Using High Resolution Chemostratigraphy to Determine Well-Bore Pathways in Multilateral Drilling Campaigns: an Example from the Horn River Formation, British Columbia, Canada*

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Search and Discovery Article #80362 (2014)
Posted March 10, 2014

*Adapted from extended abstract prepared in conjunction with presentation at CSPG/CSEG/CWLS GeoConvention 2012, (Vision) Calgary TELUS Convention Centre & ERCB Core Research Centre, Calgary, AB, Canada, 14-18 May 2012, AAPG/CSPG©2014

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Abstract

Shale resource plays have risen to the forefront of hydrocarbon exploration over the last decade. However, the fine grained, macro-scale homogeneity of most shale plays negates some of the more traditional approaches to reservoir characterization and stratigraphic correlation, resulting in the search for new methodologies that enable better understanding of shale reservoirs. In particular, one of the key challenges to shale resource development is accurately and repeatedly placing highly deviated or “horizontal” wells in a multi-lateral drilling campaign into a predefined stratigraphic framework and ensuring as much of the well-bore as possible is within the “sweet spot”.

This presentation will demonstrate how inorganic whole rock geochemical data can be used to characterize and correlate the relatively homogenous shale sequences, against which data from horizontal wells are then compared in order to precisely locate the lateral well-bore relative to the pilot hole.

Introduction

A robust chemostratigraphic zonation has been established for the Evie, Otter Park, and Muskwa members of the Horn River Formation, in northeastern British Columbia, using variations in inorganic whole rock geochemical data. A traditional chemostratigraphic approach provides a basin wide stable reference framework. Here, a different application of chemostratigraphy is demonstrated; using elemental data from cuttings, multilateral completions are placed in stratigraphic context relative the pilot hole and relative to one another.

Theory and/or Method

For several decades chemostratigraphy has been used to establish basin-wide or field-wide stratigraphic zonation schemes, predominantly in fluvial systems (Pearce et al., 2005, Ratcliffe et al., 2010, Wright et al., 2010a and Hildred et al., 2010). It has also been used in several shale plays in North America to define regional stratigraphic zonations that enable highly deviated wells to be "geosteered" (Schmidt et al., 2010). Here, traditional chemostratigraphy is used on the two vertical wells d-H52-L/94-O-8 and d-M52-L/94-O-8 to subdivide the Horn River Formation into 5 geochemical packages and 9 higher resolution geochemical units, based on variations in the key elements (U and CaO) and element ratios (Si/Zr, Th/U and the enrichment factor of vanadium (EFV) and terrigenous input) (Figure 1). The relative values of Si/Zr are related to changing biogenic silica contents (Wright et al., 2010b), whilst CaO indicates calcite abundance. EFV is calculated using the method documented in Tribovillard et al., 2006, and is a proxy for depositional redox conditions. The terrigenous input ratio is a summation of elements that are almost entirely related to land derived sediment, and Th/U represents the relationship between terrigenous material and organic content.

In the Horn River Basin, the most effective way to exploit the Horn River Formation is by the use of multilateral wells drilled from the same pad, targeting different sweet spots/members within the formation. However, hitting and remaining in the sweet spot is problematic when drilling shale resource plays because a recent study conducted by Halliburton "revealed approximately 50% of wells geosteered using the conventional gamma ray geosteering methods within an area of the Haynesville were misplaced for more than 50% of their lateral length." (http://www.epmag.com/Production-Drilling/Geosteering-Unconventional-Shale-Reservoirs-Potential_80771).

By constructing a detailed chemostratigraphic zonation in a pilot hole, it is possible to track the well-bore pathway relative to the pilot hole and relative to adjacent lateral wells (Figure 2).

Conclusions

By using chemostratigraphy, regional correlations of shale reservoirs can be achieved, which help understand broad, basinal stratigraphies and events. However, a potentially more important application is the ability to use changes in elemental compositions to determine well-bore pathways in multilateral drilling campaigns. These data can be acquired rapidly and potentially at the wellsite. Therefore, this application has large potential in the Horn River Basin and beyond.

