

SECARB Black Warrior Coal Test

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**Geological Survey of Alabama
University of Alabama (SCGCS)
Southern Company**



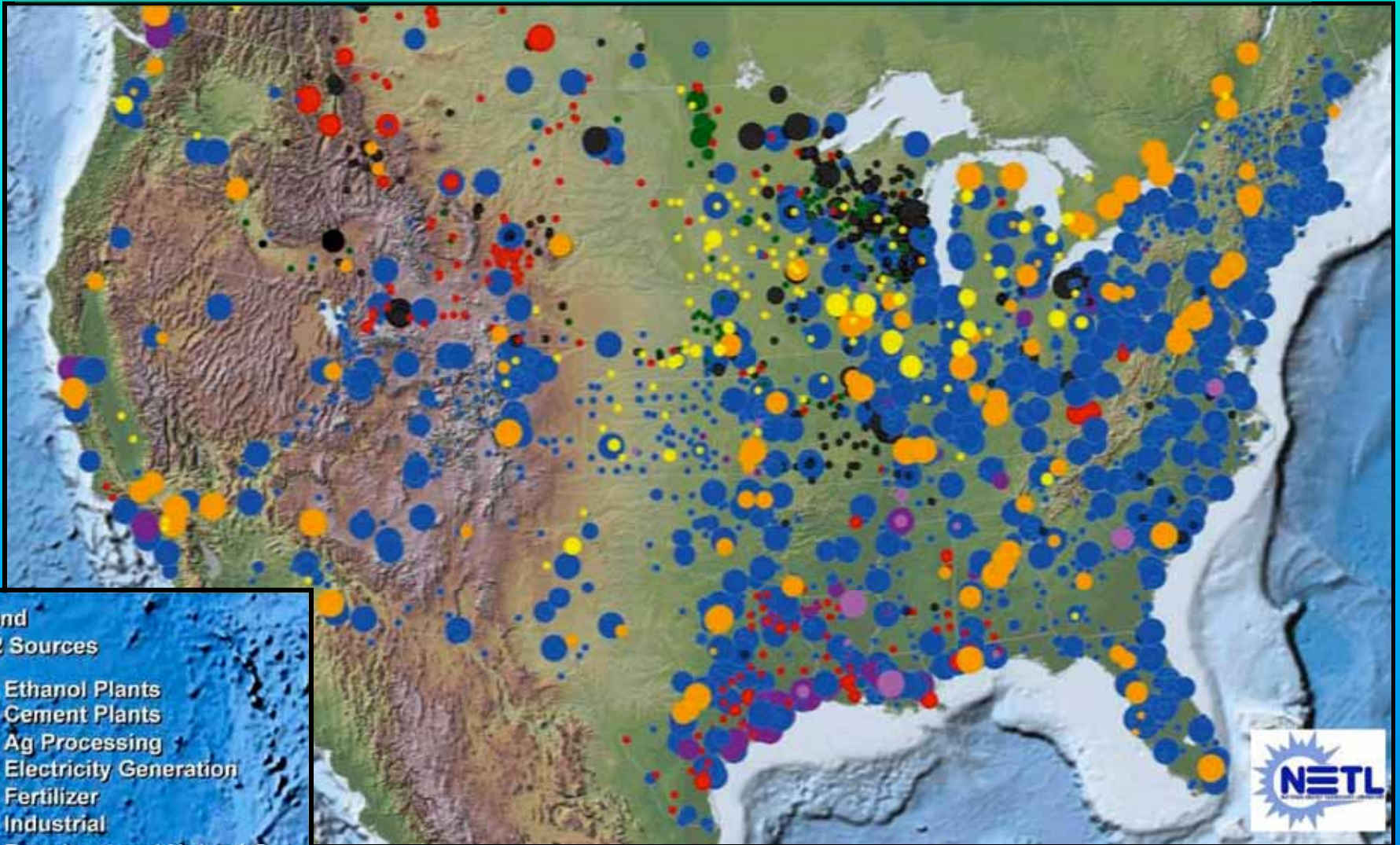
PRINCIPAL SPONSOR

U.S. Department of Energy - NETL

PROGRAM TEAM

SSEB, Virginia Tech - **Administrative Lead**
Geol. Survey of AL - **Technical Lead, Geology**
SCGCS (University of Alabama) - **Engineering**
Southern Company/EPRI – **MMV**
Univ. British Columbia - **Analytical**
Oak Ridge National Laboratory - **Analytical**
ARI - **Reservoir Simulation**
Denbury Resources - **CO₂**
Southern Natural Gas/El Paso - **CBM well**

US CO₂ EMISSION SOURCES



Legend CO₂ Sources

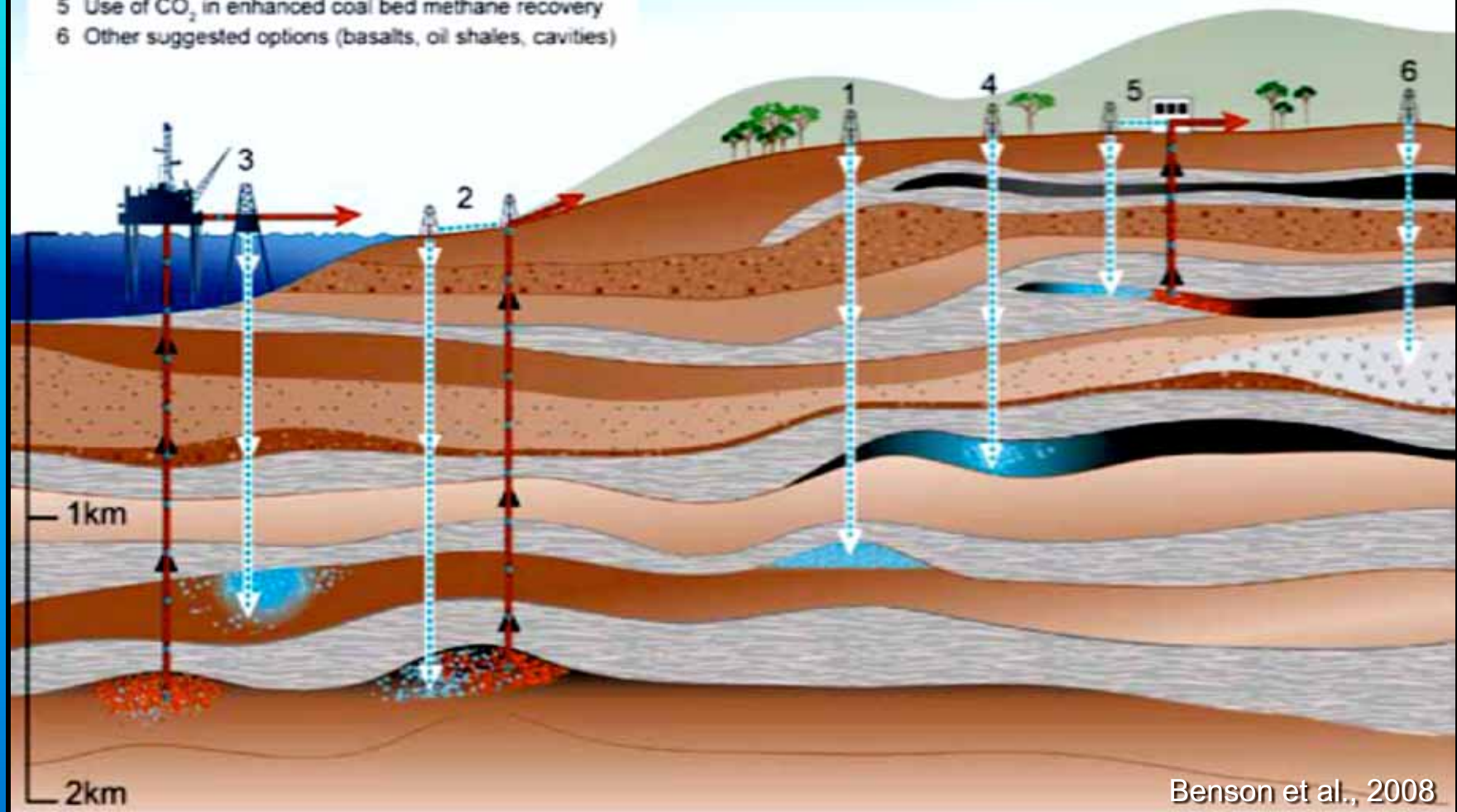
- Ethanol Plants
- Cement Plants
- Ag Processing
- Electricity Generation
- Fertilizer
- Industrial
- Petroleum and Natural Gas Processing
- Refineries/Chemical
- Unclassified



