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Reservoir Model Helps Plans for Infill Wells to Avoid Productivity Losses, Eagle Ford Shale

Integrated workflow helps optimize infill drilling in drill-to-hold leases by minimizing the occurrence of fracture hits and well interference

CHALLENGE

Plan new Eagle Ford Shale drilling programs to avoid the field productivity impairment caused by interwell fracturing interference.

SOLUTION

Mitigate the risk of interwell fracturing interference by integrating the modeling workflow to account for

- 3D formation properties
- fracture propagation
- interactions with the formation discrete fracture network (DFN), reservoir production and depletion, and evolution of magnitude and azimuth of in situ stresses.

RESULTS

Optimized development strategies for infill wells, refracturing, pad placement, and lease strategies.

Fracture hits significantly reduce production in parent well

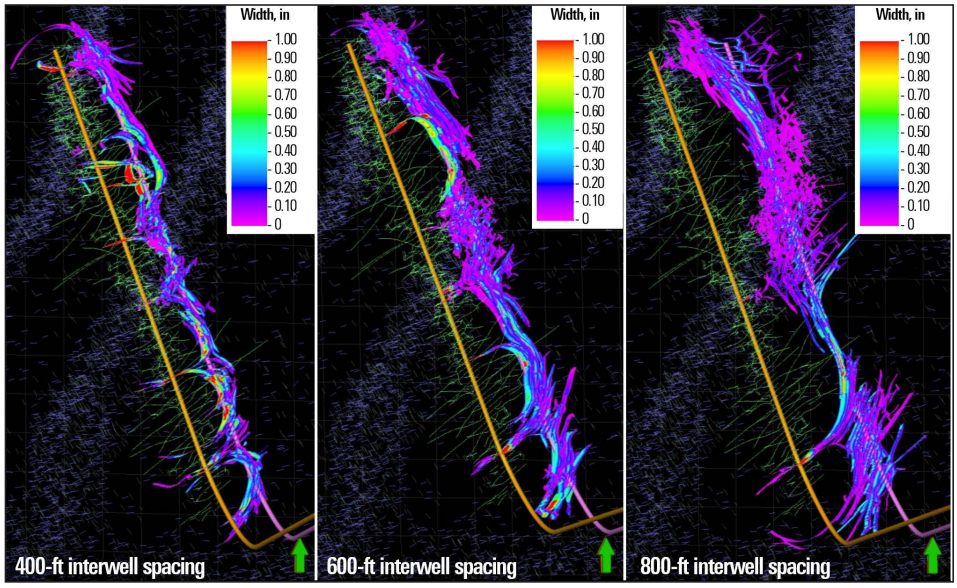
In recent years, many operators have encountered well interference when fracturing laterals adjacent to existing productive parent wells at drill-to-hold lease sites. Reduced pressure from previously stimulated or depleted areas creates a path of least resistance for a nearby infill well stimulation, causing mild, severe, or complete production impairment of the parent well.

Schlumberger investigated interwell interference on Eagle Ford parent wells and infill wells and its impact on production.

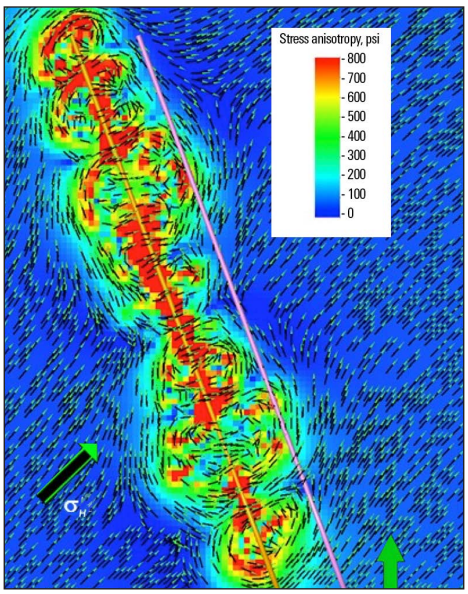
Integrate multiple data sources to accurately model and minimize risk

Schlumberger stimulation, reservoir, and geomechanics engineers developed an integrated workflow beginning with a geocellular model constructed using 3D seismic data, stratigraphic correlations from offset vertical pilot wells, and openhole well log data. The 3D seismic data were also used to characterize the spatial variability of natural fracture intensity and orientation to build the DFN model. A UFM* unconventional fracture model was generated in the Kinetix Shale* reservoir-centric stimulation-to-production software to simulate the hydraulic fracture network created with each pumping schedule in the Eagle Ford Shale.

