

Detection and Analysis of Structurally Controlled Enhanced Reservoir Potential in Mature and Emerging Oil Resource Plays in the WCSB: Tight Oil Examples from the Nordegg and Alberta Bakken

Zeev Berger*

Image Interpretation Technologies Inc.
Calgary, Alberta, Canada
zeev@iitech.ca

Brian A. Zaitlin

BMO Capital Markets
A&D Advisory Group
Calgary, Alberta, Canada

Resource plays are increasing in importance in the North American energy mix. The identification of areas with enhanced reservoir potential, defined by either storage capacity and/or deliverability, can be the difference between an economic vs uneconomic play. When exploring in mature basins, it is important to understand the entire hydrocarbon system in association with the structural framework. Integrated studies of well data, regional seismic, high resolution magnetic and gravity data have lead to the construction of a new detailed tectonic map of the Western Canada Sedimentary Basin (WCSB). This map shows the location of major faults and fracture systems, their style and timing of deformation and possible influence on the development of enhanced reservoir potential in several mature and emerging resource plays and WCSB. Structural models which are derived from the tectonic map are being used to identify critical elements of these plays which include local increase in: reservoir accommodation, heat flow, dewatering and compaction processes, and natural fracture densities.

The major structural elements that control both conventional and unconventional plays in the southern half of the WCSB are shown with a schematic map in Figure 1. The map illustrates that the structural fabric of the WCSB consists primarily of the following four different types of structures: 1) Major basement lithological boundaries and basement faults which act as zone of weaknesses throughout the tectonic history of the basin; 2) A series of graben and half graben features that were formed during Devonian and Mississippian divergent wrench tectonics and continue to be active during Triassic/ Jurassic extension; 3) A series of down to the basin normal faults that were formed as hinge lines during the formation of the Fore-Land Basin at Triassic and Jurassic time; and 4) Exposed and buried thrust faults as well as reactivated and inverted structures that reflect the development of the Rocky Mountain Thrust Belt by Laramide compression.

