
BJ
Webinars
Using Machine Learning to Optimize Completion Design
ANDREY BOGDAN
Head of Advanced Data Analytics


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Speaker

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Using Machine Learning to Optimize Completion Design

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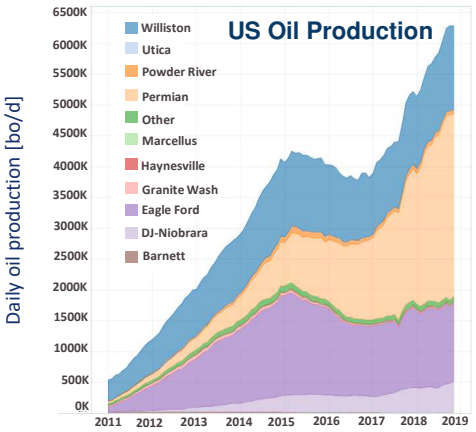
Head of Advanced Data Analytics

DRIVERS OF CHANGE

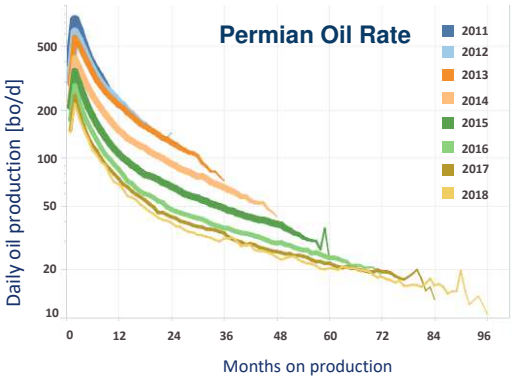
North American Shale Play Production | Daily Oil Production By Basin

Daily oil production [bo/d], shown by "Basin"



*Public data. shaleprofile.com

Production rate profiles (thickness indicates number of wells)



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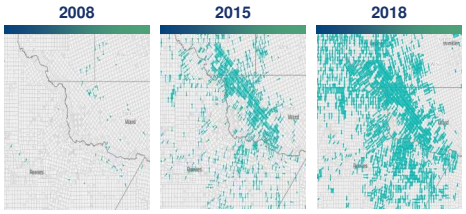
DRIVERS OF CHANGE

Explosion of Density and Diversity of Data

2008 **30,000** → 2018 **>300,000**



Map shows laterals of Bakken wells with available public data

*Source: BJ Internal Estimates, RS Energy

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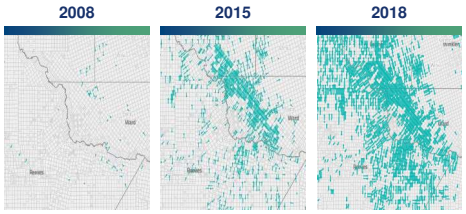
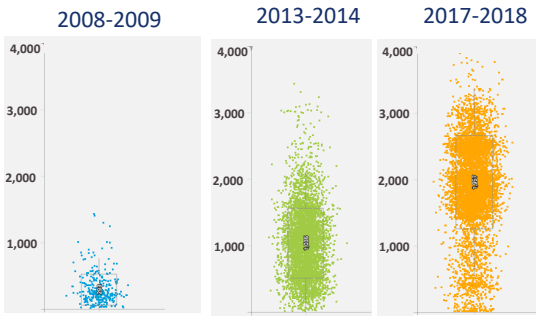


Map shows laterals of Bakken wells with available public data

*Source: BJ Internal Estimates, RS Energy

Proppant Intensity
Pumped in Permian



DENSE AND DIVERSE DATA is GOOD for using ML

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WHAT CAN BE DONE

Time to Improve Planning and Completion Design | Machine Learning

- We believe that improvement in completion efficiency and design will continue driving the U.S. Shale industry
- We use Explainable Machine Learning (ML) techniques that deliver insights and help focus on the most important parameters
- Develop ML models
  - Using rich and diverse public and private data
  - Mapping reservoir potential, identifying production drivers and optimizing completion design

