

Midwest Geological Sequestration Consortium

An Assessment of Geological  
Carbon Sequestration Options in the  
Illinois Basin

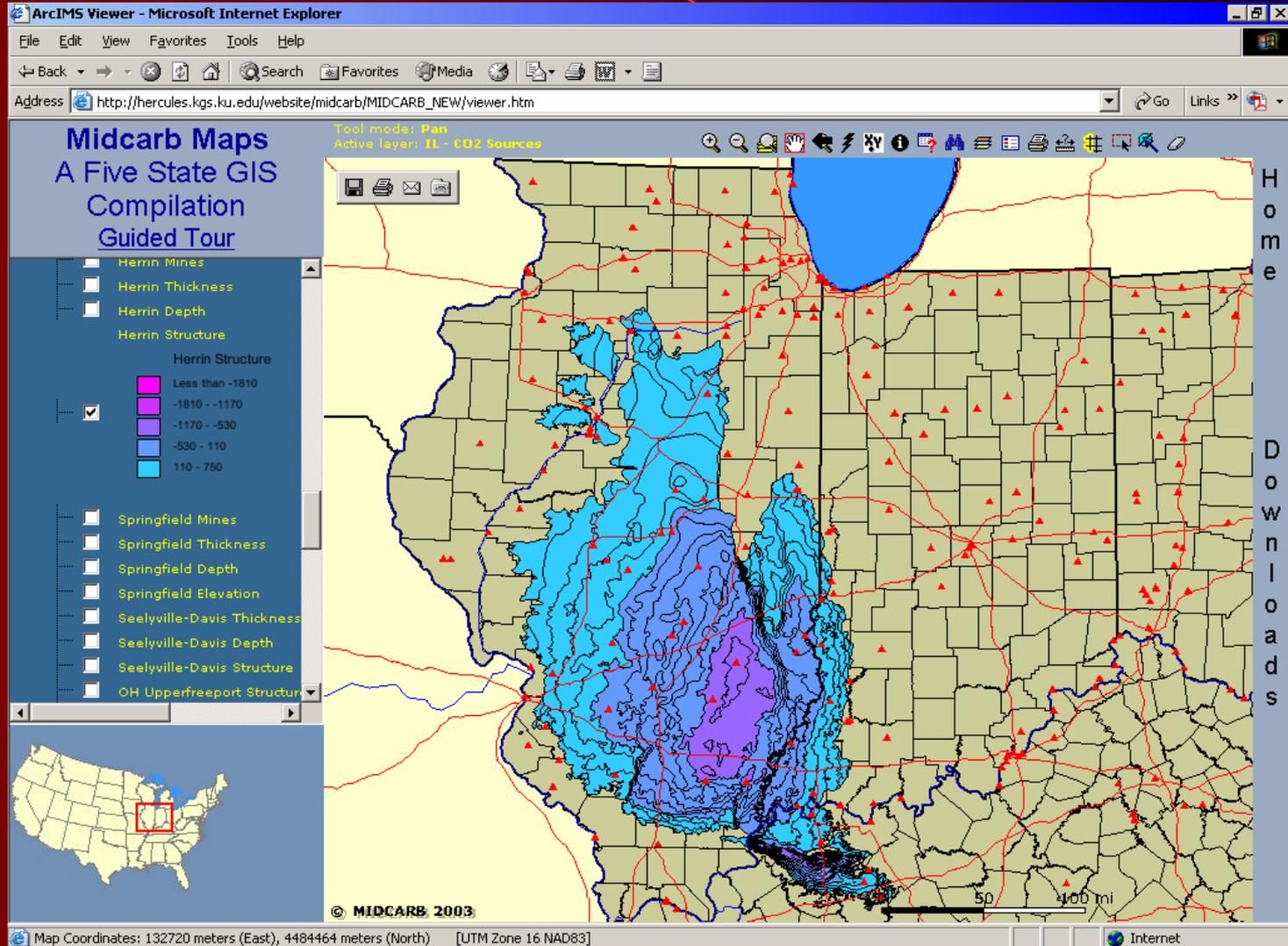
Robert J. Finley  
Illinois State Geological Survey  
and the MGSC Team

U.S. Department of Energy Kickoff Meeting  
November 3, 2003

# Partnership Focus

- Geological sequestration potential in the 60,000 sq mi area of the Illinois Basin of Illinois, western Indiana and western Kentucky
- Stationary sources emit in excess of 255 MMTCO<sub>2</sub> annually
- Emphasis on the three geological sinks: deep, uneconomic coal seams, mature oil reservoirs amenable to CO<sub>2</sub> EOR, and deep, saline reservoirs

# Herrin Coal Structure Defines Illinois Basin



# Midwest Geological Sequestration Consortium (MGSC) A DOE Regional Partnership

- Lead by Illinois State Geological Survey in collaboration with the Kentucky and Indiana Geological Surveys
- Survey staff make up six-member Technical Committee
- Subcontractors at BYU (geophysics), SIU (coal adsorption), D.J. Nyman & Assoc. (transportation [Houston]) and Dr. Dave Thomas (advisor [Chicago])

# Midwest Geological Sequestration Consortium (cont'd)

- Three utility partners: Ameren, Louisville Gas and Electric, and Cinergy
- Three industry partners: Peabody Energy, Aventine Renewable Energy, and Air Liquide
- Trade groups and consortia: IL, IN, and KY Oil & Gas associations, ICGA, EPRI, IOGCC
- Illinois Office of Coal Development, DCEO
- Illinois Department of Natural Resources

# Geologic Carbon Sequestration Options in the Illinois Basin: Project Structure

- Phase 1: Compile all available data and review CO<sub>2</sub> capture and transportation options
- Phase II: Assess the storage options, the heart of the project, looking at uneconomic coals, mature oil fields, and the deep, saline reservoirs
- Phase III: Integrate results from first two phases, determine how capture-transportation-storage would be linked, and generate plans for field tests

# Geologic Carbon Sequestration Options in the Illinois Basin: Phase I

- 1: Compile and assess data (4 months)
- 2: Assess carbon capture options for the Illinois Basin (9 months)
- 3: Assess CO<sub>2</sub> transportation options in the Illinois Basin (9 months)
- Phase I completed in Year 1
- Topical report delivered and website operational

