U.S. Department of Energy/NETL

MRCSP Phase III Geologic Test

at the Andersons/Marathon Ethanol Plant Greenville, Ohio

Briefing for the Public and Media
Greenville, Ohio
August 13, 2008

The MRCSP is being conducted by Battelle under DOE/NETL Contract DE-FC26-05NT42589

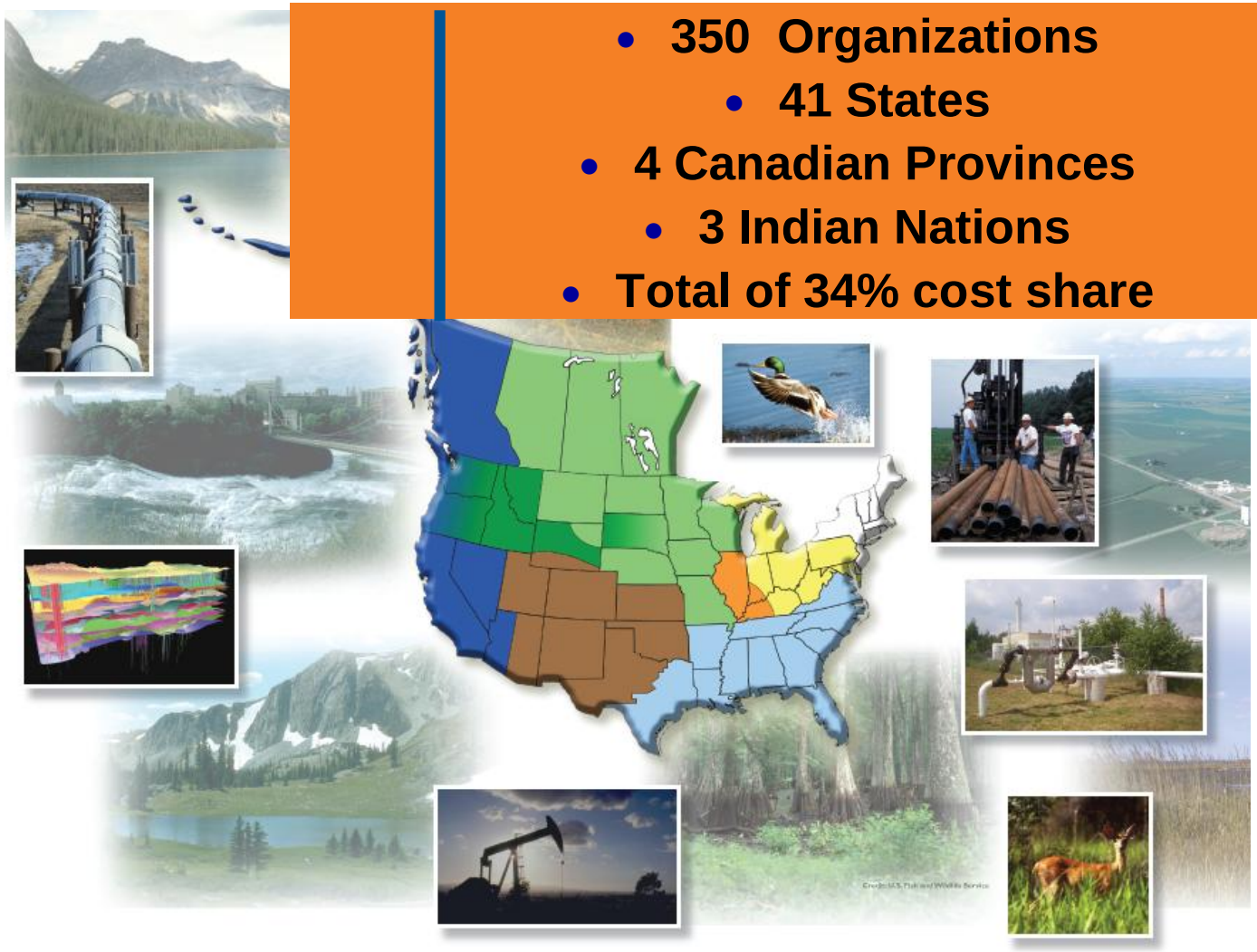
Today's Briefing

- Who are we?
- What are we proposing to do?
- Why is this important?
- Why did we choose this site?
- What are we going to do and how will we do it?
- What do we expect to learn from this test?
- Why do we think this test is safe?

Regional Carbon Sequestration Partnerships

"Developing the Infrastructure for Wide Scale Deployment"

- 350 Organizations
- 41 States
- 4 Canadian Provinces
- 3 Indian Nations
- Total of 34% cost share



Regional Carbon Sequestration Partnerships

West Coast Regional Carbon Sequestration Partnership westcarb.org	California Energy Commission http://www.westcarb.org/
Southwest Regional Partnership on Carbon Sequestration	New Mexico Institute of Mining and Technology http://www.southwestcarbonpartnership.org/
BIGSKYCARBON SEQUESTRATION PARTNERSHIP	Montana State University http://www.bigskyco2.org/
The Plains CO_2 Reduction Partnership PCOR Partnership	University of North Dakota, Energy & Environmental Research Center http://www.undeerc.org/pcor/
MGSC	University of Illinois, Illinois State Geological Survey http://www.sequestration.org/
MRCSP MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP	Battelle Memorial Institute http://www.mrcsp.org/
Southeast Regional Carbon Sequestration Partnership	Southern States Energy Board http://www.secarbon.org/

Characterization Phase

- 24 months (2003-2005)
- 7 Partnerships (41 states)
- $16M DOE funds

Validation Phase

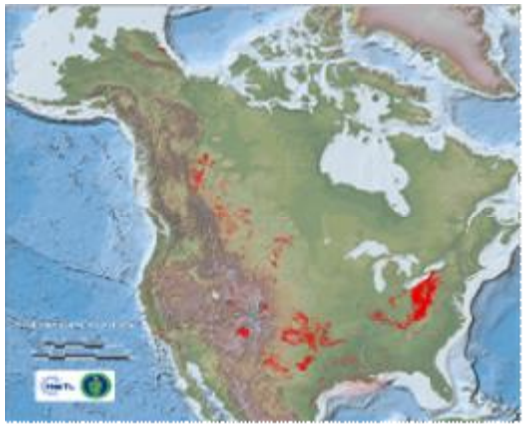
- 4 years (2005 - 2009)
- Field validation tests
  - Over 20 Geologic
  - 11 Terrestrial
- $112M DOE funds
- $43M cost share

Deployment Phase

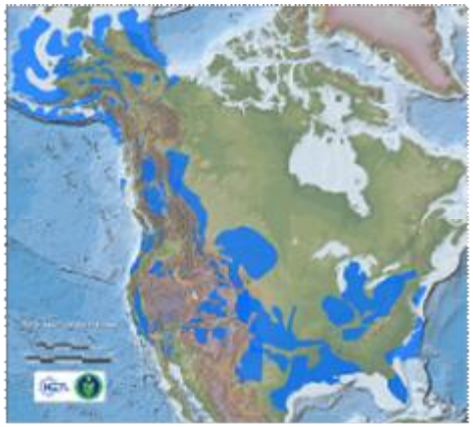
- 10 years (2008-2017)
- Seven large volume injection tests
- Over $700M DOE and cost share

National Atlas Highlights
Adequate Storage Projected

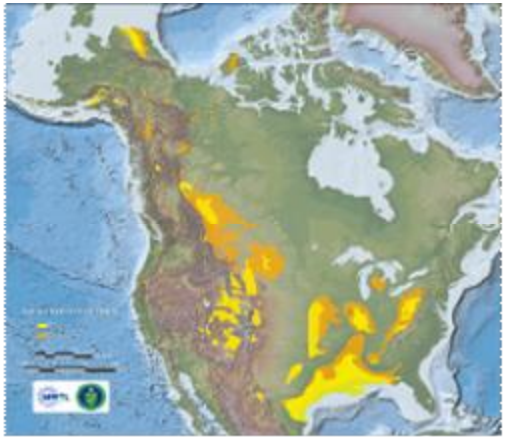
U.S. Emissions ~ 6 GT CO_2/yr all sources



Oil and Gas Fields



Saline Formations



Unmineable Coal Seams

Conservative Resource Assessment

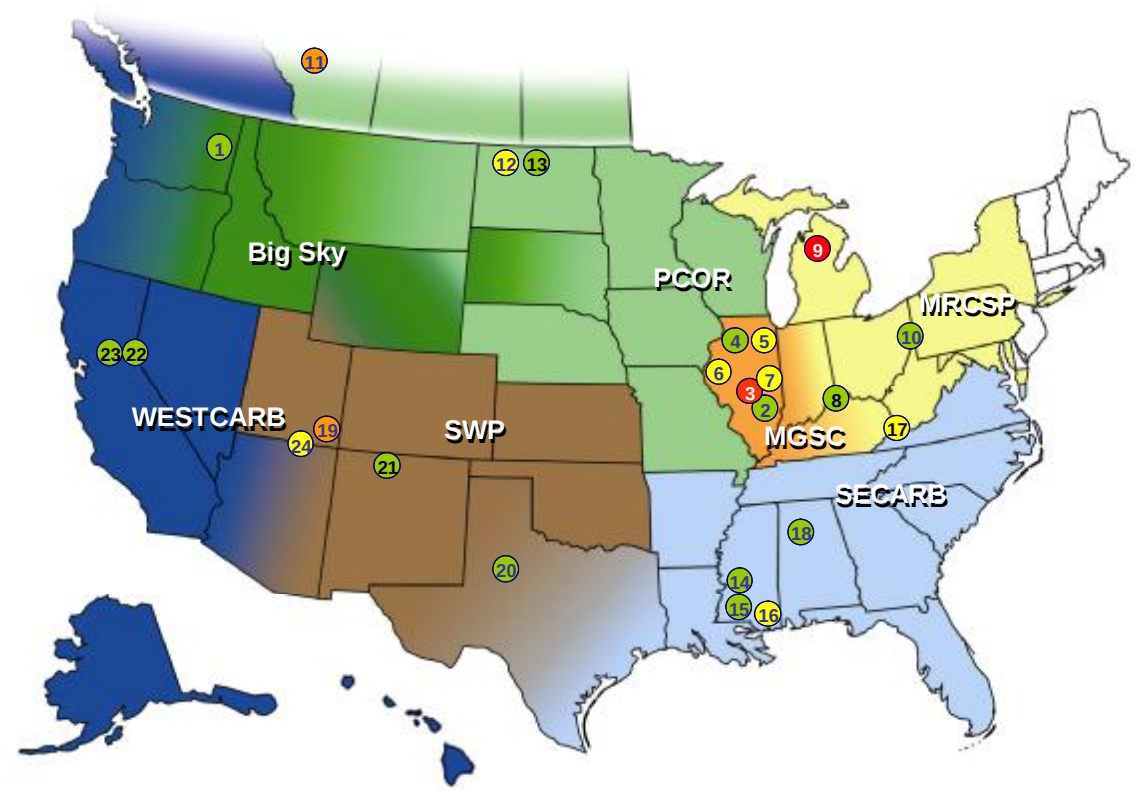
North American CO_2 Storage Potential (Giga Tons)

