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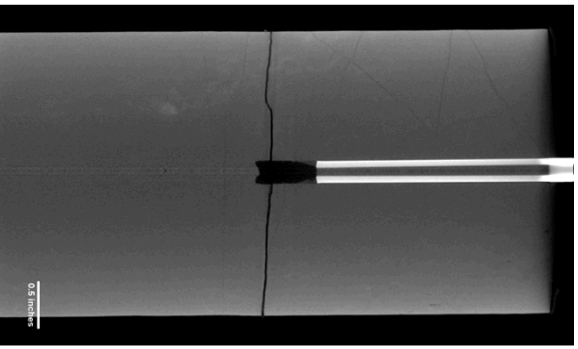

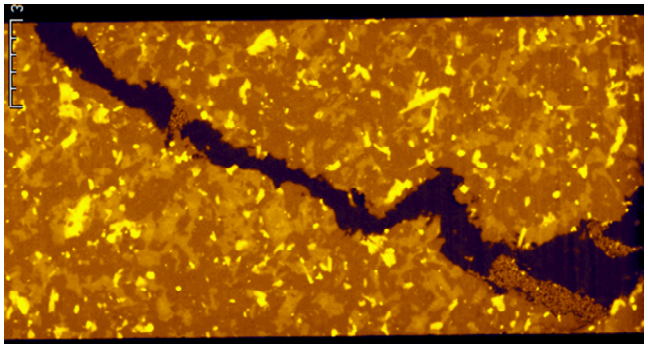

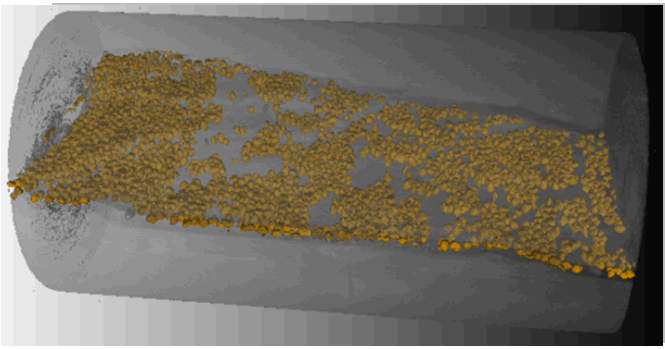

Laboratory Scale Hydraulic Fracture of Marcellus Shale

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Outline

- Motivation
- Specimen Preparation
- Preliminary testing
  - Axial Fractures in Westerly Granite
  - Proppant distribution in Granite Samples
- Fracture of Marcellus Shale
  - Stress state
  - Fracture Geometry
- Conclusions
- Continuing Work

