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Tectonic influence on the stratigraphy and complex facies distribution in the Upper Cretaceous Second White Specks petroleum system, West-central Alberta, Canada

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Summary

The Upper Cretaceous Second White Specks petroleum system consists of organic rich mudstones that were deposited during a period of sea level rise in the Western Canada Foreland basin. Several vertical wells completed in this interval have each produced over 1 million barrels of oil; however, they occur as isolated wells and attempts at offsetting them have largely been unsuccessful. The previously unappreciated heterogeneity of this interval is likely linked to reasons why the Second White Specks petroleum system is often dismissed as an unpredictable fracture controlled play. This study aims to establish the stratal architecture and facies distribution in order to map potential reservoir fairways and to understand the tectonic influence on the filling of the foreland basin. Stratigraphic correlations made using closely spaced wells (<5km) revealed the presence of low angle clinoforms and regional unconformities that can be correlated across the basin.

Introduction and Objectives

In West-central Alberta the Second White Specks petroleum system includes the Fish Scales, Belle Fourche and Second White Specks formations that comprise 500-1200m of mudstone dominated strata. The Fish Scales Formation is dominated by siliceous, and organic rich mudstones containing abundant fish scales and skeletal material. The Belle Fourche Formation consists of siliciclastic, organic rich mudstones and siltstones and the Second White Specks Formation is composed of organic rich, calcareous mudstones and siltstones deposited when warm waters from the Tethyan Sea migrated northward into the Western Interior Seaway.

Numerical foreland basin models emphasize the need for a well constrained three dimensional stratigraphic architecture and detailed mapping of facies distributions in order to understand the allogenic controls on the filling of the basin (Jordan, 1981; Heller et al., 1988; Flemings and Jordan, 1989; Jordan, 1995; Jordan et al.,1998; Paolo, 2000). A model for the tectonic influence on the deposition of sediments within the defined study area will be developed using the stratal architecture and complex facies distrubitions. This tectonic model can then be applied outside the study area in order to predict the location of potential reservoir fairways in the Second White Specks petroleum system. This study builds upon the study by Varban and Plint (2008) and Tyagi (2009) on the large scale tectonic and eustatic influences on the Upper Cretaceous mudstones of the Western Canada Foreland Basin by applying concepts of sequence stratigraphy to cross sections with closely spaced wells. This study addresses factors such as

the facies distribution, sources of sediment input and complex clinoform architecture in order to assess the relationship between the stratigraphy and the spatially and temporally changing rates of subsidence.

Methods

The stratal architecture of an area spanning T37-25, R8W5-21W5 was determined using well log and core data. Cross-sections with dense well spacing were used to map the complex stratigraphy while building on the allostratigraphic framework developed by Tyagi et al. (2007). Sedimentary litho-facies for the Second White Specks, Belle Fourche and Fish Scales formations were described using cored intervals and petrographic thin sections throughout the study area and are distinguished based on changes in rock fabric, composition, and sedimentary features. These litho-facies were used to define petro-facies using resistivity, gamma ray and PE logs. The resulting data was employed to map the complex facies distribution regionally.

Conclusions

The presence of low angle clinoforms within the Second White Specks petroleum system indicates that the rate of accomodation creation likely exceeded the rate of sediment supply suggesting that the basin was underfilled at the time of deposition. A regional unconformity in the eastern part of the study area within the Second White Specks Formation likely represents uplift of the forebulge during a period of crustal loading in the adjacent fold and thrust belt. These observations support numerical models (e.g. Heller at al., 1988; Jordan and Flemmings, 1991) that relate underfilled basins with periods of thrusting and high subsidence rates within the foreland basin that trap coarse grained clastics adjacent to the orogen margin.

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References

Flemings, P. B. and T. E. Jordan, 1989, A synthetic stratigraphic model of foreland basin development, Journal of Geophysical Research, v. 94, no. B4, p. 3851-3866.

Heller, P. L., C. L. Angevine, N. S. Winslow and C. Paola, 1988, Two phase stratigraphic model of foreland basins, 2: Application to syntectonic conglomerate, Basin Research, v. 4, p. 91-102.

Jordan, T. E., 1981, Thrust loads and foreland basin evolution. Cretaceous, Western United States, The American Association of Petroleum Geologists, v. 65, no. 12, p. 2506-2520.

Jordan, T. E., 1995, Retroarc foreland and related basins, In: Tectonics of Sedimentary Basins, C. J. Busby and R. V. Ingersoll, Blackwell Science, New York, p. 331-362.

Jordan, T. E., P. B. Flemings, and J. A. Beer, 1988, Dating thrust-fault activity by use of foreland basin strata, In: New Perspectives in Basin Analysis, W. G. E. Caldwell and E. G. Kauffman, Geological Association of Canadian Special Paper, v. 39, p. 1-30.

Paola, C., 2000, Quantitative models of sedimentary basin filling, Sedimentology, v. 47, p. 121-178.

Tyagi, A., A. G. Plint, and D. H. McNeil, 2007, Correlation of physical surfaces, bentonites, and biozones in the Cretaceous Colorado Group from the Alberta Foothills to southwest Saskatchewan, and a revision of the Belle Fourche-Second White Specks formation boundary, Canadian Journal of Earth Sciences, v. 44, p. 871-888.

Tyagi, A., 2009, Sedimentology and high-resolution stratigraphy of the Upper Cretaceous (Late Albian to Middle Turonian) Blackstone Formation, Western Interior Basin, Alberta, Canada, Doctoral Thesis, The University of Western Ontario, London, Ontario, Canada, p. 939.

Varban, B. L., and A. G. Plint, 2008, Sequence stacking patterns in the Western Canada foredeep: influence of tectonics, sediment loading and eustasy on deposition of the Upper Cretaceous Kaskapau and Cardium Formations, Sedimentology, v. 55, p. 395-421.