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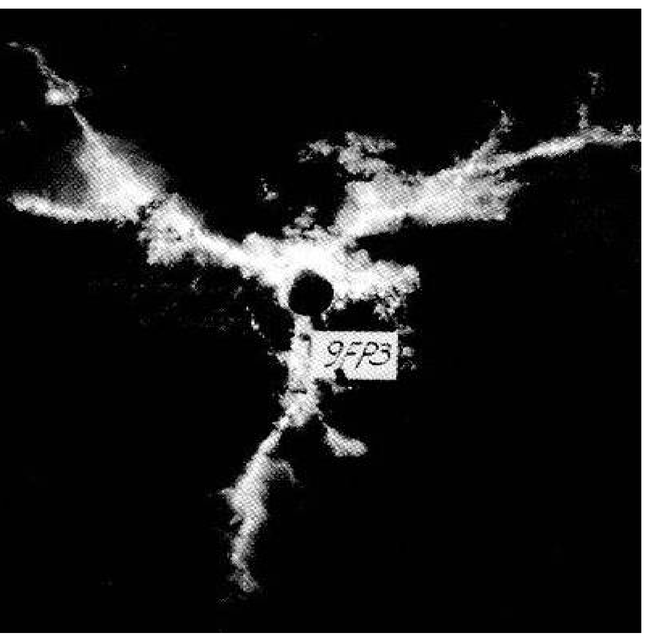
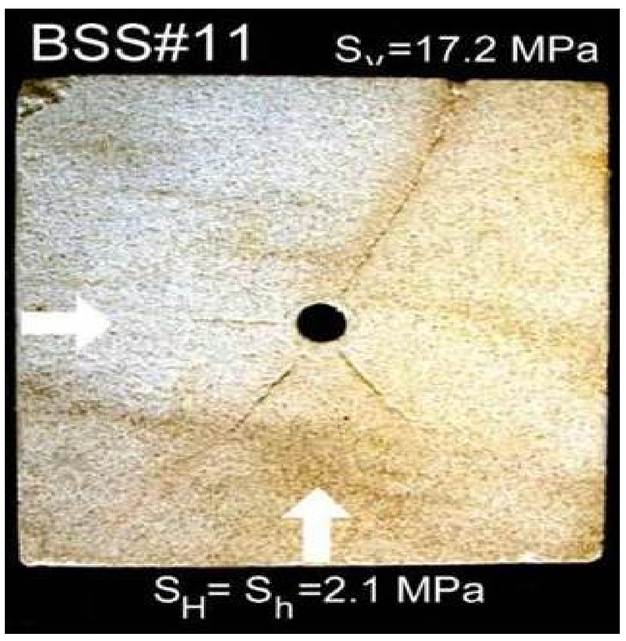
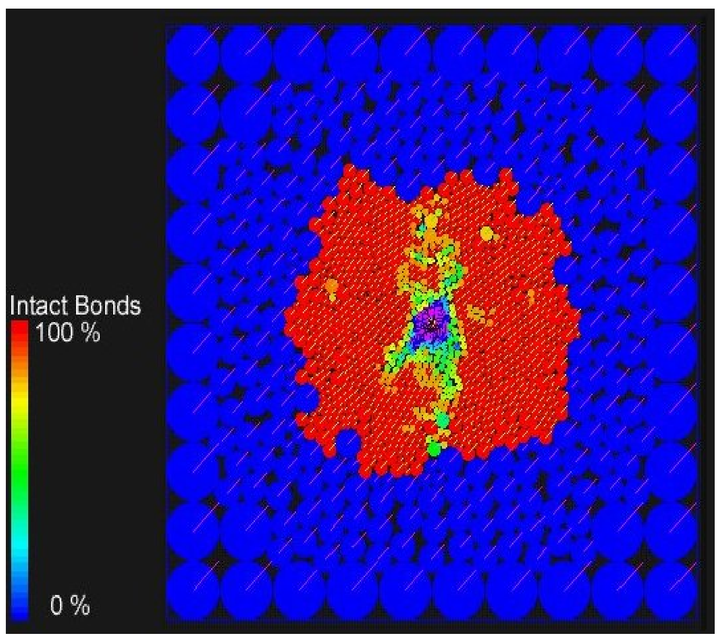
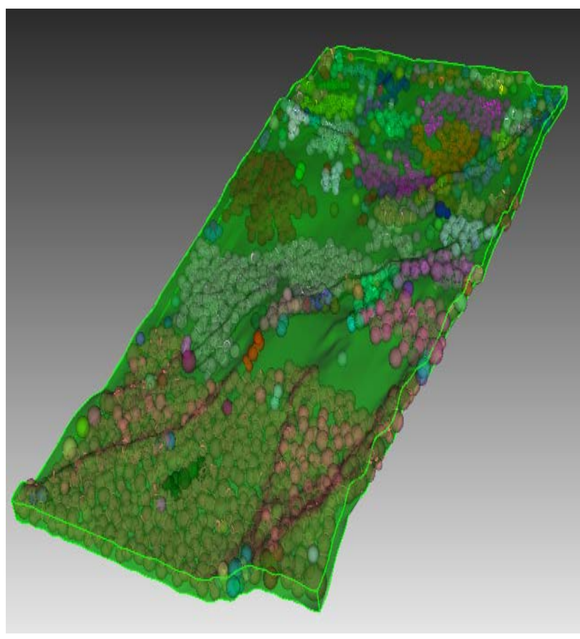