Sink Type	Low	High
Saline Formations	**919**	**3,643**
Unmineable Coal Seams	**156**	**187**
Oil and Gas Fields	**82**	**82**

Hundreds of Years of Storage Potential

Available for download at http://www.netl.doe.gov/publications/carbon_seq/refshelf.html

Validation Phase – Geologic Field Tests Injection Schedule

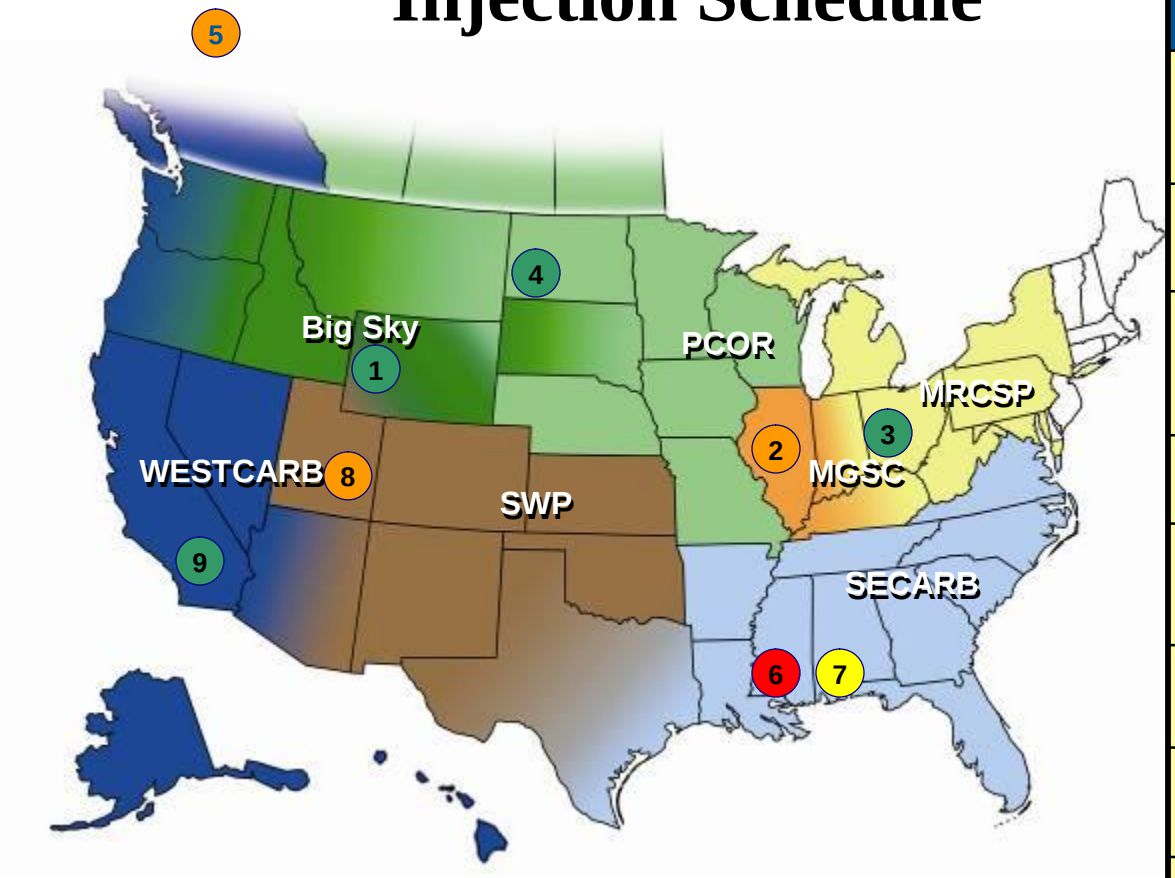


Injection Schedule

- Injection Complete
- Injection Ongoing
- 2008 Injection Scheduled
- 2009 Injection Scheduled

	Partnership	Geologic Province	Formation Type
1		Columbia Basin	Saline
2		Illinois Basin	Saline
3		Illinois Basin	Oil Bearing Heavy
4	MGSC	Illinois Basin	Oil Bearing Well Conversion
5		Illinois Basin	Oil Bearing Pattern Flood I
6		Illinois Basin	Oil Bearing Pattern Flood II
7		Illinois Basin	Coal Seam
8		Cincinnati Arch	Saline
9	MRCSP	Michigan Basin	Saline
10		Appalachian Basin	Saline
11		Keg River Formation	Oil Bearing
12	PCOR	Duperow Formation	Oil Bearing
13		Williston Basin	Coal Seam
14		Gulf Coast } stacked test	Oil-Bearing
15		Gulf Coast	Saline
16		Mississippi Salt Basin	Saline
17		Central Appalachian	Coal Seam
18		Black Warrior Basin	Coal Seam
19		Paradox Basin, Aneth Fie	Oil Bearing
20	SWP	Permian Basin	Oil Bearing
21		San Juan Basin	Coal Seam
22		Thornton Gas Field } stacked test	Saline
23		Thornton Gas Field	Gas Bearing
24		Colorado Plateau	Saline

Large Scale Field Tests
Injection Schedule



Injection Schedule

- 2008 Injection Scheduled
- 2009 Injection Scheduled
- 2010 Injection Scheduled
- 2011 Injection Scheduled

	Partnership	Geologic Province	Formation Type
1	Big Sky Carbon	Triassic Nugget Sandstone/ Moxa Arch	Saline
2	MGSC	Mt. Simon Sandstone	Saline
3	MRCSP	Mt. Simon Sandstone	Saline
4	PCOR	Williston Basin	Oil Bearing
5	PCOR	Devonian Age Carbonate Rock	Saline
6	SECARB	Lower Tuscaloosa Formation Massive Sand Unit	Saline
7	SECARB	Lower Tuscaloosa Formation Massive Sand Unit	Saline
8	SWP	Regional Jurassic and Older Formations	Saline
9	WESTCARB	San Joaquin Basin	Saline

Battelle is a global leader in developing technology for commercial use

Founded in 1929 in Columbus, Ohio

Today

- $4 billion revenue
- 21,000 staff
- $920 million energy RD&D
- 9 major facilities

Four Global Businesses

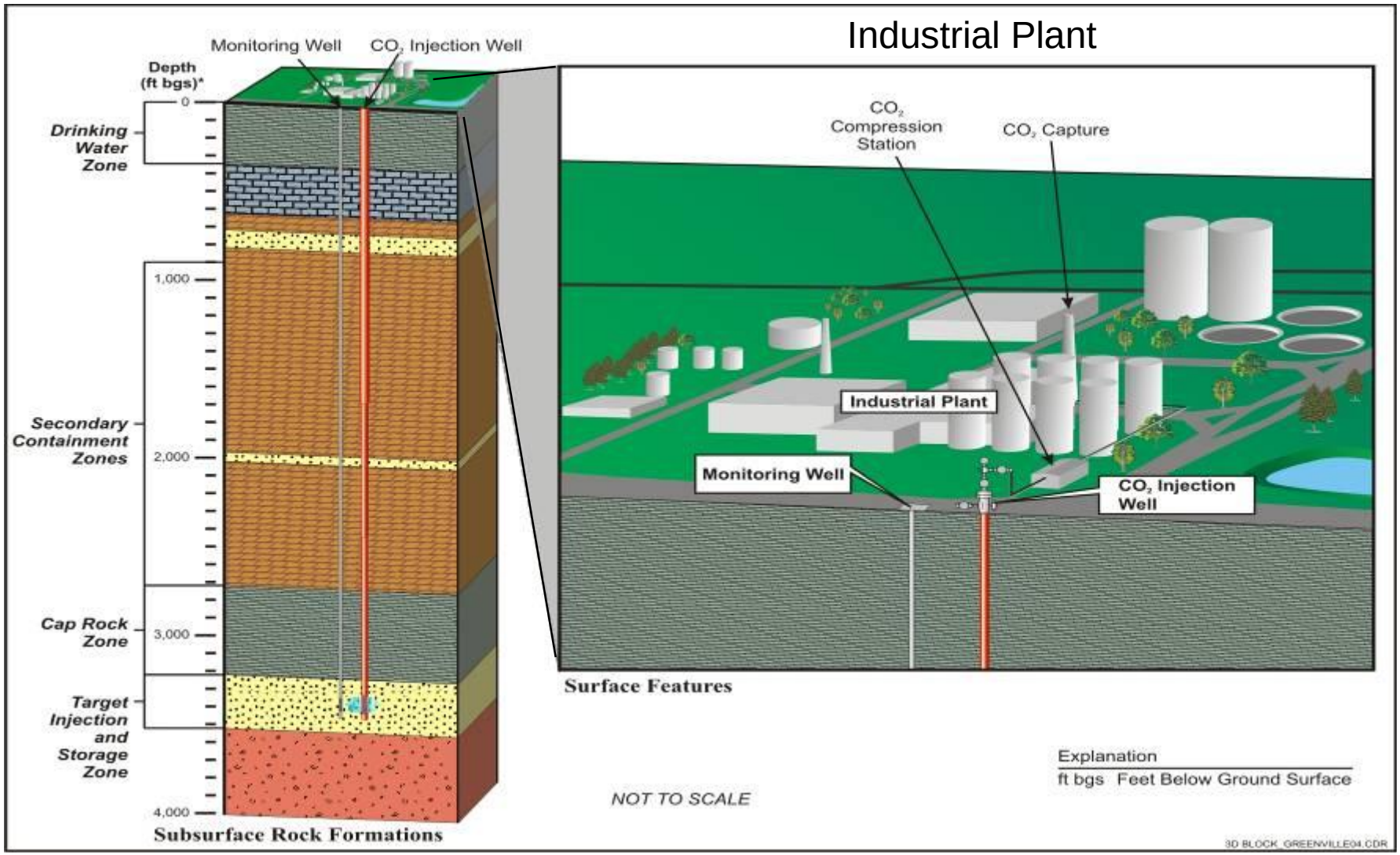
- Energy
- National Security
- Health and Life Sciences
- Laboratory Management

