

ANALYZING PAY ZONES IN THE PERMIAN

Identifying the most profitable pay zones in which to drill is probably the most important task geologists carry out today. Not all pay zones are created equal, and with the difficulties geologists face in reporting reservoirs and identifying pay zones, it could lead to unknown or inaccurate PUD evaluations.

In this study, we look at how Drillinginfo has developed a basin-wide model to identify and analyze pay zones and help deliver accurate PUD numbers. We look at examples from the highest producing areas in the Permian, identify an area where up to seven proven pay zones are in existence, and demonstrate how operators can identify landing targets for wellbores and the highest producing zones in stacked plays. This level of geological granularity leads to more effective drilling operations and delivers direct to the bottom line.

Case Study

Current Activity on the Permian – Rigs and Permits:

The Permian remains the epicenter of drilling and production activity in the U.S. with the Delaware and Midland basins remaining extremely active and the New Mexico basin growing quickly. Figure 1 (2.14) shows rigs and permitting activity over the last 30 days and figure 2 (bottom diagram on 3.09) shows the largest percentage rig growth taking place on the New Mexico side, particularly in Eddy and Lea Counties. With so much activity and a continued growth in leasing, it is vital to differentiate the geology in specific areas and determine what formations are being drilled and how effectively.

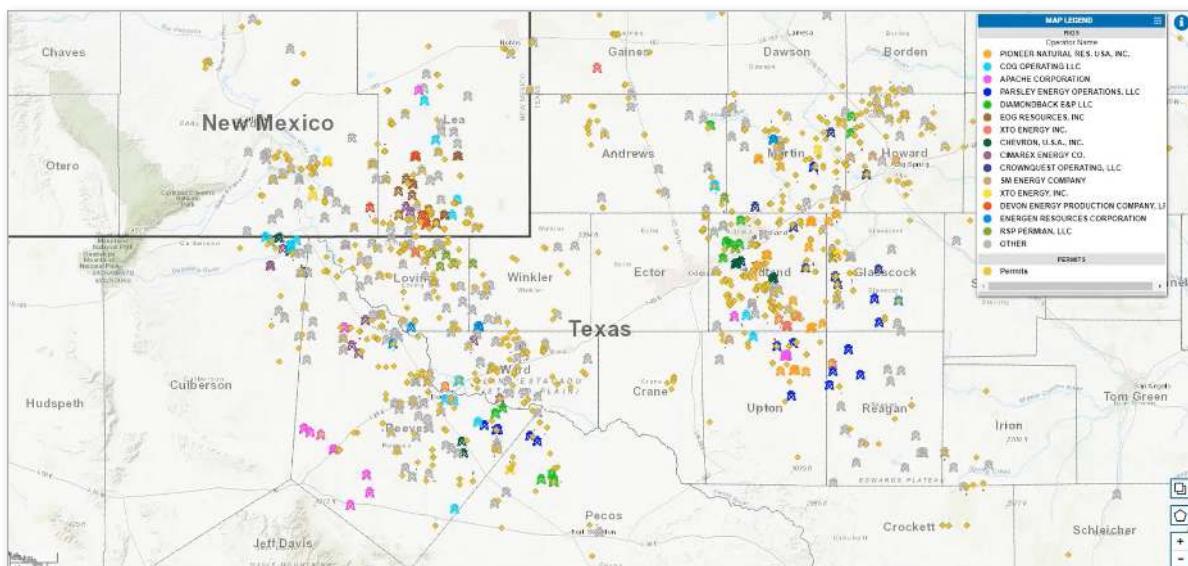


Figure 1 - 2.14

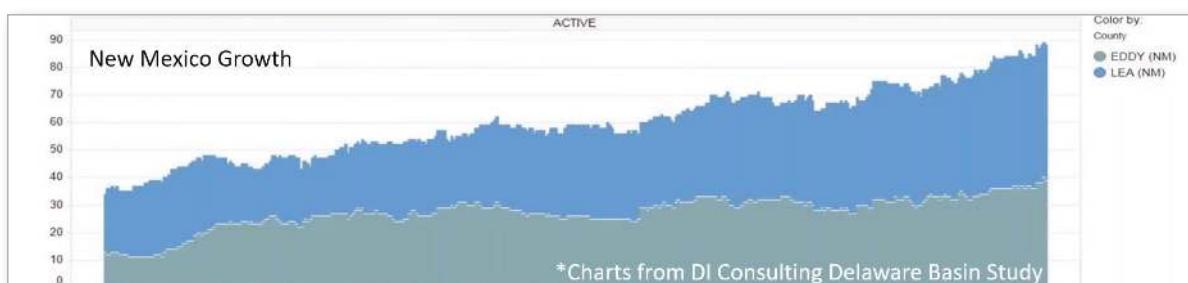


Figure 2 - 3.09

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The Growth in PUD and PDP Evaluations

The increased activity has come with growth in Proved Developing Producing (PDP) and Proved Undeveloped (PUD) evaluations. Figure 3 (5.14) shows the PDP for RSP Permian Inc. and their Delaware activities with a \$1.4 billion PDP. When you are paying for PDP/PUD, it is important to understand where these wells are landing and what is going on in these areas.

