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The Effects of Optimal Positioning of Multiple Borehole Microseismic Arrays for Monitoring Hydraulic Fracture Treatments

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Summary

Reservoir characterization and hydraulic fracture programs can be optimized with the use of microseismic monitoring. The proper placement of multiple borehole microseismic geophone arrays allows for accurate event placement and conditions the events for advanced processing techniques. 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. Developments in microseismic monitoring and processing are providing new insights to better understand geomechanics the effects of hydraulic fracture stimulation.

Introduction

Microseismic monitoring of a hydraulic fracture stimulation program plays an important role of reservoir characterization. It is used for detection and placement of microseismic emissions induced in gas bearing shales. Optimizing geophone array design is a critical step to obtain a high quality data set.

Methodology

In the summer of 2011, Nexen completed a multiwell hydraulic fracture program in the Horn River Basin. This program was monitored from multiple borehole geophone arrays 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 optimized 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.

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. Moment Tensor analysis is to be performed on these events from 46 stages.

Results

Proper placements of the multiple geophone arrays are necessary (Figure 1): to provide high confidence hodogram solutions, to avoid shadow zones, to locate events accurately, to map the entire focal sphere for advanced processing and analysis. Array positions must be modelled to determine the feasibility of providing a location solution while minimizing uncertainty. Array modelling requires an accurate velocity model of the near wellbore geology.

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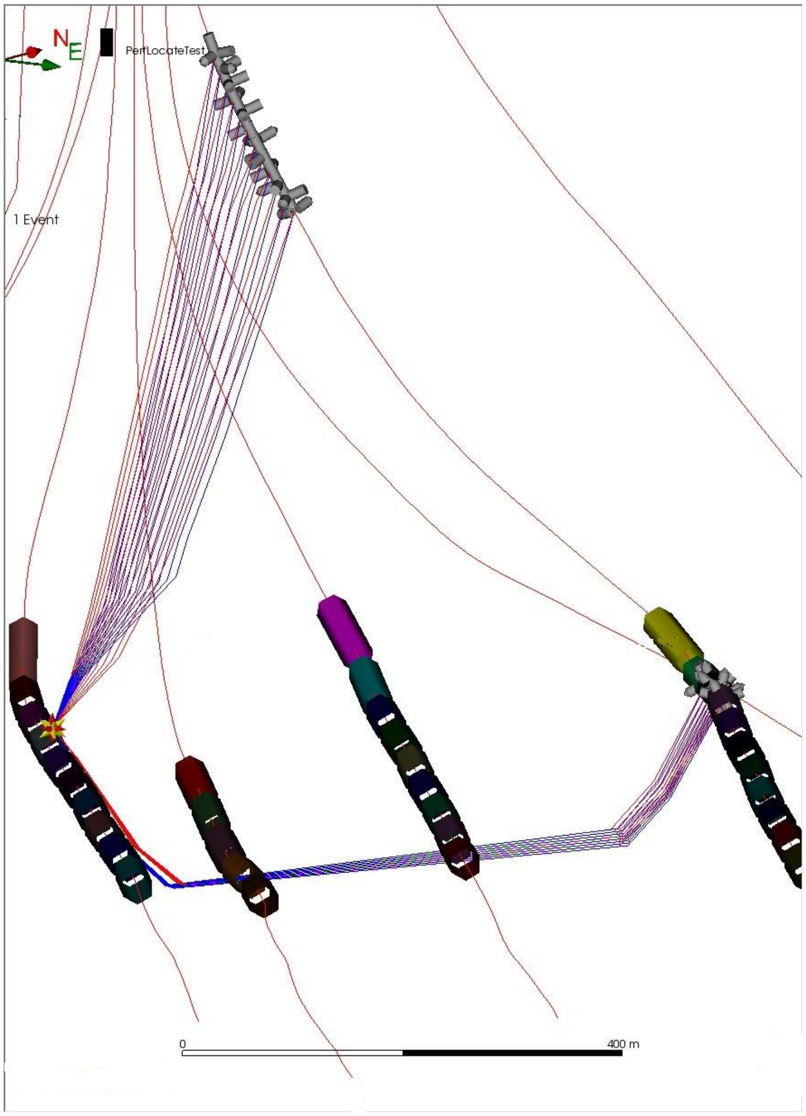

Figure 1: Raypath tracing of a perforation shot to offset geophone arrays