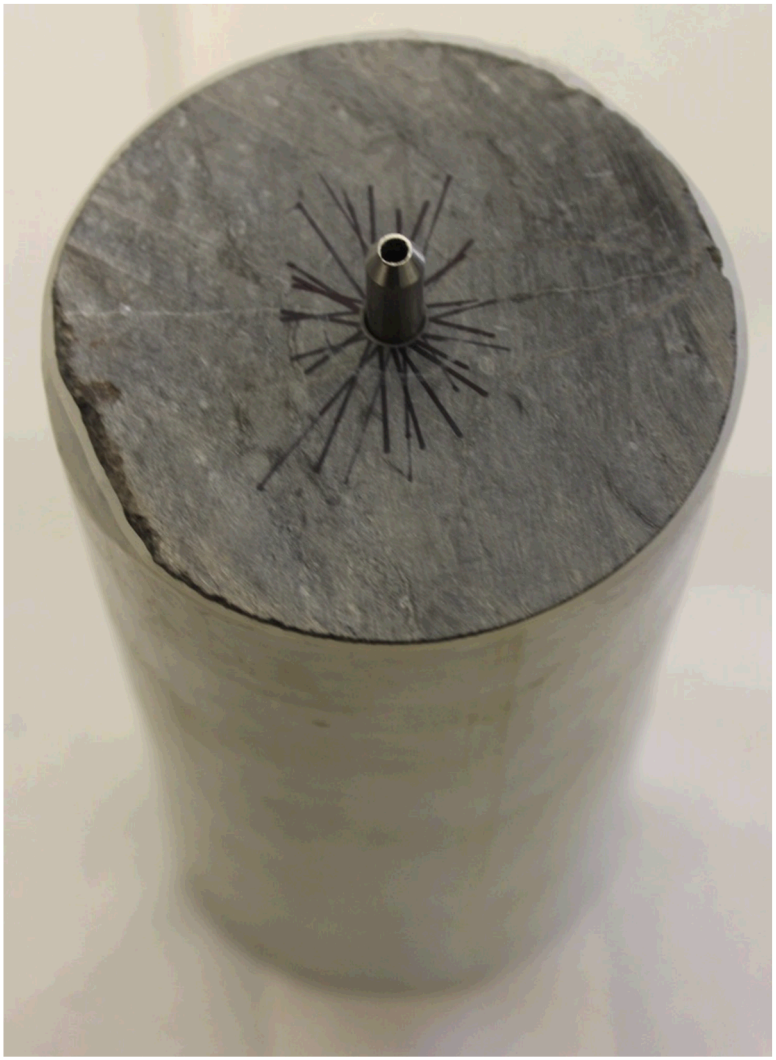
Motivation

- Determine conditions necessary for fractures to be generated which are properly oriented with respect to borehole, stress state, and bedding plane.

This work will be used to:

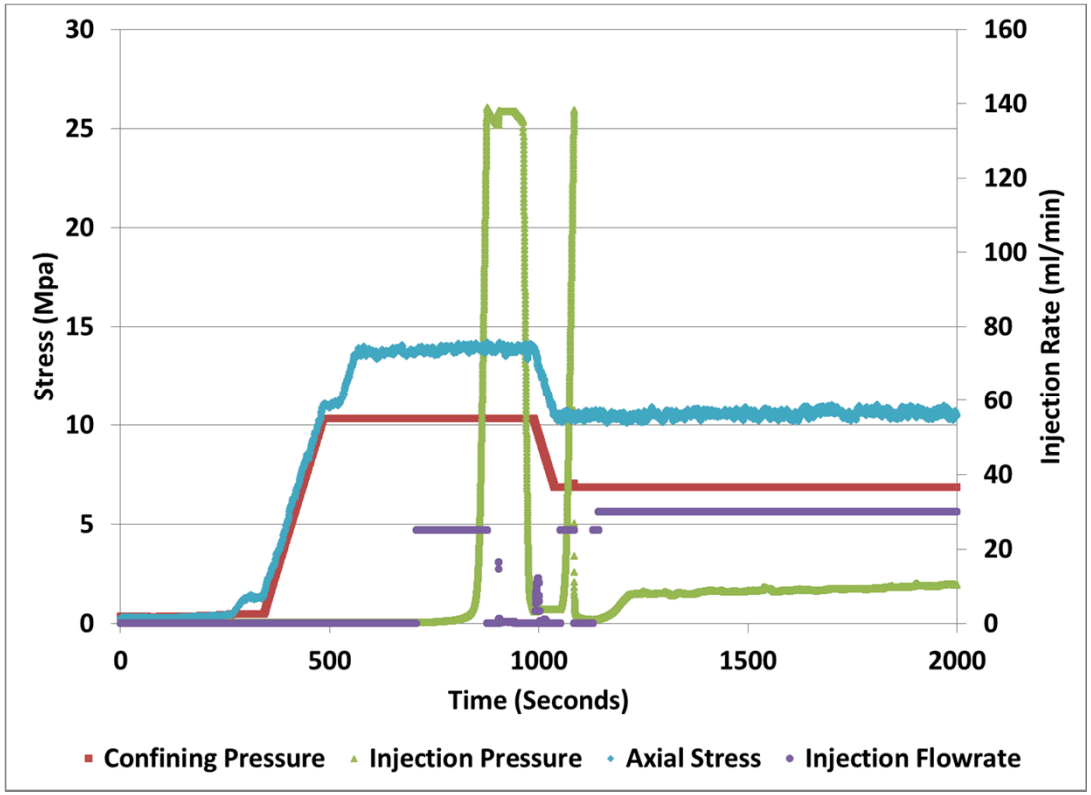
- Determine the density and distribution of proppant in a laboratory generated fracture
- Use CT Scans of propped fractures coupled with injection parameters to develop better models for proppant injection, and proppant placement.