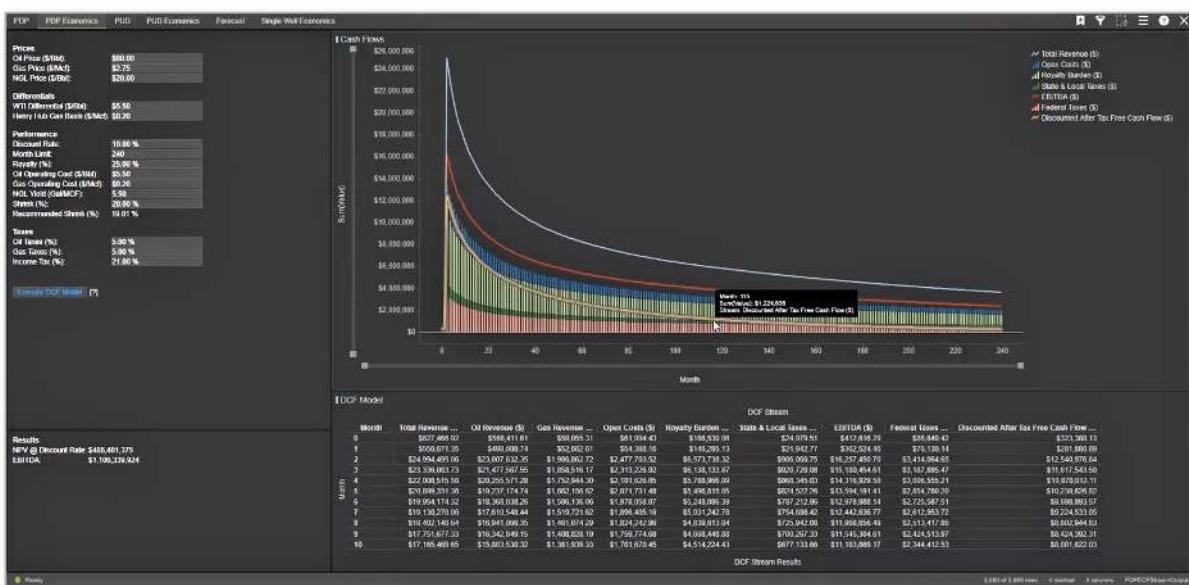


Figure 3 - 5.14

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Where are You Drilling? Identifying Formations

Let's look further into the geology using the Reed/Ward County boundary as an example. If you look at figure 4 (7.55 – upper right-hand chart), it shows first production date versus target formation. Looking at the bottom line for the Wolfcamp, it shows that from 2011 to 2014 – everything was reported as Bone Spring Third Sands and then Wolfcamp A as the main trend area from 2014 onward. Similarly, Bone Spring (second line) is 50 percent Bone Spring Third Sands and 50 percent Wolfcamp A.

Why is identifying these different formations important? It is important because different formations require different completion techniques and ultimately lead to different reserves and Estimated Ultimate Recovery (EUR) calculations.

Furthermore, with the rise in cube development – EOG in North Loving County, for example, where multiple benches and stacked laterals are being targeted and up to six different formations drilled – correct and detailed zone assignment is vital.

