Microseismic Measurement of Fracture Geometry using Synchronized Three Component Geophone Extended Arrays

James E. Wolfe*
BP, North America Gas, Calgary, AB, Canada
wolfeje@bp.com

and

Shawn Maxwell and Ulrich Zimmer
Pinnacle Technologies Inc., Calgary, AB, Canada

The Flow of Novel Geophysical Technologies

Hydraulic fracturing of reservoirs creates a seismic source for recording microseismic events up to 100's of meters from hypocenter in borehole passive seismic recording monitor wells. These mapped microseismic hypocenters measure the three dimensional fracture geometry created by the hydraulic fracture procedure in the treatment well.

A North American gas reservoir microseismic test incorporated a 22 node three component geophone array in two monitor wells spaced 1100 meters apart and synchronized with a fiber optic cable connection. In the horizontal treatment well, the geophones were above the interval of interest. A stringshot was performed to orient the geophones and to calibrate a velocity model for the formations through which the microseisms would travel.

Microseismic mapping (Waltman, C., et al., 2006) and treatment results indicated multiple fractures propagated from the horizontal well in a 70° direction relative to the horizontal treatment well. Half-length and vertical measurements indicate that much of the horizontal well was stimulated, although the fracture half-length does appear to decrease from the heel to the toe. The farthest part of the toe may be under-stimulated as the microseismic activity drops off there. The fracture height is quite uniform over most of the length of the wellbore but appears to be less at the toe.

Dual array microseismic solutions show an improved definition of fracture geometry by reducing the scatter of hypocenters both in map view and in vertical cross section. Focal mechanisms and fault plane solutions mapping confirm a 70° azimuth direction relative to the treatment well is the most likely failure plane.

References

Waltman, C., Warpinski, Norm and Heinze, Jim, 2005, Comparison of Single and Dual Array Microseismic Mapping Techniques in the Barnett Shale: SEG International Exposition and Seventy-fifth Annual Meeting, Expanded Abstracts, 1261-1265.