geoconvention
Virtual Event
September 13 - 15
2021

Hydraulic Fracture Characterization using Distributed Acoustic Sensing

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Summary

Hydraulic fracturing operations in unconventional reservoirs are increasingly being monitored with fiber-optic Distributed Acoustic and Temperature Sensing (DAS/DTS) technologies. In this presentation, we discuss how a wellbore equipped with fiber optics and a DAS system can be used as a diagnostic tool to better understand the completions program of offset wells, the fiber instrumented well provides insight into the interwell reservoir characteristics. DAS can give a better understanding of reservoir and/or completions characteristics such as cluster efficiency, fracture azimuths, fracture lengths, and fracture heights. These parameters can be used to refine reservoir models and better estimate stimulated reservoir volume (SRV).

Theory / Method / Workflow

In this presentation we discuss the results of fiber optics deployed in two completions methods: 1) Fiber optic cabling deployed behind casing as a permanent monitoring array, and 2) Deployable fiber optic cable on wireline as semi-permanent array. Permanent fiber deployed during casing installation is the traditional choice for DAS monitoring. Permanent fiber has proven to be a valuable tool for measuring far field strain responses, near field hydraulic fracture profiling, microseismic response, and production monitoring (Karrenbach et al. 2017, Ugueto et al. 2018 and 2019). More recently, fiber deployed via wireline in offset wells allows for measurements to be made without the need of permanent instillations. Near field hydraulic fracturing profiling is no longer available, however far field strain, microseismic mapping, and potentially production monitoring is available.

Results, Observations, Conclusions

Here we present various DAS diagnostic tools that help better understand the completions program. A variety of physical effects, such as temperature, strain and microseismicity are measured and correlated with the treatment program to aid in the analysis. By monitoring crosswell communication (CWC) strain measurements we show that DAS can assess the treatment and performance of neighboring wells that are not instrumented with fiber optic cable. Low frequency strain events from neighboring wells provide direct measurements of the fracture density and possible fracture network post fiber well completion. CWC measurements can provide strain levels that can be analyzed in the context of the various completion parameters including stage length, clusters, and well spacing, etc. We also discuss the fluid and proppant allocations measurements that can be performed on the well with fiber installation. We show how DAS can be used as a tool for investigating cluster efficiency, diverter effectiveness, and for determining completions problems like screenouts and stage communication

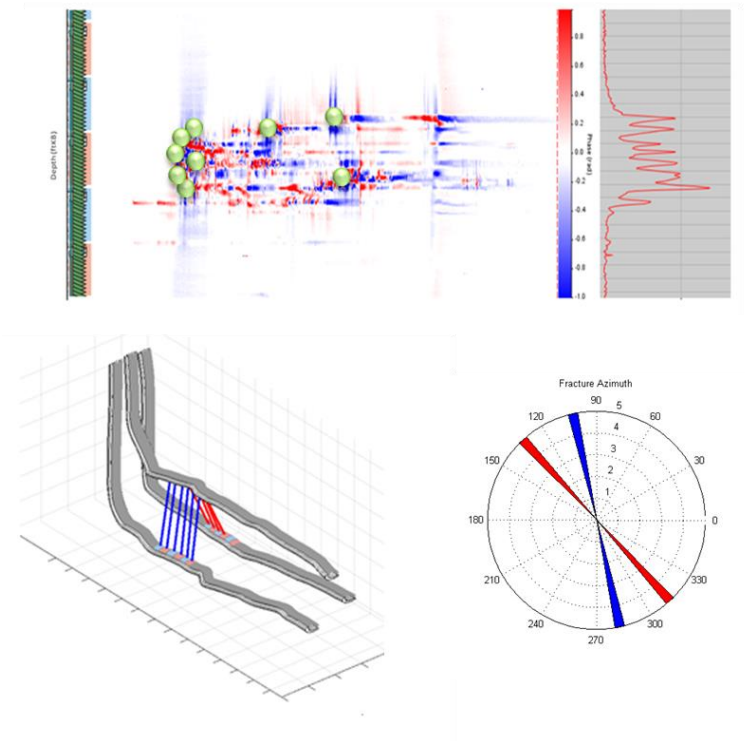

Figure 1 Top Image is a DAS waterfall display of fracture strain response from a neighboring well during a single stage completion. The summed strain is shown to the right. The bottom left image is the projected frac hits from two treated well. Bottom right image is the fracture azimuth of two completed wells.

Novel/Additive Information

The analysis of the DAS data demonstrates that current fiber-optic technology can provide enough sensitivity to detect a significant number of frac events that can be used for an improved reservoir description and as an assessment of the completions program.

References

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