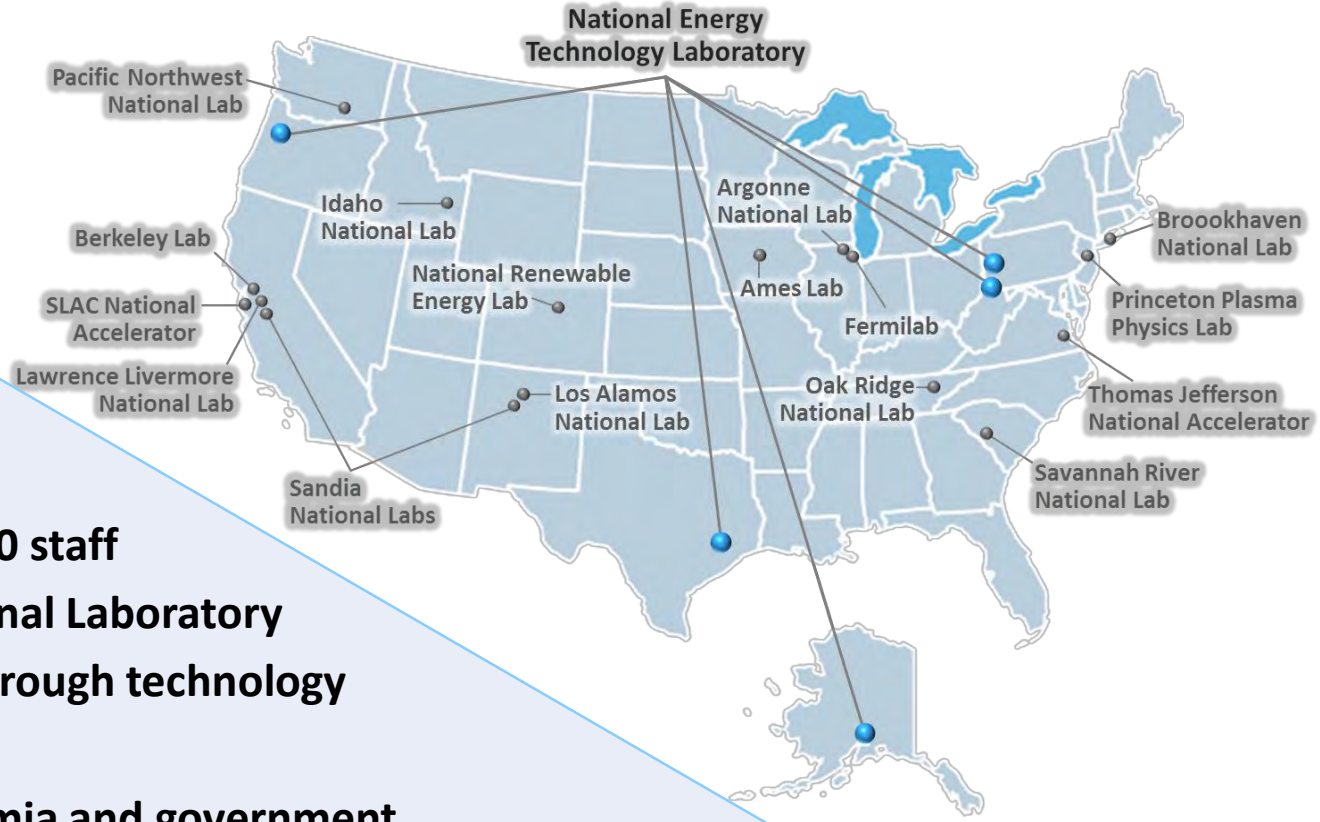
Driving Innovation ♦ Delivering Results

The National Energy Technology Laboratory & The Strategic Center for Natural Gas and Oil R&D Program

IOGCC Conference: DOE / NETL
Spill Prevention - Well Integrity Research

Roy Long
Ultra-Deepwater Technology Manager
September 29, 2015

National Energy Technology Laboratory



- Partner in DOE's national laboratory system
- Five locations with 1,200 staff
- 'Full-service' DOE National Laboratory
- Fundamental science through technology demonstration
- Unique industry, academia and government collaborations
- The Nation's only laboratory focused on fossil energy
- The only government-owned, government-operated DOE national lab

NETL's Unique Business Model

National Lab like no other

NETL's Role:

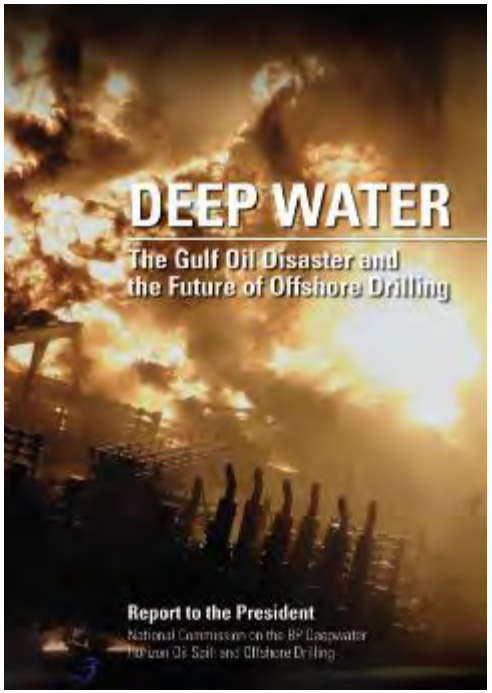
1. **Provide Financial Assistance through "Co-operative Agreements"**
   - "Substantial" DOE involvement to ensure "Best Effort"
   - Require Cost Share → 4 R's (Risk Reduction, Relevant Research)
2. **On-Site Research to fill R&D gaps**
3. **Systems Analysis to guide R&D programs**
4. **Collaboration at multiple scales**

NETL Core Competencies:

1. **Leveraging science and engineering to accelerate scale-up and technology commercialization**
2. **Coordinating large complex projects and demonstrations**
   - NEPA Regulations, Outreach
3. **Managing projects and R&D collaborations with international scope**

Wellbore Integrity Drivers Resulting from Macondo

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling Recommendations



A. Improving the Safety of Offshore Operations

1. The Need for a New Approach to Risk Assessment and Management
   - " - neither the industry's nor the federal government's approaches to managing and overseeing the leasing and development of offshore resources have kept pace with rapid changes in the technology, practices, and risks associated with the different geological and ocean environments being explored and developed for oil and gas."
   - "Also missing has been any systematic updating of the **risk** assessment and **risk** management tools used as the basis for regulation."

