Carbon Sequestration Research in Kentucky

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Kentucky Geological Survey

UK UNIVERSITY OF KENTUCKY

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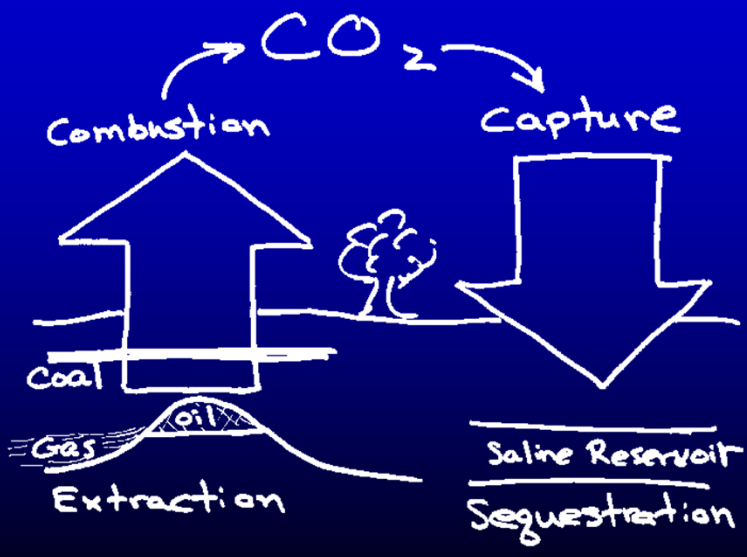
Lexington, Kentucky, 27-Sep-2011

KGS

Sequestration



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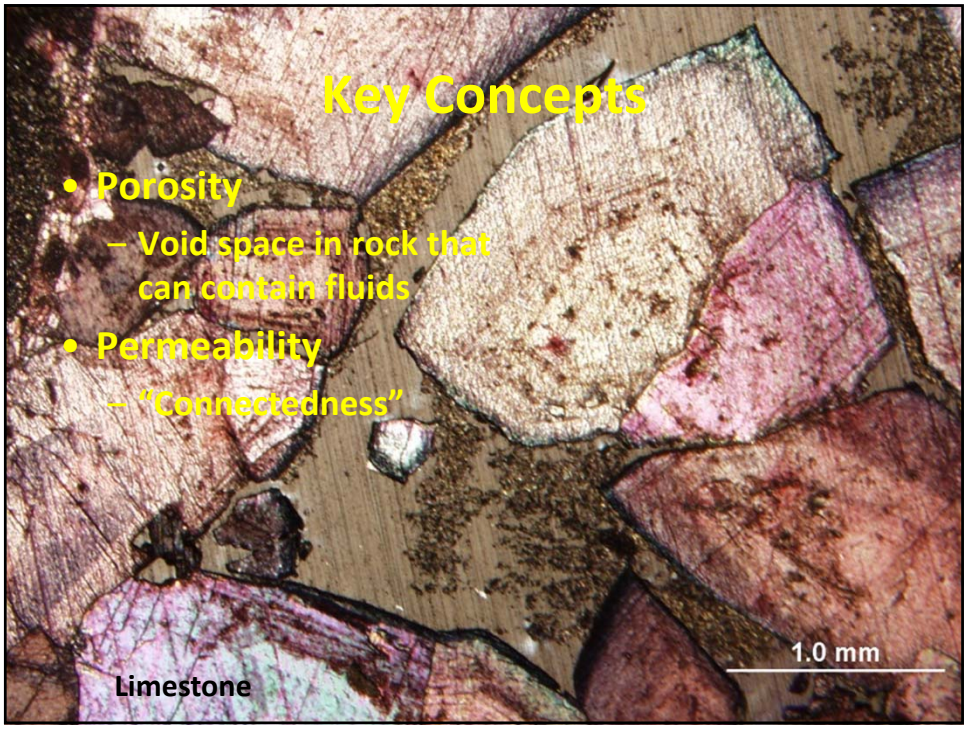

Key Concepts
• Porosity
– Void space in rock that can contain fluids
• Permeability
– "Connectedness"
1.0 mm
Limestone

What happens if there's a leak?
• Loss of life
– Lake Nyos, Cameroon
• Dead trees
– Mammoth Mountain/Horseshoe Lake, California
• Sell "fizzy" water
Perrier
50 cl
KGS

What do we do?

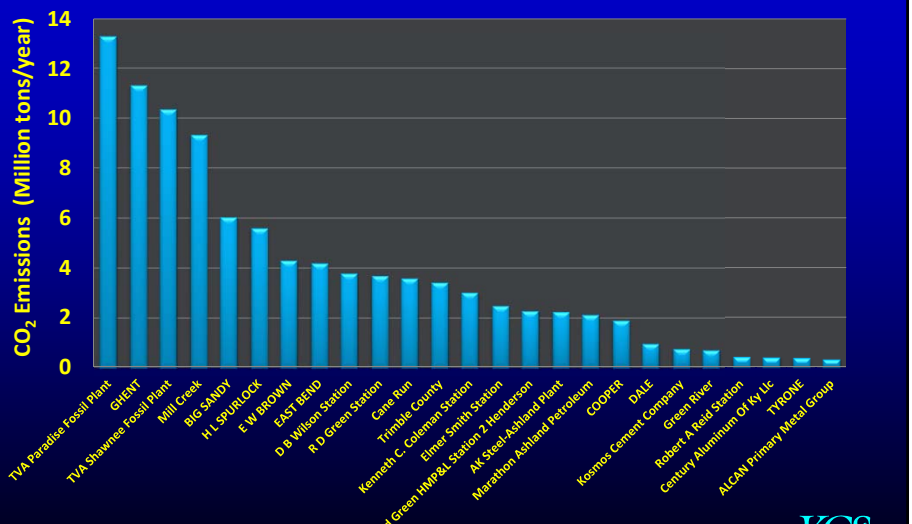
- Nothing
  - No laws limiting CO_2 emissions (*cost*)
  - No value assigned to emitted CO_2 (*revenue*)
- Regardless
  - Your electric bill will increase