Major Facilities

- Columbus Operations (headquarters)
- Pacific Northwest Lab (PNNL)
- Idaho National Lab (INL)
- Brookhaven National Lab (BNL)
- Lawrence Livermore National Lab (LLNL)
- Oak Ridge National Lab (ORNL)
- National Renewable Lab (NREL)
- BEST Center
- NBAAC

*Our **core** purpose is translating new technology to commercial practice*

In this proposed project we will be testing a technology called geologic sequestration

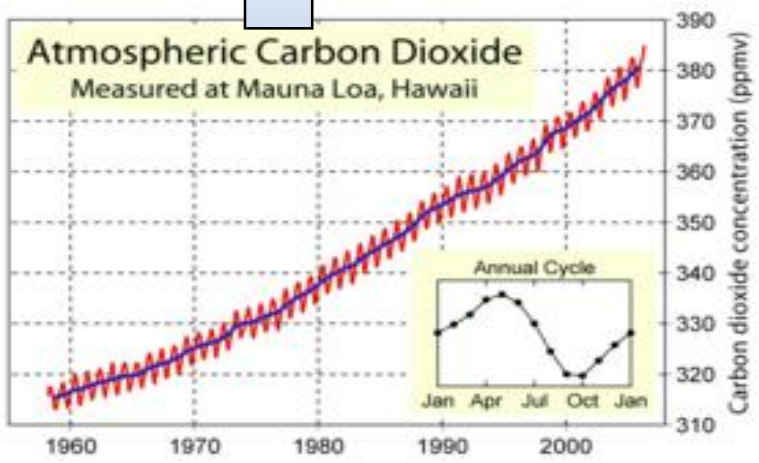


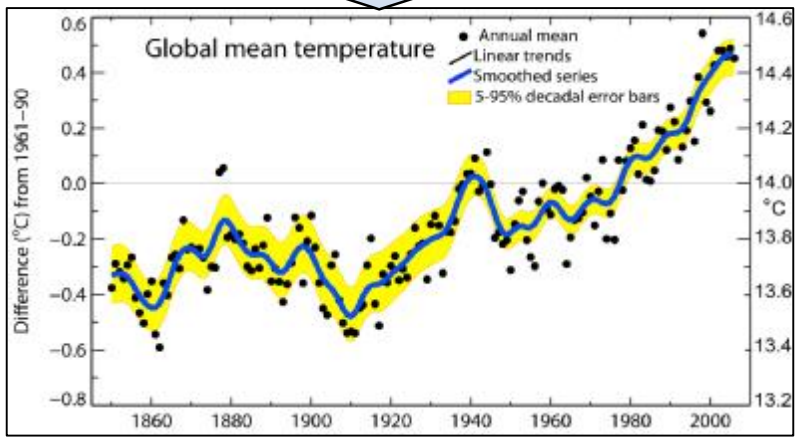
Why is this technology important?

The growing scientific consensus on climate change

"Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely due to the observed increase in anthropogenic greenhouse gas concentrations"****

This is leading to **This**

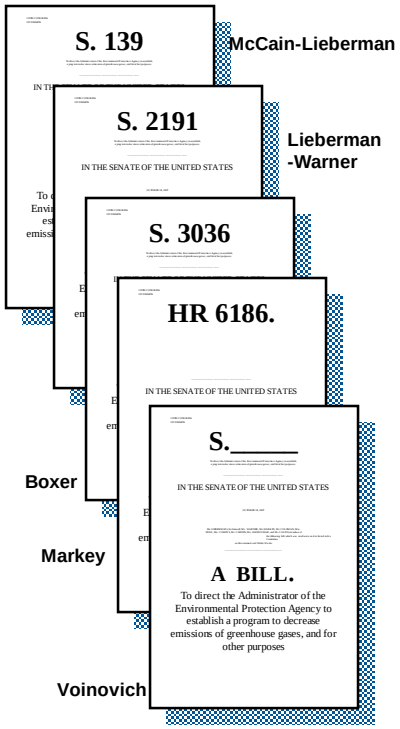




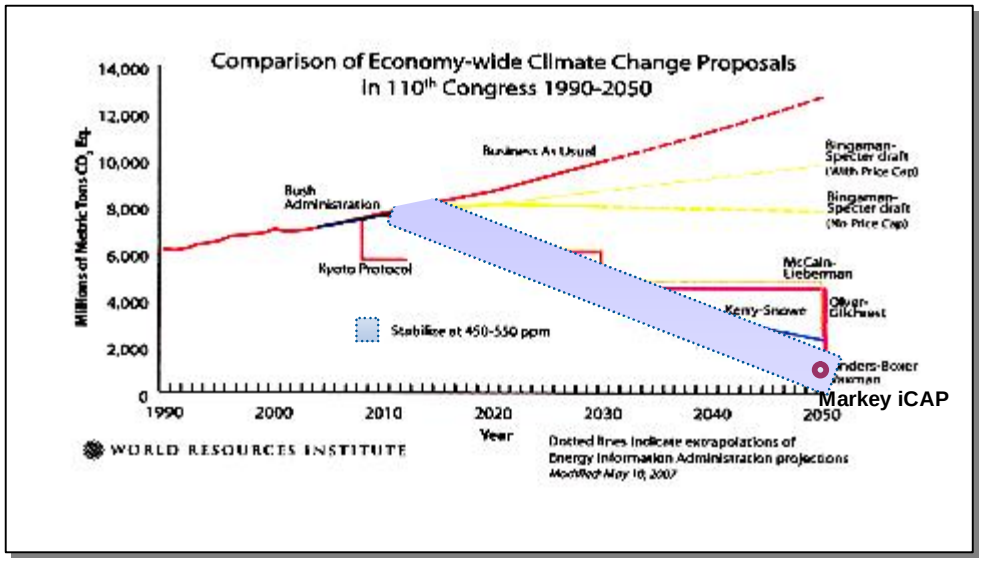
* "Very likely" = Greater than 90% probability of occurrence

**Intergovernmental Panel on Climate Change (IPCC): 4th Assessment Report

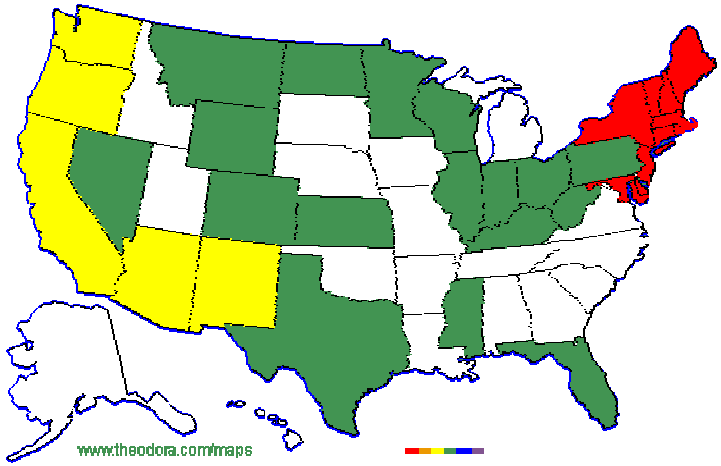
Beyond scientific evidence, policy makers in the US will likely act to limit CO_2



