GMP09

Rock Rheology, In Situ Stress and Fracture Interface Mechanics as Controls on Retained Fracture Conductivity in Prospective Unconventional Reservoirs

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SUMMARY

Unconventional resource plays encompass a spectrum of reservoir types that rely on effective fracture stimulation for economic success. Over the lifecycle of these wells, the success of the fracture stimulation is often dependent on the retention of production from induced or stimulated fractures. This fracture productivity retention is a primary goal of stimulation design in unconventional plays and requires a geomechanical understanding of the interplay between in situ stresses, rock rheology and fracture interface mechanics. Pre-frac diagnostic testing, laboratory testing and modeling studies provide a cost-efficient way to give a geomechanical context to our understanding of a play. We will show examples of how an understanding of the rheology of a rock can improve our understanding of laboratory studies of propped and unpropped fracture conductivity. In these examples measurements of viscoelastic-plastic rock behavior are used to develop analytical and numerical models of rock constitutive behavior. In this way we can differentiate between the impacts of mechanical and chemical processes on the measured conductivity of fractures in the laboratory. The character of rock-proppant-fluid interactions can thus be assessed quantitatively to better understand how significant each conductivity damage mechanism is to the productivity of fractures in the field.

This topic will be discussed here using case study examples from the emerging Duvernay Shale play in Alberta, Canada. Several contrasting examples from unconventional plays in North America are used to illustrate the dependence of retained fracture conductivity on the appropriate matching of rock rheology and in situ stress conditions to stimulation and production strategies.

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Rock rheology, in situ stress and fracture interface mechanics as controls on retained fracture conductivity in prospective unconventional reservoirs.

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Abstract

Unconventional resource plays encompass a spectrum of reservoir types that rely on effective fracture stimulation for economic success. Over the lifecycle of these wells, the success of the fracture stimulation is often dependent on the retention of production from induced or stimulated fractures. This fracture productivity retention is a primary goal of stimulation design in unconventional plays and requires a geomechanical understanding of the interplay between in situ stresses, rock rheology and fracture interface mechanics. Pre-frac diagnostic testing, laboratory testing and modeling studies provide a cost-efficient way to give a geomechanical context to our understanding of a play. We will show examples of how an understanding of the rheology of a rock can improve our understanding of laboratory studies of propped and unpropped fracture conductivity. In these examples measurements of viscoelastic-plastic rock behavior are used to develop analytical and numerical models of rock constitutive behavior. In this way we can differentiate between the impacts of mechanical and chemical processes on the measured conductivity of fractures in the laboratory. The character of rock-proppant-fluid interactions can thus be assessed quantitatively to better understand how significant each conductivity damage mechanism is to the productivity of fractures in the field.

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Figures:

- Core-calibrated log: full mechanical properties
- Comparison of several log derived stress profiles with minifrac and borehole breakout derived in situ stress constraints
- Measured conductivity vs stress plots
- Creep strain plots
- Standard triaxial test plots
- Viscoelastic-plastic FEM results of embedment process
- Fines generation analysis and SEM images
- Comparison between shale and tight carbonate issues