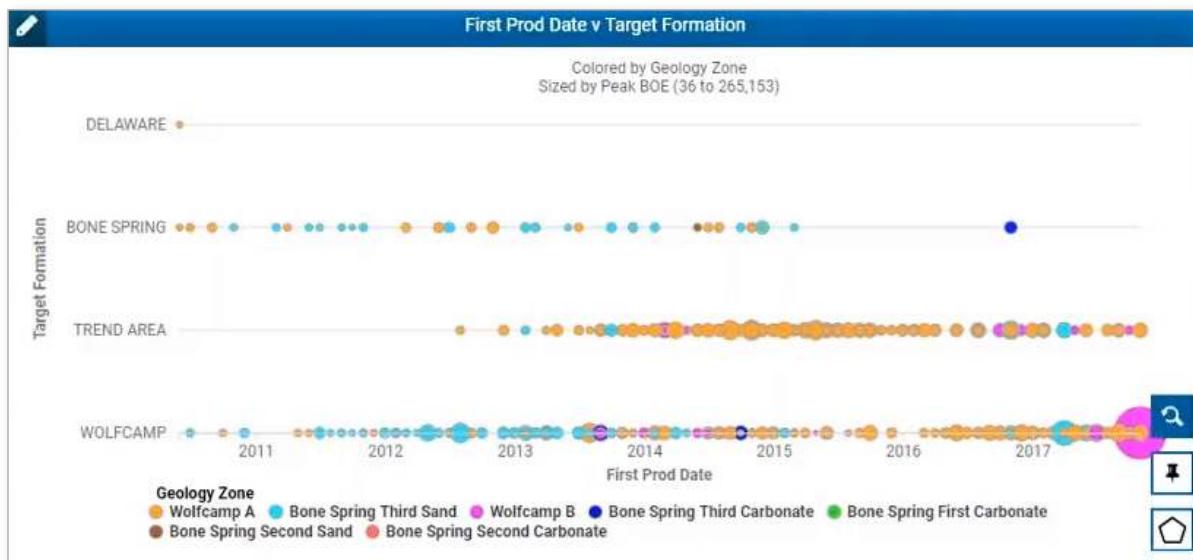


Figure 4 - 7.55

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Pay Zones Aren't Created Equal - The Dangers of Getting Estimates Wrong

The limited geological assessment of pay zones means that there is a possibility of getting production estimates wrong. Figure 5 (11.17) using the above EOG's North Loving County example and illustrating Gross versus Formation-Specific Type Curves, shows how wells in different formations – in this case Wolfcamp A and Wolfcamp B - can decline very differently. While there is a close correlation between the Delaware and Wolfcamp A (due to its' dominance in the basin), peak rates for Wolfcamp C are over 200 bbl per day lower than for Wolfcamp A. If you just focused on Wolfcamp A, there is a chance that you could heavily overestimate the amount of production.