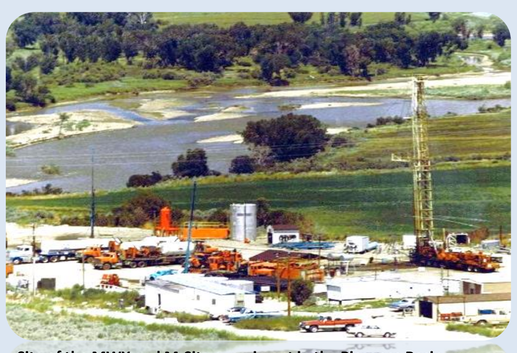
Hydraulic Fracturing R&D at Sandia

Background

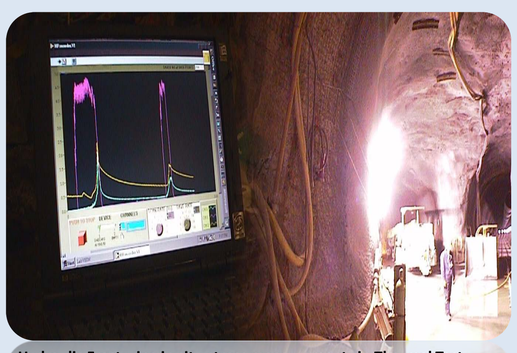
Hydraulic fracturing in conjunction with horizontal drilling has been a disruptive technology advance that enables greater access to oil/gas in shale formations. Hydrofrac involves injection of pressurized fluid from wellbore into a section of isolated intervals. A fracture network is induced and held open by injecting proppant to increase the flow in these low permeability shales. Oil/Gas will flow through the propped fracture network into wellbores, allowing access to previously inaccessible oil/gas resources.

Previous Research

- Direct observation of hydraulic and explosive fracturing in “G tunnel” at Nevada Test Site to understand stimulation processes for the recovery of natural gas from low permeability formations (1977)
- Multiwell Experiment (MWX) hydrofrac monitoring in the Piceance Basin (1983)
- Multi-Site hydrofrac diagnostic project (1992)
- The Jasper “Deep Well Treatment and Injection” (DWTI) tests to study drill cuttings injection (1993)
- The Mounds drill cuttings injection project to study complex fracture environments (1998)
- Hydraulic Fracturing Stress Measurements for WIPP and Yucca Mt nuclear waste disposal projects (1988 and 1999)
- Discrete Element modeling and laboratory simulation of slurry injection (2001)



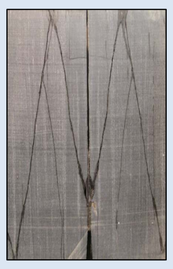
Site of the MWX and M-Site experiment in the Piceance Basin near Rifle, Colorado, for development of simulation diagnostic technology.



Hydraulic Fracturing in situ stress measurements in Thermal Test Facility, Yuuca Mountain, Nevada

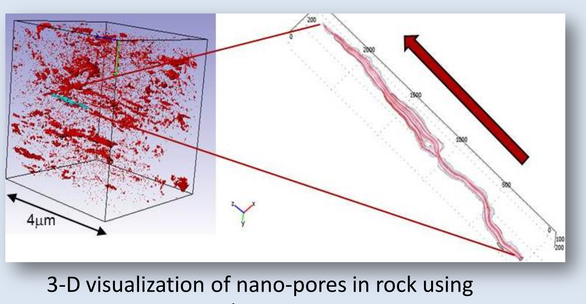
Current Efforts

- Characterization of fracture networking by monitoring natural noble gas tracers
- The Effect of Proppant Placement on Closure of Fractured Shale Gas Wells
- 3-D visualization of fractures and gas bearing nano-scale pores using Focused-Ion Beam/Scanning Electron Microscopy
- Numerical modeling of fractures and hydraulic fracturing process
- Fundamental shale science and material properties



Helium release during deformation may indicate evolution of fracture and pore structures.

Laboraotory scale hydrofrac with proppants



3-D visualization of nano-pores in rock using Focused-Ion Beam/Scanning Electron Microscopy and gas flow modeling.

Future Direction

- Quantitative prediction of matrix-to-fracture gas release mechanisms to more accurately anticipate reservoir decline
- Reservoir characterization and management
- Remote sensing of fractures and proppant placement
- Non-water based fracturing methods
- Improved well cementing methods and/or well deterioration diagnostics and remediation
- Disposal/treatment of flow back fluids
- New approaches to understanding and avoiding seismic risk

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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