B. Safeguarding the Environment

2. The Need for Greater Interagency Consultation
   - Actions needed to implement these recommendations:
     - The Department of Energy, NOAA, the U.S. Geological Survey, and other interested agencies should establish a joint research program to systematically collect critical scientific data, fill research gaps

Post-Macondo Technology Re-Focusing: Risk Reduction Technologies

In Common with Onshore

Operations Risk Reduction

- Geologic Uncertainty
- UDW Drilling and Completions Operations

Surface Facilities and Subsea Equipment Risk Reduction

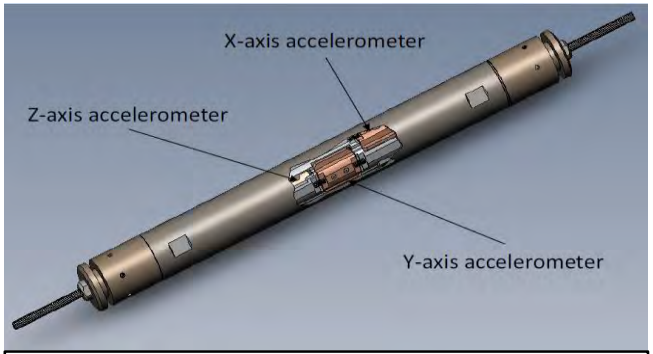
- Surface Systems and Umbilicals (Wellbore Stability)
- Subsea Systems Reliability / Automated Safety Systems

Technology Focus on Safety & Environmental Sustainability

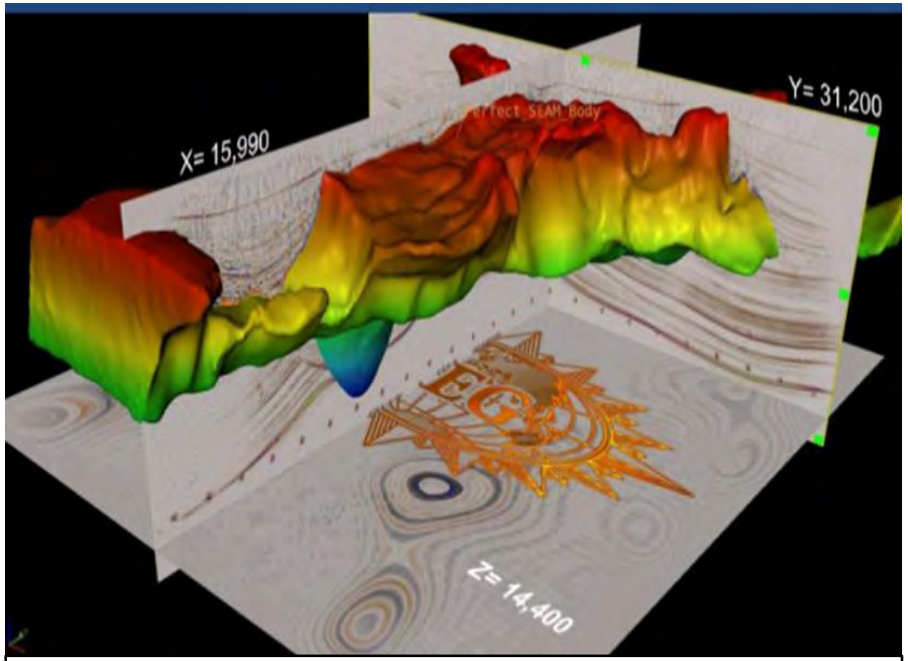
Reducing Geologic Uncertainty – New Signals / Improved Imaging Methods

Geologic Uncertainty

Much Higher Frequencies + much lower Noise ⇒ Potential Increase in Vertical Resolution from 200' to 2'



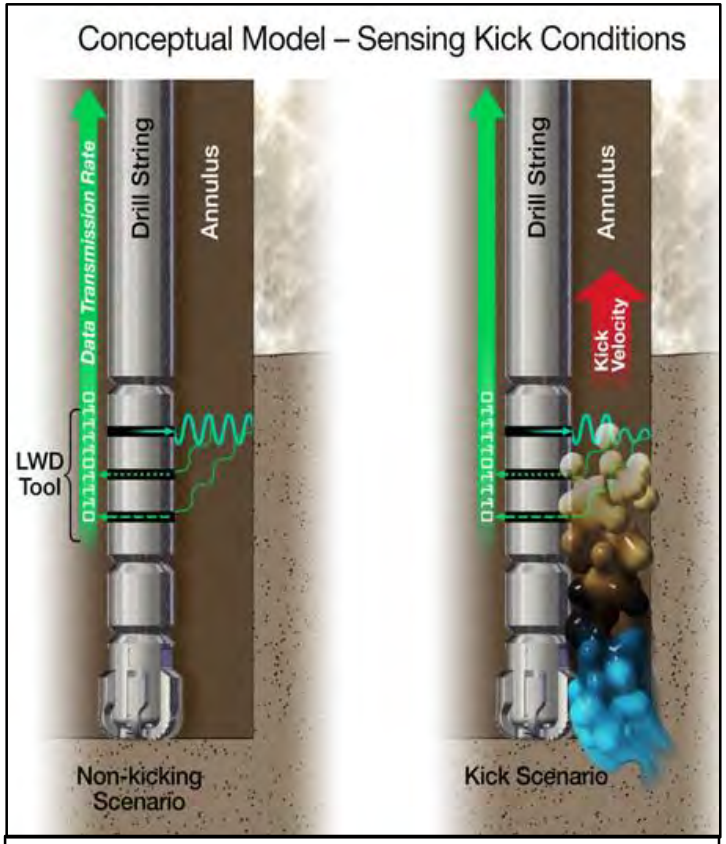
Three orthogonally-oriented, fiber optic accelerometers configured in-line with tool



