



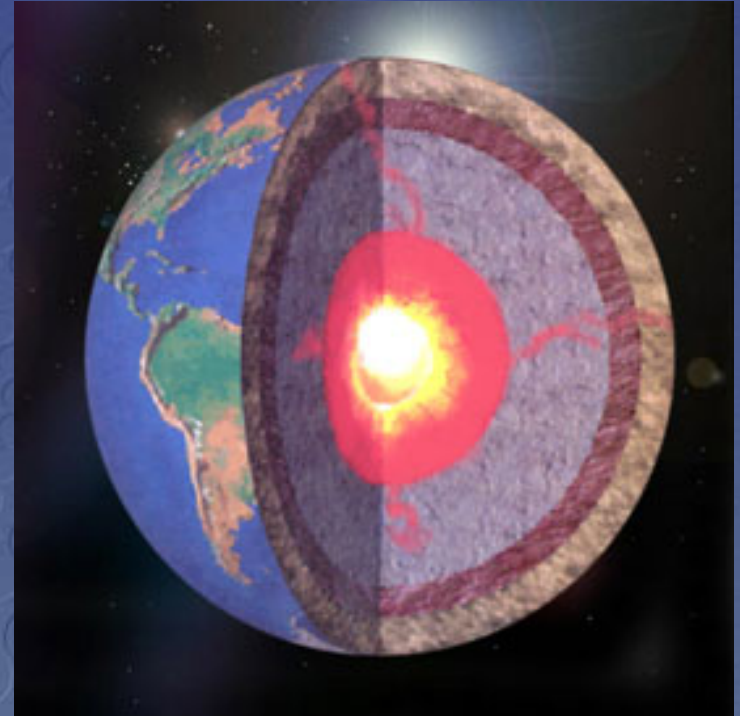
**IOGCC**  
**Micro and Nano Sensors for the**  
**Sub-Surface**  
**May 17, 2021**

**Bureau of Economic Geology**  
**Jackson School of Geosciences**  
**The University of Texas at Austin**

# Taking a Page Out of the Medical Industry...



Source - Top News Health



Source-Berkley Lab

# Smart Dust



# Our Vision

To illuminate the subsurface reservoir using novel micro- and nanosensing technology developed collaboratively with AEC members and the global community to enhance commercial extraction of oil and natural gas and create a competitive advantage for our members.

**Since our inception in 2008 we have invested over \$50 million in research and established more than 45 patents**



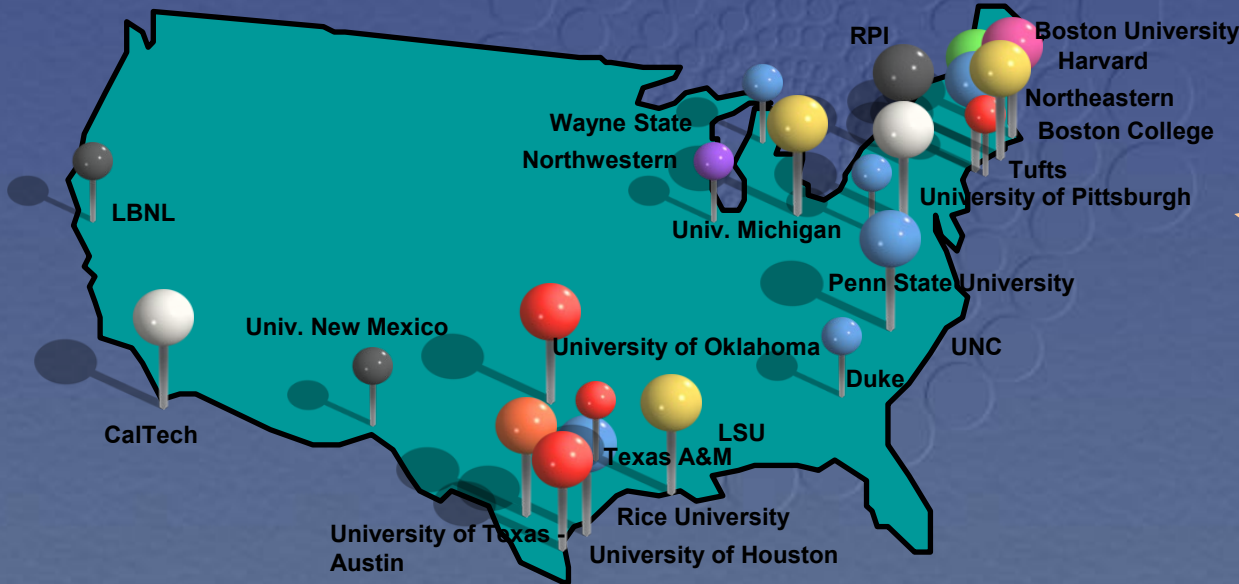
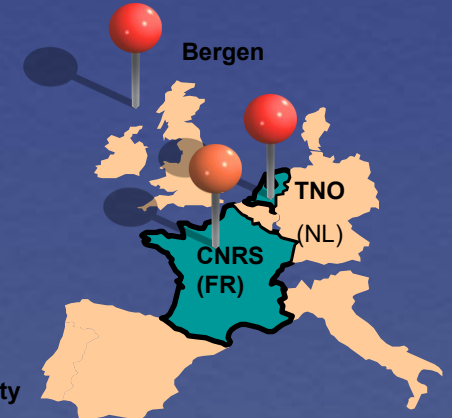


