

## **Defining the Updip Eastern Limit of Commercial Bakken Oil Production, McLean and Dunn Counties, North Dakota**

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### **Summary**

With the high density of horizontal wells drilled in the Devonian-Mississippian middle member of the Bakken Formation in Parshall Field, the eastern updip limit of commercial oil production from the Bakken in this area is reasonably well defined and understood. Similar patterns governing the commercial limit of Bakken production in Parshall should hold true south of Parshall Field where exploitation of the Bakken reservoir currently is expanding on the Fort Berthold Reservation. Knowledge gained from Parshall Field will be applied to help understand the eastern updip commercial limit on the Reservation.

### **Introduction**

QEP Resources (previously Questar) drilled and completed its first horizontal Bakken well in 2008, extending the producing trend south from Parshall Field onto the Fort Berthold Reservation (Figure 1). Since then QEP has drilled 12 Bakken delineation and development wells and one Three Forks well on the Reservation (Figure 2). To help plan the future development program efficiently and maximize economic success, the updip eastern limit of the Bakken oil play must be established.

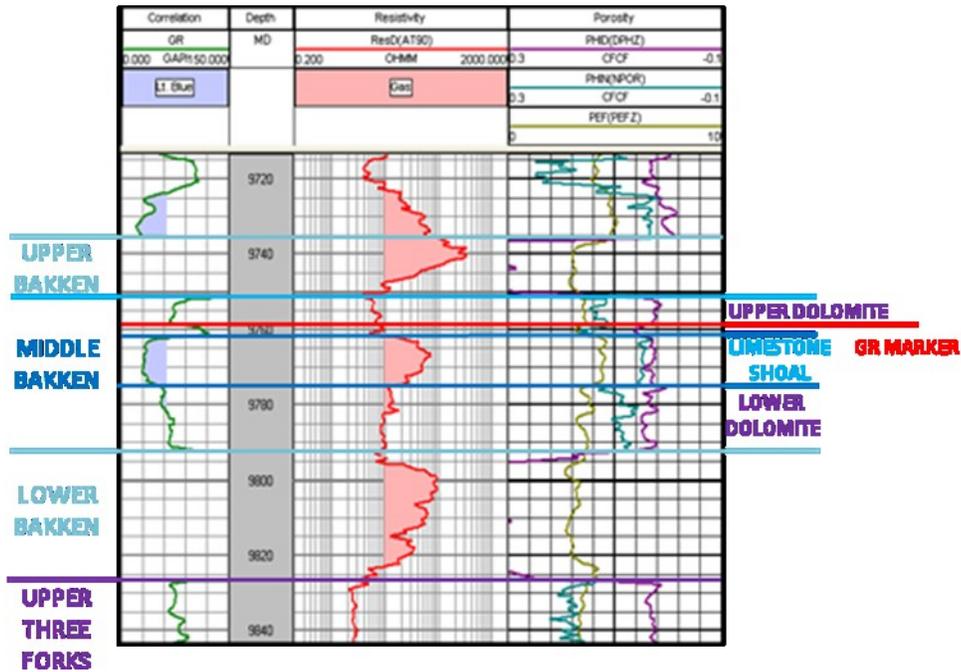


Figure 1: MHA 1-18H-150-90 type well for the Ft. Berthold Reservation.