TOP PRIORITIES FOR R&D AND INNOVATION IN 2018

Area of R&D/innovation	% of respondents labeling it a priority
Digitalization	37
Cybersecurity	36
Subsea	29
Pipelines	24
Enhanced oil recovery	20
Advanced materials	19
Smart emissions reduction	16
Floating LNG	16
Energy storage	12
Power to gas	12

DNV GL "THE OUTLOOK FOR THE OIL AND GAS INDUSTRY IN 2019", survey of Industry Executives. Shared in "The Role of R&D in Energy Sustainability…" by S. Alnuaim, SPE President, JPT Feb 2019

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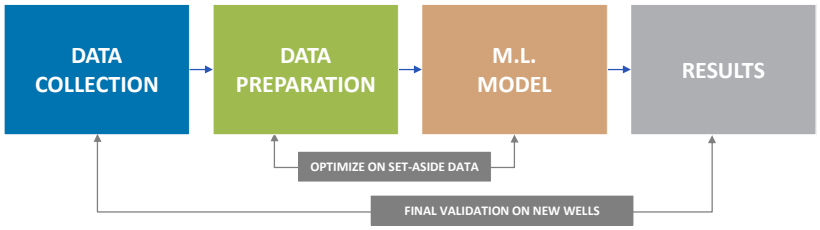
MACHINE LEARNING MODEL

Building the Model | Ensuring Usability, Stability & Interpretability



Data Sources

PUBLIC :

- Logs (vertical)
- Geology Tops
- Lateral Trajectory
- Target play
- Stages per well (some)
- Total fluid/proppant
- Types of chemicals/sand
- Monthly Production on well/lease level (Oil/Gas/Water)
- Oil Gravity
- Timeline History (SPUD, service, production dates)

SERVICE PROVIDER :

- Completion sequencing
- Cluster/stage spacing
- Perforations
- Fluid/proppant per stages
- Pumping rate
- BH pressure
- Exact fluid formulation
- Exact proppant types
- Additives used
- Diverter agent schedule

OPERATOR :

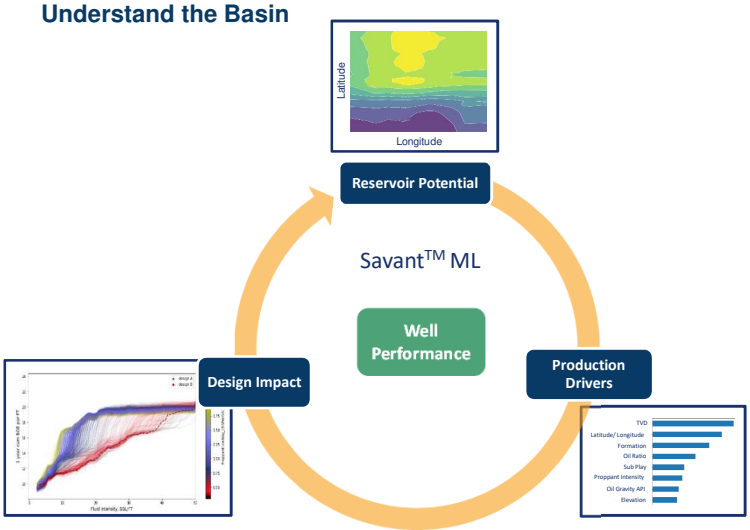
- Reservoir models
- Lateral trajectory in Pay zone
- Logs (pilot well, mud gas, etc.)
- Drilling (Lat./Long., survey, MWD/LWD gamma ray, etc.)
- Seismic, SRV
- Frac-hits
- Depletion Models
- Water Injection
- True oil/gas/water production

DATA PREPARATION

- Cleaning
- Filling missing Data
- Detecting Outliers
- Feature Engineering
- Prepare indirect data
  - Horizontal logs from Drilling Data (with help of ML)
  - Pad design
  - Well spacing
  - Parent-Child Wells
  - Wells per pad
  - Zipper wells
  - Parent-Child interaction

