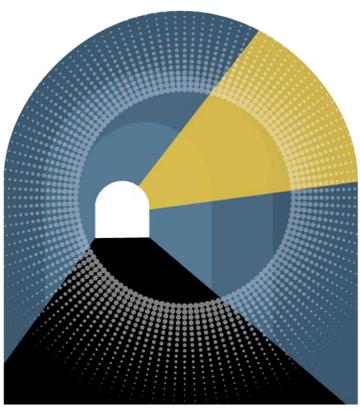


Analysis of hydraulic fractures performed on the 4100 level at the Sanford Underground Research Facility

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- Tests were performed in an alcove of the 4100 level at SURF near the Yates shaft.
- A Vertical borehole was drilled in a zone of Amphibolite with 3 rhyolite zones, two of which are very thin, the other is approximately 10 m thick.
- Tests were performed using a downhole straddle packer system with an air driven pressure intensifier pump capable of pressures to 69 MPa.
- Data was logged from a flowmeter on the pump inlet, and with pressure transducers measuring the injection, return and packer pressures.
- Measurements of fractures were made with optical and acoustic televiewer logs as well as an impression packer. Interval locations (shaded pink) are marked on the log to the right.

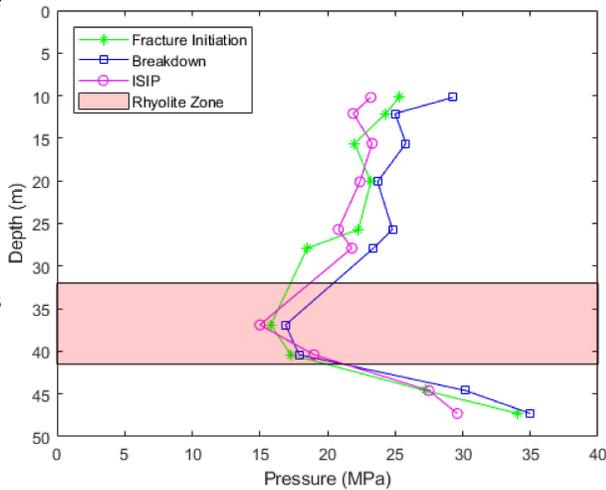
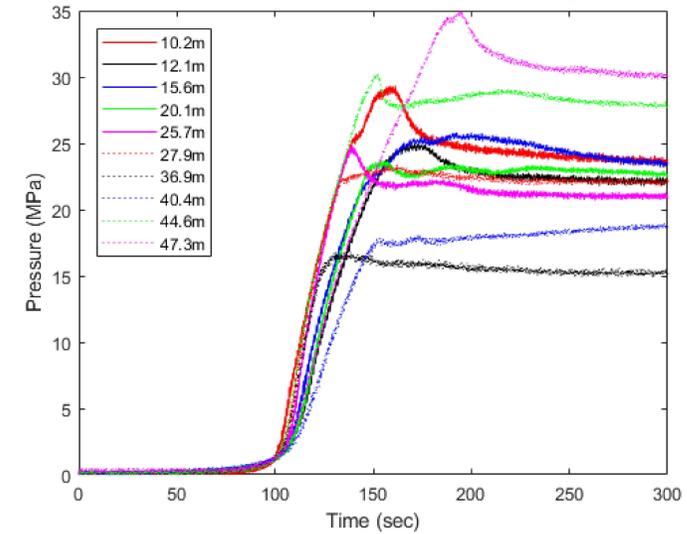
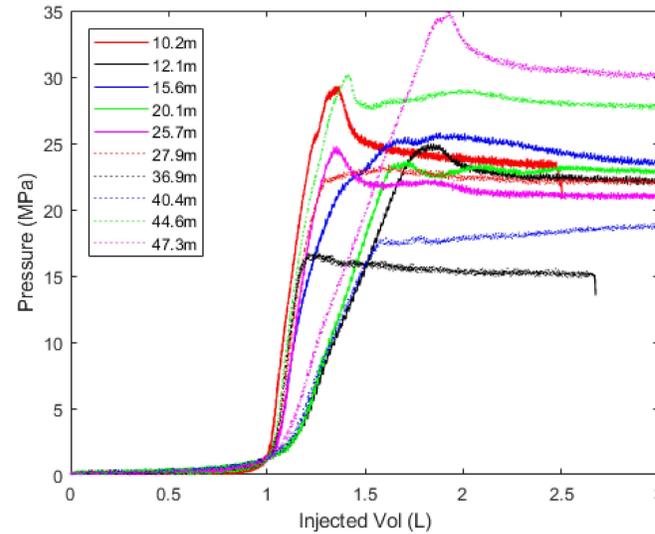
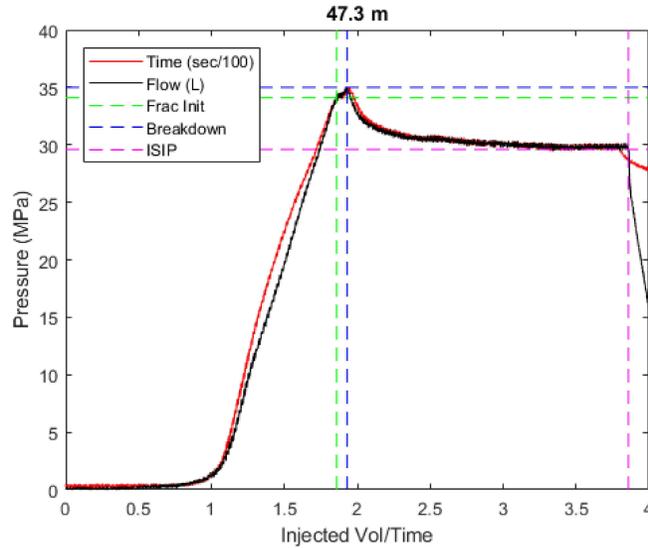


