Gamma Ray Normalization and Fluvial Characterization: The Paleocene Paskapoo Formation, Alberta

Erik M. Quartero, University of Calgary, Calgary, Canada, emquarte@ucalgary.ca
And
David Bechtel, ERCB. Edmonton, Canada, David.Bechtel@ercb.ca
Andrew Leier, University of Calgary, Calgary Canada, aleier@ucalgary.ca
Laurence R. Bentley, University of Calgary, lbentley@ucalgary.ca

Summary

In this study we present an application of gamma ray normalization to the cased interval of the Paleocene Paskapoo Formation, and establish a statistical normalization as a viable technique for correlating cased sections of gamma ray logs with uncased sections of gamma ray logs. The normalization is a correction for the suppression of the natural gamma ray response by surface casing, which limits regional and stratigraphic correlation efforts. A statistical normalization of the suppressed gamma ray allows for previously unobtainable geologic interpretations of the shallow geologic column. By applying this new data we can improve the interpretation of the architectural framework of the Paskapoo Formation in western Alberta.

Introduction

The Paskapoo Formation (Demchuk and Hills, 1991) is a heterogeneous fluvial unit that is up to 800 m thick and covers an area over 65,000 km^2. This formation serves as western Alberta's most significant aquifer. Some 64,000 wells, a third of all wells completed in Alberta from 2006, are completed within this formation (Grasby et al., 2008). Reservoir modeling of these aquifers is essential for the responsible exploitation of ground water resources. Since 2006, the ERCB has mandated well log data be collected to surface, including the surface casing interval (ERCB directive 043, 2006). The intensity of gamma rays measured through the cased section is suppressed by the steel casing and requires a statistical normalization in order to be used with measurements from the uncased log. The normalization allows for mapping and characterization of the shallow geologic column, leading to a better geologic understanding of these important aquifers.

Theory and/or Method

The normalization technique is done with values obtained from logs both through the cased zone and analogous uncased zone. In this example the analogous strata extends from the base of surface casing to the base of the Ardley coal zone within the underlying Paskapoo and Scollard formations. In both cased and uncased zones, mean low and high statistical values are taken for all wells in the project area. These four values represent the mean high and low API reading for both the cased zone and the analogous uncased zone. The normalized value is determined using Equation 1. The normalized curve is then clipped at its base and attached to the original gamma ray log to give an uninterrupted curve. This normalization technique is commonly used by oil and gas industry to correct for logging tool bias, or for the effects of intermediate casing.

$$Normalized\ value = \boldsymbol{low\ uncased\ value} + (Cased\ value - \boldsymbol{low\ cased\ value}) * \frac{\boldsymbol{high\ uncased\ value\ -\ low\ uncased\ value}}{\boldsymbol{high\ cased\ value - low\ cased\ value}}$$

Equation 1: Values in bold represent the statistical low and high values for both the cased and uncased zones, the cased value being corrected for all wells.

Examples

The Haynes Member of the Paskapoo Formation provides an example for the efficacy of the normalization procedure. The Haynes Member is a roughly 50m thick succession of amalgamated fluvial sand channels. Its base is characterized as the first prominent sandstone above the last prominent coal in the Scollard Formation. Regional correlation of the Haynes Member is demonstrated with integrated uncased and normalized logs. Numerous offset wells with varying casing points show good well-to-well correlation across raw and normalized logs.

The success with the Haynes Member has allowed us to begin describing the remainder of the shallow geology. The geologic constraints derived from the normalized data may then be used to populate hydraulic models of this important aquifer.

Conclusions

Preliminary results indicate that normalization of well log data enables confident regional correlation of fluvial sand bodies within the Paleocene Paskapoo Formation. The Haynes Member is readily identifiable both with the normalized “cased” log and the raw “uncased” log.

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References

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