But…

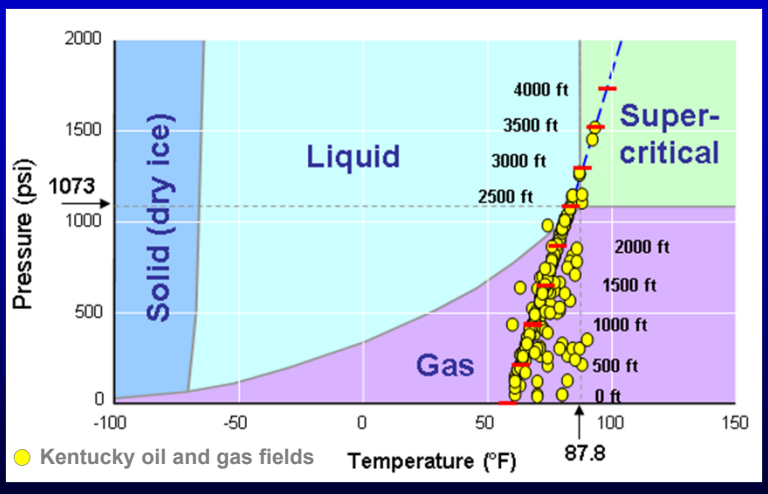
Kentucky's Carbon Numbers

- 3rd nationally in annual coal production
- 29.5 billion tons of recoverable coal reserves
- 92% of electrical generation is coal-fired (2006 EIA data)
- 152 million metric tons CO_2 emissions (2005)
  - 60% from electricity generation

