GeoConvention 2015
GEOSCIENCE
new horizons
Telus Convention Centre • 4-8 May 2015 • Calgary, AB Canada

Complex Facies Delineation: A Geological Model of the Hoadley Barrier Bar in Central Alberta

Adrienne E. McDougall, University of Calgary.
Per K. Pedersen, University of Calgary.

Summary

The Hoadley Barrier Bar Complex is a giant gas and condensate field located in Central Alberta and has been the subject of analysis since its discovery in 1977. Despite this, there is still much to learn about this Lower Cretaceous sand package. New drilling technologies may unlock further potential for this field, and recent horizontal drilling into the Upper Glauconite provides an abundance of new data for analysis in this study.

The Hoadley Bar has a width of approximately 24km and length of 209km, with a southwest-northeast orientation and dip direction toward the southwest (Chiang, 1984). The series of northwest prograding marine bars were deposited into the shallow interior seaway in marine to subaerial conditions, with a number of distinct sand cycles comprising the Upper Glauconite (Chaing, 1984). Localized channels are present in many areas across the sand bar (Chiang, 1984; Rosenthal, 1988). Due to the complex interaction of sand facies, in-depth geological characterization of the Hoadley Field is necessary for identifying potential zones for hydrocarbon development. Recent drilling events have utilized horizontal drilling techniques to optmize production from tight hydrocarbon-bearing zones with variable results. This study will analyze two horizontal wells located at 01-18-043-02W5 and 04-18-043-02W5 to analyze geological causes for the lower than expected production volumes. This study will utilize work from the corresponding geophysical model produced by Aamir Rafiq (MSc. thesis, University of Calgary).

Theory and Discussion

Correlating well log response with facies observed in core is crucial for the interpretation of depositional environments in wells without core in the sandprone Upper Glauconite. The cores analyzed contain high energy sandstones, lower energy marine sandstones, channel sandstones, coal, and low energy lagoonal deposits comprised of muddy, fine-grained sediment. Cores and cross-sections were used to determine depositional trends within the Upper Glauconite, and this data was compared with production in the area to better understand the controlling factors on reservoir quality. The proposed controls are sedimentological factors, structural controls such as faulting and natural fractures, or a combination of these two factors. Understanding which of these controls most affects production is a significant aim of this study, and may also provide insight for subsequent studies in the Upper Glauconite in this region.

Well logs and core analyses were utilized to delineate sandbodies within the barrier bar complex. Six cores in the study area have been described and interpreted, with thin section samples collected from each facies. Mineralogy identified from thin sections, along with core porosity and permeability data were used to further define sandbodies within the Upper Glauconite. Porosity types were also determined from thin section analysis and SEM images to better understand producability from different depositional cycles within the sand package. As well, determining depositional and diagenetic causes for any observed changes in porosity and mineralogy provide more information about potential for hydrocarbon production.

Conclusions

Facies mapping based on log signatures shows southwest-northeast trending coarsening-upward sand bars, which correspond to those outlined in literature (Chiang, 1984). In-depth well log and core analysis of the study area revealed lateral variability of facies surrounding the 01-18 and 04-18 wells. Coarsening-upward gamma ray signatures have been interpreted to represent distinct cycles of shoreface sandbars, with a variable number of depositional cycles in the study area. Distinct sand facies, though clear in core signature, are not always evident in well logs, demonstrating the importance of using core data.

Core and well log data, along with thin section analysis and SEM images show variability among the sand facies at both a large and small scale. Lithological changes appear to be the most significant determining factor limiting the continuity and the quality of sandstones in the Upper Glauconite. SEM images show the presence of pore-filling clays and bitumen in some facies, reducing effective porosity. Faulting has also been identified in the area, as mineralized fractures were observed in core. Compartmentalized microseiemic events surrounding the 01-18 and the 04-18 wells, along with sedimentological variances seen in the positive and negative curvature data are observed in the geophysical model, highlighting the complexity of these reserviors.

Acknowledgements

A special thanks to Aamir Rafiq for his work on the geophysical model in this study area, and to Dr. Christopher Debuhr for his SEM analysis and imaging. This project would not be possible without the support of the TOC, ConocoPhillips Canada and the Department of Geoscience at the University of Calgary.

References

Chiang, Kam K. (1984). The Giant Hoadley Gas Field, South-Central Alberta. *M 38: Elmworth: Case Study of a Deep Basin Gas Field*. 297-313

Eaton, David, Rafiq, Aamir, Pedersen, Per K., van der Baan, Mirko. (2014). Microseismic expression of natural fracture activation in a tight sand reservoir. University of Calgary, University of Alberta. DFNE 2014 Conference.

Hopkins, J.C., Hermanson, S.W., Lawton, D.C. (1982). Morphology of Channels and Channel-Sane Bodies in the Glauconitic Sandstone Member (Upper Mannville), Little Bow Area, Alberta. *Bulletin of Canadian Petroleum Geology.* 20 (4). 272-285.

Rosenthal, L. (1988). Wave-Dominated Shorelines and Incised Channel Trends: Lower Cretaceous Glauconite Formation, West-Central Alberta. *Sequences, Stratigraphy, Sedimentology: Surface and Subsurface.* Canadian Society of Petroleum Geologists, Memoir 15. 207-220.

Sherwin, M.D. (1996). Channel trends in the Glauconitic Member, southern Alberta. *Bulletin of Canadian Petroleum Geology.* 44(3). 530-540.

Wadsworth, J., Boyd, R., Diessel, C., Leckie, D., Zaitlin, B.A. (2002). Stratigraphic style of coal and non-marine strata in a tectonically influenced intermediate accommodation setting: the Mannville Group of the Western Canadian Sedimentary Basin, south-central Alberta. *Bulletin of Canadian Petroleum Geology.* 50(4). 507-541.

Young, H.R., Doig, D.J. (1986). Petrography and Provenance of the Glauconitic Sandstone, South-Central Alberta, with Comments on the Occurrence of Detrital Dolomite. *Bulletin of Petroleum Geology.* 34(4). 408-425.