LINQX

Case Study

A Unique Approach to Each Fracture Ensures Appreciable Increases in Per-Well Recoveries

Overview

A fully integrated frac design strategy developed by LINQX customizes individual frac stages using readily available mud log data and historical frac performance. By quantifying permeability and reservoir quality along the lateral, the approach enables more precise stage-level treatment design and improved alignment with reservoir variability. This data-driven methodology has demonstrated measurable gains in stimulation effectiveness and increased per-well recoveries.

Challenges

The Bone Springs formation in the New Mexico Delaware Basin was historically viewed as a secondary or fallback target, with most development efforts focused on deeper formations such as the Ellenburger and Morrow. Early evaluations underestimated its potential due to limited logging technology and an incomplete understanding of pay thickness and reservoir quality. As horizontal drilling and multi-stage hydraulic fracturing accelerated, operators began targeting the Bone Springs more aggressively, but faced challenges in effectively designing completion strategies across laterals with variable reservoir characteristics. Traditional frac designs lacked the resolution needed to optimize stage placement and treatment intensity in heterogeneous rock.

Solution

To overcome these challenges, LINQX developed a fully interconnected frac design strategy that customizes individual frac stages using readily available mud log data and historical frac performance. This approach quantifies permeability and reservoir quality along the lateral, enabling more precise, data-driven completion and stimulation planning. By integrating formation response with historical treatment outcomes, the methodology allows for stage-by-stage optimization that better aligns frac designs with localized reservoir conditions.

Analysis Results and Benefits

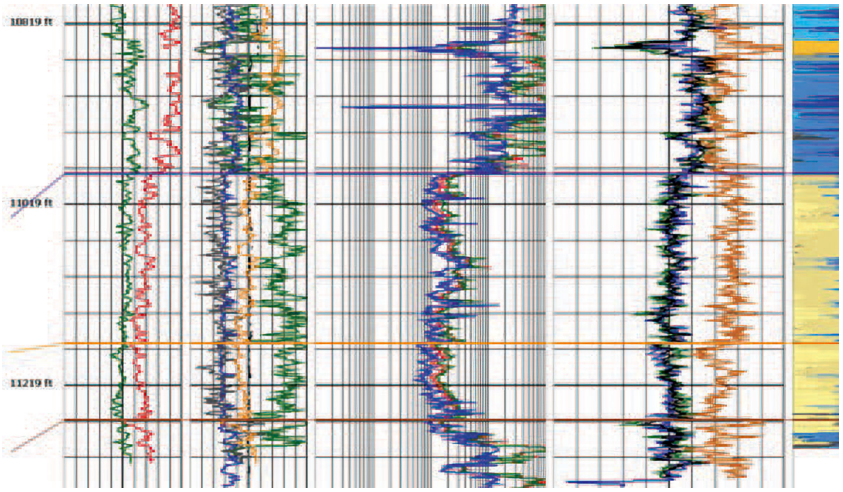
The evolution of horizontal development in the Bone Springs has delivered production performance that exceeded initial expectations. The U.S. Energy Information Administration identified the Bone Springs as a major contributor to the Permian Basin's more than 60 percent production increase between 2008 and 2013, with the Wolfcamp, Bone Springs, and Spraberry formations accounting for approximately three-quarters of incremental oil production during that period. Within this broader growth trend, LINQX customized frac-stage strategy has demonstrated appreciable increases in per-well recoveries by improving stimulation efficiency and enhancing reservoir targeting along the lateral. The integrated, data-driven approach not only supports stronger production outcomes, but also enables more efficient capital allocation and ongoing reductions in development costs, helping operators maximize well performance and long-term asset value.

Geological Deposition/Composition

As currently delineated by activity, the fairway of the Permian Bone Springs (known interchangeably as the Leonard or Avalon play) underlies some 1,313 sq miles largely across the Delaware Basin of southeast New Mexico, but extending into West Texas where it carries the Spraberry designation. The complex formation, which overlies the Wolfcamp shale, the Ellenburger Group, and the Morrow at depths ranging from 6,000 to 13,000 ft, is described as a thick sequence of interbedded sandstones, carbonates and shale. Stratigraphically, each layer of the hree-bench Bone Springs comprises equally productive sand carbonate layers.

Drilling, Completion Evolution

Prior to the rapid build-up of horizontal drilling and hydraulic fracturing, the Bone Springs source rock was largely a bypass zone of last resort for vertical wells targeting the underlying horizons then seen as far more prospective. However, once new-generation logs revealed a much thicker pay zone than that seen in earlier logs, the once-ignored Bone Springs emerged quickly as the primary target for horizontal wellbores. In short order, the placement of laterals with several frac stages gained steam in the Bone Springs, boosted in no small part by the superb well control realized when landing the horizontal sections between mature and deeper vertical wells.