# But how does this effect a regulator?



# We Wanted to Engage the Best and Brightest Minds

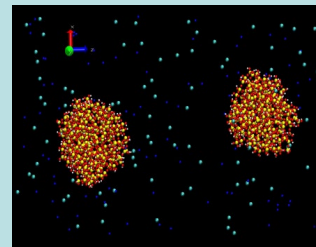
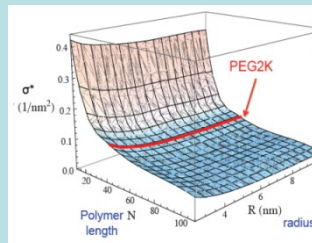
More than 400 Academics from  
30 different Universities &  
Research Institutions around  
the world



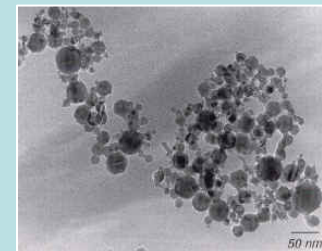
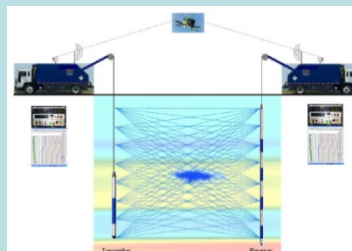
# AEC Research Portfolio

## (Four Scientific Thrusts)

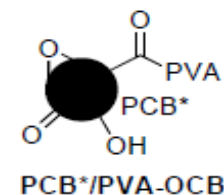
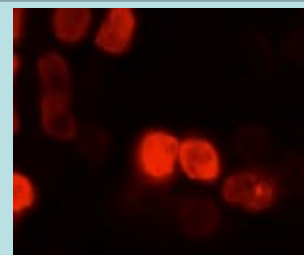
### 1) MOBILITY



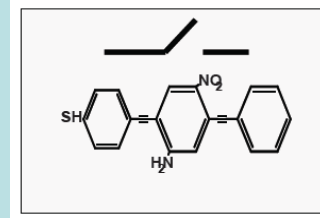
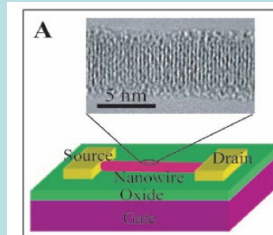
### 2) CONTRAST AGENTS



### 3) NANOMATERIAL SENSORS



### 4) MICRO-FABRICATED SENSORS





# AEC Research

In the first 6 years of the consortium we developed an impressive base of understanding



