Determining Well-Bore Pathways During Multilateral Drilling Campaigns in Shale Resource Plays: An Example Using Chemostratigraphy from the Horn River Formation, British Columbia, Canada

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Abstract

Although shale resource plays are coming of age in North America, elsewhere in the World, including Australia, they are still in the early stages of development. One lesson learnt from North American shale play developments is the difficulty of conducting stratigraphic studies in the apparently homogenous mudrocks typical of these resource plays. Of most practical importance for stratigraphic understanding is the difficulty of being able to ascertain where, relative to the "sweet spot", a lateral well has travelled. This is encapsulated by a recent study conducted by Halliburton that 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). One stratigraphic method that has been used in North American shale plays is chemostratigraphy.

Chemostratigraphy is a stratigraphic method that is used extensively in conventional petroleum plays to define correlation frameworks. Data for up to 50 elements (10 major elements, 23 trace elements and 17 rare earth elements) are typically gathered from core, cuttings or SWC samples. Variations in these elements are used to model geological features such as facies, provenance, palaeoclimate and palaeoredox, which allow recognition and correlation of chemostratigraphic packages and units.

This paper initially demonstrates how the technique of chemostratigraphy can define a regional stratigraphic framework and then subsequently how high resolution chemostratigraphy is able to help relate lateral wells to one another and to the vertical pilot hole. The study interval is the Horn River Formation, an organic-rich, variably siliceous and calcareous shale of Devonian age. In north eastern British Columbia, this formation is estimated to have 500 Tcf gas in place, which makes it the third largest North American natural gas accumulation discovered prior to 2010.

A robust stable reference framework has been devised for the Evie, Otter Park and Muskwa members of the Horn River Formation, in northeastern British Columbia. This framework is based on changes in elemental data that reflect variations in the carbonate vs. terrigenous content of the sediments, changing palaeoredox conditions during deposition and the amount of biogenic silica present. The stratigraphic framework can be recognized and extended for tens of kilometers and provide correlative units with a resolution of 10-50m.

The Horn River Formation is typically exploited by drilling multilateral wells from a central pad that target different sweet spots/members within the formation. In this study, data have been collected from 4 pad locations. For each location inorganic geochemical data have been collected from the vertical pilot hole and subsequently data have been collected from the lateral wells, up to 16 wells from each pad. Examples of how the elemental data enables the lateral well-bores to be related to the regional chemostratigraphy as well as enabling recognition of thin "stringers" that can potentially affect the reservoir quality.