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Wellbore Integrity for US Energy Security

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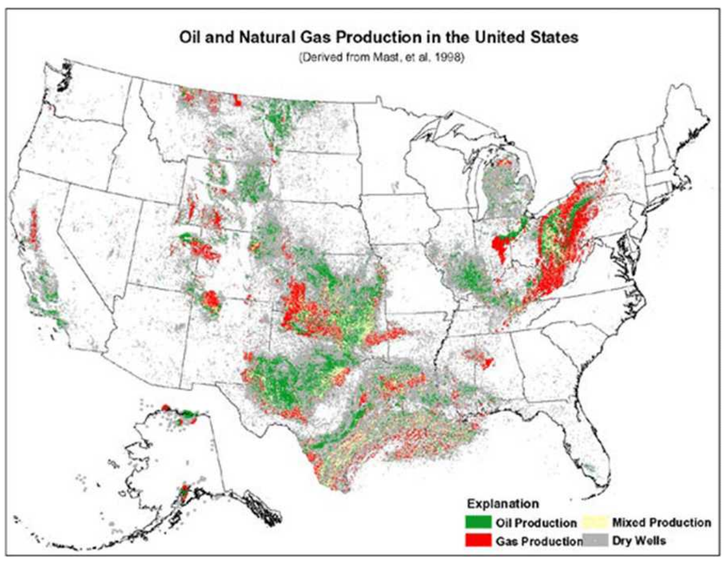
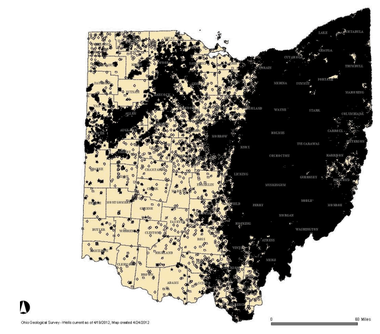
Establish Center of Excellence to design and implement autonomous, self-powered, self-monitoring wellbore systems, rapid failure event detection via deployable or embedded sensor networks, machine-learning/data science, and in situ repair methods.

Wellbores are at once the single most important aspect of interrogating the subsurface, emplacement of waste for disposal and storage, and extraction of hydrocarbon and geothermal resources. They provide access to underground energy resources and provide zonal isolation between liquids and/or gases and the surrounding formation.



- ~93% of US total energy supply is dependent on wellbores in some form
- Global well population is ~ 1.8 Million of which ~ 35% has some signs of leakage (i.e. sustained casing pressure)
- ~5% of offshore oil and gas wells "fail" early, more with age and most with maturity

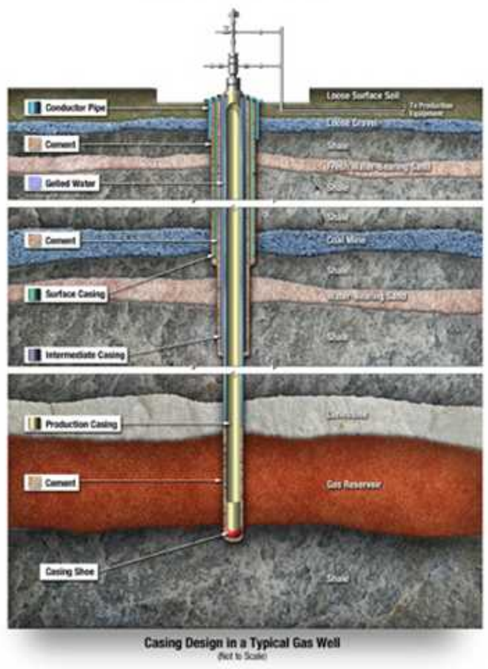


OGS map of shale gas wells in Ohio

Wellbore Interactions with the Near-Environment

The wellbore and near-wellbore environment is a complex assortment of layered, discontinuous systems including well casing, surrounding cement, drilling fluid filter cake, damaged rock from drilling, and undamaged, heterogeneous lithology. The goal of this task is to:

- Develop methods and models for stress heterogeneity and deformation mapping
- Assess vulnerability
- Develop materials and methods to minimize formation damage
- Develop means to sustain injectivity and productivity