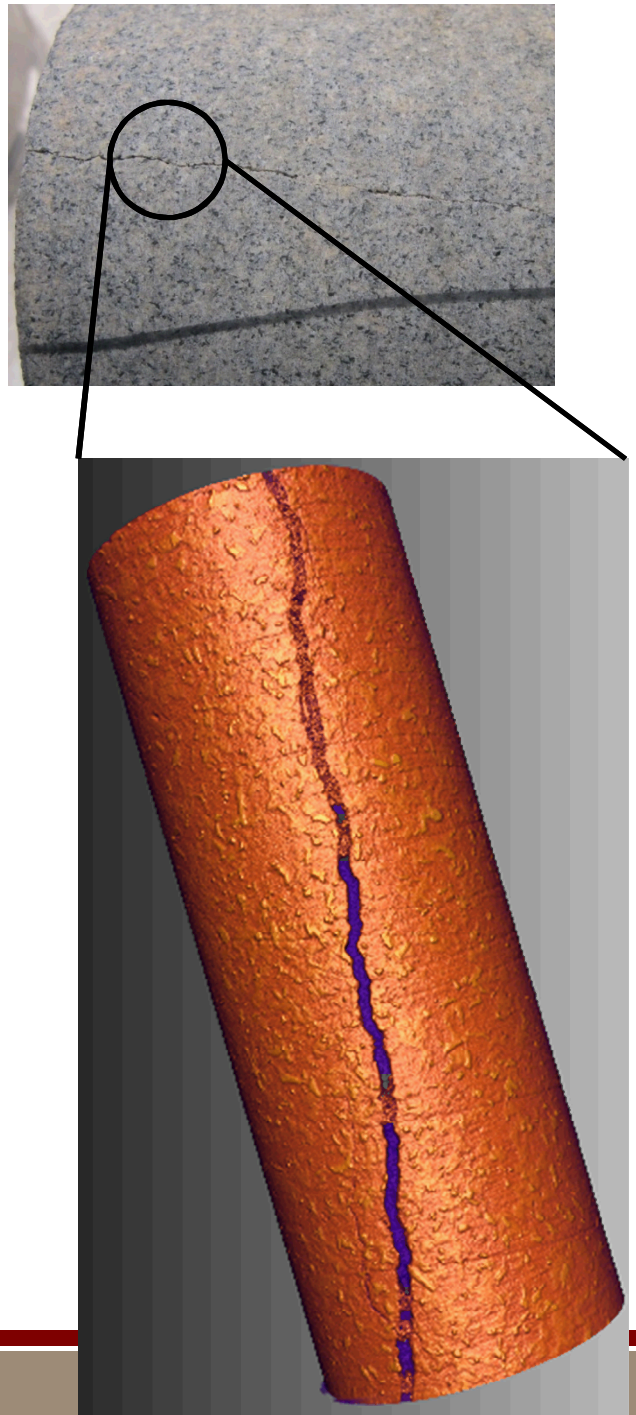
Specimen Preparation



- Injection pipe epoxied into place in specimen
- Specimen wrapped in a porous metal mesh
- Jacketed in Polyolefin
- Metal mesh was also on the bottom of the specimen to act as a fluid drain.