- Chemical coatings for mobility
- Smallest pressure sensors
- ph, resistivity, stress, pressure, temperature sensors
- High temperature batteries
- High temperature sensor platform
- Payload delivery capsules
- EM modelling software
- Contrast agents



# Prototyping



**Smarter Sensors/Proppant**



**Particles to illuminate  
the subsurface**



**Downhole Semiconductors**



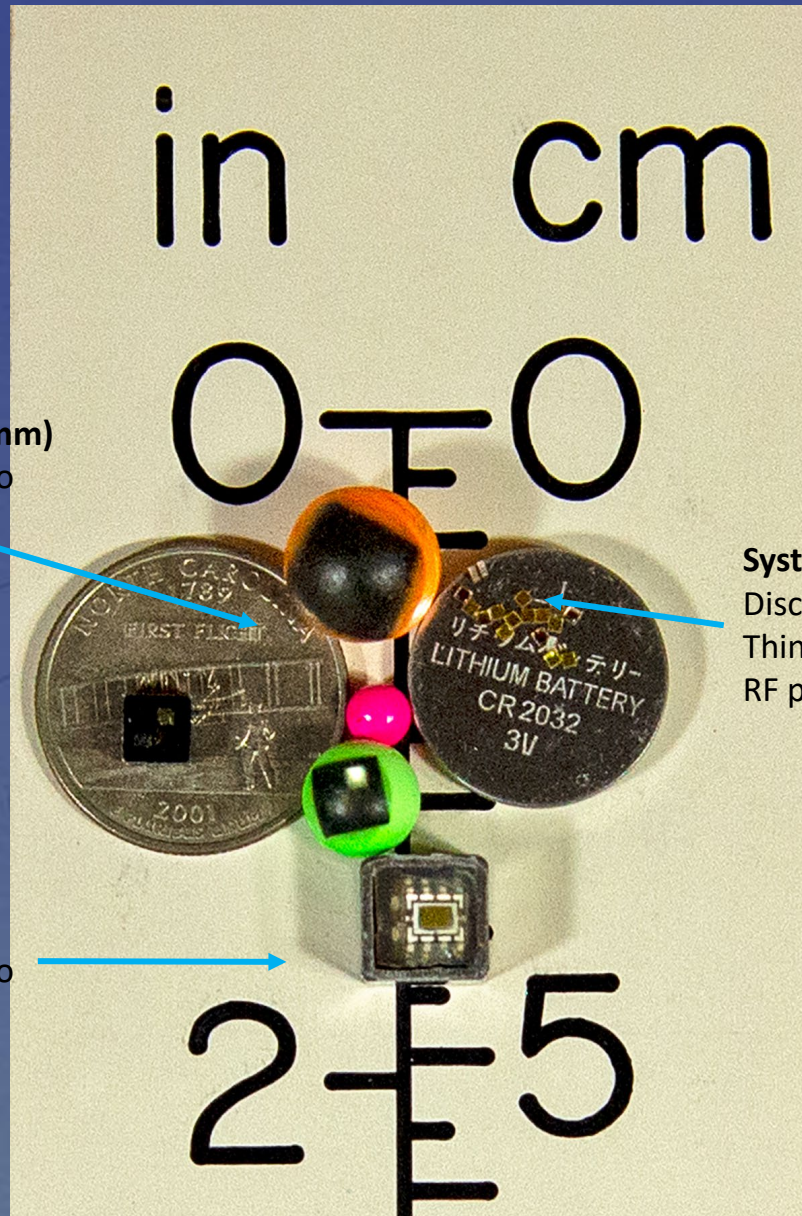
**Micro and nano  
payload delivery  
capsules**