# Geologic Carbon Sequestration Options in the Illinois Basin: Phase II

- 4: Assess coalbed sinks and methane production options (13 months)
- 5: Assess oil reservoir sinks and oil recovery options (15 months)
- 6: Assess deep saline reservoirs sinks (13 months)
- Tasks extend 4-5 months into Year Two

# Geologic Carbon Sequestration Options in the Illinois Basin: Phase III

- 7: Integrate storage options to linked capture-transportation pathways (4 months)
- 8: Assess environmental-regulatory framework for linked capture-transportation-storage options (3 months)
- 9: Define scenarios and evaluate outcomes (4 months)

# Geologic Carbon Sequestration Options in the Illinois Basin: Phase III (cont'd)

- 10: Compile results in print and digital media  
(6 months)
- 11: Carry out education/outreach activities  
(5 months)
- 12: Generate action plan for technology validation  
activity (5 months)
- All Phase III tasks in Year 2

# Illinois Basin Offers Multiple Opportunities to Test Geological CO<sub>2</sub> Sequestration Options

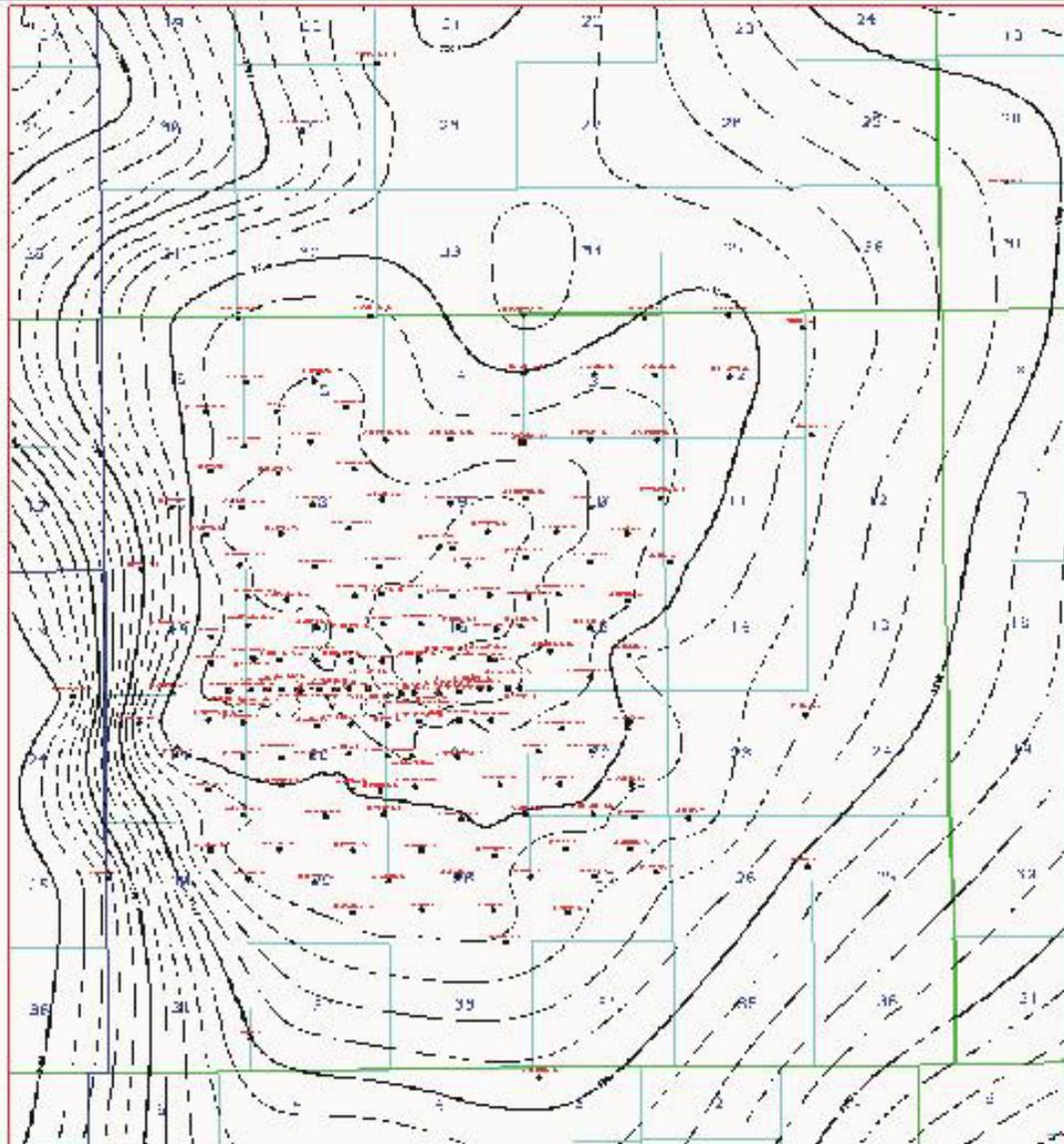
- Potential CO<sub>2</sub> sinks are vertically stacked in much of the central and southern parts of the Illinois Basin
- CO<sub>2</sub> available from ethanol production for field testing
- Illinois has a strong interest in coal redevelopment including gasification processes leading to sequestration-ready CO<sub>2</sub> streams

# Mt. Simon Sandstone Supports Natural Gas Storage

- Illinois is the second leading state in natural gas storage capacity in the nation
- Many of these facilities are in the Mt. Simon, proving gas containment capability and providing a data base of cores, water chemistry data, and reservoir engineering properties
- ISGS has completed a Mt. Simon storage facility study for DOE

# Manlove Field Geology

- 175 wells in northwest Champaign County, IL
- Depth to top Mt. Simon averages about 4,000 ft
- Porosity 7-15 %, permeability mostly ~ 100 md
- Excellent caprock with 300-400 ft of Eau Claire shale/silt sealing the Mt. Simon