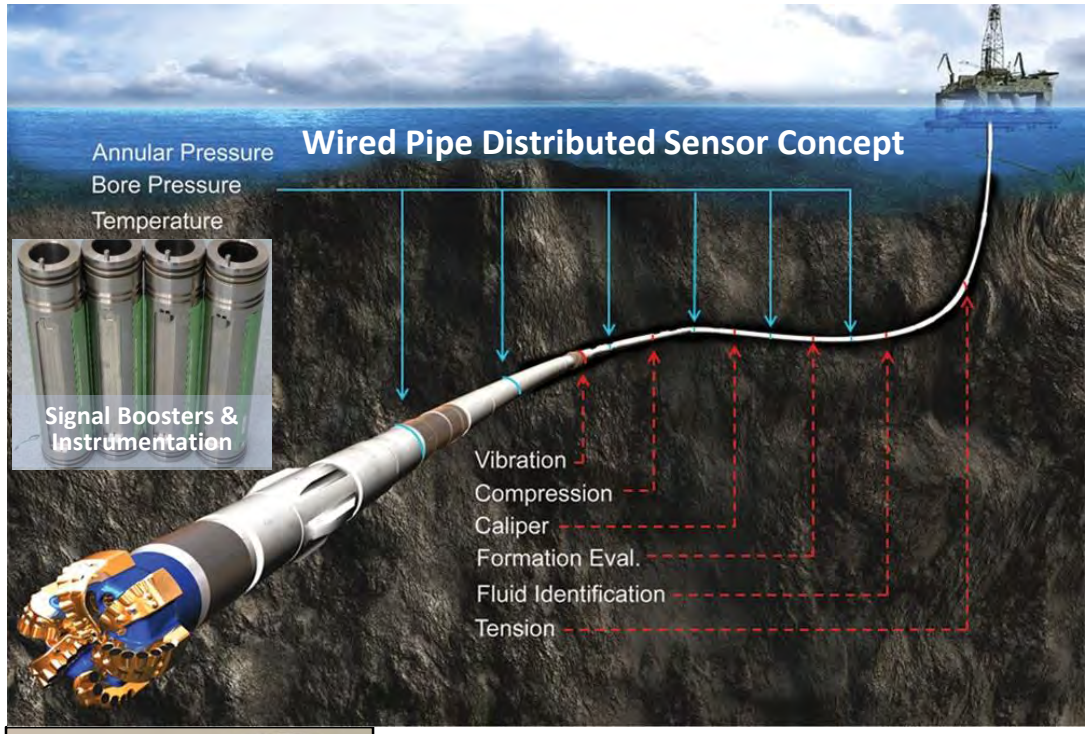
Improved Seismic Imaging Methods Focused on Pressure Prediction and Hazard Avoidance

Reducing Geologic Uncertainty: Early Kick Detection and Management

Geologic Uncertainty



Downhole Kick Detection:
Based on LWD Signal Analytical Model



<u>Enabling Technology</u>: First HPHT DP Cell: Tested to 150 psi DP (2 X Full Scale) with Static Pressure Protection to 22,500 psi. Accurate to 0.5% Full Scale – testing 2 psi full scale device – to sense 0.2 ppg change over a one foot interval