From Basin to Well

Understand the Basin



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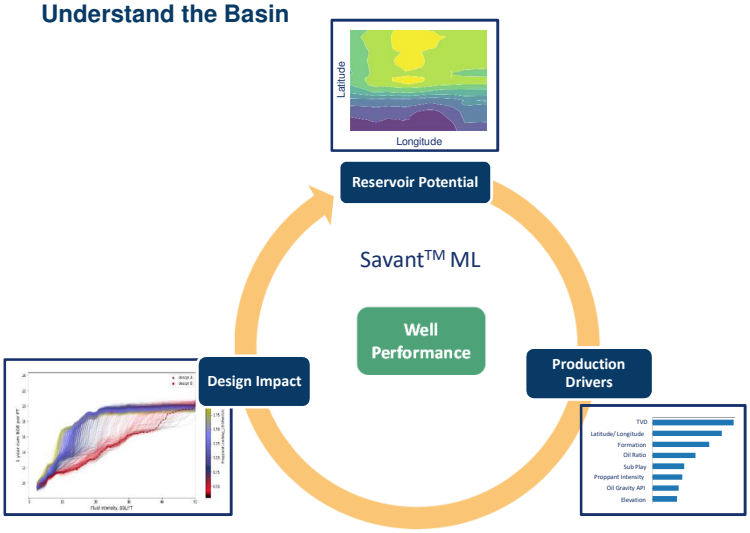
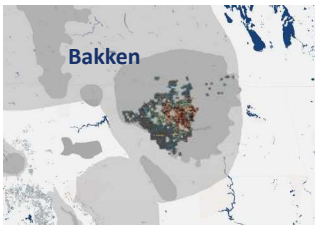
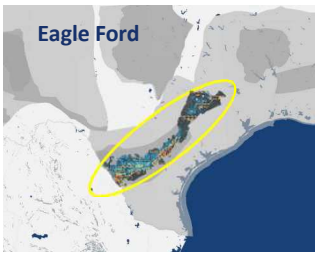


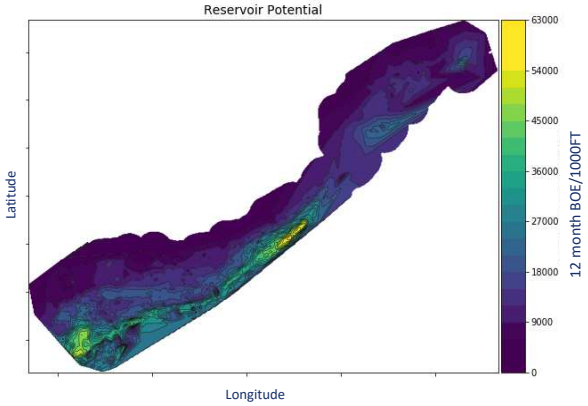




From Basin to Well

Basin Potential: Eagle Ford

Potential Production (12 month *BOE/1000ft*)



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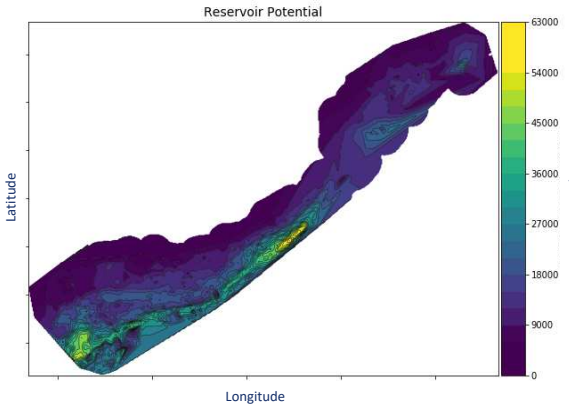
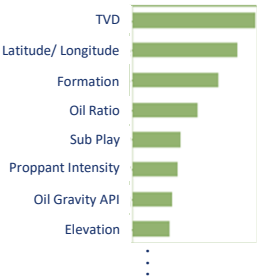


