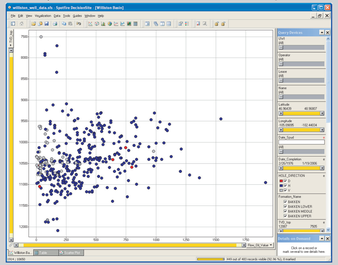
Return to HTML

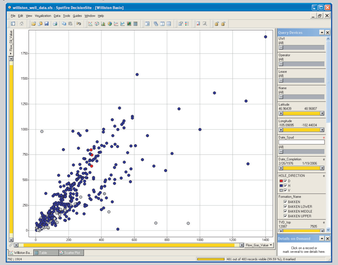
Analysis - Building the Play Elements

Spotfire DecisionSite Analysis

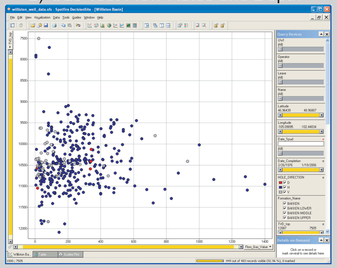
1) Oil Test Flow Rates and Depth



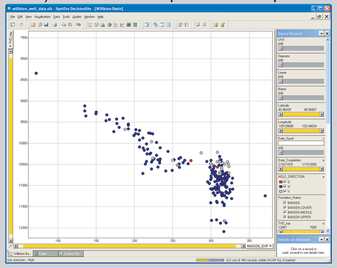
4) Relationship between Gas and Oil Rates



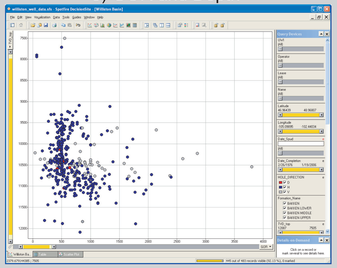
2) Gas Test Flow Rates and Depth



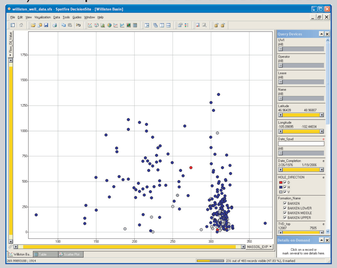
5) Mass of Oil Expelled vs. Depth



3) GOR and Depth



6) Oil Expulsion and Oil IP Test Rates



Critical Element Analysis

Figure 1 demonstrates that oil test flow rate is depth dependent. Most successful Bakken wells have been drilled between 9,300' and 11,500'. The upper (shallow) limit is governed by thermal maturity and correlates with the depth at which significant oil expulsion begins.

Figure 2 shows a gradual increase in gas flow rate, which abruptly declines below 11,500'. This may signify a decline in reservoir quality with depth. However, more drilling is required to sufficiently determine whether a depth control over reservoir quality exists.

Figure 3 suggests a gradual increase in Gas:Oil Ratio (GOR) with depth, but the trend is poorly defined. Because GOR doesn't correlate well with depth or maturity, and the Bakken is a high-quality oil-prone source rock, possibly reservoir quality (RQ) or completion practices are the fundamental controls.

Figure 4 shows that tests with low oil flow rates tend to have higher gas flow rates. Because the Bakken isn't overmature for oil generation anywhere in the basin, this relationship reinforces the idea that RQ and well completion practices govern gas production and GOR. Vertical Bakken tests have higher GOR than do horizontal. Recent Bakken completions in Richland Co., MT have lower GOR.

Figure 5 illustrates the depth-dependent relationship between oil expulsion and depth. Thickness and maturity control oil expulsion in the Bakken.

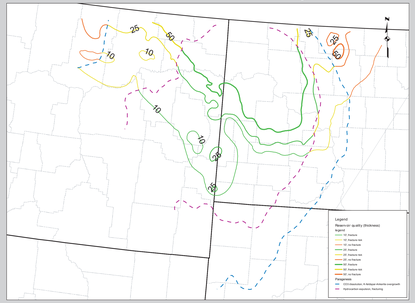
Figure 6 shows that local charge does not appear to govern oil test rates. However, in areas where the Bakken is immature, oil tests are low.