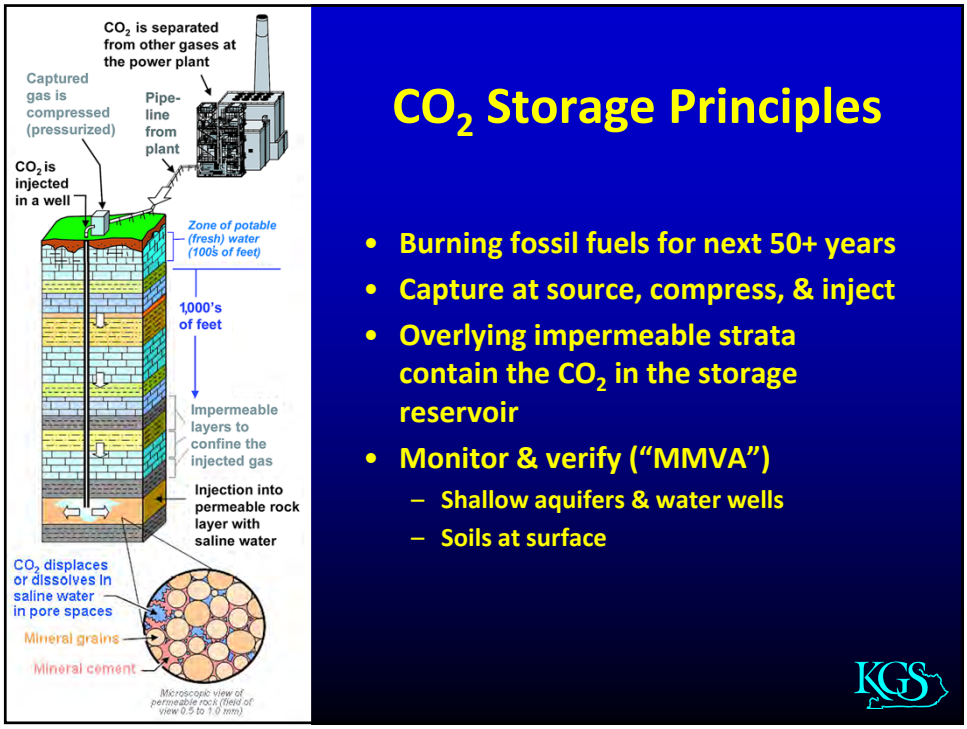
Top 25 Kentucky CO_2 Sources



CO_2 Phase Diagram



CO_2 will be in a dense (supercritical) phase at depths below 2,500 ft


CO_2 is separated from other gases at the power plant
Captured gas is compressed (pressurized)
Pipe-line from plant
CO_2 is injected in a well
Zone of potable (fresh) water (100s of feet)
1,000's of feet
Impermeable layers to confine the injected gas
Injection into permeable rock layer with saline water
CO_2 displaces or dissolves in saline water in pore spaces
Mineral grains
Mineral cement
Microscopic view of permeable rock (field of view 0.5 to 1.0 mm)
CO_2 Storage Principles
Burning fossil fuels for next 50+ years
Capture at source, compress, & inject
Overlying impermeable strata contain the CO_2 in the storage reservoir
Monitor & verify ("MMVA")
Shallow aquifers & water wells
Soils at surface
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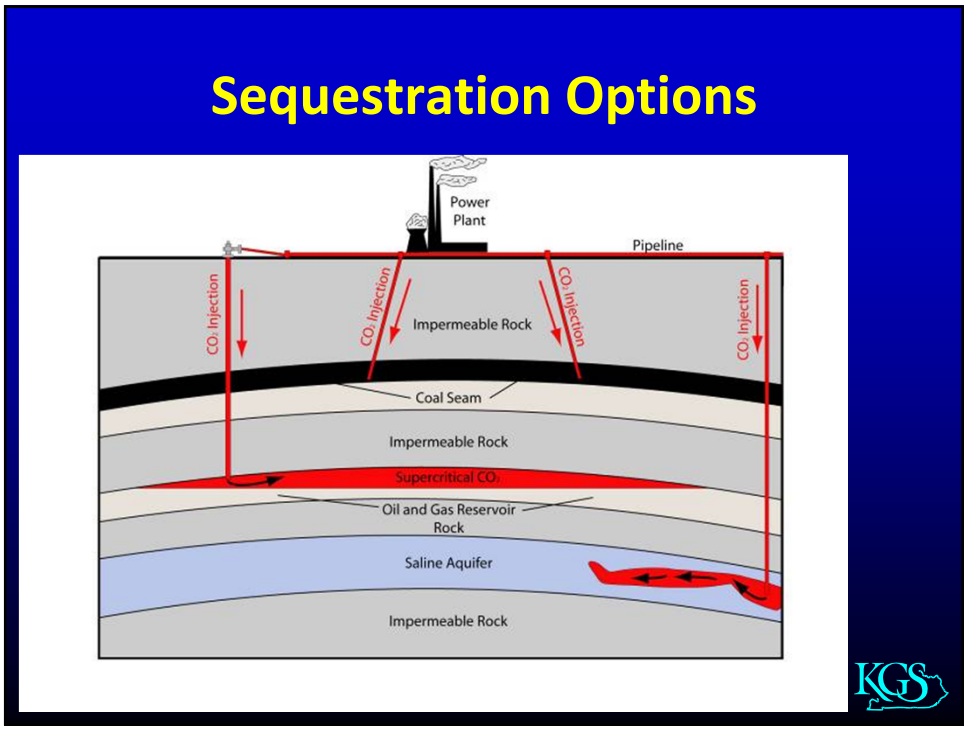
Sequestration Options
Power Plant
Pipeline
CO_2 Injection
CO_2 Injection
CO_2 Injection
CO_2 Injection
Impermeable Rock
Coal Seam
Impermeable Rock
Supercritical CO_2
Oil and Gas Reservoir Rock
Saline Aquifer
Impermeable Rock
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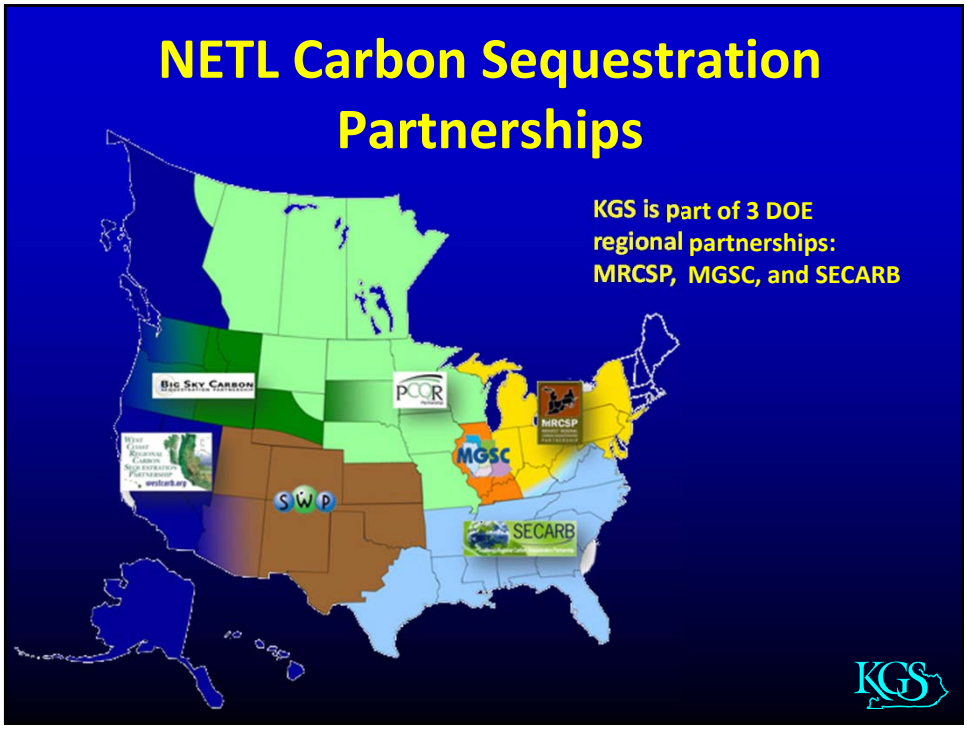
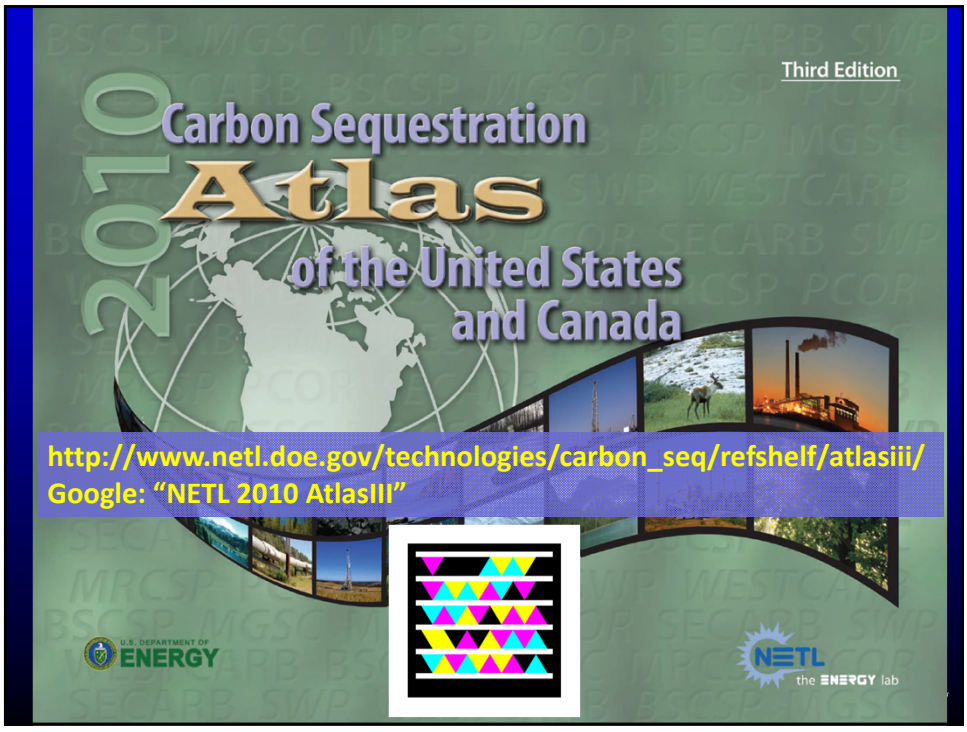