# AEC's Microsensor Technology

**Stacked Chip System (5-12mm)**  
Temp/Pressure/Time Combo  
Polymer Packaging  
10-40hrs lifetime

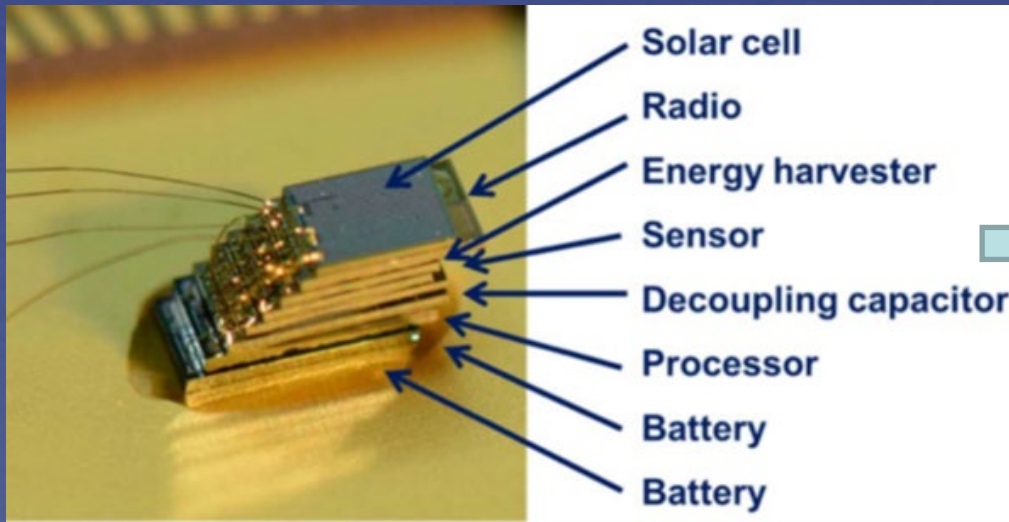
**System on a Chip (1mm)**  
Discrete Temp, Press, Resist, pH  
Thin film packaging  
RF powered, battery-less, 30yr lifetime

**System on a Board (8mm)**  
Temp/Pressure/Time Combo  
Steel Packaging  
10-16hrs lifetime

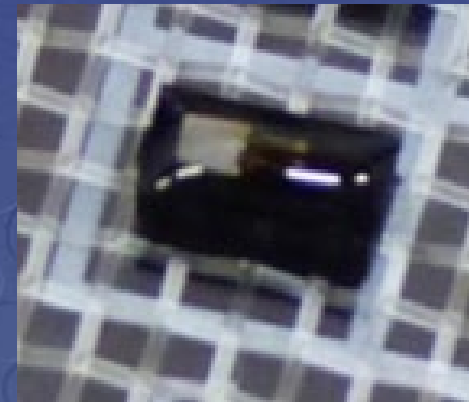




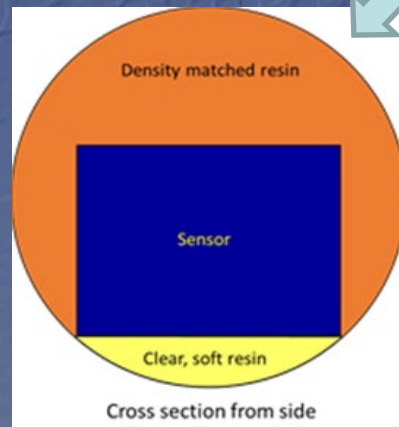
# Microsystem Components



Stacked Chip System



Hermetic Encapsulation



Buoyancy Adjusting Final Encapsulation (5-12mm)

