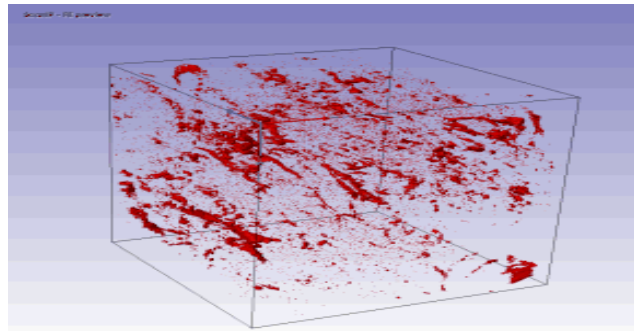
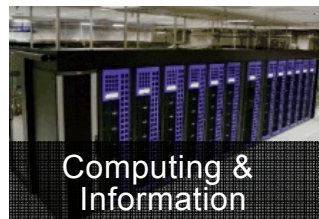
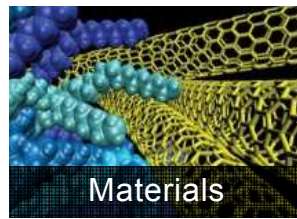
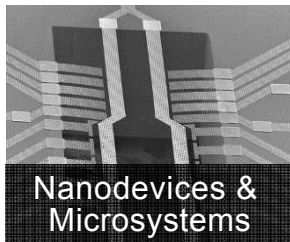
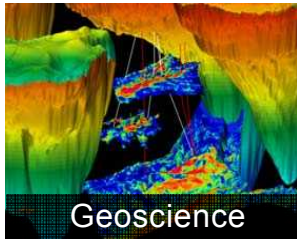


Exceptional service in the national interest



Leverage Research Foundations



Fossil Energy Themes

Microscale Experimentation

Unconventional Shale Science

Combustion & Natural Gas Risk

Micro & Induced Seismicity

Water

Emissions Monitoring

Downhole Tools

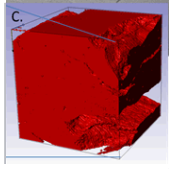
Advanced Physics & Algorithms

What is the capability?

What is the application?

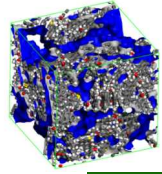
What is the novel technology?

Microscale Experimentation & Unconventional Shale Science



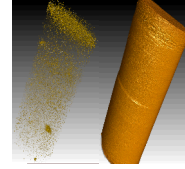
Capability

- Step-wise 2D and 3D observations
- Uni- to triaxial deformation
- Geochemical reaction / alteration / corrosion
- Extremely high pressures
- Nanopore to core scales
- Cryogenic to geothermal
- Creep to shock physics
- Natural, digital, and downhole materials
- Density functional theory and molecular dynamics in nanopores



Application

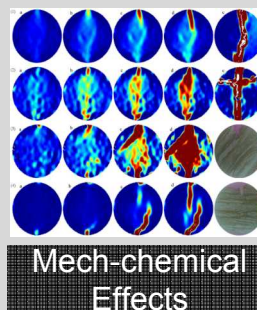
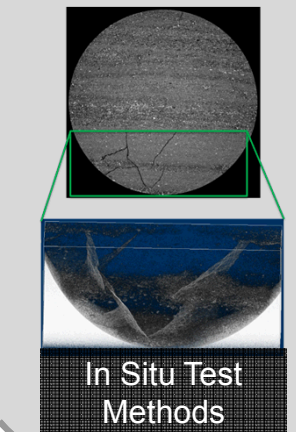
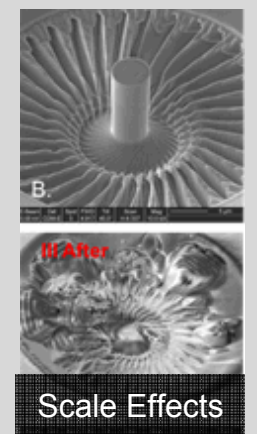
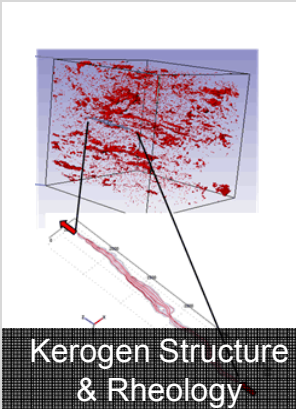
- Fracking & borehole failure
- Chemical behaviors in nanopores and from fracking
- Gas disposition in shale matrix
- Shale EOR / water flood design
- Frack design without wellbore damage
- Water-free fracking
- Fracture network pattern characterization and prediction
- Treat holes in frack patterns



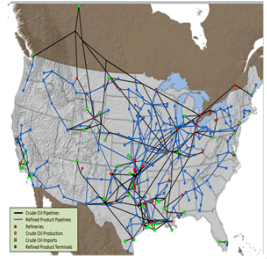
Novel technology development

- Microfluidics
- Micro compression
- Combined mechanical-TEM imaging

Example projects



Combustion & Natural Gas Risk



Capability

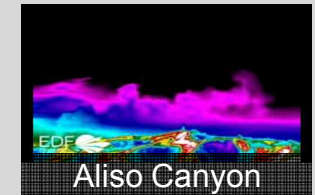
- Natural gas transport and network tools for surveillance, optimization, resilience, safety, and decision support
- Large scale burn testing
- Small pool fires (small LNG spills)
- Fireball testing (LNG vapor cloud)
- Validate predictive models
- Expected damage
- Hazard distances
- Dispersion hazards



