GeoConvention
Calgary • Canada • March 7-11 2016
OPTIMIZING RESOURCES

The Signature of Proppant in Microseismicity

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Introduction

Hydaulic fracture monitoring with microseismicity is becoming an increasing used tool to answer engineering design questions about the completions of horizonal wells in shale reservoirs. Inferring the geometry of the hydraulic fracture distribution from event locations has become standard, even though it is often recongnized that there can be a number of seismogenic processes in the reservoir and distiguishing fluid-induced seismicity from stress driven processes (often posed as “wet” vs “dry”). These methologies offer promise to determining directly the region of fluid influence during the completion. However, the question that is of more relevance is to determine the propped volume, the region of the reservoir where proppant has penetrated into the fractures opened during the stimulation.

Often it is assumed that the events that occur during the proppant injection are propped, that is that the proppant is directly involved in the source region of these events. However, the injection of proppant has a perhaps counter-intuitive response on the progression of the hydraulic fracture: event rates tend to decline and propagate further out from the perforations. This is in contrast to the events observed during the pad stages of the fracturing, that are close to the perforations with relatively high rates. We suggest that the proppant is effectively being deposited in this pad region, and in contrast the events during the proppant stages are responding to stress perturbations induced by the proppant injection pushing fluids to the extremities of the fracture (as interpreted from the event distribution). To validate this hypothesis, we examine the source parameters and mechanisms of the events recorded during the pad and proppant stages to highlight the regions most effectively responding to fluid and those events responding to stress activation.