Decimating a Microseismic Dataset: How Many Events are Needed to Properly Sample Hydraulic Fracture Stages with a Multi-Array Monitoring Program?

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GeoConvention 2012:Vision

Summary

Microseismic monitoring systems can be used to monitor the Completion phase of gas bearing shale development. The use of multiple geophone arrays in multiple boreholes allow for acquisition of large, detailed microseismic datasets. In turn these events can be used to characterize the reservoir, test wellpad designs, test completions techniques, optimize frac techniques, and ultimately enhance gas recovery. However, large monitoring programs are not always possible. This paper examines the decimation results of a large dataset to see if decimated datasets provide similar frac stage characterization.

Introduction

Microseismic monitoring plays an important role in the understanding of hydraulic fracture treatments and reservoir characterization. It is used for detection and placement of microseismic emissions induced in gas bearing shales. Large microseismic datasets are useful to characterize the microseisms generated by hydraulic frac treatments. However, large datasets are expensive and require multiple monitoring wellbores.

Methodology

In the summer of 2011, Nexen completed a multiwell hydraulic fracture program in the Horn River Basin. This program was monitored from multiple monitoring locations as close as 200m from the fracport and up to 1000m away. Multiple borehole arrays made up of multiple geophones were used to monitor over 70 frac stages. The microseismic acquisition program was designed to obtain a high quality, high quantity set of microseismic events. The standard processing deliverables were event location and error, moment magnitude, corner frequency, seismic energy, distance to each array, distance to frac port, and the source radius of the event. In addition, Seismic Moment Tensor Inversion was performed on a specific set of high quality events, and these deliverables include Moment Tensor (focal mechanism) plots, Source Type plots (Hudson Plot), deformation analysis, fault plane analysis, fracture sets, volumetric strain, and Stimulated Reservoir Volume estimation.

Using the microseismic events from a single frac stage, the geometric distribution reveals a stimulated microseismic volume. This event density and distribution of this event volume can affected by many variables including the method of acquisition, the proximity of the geophone arrays, attenuation, the Poisson's ratio of the rock. When the events are spatially and temporally decimated to simulate reduced event sampling, alternate microseismic interpretations are made depending on the geometric representation of the events. This in turn may validate or invalidate the accuracy of sparse sampled datasets.

Data

The collected raw data was harvested and examined for location and source parameters. Over 150,000 microseismic triggers were identified, and over 90,000 events were located. A high quality subset of 46,000 events was chosen and analyzed.

Acknowledgements

Thanks to ESG for their technical work and contribution to our project.

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