

Basin-scale stratigraphic architecture and Paleocene distributary fluvial systems of the Cordilleran Foreland Basin, Alberta, Canada

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Summary

The Paleocene Paskapoo Formation in Alberta, Canada is composed of several hundred meters of fluvial strata deposited 60 million years ago in the actively subsiding foreland basin of the Canadian Cordillera. The Paskapoo Formation is the major groundwater aquifer system in western Alberta, and covers approximately 65,000 km² (Grasby et al., 2008). A large new subsurface data set of this unit has become recently available as a result of new governmental regulations (ERCB directive 043, 2006). In this study we utilize gamma ray normalization methodology to generate well logs of the near surface cased interval to reconstruct large-scale stratigraphy and depositional history of this foreland basin fluvial system.

Introduction

The Paskapoo Formation is divided into the upper Dalehurst Member, the mud dominated Lacombe Member and the basal Haynes Member (Demchuk and Hills, 1991). This heterogeneous fluvial unit comprises the youngest preserved bed rock of the western Canadian sedimentary basin and was deposited in the actively subsiding foreland basin of the Canadian Cordillera (Demchuk and Hills, 1991). In 2006 the Government of Alberta mandated the collection of all natural gamma ray logs to surface, including the cased near surface section. A gamma-ray normalization algorithm has been implemented to correct for the suppression effects of the steel surface casing so that both the cased and uncased gamma ray logs can be used together for stratigraphic interpretation. The normalized logs of the Paskapoo Formation provide a regional three-dimensional data set of the foreland basin fluvial stratigraphy. Characterizing the three-dimensional distribution of aquifers is also a first-order requirement for assessing and predicting groundwater resources (Burns et al. 2010)

Theory and/or Method

Here, we utilize over 1000 recently drilled wells from the foreland basin of Alberta to characterize and interpret the fluvial deposits of the Paleocene Paskapoo Formation. The logs are first normalized using constants derived from analogous strata, estimating the second and ninety-fifth percentiles of the API values in the uncased gamma ray log, and applying these constraints to the cased section of the well log. The normalization allows for clear discrimination of sandstones and mudstones units. These data are used in the generation of

net to gross sand fraction maps, as well as stratigraphic cross sections, in order to reconstruct the large-scale stratigraphy and depositional history of this foreland basin fluvial system.

Examples

The overall fluvial stratigraphy of the Paskapoo Formation varies from south to north across the basin. In the south, the base of the formation consists of amalgamated fluvial sandstones, which become less prominent to the north and are absent in the distal eastern portion of the basin. Net to gross maps indicate a relatively sand-rich area in the upper portion of Paskapoo Formation in the northern portion of the basin. This package is clearly visible in map and cross-section view. This feature has a maximum thickness of 220 meters (m), averaging 175 m, and covers an area of over 3,000 km². The feature fans out from the front of the adjacent fold-thrust belt in two distinct lobes that originate from an apparent point source. Based on the geometry, we interpret this feature as a distributary fluvial system, or megafan, similar to features identified in modern foreland basins. The degree of sandstone amalgamation throughout the Paskapoo Formation suggests two modes, which record relative variations in accommodation and sediment supply. Periods of rapid subsidence, likely associated with thrust emplacement in the adjacent fold thrust belt, resulted in the deposition of lower net to gross sand fraction, whereas tectonically quiet periods associated with less subsidence resulted in more amalgamated sandstone units.

Conclusions

The distribution of the Paskapoo Formation and its members likely represents periods of variable thrust-driven subsidence rates association with deformation in the Rocky Mountains. The basal Haynes Member is characterized by amalgamated sandstones and represents a period of relatively low accommodation. The middle Lacombe Member is characterized by nonmarine mudstones and isolated sandstones and represents a period of increased subsidence. Net-to-gross maps using normalized gamma ray logs help identify along-strike variation in the stratigraphy between the South/Central and Northern portions of the basin. Importantly, these data demonstrate the presence of a distributive lobate system with highly interconnected channel sequences that occurs in the northern portion of the basin. The correspondence between the location of this distributary fluvial system and modern day drainage outlets suggest this portion of the Alberta foreland basin may have been the site of a fluvial outlet point for millions of years. Collectively, these data indicate a variable stratigraphy within the Paskapoo Formation, both vertically within the section and laterally across the basin.

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