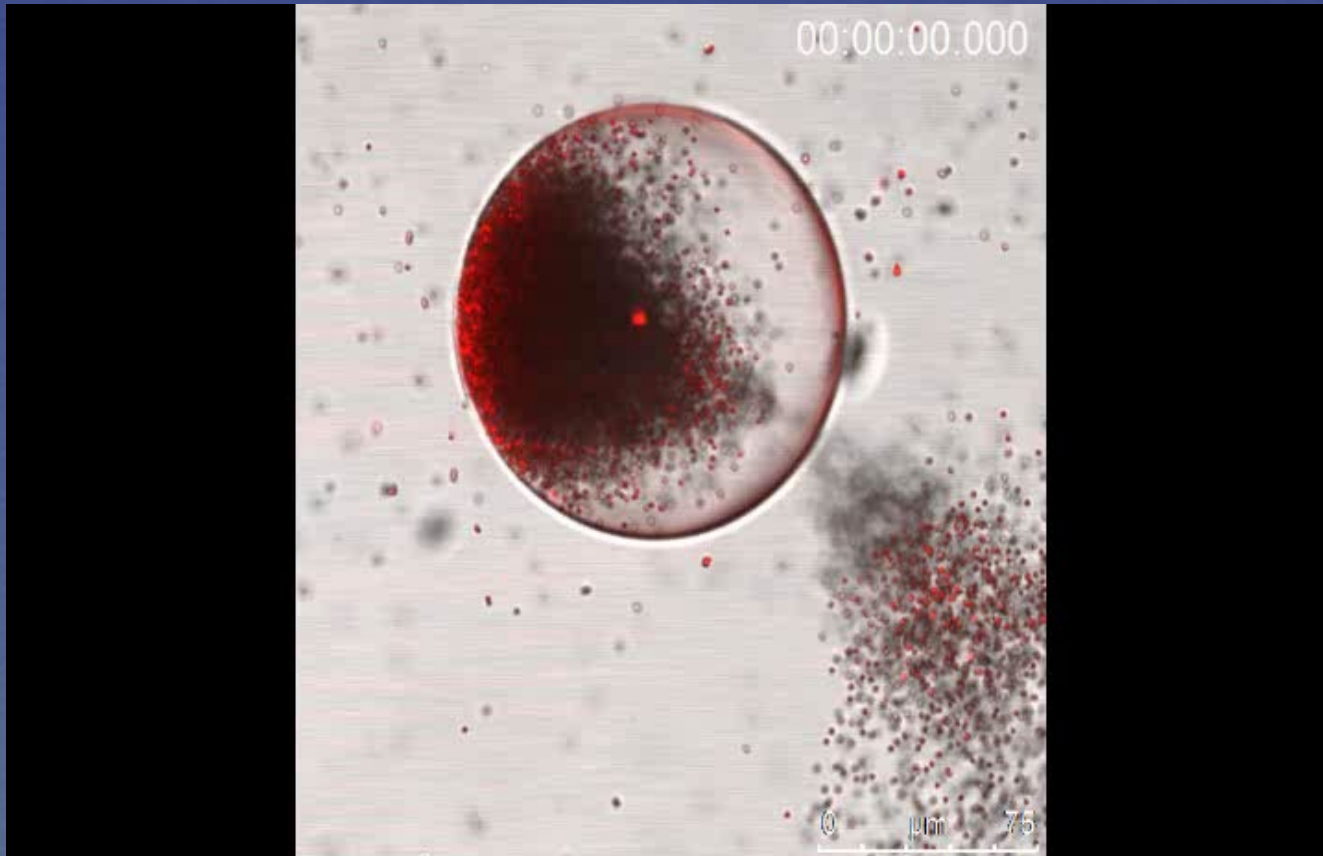




# Payload Delivery



# Payload Delivery

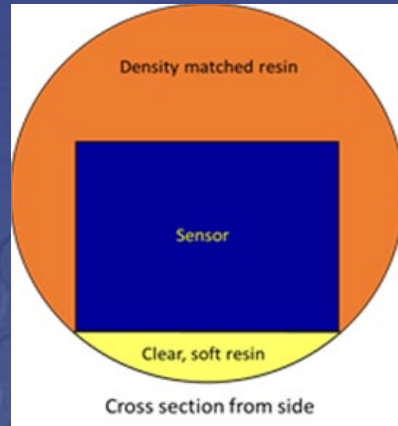




# Some Current Applications



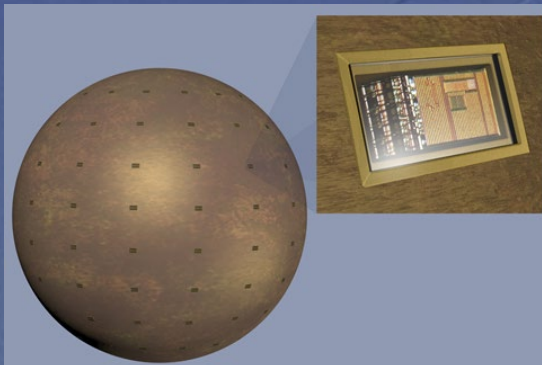
Attached to Well Rod