NETL Carbon Sequestration Partnerships
KGS is part of 3 DOE regional partnerships: MRCSP, MGSC, and SECARB
Big Sky Carbon
PCOR
MRCSP
MGSC
SWP
SECARB
KGS


Third Edition
2010
Carbon Sequestration Atlas
of the United States and Canada
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasiii/
Google: "NETL 2010 AtlasIII"
U.S. DEPARTMENT OF ENERGY
NETL
the ENERGY lab

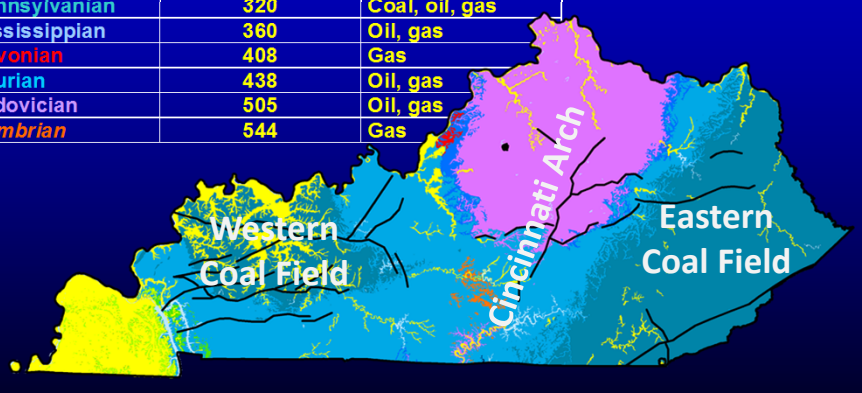
House Bill 1, 2007

- Incentives for coal-to-liquids & gasification
- $5 million for sequestration research
- Requires KGS to test
  - CO_2 enhanced oil recovery
  - Deep saline reservoirs in coal fields
  - Devonian shale for CO_2 storage potential
- Quantify sequestration capacity
- Most ambitious state-funded CCS demonstration program

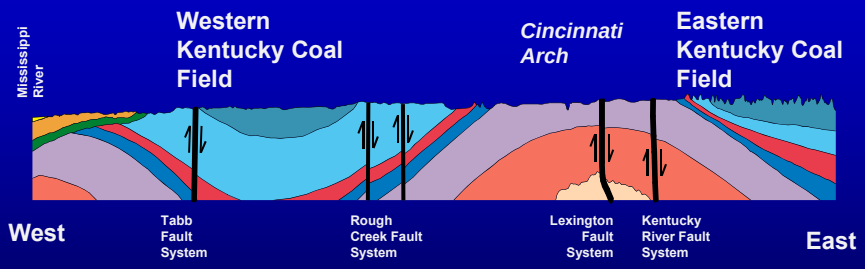
www.kyccs.org

Kentucky Surface Geology

Name	Million years ago	Resource
Pennsylvanian	320	Coal, oil, gas
Mississippian	360	Oil, gas
Devonian	408	Gas
Silurian	438	Oil, gas
Ordovician	505	Oil, gas
Cambrian	544	Gas



West to East Across Kentucky



Two major coal basins separated by an arch.