The effect of various bills before the 110th congress

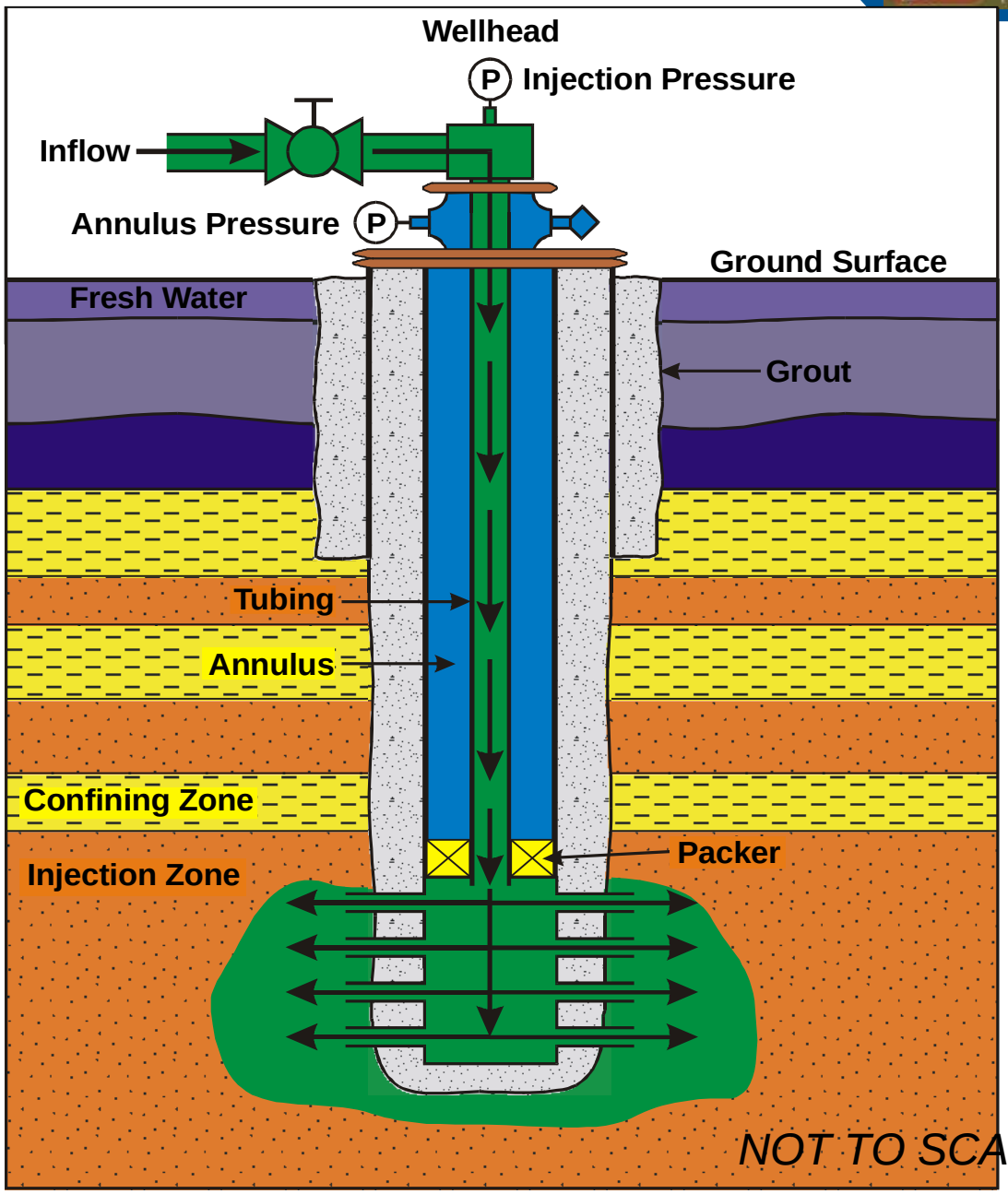


More than half the states in the US have some form of proposed legislation that would limit CO_2 emissions



Typical Injection Well

Injection Well Design and Protective Mechanisms

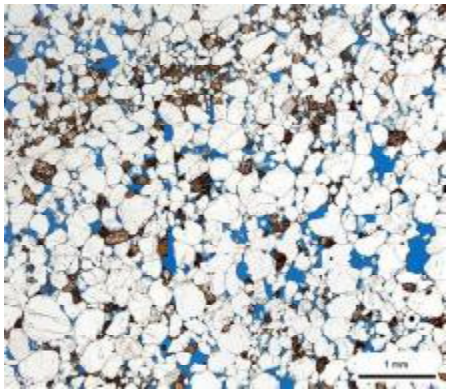


How does carbon dioxide storage in geologic formations actually work?

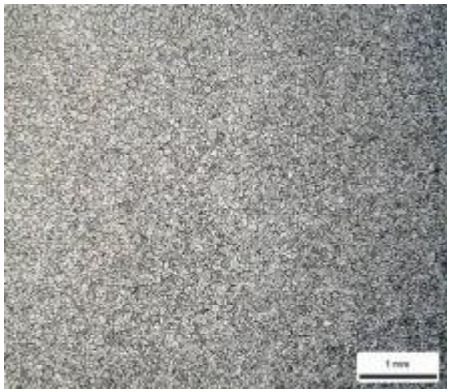
- Porosity is the amount of space between grains of rock; permeability is the connectedness of the pore spaces.
- A good storage reservoir has a lot of porosity and permeability which are combined in a term called “injectivity”
- A good cap rock has low porosity and permeability and acts as a barrier to prevent carbon dioxide from rising to the surface

Both images show a slice of rock that has been magnified 100 times and treated with blue dye to show the pore spaces. The image on the left is sandstone, a good storage reservoir. The image on the right is a shale, which forms a good cap rock or seal.

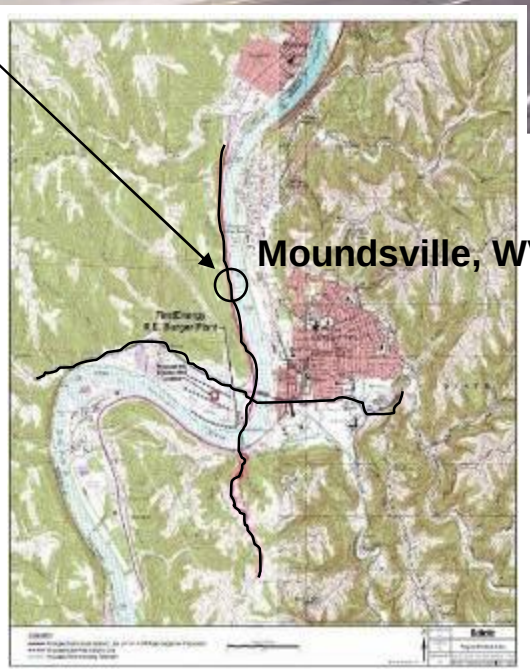
Storage Reservoir



Cap Rock



What happens at a test site?



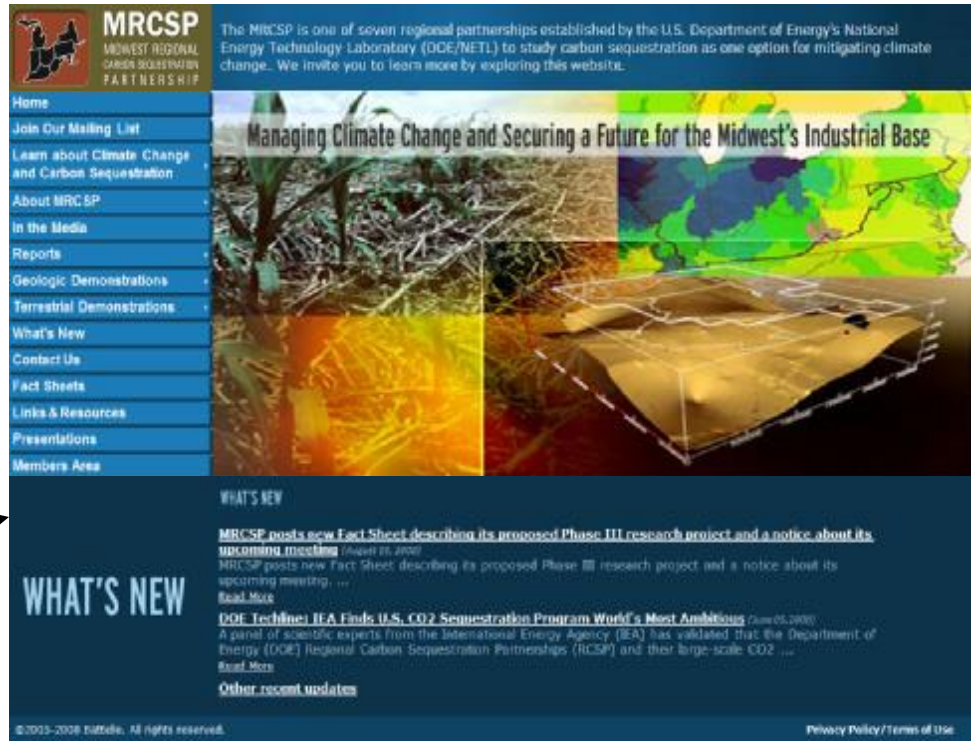
Seismic Lines

Injection Well (Michigan Site)