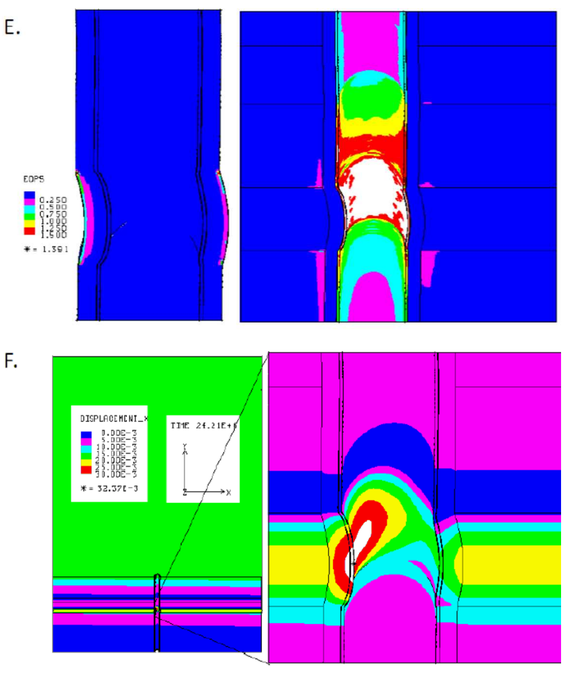


Casing Design in a Typical Gas Well

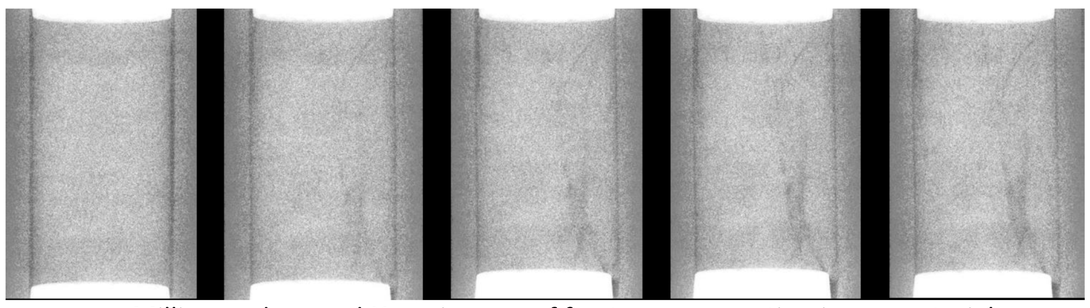
Failed centralizers threaten wellbore integrity

Precursor-to-Failure Detection and Smart Well Design and Implementation

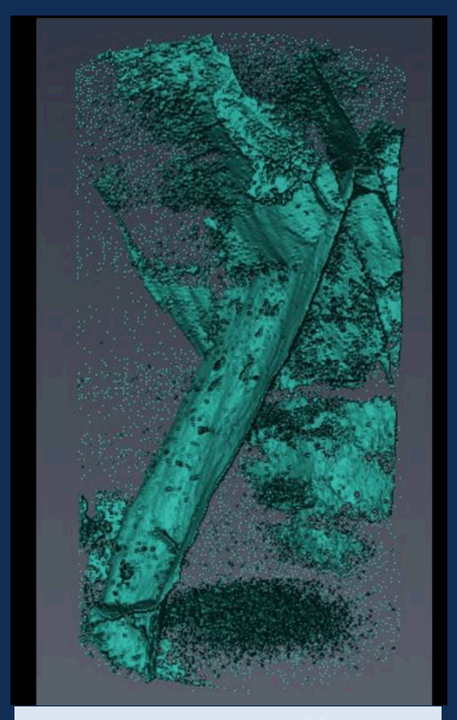
With colleagues from UT-BEG, develop and test methods for detecting precursors to failure chemically, ultrasonically, and (geo)mechanically with micro-CT imaging of leakage pathway development. This includes sensor development, downhole power harvesting and sensor networking and surface communication.



FE Model of wellbore deformation at Cranfield CO2 injection site (Dewers et al., 2017)

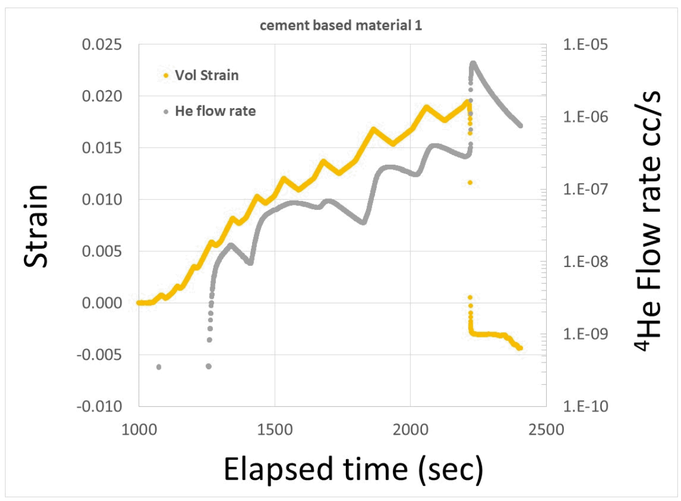


Millisecond-spaced X-ray images of fracture propagation in geomaterial



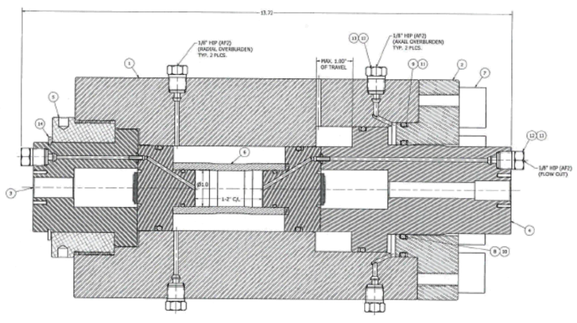
μCT reconstruction of fracture networks

Cement Integrity and Leakage Mitigation



Helium release from cementitious material during deformation, measured with in-line mass spec. Shows influence of cyclic loading (history)

This task, with colleagues from UNM, focuses on maximizing efficiency of sealing capabilities of cement and remediation techniques, including detection of flaws and microcracks, developing novel methods to heal cement, limit corrosion, and to emplace and cure cements downhole.



HPHT triaxial vessel for curing cement under load at temperature. With ultrasonic transducers for measuring p and s wave changes during curing

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