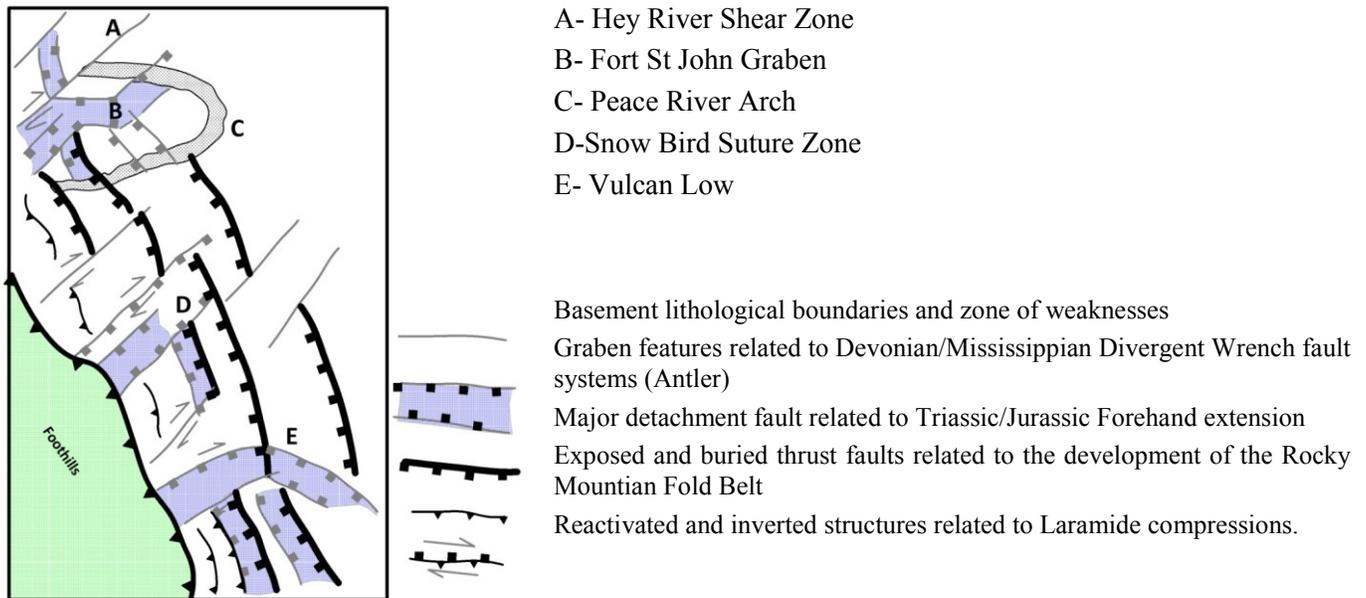


Figure 1: Schematic map of major structural features of the Southern Half of the WCSB (not to scale).

The contribution of structural/tectonic studies to the evaluation of resource plays are demonstrated here with examples from the two emerging tight oil plays of the Nordegg and the Exshaw/Bakken formations. Figure 2 illustrates that the known areas of enhanced reservoir potential of the emerging Nordegg play are located mostly along major basement and sedimentary faults particularly in areas where the faults cut and offset Devonian reefs. In contrast, the areas of enhanced reservoir potential of the Exshaw/Bakken play are clearly related to the presence of Devonian/Mississippian graben features which were reactivated and inverted during the formation of the Fore-Deep basin and the Rocky Mountain Thrust Belt (Figure 3). In both cases, successful development of both plays will be largely dependent on early identification of areas with enhanced reservoir potential that are controlled by the presence of different structural features which were presented in this talk.

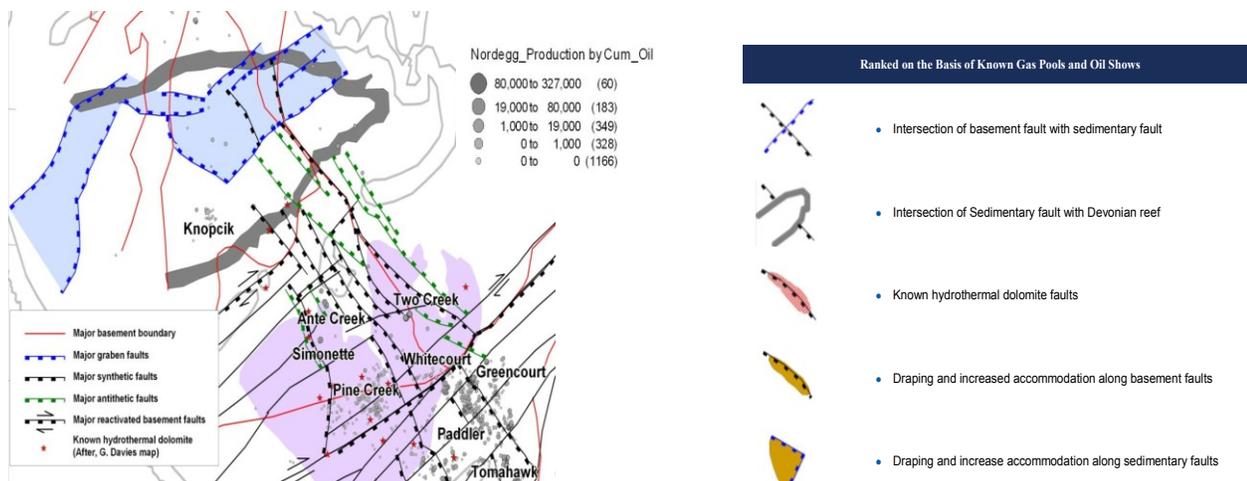


Figure 2: Summary structural model identifying major basement boundary and fault patterns with superimposed Nordegg production.

