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Dots in a box transcended: Strategies for integrating microseismic data with geomechanics and reservoir models

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Summary

The microseismic (MS) response to hydraulic fracturing depends on a host of parameters. Although it is well established that MS response is strongly dependent on treatment parameters, such as viscosity of the fracturing fluid, pressure, injection rate and proppant concentration, the relationship of microseismic response to geomechanical properties and reservoir characteristics is less well understood. In particular, the following reservoir parameters are thought to play critical, but as-yet poorly quantified, roles: in situ state of stress, including stress anisotropy and laterial stress gradients; pore-fluid pressure; density, geometry, and cementation of pre-existing fracture systems; and surface-energy parameters for formation of new fractures.

At a minimum, MS observations include the origin times, hypocentral locations and event magnitudes, which are used to estimate the length, height, azimuth and complexity of activated fractures, as well as anomalous behaviour such as induced seismicity. Microseismic observations are often enriched with moment-tensor (MT) parameters or MT proxies such as S/P amplitude ratio. Important but underutilized constraints are also available from statistical analysis of microseismicity and its spatio-temporal evolution, spectral characteristics of the radiated energy including low-frequency tremor signals, and temporal variations in path effects due to seismic anisotropy and attenuation.

Integration of microseismic observations with geomechanical simulations, DFIT analysis, other fracture-diagnostic data such as tiltmeter observations, and seismic-derived attributes, offer significant potential for enhancing the integration of microseismic data with reservoir models, mapping propped fractures after stimulation, and inferring flowback and production parameters.