Integrated High Resolution Sequence Stratigraphy of Cardium Formation, Bilbo Field – Key to Finding Hidden Shoreface Reservoirs

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Summary

Western Interior Seaway (WIS) comprises of vast hydrocarbon accumulations within the Cretaceous sand fairways from Gul of Mexico to Alberta. The sand and conglomerate bodies were deposited during transgressive-regressive cycles. Episodic supply of sediments and tectonic activities have an influence on T-R cycles as well as the placement of coarse conglomerate reservoirs. These individual high productive sand lenses are mostly undetectable by conventional seismic analysis. Our results show that using rock cuttings, core and logs analysis in conjunction with paleocurrent indicators from dipmeter, FMI or parasequence residual isopach mapping could locate theses prolific reservoirs more precisely. In addition, multi-attribute analysis of seismic data provides geomorphologic indicators which can guide the integrated sequence stratigraphic analysis.

Introduction

Well log analysis integrated with core data, dipmeter data and well cuttings can provide insight into the geologic processes capable of predicting the distribution of reservoir sandstones and conglomerates. In addition, pressure and production data can further delineate thin shoreface sands, containing millions of barrels of un-found potential. Wapiti-Bilbo Cardium project is a comprehensive analysis of all data types which can lead to the better understanding of paleo-shorelines and provides insight into longshore currents and tidal wave distribution process of thin conglomerate. A small sample area TWP65-RGE6 (Bilbo, A Cardium A-pool) has been analyzed as a lead project to investigate the affects of paleo-geomorphology on subsequent deposition.

Method

By monitoring the geological processes closely we are able to show that the seismically irresolvable Cardium zone conglomerate lenses are predictable using high resolution sequence stratigraphic principles. Also, the residual mapping of thickness of Kakwa member shows it to be highly linear in its trend which fits the interpretation of strandplains (Hart and Plint, 2003). Our study shows that every preceding T-R cycles have tight spatial control over the next cycle.

The high resolution sequence stratigraphic method comprises of multiple steps defined as follows:

1. Log interpretation includes inspecting the GR patterns and dividing the log signature into individual parasequences.
2. Individual channels are identified and mapped with negative value assigned to their erosional surface.
3. Difference between lowest shale points (maximum API) to the highest sand point (minimum API value) are mapped normalized by the total thickness of individual parasequences. This provides the indicators of lateral shifts in the energy and focal points of the rip currents.
4. Quantitative and qualitative log analyses are then integrated to rock cutting samples to identify various lithologic units. This step also provides the definition of depositional environment and grain-size distribution within the shoreface.
5. Dipmeter or FMI data, although rarely available, provides detailed paleocurrent direction and stratigraphic dips.
6. Cores are inspected for burrows, roots and other features to indicate any sub-aerial exposure of the interfaces.
7. Log cross-sections along the strike and dip of the pool are created to correlate the three T-R cycles and also to interpret overlying and underlying changes.
8. All of the stratigraphic data is then used for detail stratigraphic maps to reveal the complexity and to predict the cyclicity of the conglomerate lenses as well as their depositional azimuth.

Example

The detailed analysis was done over the ‘A Cardium A’ Bilbo lenticular pool (Figure 1), which extends about 6-8 miles in NW-SE direction with a width of about 200-300 meter.