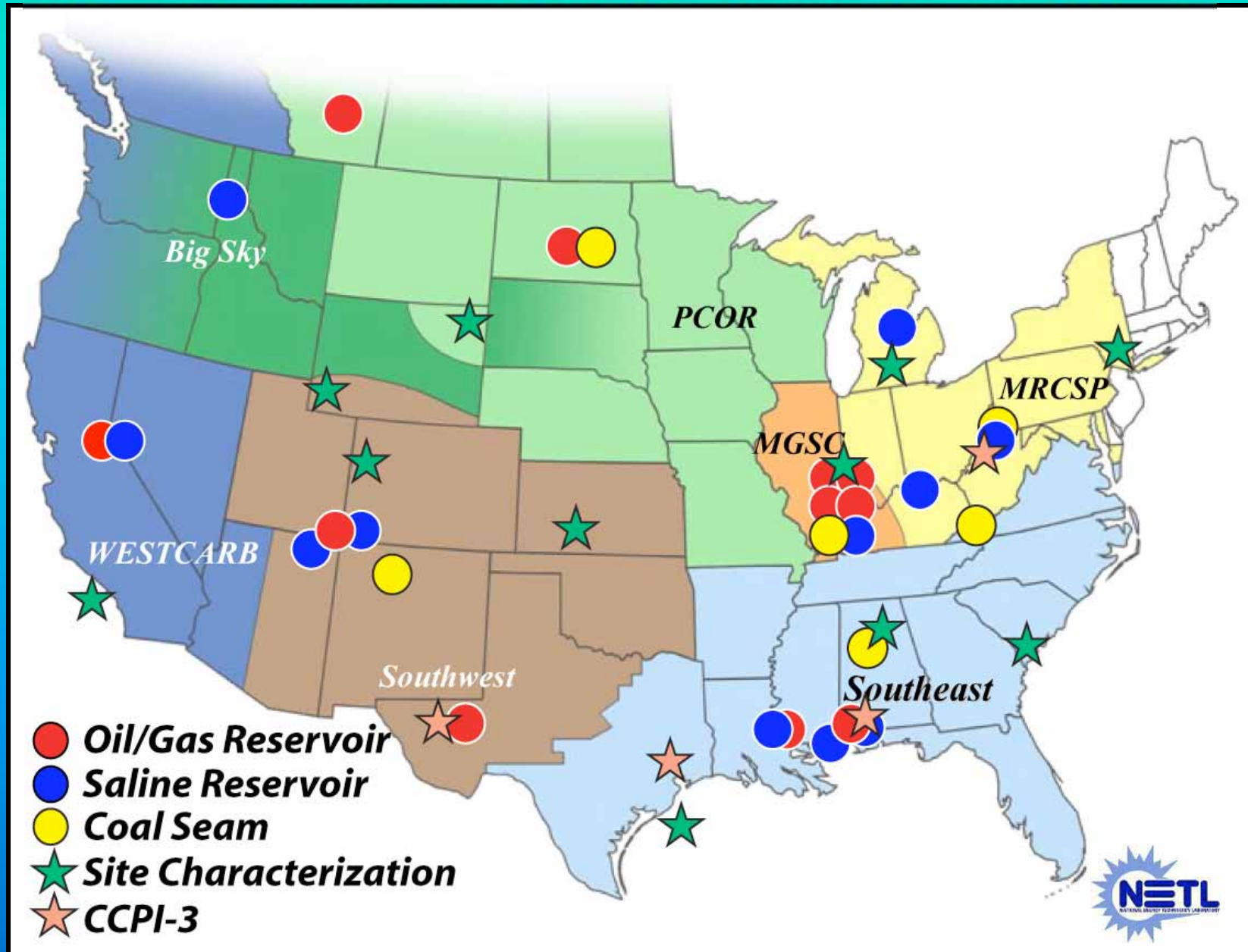
CO₂ STORAGE OPTIONS

Geological Storage Options for CO₂

- 1 Depleted oil and gas reservoirs
- 2 Use of CO₂ in enhanced oil recovery
- 3 Deep unused saline water-saturated reservoir rocks
- 4 Deep unmineable coal seams
- 5 Use of CO₂ in enhanced coal bed methane recovery
- 6 Other suggested options (basalts, oil shales, cavities)



REGIONAL PARTNERSHIPS



CO₂ Sequestration

SECARB II Black Warrior and Virginia Coal Tests (DOE, SSEB, VT, SOCO, EPRI, El Paso, CNX, Denbury)

SECARB III Anthropogenic Test, Plant Barry (DOE, SSEB, SOCO, EPRI, ARI, Denbury)

SECARB III Offshore Assessment (DOE, SSEB)

CO₂-EOR, Citronelle Field (DOE, UAB)

Gorgas Site Characterization (DOE, UA, SOCO, SLB)

SECARB-Ed (DOE, SSEB, VT)

CO₂ Injection Well, Citronelle



Plant Gorgas



WHY COAL?

CO₂ capacity ~ 173 Gt (49 yr) in US.

CO₂-ECBM potential ~ 4.3 Tcm (150 Tcf).

**Shallow reservoir (150-1500 m) with low
P&T can reduce compression cost**

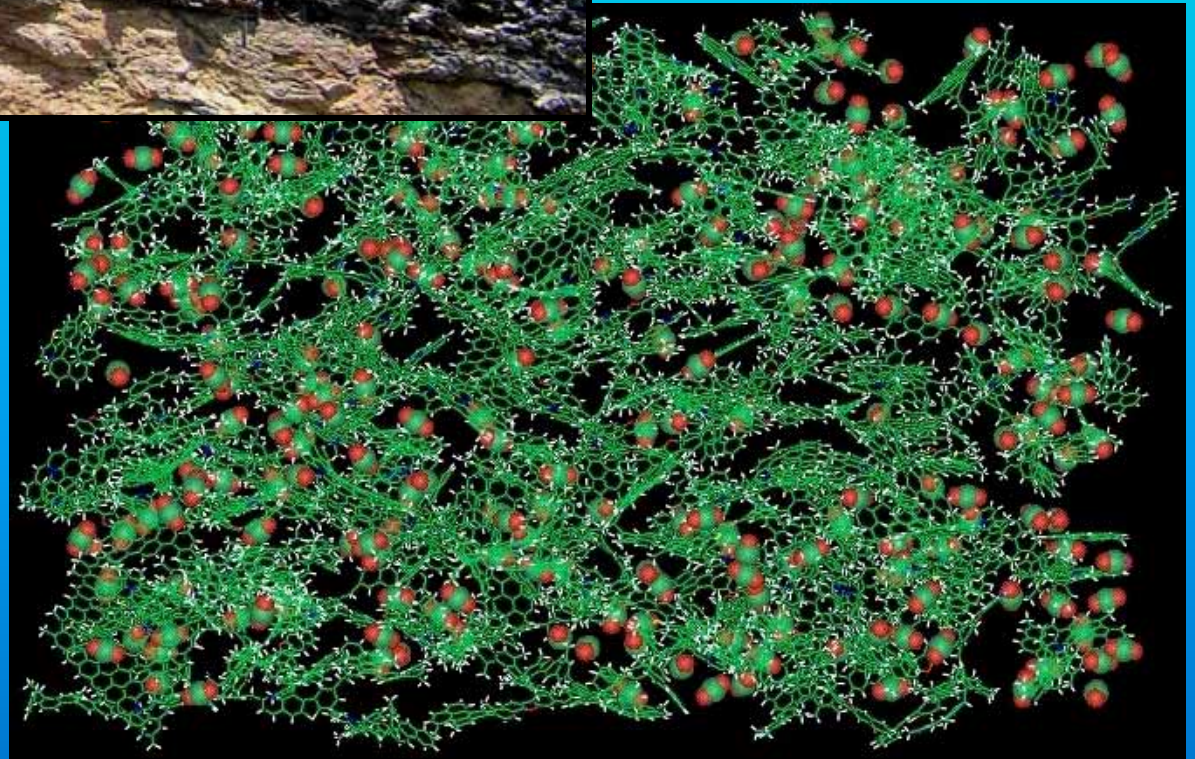
**Coal is abundant near major CO₂ emission
sources, such as power plants.**