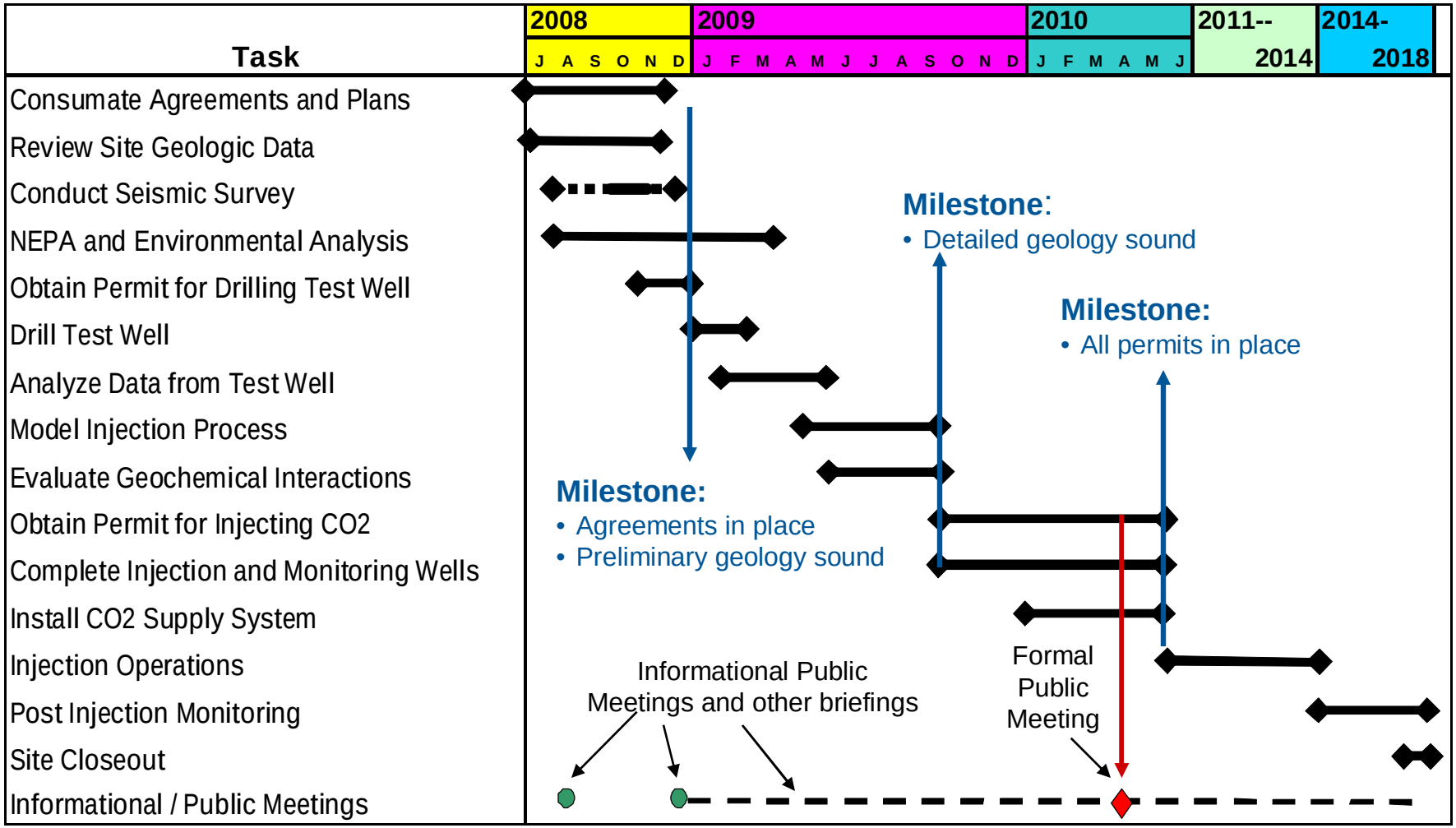
Drill Rig

Outreach with the public is a key requirement of our project

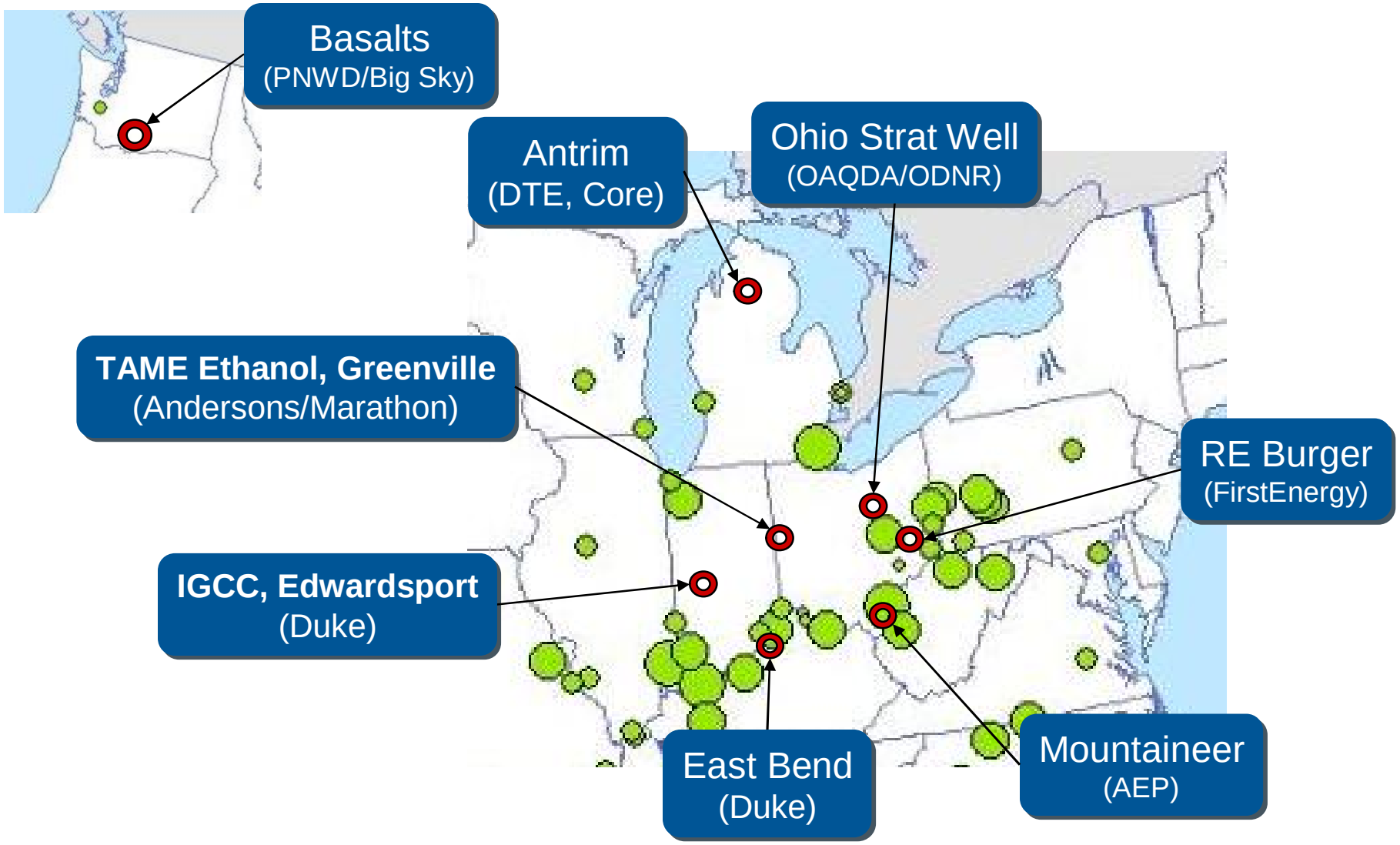
- We have held public meetings like this one for all our geologic field projects
- We will plan to hold additional meetings like this at key points for this proposed test
- We will also inform stakeholders by mail and other means throughout the course of the project.
- Our project web site, www.mrcsp.org, will have information on this proposed test and other aspects of the MRCSP



Proposed Schedule



Other geologic tests Battelle is conducting



Battelle has been conducting sequestration research at AEP's Mountaineer plant for over five years

1,300 MW Generator

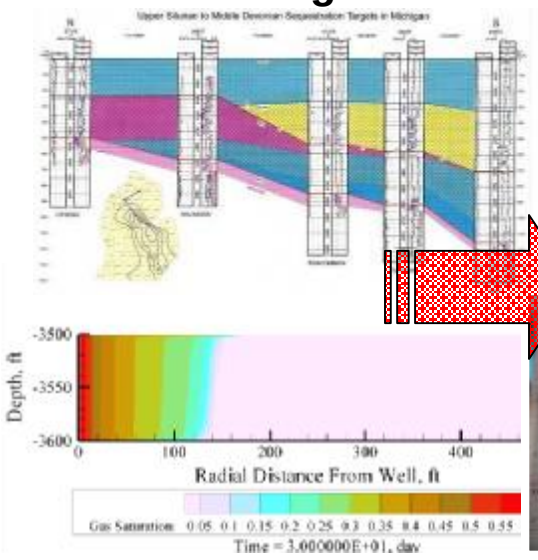
Project Location
New Haven, WV

Why did we choose the Andersons/Marathon site near Greenville?

- The ethanol process, provides reliable quantities of high purity carbon dioxide suitable for injection.
- The Andersons/Marathon plant near Greenville lies over the Mount Simon Sandstone, an important regional reservoir having suitable geology for carbon dioxide storage.
- The test will enable geologists to learn more about the capacity of the Mount Simon Reservoir on a regional basis.

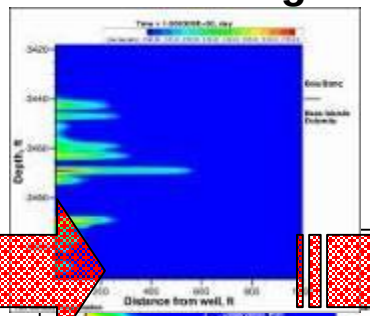
Field tests like this proposed test allow us to improve and validate our models

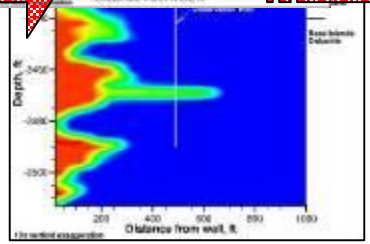
Preliminary Modeling Based on Regional Data