Application

- LNG storage risk
- Safety assessment and surveillance
- Natural gas storage and pipeline requirements for electric power sector
- Emerging issues in road, rail, and marine transport

Example projects

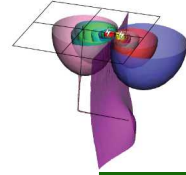


Micro & Induced Seismicity



Capability

- Large-scale, multi-data, space-time data analytics
- Integrated geophysical methods
- Image fracture networks



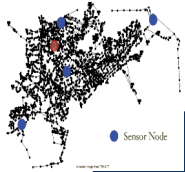
Application

- Optimize frack in near real-time
- Determine mechanism and location of origin of seismic event
- Stimulation surveillance and diagnostics
- Fiber optics for 4D imaging and sensing into the reservoir or uncased wells
- Induced seismicity – seismic event, timing, and relation to fault data



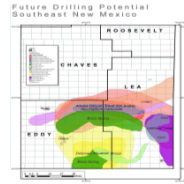
Novel technology development

- Microseismic for > 1 yr time scales for stimulation surveillance and diagnostics



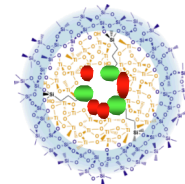
Capability

- Water infrastructure security – contamination warning, network optimization & resilience
- Testing and developing water nanofiltration & desalination technology
- Real time chemical logging tools and sensors for produced water



Application

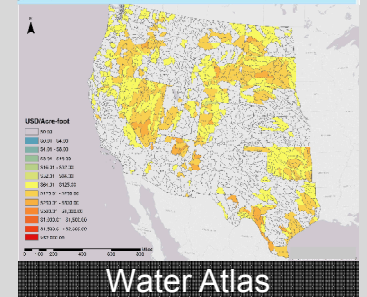
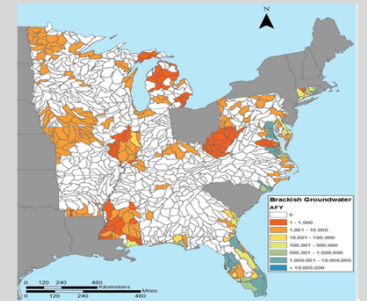
- Identify, assess, and evaluate impacts of fracking regulations and future development
- Rapid field testing
- Water treatment – arsenic, silica & H₂S
- Contaminant selective technologies for radionuclide and heavy metal remediation
- Desalination and treatment pilots



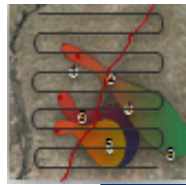
Novel technology development

- Crystalline silico-titanates used at Fukushima Sr remediation
- Apatites and modified apatites for heavy metals at Hanford
- Biomimetic membrane
- High efficiency electro dialysis membrane
- Groundwater National Desalination Research Facility

Example project

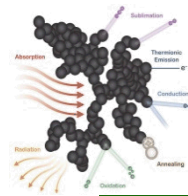


Water Atlas



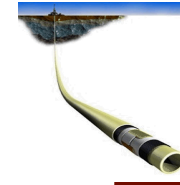
Capability

- Optimization methods with heterogeneous data
- Atmospheric measurement
- Inverse modeling
- Uncertainty quantification



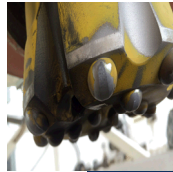
Application

- Quantify emissions of climate pollutants
- Improved fugitive emissions monitoring
- Transport models in pipes, air & subsurface
- Sensor detection at a point, along a line & path
- Cost constraints & failure rates



Novel technology development

- Proppant taggant for > 1 yr time scales
- Real-time noble gas techniques for surveillance and diagnostics
- Real-time optimized distributed fiber optic sensing



Capability

- De facto “UL Labs” for high-temperature components
- Work with almost all manufacturers
- Analyze failure & provide solutions
- Develop tools, fabrication methods, & prototypes
- Long-term testing
- Extensive interactions w/ industry motivate work activities



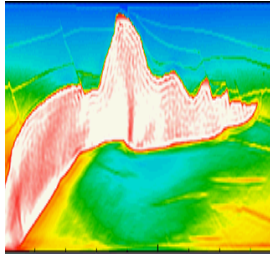
Application

- Electronic / electromechanical downhole monitoring
- Real-time diagnostics during drilling & stimulation
- Methods for placing proppant
- Wellbore damage monitoring
- Energetic, water free stimulation methods for control rapid pressurization of the wellbore



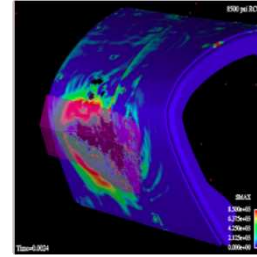
Novel technology development

- Automated drilling systems
- Real-time chemical logging tool
- High temperature clamping system for microseismic monitoring
- HT drilling systems
- Down-the-hole-hammers
- Compact drilling motor
- Elastomer free axial piston drilling motor
- Low weight-on-bit drilling systems



Capability

- Geophysics & multiphysics
- Computational science & mathematics
- Optimization & uncertainty quantification
- Quantitative modeling & analysis
- Extensive industry partnering
- High performance computing



Application

- Large scale full waveform inversion for complex media and geological structures
- More accurately model wave propagation in the earth for signal interpretation
- Future work in complex structure interfaces such as salt bodies
- Carbon storage monitoring

Fossil Energy Capability Map

