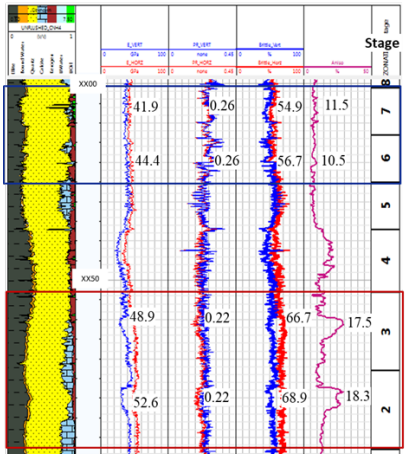
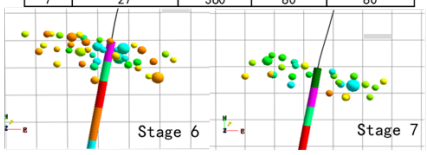
Interpretation and Evaluation Services

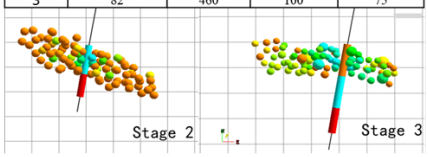
Identified Relationship Between Geomechanical, Artificial Fracture Features



Stage	Microseismic events	Length (m)	Width (m)	Height (m)
6	43	360	100	90
7	27	360	80	80



Stage	Microseismic events	Length (m)	Width (m)	Height (m)
2	87	460	100	70
3	82	460	100	75



Fractures in Stages 6/7 were quite small compared to Stages 2/3 even with similar mineral composition. The geomechanical parameters were the dominant reason to this situation. Stages 2/3 had higher Young's modulus, a lower Poisson ratio, and higher brittleness which are advantages for hydraulic fracturing. In Stages 2/3, the fractures grew longer radially along the borehole, and the formation was better fractured (more microseismic events monitored). The fracture heights of Stages 2/3 were smaller than in Stages 6/7 as the anisotropy in horizontal wells of a shale reservoir may restrict the fractures going vertical direction.

Objectives

- Run the CXD tool and compare the results with earlier logged microseismic data.
- Use the CXD logs to prepare an anisotropy model and calculate the geomechanical parameters along the entire horizontal drain.
- Prepare and optimize the stage fracking and perforation design to maximize the producibility for the shale gas reservoir.

Our Approach

- Weatherford personnel ran the super combo logging tools—MPD, MDN, MAI, CXD, MSG —in the horizontal well to conduct a shale formation reservoir evaluation.
- The data from the combo was used to calculate geomechanical parameters such as Poisson's ratio, Young's modulus, formation brittleness, UCS, horizontal stresses, and the fracture pressure.
- The microseismic monitoring results were used to determine the hydraulic fracture features such as fracture length, fracture height, fracture width, and the number of microseismic events of each stage.
- Weatherford experts researched the relationship between geomechanical parameters and artificial fractures and calculated the relevant geomechanical parameters for each fracture feature.

LOCATION
China

WELL TYPE
Appraisal

HOLE SIZE
8-1/2 in., open hole

DEPTH
15,059 ft (4,590 m)

PRODUCTS/SERVICES
- Interpretation and Evaluation Services
- Spectral gamma ray (MSG) tool
- Compact array induction (MAI) tool
- Compact photo density (MPD) tool
- Compact dual neutron (MDN) tool
- Compact borehole navigation (MBN) tool
- Compact cross-dipole sonic (CXD) tool

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Our Approach (continued)

- The research determined that the Poisson's ratio was negatively correlated to the fracture length, and microseismic events and stimulus volume were the most sensitive parameters to the hydraulic fracturing.
- The formation brittleness was positively associated with the fracture length and the microseismic events number.
- The anisotropy was negatively related to the fracture height in the shale gas formation.
- The experts successfully completed the petrophysical and geomechanical interpretations providing recommendations to the upcoming frac design.

Value to Customer

- Weatherford expert analysis based on the comprehensive results from Weatherford's logging tools enabled the customer to optimize the stage designs, keep the petrophysical and geomechanical parameters similar in each stage, and optimize the perforation placements and cluster spacing.
- The analysis also enabled effective prediction of hydraulic factures based on the geomechanical properties.
- The results enabled the customer to take proactive measures to control the developing of the fractures for each stage and optimize the fracturing fluid and proppant design.
- The gas production was 1.5 times of the adjacent horizontal well in which a CXD log was not run.