Factors Influencing Whether Induced Hydraulic Fractures Cross Pre-Existing Discontinuities

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Hydraulic fractures are generally modelled as simple, planar, tensile fractures that propagate away from the wellbore in a plane that is perpendicular to the minimum principal stress. A hydraulic fracture mine through experiment at Northparkes, carried out in a naturally fractured rock, documented fracture branching and offsetting interactions. As the hydraulic fracture approaches pre-existing discontinuities it may dilate the discontinuity or form a new fracture on the other side of the discontinuity. Therefore the induced fractures have a more complex shape than predicted by planar models. We have studied the interaction of hydraulically induced/pre-existing fractures in our laboratory to help in designing effective hydraulic fracturing jobs.

Existing criteria that are used to predict whether or not the hydraulic fracture will cross the pre-existing discontinuity are based on simplified stress distributions on the interface and require information difficult to obtain (Blanton) or were developed using non-hydraulic loading (Renshaw and Pollard).

Our laboratory and theoretical study was conducted to extend Renshaw and Pollard's and Blanton's work. Fluid viscosity effects were considered, as they were shown to play a significant role at the beginning of the interaction and have been postulated to be important in crossing mechanics.

Our experiments were designed to produce fracture growth in regimes dominated by either viscous dissipation or by rock fracture toughness. The results show that the higher fluid viscosity in a medium-low permeable environment resulted in fracture propagation through the pre-existing discontinuities that were not crossed when a low-viscosity fluid was used.