## Top Mt. Simon Structure

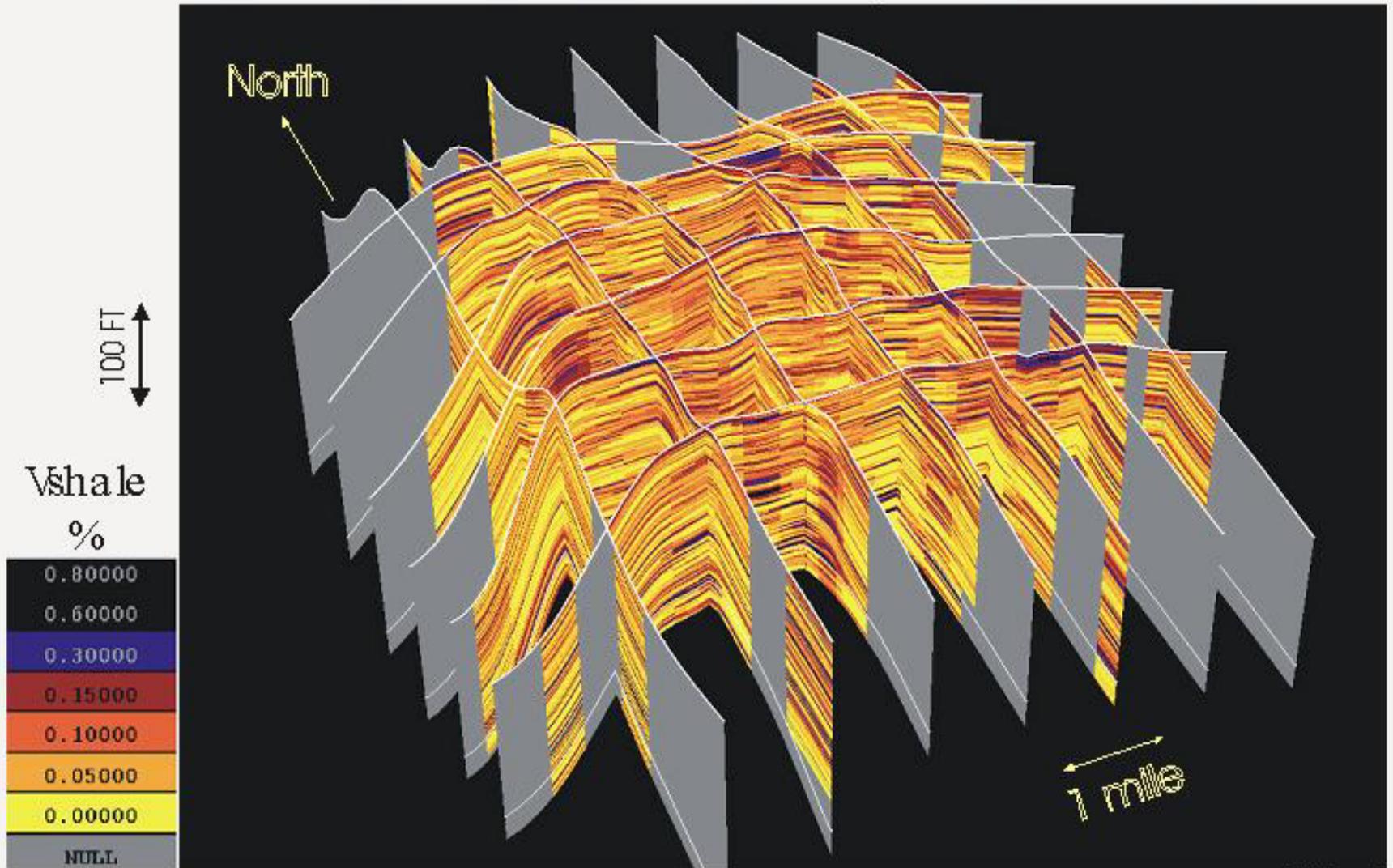


Manlove Field  
Champaign Co, IL

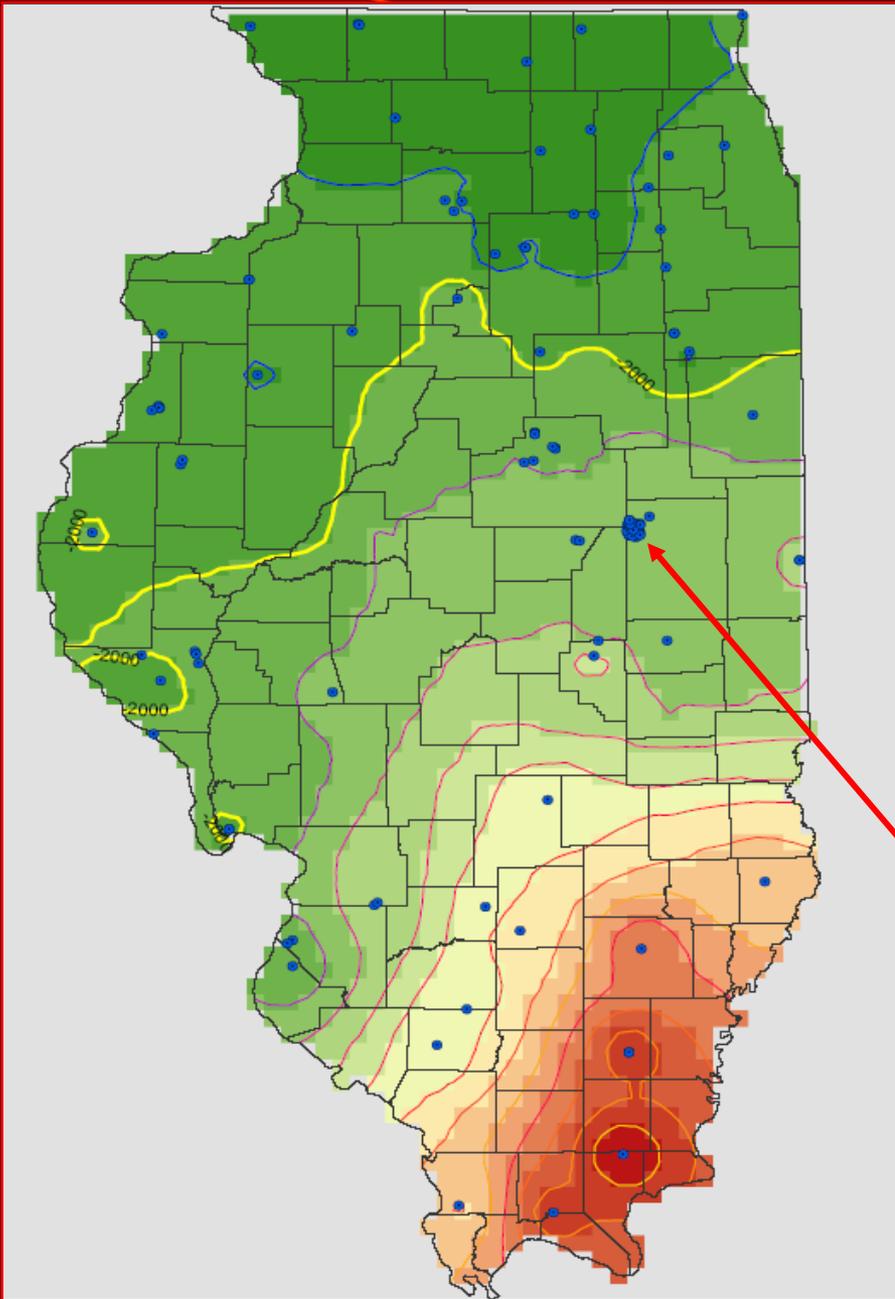
CF= 20 ft

5000'  
1 mile

# Vshale Structure Fence Diagram- Manlove