Can You Feel the Strain? DAS Strain Fronts for Fracture Geometry in the BC Montney Groundbirch

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Summary

The use of Distributed Acoustic Sensing for Strain Fronts (DAS-SF) is gaining popularity as one of the tools to help characterize the geometries of hydraulic fracs and to assess the far-field efficiencies of stimulation operations in Unconventional Reservoirs. These strain fronts are caused by deformation of the rock during hydraulic fracture stimulation (HFS) which produces a characteristic strain signature measurable by interrogating a glass fiber in wells instrumented with a fiber optic (FO) cable cemented behind casing. This DAS application was first developed by Shell and OptaSense from datasets acquired in Groundbirch. The most recent acquisition, along with new interpretations and analyses of previous datasets show how monitoring high-resolution deformation via FO combined with the integration of other data can provide high confidence insights about stimulation efficiency, frac geometry and well construction defects not available via other means.

Theory / Method / Workflow

In this case, we show examples of DAS-SF in wells stimulated for a variety of completion systems: plug-and-perforating (PnP), open hole packer sleeves (OHPS), as well as, data from a well completed via both ball-activated cemented single point entry sleeves (Ba-cSPES) and coil-tubing activated cemented single point entry sleeves (CTa-cSPES). By measuring the strain fronts during stimulation from nearby offset wells and where they occurred on the FO monitoring well, it is possible to determine characteristics of fracture geometry and stimulation efficiency.

Results, Observations, Conclusions

It was observed that most stimulated stages produced far-field strain gradient responses in the monitor wells and, when mapped in space, the strain responses were found to agree with and confirm the dominant planar fracture geometry proposed for the Montney, with hydraulic fractures propagating in a direction perpendicular to the minimum stress (figure 1). However, several unexpected and inconsistent off-azimuth events were also observed during the offset well stimulations in which the strain fronts were detected at locations already stimulated by previous stages. Through further integration and the analysis of multiple data sources, it was discovered that these strain events corresponded with stage isolation defects in the stimulated well, leading to "re-stimulation" of prior fracs and inefficient resource utilization. Strain front monitoring in the Montney has provided greater confidence in the planar fracture geometry hypothesis for this formation. The high resolution frac geometry information provided by DAS-SF away from the wellbore in the far-field has also enabled us to improve stage offsetting and well azimuth strategies. In addition, identifying the re-stimulation and loss of resource access that occurs with poor stage isolation also shows opportunities for improvement. This in turn, should allow us to optimize operational decisions to more effectively access the intended resource volumes.

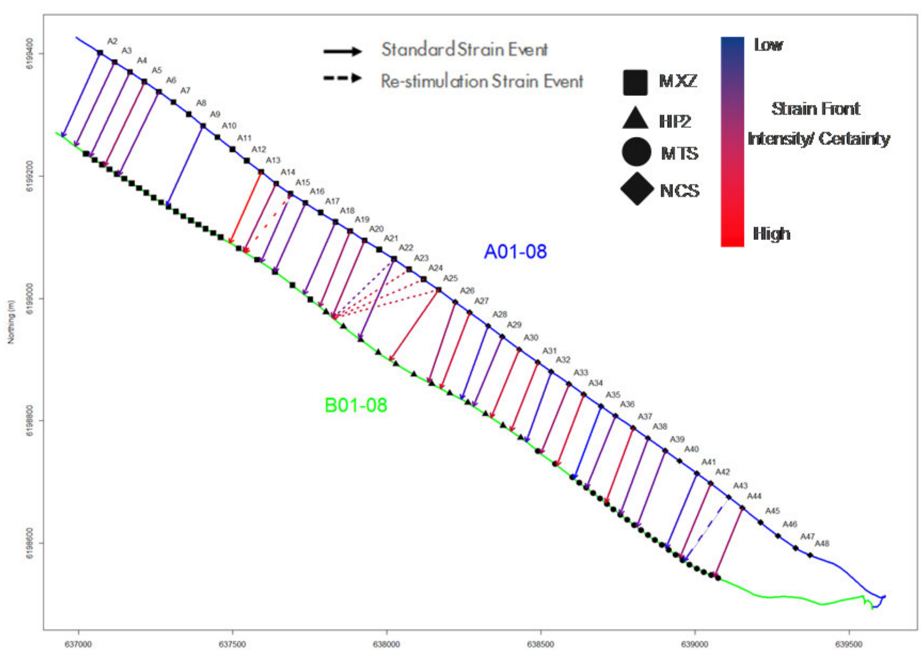

Figure 1. Spatial representation of strain fronts from A01-08 stimulation mapped to the B01-08 monitor well (plan view). Strain events suggesting re-stimulation due to poor isolation identified by dashed arrows, both in the ball and coil-tubing activated portion of the cSPE stimulated well.