Play Fairway Interpretation

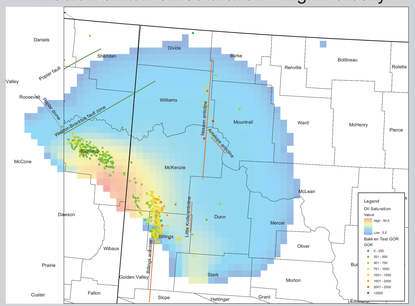
The first oil saturation map is the result from PetroMod's default compaction model. The second oil saturation map is derived from the calibrated porosity-depth curve, and illustrates the result of 300 BBO with too little pore space to occupy. The actual distribution of oil saturation probably lies somewhere between these two results. We attempted to predict the occurrence of fracturing caused by overpressure during peak oil generation (>120C). We also modified default compaction parameters of the middle Bakken siltstones to match published core porosity data.

Depth of burial, estimated reservoir quality and modeled oil saturation are used to construct a map of middle Bakken play areas. The spots on the map are middle Bakken wells completed since January 1, 2005, when we completed our interpretation of the play fairways.

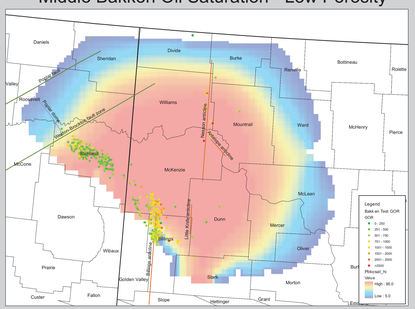
Middle Bakken Reservoir Quality Zones



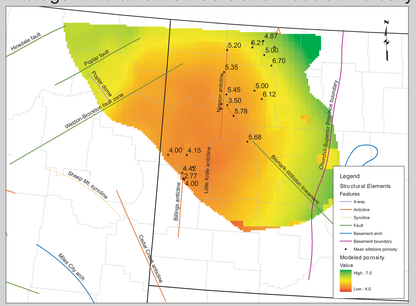
Middle Bakken Oil Saturation - High Porosity



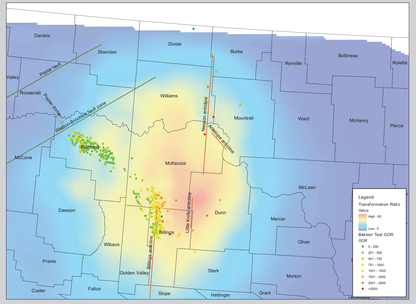
Middle Bakken Oil Saturation - Low Porosity



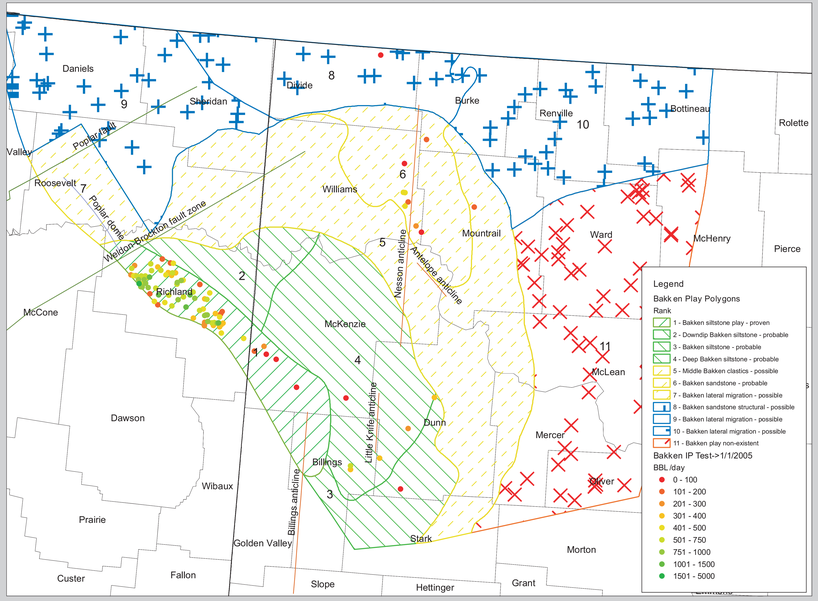
Average Middle Bakken Core and Modeled Porosity



Lower Bakken Transformation Ratio and Test GOR



Middle Bakken Play Fairways



Conclusions

1) Maximum temperature, which was reached in the early Tertiary, is the governing factor over
- oil generation
- fracture development
- primary reservoir quality

2) The effectiveness of the stratigraphic trap along the southwestern basin margin is primarily responsible for
- >90% oil saturation
- high drilling success rates

3) These conditions also exist
- downdip, toward the basin center
- along strike to the south east

4) Additional middle Bakken reservoirs exist in North Dakota, which may expand the play if
- structural traps can be identified
- fracture porosity is developed

5) Bakken shales may prove productive with modern drilling and completion practices.