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6 of 15

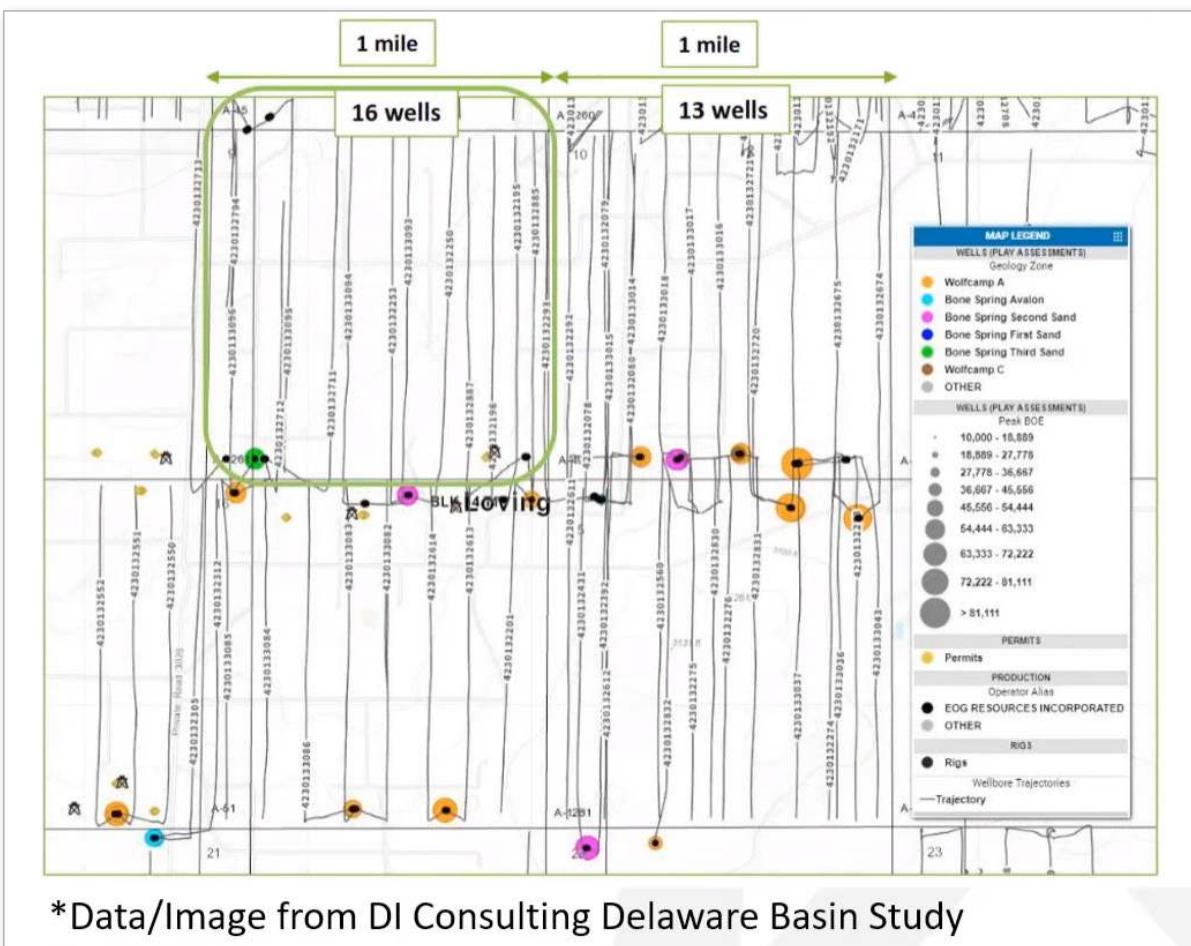


Figure 5 - 11.17

*Data/Image from DI Consulting Delaware Basin Study

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Identifying Geology Zones Going Granular for Wellbore Targeting

To counteract these dangers, there is a need to go further into the geological granularity as Drillinginfo solutions enable. Figure 6 (12.27) shows a south west to north east cross section flattened on top of the Lower Spraberry trend. By taking raster logs and digitizing them, creating LAS curves and then picking tops, the geologist can view a structural model with the different structures overlain.

Pairing these with directional surveys, figure 7 (13.50) provides detailed wellbore targeting. In this case, the red line is the digitized deviation survey. Once the wellbore hits the 80-degree inclination (marked by the blue dot) from that point to the toe is what we are calling the lateral. In this case, the lateral stays 100 percent in zone and we can then tag this as a Wolfcamp C well. It is this level of detail that is vital for geologists and for drilling decisions.

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Case Study

8 of 15



Figure 6 - 12.27

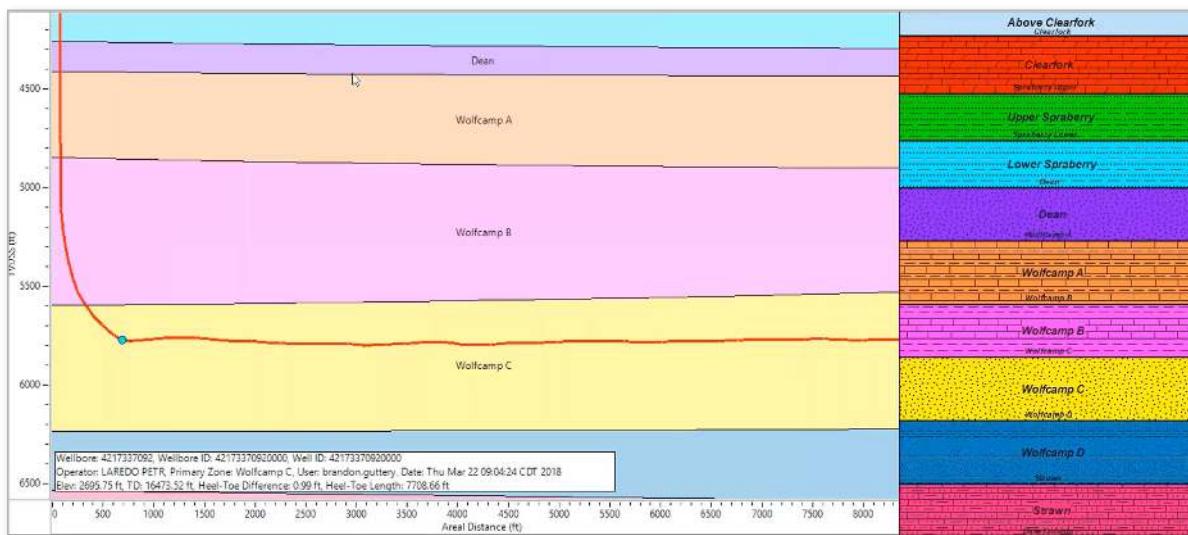


Figure 7 - 13.50

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Identifying Stacked Pays

A geologist can also identify stacked pays. Figure 8 (15.51) in Wolfcamp B shows how in 2013, operators were mainly targeting 250 feet from the top zone with the average distance from top of zone and first production date on the x-axis. From the illustration, one can also identify the different intervals where operators are starting to drill in Wolfcamp B. Such information will have a significant impact on PUD evaluations and well economics.