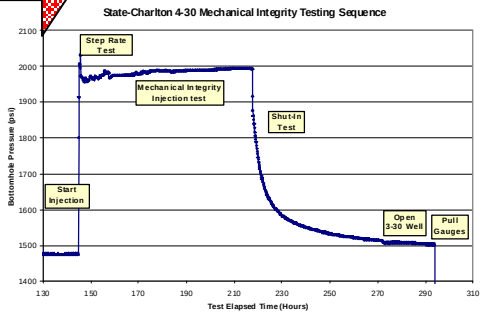
Site Drilling and Testing

Site Specific Modeling





Post-Injection Calibration/Validation

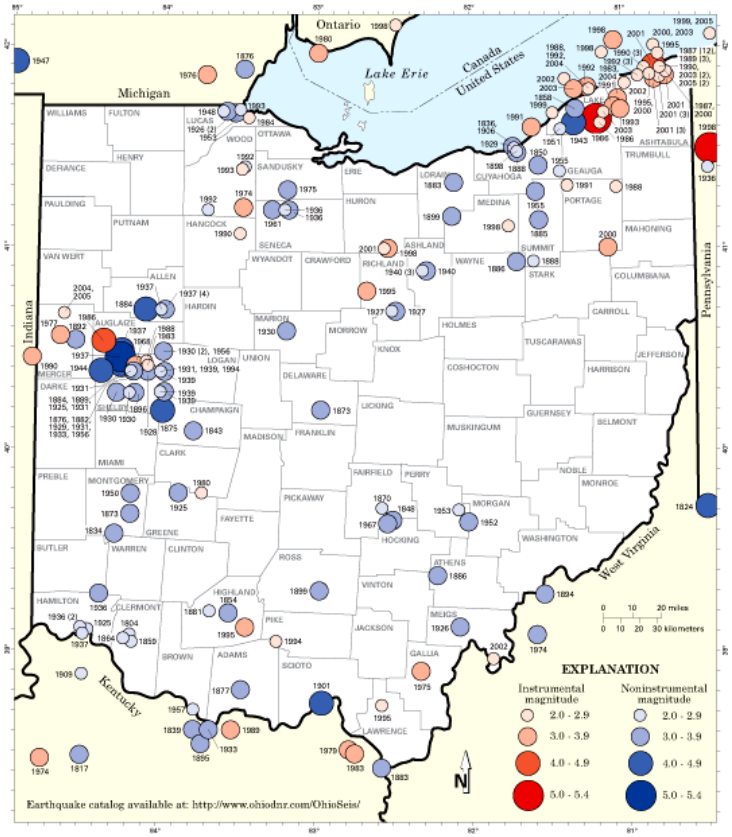


Conceptualize > Characterize > Design > Monitor > Calibrate > Validate

----------Communicate----------

We know that seismic concerns have been raised relative to this proposed test

- Seismic analysis is a key part of all our geologic sequestration projects
- Seismic issues tend to be of two types
  - Leakage paths created in the past or future due to natural seismic activity
  - Seismic activity caused by injection operations
- A detailed seismic analysis and review is one of the early activities planned for the site.
- The permitting process sets pressure limits for this and any other deep well injection specifically for minimizing the potential for inducing fractures in the surrounding formations.



Past seismic events in Ohio

Is it safe?

- Carbon dioxide is a non-toxic gas that occurs naturally in deep underground formations
- It, along with oil and natural gas, have been contained in similar underground formations for millions of years
- Carbon dioxide has been injected into deep formations for producing oil for several decades without incident.
- Both drilling and injection are regulated according to the Underground Injection Control (UIC) program.
- We have an extensive team of geoscientists, engineers, risk assessment specialists and others, including the Ohio and Indiana Geological Surveys that will review data each step of the way.
- Battelle and its suppliers have been carefully chosen for this project based on our experience

Summary

- Geologic storage of CO_2 is an important part of a national strategy for addressing climate change
  - Especially important for the Ohio and the Midwest
- There are a number of similar tests underway around the US and other parts of the world, many of them conducted by Battelle
- This proposed test at Greenville is important because it is the next logical step needed for further development of the technology
- There are a number of safe guards built into the project
  - Injection occurs deep in the ground, well away from drinking water supplies
  - Geology is selected to ensure good cap rocks or seals above the injection zone
  - Detailed monitoring of the process will occur throughout.
  - Many of the techniques and processes are proven from other applications
  - The regulatory process is designed to assure safety
- We will plan to meet with the public at various key points in the process to keep you informed of our analysis and plans
- Public communication is a key part of our project. We will provide opportunities for people to learn about and provide input on this important technology

Thank You

For more information on the MRCSP

see: **www.mrcsp.org**

Battelle Contacts:

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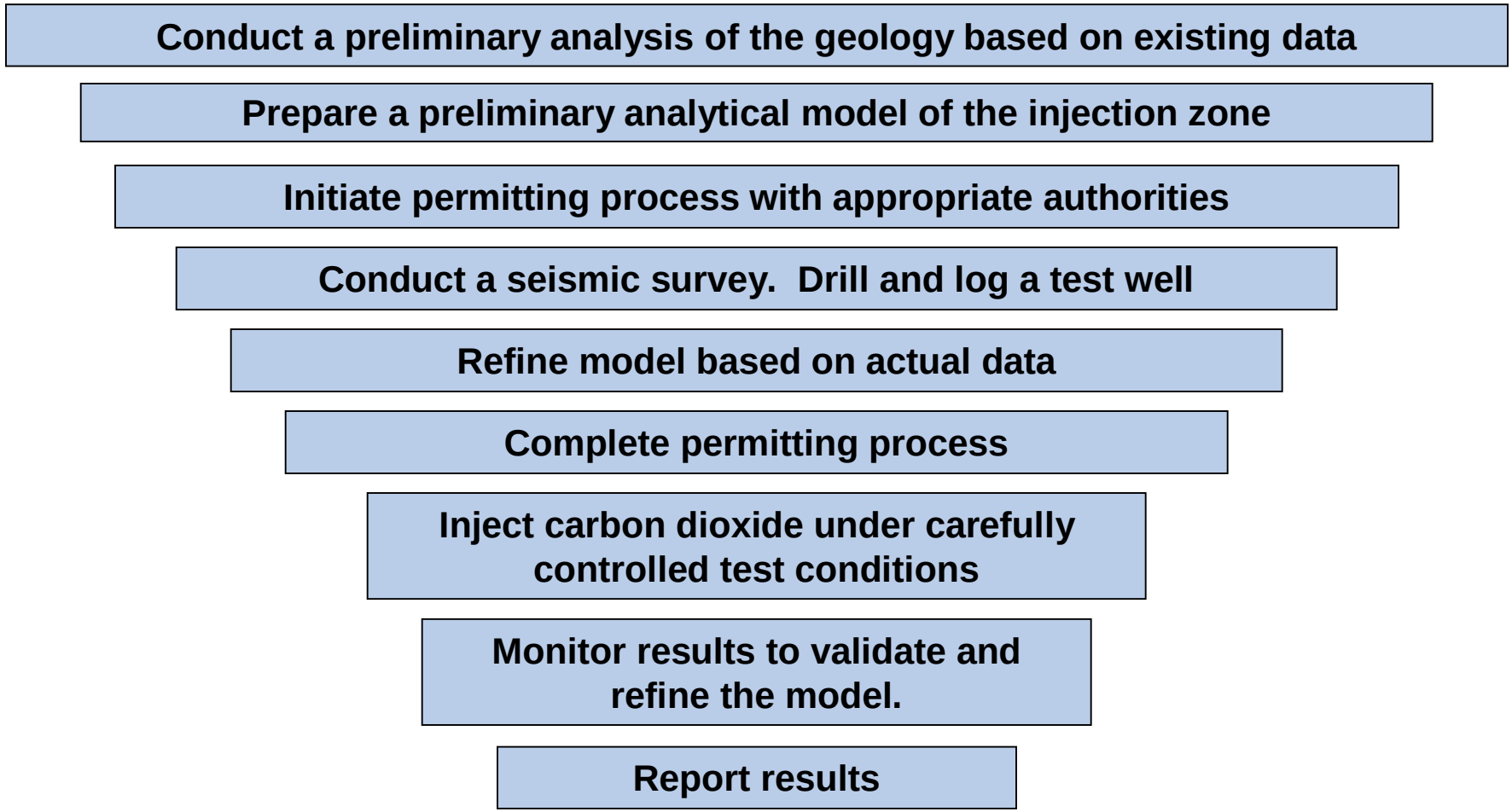
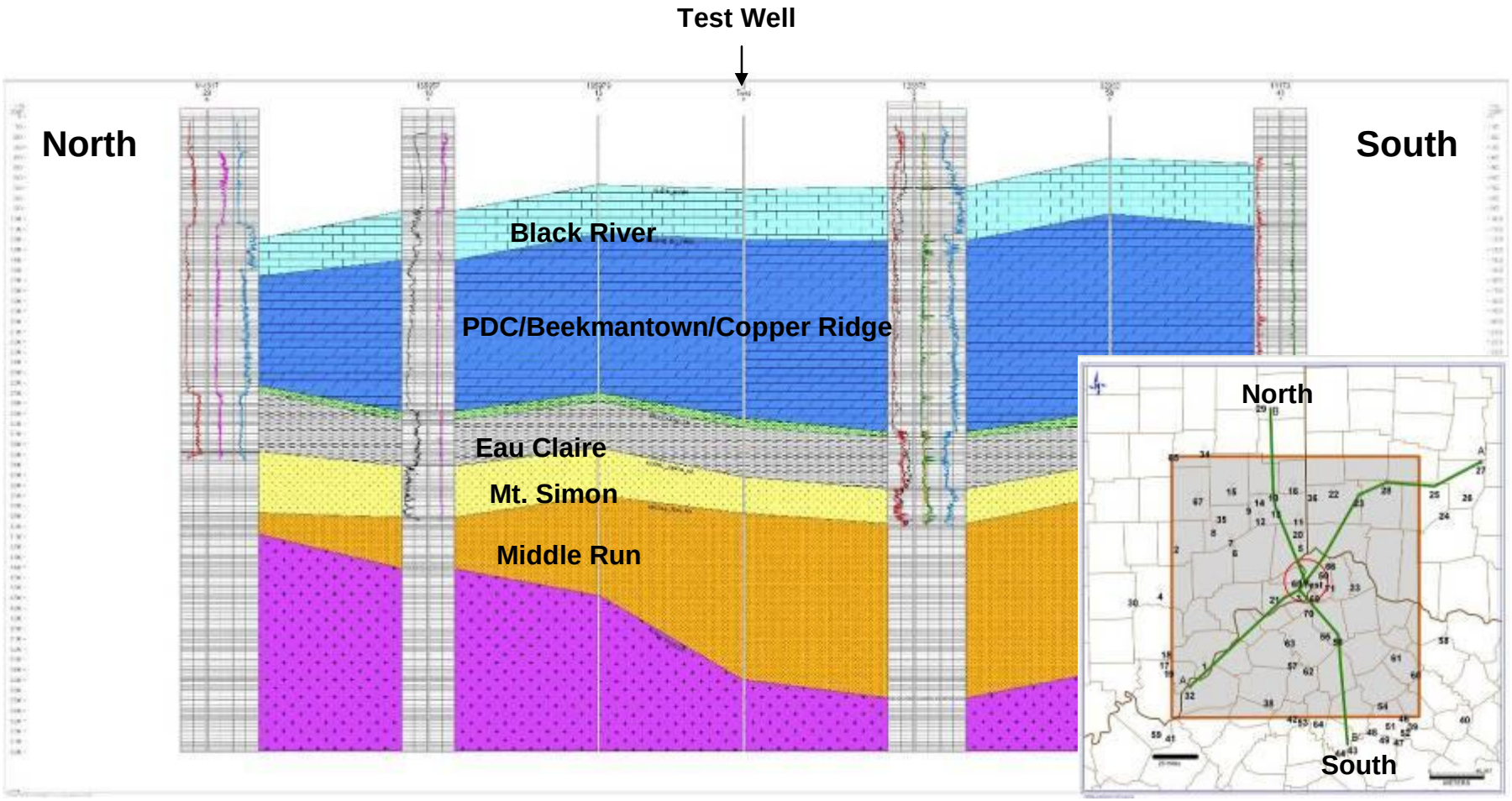
BACKUP SLIDES