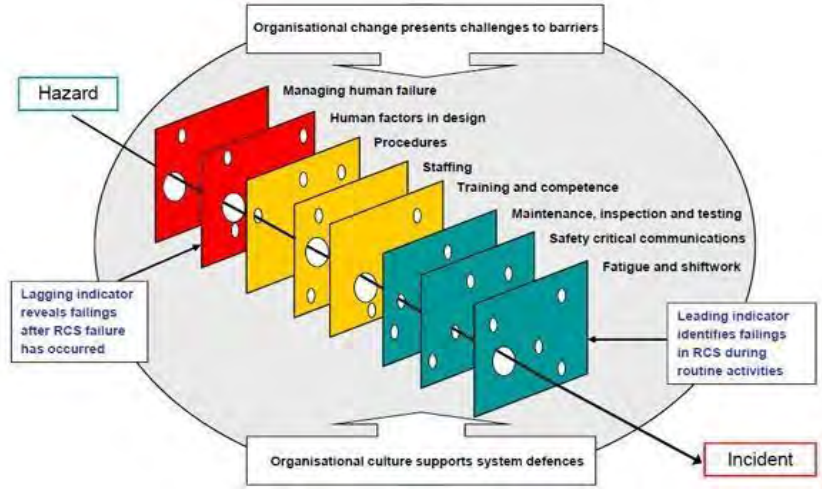
The New/Re-Emphasis on Risk Reduction

Drilling and Completions

Culture of Safety

Leadership

Human Factors – Performance Indicators



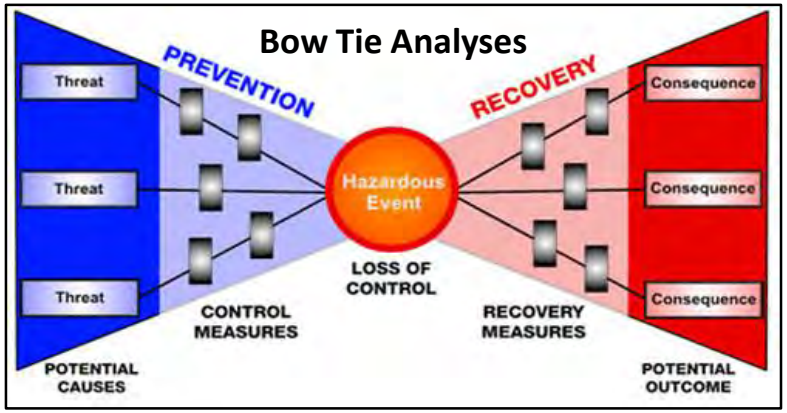
Wellbore Integrity

Barrier Validation

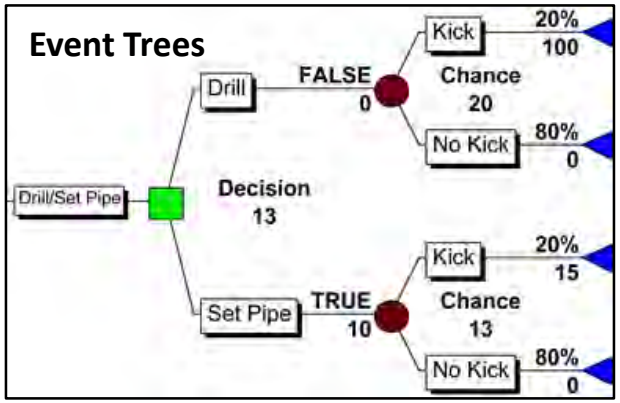
Life of Well

Offshore Energy Safety Advisory Committee

API RP-65-2: Isolating Potential Flow Zones During Well Construction, 2nd Ed./Dec. 2010



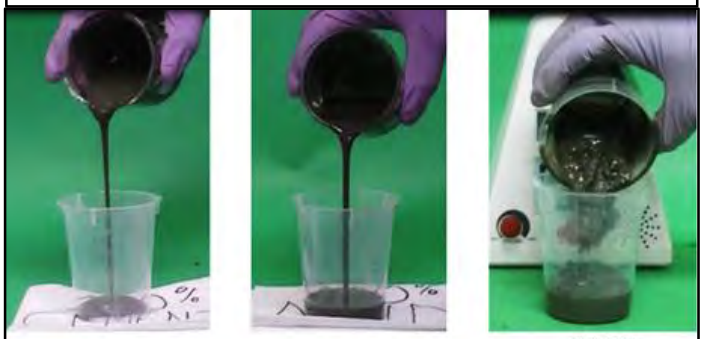
API RP-96: Deepwater Well Design and Construction



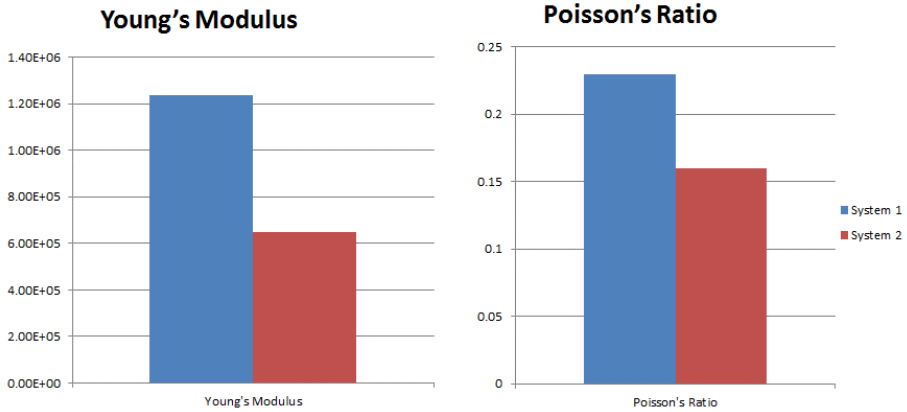
Technologies for Improved Cement Barrier Development and Validation

Drilling and Completions

Improved Understanding of Cement Contamination Limits

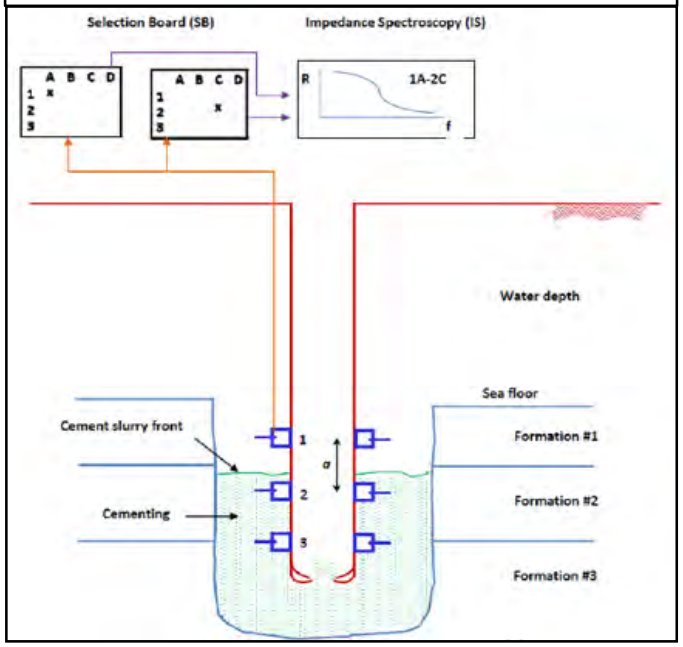


- Overall, System 1 has a much higher durability than System 2



Improving Cement Durability to Hydraulic Fracturing

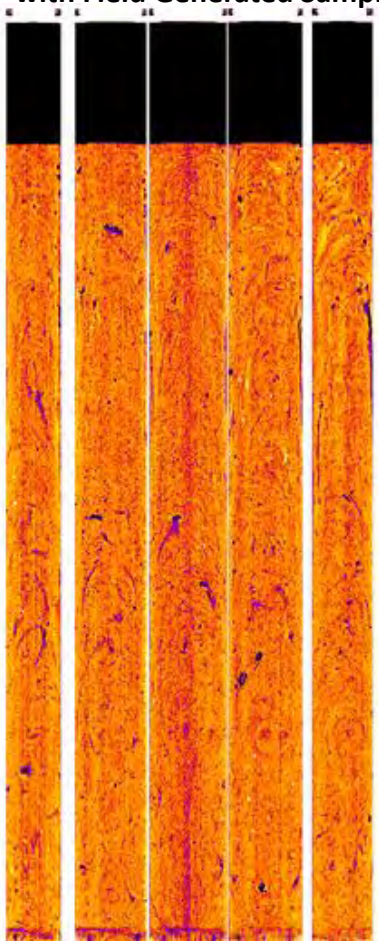
Cement Condition Sensing Using Nanomaterials