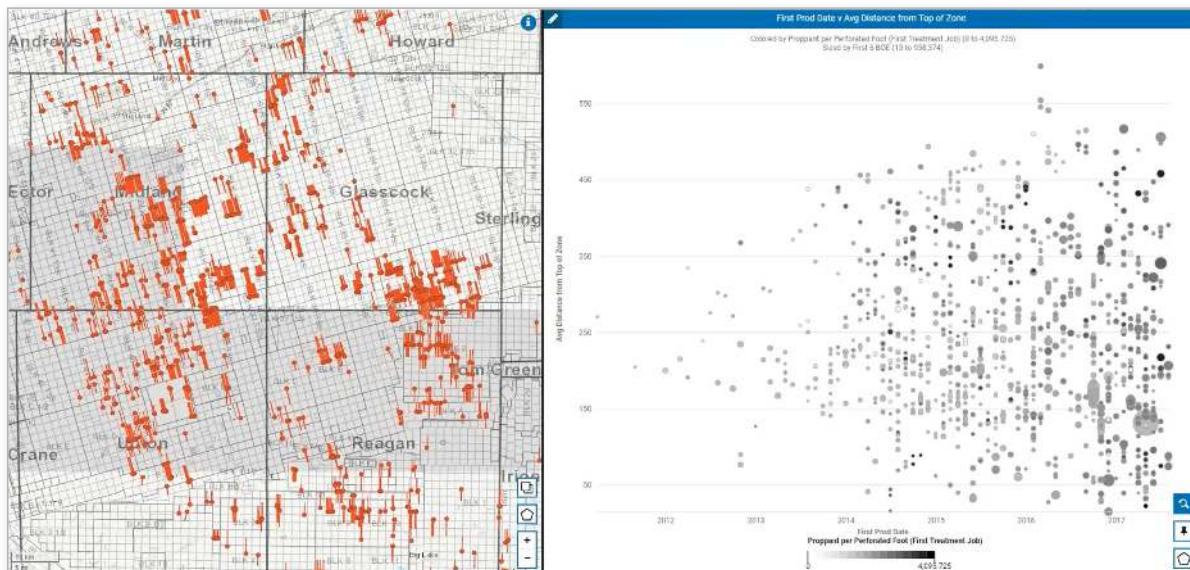


Figure 8 - 15.51

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Identifying Seven Formations in Eddy/Lea

Through geological granularity we can identify seven proven formations on the Eddy/Lea County boundary – one of the best areas in terms of production (see figure 9 17.39). Here the average EUR is 1,196 and average return 56 percent.

Another example refers to Halcón Resources and how the company has consolidated acreage in the Western and Central Ward counties. Here in figure 10 (18.48), one can see proven pay zones in Wolfcamp A, B, and C and Bone Spring Second and Third. Looking at the chart in the bottom right, one can also see different EURs per zone. If you look at the average EUR (605,487 BOE), for example, this could be misleading as Wolfcamp B has a much higher EUR at 830,010. This demonstrates the importance of identifying geological granularity on different formations.

