

Integrated Assessment of the Niobrara and Mowry Shale Plays, Powder River Basin, Wyoming*

**Yanet Cuddus¹, Dave Phillips¹, Celina Will¹, Lee Swager¹, William Ray Moore Jr.¹,
Midowa Gbededo¹, Yanil Del Castillo¹, and Matthew Belobraydic¹**

Search and Discovery Article #11280 (2019)**

Posted December 16, 2019

*Adapted from oral presentation given at 2019 AAPG Rocky Mountain Section Meeting, Cheyenne, Wyoming, September 15-18, 2019

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¹Schlumberger, Houston, TX, United States (YCuddus@slb.com)

Abstract

Over the last 10-years, numerous unconventional resources have become economically viable with advancements in horizontal drilling and completion technologies. The Powder River Basin experienced a 3500% increase in drilling during the 2007-2012 period, particularly for horizontal drilling of the Niobrara Shale formation. The Mowry Shale is an organic-rich play and indicates a promising potential based on other shale play analogs. Exploration of the Mowry was delayed due to the 2015 downturn, therefore limited production data is available today. As the market rebounds, the basin has been revitalized with 21,000 permits currently awaiting approval and almost 3,000 permits ready for drilling. Due to the market interest in the Powder River Basin and the limited understanding of optimized drilling and completion techniques to transform the Niobrara and Mowry to prolific plays, this study aims to add to the basin-wide understanding of these shale plays to support the forecasted increase in production activity. This multiple-disciplinary research utilizes core analysis and well log interpretations over the entire basin to understand the spatial distribution and geometry of the Niobrara and Mowry shale reservoirs. Rock properties were calibrated to wireline logs and core data, upscaled, and distributed to generate a geostatistical 3D model. This 3D basin assessment model is calibrated to production results for basin reservoir characteristics and predictions. The resulting model is a tool that can help identify valuable play areas for future exploration and a reference to help mitigate potential risks associated with drilling and completions.

References Cited

Sonnenberg, S. The Niobrara Formation in the Southern Powder River Basin, Wyoming: An Emerging Giant Continuous Petroleum Accumulation. in Proceedings of the 6th Unconventional Resources Technology Conference (American Association of Petroleum Geologists, 2018).

Taylor, J. Petroleum system analysis of the Niobrara Formation in the Southern Powder River Basin, Wyoming: Master of Science thesis, Colorado School of Mines, Golden, Colorado, 2012.

Kenny, R. et al. Reservoir Quality and Stratigraphy of the Frontier to Dakota Interval of the Powder River Basin, a Core Log Seismic Exercise. in (Unconventional Resources Technology Conference, 2016).

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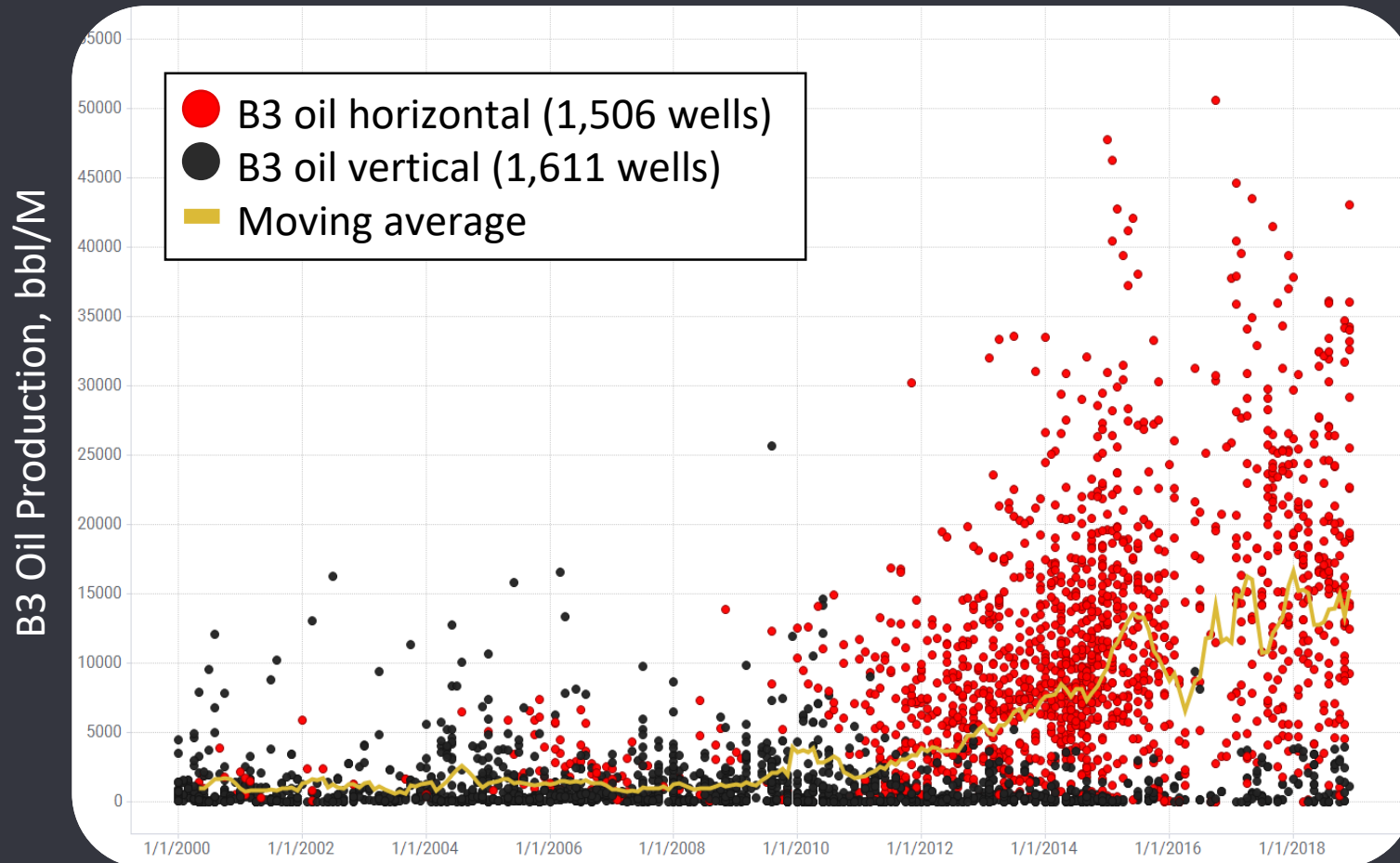
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Summary

