Case Study

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Higher confidence in event location accuracy provides better information on which to base cost-related decisions

ESG performed its 2nd look re-processing services on data acquired in the Barnett shale. By applying advanced processing techniques such as ESG's proprietary Particle Swarm Optimization (PSO) Analysis, location errors improved by 42% from the initial processing results. The new velocity model accurately reflected geological structures.

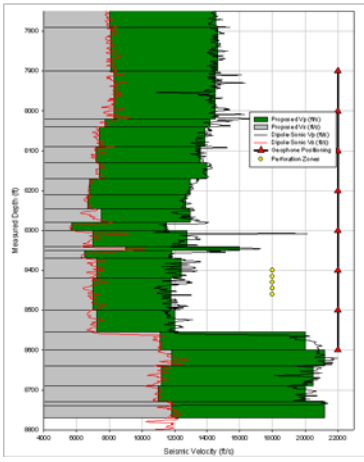

Fig. 1: Initial velocity model

During hydraulic fracture operations, increasing pressures, fluid concentrations and resulting fracture growth through the rockmass will inevitably alter the geophysical characteristics of the reservoir. In particular, P- and S-wave velocities can change dramatically over time. Commonly, velocity models first developed prior to the treatment no longer accurately reflect the reservoir and higher location errors are observed for later stages.

Challenge

A client operating in the Barnett shale received very poor event location results from a microseismics company for a 14-stage hydraulic fracture treatment. ESG was chosen to reprocess and analyze this data which was originally recorded from one vertical 8-level observation well.

In total, 2905 events were located over 14-stages using a Simplex based azimuth ray tracing approach and a velocity model was derived from a dipole

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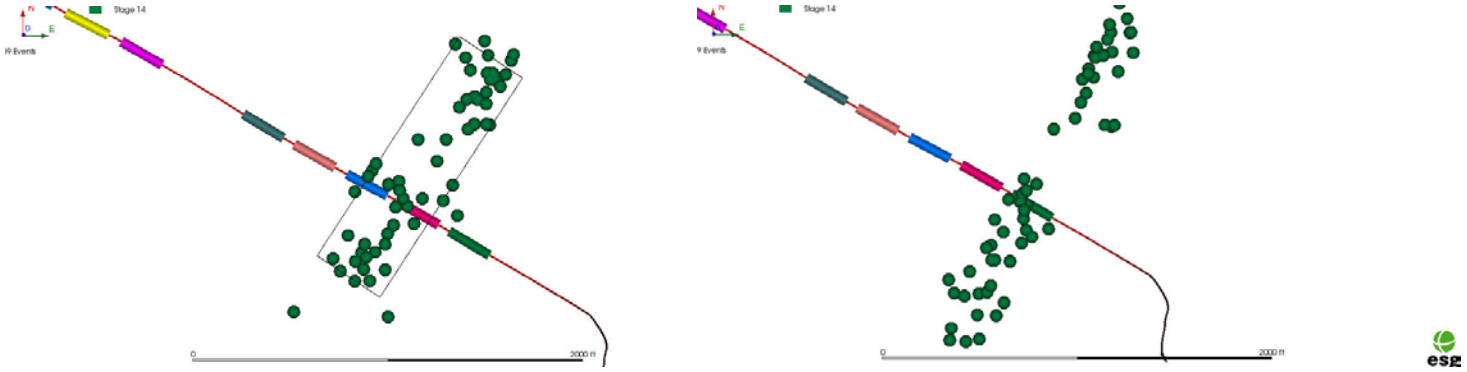

Fig. 2: Example of events from stage 14: (left) events locating out of zone using the initial velocity model and (right) events locating in-zone after the PSO method is applied to the data and the velocity model is adjusted to account for the geological structure between stages 9 and 10.

sonic log in the observation well. Initial velocity models did not appear to properly account for a geological structure located between stages 9 and 10. While events for stage 9 located accurately, events for stages 10-14 were locating out of zone, while still accurate in terms of depth and delineation. As well, increasing location error was observed with increased distance from the observation well.

ESG Solution

ESG performed two separate velocity inversions using the proprietary Particle Swarm Optimization (PSO) method. PSO is a stochastic optimization technique that accounts for changes in velocity by iteratively inverting locations and velocity structure until it converges on a solution that minimizes the residuals of the given events.

The first inversion made use of known locations from a perforation shot. The second inversion further refined event locations and velocity model to account for distance from the observation well.

Incorporating the velocity changes calculated by PSO into the velocity model resulted in event locations with much higher confidence than in a previous analysis. Improved source locations resulted in a more clear understanding of the resulting fracture dimensions and orientations for the treatment.

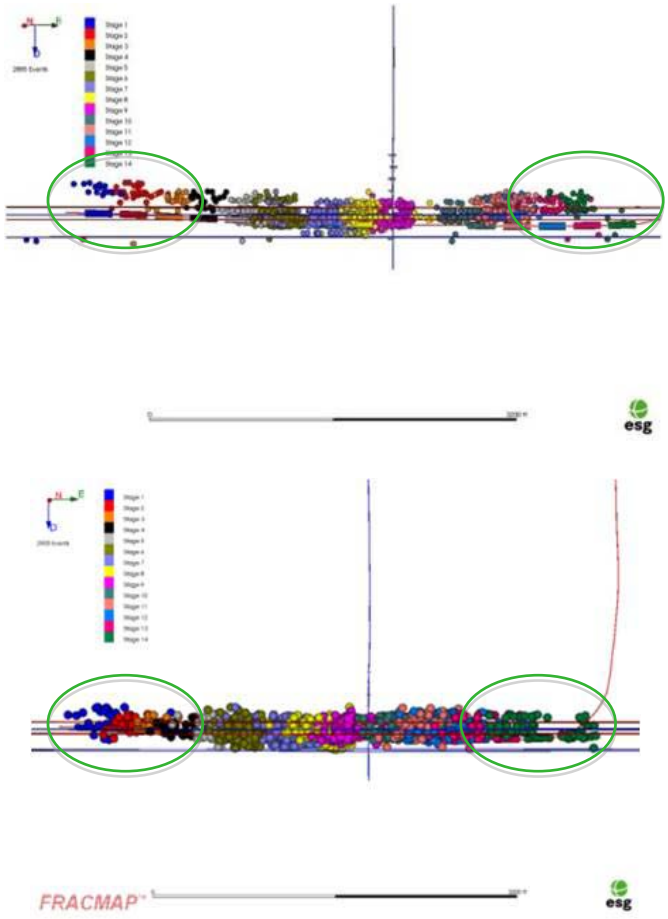

Fig. 3: Example of events for all stages of the fracture treatment: (top) before PSO is applied and (bottom) after PSO is applied

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