**Gas is stored in coal securely by adsorption
rather than by free storage or solution.**

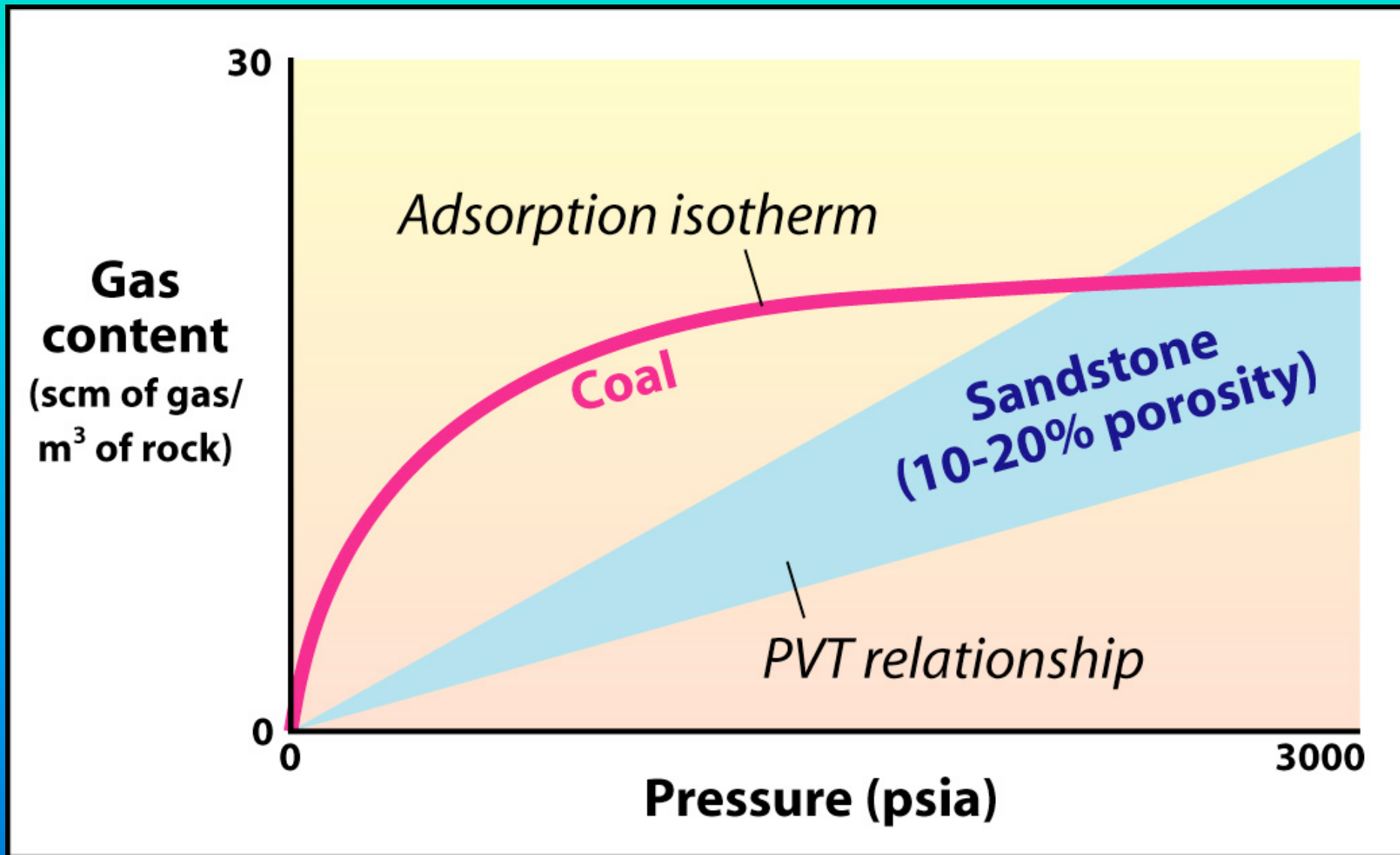


**CLEATED
COAL**

**AROMATIC
NET**

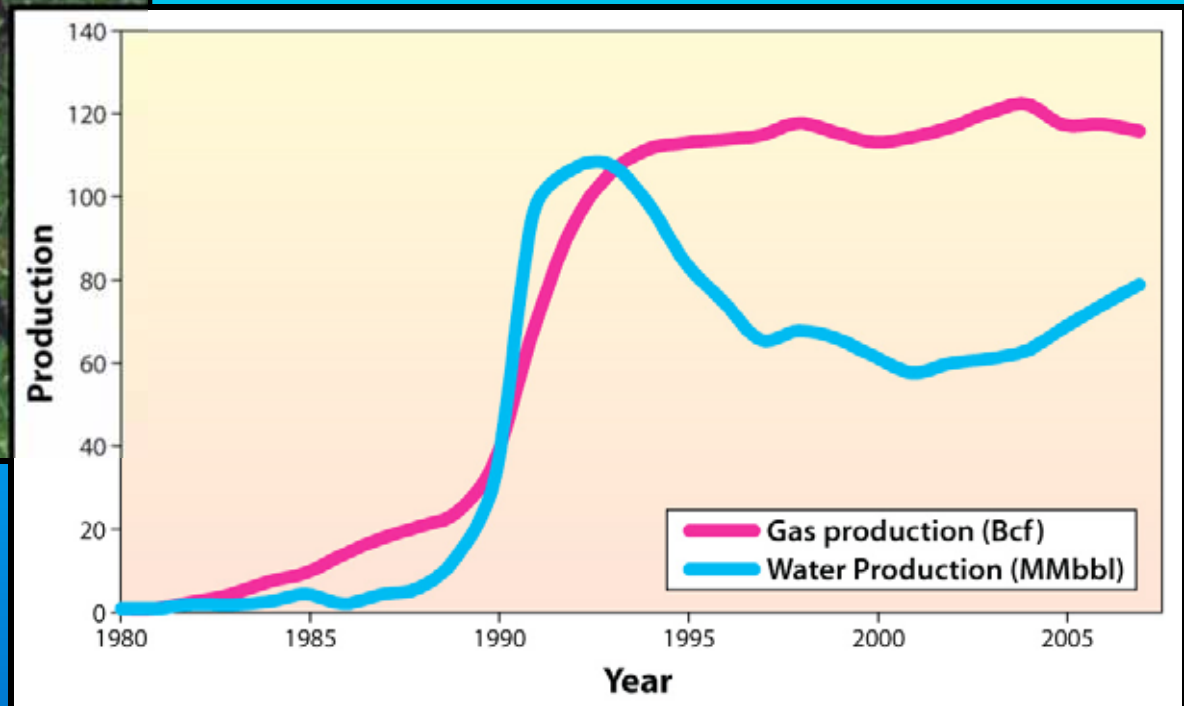
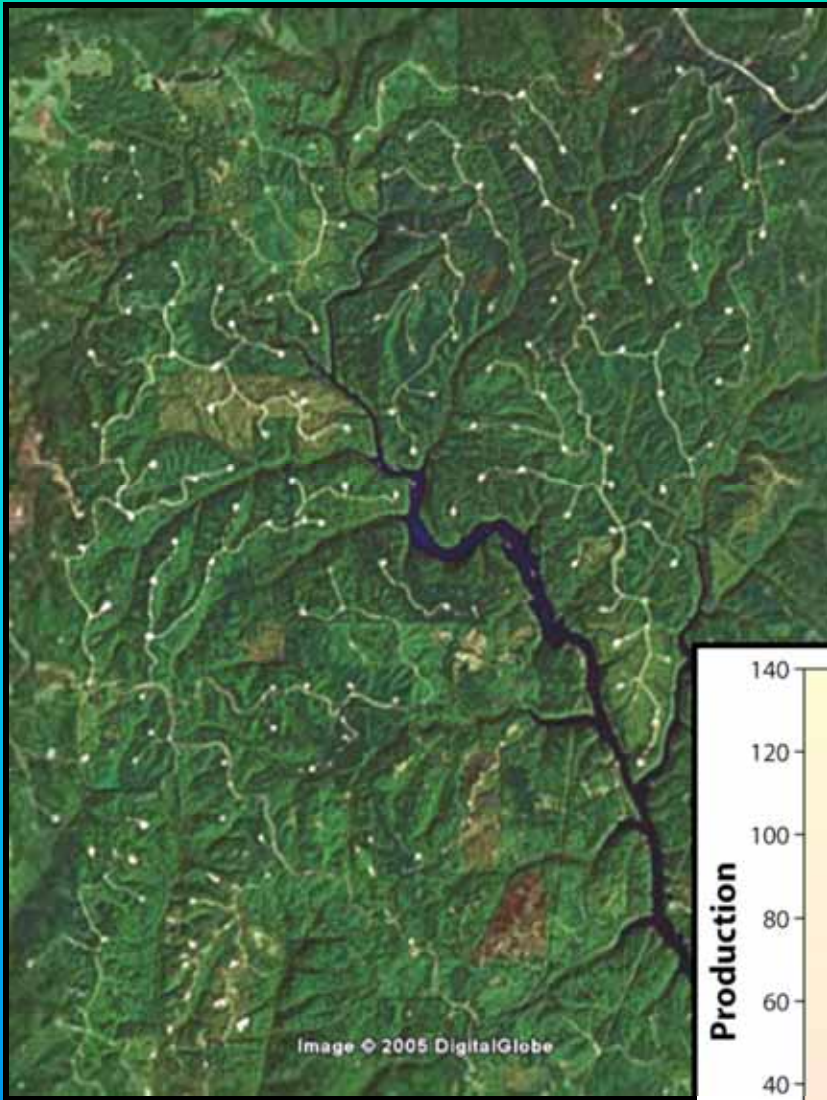


