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Pore scale modeling of acoustic events

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It is well established that acoustic emission is generated during hydraulic fracturing. Acoustic emission is used to find the volume effected by hydraulic fracturing, which is known as stimulated rock volume (SRV). Understanding the flow and transport properties of SRV is important as it effects the EUR of the oil reservoirs. In this study we analyze the change in permeability, an important transport property, using pore scale modeling of the acoustic events.
We conducted a hydraulic fracturing experiment on a block of sandstone in the lab and recorded the acoustic emission events generated during fracturing; the hypocenters of the acoustic emission are the positions where fracturing occurs. Then we integrated the acoustic emission data into a physically representative network model of the sample, which has a unit volume. The network model is a theoretical pore scale model with a 2D lattice geometry, where the pore space is characterized by a network of capillary tubes. We generate multiple such networks with different number of acoustic events integrated into it, so that we can capture all the different acoustic event density, the number of acoustic events per unit volume that occurs in the sample block during fracturing. We solve and upscale the pore scale network to predict the core scale permeability.
We hypothesize that if the acoustic event density at any location in the sample block is below a certain threshold value, we can predict the change in transport properties, such as absolute permeability compared to intact conditions using the principles of percolation theory. To test our hypothesis, we compare the predicted results with lab measurements. The permeability measurements (data) are obtained on core plugs that are extracted from the sample block after fracturing.

Our results indicate that in regions where the acoustic event density is below the threshold, there are only isolated fractures that are poorly connected, therefore there is no change in absolute permeability compared to intact conditions. But in sample region where this acoustic density is above the threshold value, there are enough fractures present for a percolation spanning cluster to occur. Hence, this region of the sample contains a macroscopic fracture that results in high permeability compared to the intact conditions.

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