Basin Top Drivers: Location, Formation, Oil



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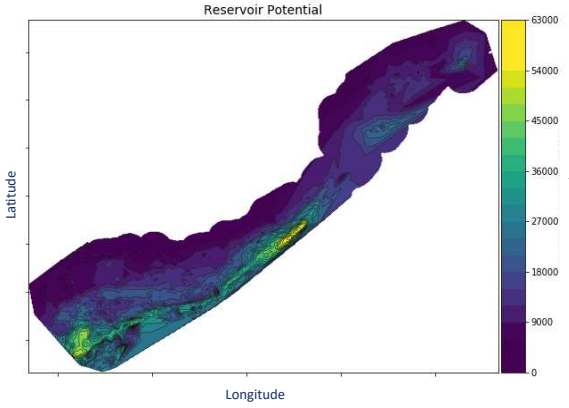

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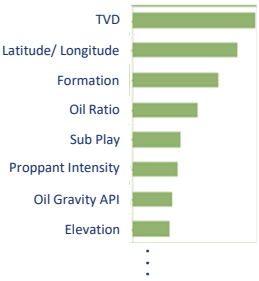
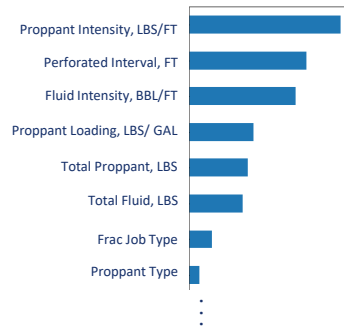


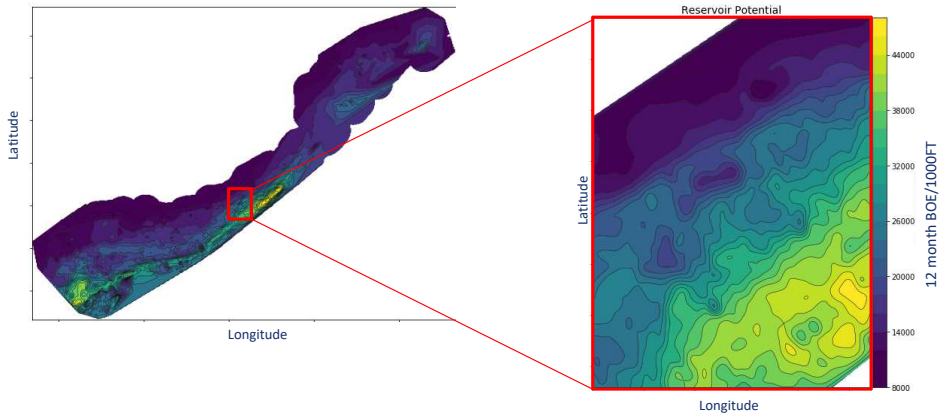
Basin Top Completion Drivers: Intensity and Lateral



From Basin to Well

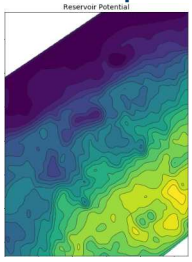
Local Potential

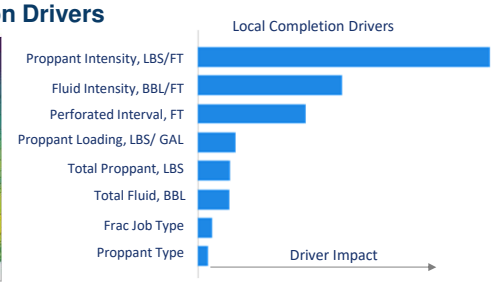
Potential Production (12 month *BOE/1000ft*)



From Basin to Well

Local Completion Drivers





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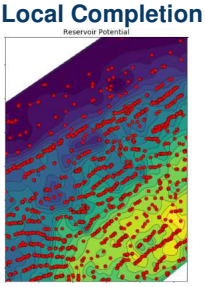

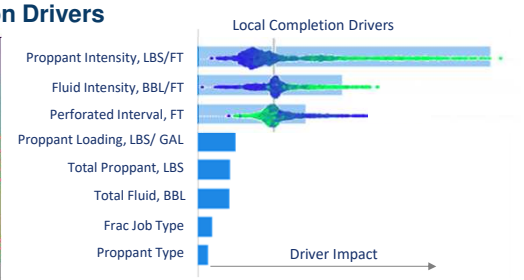

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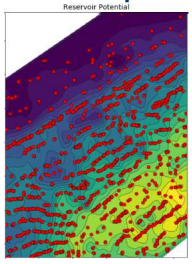