Key Steps in Geologic Carbon Storage Demonstration Test

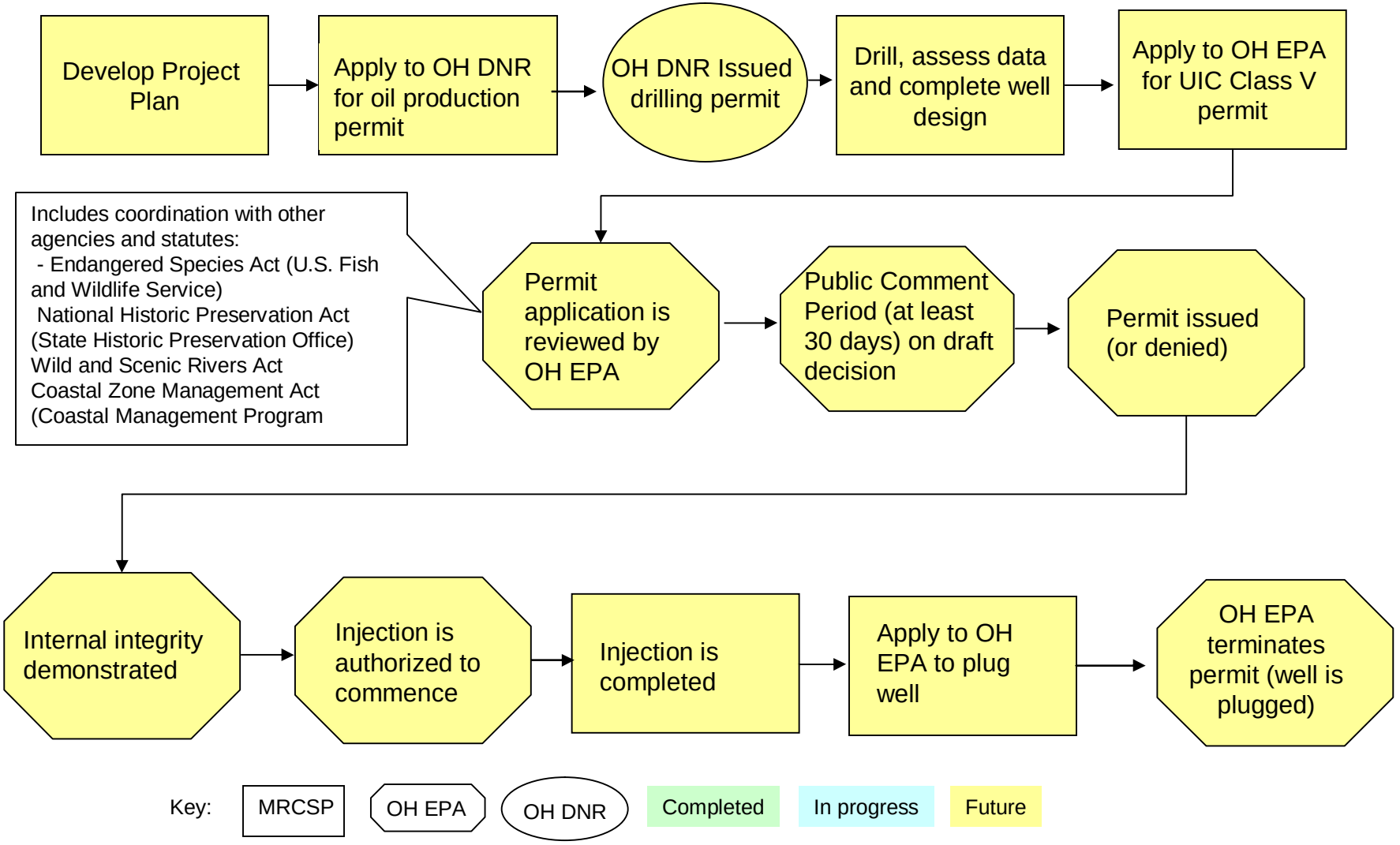


The Goal: demonstrate the feasibility of carbon dioxide storage in the real world as a step towards commercial deployment

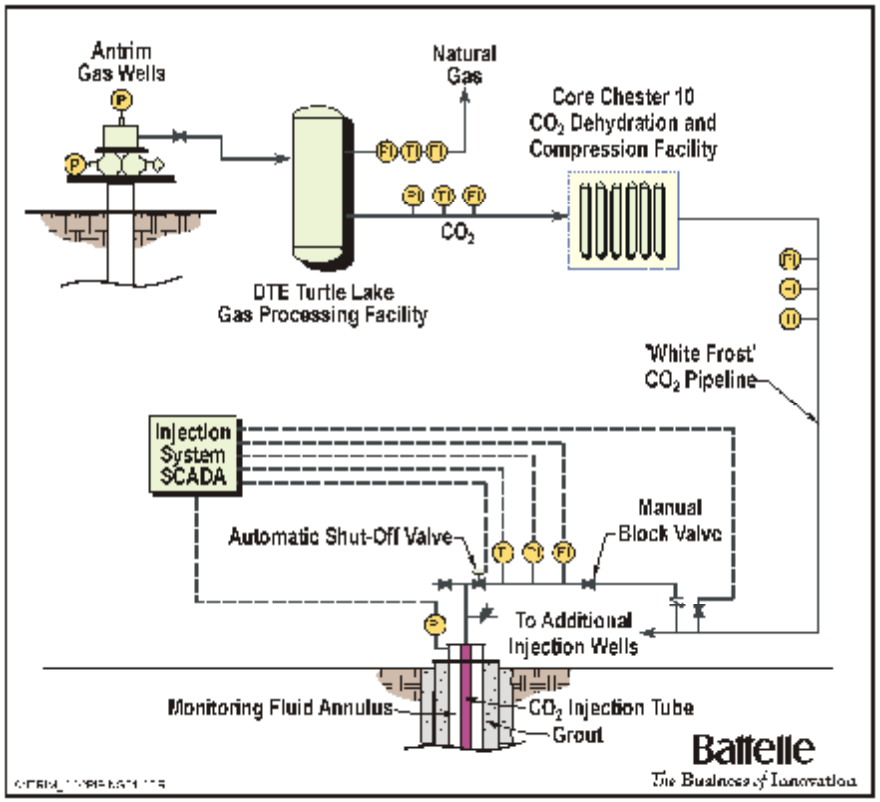
Preliminary Geologic Characterization



Ohio Regulatory Process



Phase III Monitoring – Wellhead Pressure and Temperature



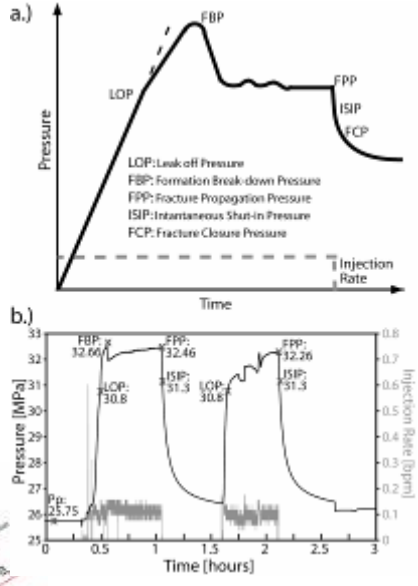
Example for Michigan test site shown

- Pressure and temperature will be continuously monitored at the surface
  - Data collection will also occur at the base of the well
- Automatic sensors will report any unusual change in pressure, temperature or volume.
- There will be ongoing update of the models with field data

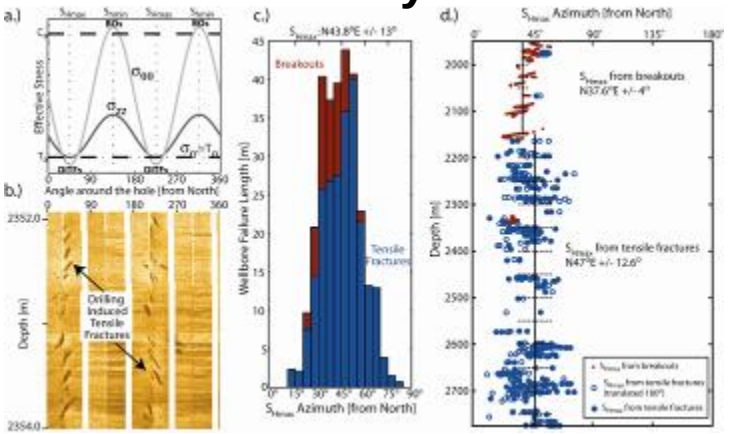
Geomechanical Framework
Evaluating Safety and Reservoir Stimulation

- Example from a detailed geomechanical analysis framework developed for Mountaineer site
- Extensive geomechanical component in Phase II at MI Site and planned for Phase III