Acknowledgements

The authors would like to thank Apache Corporation for their permission to display this data in the public domain, and are grateful to Chemostrat for allowing the time and providing the support needed to prepare the presentation.

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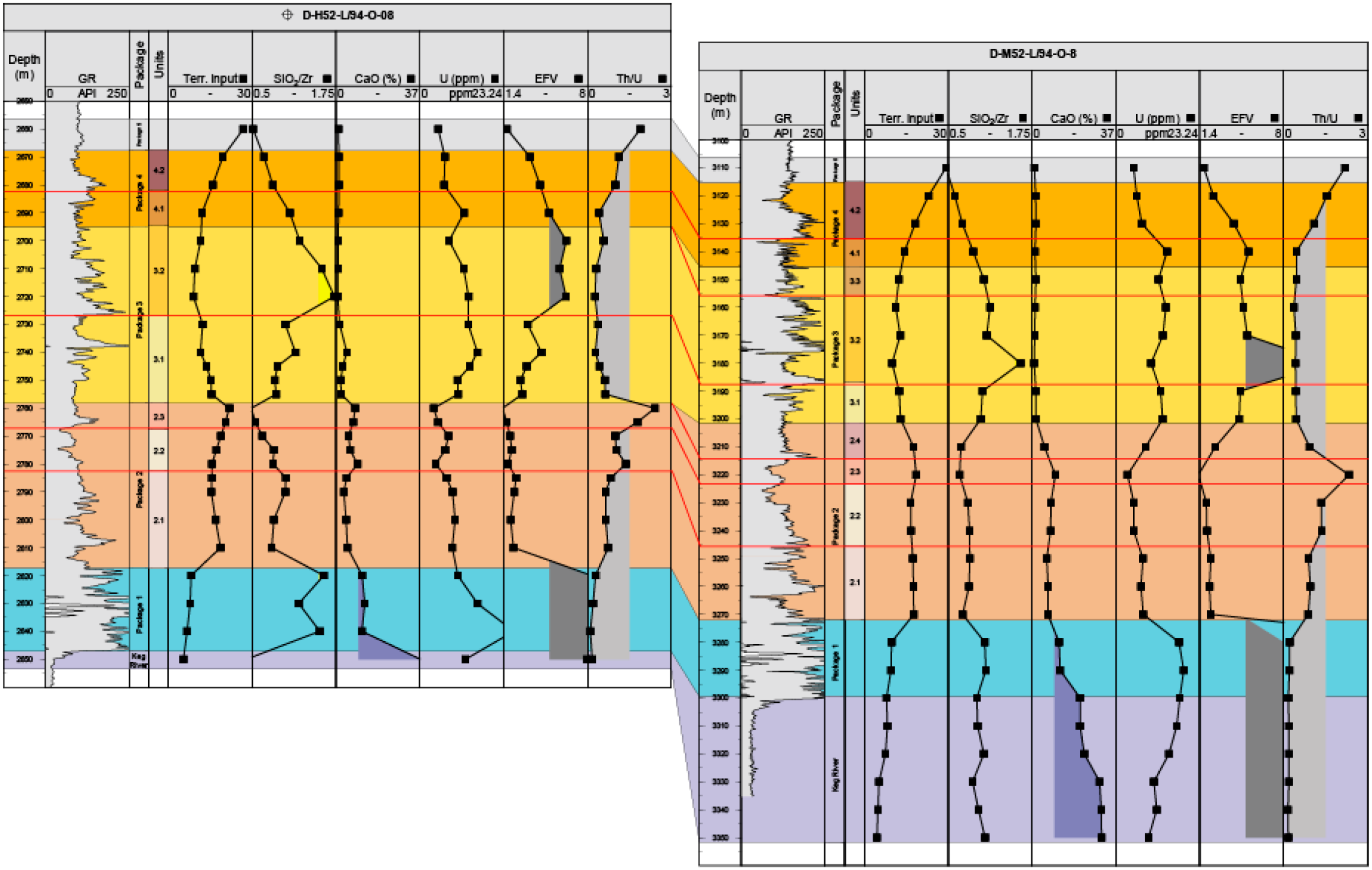

Figure 1. Chemostratigraphic characterization and correlation of the Horn River Formation in two vertical wells.