- Production drivers are not singularly tied to hydrocarbon pore volume
- Well performance corresponds to facies and mineral distributions
- Advancements in completion design have driven production increases

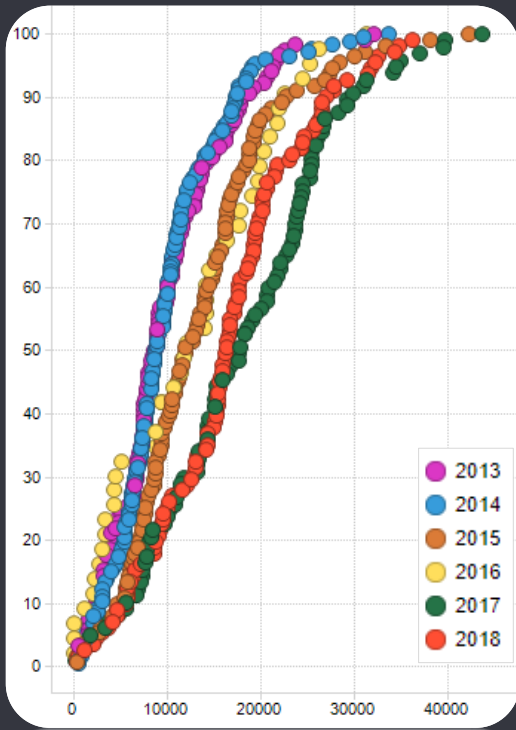
3000% increase in horizontal well performance

