Detection and analysis of structurally controlled sweet spots in the Bakken/Three Fork oil shale play of the Williston Basin and the Exshaw/Big Valley oil shale play of the foreland basin of Southern Alberta and Northern Montana

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Abstract

The structural fabric of the Williston Basin and the foreland basin of southern Alberta and Northern Montana is dominated by the presence of large scale divergent wrench fault systems that were initiated at early Proterozoic time and continue to be active throughout the tectonic history of these basins. These structures are characterized by the presence of several pull-apart basins that acted as the focal point for the deposition of thick sections of the Bakken/Three Forks and Exshaw/Big Valley shale packages. These unique structural features form the prime location for the exploitation of these two emerging resource plays. Drilling results however indicate that the sweet spots of both plays do not occur in areas of maximum reservoir thickness, they rather occur along the faulted edges of the pull-apart basins where the shale package appear to become more brittle due to the combined effect of differential compaction, dewatering and increased density of natural fractures.

In the foreland basin area, the development of sweet spots along the faulted edges of the pull-apart basins is further enhanced by two main processes: 1) a Triassic-Jurassic extension related to an early development of the foreland basin and 2) late Cretaceous compression related to the development of the thrust belt to the west. The first process reactivated portions of the basins and lead to the development of a well-defined foreland hinge line which defines the eastern boundary of the over pressure zone of this resource play. Whereas, the second process lead to the development of inverted structures and thrust related anticlines which form prospective structural traps for this resource play.