Oil Generation Rates and Subtle Structural Flexure: Keys to Forming the Bakken Sweetspot in the Parshall Field of Mountrail County, North Dakota

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The recent discovery of several 1,000 bbl/d oil wells in the Parshall Field in Mountrail County, North Dakota has focused significant attention on the geologic factors that contribute to this extraordinary production. The Bakken Formation in Mountrail County contains organic-rich upper and lower shales with an intervening mixed carbonate-siliciclastic middle member. The shales contain an average of 11percent organic carbon and, together with algal-derived kerogen in the middle member, are believed to be the source of the oil produced at Parshall. The carbonate-siliclastic middle member acts as the reservoir in which natural and artificial fractures provide conduits for oil along horizontal well bores drilled through the tight middle member. The "sweetspot" present in the Parshall Field appears to be related to overpressuring caused by oil generation, induced shale compaction, and the formation of fractures along a subtle structural flexure.

The Parshall Field lies adjacent to, and updip of a northsouth trending organic maturation front that is evidenced by a regional-scale decline in the average hydrogen index (HI) of the Bakken shales. The zone of maximum rate of change in the HI corresponds with a Tmax of about 435º C and is therefore interpreted to define the region in which oil-generation rates within the Bakken shales are at a maximum. This is significant because the conversion of load-bearing kerogen to movable oil could result in compaction that injects over-pressured fluids into the middle member. Elevated pore pressures in the middle member could also lead to spontaneous fracturing in response to tectonic stresses that form localized structures.

The Bakken Formation in the Parshall Field is significantly over-pressured (~6300 psi) and exhibits a subtle monoclinal flexure (convex upward) that is evident on 2nd derivative maps of the Bakken structure and highly exaggerated cross sections made from well data and seismic lines. The flexure appears related to basement faulting that has been episodically active until, at least, the Jurassic.

These observations are consistent with a model of maturationinduced compaction that generates pore pressures, that together with stresses associated with subtle local structures, results in significant fracturing and the formation of a "sweetspot" centered in the Parshall Field.