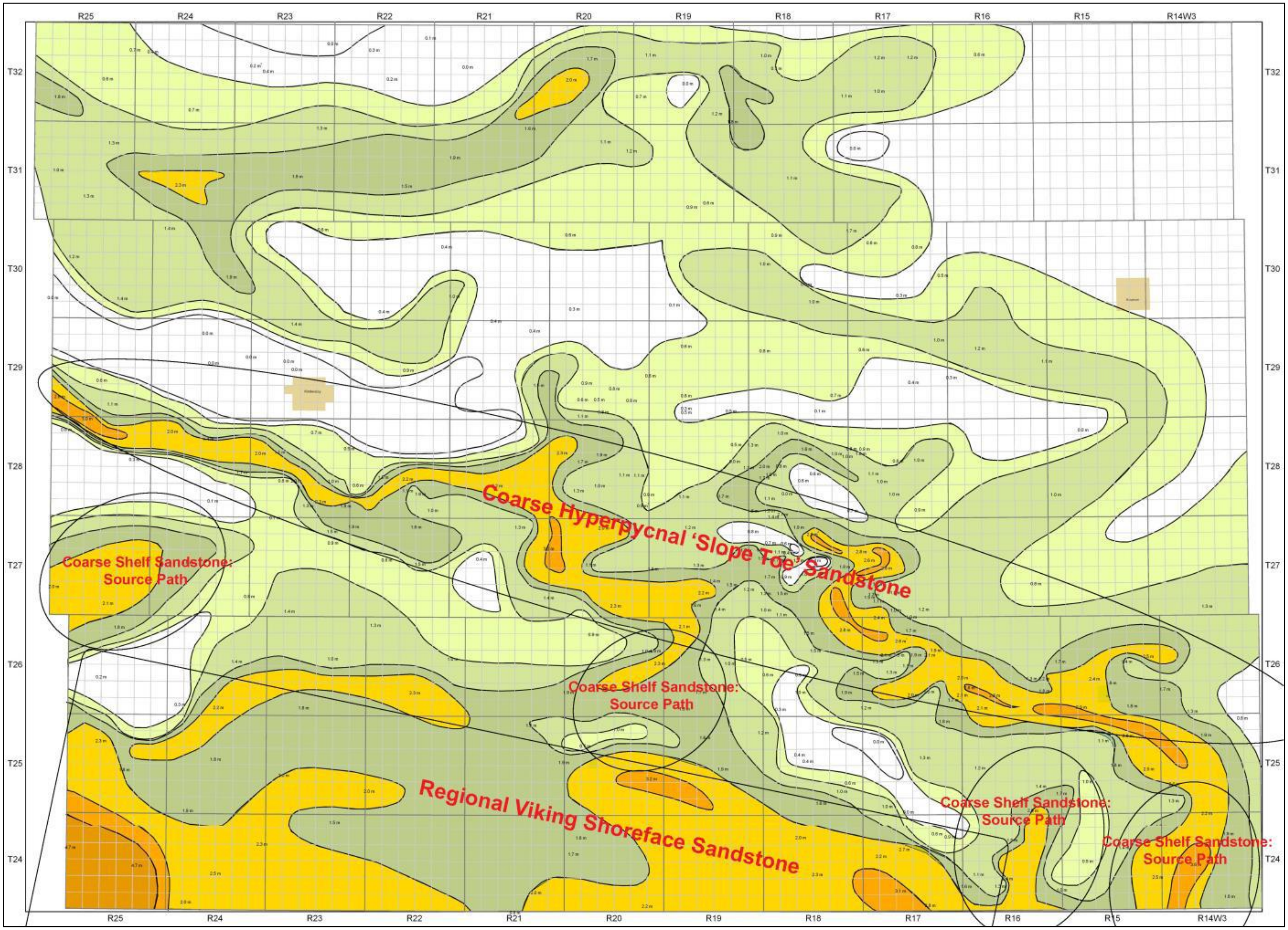

Figure 2. A facies map documenting the study area and the approximate total thickness of all chert sandstone beds within the Viking (colored interval is >0.5m, contour interval is 0.5m).