Case Study

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Real-time Microseismic Monitoring for Nexen's 143-Stage Multi-Well Horizontal Fracture Operation in the Horn River Basin

ESG performed real-time microseismic monitoring 24 hours a day during a 43-day 8-well hydraulic fracture stimulation for Nexen Inc. Engineers and geophysicists at Nexen were able to gain valuable insight into the behavior of fracture development, and make adjustments to fracture plans to optimize future projects in the Horn River basin.

Fig. 1: Location of the Horn River Basin in northeastern B.C.

The Horn River basin is located in northeast British Columbia, Canada, north of Fort Nelson and south of the border with the Northwest Territories and covering on area of approximately 4,200 square miles. The Horn River basin is part of a Devonian era sedimentary formation and contains gas rich shale layers including the Muskwa, Otter Park and Evie formations located at a depth of approximately 2500-3000 m and are approximately 150 m thick. Horn River shale contains high amounts of silica, making it easier to fracture than the Barnett shale, however at some depths the temperature can be as high as 140°C (284°F).

Background

The gas-rich shale found in the Horn River basin of British Columbia is accessed by drilling horizontal wells at depths of approximately 2500-3000m and performing multiple stage fractures along long laterals to release the trapped gas. Wells were first drilled in the area in 2005 and since then, the

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Horn River basin has been flagged as potentially the most substantial shale play in North America, citing an estimated 500 tcf of gas resource, of which 20% could be recoverable.

Challenge

Since the Horn River basin is a relatively new play, many operators can benefit from an increased understanding of how the shale behaves when subjected to fracture stimulations. An enhanced understanding will help improve and optimize fracture design for future projects. Microseismic monitoring is a reliable and cost-effective method to provide enhanced understanding of reservoir behavior in response to fracture stimulation.

ESG Solution

The goal of the microseismic analysis for Nexen's 143-stage multi-well fracture project was to observe how the reservoir accepted the frac fluid, paying particular attention to any fracture asymmetry, fracture azimuth and instances of vertical fracture growth.

Downhole geophone toolstrings were deployed in a variety of combinations in both the horizontal and vertical sections of the eight available wells. The program was designed to make use of production wells for microseismic observation and removed the need for dedicated observation wells to be drilled on-site. Microseismic data was acquired using arrays of OYO Geospace geophones ranging from 8-21 sensors.

ESG performed real-time around-the-clock microseismic monitoring of 143 fracture stages over a period of 43 days. A total of 144,057 microseismic events were captured using multiple near-vertical and horizontal sensor arrays, of which 40,858 were used for the microseismic analysis. 24-hour monitoring gave real-time images of fracture geometries and azimuths which engineers could use to verify frac models and optimize future stages.

A calculation of stimulated reservoir volume (SRV) also provided an estimate of the total volume of the reservoir which was effectively stimulated during the fracture treatment.

ESG also demonstrated proven tool survivability with sustained deployment in 140°C environments with no recorded downtime.

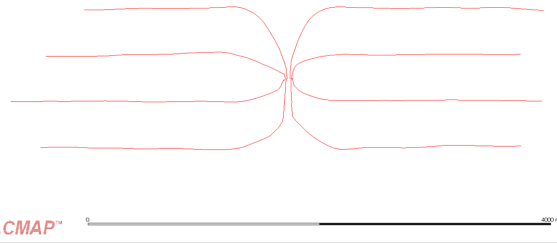

Fig. 2: Well design for a multi-well multi-stage hydraulic fracture (plan view).

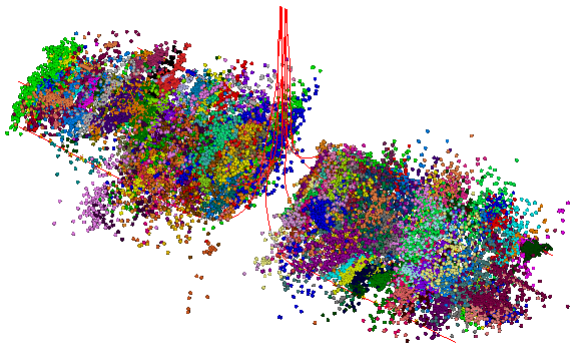

Fig. 3: Events located during an 8-well 143-stage hydraulic fracture operation. Events are coloured by fracture stage.

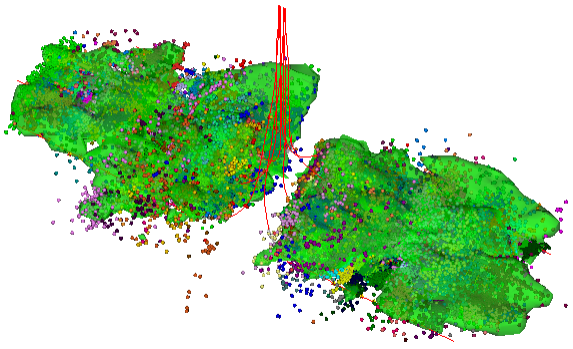

Fig. 4: Estimated Stimulated Reservoir Volume (SRV) for the multi-well fracture operation.

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