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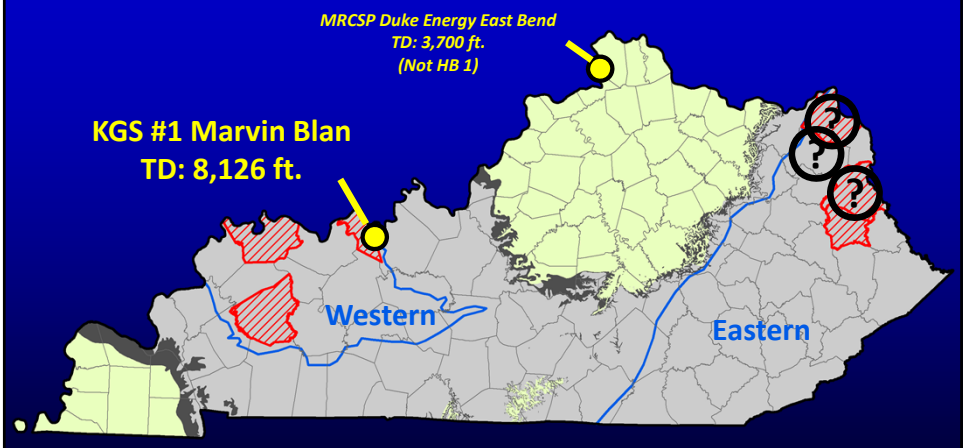
Deep Well Projects



Evaluating sites in Greenup and Lawrence Counties

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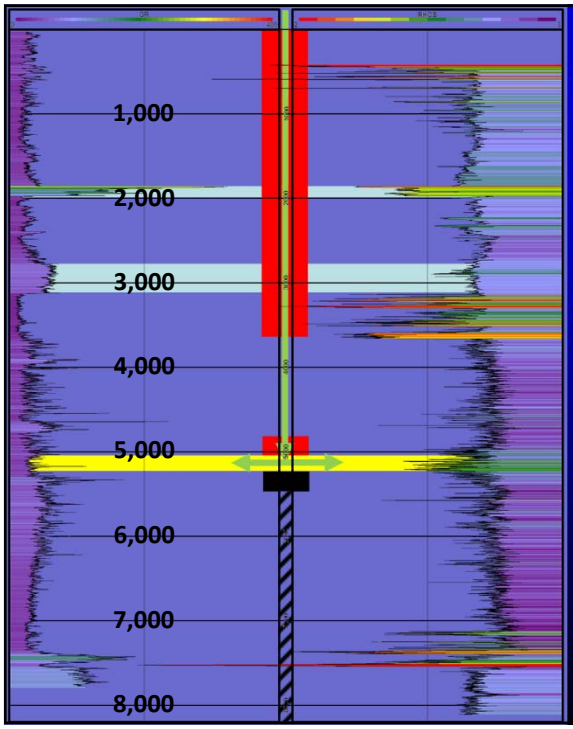
Blan Well Funding Partners

- $8 million
  - $1.35 million HB 1 funds
- Western Kentucky Carbon Storage Foundation
  - Conoco Philips
  - Peabody Energy
  - E.On U.S. (now LG&E/KU)
  - Illinois Office of Coal Development
  - TVA
- DOE/NETL (Phase 2)

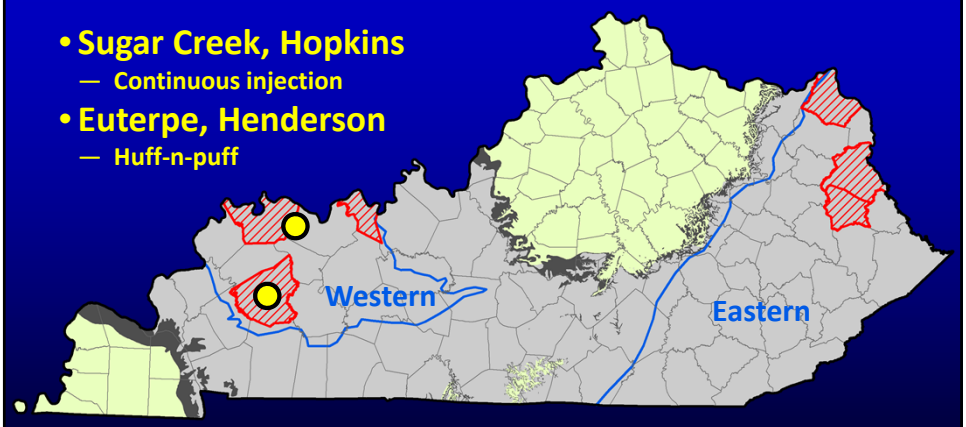


KGS 1 Blan

- 8,126 ft. depth
- 3,660 ft. casing
- Seals
- Phase 1
  - 4,568 bbl brine
  - 323 tons CO_2
- Plugged 5,268 ft.
- Liner @ 5,033 ft
- Phase 2
  - 4,265 bbl brine
  - 327 tons CO_2

