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Using Microseismic Observations in Unconventional Plays to Influence Well Spacing and Stage Spacing Decisions

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Abstract

Hess Corporation has recently collected and analyzed microseismic data sets that have direct impact on two of the most important decisions needed for efficient development of unconventional plays: 1) well spacing and 2) stage spacing. By pumping in and around depleted wells, we have observed microseismic events that highlight the area of depletion around a producer well. Pressures recorded during these operations are low enough to ensure that these events lie within the depleted section, and are not so high as to be shearing or fracturing the undepleted rock. We have previously described this method, which we term microseismic depletion delineation, MDD, for a case in which a nearby infill well fractured into the old producer, simultaneously pressuring up the depleted wellbore and its connected fracture system, causing multiple shear events. This year, in two separate MDD experiments, Hess successfully invoked shear slips by pumping into producer wells at low pressures and rates to delineate depletion while monitoring for microseismic events. These depletion footprint maps are important for our analysis of development well spacing in the Bakken.

Hess Corporation is also actively performing microseismic monitoring in the Utica Play in eastern Ohio at various multi-well pads. Having learned from the Bakken, that depletion greatly affects the formation of nearby hydraulic fractures in subsequent development wells, we have drilled multi-well pads in the Utica Play that will be completed and produced simultaneously. Analysis of microseismic observations from these pads shows evidence of fracture interaction attributable to stress shadowing that will impact our understanding of completion stage spacing. Multiple wells have been analyzed using depth histograms of microseismic activity representing distance relative to the wellbore. We find that a regular pattern emerges whereby closely spaced stages appear to "bounce" slightly out-of-zone in a repeating pattern along the borehole. Using a simple model for the changes in stress resulting from the introduction of a single crack, we suggest that the bounces are a result of diminishing stress contrast at the boundaries of induced fractures that allows them to escape out-of-zone. We show recent examples of this pattern which we hope will lead to improved fracture models while optimizing the cost/benefit ratio of adding stages to a wellbore.