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Please fill in your abstract title.	Initiation of Stimulation Treatments Depends on Wellbore Mechanical Responses During Drilling

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Abstract

Objectives/Scope:

The initiation of a hydraulic stimulation is essentially a continuation of the set of processes that occur during well construction, where the creation of an opening causes a major change in stress state, and may involve rock deformations affecting the wall of the wellbore. Mudweight and other causes of pressures in the wellbore (such as stimulation) affect the wellbore diameter, which is well known, but it is not always recalled that these modify a situation that already has been changed by the drilling.

Methods, Procedures, Process:

We describe numerical simulations of these near-well geomechanical processes, using a method that is based on a combined finite-discrete element formulation. The numerical method treats the model domain as a continuum (or a continuum partitioned by pre-existing discontinuities), and allows fractures to develop along any of the faces of the finite elements, with composite fractures able to grow into large and complex configurations.

Results, Observations, Conclusions:

Depending on the far-field stress state and the selected material properties, our simulations of the drilling phase develop ‘cycloidal’ fracture arrays that lead to borehole elongation in the far-field minimum stress direction. Those arrays are geometrically comparable to the fracture patterns in published physical experiments. However, in the simulations, they develop in an episodic fashion, altering the near-well stress states in a series of steps. Simulations with overbalance or stimulation loads result in deformation processes that affect the wellbore wall area aligned with the maximum far field stress. Except with the strongest and stiffest rock properties, the fractures in this region (near but not on the axis) initiate and develop mainly as shears, contrasting sharply with the received wisdom for what is expected. Analysis reveals that the reason for the shear-dominated response is because the shear fractures and related changes in elastic strain relieve a much larger quantity of prior elastic energy, compared to a much smaller reduction related to the opening-mode fracture normally said to occur in this position.

Novel/Additive Information:

An unexpected "discovery" from this work is that the classical way of undertaking an analysis of wellbore geomechanics - namely to use a model with a pre-existing hole - leads to results that are very different to those which are derived from simulations that create a hole within a pre-loaded domain. The differences in well-edge stresses range to factors of 2+ over-estimates of hoop stress, if calculated with a pre-existing hole. Further investigation has shown that the classical analytical expressions often used in these analyses are not a correct solution to the elastic problem they purport to solve. Our results challenge the standard practices in an important aspect of geomechanics, which has historically been founded on ideas using simple models and continuum-based thinking.