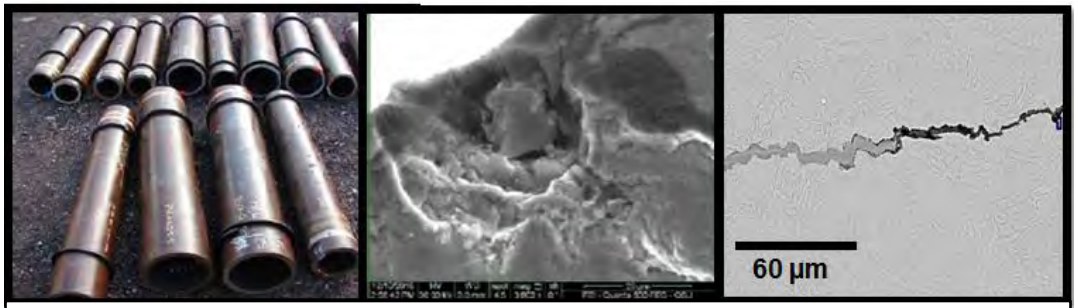


Technologies for Improved Cement Barrier Development

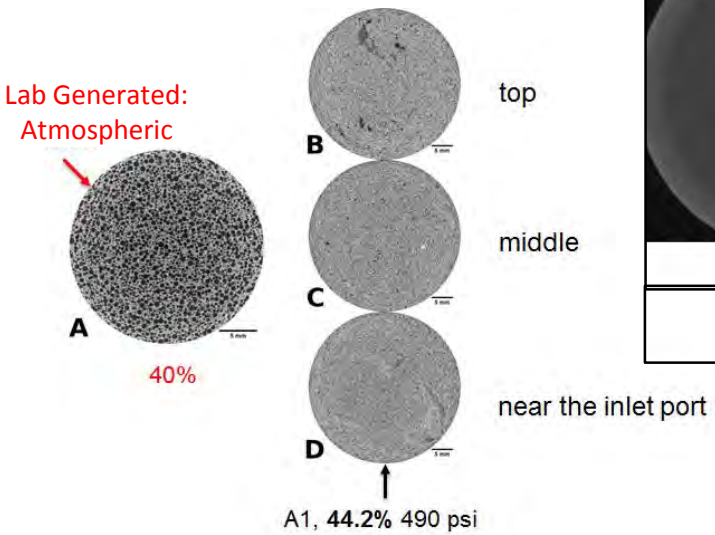
Drilling and Completions

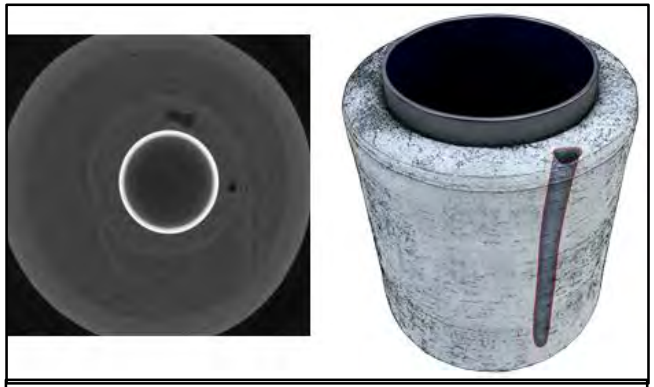
Heterogeneity Comparison of Lab Generated Foam Cement with Field Generated Samples





Evaluating Conventional and Advanced Alloys and Surface Treatments in Extreme Wellbore Conditions

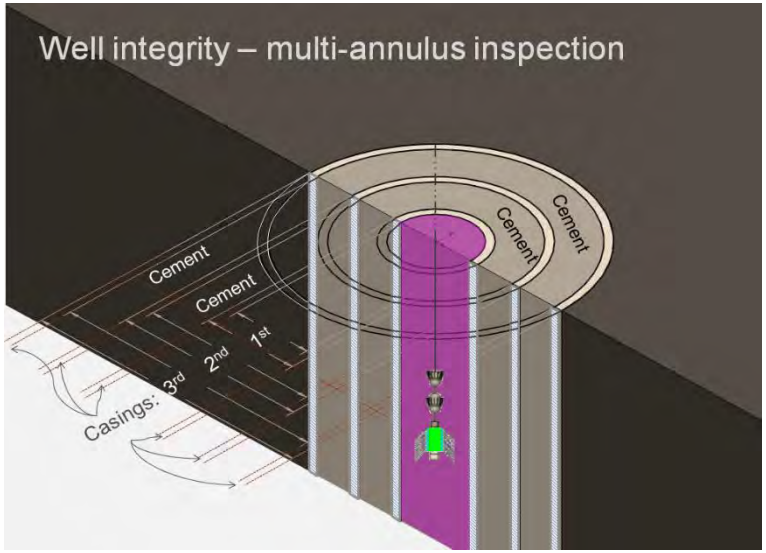




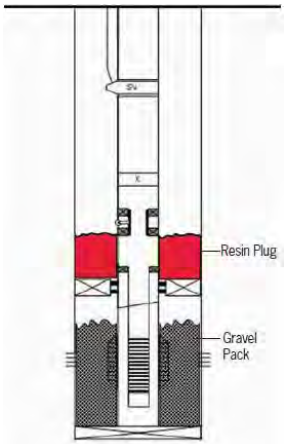
Barrier Interface Integrity Under Subsurface Conditions