GAS STORAGE



BLACK WARRIOR BASIN

COALBED METHANE



CUMULATIVE GAS PRODUCTION

SECARB test site

NE edge of Cretaceous

Gorgas

Miller

Oak Grove

Short Creek

Robinson's Bend

Deerlick Creek

Brookwood

Cedar Cove

Taylor Creek

Little Buck Creek

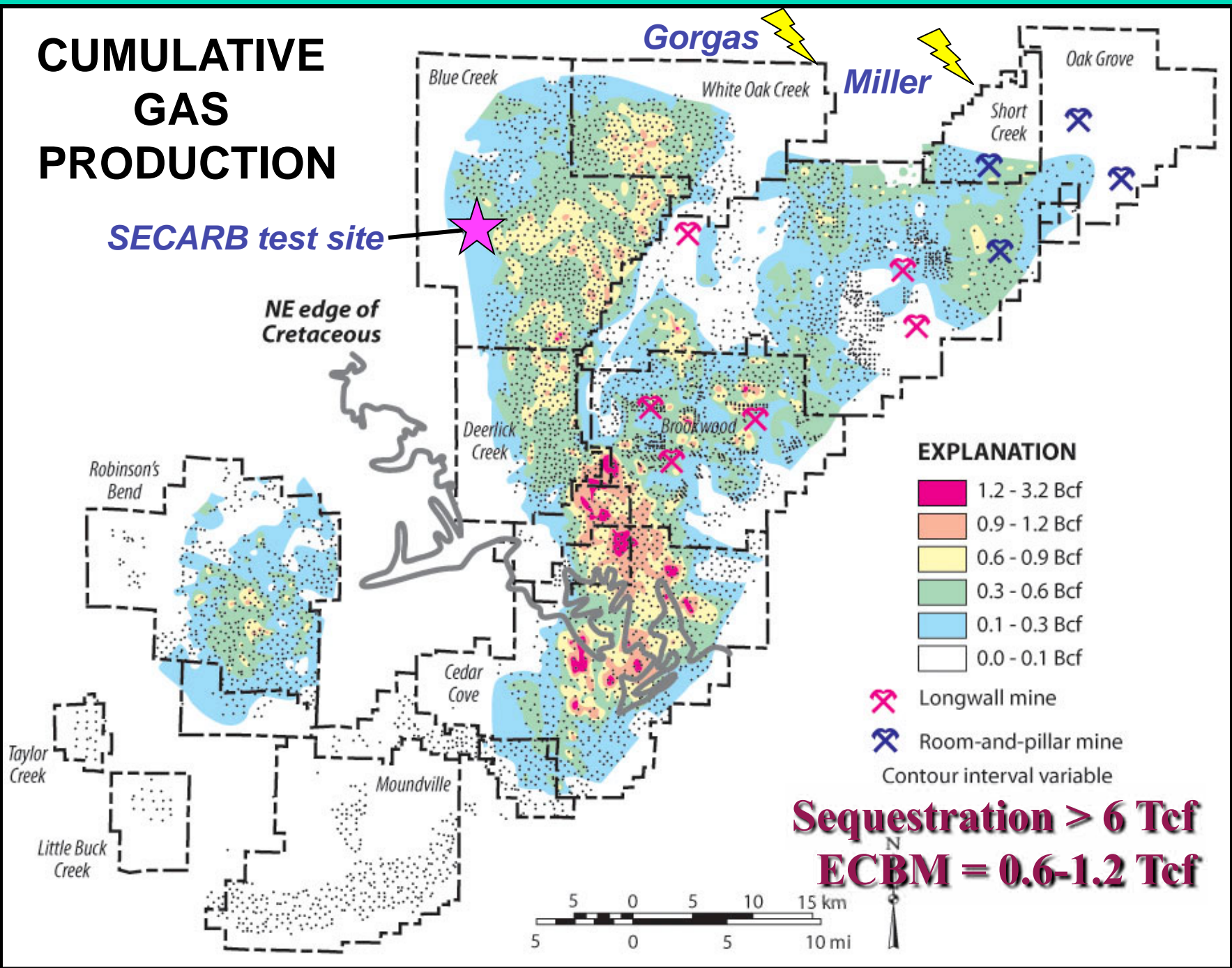
Moundville

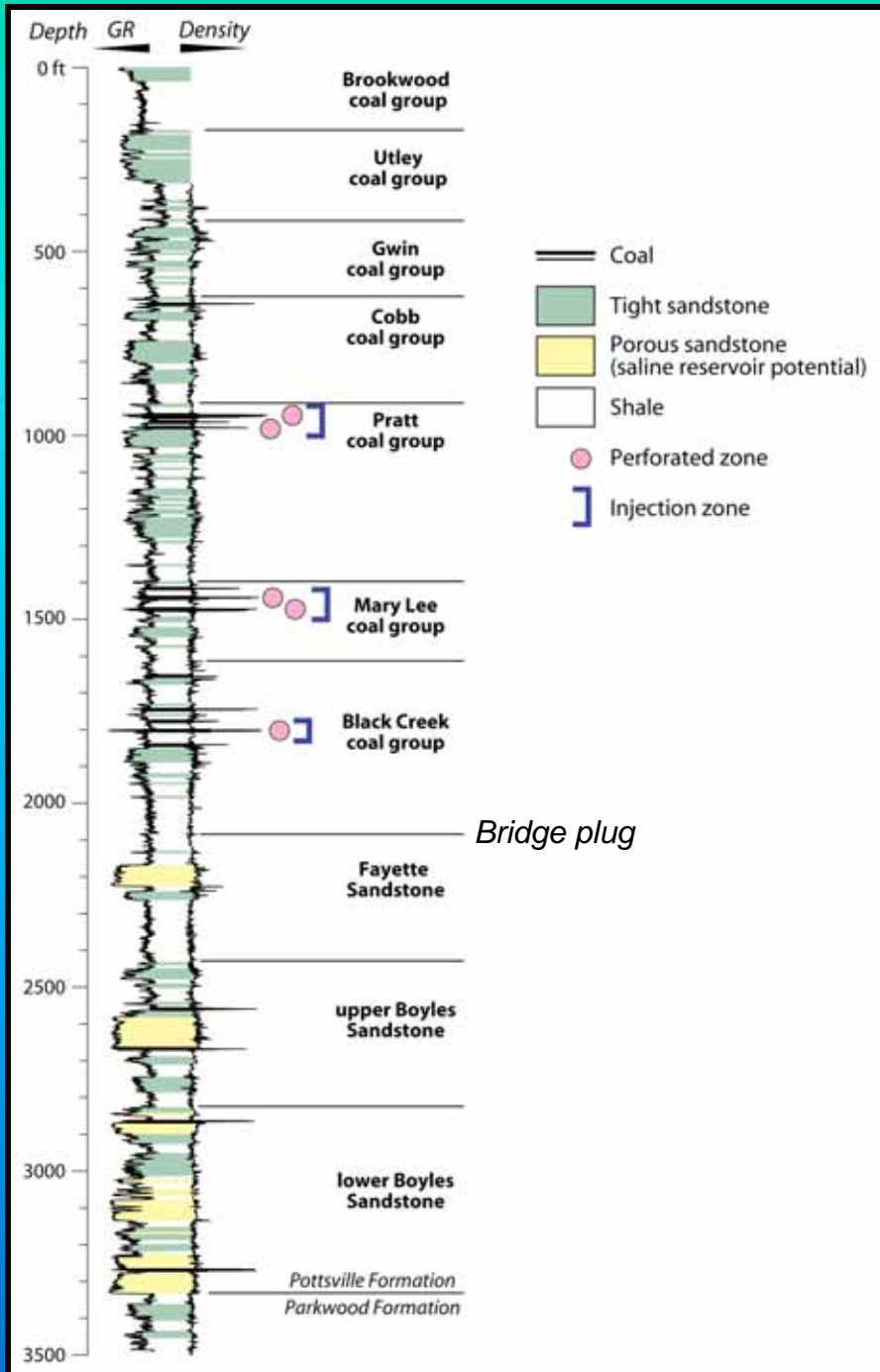
EXPLANATION

- 1.2 - 3.2 Bcf
- 0.9 - 1.2 Bcf
- 0.6 - 0.9 Bcf
- 0.3 - 0.6 Bcf
- 0.1 - 0.3 Bcf
- 0.0 - 0.1 Bcf

- ✂ Longwall mine
- ✂ Room-and-pillar mine
- Contour interval variable

Sequestration > 6 Tcf
ECBM = 0.6-1.2 Tcf





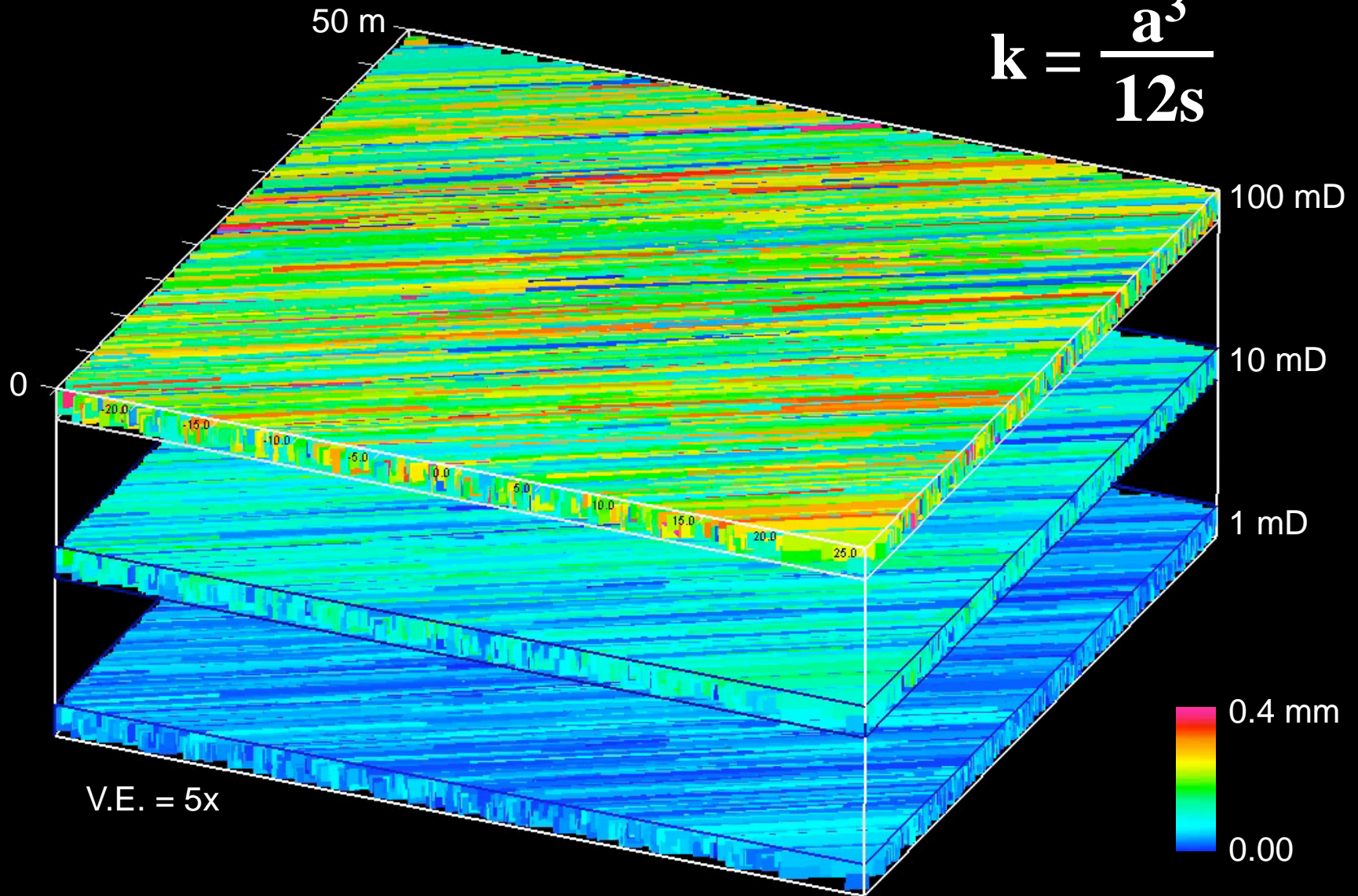
POTTSVILLE STRATIGRAPHY

Well 17-09-122
Permit 12450-C-GI-10-01
Blue Creek Field



COAL PERMEABILITY

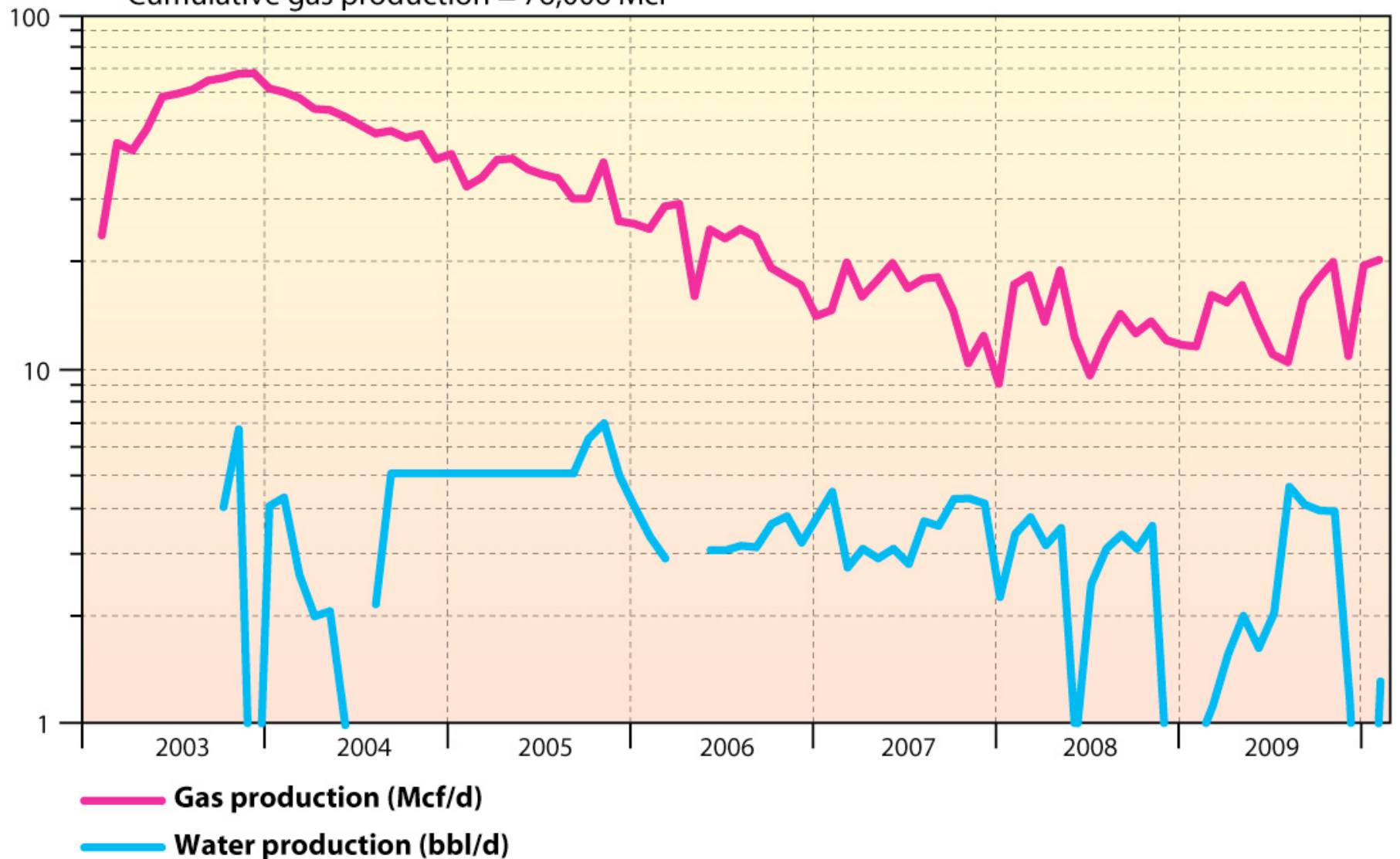
$$k = \frac{a^3}{12s}$$



PRODUCTION HISTORY

Time producing = 7 years
Peak gas production = 69 Mcf/d
Cumulative gas production = 76,006 Mcf