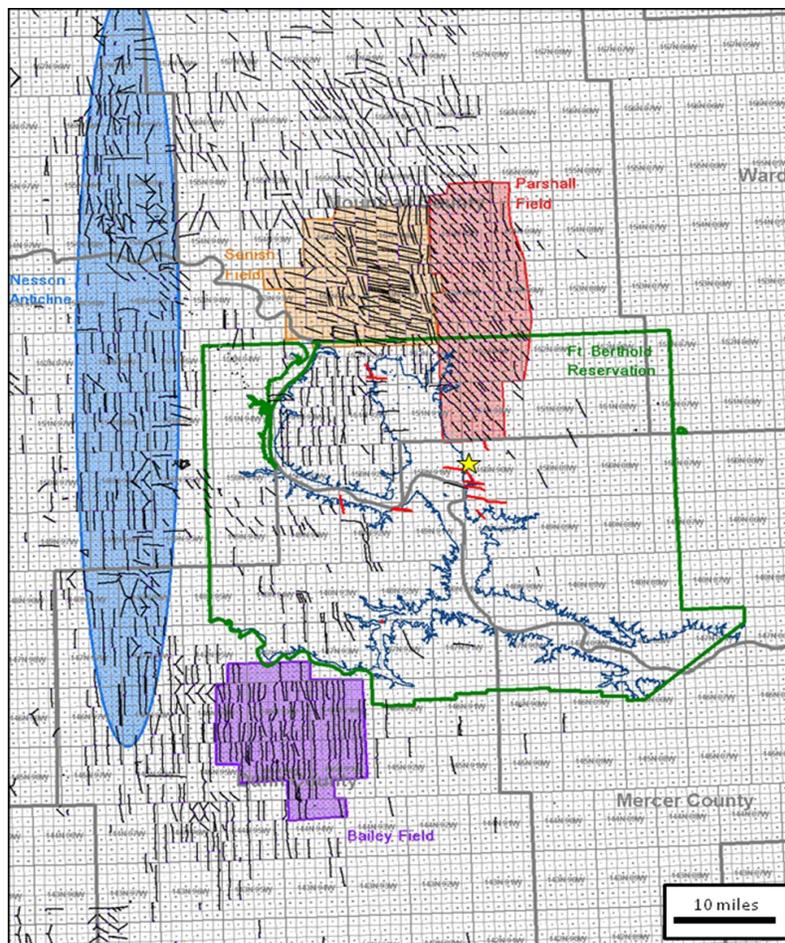


Figure 2: Producing Bakken oil fields location map with a yellow star showing the location of the MHA 1-18H-150-90 type well and QEP Resources operated wells in red.

## **Theory and/or Method**

By evaluating mud-gas shows, utilizing water saturation calculations from vertical and horizontal wells, and integrating oil- and water-production data, a transitional zone of non-commercial oil production can be identified on the eastern updip edge of the Bakken oil accumulation on the Fort Berthold Reservation similar to that observed at Parshall Field. Progressive updip decrease in Bakken oil production across this non-commercial zone is accompanied by a progressive increase in percent water produced, reflecting a west-to-east transition zone with water saturation progressively increasing updip.

## **Examples**

Maps of various thermal-maturity parameters (e.g., HI and Tmax) identify a north-south trend spanning a few townships in width in which the updip commercial limit likely occurs. In Parshall Field, this eastern production limit has been tested and established with relatively dense well control. Within the trend of favorable thermal maturity, horizontal wells on the east flank of Parshall Field demonstrate that the transition from commercial to non-commercial Bakken production commonly occurs across a distance of about one mile or less. Mudlogs from several updip laterals drilled roughly normal to the east-flank of the Bakken transition zone record strong oil and gas shows downdip reflecting commercial Bakken oil, deteriorating shows structurally updip through a transition zone (less than 1,000 feet wide in one well), and poor shows farther updip, probably reflecting non-commercial Bakken oil. Key horizontal wells on the east flank of Parshall Field show that, updip from the structurally highest commercial wells, significant (though non-commercial) amounts of oil can be produced from the Bakken across a distance as broad as three miles before reaching wells that produce no Bakken oil. Approximately four townships south of Parshall Field toward the southern boundary of the Fort Berthold Reservation two horizontal wells drilled in opposite directions (updip and downdip) from the same pad exhibit mud-gas shows that reflect the updip transition from commercial to non-commercial oil production and clearly define these zones.

The observed progressive updip increase in the amount of water produced relative to oil on the east flank of Parshall Field is accompanied by increasingly higher calculated water saturations in the more limited suite of vertical wells. Increase in water saturation is associated with an updip decrease in porosity, which restricts updip movement of oil, and is controlled in part by depositional facies.

Triple-combo logs run in the east-west horizontal leg of a recent well in which mud-gas shows are equivocal provide superior data that help define the updip limit of commercial production. Although there are difficulties in directly comparing water saturations from laterologs in vertical wells with saturations from induction logs in horizontal wells, water saturations calculated along the length of the lateral increase updip to the east, suggesting that this wellbore likely spans part of the transition from commercial production to poorer, possibly non-commercial, Bakken production.

## **Conclusions**

Patterns observed on the eastern commercial limit of Parshall Field are believed to hold true for the eastern commercial limit on the Fort Berthold Reservation. By evaluating existing production data, mudlogs from laterals, and calculated water saturations from wireline logs across the Bakken, the eastern commercial limit can be defined, saving millions of unnecessary drilling and completion dollars.

## **Acknowledgments**

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