Supporting Data: Creep Properties of Shale and Predicted Impact on Proppant Embedment for the Caney Shale, Oklahoma

Data associated with RMRE paper titled "Creep Properties of Shale and Predicted Impact on Proppant Embedment for the Caney Shale, Oklahoma"

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Summary

As part of characterizing the material properties of the Caney shale, core sample experiments generated data from unconfined, triaxial, and creep testing. This data is presented in the paper and the impact of these properties on fracture closure and proppant embedment are discussed. The data presented includes axial and radial strain for single-stage triaxial testing conducted at 3000 psi confining pressure, including the correlating Young's modulus, Poisson's ratio, Friction angle, and Cohesion. Friction angle and Cohesion are also presented with the measured maximum strength of the samples with respect to different confining pressures. Additionally, the creep compliance over time is presented for the multiple load/unload stages of creep testing, with specific attention paid to the 72-hour loading stage and the corresponding power-law estimations of creep compliance over time.

From analysis of the data, it was found the unconfined and triaxial properties were insufficient to differentiate the nominally ductile zones from the nominally brittle zones. Zones which experienced more creep deformation over time, a ductile behavior, did not have the corresponding low Young's modulus which would be expected. While the ductile zones did have lower unconfined compressive strength than the reservoir zones, this metric is not a reliable indication of ductility as other factors such as the presence of internal conglomerations could impact these results. To properly describe the behavior of a given formation, unconfined, triaxial, and creep testing are required, and only creep testing is capable of differentiating between ductile zones, which will undergo more creep, and brittle zones.

Detailed results and analyses are provided in the corresponding paper. This document serves as a Readme file for the supporting data.

Data Files in this Archive

This archive contains 4 files with data for figures 10 through 14, labeled according to the figure the data is presented in. Each file is an excel file with multiple pages.

- Figure 10 is the plot of axial and radial strain vs stress for the 3000 psi confined samples
    - The first page of the file is the graph
    - Subsequent pages contain the load frame data for each sample
    - Load frame data includes
        - Sample dimensions
        - Time for test
        - Applied axial stress
        - Load frame piston position
        - Applied axial load
        - Microstrain from strain sensors
        - Calculated axial and radial strains from the strain sensors as well as the axial stress from the crosshead displacement
        - Percent of maximum stress applied to the sample (used to determine range to calculate Young's modulus and Poisson's ratio)
        - Range start/end (as % of maximum stress) for Young's modulus and Poisson's ratio calculations
        - Individual and average Young's modulus and Poisson's ratio values from the strain sensors and the crosshead (average does not include the crosshead calculation)
- Figure 11 and Figure 12 present the data used to generate the corresponding figures. As it is difficult to determine exact values on the graphs, the raw data is presented to the left of the graphs. This file contains only the single page.
- Figure 13 provides the creep compliance for all stages
    - The first page contains the graph presented in the document
    - Subsequent pages contain data from the load frame and strain sensors
        - Note the strain sensors were not used in the analysis due to the deterioration of the adhesive during testing
    - Strain data for each sample includes
        - Sample dimensions
        - Offset values for LVDT strain to set reference point at the end of the hydrostatic stage
        - Time for test in seconds and in hours with the date and time of the test
        - Applied axial force in pounds force
        - Displacement of the piston from the load frame (in inches)
        - A voltage used to monitor the power supply to the LVDTs as a quality control measurement
        - Displacement measured by the LVDTs in inches
        - Time stamp from the strain data acquisition box
        - Strain from the strain sensors in microstrain
        - Calculated axial stress in MPa
        - Axial displacement of the piston and LVDTs in mm

            - Calculated strain from the LVDTs and sensors, with averages for all 3 LVDTs and 4 strain sensors
            - An adjusted time used to align the curves for graphing
                - Calculated using the time the sample took to begin the first 20-minute load, with an extra 1000 seconds added to the front to buffer the time so the log scale would be more readable
            - Creep compliance
            - Adjusted creep compliance, which shifts the compliance to be zero at the end of the hydrostatic phase
                - Calculated at the point in time just before the 20-minute load cycle
            - Strain component markers to indicate the end of each loading stage of interest
                - Includes offset time and adjusted compliance from raw data, time points were obtained during analysis
- Figure 14 plots the 72-hour data and power laws
    - The first page contains the graph and power-law fit for each
    - The second page contains the 5-year power law graph for each of the samples using the power-law fit from the first graph
    - The third page contains the data to generate the 5-year graph, with the power-law equations at the top, time for each zone in years and seconds, and the calculated compliance at each data point
    - Additional pages contain the raw data for the 72-hour graph
        - This is the same data from Figure 13, only with all data prior to the 72-hour loading stage removed

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