Enhanced Oil Recovery Projects

- Sugar Creek, Hopkins
  - Continuous injection
- Euterpe, Henderson
  - Huff-n-puff



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Euterpe Single Well Cyclic CO_2 Injection

- 2 Rounds of Liquid CO_2 Injection
  - 20 tons/6 hrs 10/25/2010
  - 60 tons/3 days 01/22-24/2011

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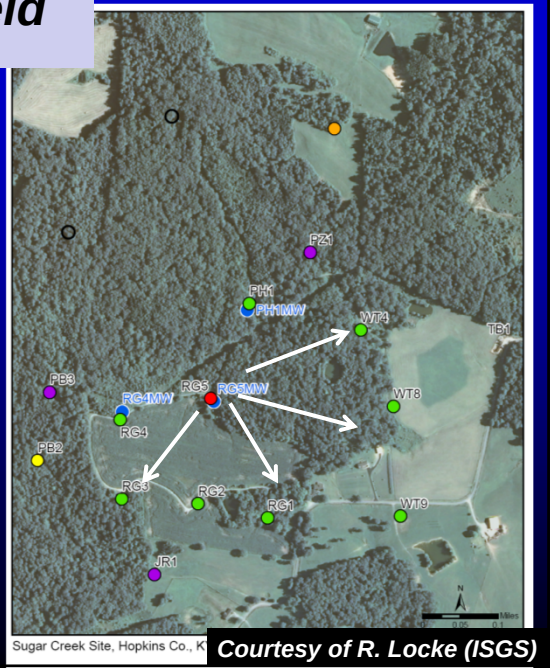
Sugar Creek Field

- CO_2 injection well
- Active oil well
- Temp. aband. oil well
- Water injection well
- Dry or unknown
- Reservoir monitoring well
- GW monitoring well

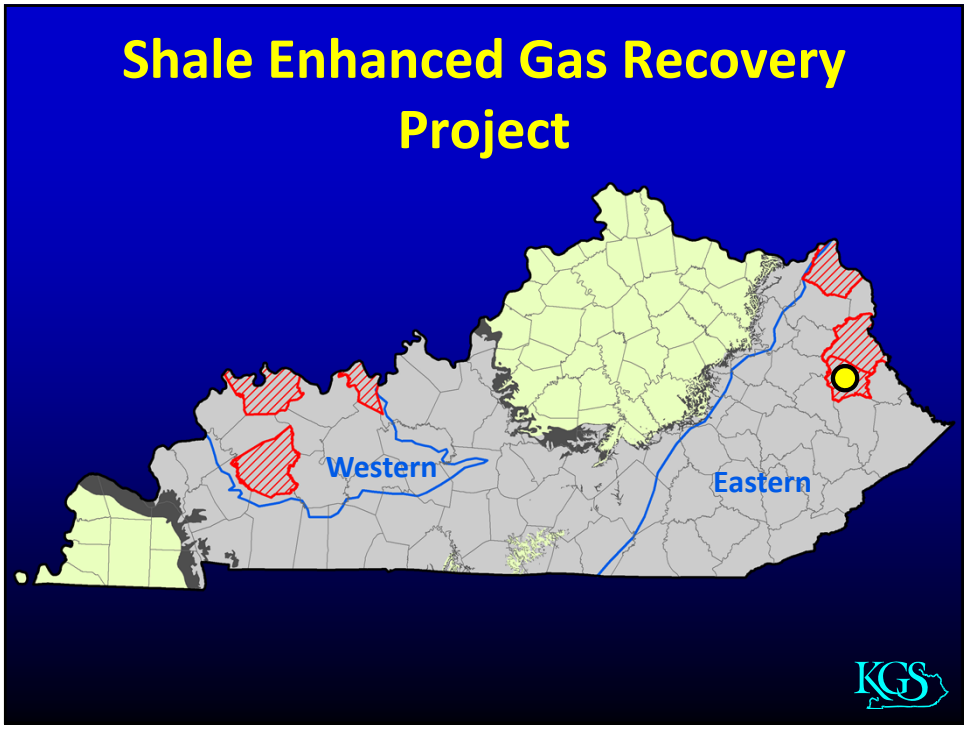


Courtesy of R. Locke (ISGS)

EOR Project Summary

	Euterpe	Sugar Creek
Type	Cyclic ("Huff-n-puff")	Continuous
Injected (tons)	80	≈ 7,100
Recovered (bbls)	≈ 120	1,000
Efficiency	2.85 Mcf CO_2/Bo	123 Mcf CO_2/Bo
Status	Suspended (mechanical problems)	Injection complete
Monitoring	Continuing	Complete

Lesson: In Kentucky's shallow fields, cyclic likely to have broader application.