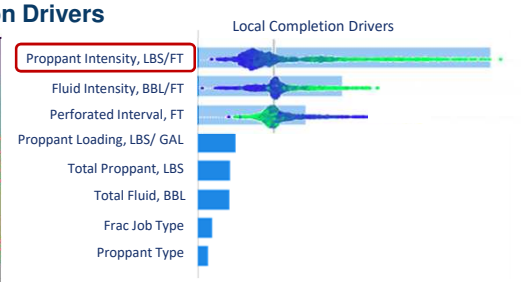

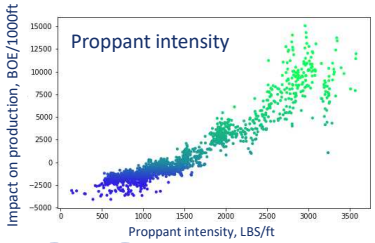

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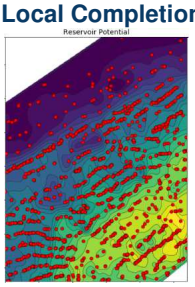

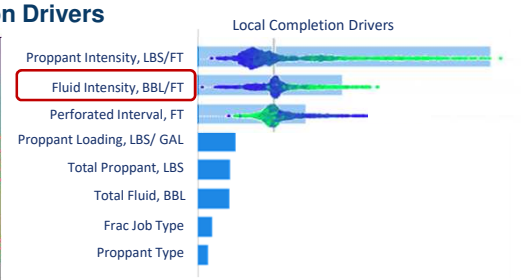

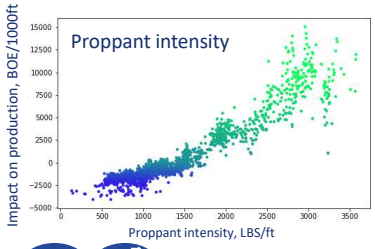

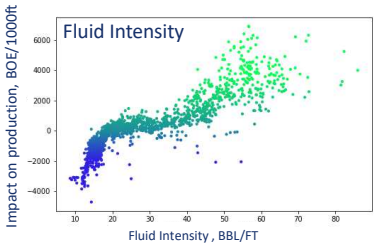

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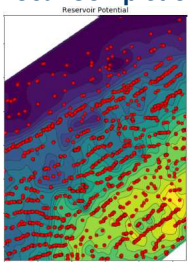
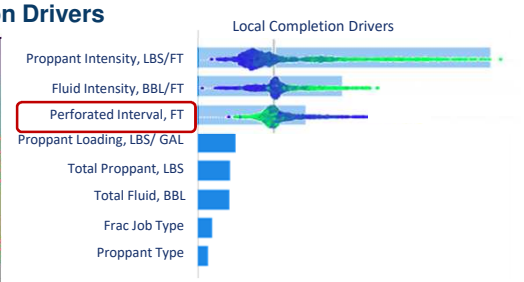
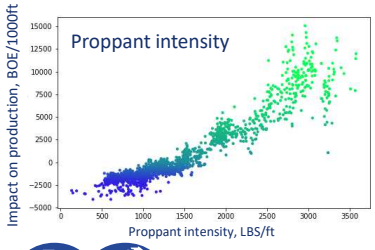
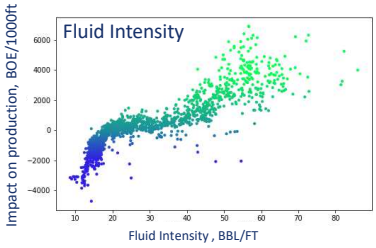
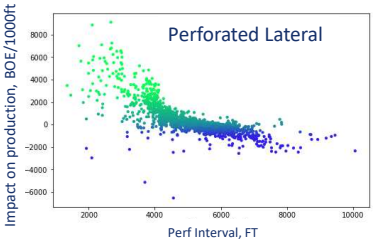