Month of First Oil Production

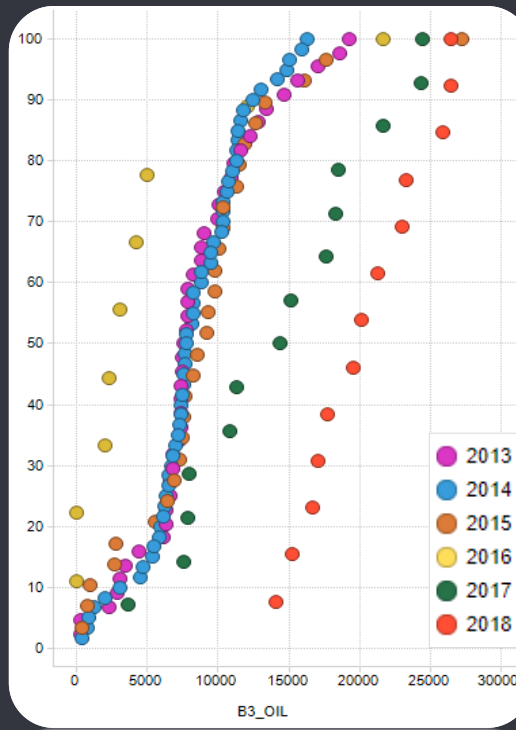


Last seven years of horizontal drilling activity

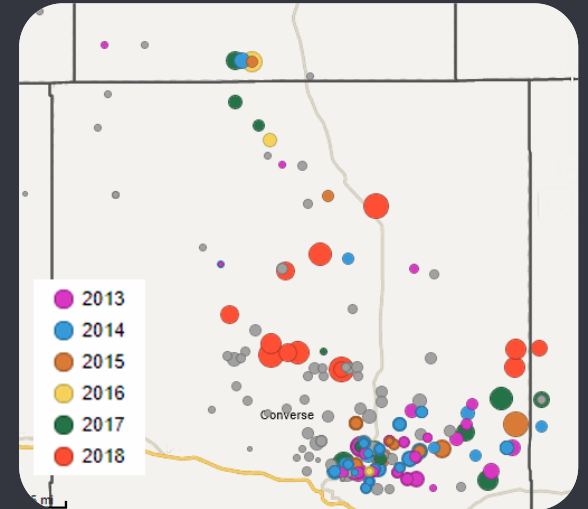
All Formations
B3 Oil per vintage



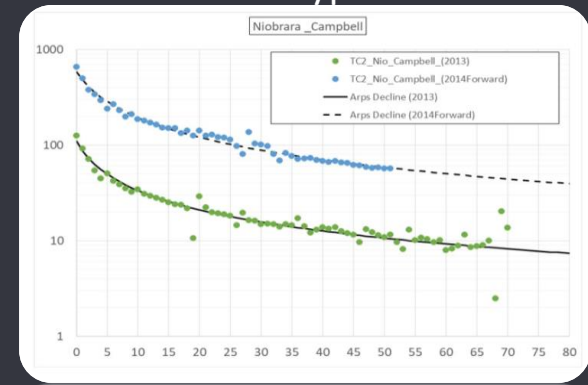
Niobrara
B3 Oil per vintage



Niobrara horizontals per vintage



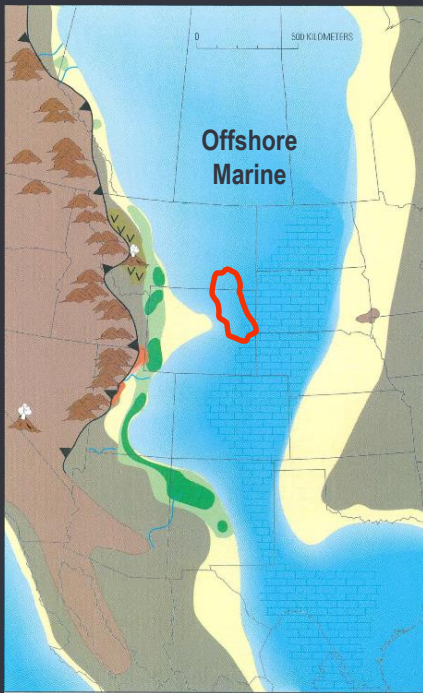
Niobrara Type curves



Shale reservoir characterization

Niobrara Shale

Campanian (87 to 82 Ma)

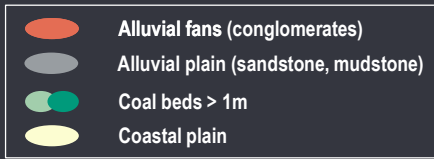


Carbonate
 Mature source rock
 Major producer
 Type II kerogen¹
 TOC ~2-4%

Thickness ~ 300 ft.

Low porosity (<10%)¹
 Low perm (<0.01 md)^{1,2}

USGS Professional Paper 1561
 (Roberts & Kirschbaum, 1995)



Mowry Shale

Cenomanian (98.5 to 93.5 Ma)



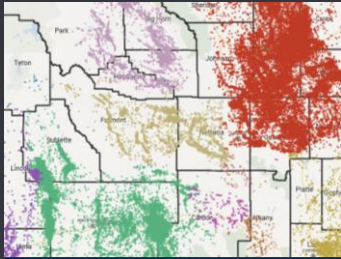
Clastic
 Immature source rock
 Not a major producer
 Type I kerogen³
 TOC < 5%
 Abundant bentonites
 Thickness ~ 200 ft.

Low porosity (<2-8%)³

S_w avg 64%
 (range from 55-75%)³

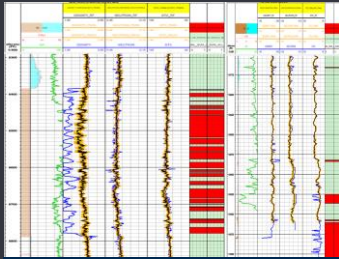
¹ Sonnenberg, 2018
² Taylor, 2012
³ Kenny et al., 2016

