Modeling the Impact of Deep Structures on Liquid Production in the Bakken Oil Shale Play of the Williston Basin of Canada and the USA

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The Mississippian - Devonian Bakken Formation of the Williston Basin overlies the Upper Devonian Three Forks Formation and underlies the Lower Mississippian Lodgepole Formation. It has been subdivided into three members: Lower, Middle and Upper Members. The Lower and Upper members are dark shale layers with a high organic content. The Middle member has a variable lithology and consists of interbedded siltstones and sandstones with lesser amounts of shale, dolostone, and limestone. Deep seated structural anomalies have played important roles in controlling the Bakken Oil Play in the Williston Basin, e.g. the Trans-Hudson Orogenic Belt.

A horizontal well in the Bakken Formation may develop highly variable liquid production which has various impacts on the economics of development. The reason for the variable results in this play is complex. High water cuts may be due to communication out of the zone into water laden formations such as the overlaying Lodgepole. Low oil productivity may be the result of sub-optimal completion in zones of natural fracturing.

In this talk we will examine the cause and effect of various styles of structures and their relationship to a variety of fracture patterns. It will be demonstrated that these fracture patterns can be modeled and predicted using a new statistical fracture modeling tool called 4DFrac*. This software provides fracture network characterization giving insight into fracture patterns as well as direct volumetric and directional outputs for reservoir simulation. The main approach for fracture modeling in 4DFrac is the generation and visualization of a Discrete Fracture Network (DFN) model on appropriate surface geometries (paleo-structural anomalies). This workflow driven approach allows rapid scenario testing and will be used to predict a variety of the fractures caused by deep seated structural anomalies. Finally, we will use local well control to identify the model that most closely simulates the observed fracture pattern.

Combining this modeling technique with field data allows us to predict, and therefore avoid, areas that have a propensity for faulting and fracturing in the shale. The results of this study will allow a higher degree of success in drilling and completing horizontal wells in the Bakken formation of the Williston Basin.

* 4DFrac is part of the Move suite of structural modeling software written by Midland Valley Exploration, Glasgow, UK.