Shale Enhanced Gas Recovery Project
Western
Eastern
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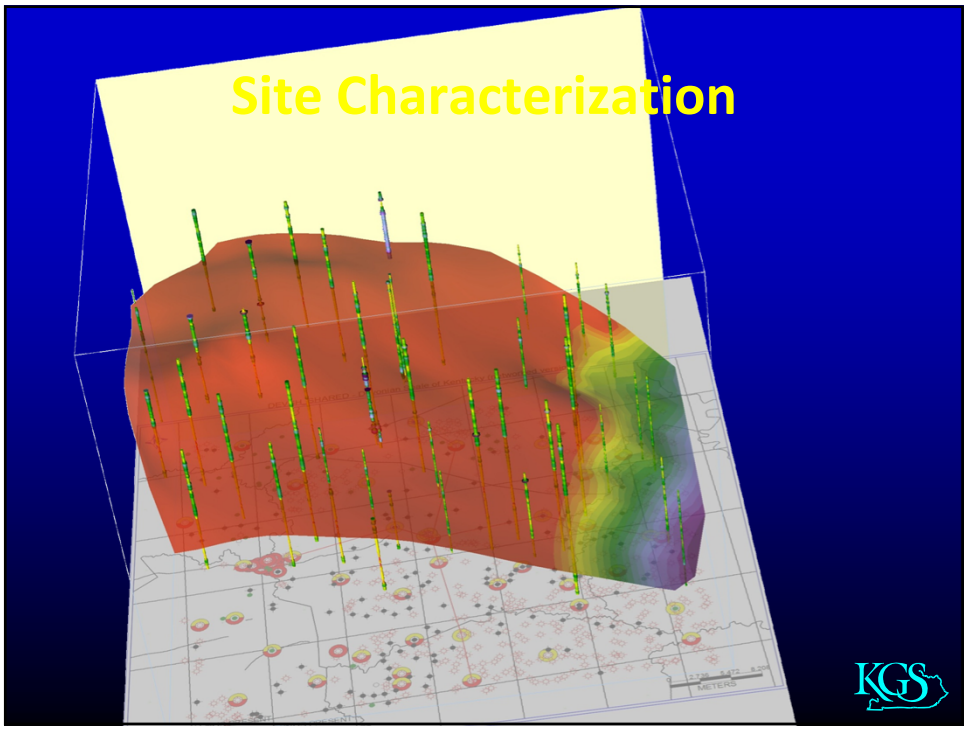
Site Characterization
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Interstate SS-#1 Fee

- Site construction
- Gas sampling
- Logging program
- Well head design
- Injection program
- Monitoring program

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Evaluation of Geologic CO_2 Sequestration Potential and CO_2 Enhanced Oil Recovery in Kentucky

Marty Parris, Steve Greb, and Brandon Nuttall

DEDI
KENTUCKY DEPARTMENT for ENERGY DEVELOPMENT & INDEPENDENCE

http://kgs.uky.edu/kgsweb/olops/pub/kgs/Energy/RI21_12/RI21_12.htm

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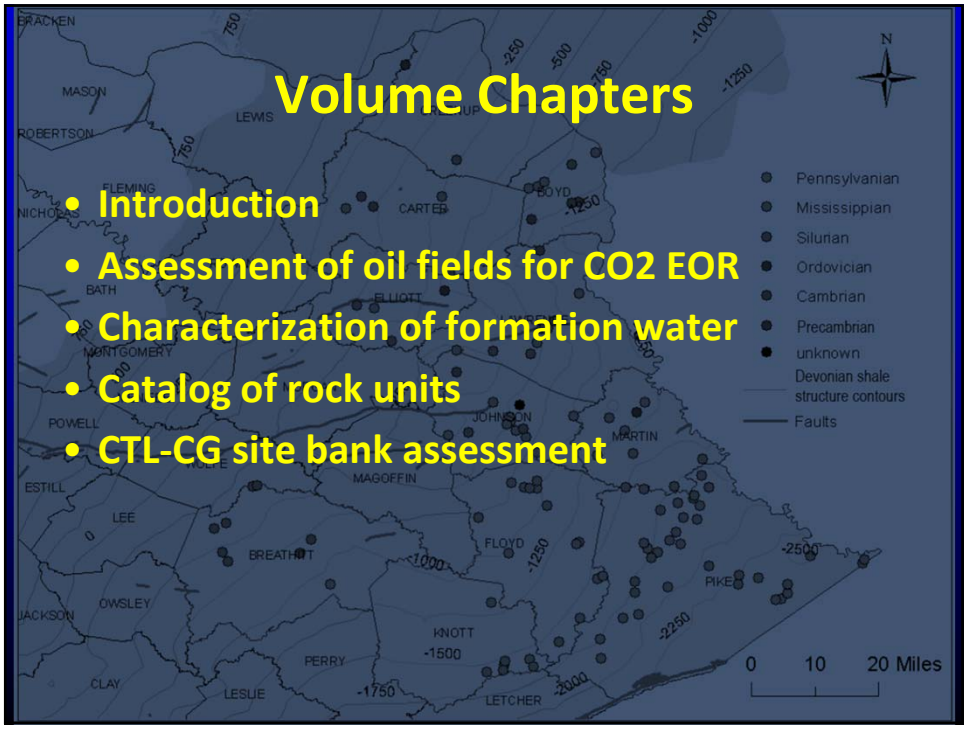
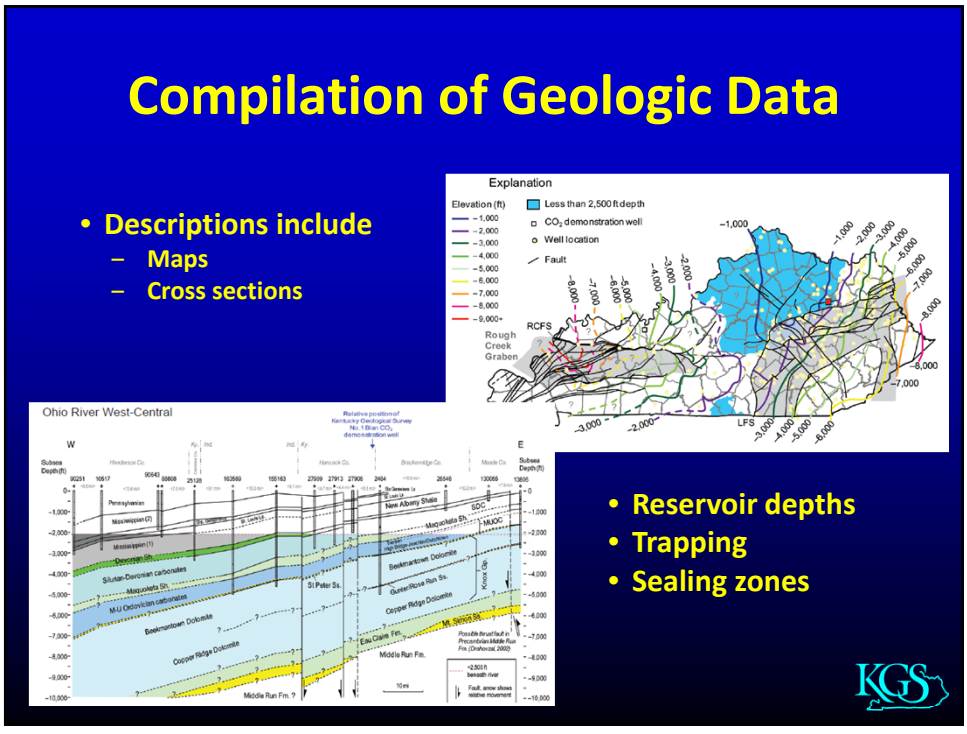