Peak water production = 7 bbl/d
Cumulative water production = 7,546 bbl

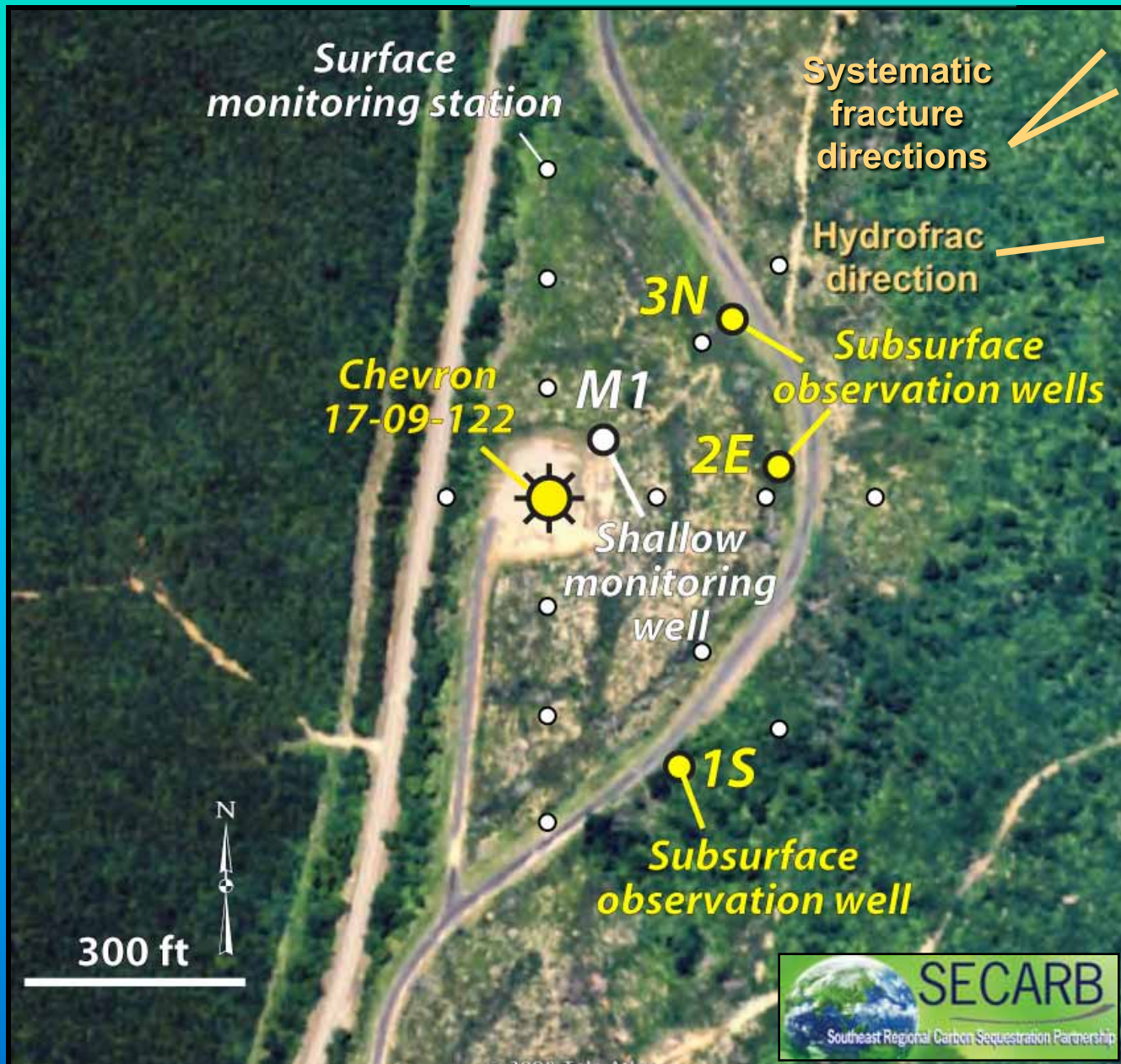


RESERVOIR CHARACTERISTICS

Coal group/bed	Pratt	Mary Lee	Black Creek
Depth (ft)	940	1435	1797
Original pressure (psi)	394	398	772
Original pressure gradient (psi/ft)	0.42	0.28	0.43
Hydrofrac Pumping rate (bpm)	34.8	36.3	20.0
Fluid Volume (gal)	12,000	12,000	4,000
Fracture gradient (psi/ft)	0.84	0.71	Screenout (0.72)
Max CO ₂ injection pressure (psi) At reservoir depth	752	1005	1258



SITE LAYOUT



SITE DEVELOPMENT

Monitor well drilling



SURFACE MONITORING

Soil Gas Monitoring



Groundwater Monitoring

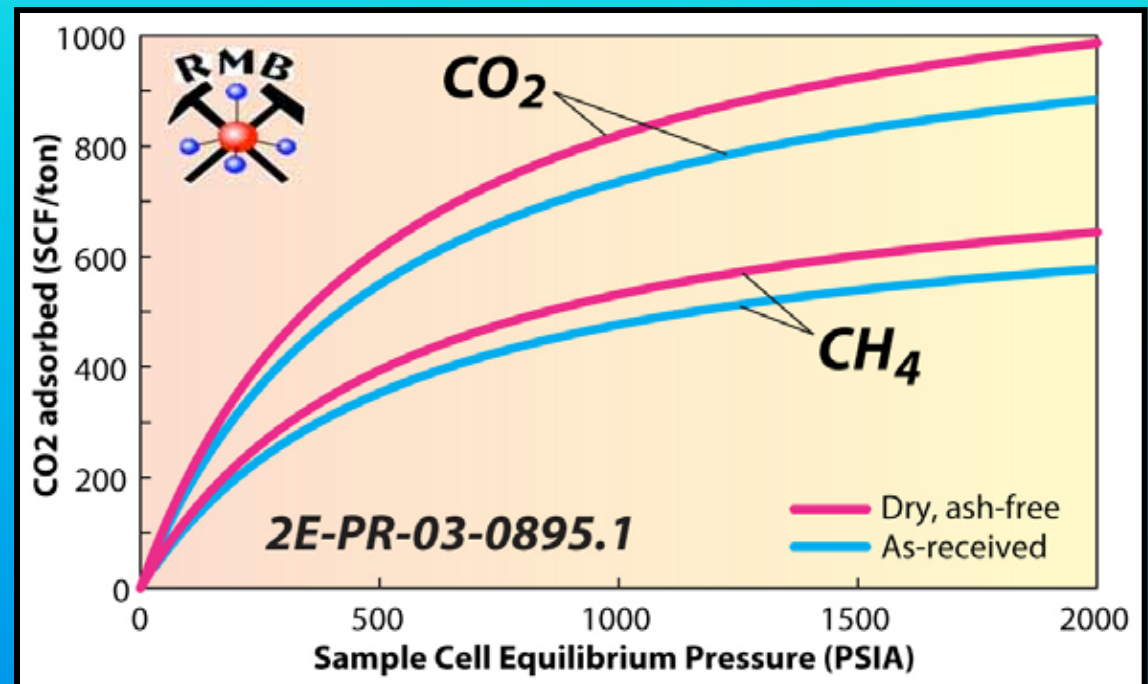


SITE DEVELOPMENT

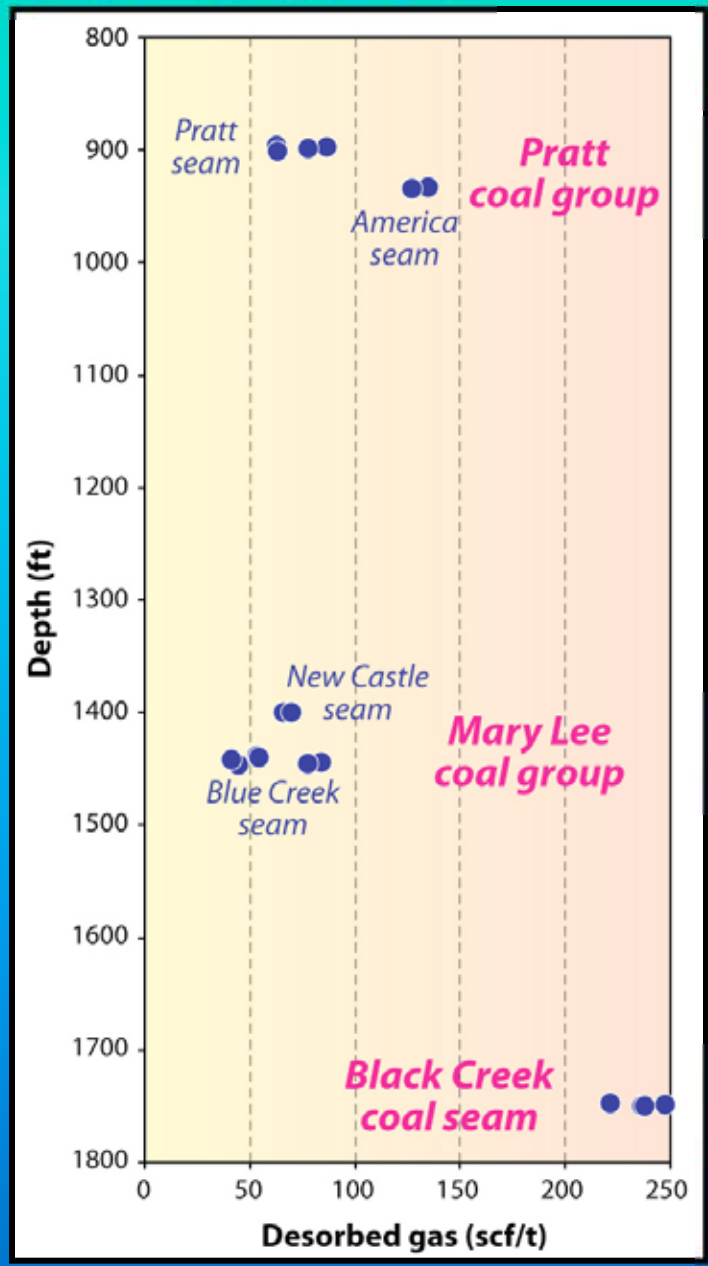
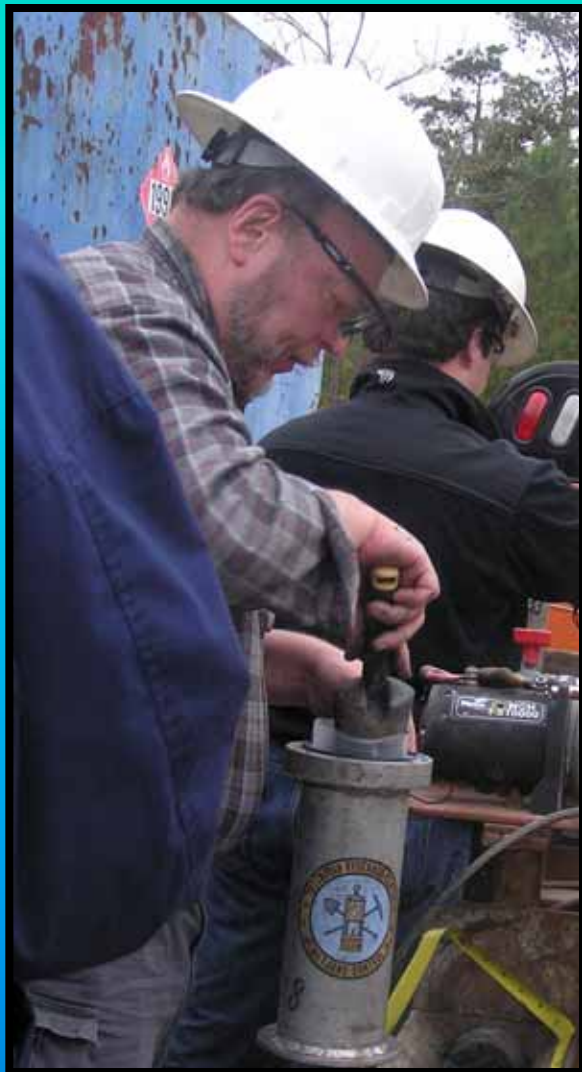
Coring