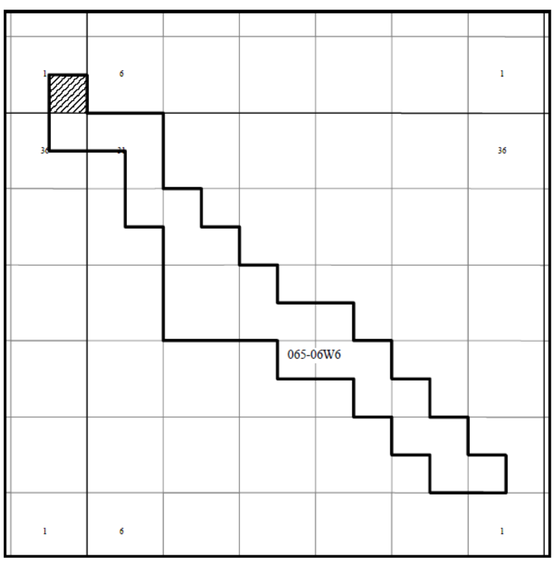

Figure 1: Bilbo Field Extents as per ERCB database

Our study shows that thin pebble conglomerate bodies of Cardium Zone have a peculiar relationship to the Kakwa member strandplains. The sand lenses either terminate against the strandplains or have a major change in their grain-size distribution and they have a certain angle (20-25 deg) to the Kakwa member strandplains. As there are three to four T-R cycles above the Kakwa member the placement of prolific sand lenses is quite variable. Kakwa member strandplains can be detected by amplitude and attribute mapping of the high resolution seismic data (Mustaqeem et. al., 2004) or by mapping of residual isopach maps where well concentration is quite high.

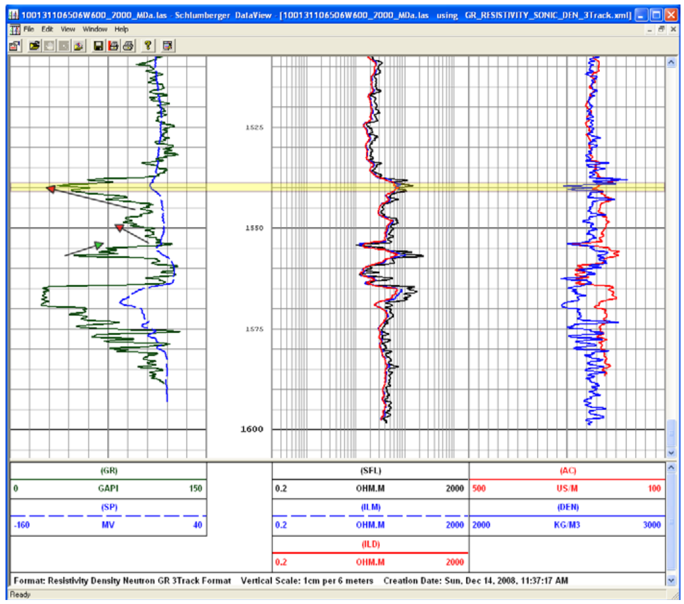

Figure 2: Well 13-11-65-6W6 showing thin A Cardium sand reservoir above tight Kakwa member

By developing the depositional history and mapping the individual cycle thicknesses we were able to narrow down the position of conglomerate body and are able to predict the possible model to locate distal prolific lenses. Another indicator in this area is the presence of fluvial channel system and mini-deltas of the Moosehound member.

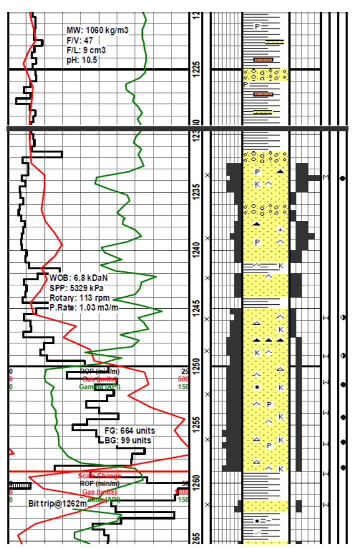

Figure 3: Strip log showing Cardium Zone conglomerate layers above massive sand of Cardium Kakwa member

Conclusions

Adding paleocurrent data and high-resolution sequence stratigraphic maps to the mix of log and cross-section analysis leads to better identification of sediment transport systems working in Late Turonian deposition of thin conglomerate layers of Cardium Zone.

References

Hart, B.S. and Plint, A.G. 2003. Stratigraphy and sedimentology of shoreface and fluvial conglomerates: insights from the Cardium Formation in NW Alberta and adjacent British Colmbia. Bulletin of Canadian Petroleum Geology, v. 51, p. 437-464.

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