Please fill in the name of the event you are preparing this abstract for.	International Petroleum Technology Conference
Please fill in your 5-digit IPTC manuscript number and IPTC Control number.	Top Rated Paper from IPTC Sponsoring Societies
Please fill in your abstract title.	Microseismic Event Location Using Direct and Reflected Waves

Please fill in your author name(s) and company affiliation.

Given Name	Surname	Company
Nidhal	Belayouni	Baker Hughes, a GE company

Abstract

Objectives/Scope:
The objective of our study is to enhance the location accuracy of microseismic event from borehole acquisition configuration. In order to achieve a better location, we add the reflected P-wave phase in the calibration and location process. We illustrate the performance of our multi-phase event-location technique on a field data set acquired in the hydraulic-fracturing context.

Methods, Procedures, Process:
Two important factors drive the precision of the hypocenters of the microseismic events: the quality of the modeled traveltimes and the effective aperture of the recording network. In this study, we focus on improving the two aspects mentioned above. First, by adding the reflected P-wave in the velocity model calibration, we increase the constraints and avoid falling into secondary minima. The second part consists in the enhancement of the effective data-acquisition aperture for the location porpose. We achieve this through adding the secondary wave arrival used in the calibration and recorded by the same sensor network.

Results, Observations, Conclusions:
To apply this approach, it is important to identify the reflected phases in recorded data, determine the reflector generating them, and accurately measure the traveltimes of both direct and reflected waves. Once this achieved by analyzing the data and comparing to synthetic seismograms computed in similar models, we proceed to the calibration and location phase.

We calibrate two sets of velocity models using different random initializations. In the first set, we use only the direct P- and S-wave traveltimes and add the reflected P-wave for the second set. The analysis of the variation of the velocity and anisotropy parameters show a better constraint when using the additional reflected P-wave in the calibration process.

When located using the direct P- and S-wave arrivals, the microseismic event hypocenters extend vertically by over 100 m around the injection point. The vertical dispersion of the microseismic events is drastically reduced when located with direct and reflected waves indicative of a contained upward growth of microseismicity from the perforations in the treatment well towards the top of the formation. The differences between the two event populations illustrate the influence of the ray aperture at event sources on the propagation of noise into the estimated hypocenters.

Novel/Additive Information:
In this study, we investigated the contribution of the reflected waves to two important aspects in the monitoring of microseismic events. We built a better velocity model for the reflection path and increased the effective aperture of the monitoring network by including the reflected traveltimes in the location process.