Laboratory Analysis



CORE TESTING



76 MMscf
produced

84 MMscf

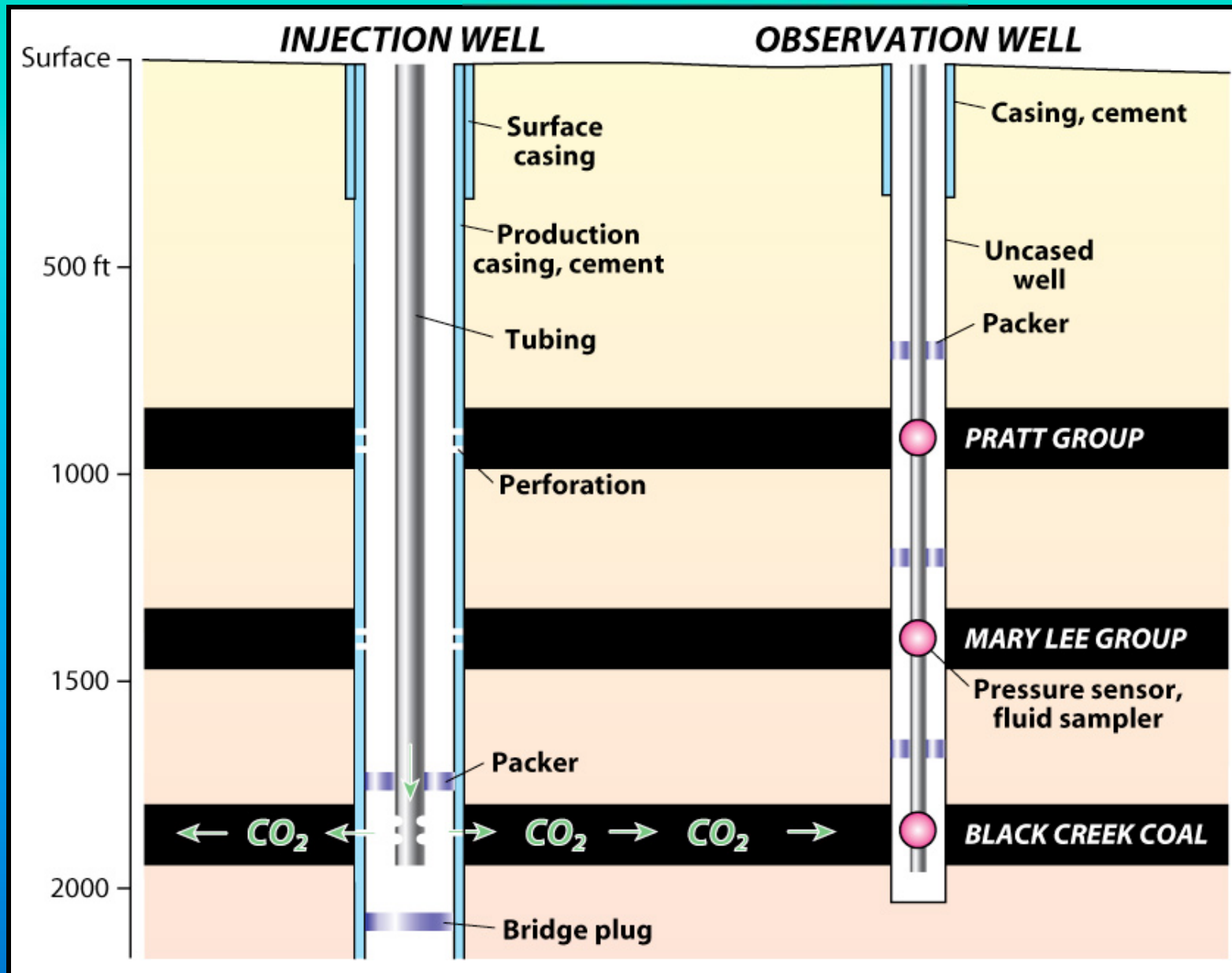
86 MMscf

121 MMscf

290 MMscf



DEEP TESTING



PACKERS, PRESSURE CHAMBERS

Inflatable packers



Helium chambers



Packer testing



CAPILLARY TUBING

Coiled tubing



Workover Rig



Wellbore
installation



MONITOR WELLHEAD



DATA COLLECTION

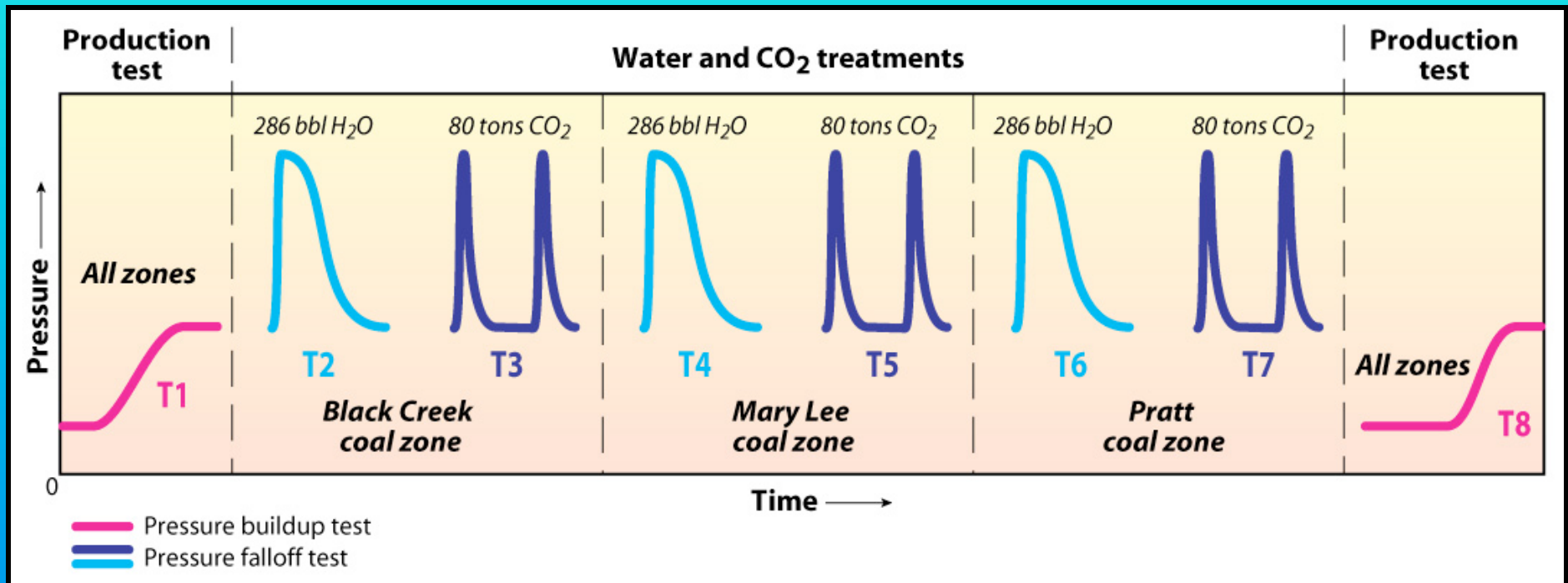