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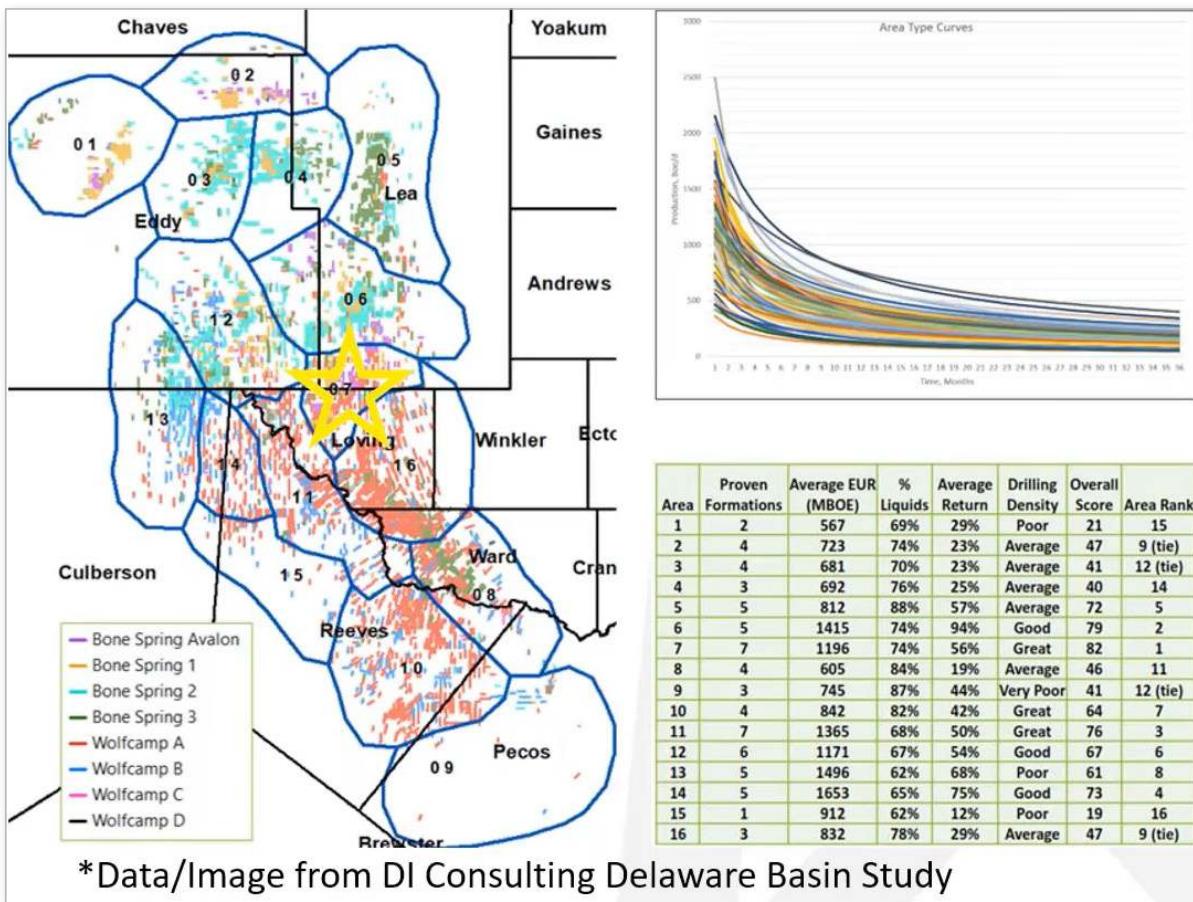
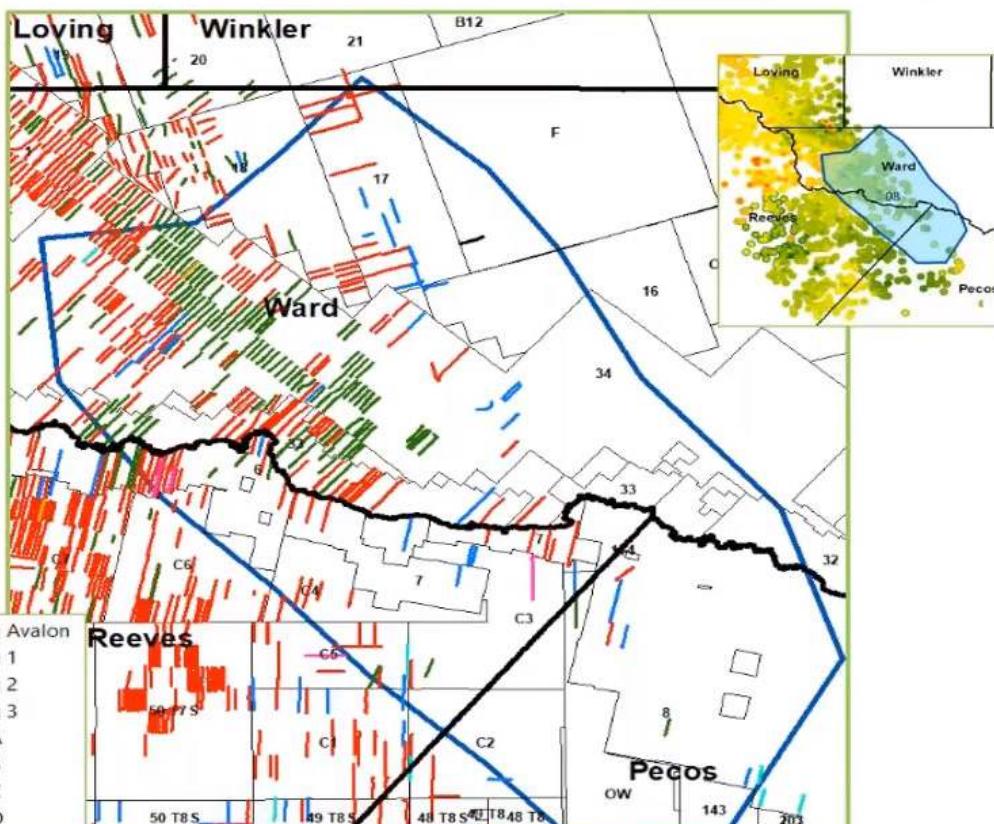