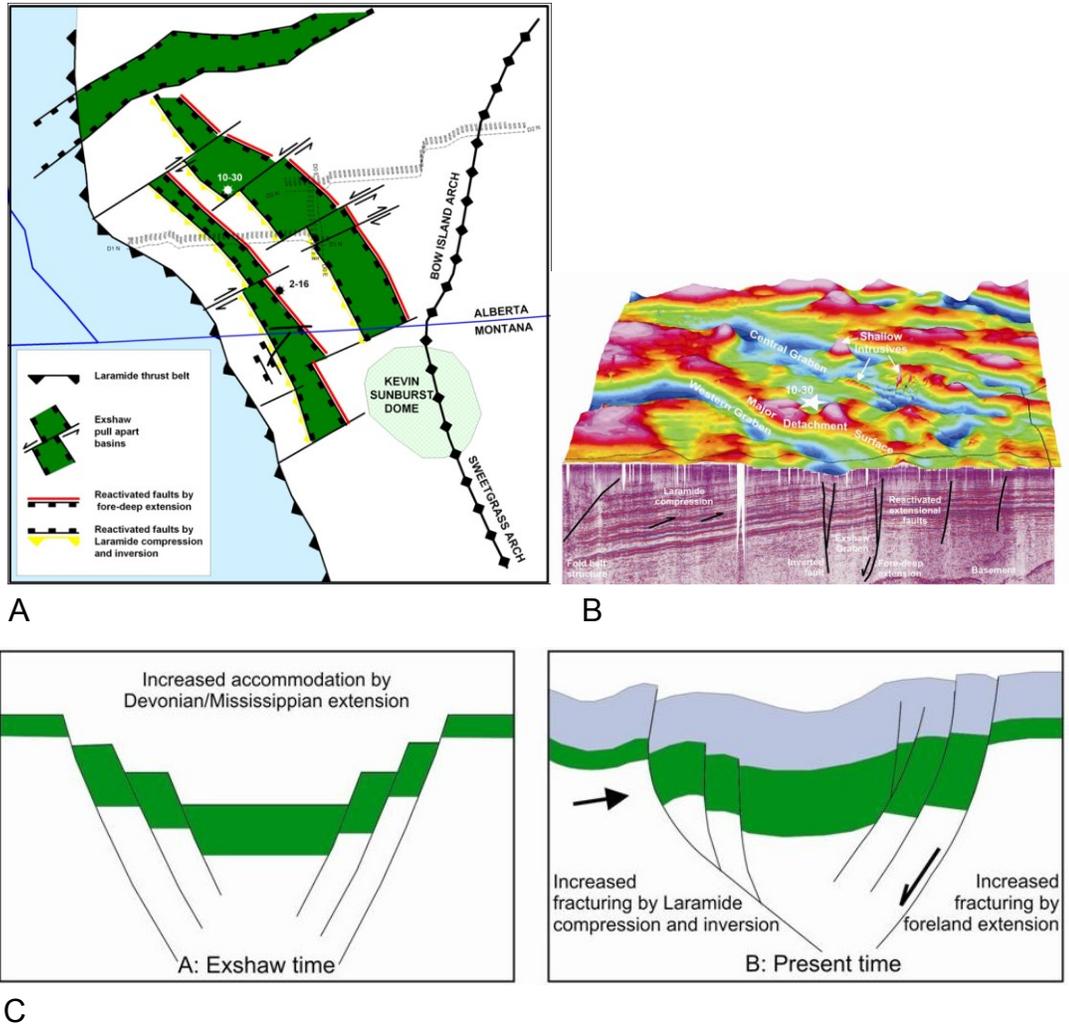


Figure 3: Integrated structural study of the Exshaw Bakken play showing: A) general tectonic map of the Alberta Bakken play fairway area; B) a three dimensional block diagram of HRAM data and regional seismic depicting structural style; and C) a structural model illustrating the development of enhanced reservoir potential within the Exshaw/Bakken graben features i- during Exshaw time; ii – present time.