Field

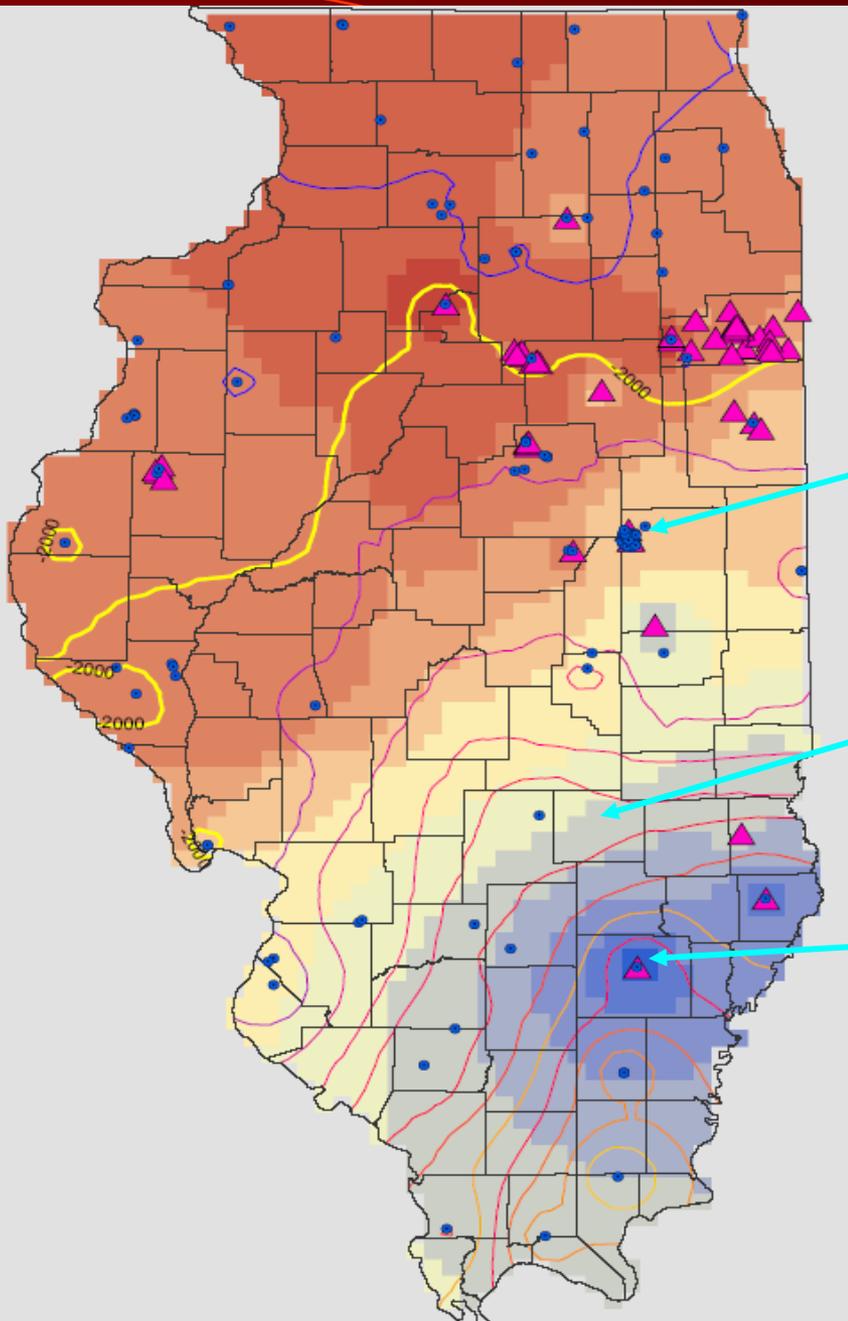


# Mt. Simon Structure



- Sub sea depths from < 1,000 ft in northern Illinois to > 13,000 ft in southeastern Illinois
- Manlove Field southernmost area of detailed data