Figure 9 - 17.39

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Figure 10 - 18.48



Type Curve	DCC Cost	EUR OIL (BBL)	EUR Dry GAS (MCF)	EUR NGL (BBL)	EUR BOE (BBL)	% Liquids	NPV	EBITDA	IRR, %	Gas Breakeven	Oil Breakeven
TC8 BS 2	\$7,290,000	275,410	405,897	72,482	415,541	84%	\$477,526	\$4,070,715	14%	(\$0.60)	\$55.48
TC8 BS 3	\$7,290,000	402,921	569,541	101,704	599,548	84%	\$1,806,949	\$9,257,395	20%	(\$6.68)	\$46.22
TC8 WC A	\$8,750,000	515,511	772,371	137,923	782,163	84%	\$2,657,878	\$12,552,911	22%	(\$7.36)	\$43.81
TC8 WC B	\$8,750,000	622,124	625,326	111,665	838,010	88%	\$4,649,167	\$16,034,328	39%	(\$19.78)	\$37.25
TC8 WC C	\$8,750,000	220,487	497,296	88,803	392,173	79%	(\$1,883,350)	\$864,354	2%	\$13.24	\$80.15
TC8 Average	\$8,166,000	407,291	574,086	102,515	605,487	84%	\$1,541,634	\$8,555,941	19%	(\$4.24)	\$52.58

*Data/Image from DI Consulting Delaware Basin Study

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Tying the Geology Back to Predicted Production

It is this detailed granular information that can be then tied back to production as illustrated in figure 11 (19.45) – a multivariable, analytical model developed for Wolfcamp A based on 2,000 pounds of proppant and a 7500 lateral. Based on other parameters on the left-hand side (thickness, temperature, density porosity, gamma ray, etc.), one can then develop a predicted six-month production map for Wolfcamp A. The results correspond well with the Eddy/Lea County findings previously highlighted.

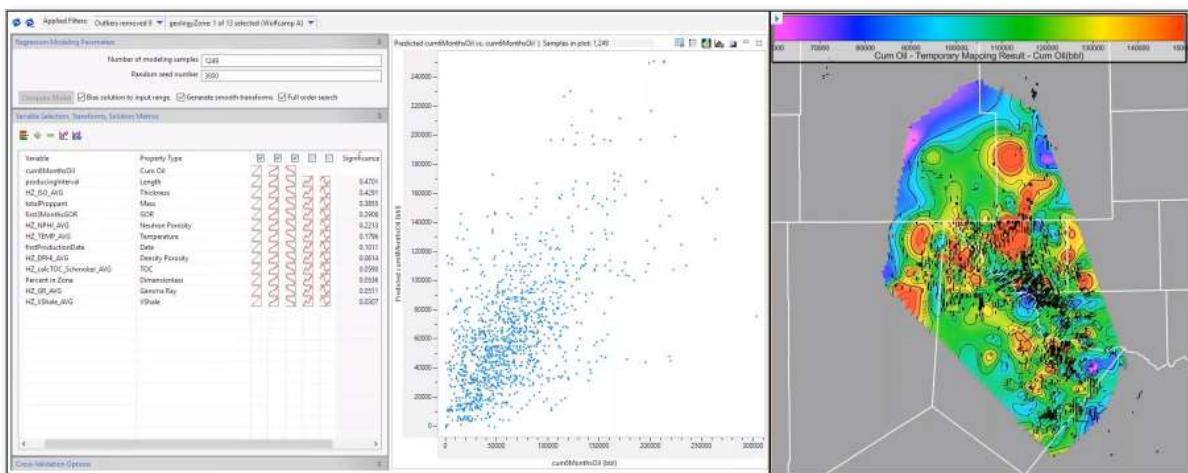


Figure 11 - 19.45

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And the Well Economics...

Finally, such geological data can be used for well calculations. Figure 12 (27.32) focuses on a less commonly drilled upper interval of Wolfcamp B in the Culberson/Reeves Counties area. Here, decline curve analysis (figure 13 28.40) shows a payout of 2.3 years, Net Present Value (NPV) of more than \$1 million, and breakeven of \$51 per barrel – just one example of multiple lenses on a particular formation. When targeting specific formations, users can also access Drillinginfo's LandTrac Leases to identify if leasing prospects contain Pugh clauses or depth severance.