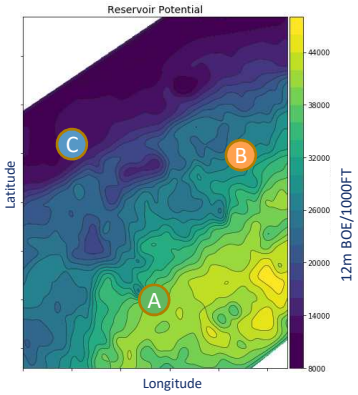


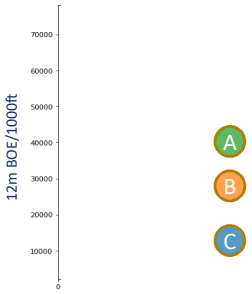




From Basin to Well

Optimal Design is Location Specific





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From Basin to Well

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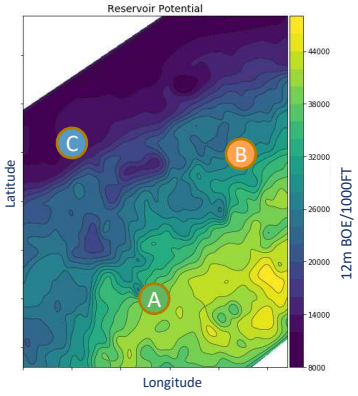

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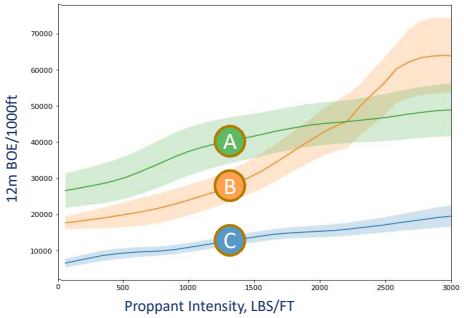

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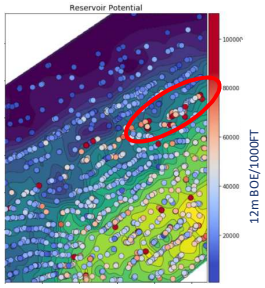

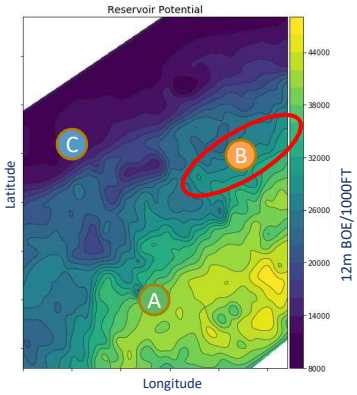

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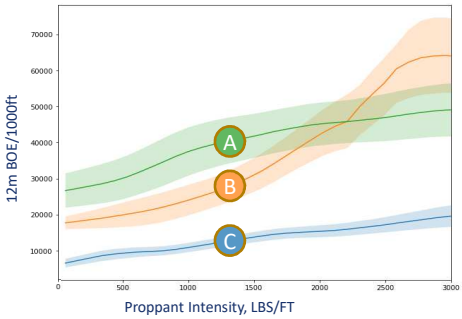
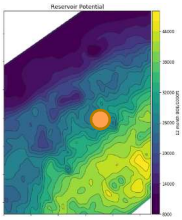


From Basin to Well

Impact of Well Completion Drivers

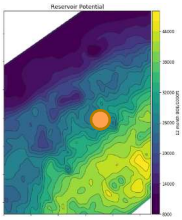


Initial Completion Design

Proppant Intensity	1300	lbs/ft
Fluid Intensity	40	bbl/ft
Proppant Loading	0.8	lbs/gal
Frac Job Type	Slick Water & Linear Gel Hybrid	
Proppant Type	Sand Only	

From Basin to Well

Impact of Well Completion Drivers



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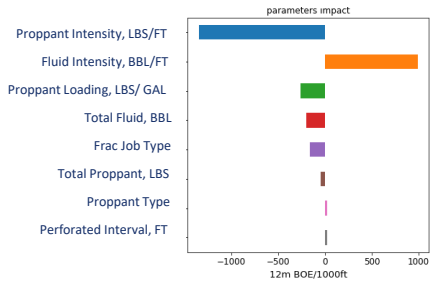
Main Drivers

