recovery energy environment economy
2011 CSPG CSEG CWLS Convention

Seismic-stratigraphic Analysis and Sequence-stratigraphic Controls on the Second-order Transgressive – Regressive Cycle of the Uppermost Devonian to Carboniferous Deposits and the Exploration Significance of the Erosion Unconformity in the Upper Paleozoic Strata of the Eagle Plain Basin, Northern Yukon of Canada

Gillian Q. Chi*
University of Calgary, Calgary (Open Students),
2500 University Drive N.W. Calgary, Alberta, Canada T2N 1N4
qchi@ucalgary.ca
Larry Lane
Geological Survey of Canada, Calgary

Summary

Investigation of the Uppermost Devonian to Carboniferous sedimentary strata in the Eagle Plain basin of Northern Yukon shows that this highly cyclic rock succession is composed of a second-order transgressive – regressive cycle characterized by the Uppermost Devonian sandy incised channel-fills in the base and resting on a large scale of unconformity separating with the underlying Upper Devonian turbidite deposits; thick shaly Lower Carboniferous Ford Lake Formation transgressing these channel deposits and followed by eight southward prograding depositional wedges from the Hart River to Ettrain Formations during the Middle and Late Carboniferous. High rates of sediments supply, subsidence on the continental shelf and regional and local tectonic activities are believed to produce and control to some extent these prograding wedges that recorded the high frequency regressive episodes and were corresponding to the globe sea level drop. Large scale of slump occurred during this time and covered a large area in the southern Eagle Plain basin. Parts of the top surfaces of these wedges have been eroded out by the fast tectonic uplifting in the north. Oil and gas have been discovered half century ago in one of these wedges, such as the Chance oil field with a type of structural - stratigraphic trap. Local faults cut these wedges, extended to the underlying source rock of the Middle to Late Devonian Cano and Imperial Formations and controlled on local hydrocarbon migration. So to delineate the complex stratigraphic framework of these depositional wedges with the relationship of the local faults is vital to hydrocarbon resource assessment in this play.

Based on two different seismic expressions, the Tuttle Formation in Eagle Plain basin can be identified as Upper Tuttle Formation and Lower Tuttle Formation. The Upper Tuttle Formation is composed of sandy incised channel-fills in the base of this transgressive – regressive cycle with a makeable of regional unconformity; and the Lower Tuttle Formation consists of wedge-shaped turbidite deposits between this erosion surface and the underlying Upper Devonian Imperial Formation. Detailed regional seismic stratigraphic studies have documented this regionally extensive erosion unconformity truncated with Sub-Mesozoic unconformity in the northern edge of the Lower Tuttle Formation in the middle part of the basin and extended to south, a distance of 120 km around. An origin by the tectonics in the north or northeast may contributed to this remarkable erosion unconformity and tectonic uplift in the study area during the Uppermost Devonian and Early Carboniferous changed paleo-tectonic regimes and new sourcelands generated in the north, which resulted in the clastic wedges of the northeastern progradation of the Middle and Upper Devonian Imperial Formation and Lower Tuttle Formation overlaid by the north-sourced depositions. It was possible assumed that tectonically uplifting in this period may caused the north-northwest trending Richard Trough to raise up to the surface and sequent folded as the Richardson Mountain anticlinorium.

The exploration significance of this erosion unconformity is as follows:

- The northeastern prograding turbidite clastic wedges between the Middle and Upper Devonian Imperial Formation and Lower Tuttle Formation were regionally truncated by this erosion unconformity. Hydrocarbon from these turbidite deposits have been discovered in the eastern Peer Plain and Plateau areas. The stratigraphic contact patterns of this erosion surface with the underlying turbidite deposits controls on the hydrocarbon systems in turbidite play.

- Channels in the Upper Tuttle Formation deeply cut into this unconformity with sandy-fills, and followed by the covering of the maximum thick up to 679 m shaly transgressive deposits. The resulting geometry may keep many types of channel sand bodies in the large areas from the middle to southern basin with a good potential for stratigraphic trapping although the prediction of the sand bodies is difficult.

Acknowledgements

This study is the result of collaboration between the co-authors that conducted in Geological Survey of Canada as part of the Geo-Mapping for Energy and Minerals (GEM) Program from February to July 2010. We would like to thank John Harper, Director of Geological Survey of Canada (Calgary), for his insights

and experience on seismic interpretation with the help of recognizing the slumps in seismic profiles. We also thank Drs. Rob McNaughton, Ashton Ambry, Thomas Hadlari, Zhuoheng Chen and Jim Dixon for their invaluable input into this study; Special thanks to Burnie. C. MacLean, Tom Brent and Phillips Lawrence for their geophysical supports. The authors acknowledge the critical role of Canada's National Energy Board (NEB) for the release of geophysical seismic data which form the basis of this regional seismic study.

References

Lane, L.S., Utting, J., Allen, T., Fraser, T., and Zantvoort, W. 2007. Refinements to Lithostratigraphy, Biostratigraphy and Structural Geometry of the Devonian and Carboniferous Imperial and Tuttle formations, eastern Eagle Plain, Northern Yukon. 2007 CSPG CSEG Convention.

Lane, L.S., 2007. Devonian-Carboniferous paleogeography and orogenesis, northern Yukon and adjacent Arctic Alaska. Can. J. Earth sci. 44: 679-694.

Osadetz, K.G., Chen, Z., and Bird, T. D. 2005. Petroleum Resource Assessment, Eagle Plain Basin and environs, Yukon Territory, Canada. Yukon Geological Survey Open file 2005-2 and Geological Survey of Canada, Open File 4922, 88 p.

Richards, B.C., Bamber, E.W. and Utting, J., 1997. Charter 8: Upper Devonian to Permian. In: The geology, mineral and hydrocarbon potential of northern Yukon Territory and north-western District of Mackenzie. D.K. Norris (ed.), Geological Survey of Canada Bulletin 422.