**Supporting Data: Core-Based In-Situ Stress Estimation for Utah FORGE Well 16A(78)-32 using Triaxial Ultrasonic Velocity and Deformation Rate Analysis**

**Data associated with Milestone 2.1.1 of Utah FORGE project 2439: A Multi-Component Approach to Characterizing In-Situ Stress at the U.S. DOE FORGE EGS Site: Laboratory, Modeling and Field Measurement**

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# Summary

Core-based methods for in-situ stress estimation were applied using samples from 5 intervals within the Utah FORGE 16A(78)-32 well. At three of these locations, Triaxial Ultrasonic Velocity (labTUV) tests were performed, resulting in experimentally-determined relationships between wave velocities and stresses. Non-monotonic increase in the velocity-stress relationships are inferred provide evidence of stress history and are therefore used to estimate in-situ stress magnitudes. Additionally, Deformation Rate Analysis (DRA) tests were run on core plugs from various orientations at each of the 5 sampling locations. These, too, provide evidence of stress history based on stress-strain behavior. A novel Weight of Evidence (WoE) method was developed as a means of synthesizing in-situ stress evidence from these two types of tests. Results indicate the minimum horizontal stress gradient ranges from 0.58 psi/ft to 0.69 psi/ft, with 4 of the 5 values between 0.66 psi/ft and 0.69 psi/ft. The vertical stress gradient ranges from 1.05 psi/ft to 1.12 psi/ft, with 4 of the 5 zones given results between 1.09 psi/ft and 1.12 psi/ft. The maximum horizontal stress gradient ranges from 0.98 psi/ft to 1.34 psi/ft, with 4 of the 5 zones falling between 0.98 psi/ft and 1.24 psi/ft. The stress regime thus appears to be on the edge between normal faulting and strike-slip faulting, potentially flipping back and forth between the two regimes due to variability of rock properties, structures such as faults, and/or thermal anomalies. Only near the toe of the well does the regime appear to be clearly strike-slip with the best estimate of maximum stress gradient at 1.34 psi/ft. However, only a few meters away but in an apparently quite different composition and fabric of rock, the maximum stress gradient is 1.05 psi/ft. Additionally, the only unit that is very clearly in normal faulting regime is the Lower Granitoid, but it also has a unique fabric and lower stiffness compared to the others. The picture that emerges is of higher and lower stress zones in terms of the maximum horizontal stress. With that said, projecting the rate of increase of maximum stress for the lower stress zones implies that even these might become strike-slip below a depth of about 2700 m. Finally, although the confidence level is not very high, there is some evidence from the inclined core taken from the Gneiss near the toe of the well that the minimum horizontal stress orientation is dipping by 20 degrees or more from the horizontal. This could be indicative of the impact of nearby structure(s) and/or thermal anomalies. Such in-situ stress inclination could cause the hydraulic fracture orientation to deviate noticeably from vertical.

Detailed results and analyses are provided in the corresponding report for Milestone 2.1 (Bunger et al. 2023). This document serves as a Readme file for the supporting data.

# Data Files in this Dataset

This dataset contains data for labTUV and DRA for Utah FORGE well 16A(78)-32.

Within the labTUV data archive, there are four folders:

* 16A\_78\_32\_waveforms: Contains raw waveform data for each of the 3 zones tests. Each zone has a “round 1” and “round 2”, owing to there being two loading cycles, one for each shear wave polarization (as detailed by Bunger et al. 2023). For each, there are:
	+ \*.DTA files, which are the binary files that can be used to replay each test on Mistras AEWin software.
	+ \*.TXT files, which present the trigger times for each channel.
	+ \*.csv files, which give the waveform data.
	+ All of these follow a naming convention with four parts:
		- Indication of loading combination, x#\_y#\_z#, where the “#” indicates the load in each direction, in MPa.
		- Indication of shear wave polarizations captured by each loading configuration, i.e. “xz\_yz\_zx” indicates that the transducers are oriented to obtain vxz, vyz, and vzx (as well as the corredponding p-waves).
		- The direction of propagation for the direct pitch-catch for each test (\_x\_, \_y\_, or \_z\_).
		- For waveforms, indication of the recording channel (7-12), where correspondence of channel to x, y, or z direction can be ascertained from the summary files.
* Directories of summary data for each of the three zones.
	+ Data collected in the lab for hand-picked first arrivals of p- and s-waves, with naming convention as mentioned above.
	+ A “SummaryData” file that harvests only the stress and wave slowness combinations that are needed from the raw calculations in the other two files.
	+ A folder “charts” that contains plots generated using this data.

Within the DRA data archive, there are five folders, one each for the five zones sampled for DRA testing. These contain subfolders for each direction, horizontal 1-3 and vertical, including repeated tests when a second sample from the same location was available. Each of these contain:

* “Data Sheet” describing specimen dimensions and loading sequence.
* “INSTRON” data giving load versus time.
* TestName.xlsx giving the data from the three LVDTs used to compute axial displacement.
* A folder “charts” that contains plots generated using this data.

Note that the time for INSTRON and LVDT data are not necessarily synchronized, but this is readily done in postprocessing by synchronizing the peak displacement with the peak load at the moment where loading ends and unloading commences.

# References

Bunger AP, Higgins J, Huang Y, Kelley M. 2023. Core-Based In-Situ Stress Estimation for Utah FORGE Well 16A(78)-32 using Triaxial Ultrasonic Velocity and Deformation Rate Analysis. Milestone Report 2.1.1 for Utah FORGE Project 2439. <https://gdr.openei.org/submissions/1438>.