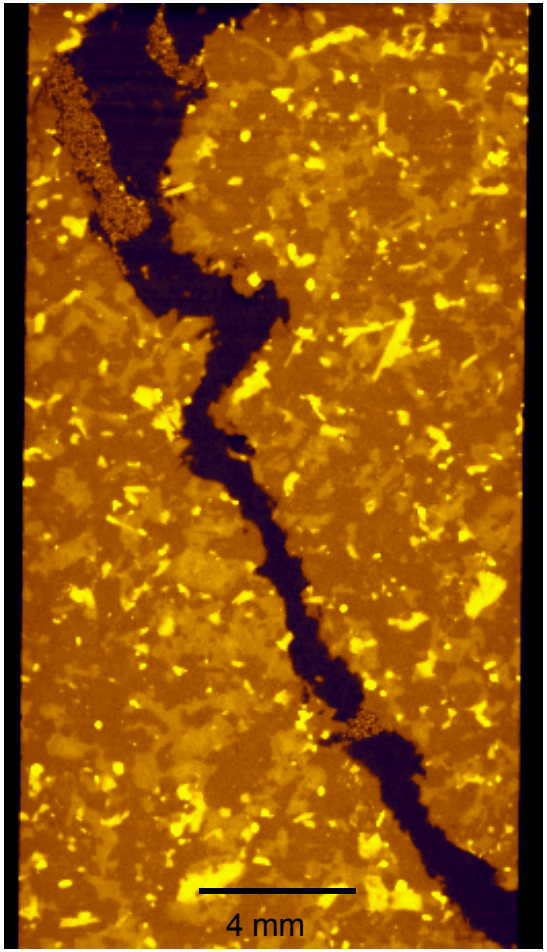
Granite Hydrofrac

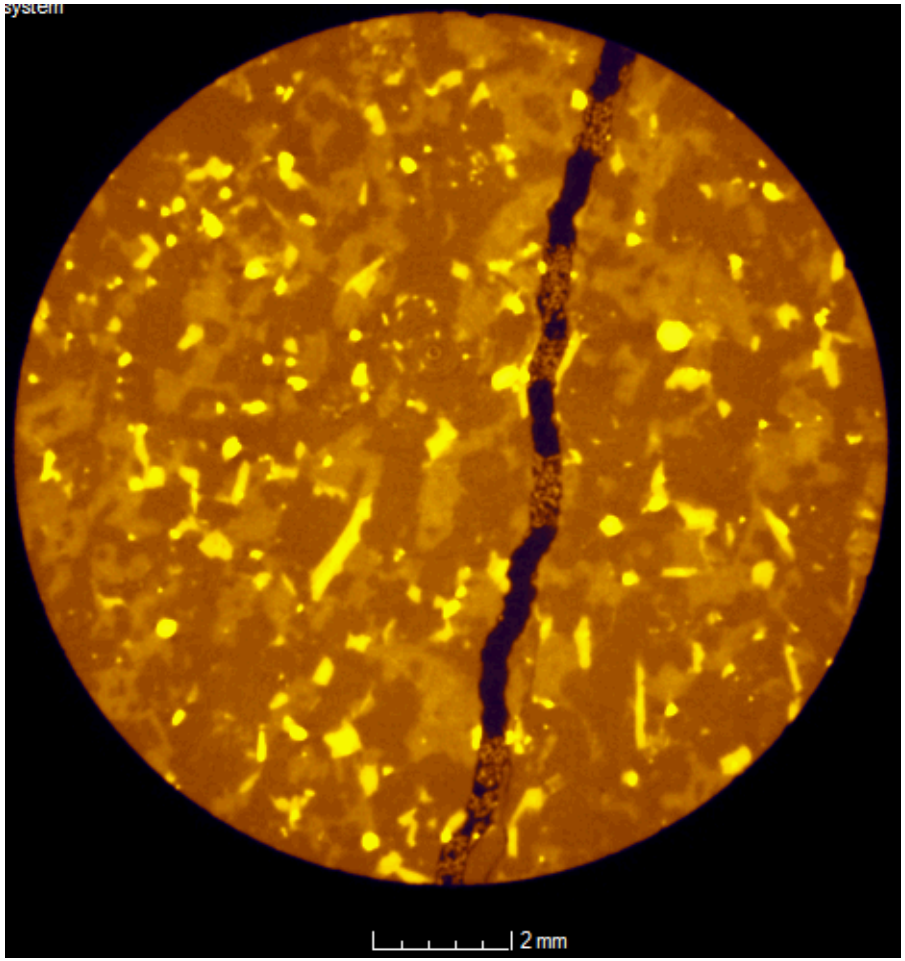




- Fractures were performed with water, which was then chased with guar thickened water laced with proppant.