Basin-scale multidisciplinary research



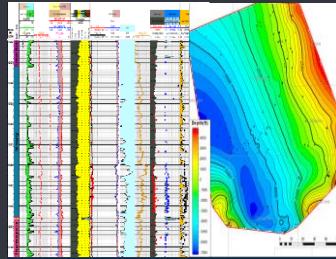
01

Data audit
Organization



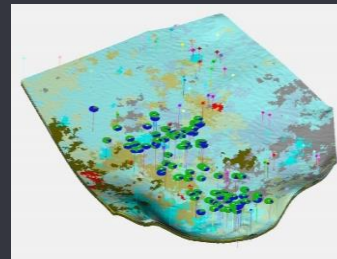
02

Core
Wells
Production



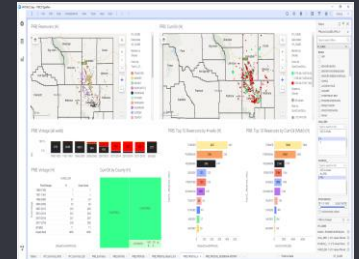
03

Petrophysics
Geology
Engineering



04

Geomodeling



05

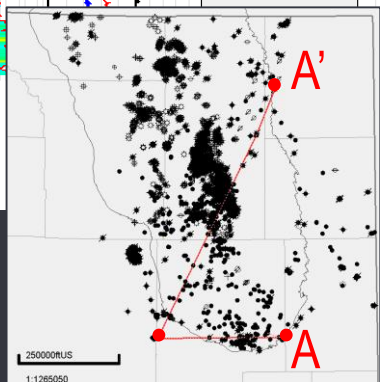
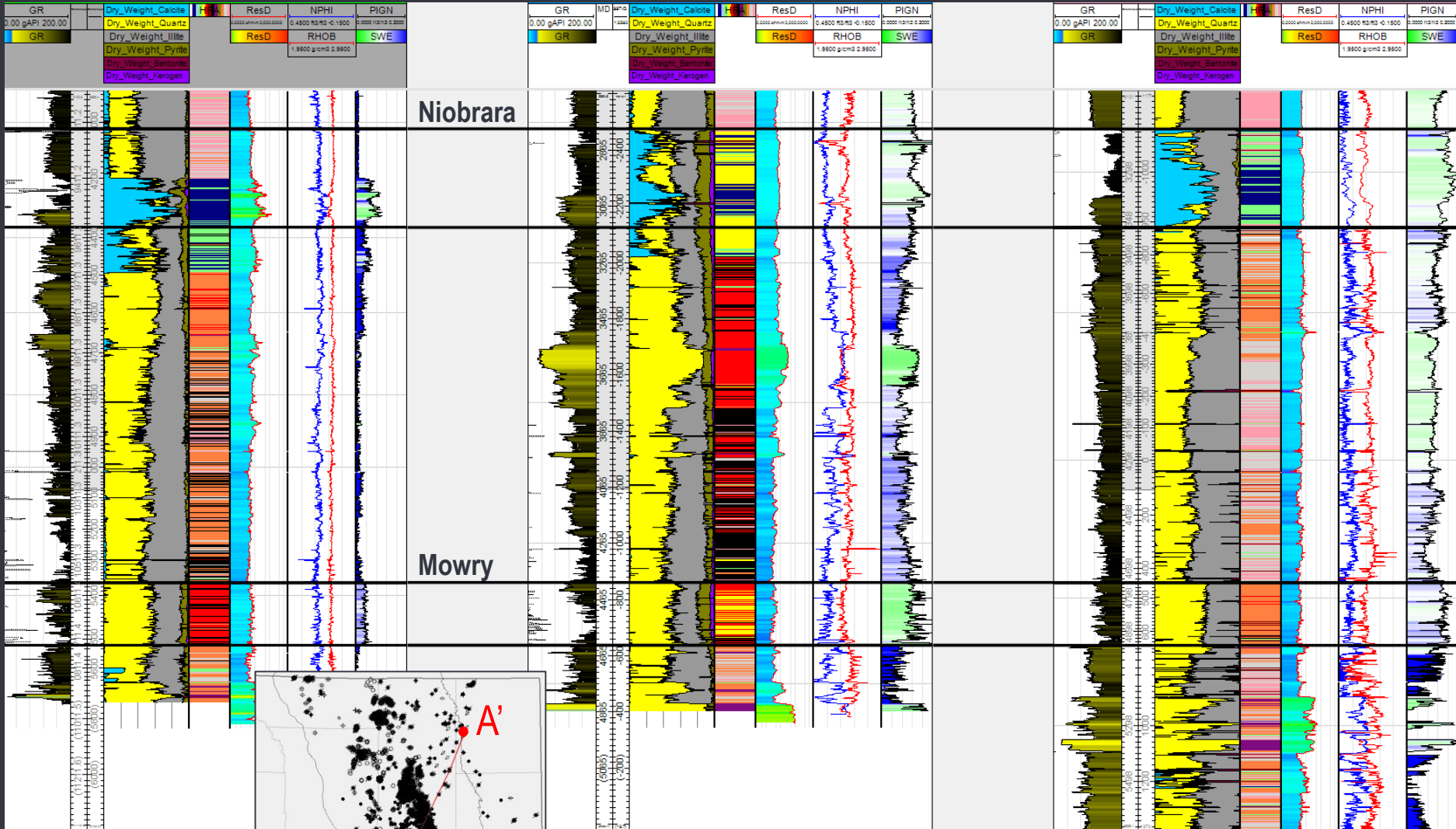
Advanced
workflows
and results

SE

A

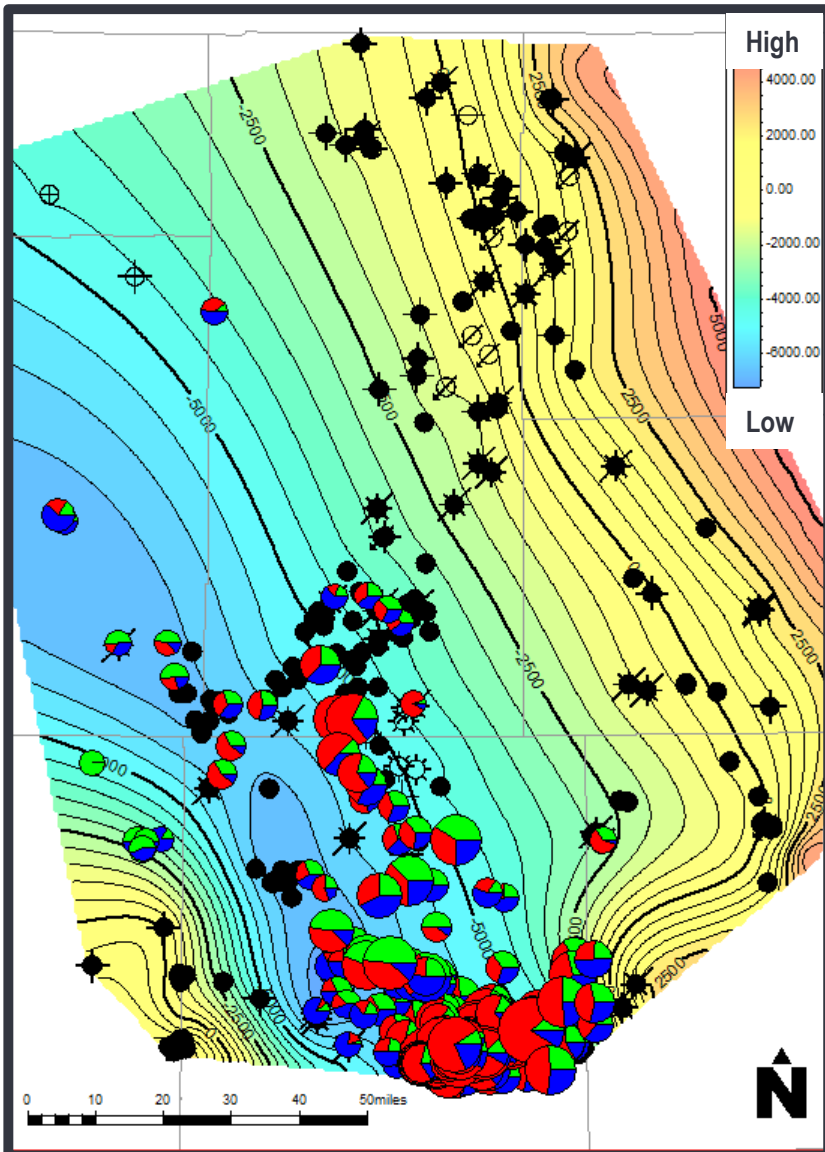
NE

A'

