SEQUESTRATION POTENTIAL IN THE ILLINOIS BASIN COAL BEDS; FACTS AND UNCERTAINTIES.

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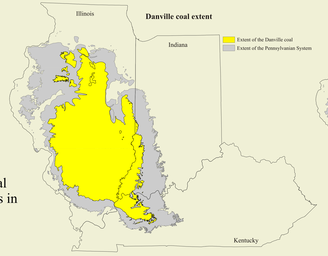
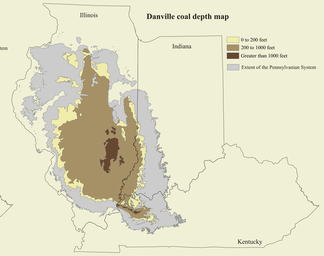
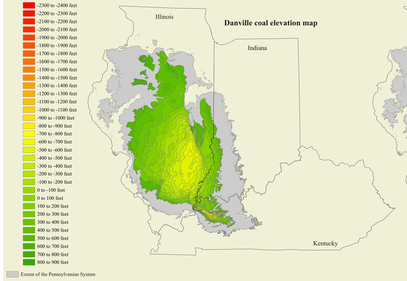
COAL BEDS CHARACTERIZATION

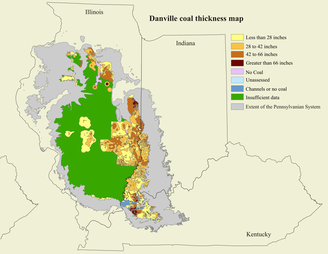
Carbon dioxide sequestration is a process by which carbon dioxide is captured before emission to the atmosphere and stored indefinitely. It can be stored in geologic formations, such as coal beds, oil and gas reservoirs, or deep saline aquifers.
This study evaluates CO2 storage potential and simultaneously methane recovery in the coal beds of the Illinois Basin.

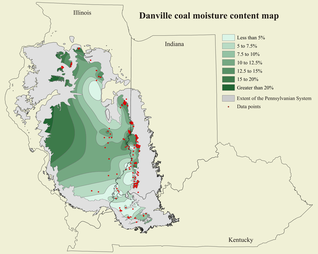
Maps of extent, thickness, depth, elevation, and coal quality have been created for seven major coal beds in the Illinois Basin, including: Danville, Hymera/ Jamestown/Paradise, Herrin, Springfield, Survant, Colchester, and Seelyville/Davis/Dekoven.

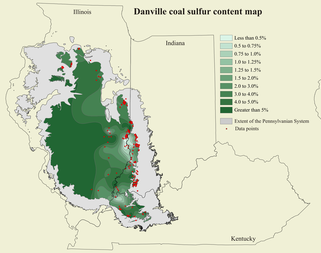


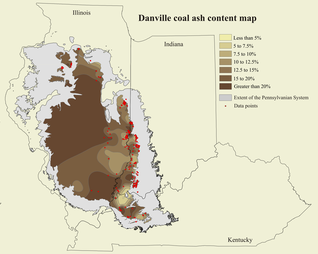


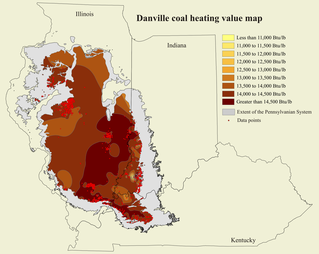






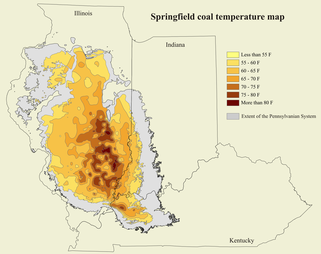


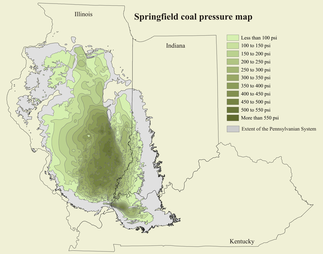




TEMPERATURE AND PRESSURE REGIME

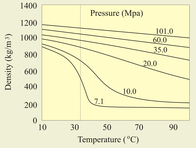
Additional maps of critical parameters such as temperature, pressure were also generated for use in assessment of the CO_2 sequestration potential of these coal formations. Shown here are example temperature and pressure maps for the Springfield coal.

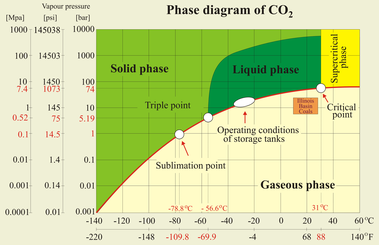




CO_2 PHASE CONSIDERATIONS

To predict the behavior of injected CO_2, we need to understand properties of CO_2 under the conditions that will be typical for underground storage.
The summary presented in the table on the right is a compilation of observations and hypothesis that need to be verified and tested.