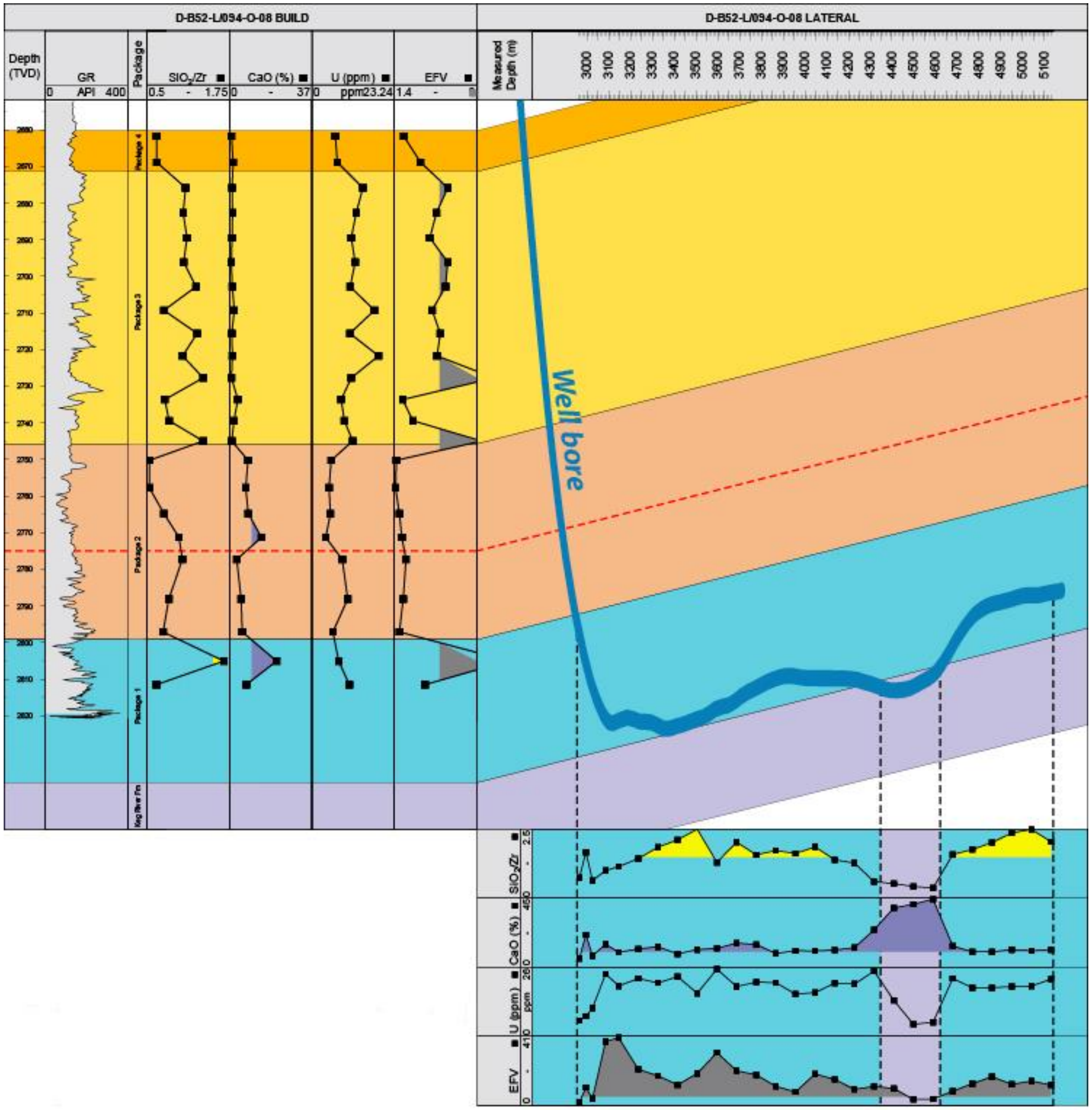

Figure 2. Placement of the build and lateral sections of well d-B52-L/094-O-08 into the pre-existing chemostratigraphic framework for the Horn River Formation.