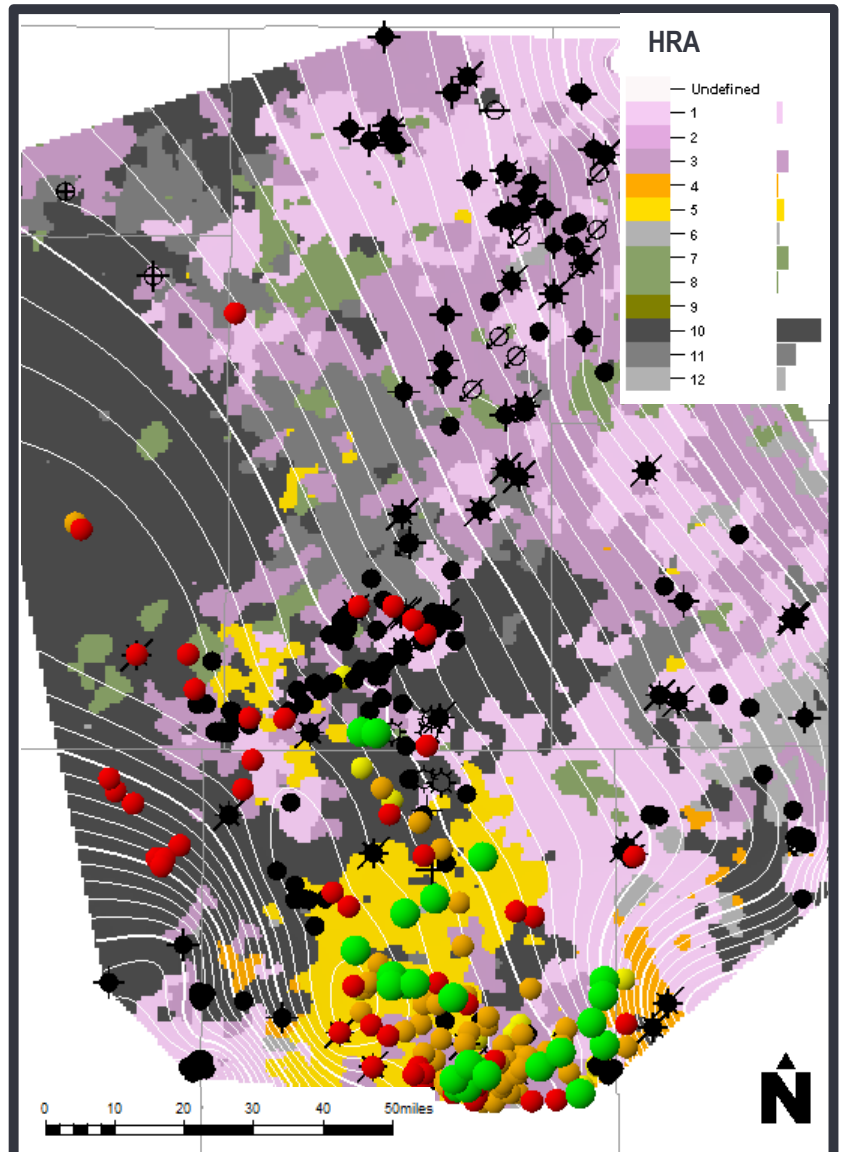


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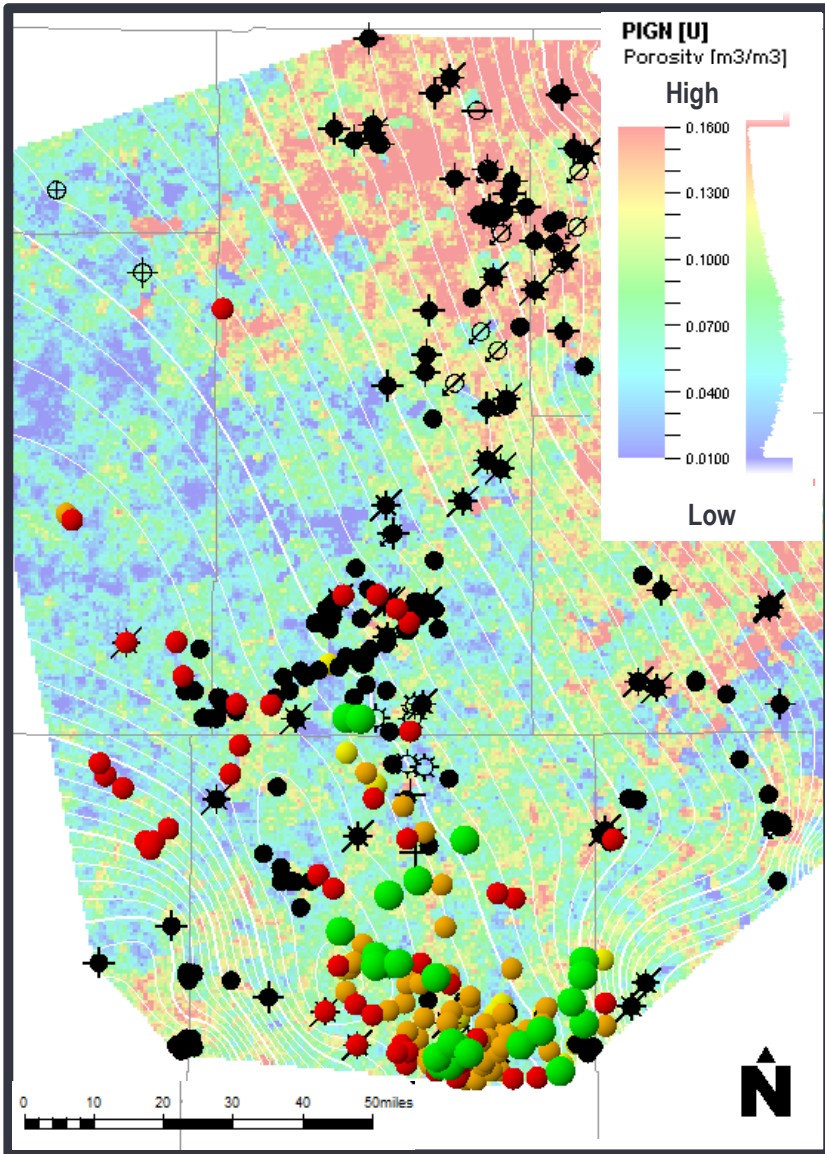
Niobrara Structure with Cum Production