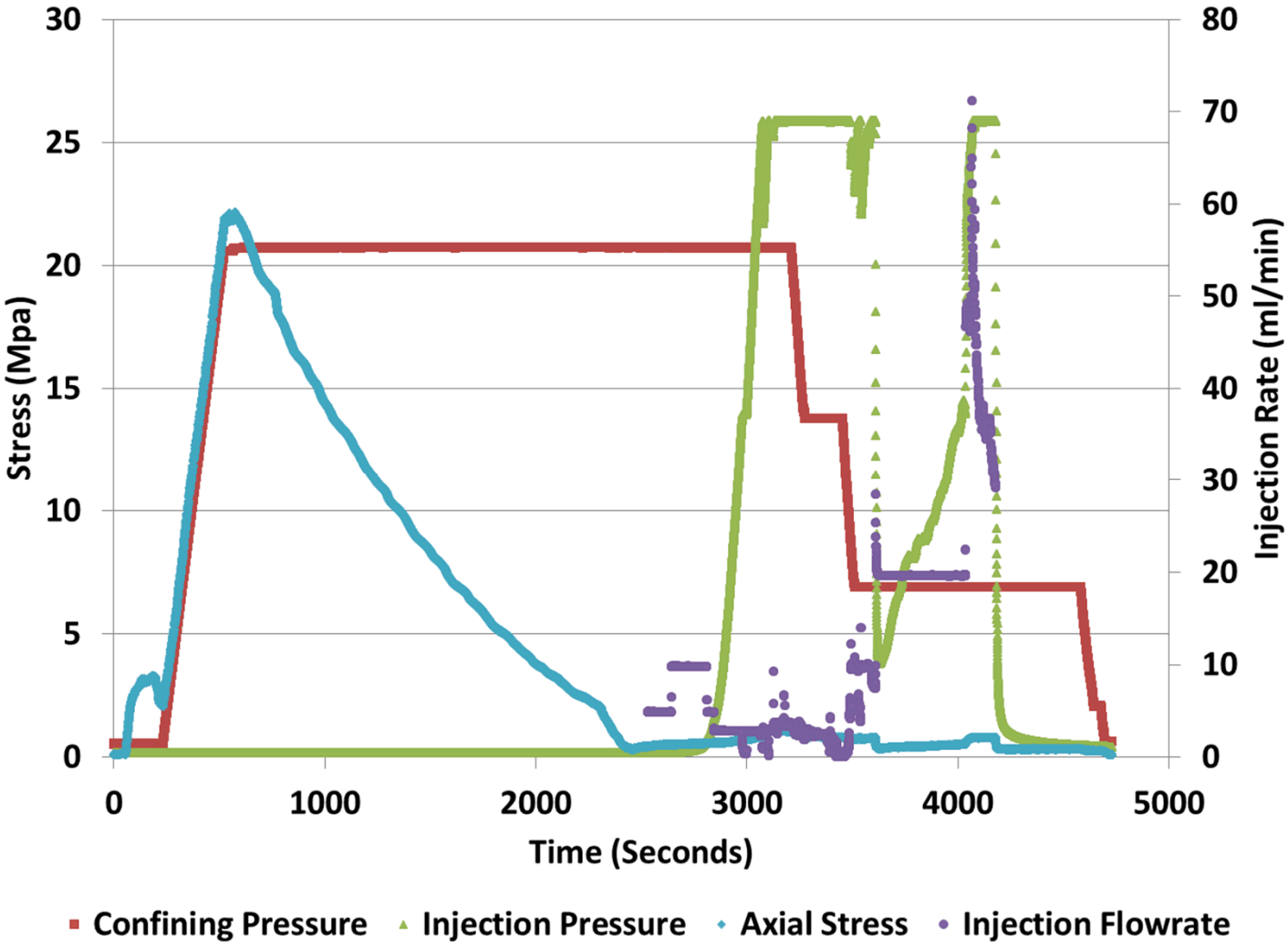
Proppant distribution





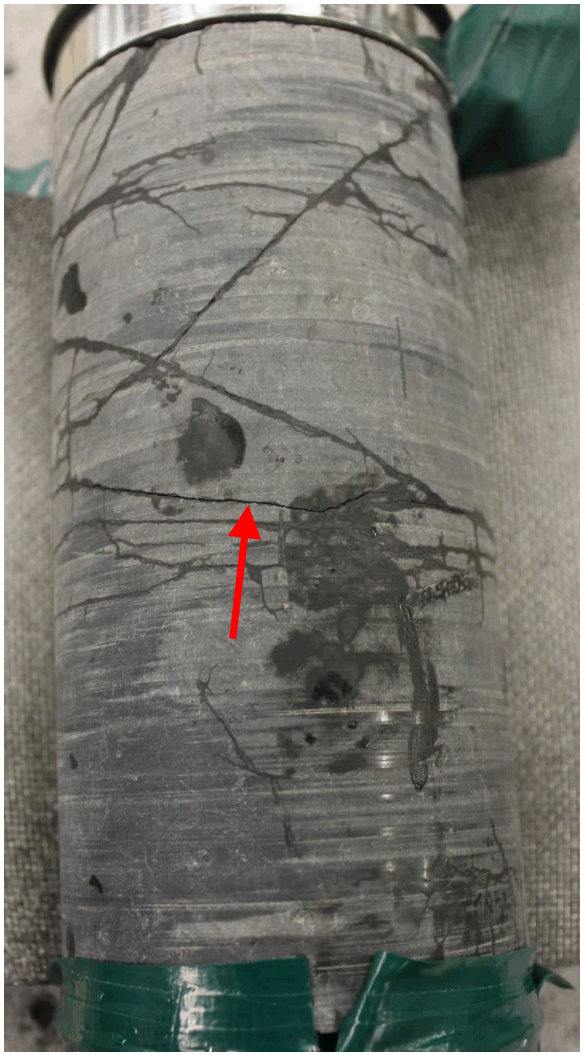
- Heterogeneous proppant distribution from constant flow injection
- Multilayer islands of proppant
- Fracture aperture ~0.4 mm

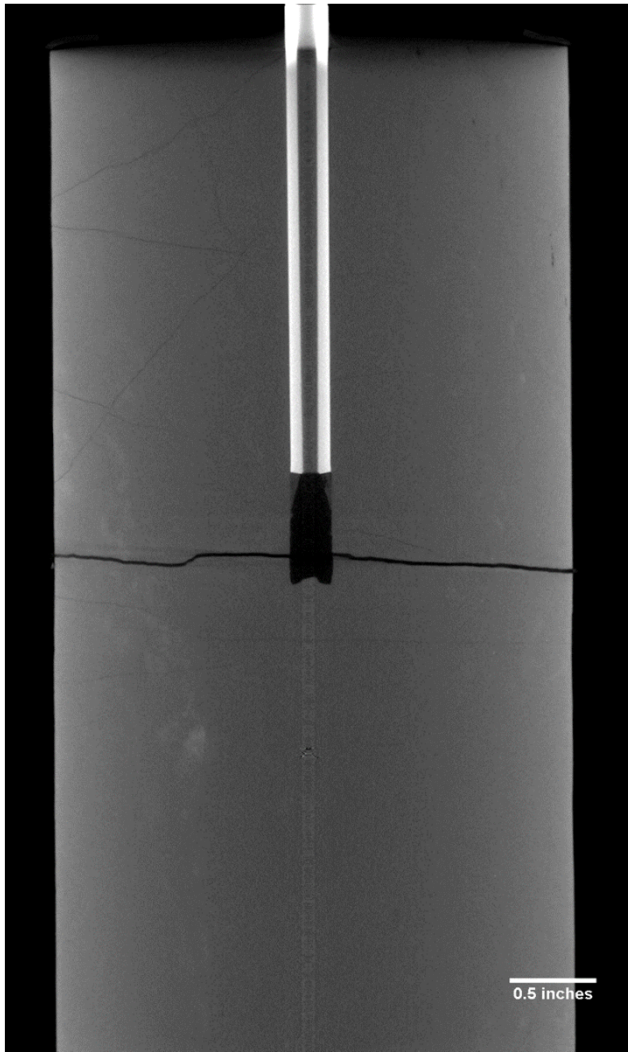
Shale Fracture Stresses



UCS=46 MPa

Extensile Hydrofrac Geometry





- Fracture plane crossed preexisting fractures
- There was little influence in fracture propagation from preexisting fractures
- It appears that preexisting/healed fractures were more permeable than the host rock

Conclusions

- Disk on string fracture pattern can be replicated in the laboratory under appropriate loading conditions and orientation of bedding/borehole
- Interaction of hydraulic fractures with natural fractures was not observed, this lends support to the results of Zhou et al. (2008)
  - Stress state
  - Inclination between fractures
  - Strength of host and natural fracture
- Natural fractures were more permeable than host, but did not open to accept proppant

Continuing Work

- Continued testing to achieve fracture at more realistic stress states
  - Currently sealing the injection line is problematic
- Modeling
  - Proppant transport
  - Flow through proppant pack
  - Proppant packing efficiency

Questions?