Volume Chapters
• Introduction
• Assessment of oil fields for CO2 EOR
• Characterization of formation water
• Catalog of rock units
• CTL-CG site bank assessment
Pennsylvanian
Mississippian
Silurian
Ordovician
Cambrian
Precambrian
unknown
Devonian shale structure contours
Faults
0 10 20 Miles


Compilation of Geologic Data
• Descriptions include
– Maps
– Cross sections
Explanation
Less than 2,500 ft depth
Well location
Fault
Rough Creek Graben
RCFS
LFS
Ohio River West-Central
• Reservoir depths
• Trapping
• Sealing zones
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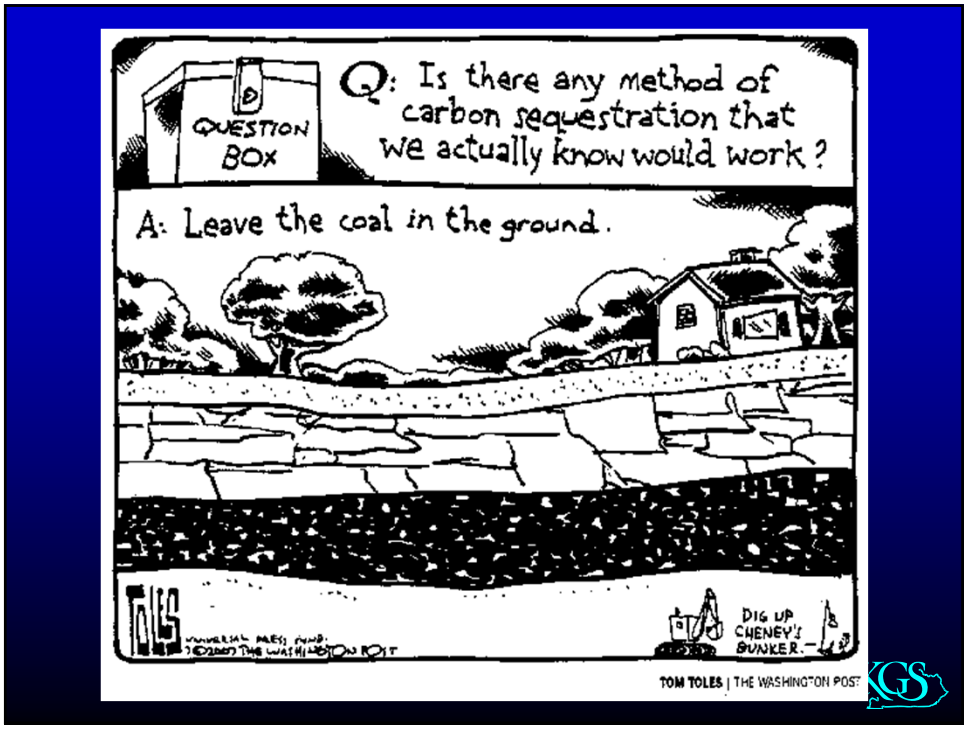

Acknowledgments

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- Kathryn Takacs (EOR, assessment)

Thank you

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