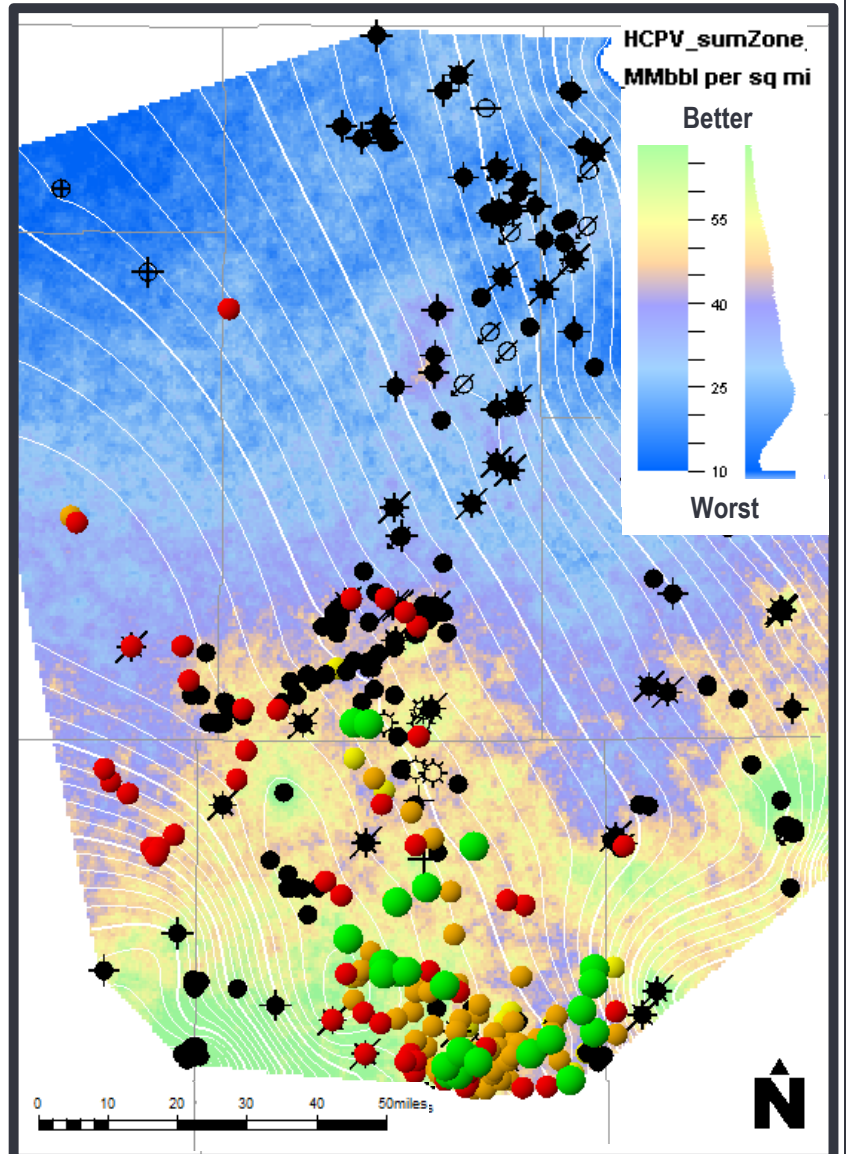
Electrofacies with Production Quartiles

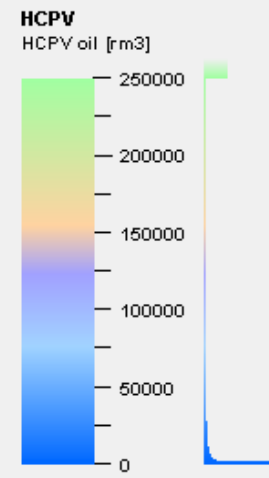
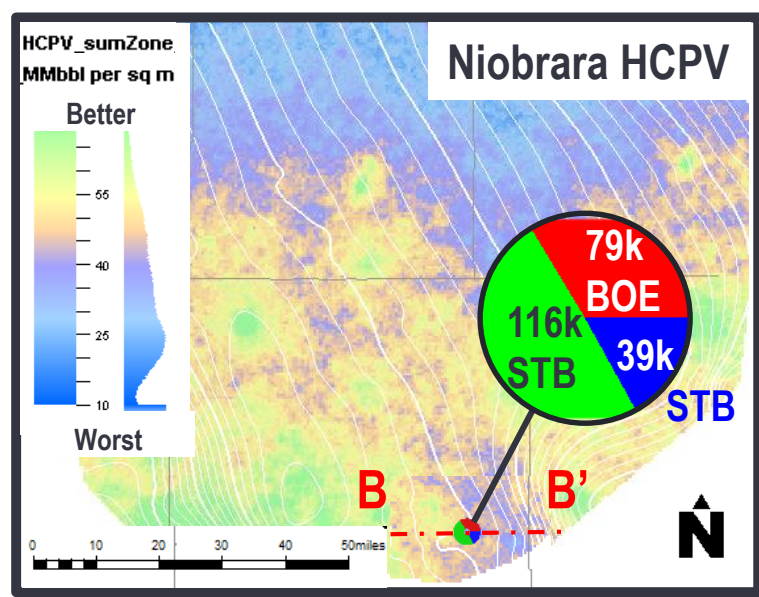