Fluid sampling



Data logging system

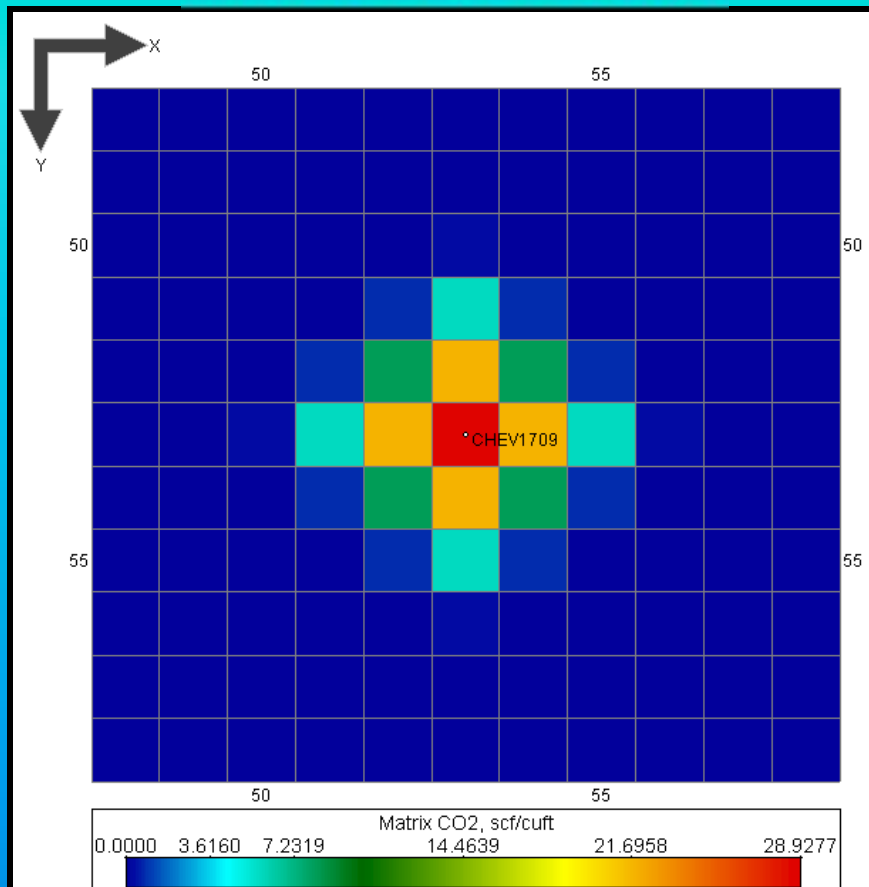


PRODUCTION AND INJECTION TESTS

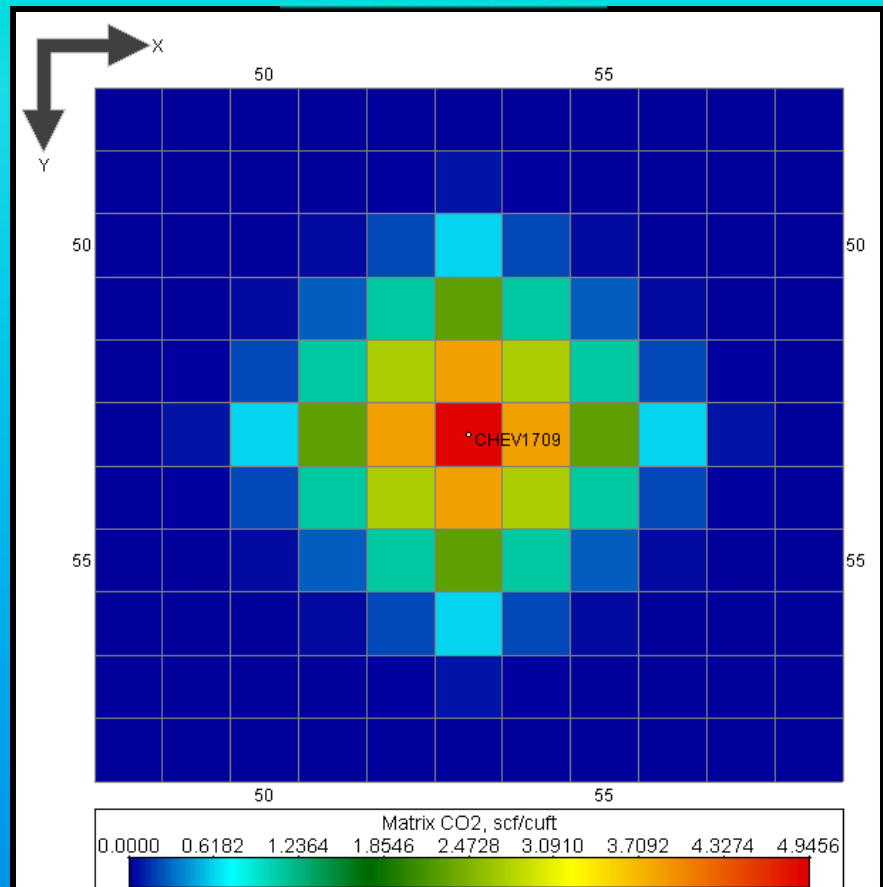


RESERVOIR MODELS

Black Creek zone



Pratt zone



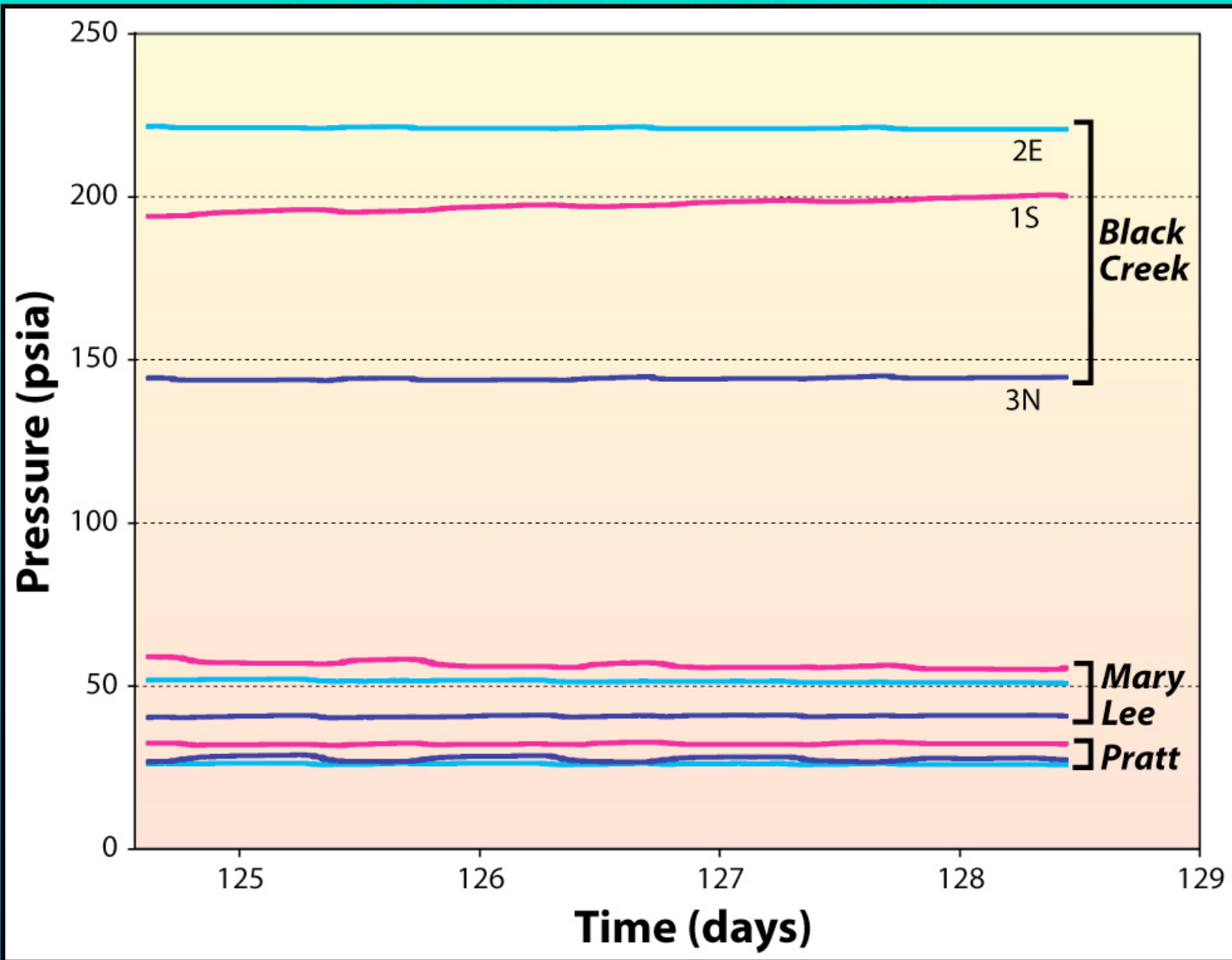
Grid blocks = 10,000 ft²



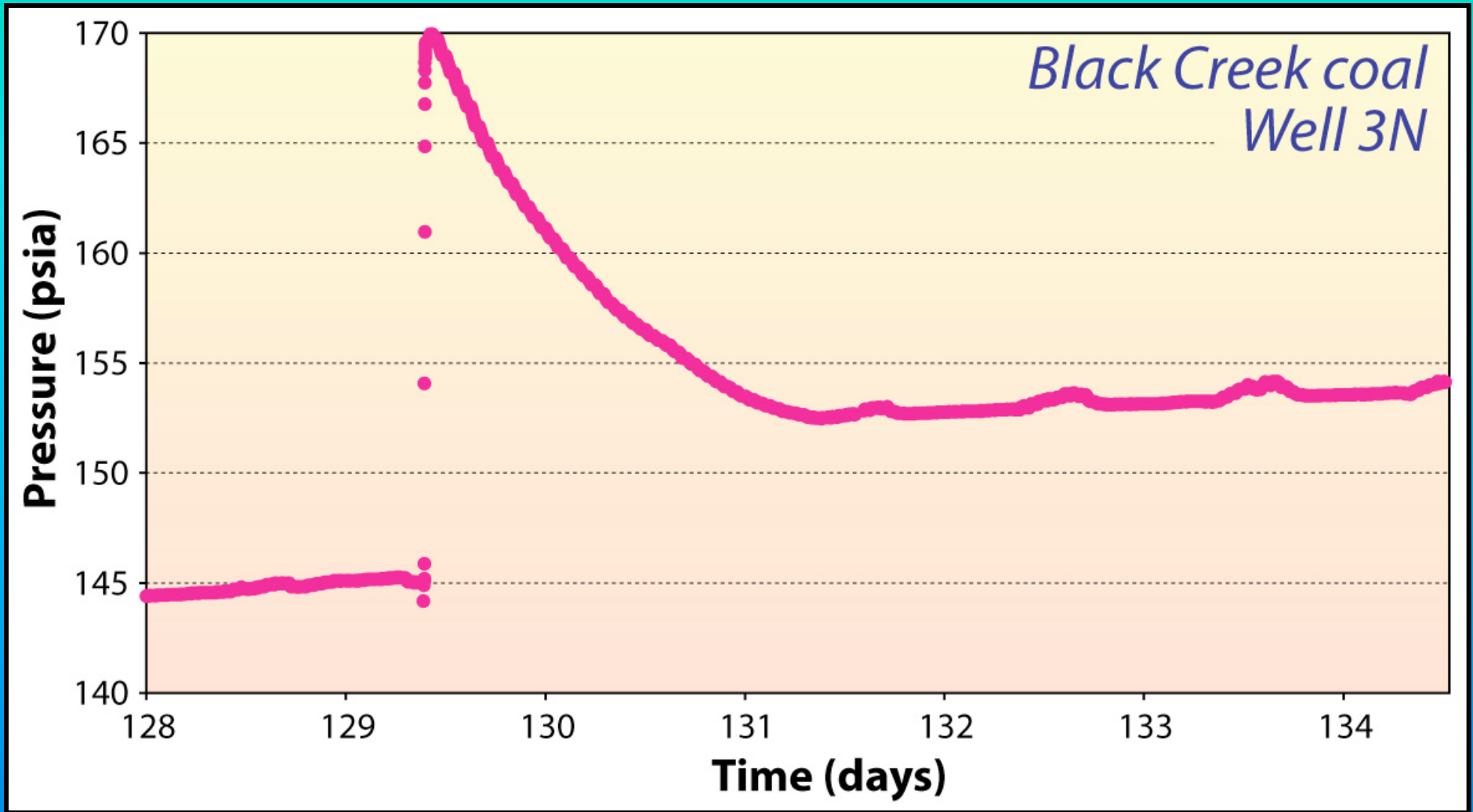
COMET3 models by Advanced Resources International