New Technologies for Inspection and Remediation

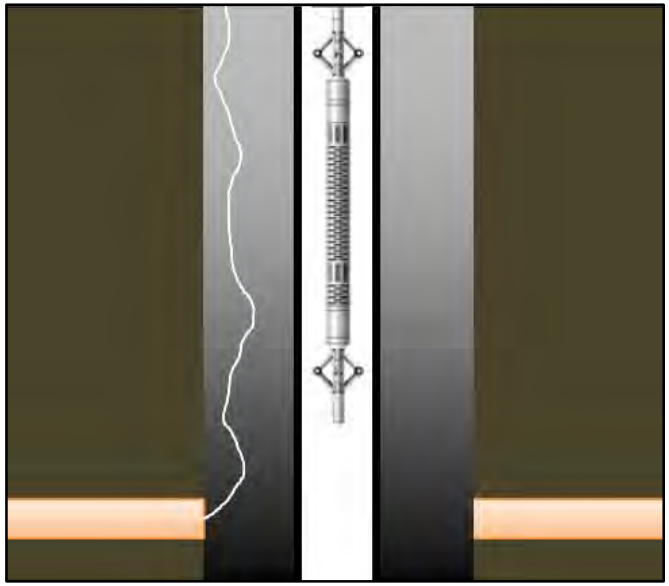
Drilling and Completions



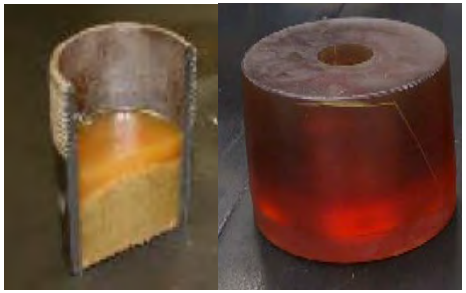
Deeper Sensing Tools for Improved Monitoring



Resin Seal for a Leaking Packer



Flow Detection/Orientation Technology For Precise Remediation

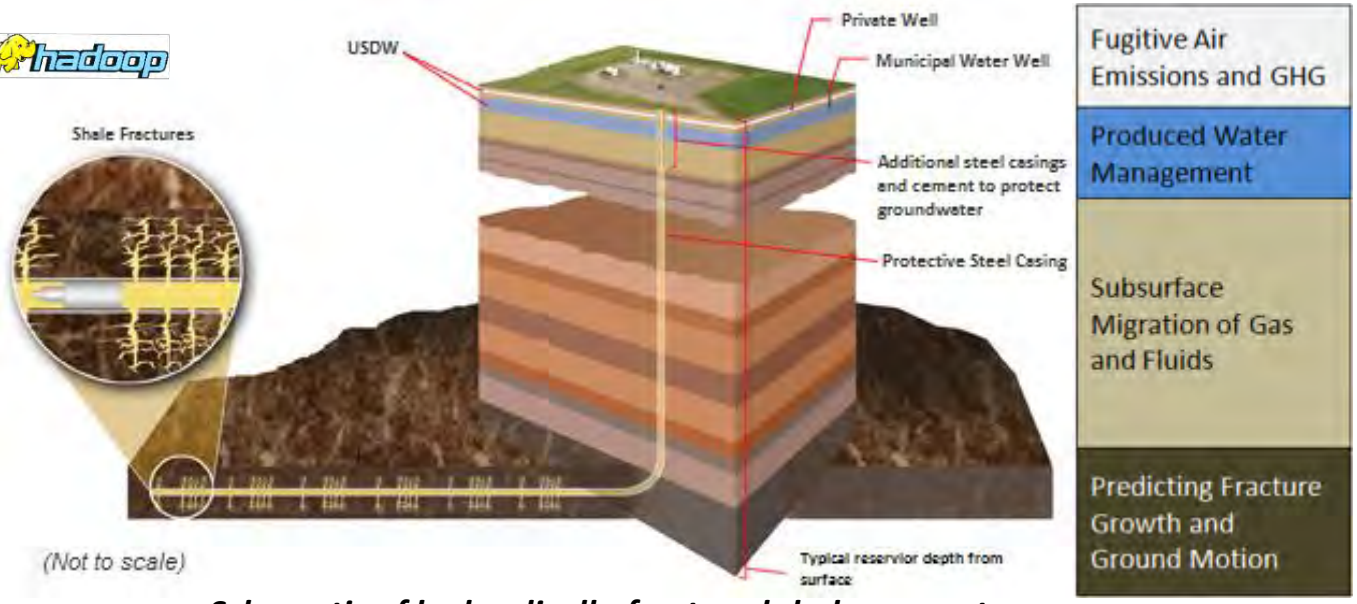


Prior Deep Trek Work

Resin Falling/Roping Through Water

Big Data -
in the Age of Onshore Risk Reduction

Sustainable Unconventional Resource Development



Schematic of hydraulically-fractured shale gas system

https://edx.netl.doe.gov/UCR

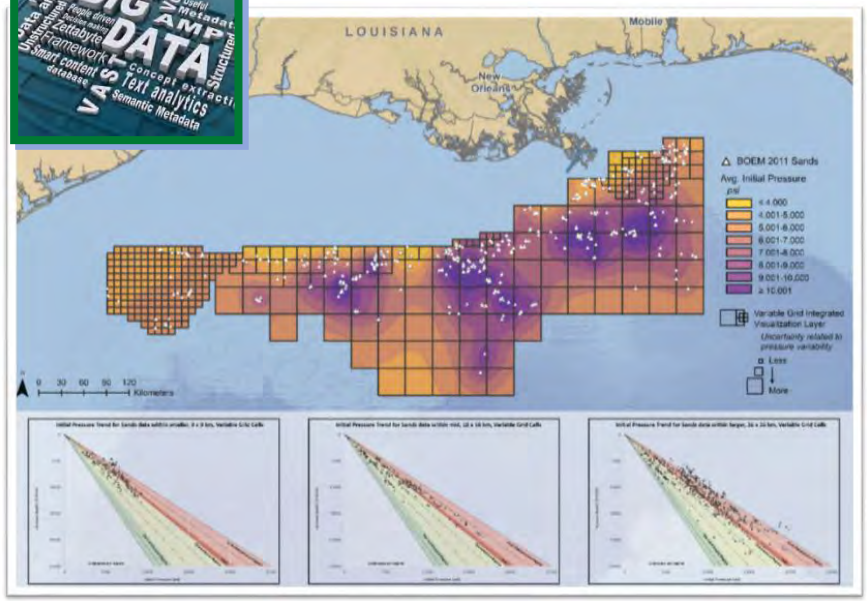
The research includes building a general understanding of:

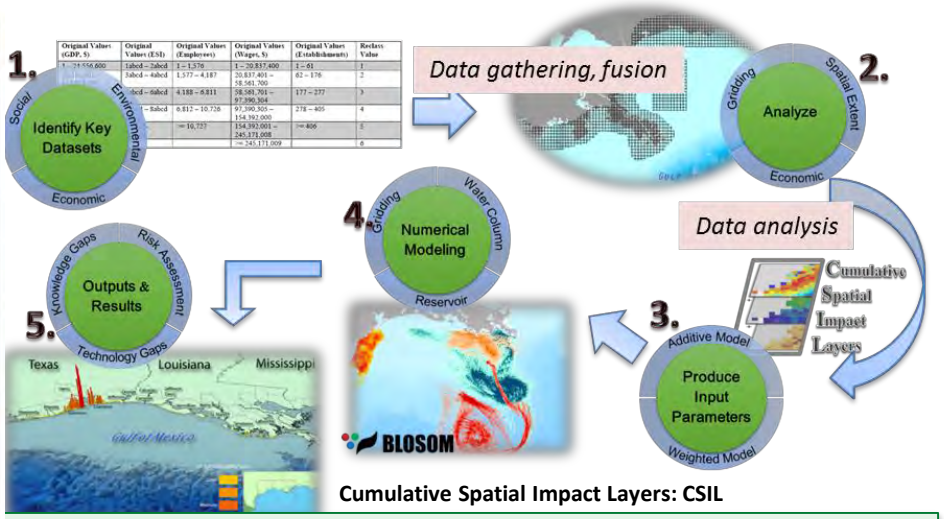
- Spatial variations in reservoir properties that impact risk
- Wellbore integrity (particularly for pre-existing wellbores)
- Fracture propagation dynamics
- Groundwater and surface water geochemistry and hydrogeology
- Air quality

Results from the various components of this research plan will form the groundwork for developing an Integrated Risk Assessment Model (IRAM) for predicting subsurface risks associated with unconventional shale gas development.

Big Data -
in the Age of Offshore Risk Reduction

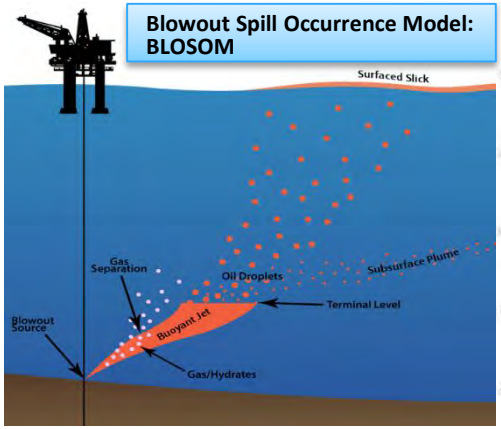
hadoop



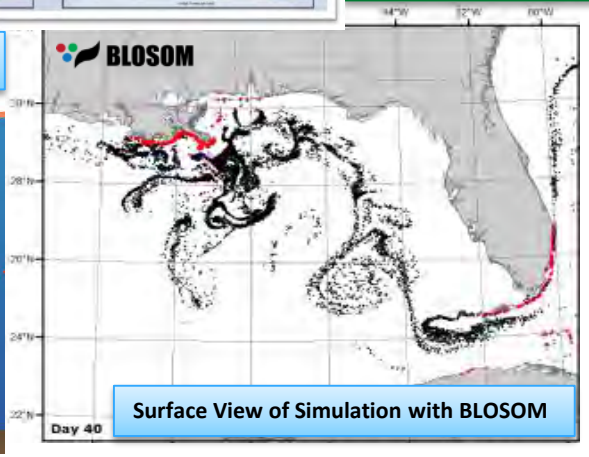


Cumulative Spatial Impact Layers: CSIL

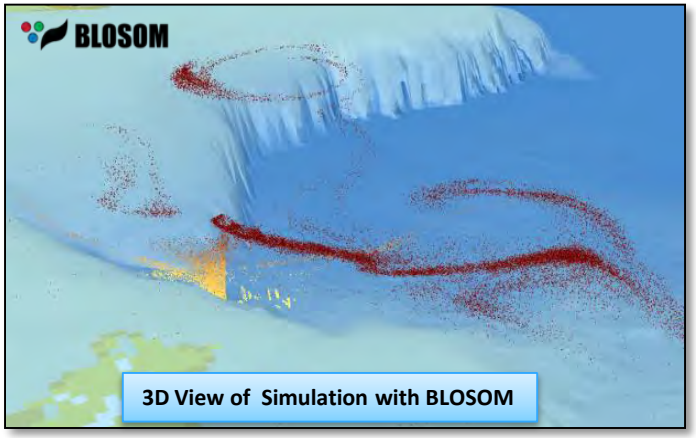
Example geospatial, spatio-temporal statistical approach developed by NETL to support offshore hydrocarbon impacts assessment