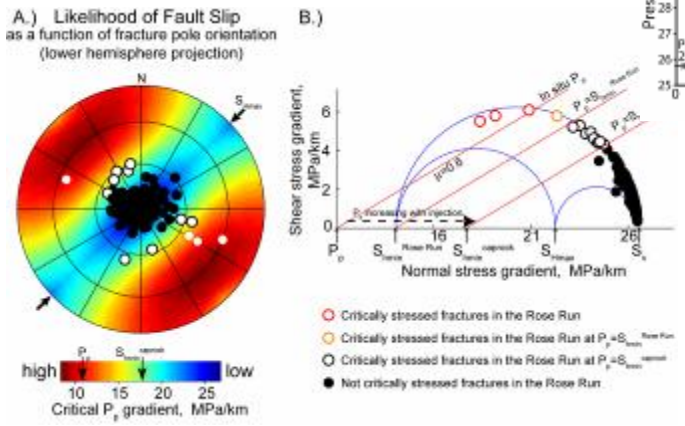
Mini-Frac Tests



FMI Analysis



Stress-Strain Analysis

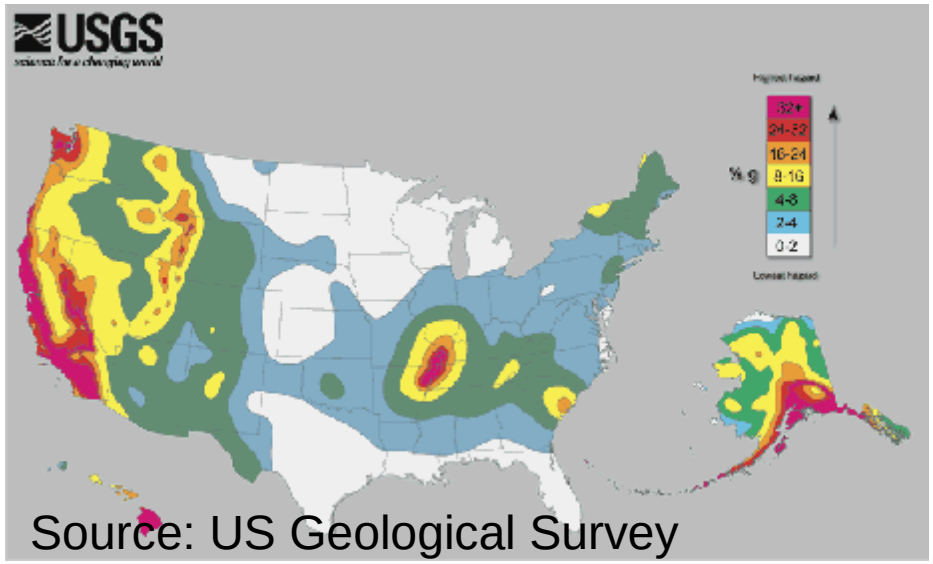


Joint work with Mark Zoback, Amie Lucier, Laura Chiaramonte

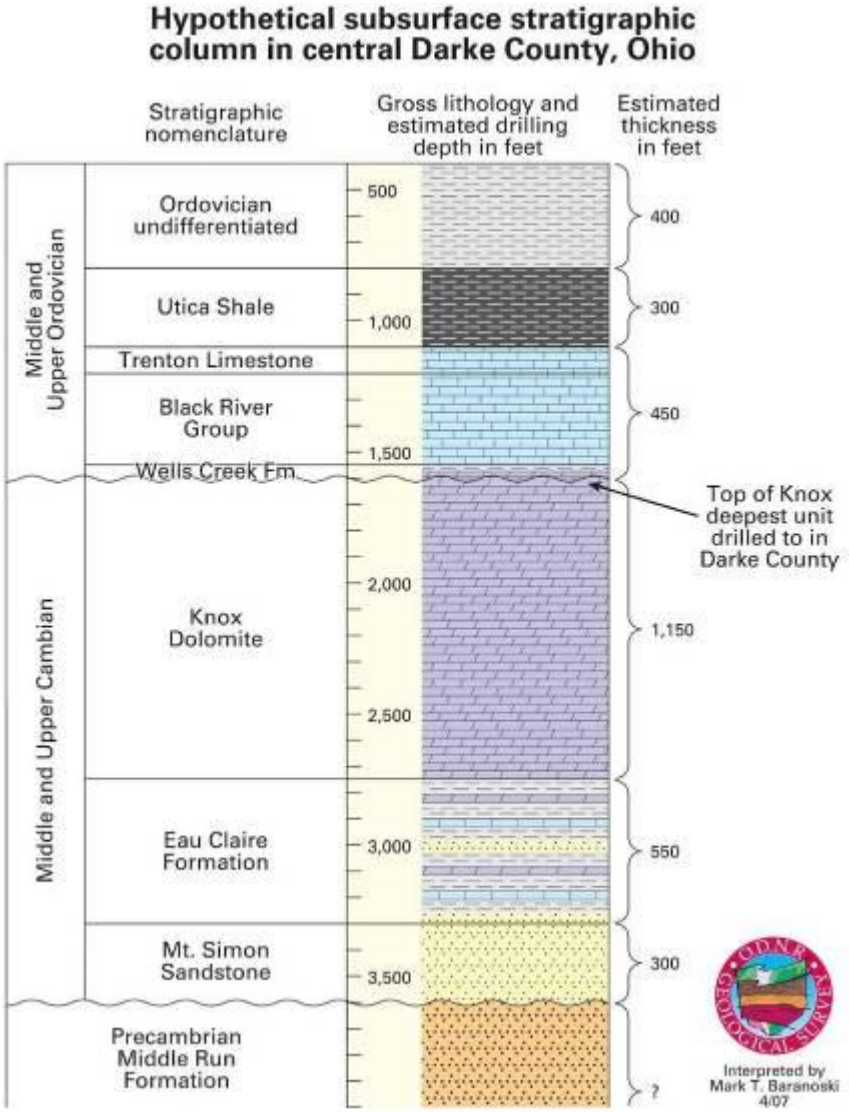
MRCSP Membership

Geologic framework at the TAME site

- A thick sequence of sedimentary rocks is present in the project area.
- The Mount Simon Reservoir is the only injection target deep enough for storage consideration at this site.
- The area has a low seismic hazard as shown in the map below.

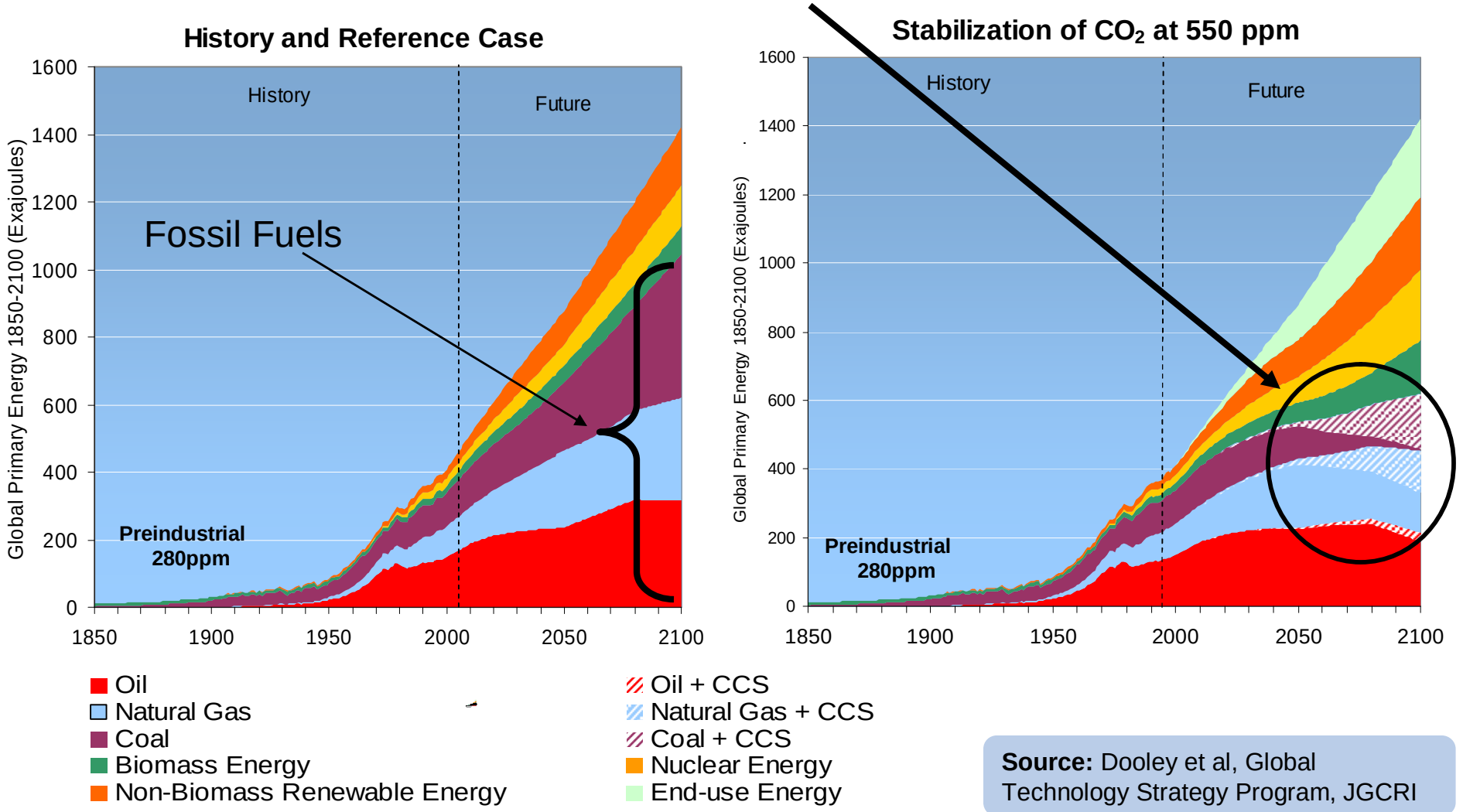


Source: US Geological Survey



Why is geologic sequestration important?

It is the only technology that directly controls CO_2 emissions from fossil fuel use. Without it, we will have to stop using fossil fuels.



Source: Dooley et al, Global Technology Strategy Program, JGCRI