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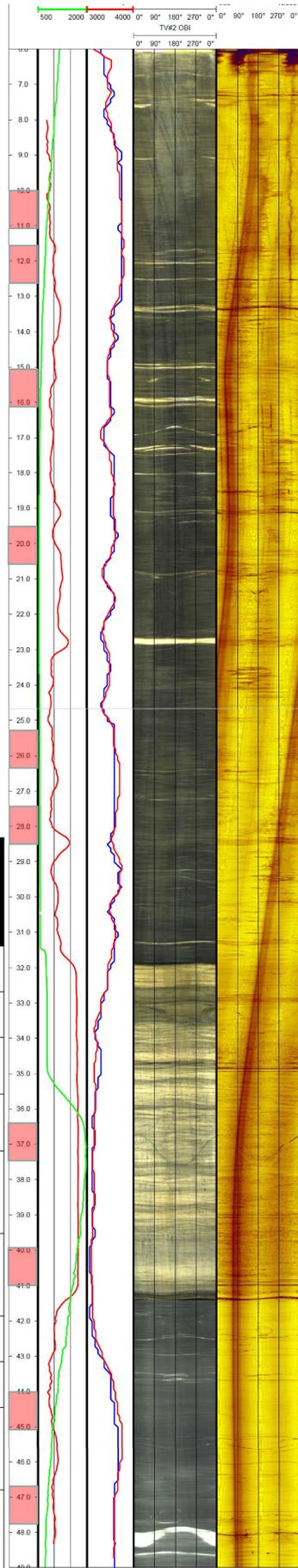


The DOE-funded EGS Collab project is a multi-institution collaborative in which R&D at SURF is being used to increase our understanding of intermediate scale (10 m) rock mass response to hydraulic stimulation and flow, thus increasing our understanding of the thermal-hydrological-mechanical-chemical response of the rock to engineered activities.

- Hydraulic fracture results show that above the rhyolite zone, fracture signatures appear relatively typical for this type of rock/burial depth, and show relatively consistent fracture pressures (except for zones that appear to have reopened pre-existing fractures).
- Zones in close proximity to the rhyolite dyke show anomalous behavior.
- The zone above the rhyolite shows lower pressures likely due to the more compliant rhyolite creating a stress inhomogeneity.
- The zone below the rhyolite shows higher pressures likely because the lower interval is carrying the residual load from the rhyolite stress inhomogeneity
- Fractures which appear to have reactivated a preexisting natural fracture show a flatter breakdown curve where the fracture initiation and breakdown are similar, and often correspond well with the ISIP.



Frac #	Interval Center (m)	Fracture Initiation (MPa)	Breakdown (MPa)	ISIP (MPa)	Fracture Orientation from True North	Fracture Dip	Notes
1	10.2	25.3	29.3	23.2	Unclear		Amphibolite - Normal Signature
2	12.1	24.3	25.0	21.9	221	56	Amphibolite - Normal Signature
3	15.6	22.0	25.8	23.3	207	59	Amphibolite - Somewhat flat - likely reopened natural fracture
4	20.1	23.2	23.7	22.4	207	68	Amphibolite - Somewhat flat - likely reopened natural fracture
5	25.7	22.3	24.8	20.8	200	59	Amphibolite - Normal signature – low initiation and ISIP may be due to proximity to rhyolite/fracture reopening
6	27.9	18.5	23.4	21.8	201	63	Amphibolite - Flat signature and lower pressure likely due to proximity to rhyolite/fracture reopening
7	36.9	15.8	16.9	15.0	201	84	Rhyolite – Likely opened preexisting fracture
8	40.4	17.3	17.9	19.0	193	79	Rhyolite – Likely opened preexisting fracture
9	44.6	27.2	30.2	27.5	181	66	Amphibolite - Normal signature, high pressure likely due to interval carrying more load due to proximity to rhyolite
10	47.3	34.1	35.0	29.6	178	60	Amphibolite - Normal signature, high pressure likely due to interval carrying more load due to proximity to rhyolite



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