Blowout Spill Occurrence Model: BLOSOM

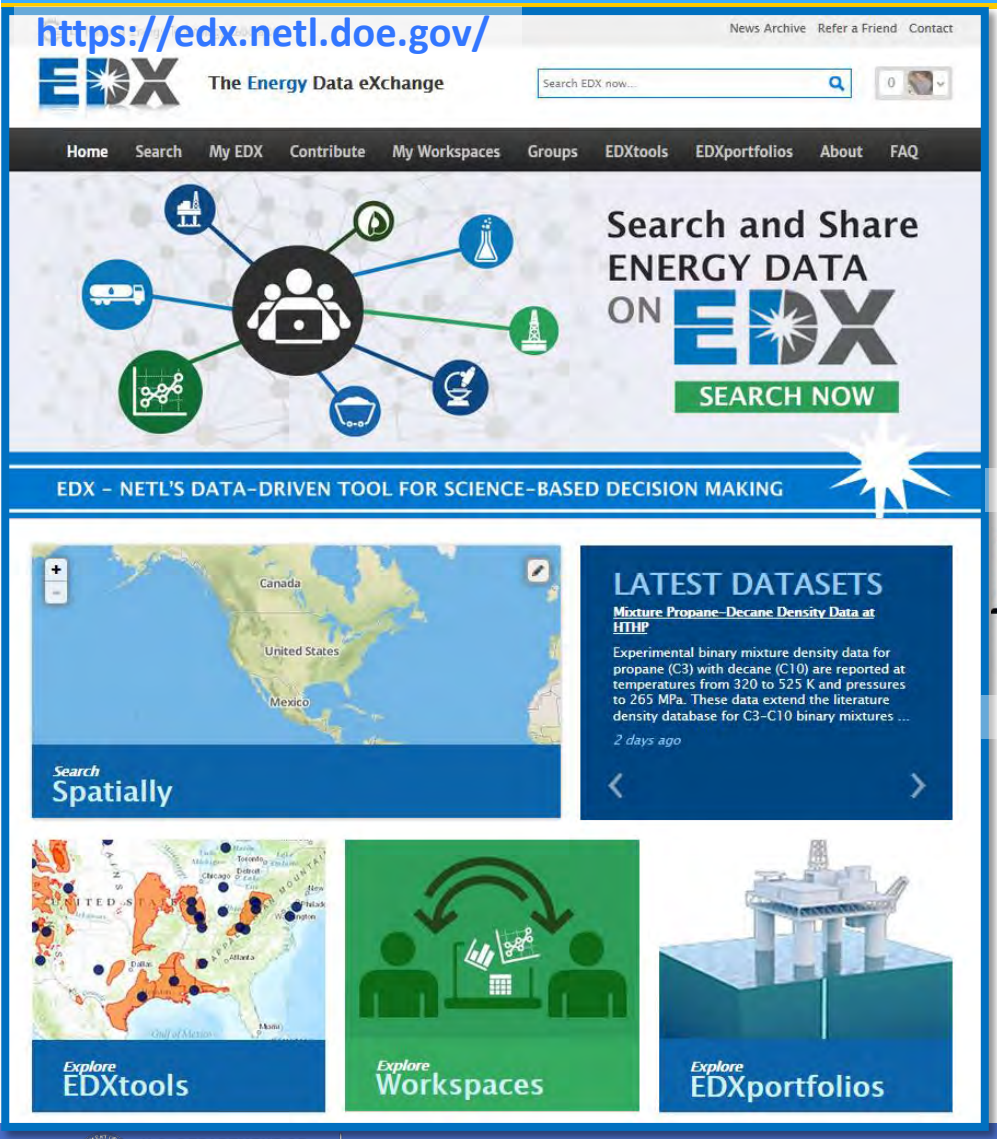


Surface View of Simulation with BLOSOM



3D View of Simulation with BLOSOM

EDX: NETL's Big Data Portal



Motivation for EDX was in part a result of the BP Deepwater Horizon

EDX is ready to serve if there are needs requiring multi-organizational energy R&D to support the government efforts.

https://edx.netl.doe.gov/Offshore

https://edx.netl.doe.gov/UCR

What is EDX...

- An online platform for **rapid and efficient access** to priority datasets
- Provides an opportunity for researchers to **share** and "publish" online **datasets & data-driven products**
- A **secure** environment for **multi-organizational** research **teams** to share, build, and **collaborate** in a common workspace
- **Online** tool to **disseminate** data, information, and results from **DOE's Fossil Energy** intramural **research** portfolios

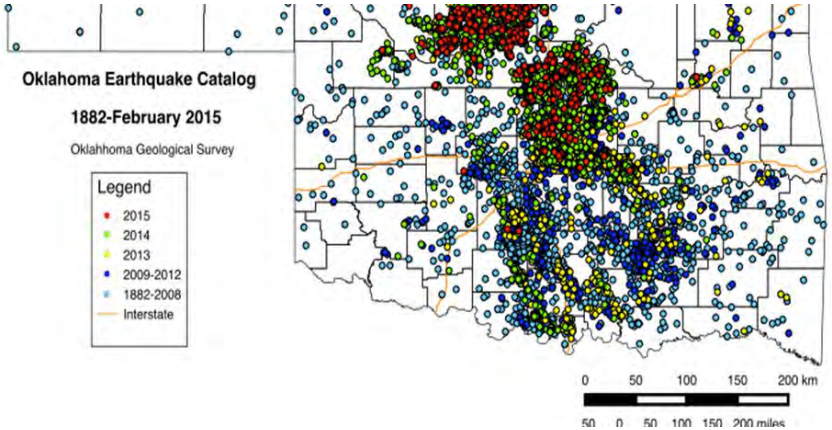
Potential Future Applications of New Technologies

Enabling Mapping of M0.0 Events –
and Possibly Lower Magnitudes

hadoop

Big Data Analytical Solutions

Enhance Research to Help Mitigate:



Best conventional technology (EarthScope transportable array) not adequate to accurately locate events smaller than about a magnitude 2.5

NETL Project #12122-91:
"4D Integrated Study Using Geology, Geophysics, Reservoir Modeling & Rock Mechanics to Develop Assessment Models for Potential Induced Seismicity Risk"
Awardee: Oklahoma Geological Society
PI: Dr. Jeremy Boak

It’s All About a Clean, Affordable Energy Future

For More Information, Contact NETL

the ENERGY lab

Delivering Yesterday and Preparing for Tomorrow