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

H11K-1642

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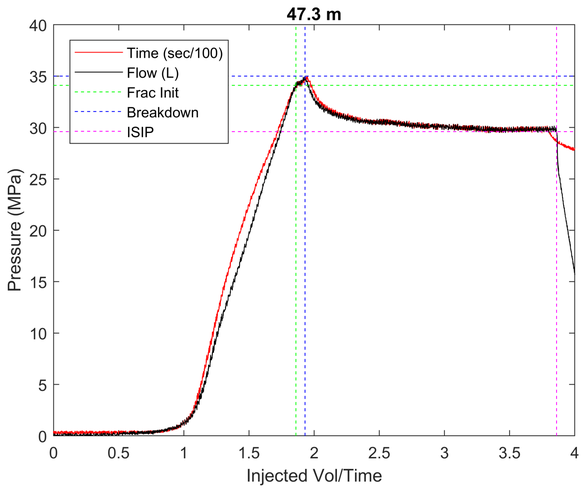
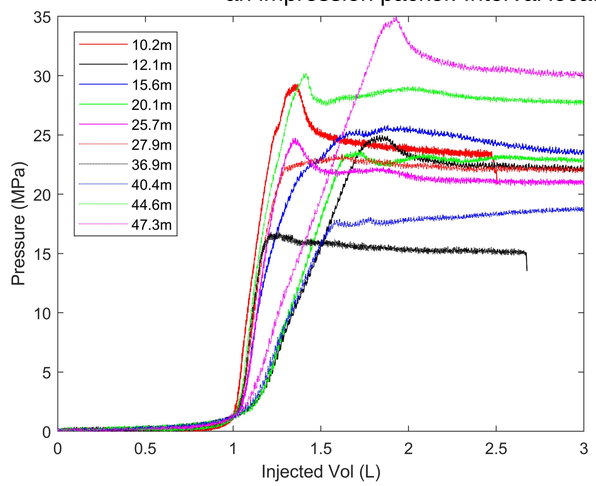
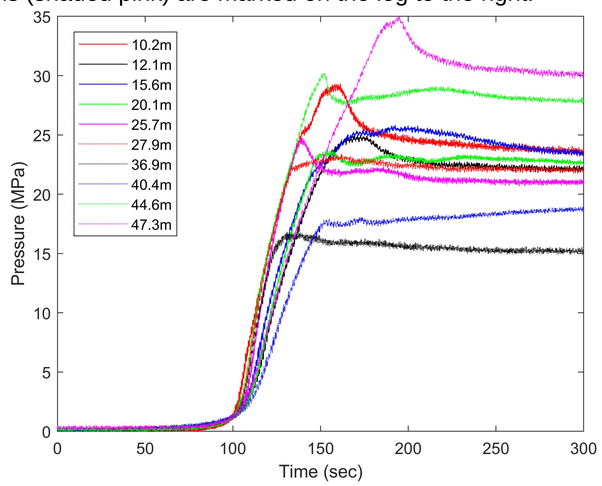
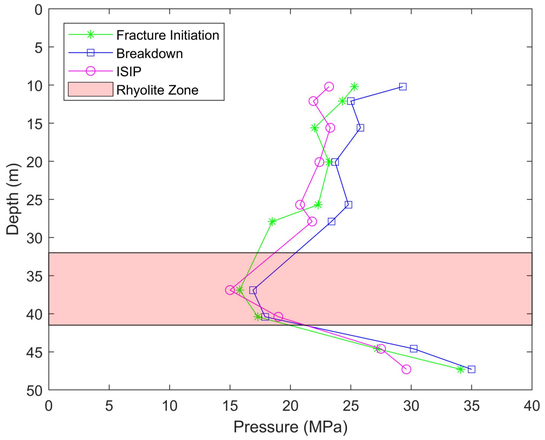
The DOE-funded EGS Collab project is a multi-institution collaborative in which R&D at SURF is being used to increase our understanding of intermediate scale (10 m) rock mass response to hydraulic stimulation and flow, thus increasing our understanding of the thermal-hydrological-mechanical-chemical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

- 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.



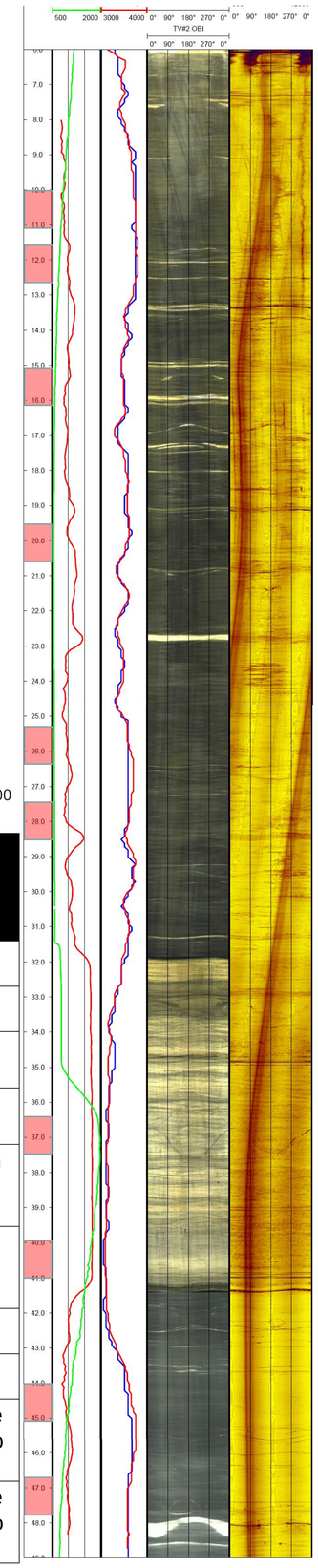






- Hydraulic fracture results show that above the rhyolite zone, fracture signatures appear relatively typical for this type of rock/burial depth, and show relatively consistent fracture pressures (except for zones that appear to have reopened pre-existing fractures).
- Zones in close proximity to the 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) Interval length is 1.1m	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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This material was based upon work supported by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), Office of Technology Development, Geothermal Technologies Office, under Award Number DE-NA0003525 with SNL. The United States Government retains, and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes. The research supporting this work took place in whole or in part at the Sanford Underground Research Facility in Lead, South Dakota. The assistance of the Sanford Underground Research Facility and its personnel in providing physical access and general logistical and technical support is acknowledged.
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