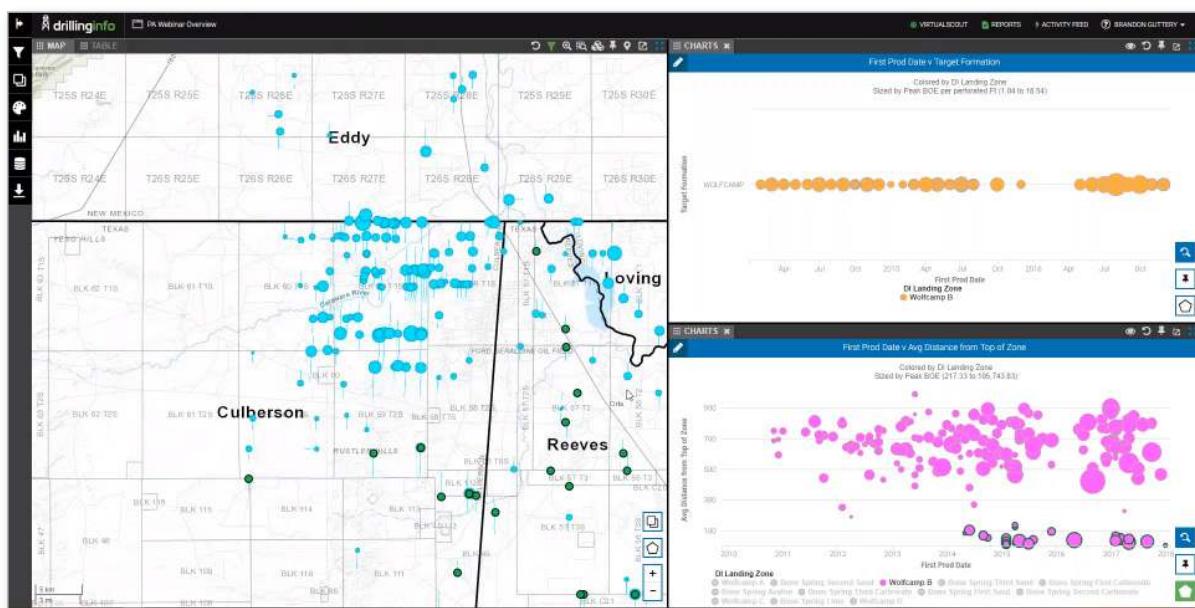


Figure 12 - 27.32

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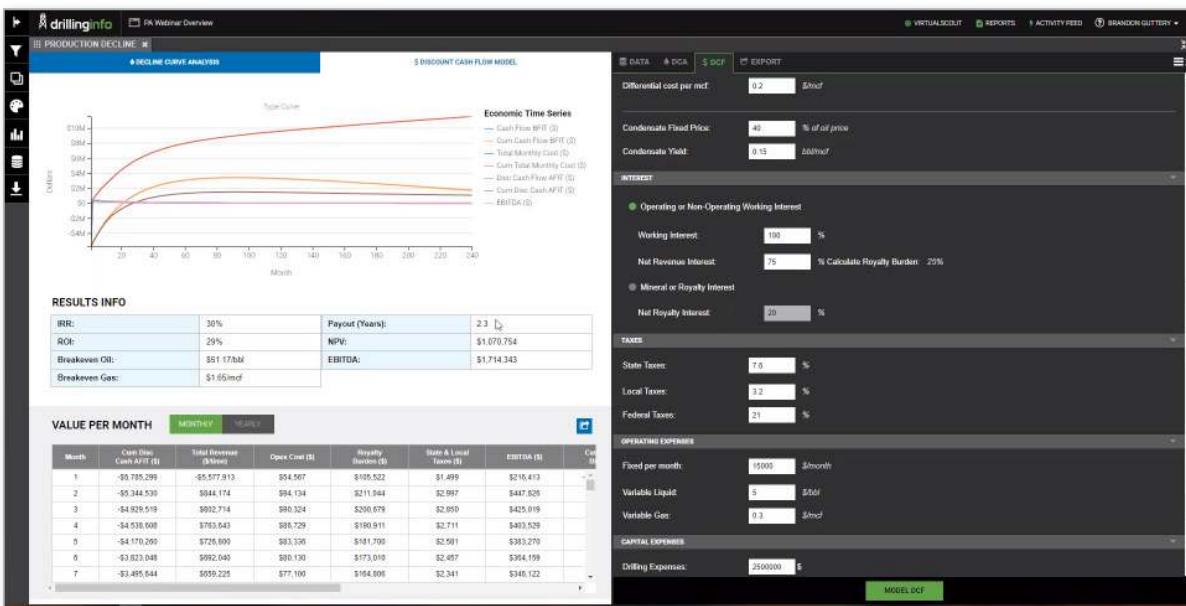


Figure 13 - 28.40

No Pay Zone is Created Equal!

No pay zone is created equal and every zone comes with different characteristics and sometimes formations. It is only through this granular and detailed approach to the Permian's geologies as explained in this study that pay zones can be identified, wellbore landings targeted, accurate PUDs evaluations generated, and long-term drilling and production development achieved.

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