# Mt. Simon Porosity

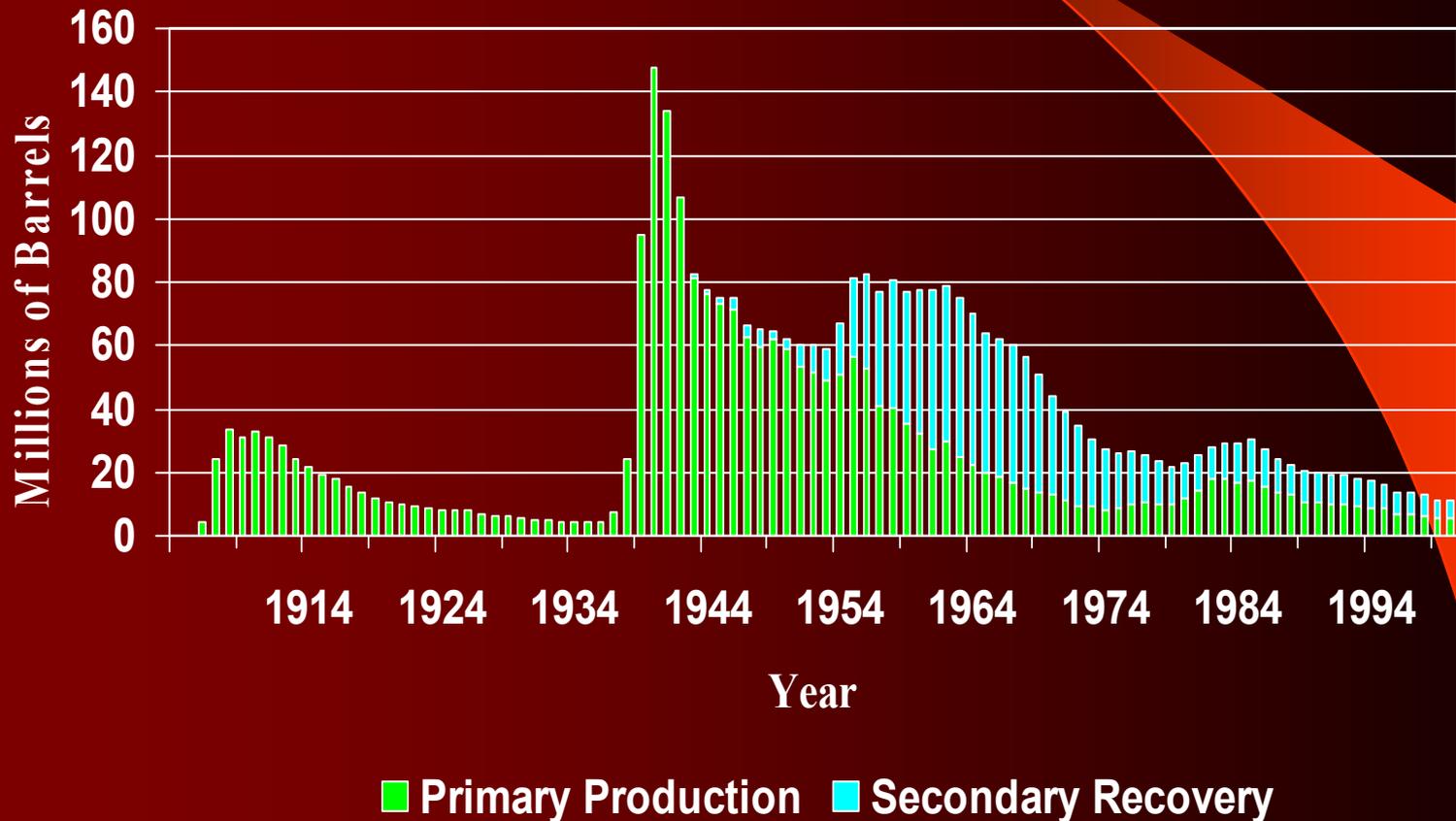


- Porosity at Manlove Field can be up to 15%, mostly 9.5-11%
- Porosity expected to decrease with depth: ~ 7-8% at 8,000 ft
- 3% porosity at deepest locations?

# Oil Reservoirs in the Illinois Basin

- Oil industry in Illinois is mature: production declined from 18 mmbbls in 1989 to 11 mmbbls in 2001; peak in 1940 was 140 mmbbls
- Three major reservoirs: Cypress and Aux Vases sandstones and St. Genevieve limestone
- CO<sub>2</sub> flooding largely untested
- Numerous reservoirs depleted

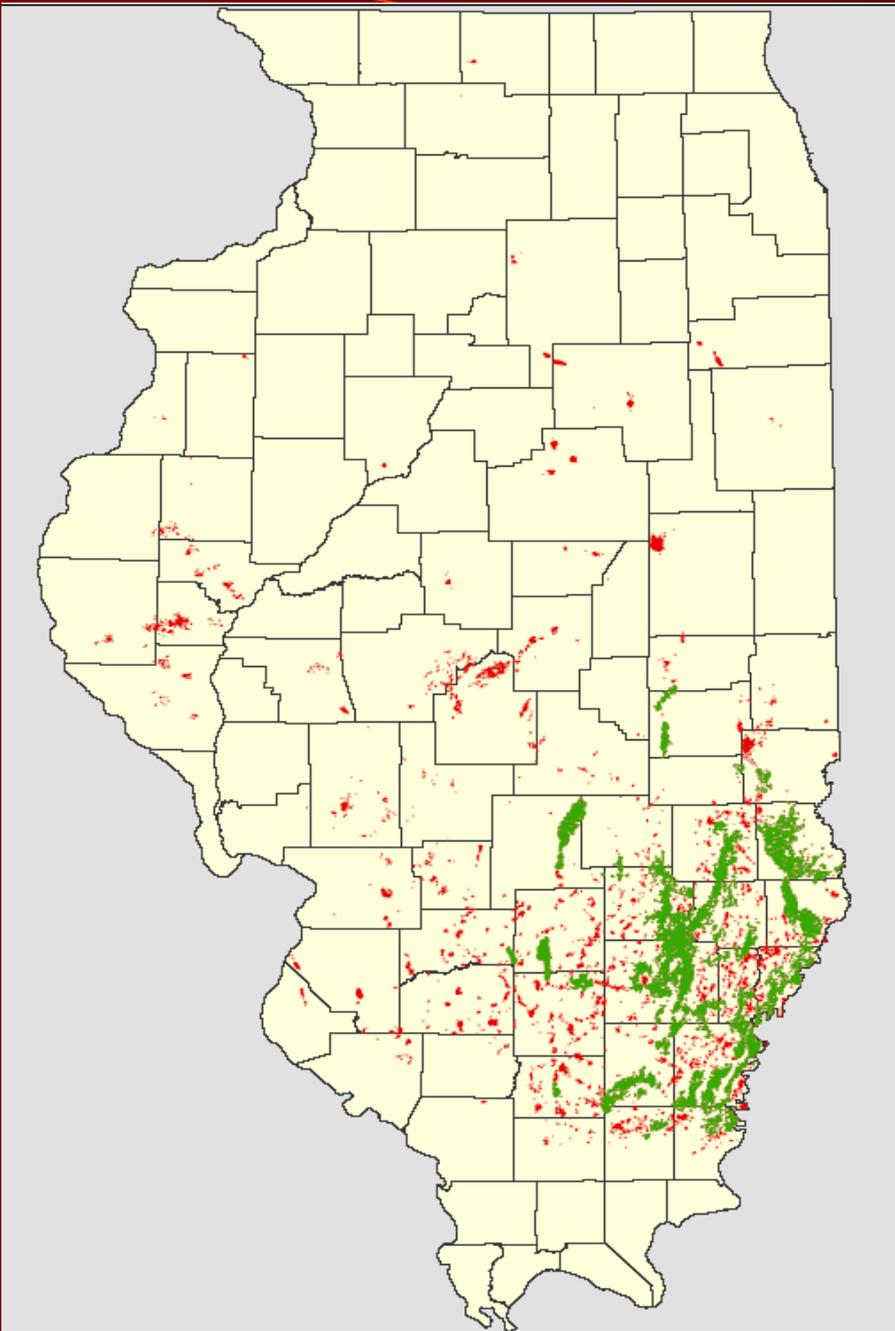
# Conventional Production and Waterflood Production have Matured in Illinois