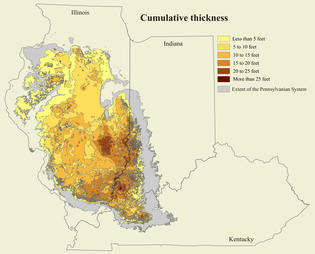


Effects of CO_2 sequestered into the coal beds

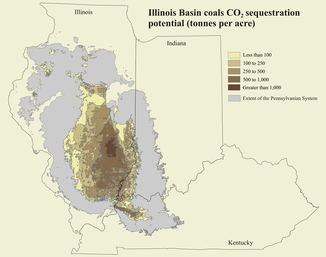
	Gaseous CO_2	Supercritical CO_2
Temperature	<88°F	>88°F
Pressure	<1073 psi	>1073 psi
Density	Low - 1.97g/L at 298K	High, temperature and pressure dependent
Volumetric considerations		
Storage capacity	Low reservoir pressure limits the volume of CO_2 that could be held	Higher storage capacity because of higher pressure
Effects on coal		
Reactions with coal	Little information available Coal rank dependent	Little information available Coal rank dependent
Coal properties affected	-Lowering softening temperature? -Plasticizing coal? -Limited extraction smallmolecules trapped in the macromolecular network?	-Lowering softening temperature? -Plasticizing coal? -Effective extraction small molecules trapped in the macromolecular network?
Drying of coal	Extensive	Extensive
Coal swelling	Coal rank dependent	Coal rank dependent
Coal permeability	Lowers initially high permeability	Further reduction of initially low permeability
Effects on minerals		
Solvent properties	Thermodynamically stable Not very effective solvent	Thermodynamically more reactive Very effective solvent
Reactions with minerals	Limited dissolution because of lower pressure	Extensive dissolution of minerals (calcium, magnesium)
Environmental considerations		
Possibility of leakage	High	Low
Long term stability	Unknown	Unknown, but longer than for gaseous CO_2
Sealing potential	Past or current mining in shallow seams makes the hard rock prone to development of fractures, compromising the sealing potential	No mining-related fractures present around deeper unmineable coals

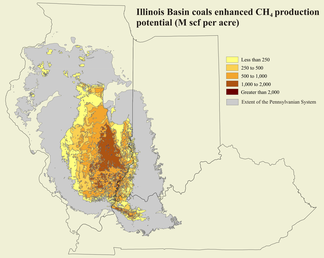
CO_2 AND CBM POTENTIAL

Volumetric equations using the coal thicknesses and areal extents, in combination with other mapped and measured parameters were used to estimate;
a) *in situ* adsorbed coalbed methane content;
b) CO_2 that can be adsorbed onto the coal matrix;
c) free phase CO_2 that can reside in the cleats, and;
d) CO_2 that can be dissolved in formation water.
High, medium, and low probabilistic values were selected from the distribution of measured values to put key variables into the equations, encompassing the range of uncertainty associated with these data.



The volumetric equations were incorporated into a cellular GIS model for each coal bed map layer, and the results were summed to obtain the basin-wide estimates of CO_2 sequestration and enhanced CH_4 production potential.





PRELIMINARY RESULTS FOR ENHANCED CH_4 PRODUCTION AND CO_2 STORAGE POTENTIALS IN ILLINOIS BASIN COALS

Coals considered: a) coal 500-1000′ deep and 18-42 inches thick*; in addition to b) coal >1000′ deep and >18 inches thick* (and not mined).

Illinois Basin seam	ECBM recoverable (scf)	CO_2 storage (scf)	CO_2 storage (tonnes)
Danville	791,644,000,000	7,999,789,200,000	424,392,000
Hymera	194,864,000,000	1,986,658,050,000	105,393,000
Herrin	940,390,000,000	9,851,443,550,000	522,623,000
Springfield	1,285,320,000,000	13,654,449,900,000	724,374,000
Survant	1,024,030,000,000	10,608,139,100,000	562,766,000
Colchester	1,070,910,000,000	11,380,329,350,000	603,731,000
Seelyville/Davis	832,678,000,000	10,535,434,650,000	558,909,000
IB TOTALS			
Illinois	5,580,650,000,000	60,355,438,000,000	3,201,880,000
Indiana	315,937,000,000	3,052,851,750,000	161,955,000
Kentucky	244,076,000,000	2,615,739,100,000	138,766,000
Total	**6,140,663,000,000**	**66,024,028,850,000**	**3,502,601,000**

* 14 inches was used as the minimum thickness for some seams that were newly-mapped at the Basin wide scale, due to differences between the states, the USGS, and minimum coal thickness definitions in our respective coal resource studies.

Coal thickness has been estimated in certain areas where coal resource information is sparse, yet where the coals were known or believed to be present as based previous structural mapping studies, identification on e-logs, etc.

ECBM recoverable is based on depth-dependent CH_4 recovery rates of approximately 45 to 80% as modeled in COMET for different P/T, porosity, and other conditions.

CONCLUSIONS

1) CO_2 storage in the coal beds and the ECBM recovey in the Illinois Basin estimated in this study shows potential for CO_2 storage sequestration in the basin. Considering numerous power plants within the basin area, there should be an incentive to utilize these coals for sequestration purposes.

2) The volumetric numbers should be treated as rough estimates. A CBM recovery factor and generally undersaturated nature of the Illinois Basin coals will modify the relationship between CO_2 and ECBM volumes. Also, while numerous parameters used in the model are well understood (thickness, depth, etc.), others (for example methane content, methane storage capacity etc.), are based on very limited data.

ACKNOWLEDGMENTS

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