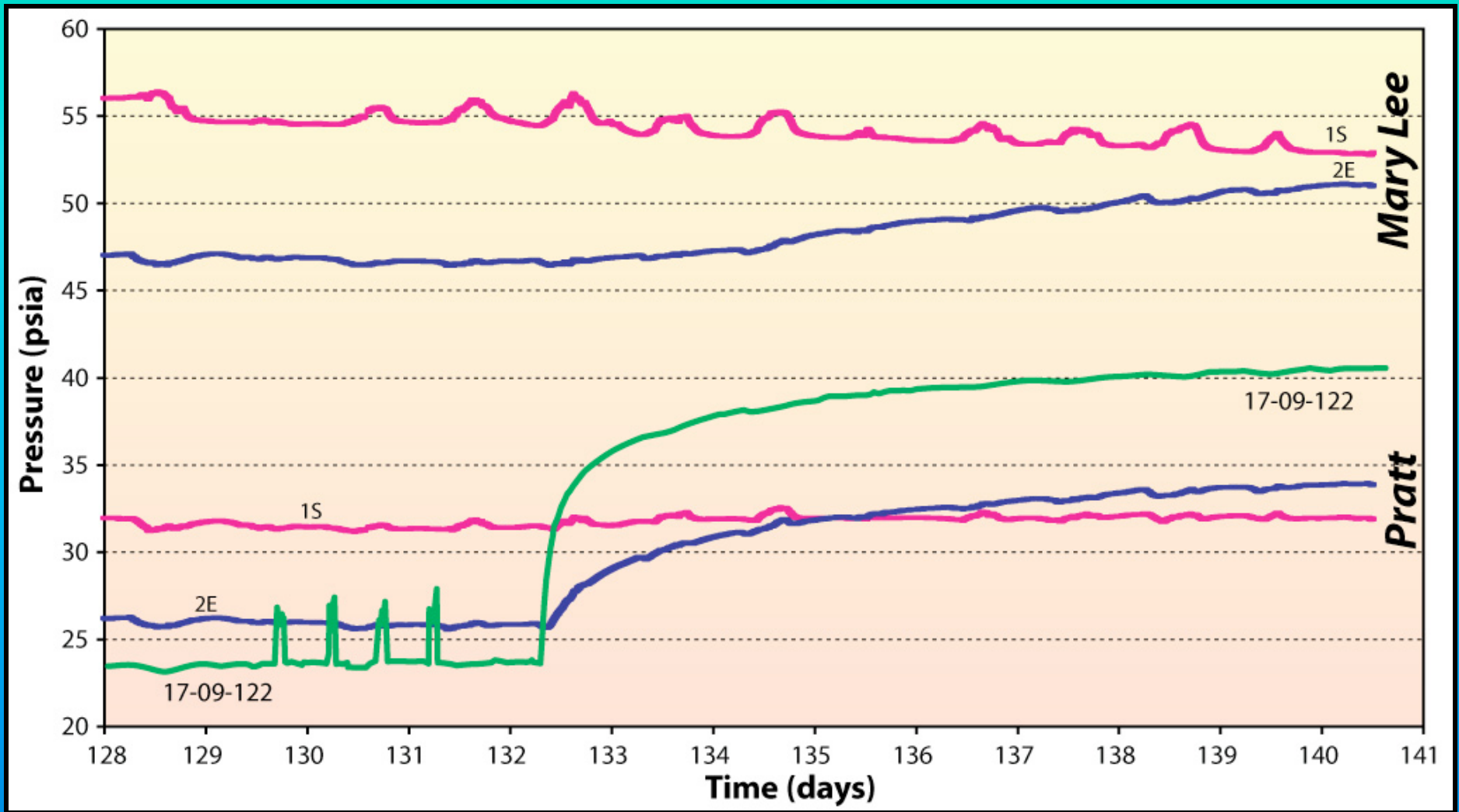
BASELINE PRESSURE



SLUG TESTING



PRESSURE BUILDUP TEST



INJECTION SYSTEM

Compression

Storage



Propane

Heating

Injection

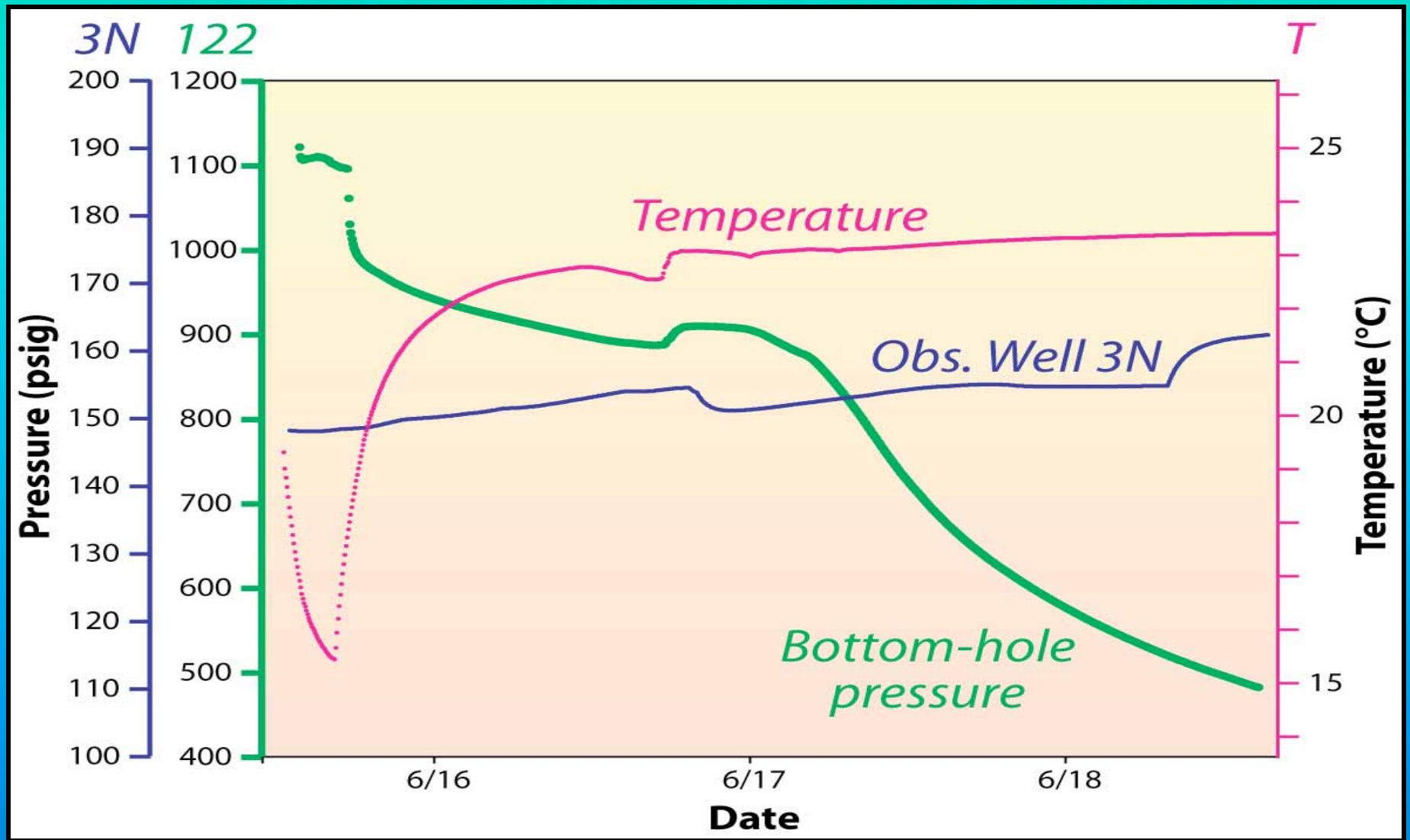
Injection system used at SECARB Plant Daniel and Black Warrior test sites



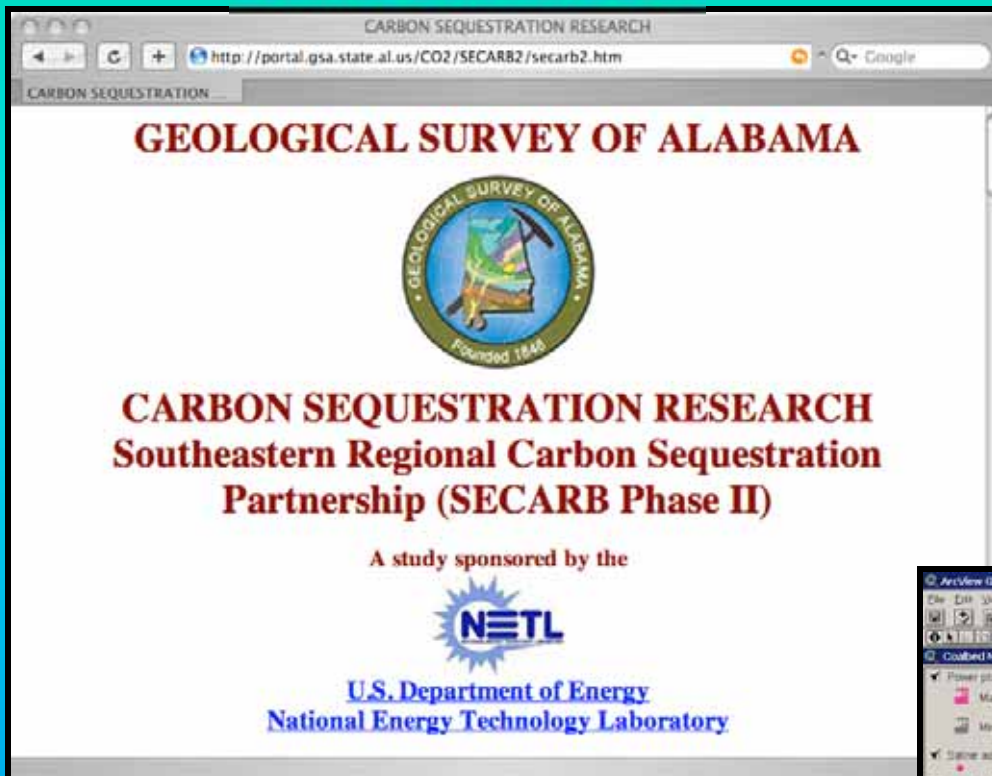
WELLHEAD ASSEMBLY



BLACK CREEK INJECTION RESULTS




Web resources



CARBON SEQUESTRATION RESEARCH


<http://portal.gsa.state.al.us/CO2/SECARB2/secarb2.htm>

GEOLOGICAL SURVEY OF ALABAMA



CARBON SEQUESTRATION RESEARCH
Southeastern Regional Carbon Sequestration
Partnership (SECARB Phase II)

A study sponsored by the



U.S. Department of Energy
National Energy Technology Laboratory

OUTREACH ACTIVITIES

Publications

<http://gsa.state.al.us/CO2/CO2.htm>

Meetings