# Issues with CO<sub>2</sub> Enhanced Oil Recovery Potential in Illinois

- Most reservoirs in Illinois would be primarily suitable for immiscible flooding
- Some reservoirs would be amenable to miscible flooding at depths  $> 2,500$  ft with API oil gravity of 25 or greater
- Uncertain economics have prevented development, particularly the availability of CO<sub>2</sub>

# Oil Field Distribution



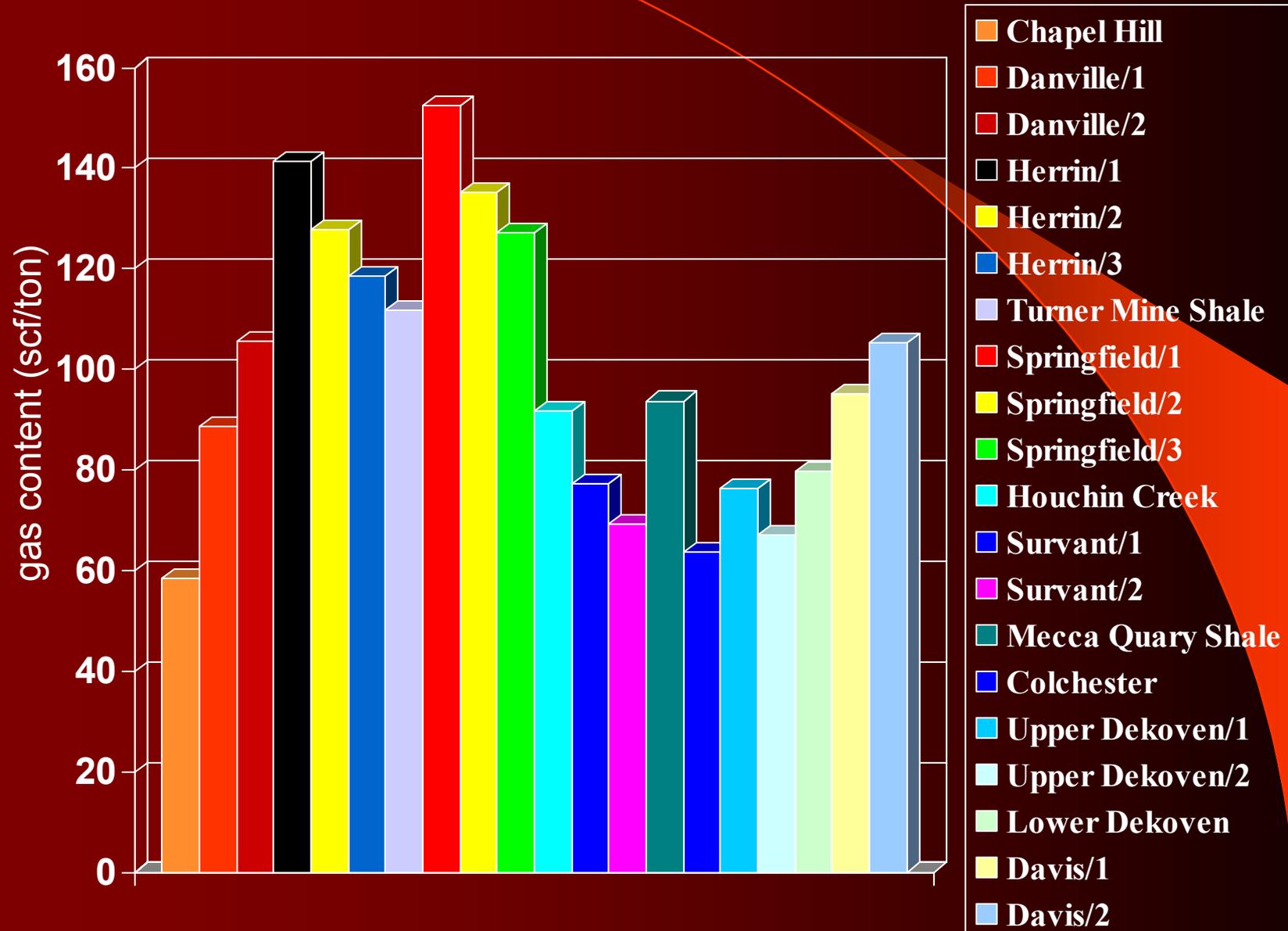
- 559 oil and gas fields shown in red
- 43 large oil fields (green) have one or more reservoirs at  $>2,500$  ft depth
- Large fields average  $> 18$  sq mi and have produced  $\sim 2.4$  billion bbls oil

# Illinois Contains Extensive Coal Resources

- Coal is mostly hi-vol C and B bituminous
- Over 36,000 sq mi is underlain by multiple seams
- Most bituminous coal of any state
- Two major seams (Herrin and Springfield) and 7 additional seams account for most resources
- Total resources of 199 billion tons of which only 30% economically minable (current and foreseeable future)