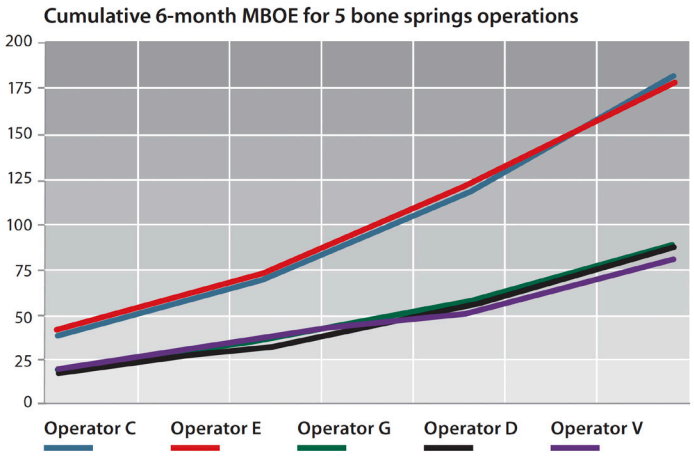
Type log of a third Bone Springs well indicating lateral landing position.

Since then, the Bone Springs has grown appreciably and is now the most sought-after prospective horizon in New Mexico. Following the commencement of horizontal drilling, the next step in the evolutionary process was isolating the most advantageous landing of the laterals, followed with generalized designs of completion/ stimulation programs. The next natural phase in the Bone Springs evolution was the wholesale change to more play compatible ceramic proppant, augmented with stage-specific mesh concentrations. The next logical step in this methodical progression features a novel solution that allows the customization of every frac stage to maximize production and estimated ultimate recovery (EUR).

State-of-the-Art: Quantifying Reservoir Quality Across the Lateral

At the onset of the Bone Springs horizontal play, operators shied away from the expensive logging suites employed in vertical wells, largely because of the sticking risks and difficulty in accessing extended reach targets. Furthermore, owing to the then consistent uniformity of every frac stage across a lateral, operators questioned the inherent value of using premium, and risky, logging technologies. It soon became apparent that the typical homogeneous strategy defined with identical stimulation of every frac stage resulted in inadequate coverage of the total pay. Specifically, fracing uniformity across the lateral left little opportunity to optimize stage efficiencies, as both lower and higher permeability zones were equally stimulated, thereby considerably restricting cumulative reservoir drainage. Therefore, the key to optimizing production and maximizing asset value is to precisely determine the permeabilities in each zone of the lateral, and tailor each frac stage to capitalize on the identified degree of permeability in individual zones. And, to do so without reliance on premium logging suites. The foundation of the LINQX Bone Springs completion/-stimulation solution is the engineering of unique designs for every frac stage, using readily accessible mud logging response data. In simple terms, mud log data response, which is corrected to account for human error, is used to characterize the permeability, and hence reservoir quality across the entire lateral. LINQX then uses the data to tailor the design of each stage to match the measured permeability of the individual zones.

With our STRATASTIM™ customized workflow, in conjunction with FracPro fracture design and analysis software, LINQX consultants use the mud log response data to precisely plot distinct reservoir permeabilities. This is accomplished by randomly selecting stages and conducting a step-rate test with shut-in to capture the fluid leak-off of individual zones. Based on the leak-off data set, FracPro software is used to develop a closely corroborated numerical equivalent of rock characteristics, including stresses, permeability and reservoir pressure. A primary objective of this exercise is to precisely quantify the relationship between permeability and closure grade, which is tied directly to other key reservoir properties. LINQX is working closely with operators during the well planning stage to modify lateral placement and ensure the thickest and richest pay zones are thoroughly covered and exploited. Incorporating permeability models during the well design phase has proven highly effective in designing completion and stimulation programs, including stage-specific ceramic proppant placement and concentrations, designed to frac and prop the maximum extent of the sweet spot.



LINQX served as a consultant for Operators "C" and "E" wells, and helped deliver appreciable production increases compared to operators "G", "D" and "V."

The Evolution Continues: Optimizing Placement, Perf Efficiencies

Going forward, LINQX's steadily evolving and fully interconnected Bone Springs completion and stimulation optimization strategy is concentrated on lateral placement, specifically oriented to enhance the cost-reward ratio. Work is continuing on evaluating all the pertinent components, including optimizing net pressure to maximize the most cost effective proppant placement to deliver optimal propped frac height. Complementing ongoing research on fluid properties and frac design, further evaluation also is required in improving the pervasive deficiency in perforation efficiency. Specifically, attention is focusing on increasing the proportion of open perforations in conventional linear entry perf clusters.

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