Microseismic Event Positional Uncertainty

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Abstract

Microseismic monitoring has emerged as one of the top methods to confirm the effectiveness of stimulation activities in shale oil and gas plays. Stimulation effectiveness is defined by the fracture conductivity that results from the treatment. With passive seismic methods, microseismic events are detected from seismic data acquired via borehole, near-surface, and surface-based arrays of seismic receivers. The resulting microseismic event location or position resolution and uncertainty remains one of the most critical aspects of passive seismic for the user community. Uncertainty for a migration based approach to surface and near-surface microseismic monitoring occurs in two ways: uncertainty in the validity in detected event and uncertainty in the estimated position of the event. Synthetic modeling and comparison to case studies show that sign-to-noise-ratio is a key indicator of both types of uncertainties.

In order to have confidence with "beyond the dots" microseismic applications such as hydrofracture length, height, and stimulated rock volume calculations, it is crucial to understand the inherent capabilities, limitations, and drivers for event locations from downhole, surface, and near-surface microseismic acquisition geometries. These capabilities, limitations, and drivers are reviewed for both the downhole and surface acquisition methods. Any mitigating actions enabled from the consideration of microseismic uncertainty depends on operator willingness to consider engineered stimulation approaches to hydrofracturing rather than the "factory mode" approach. Engineered stimulation is enabled by independent information on stimulation effectiveness.