# Franklin County Gas Contents

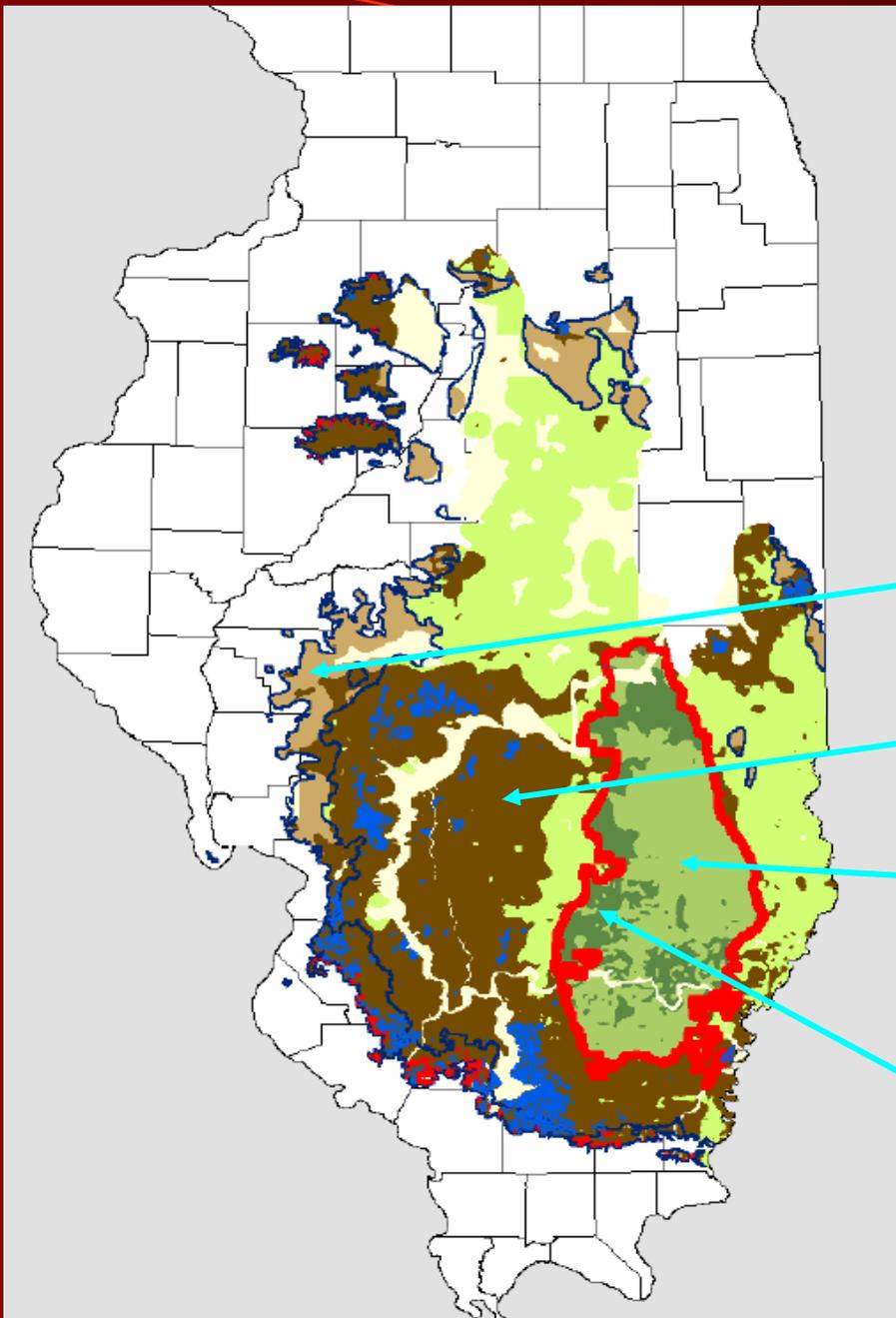
(dry, mineral matter free basis)



## Classification Chart

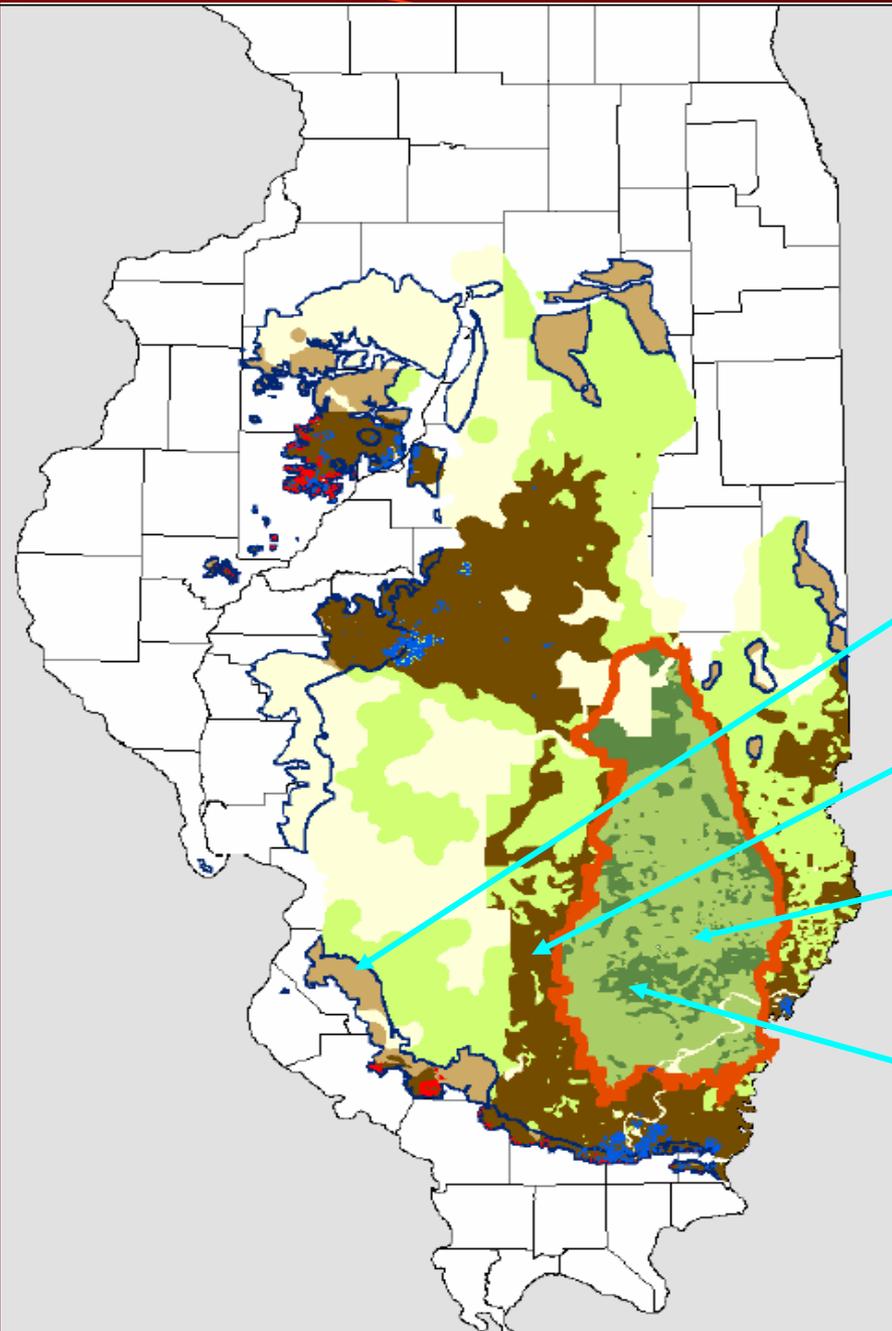
Depth	Thickness	Class
<b>Shallow</b> ( Depth < 200 ft )	0" ~ 17"	<b>Thin Coal Seam</b>
	18" ~ 41"	<b>Coal Seam Probably Available for Mining Only</b>
	42" ~ 66"	<b>Coal Seam Available for Mining Only</b>
<b>Moderate</b> ( 200 ft ≤ Depth < 900 ft )	0" ~ 17"	<b>Thin Coal Seam</b>
	18" ~ 41"	<b>Coal Seam Possibly Available for CO<sub>2</sub> Sequestration</b>
	42" ~ 66"	<b>Coal Seam Available for Mining Only</b>
<b>Deep</b> ( Depth ≥ 900 ft )	0" ~ 17"	<b>Thin Coal Seam</b>
	18" ~ 41"	<b>Coal Seam Available for CO<sub>2</sub> Sequestration</b>
	42" ~ 66"	<b>Coal Seam Probably Available for CO<sub>2</sub> Sequestration</b>