Recirculated in Wellbores, for Fracture Stage Contribution



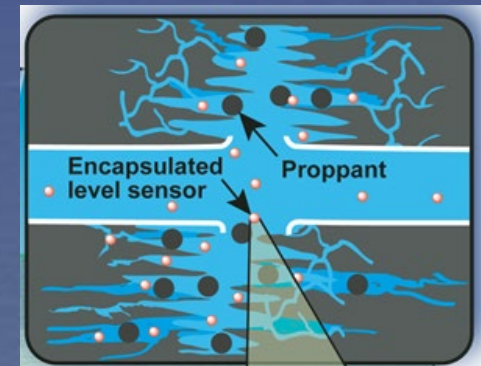
Entrapped in Cement



Frac Stage Isolation



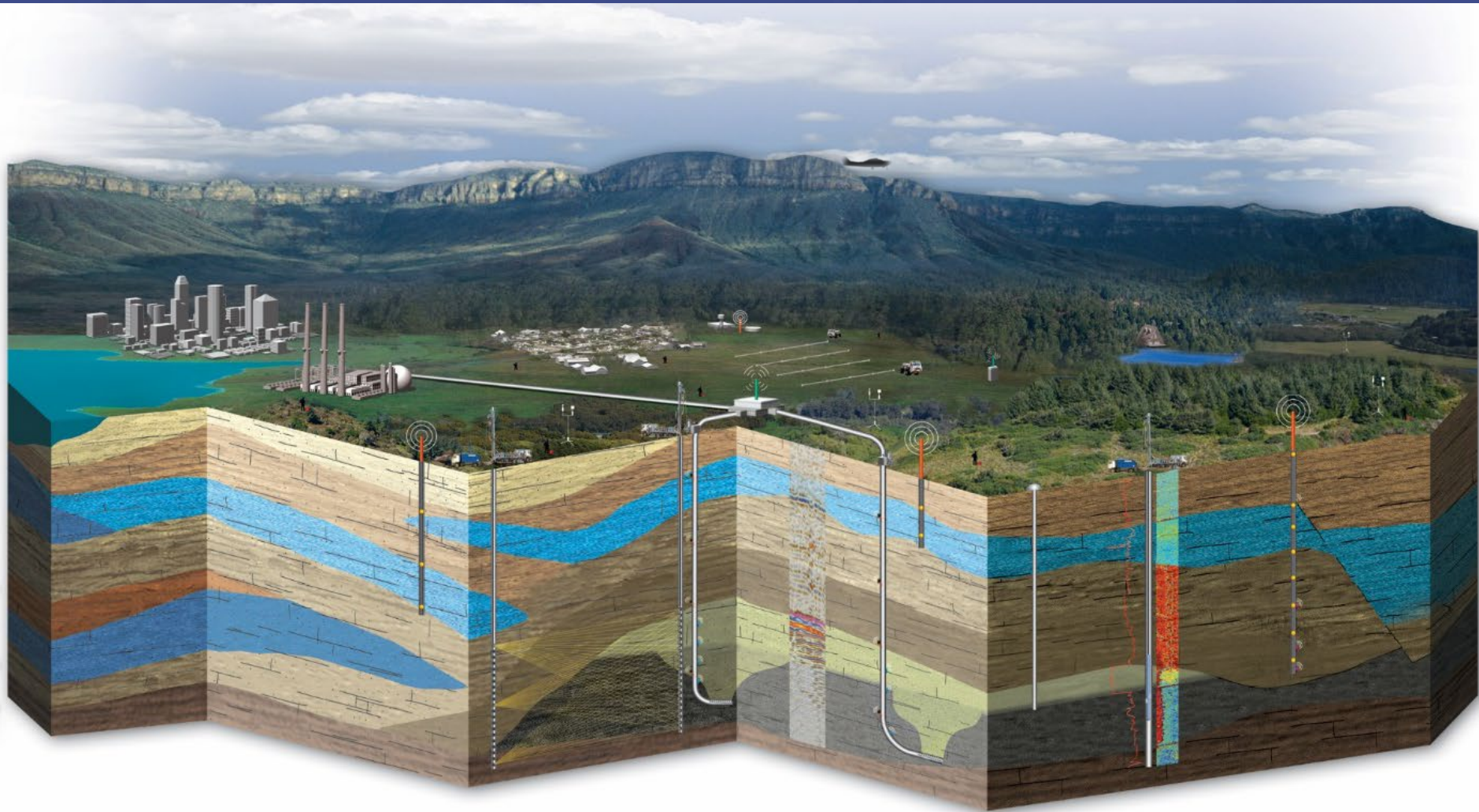
Pipeline Pigging – data driven corrosion inhibitor schedule\*