Individual impact of chosen completion design parameter for well performance



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From Basin to Well

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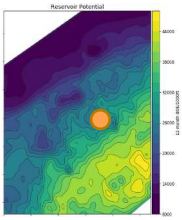

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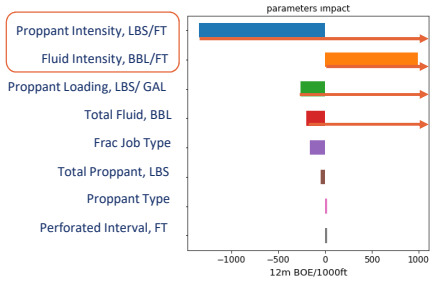

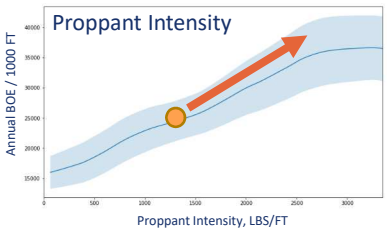

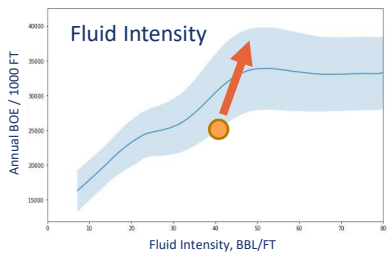

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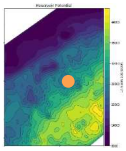
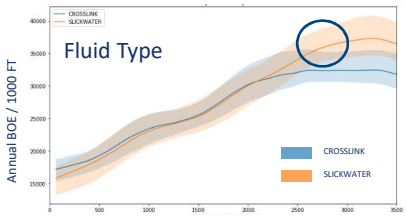
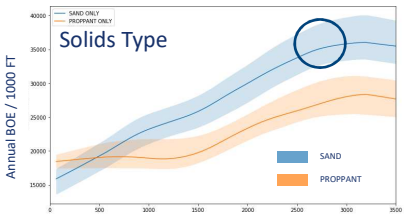
From Basin to Well

Optimize Well Completion Design

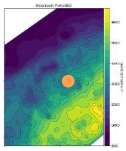


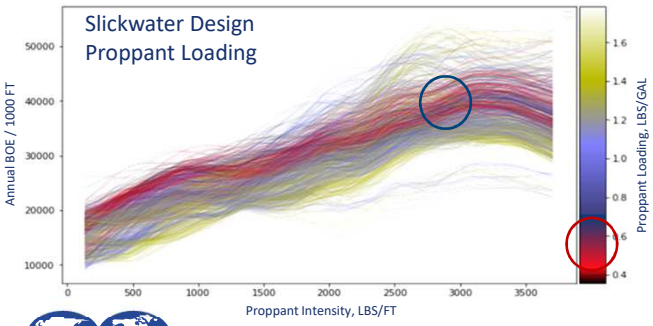


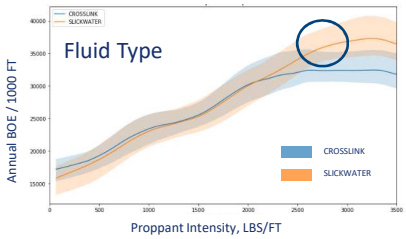


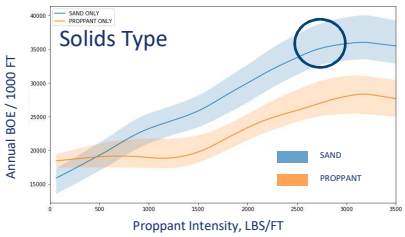
From Basin to Well

Optimize Well Completion Design









CONCLUSION

ML Brings Powerful Insights on Optimal Well Location & Completion

- Mapping the reservoir production potential is fast and brings immediate insights.
- The Production Drivers are location specific and we can catch it.
- For some wells the optimized completion can compensate poor potential.
- Copy & Paste Design will not deliver optimal solution even for local wells.
- Study of individual drivers brings fast understanding of important values range.
- Response to completion diagram is a powerful optimization tool.