Porosity with Production Quartiles

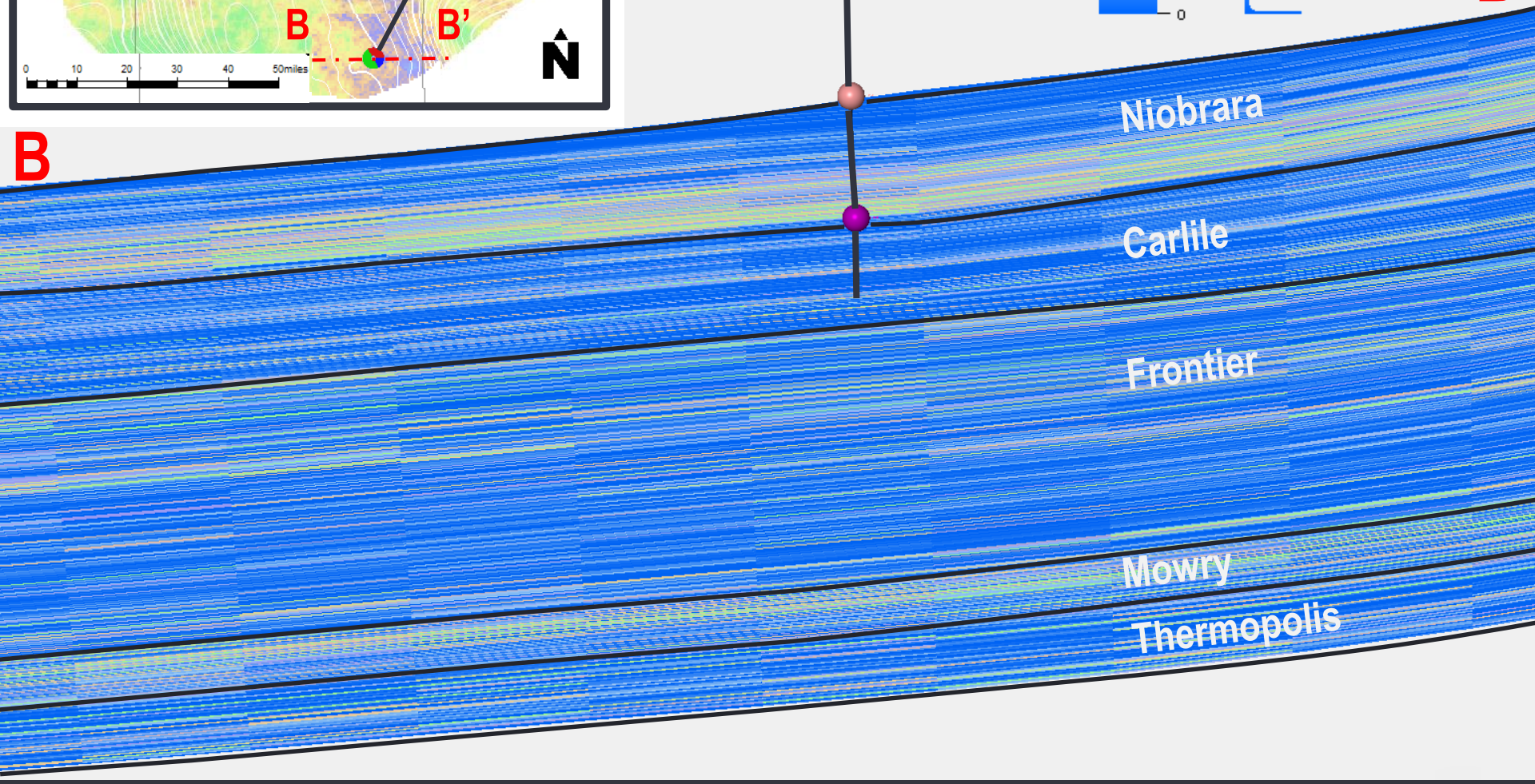


HCPV with Production Quartiles



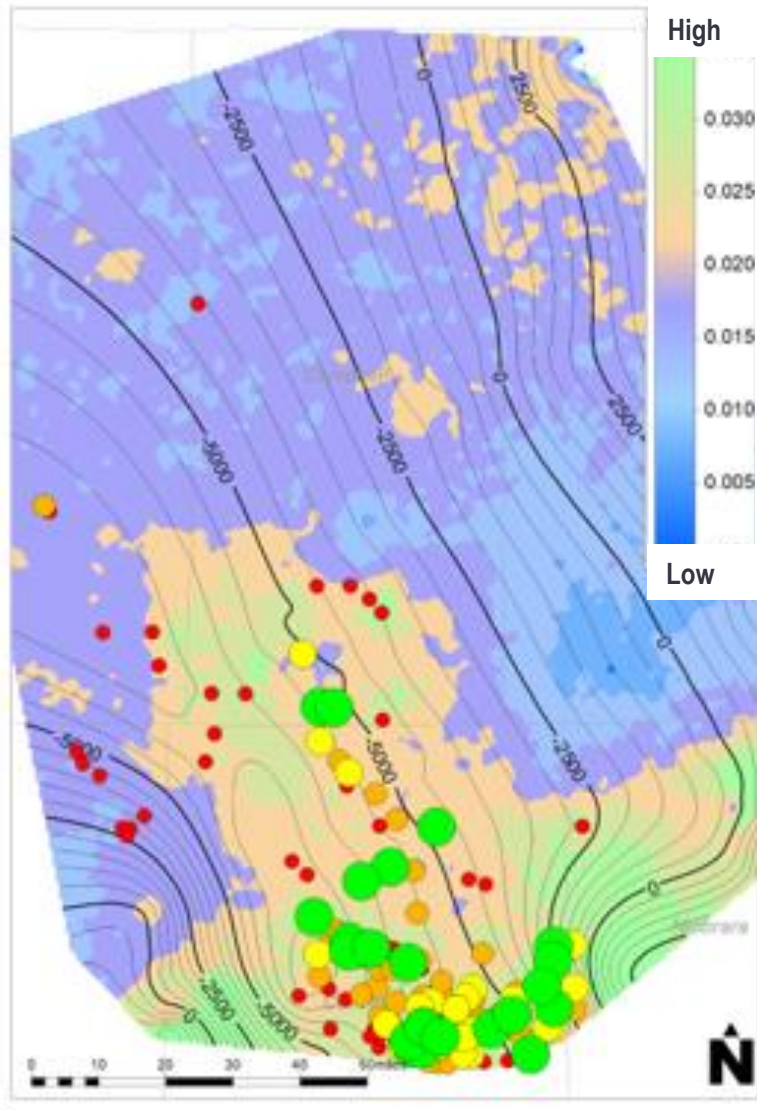


B

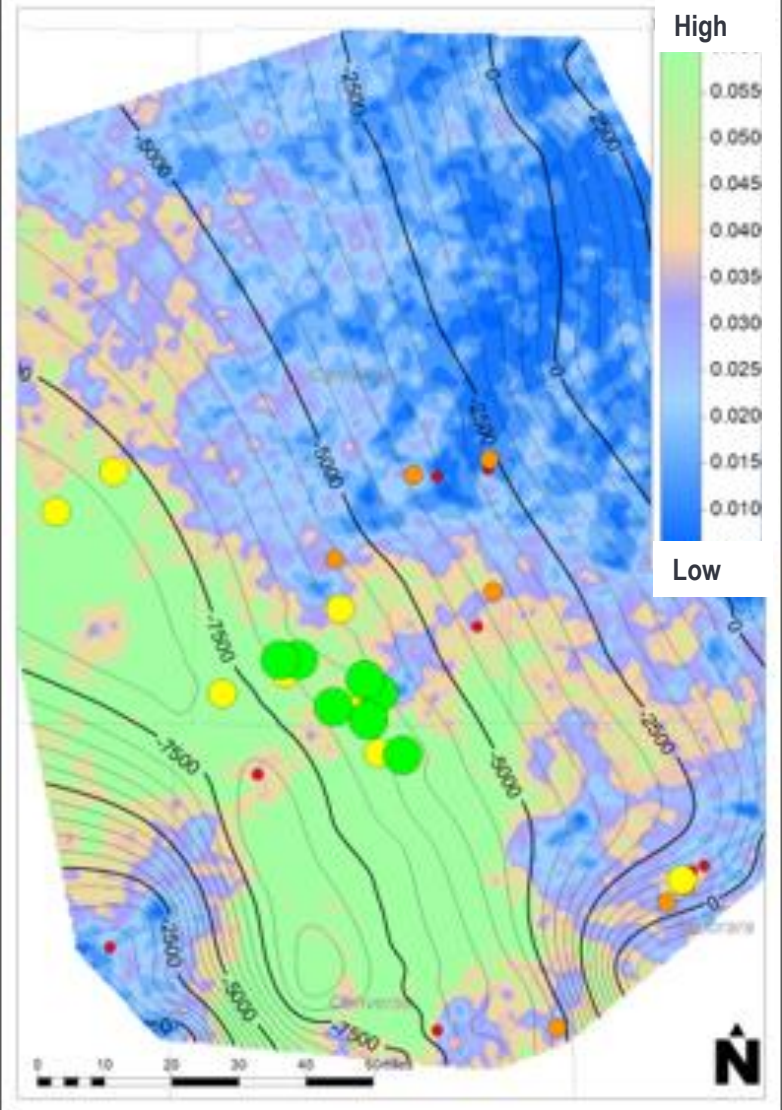


Reservoir quality tied to well performance

Niobrara Kerogen vs. Production Quartiles



Mowry Carbonate vs. Production Quartiles



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Acknowledgments

- Wyoming Oil & Gas Commission
- Schlumberger
- Co-Authors

Citations

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