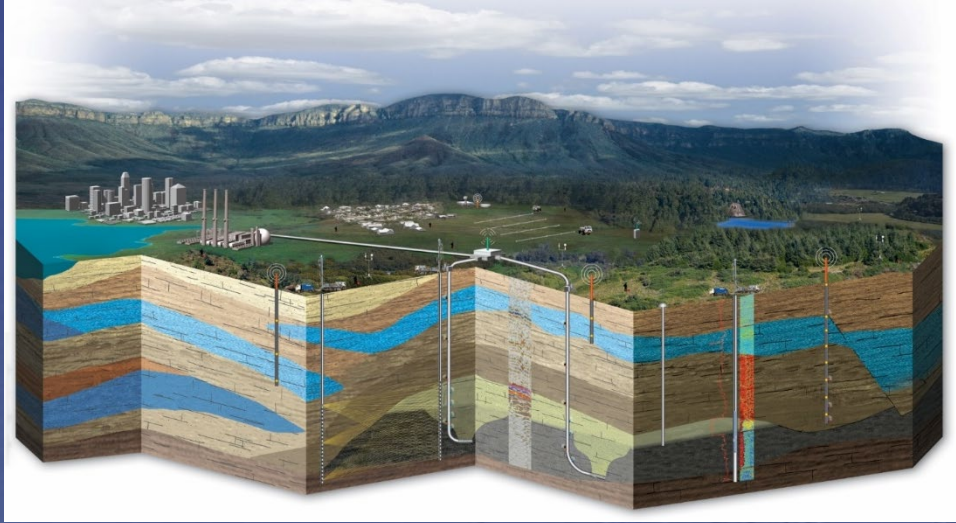
Entrapped in Fractures



# Numerous Applications Identified



# Non Oil & Gas Applications



There are numerous applications for subsurface sensors in other industries.

The AEC has created an impressive set of capabilities that others can leverage. We just need to find the large scale field environments to prove the value of these new cutting edge applications

- Pipelines – sensors on pipeline pigs
- Carbon Sequestration – mapping CO2 plumes
- Geothermal Energy – developing subsurface temperature maps
- Mining – sensors and mapping of leaching operations
- Nuclear – down hole well bore integrity, temperature and pressure monitoring
- Water – water remediation
- Construction – cement stress monitoring



## Summary...

- **Opened consortium in Jan. 2008**
- **Invested more than \$50 million in research**
- **Initiated more than 45 patents**
- **Over 300 peer reviewed papers**
- **Technologies ready to commercialize**
- **Potential to move into many other markets**

# But how does this effect a regulator?



**Thank-you**

**Questions?**