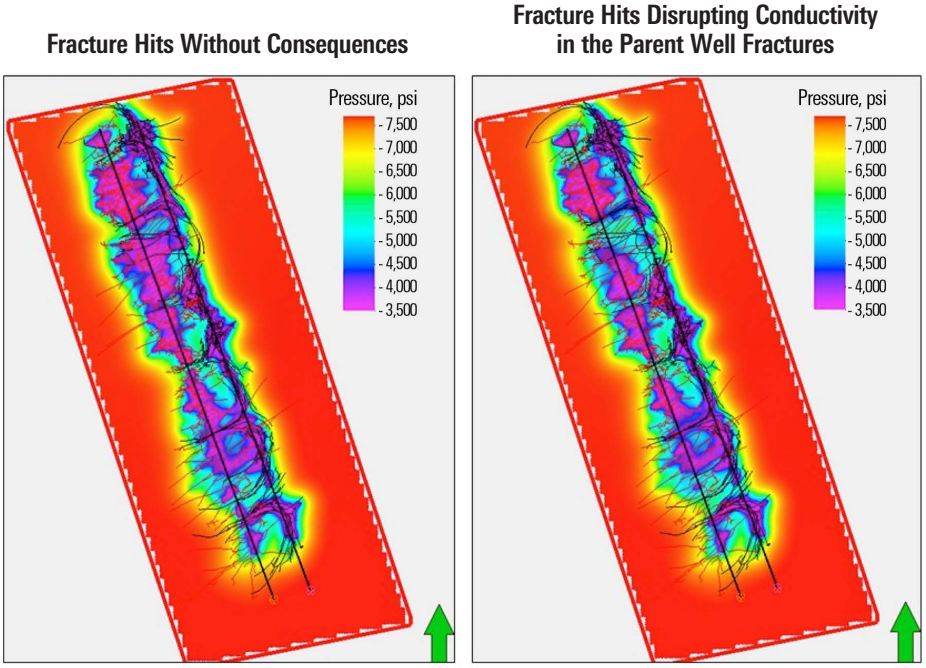
Initial production and depletion of the parent well were simulated with the INTERSECT† high-resolution reservoir simulator, which included pressure-volume-temperature data, relative permeability, and pressure-dependent fracture conductivity.



Simulated complex fracture network for the infill well at different interwell spacing from the parent well.



Parent well fracture network with stress anisotropy shown as color in the background (red is high; blue is low). Maximum stress azimuth is shown by black body arrows with green tips. Far-field orientation is NE–SW, but stress rotates around the depleted zone, influencing the hydraulic fracture propagation from the infill well.



Depletion-induced pressure field simulated for the combined system, including the parent well and infill well. Pressure is shown as color in the background (red is high; purple is low). The fracture network loses connection to the wellbore of the parent well at each stage with fracture hits, which causes faster decline on pressure and production (right).

The simulated 3D reservoir pressure field was imported into the VISAGE* finite-element geomechanics simulator to determine the spatial and temporal evolution of magnitude and azimuth of the in situ stresses, which were then used as input to model fracture propagation for the infill well. A final simulation combining the parent and infill well completed the workflow.

Operators optimize development strategies to minimize risks

The ability to model pressure depletion and the associated new stress state with respect to the time between production of the parent well and fracturing of the infill well was an integral part of the overall basin production strategy. The complex interaction between stress reduction, stress anisotropy, and stress reorientation with the DFN determined if newly created fractures will propagate toward or deflect away from the parent well.

In recognition that the UFM model workflow enables a deeper understanding of how to rationalize complex drilling and completion operations, several Eagle Ford Shale operators have selected Schlumberger to model the complex fractures and interwell interference. The Kinetix Shale software's stimulation design and modeling workflow has been used for subsequent development strategies, including optimization of infilling and refracturing programs, spacing of infill well laterals, and control of fracture propagation to minimize undesired fracture hits and other interferences.

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* Mark of Schlumberger
[1] Mark of Schlumberger; the INTERSECT simulator is a joint product collaboration of Schlumberger, Chevron, and Total.
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