# Herrin Coal Resources



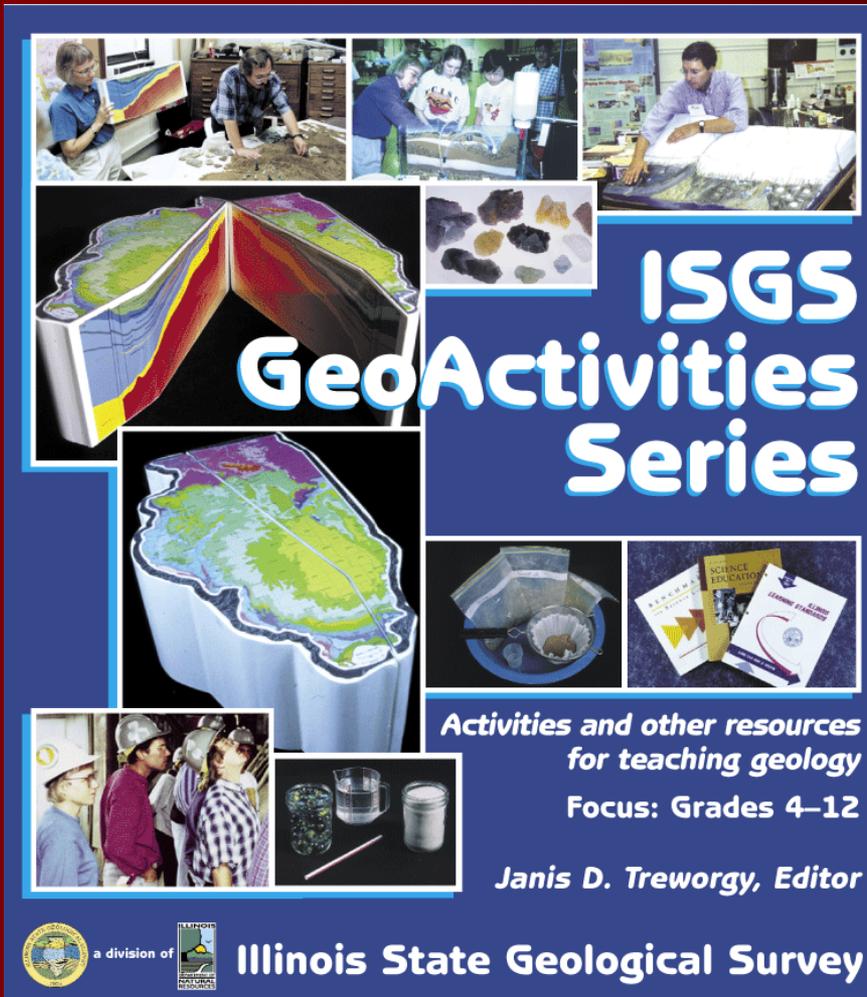
- Mined areas around basin margin
- Shallow coals are strippable at < 200 ft
- Coal > 42 in thick is minable at 200 to 900 ft
- Coal > 42 in thick and > 900 ft probable for sequestration
- Coal < 42 in thick and > 900 ft most likely sequestration target

# Springfield Coal Resources



- Mined areas at basin margin
- Shallow coals are strippable at  $< 200$  ft
- Coal  $> 42$  in thick is minable at 200 to 900 ft
- Coal  $> 42$  in thick and  $> 900$  ft probable for sequestration
- Coal  $< 42$  in thick and  $> 900$  ft most likely sequestration target

# Project Includes Customized Outreach Materials



The image shows the cover of the 'ISGS GeoActivities Series'. It features a collage of images: a 3D geological cross-section of a landscape, a group of people working with a large map, a person using a microscope, and various geological samples. The text on the cover includes 'ISGS GeoActivities Series', 'Activities and other resources for teaching geology', 'Focus: Grades 4-12', and 'Janis D. Treworgy, Editor'. At the bottom, it says 'a division of' followed by the Illinois State Geological Survey logo and name.

**ISGS**  
**GeoActivities**  
**Series**

Activities and other resources  
for teaching geology  
Focus: Grades 4-12

Janis D. Treworgy, Editor

a division of  
**Illinois State Geological Survey**

- *GeoActivities* sequestration module to be created; ISGS workshops reached ~ 5,000 Illinois teachers in the last 4 years; IN and KY Surveys also conduct workshops
- Newsletter contributions for the three O & G associations, EPRI, IOGCC
- Illinois Corn Growers Association reaches 5,000 members throughout the state

# Project Outlook

- Project Advisory Group meetings twice annually beginning January 21, 2004
- Web site up by end of Year 1, topical report on capture and transportation
- Carry out extensive outreach activities in last four months with seminars in Springfield, IL and Evansville, IN, final report, 3D models and visualizations, classroom materials, ArcGIS files
- Define plans for a field test of CO<sub>2</sub> injection