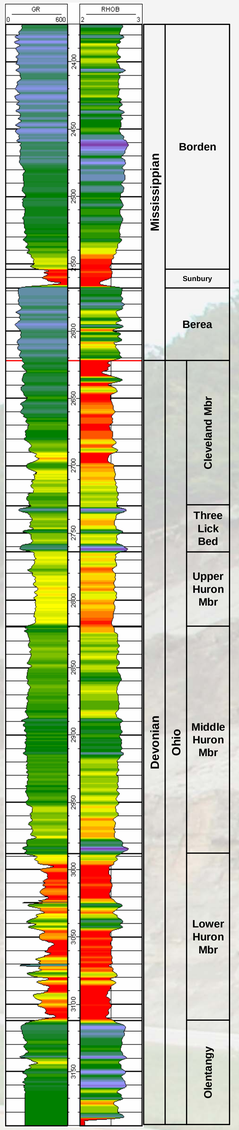
CO_2 Sequestration in Gas Shales of Kentucky

Nuttall[1], Brandon C. (presenter), bnuttall@uky.edu, **Drahovzal**[1], James A., drahovzal@uky.edu, **Eble**[1], Cortland F., eble@uky.edu, **Bustin**[2], R. Marc, bustin@interchange.ubc.ca
[1]Kentucky Geological Survey, 228 Mining and Mineral Resources Building, University of Kentucky, Lexington, KY 40506-0107, Phone: 859-257-5500, Fax: 859-257-1147
[2]Department of Earth and Ocean Sciences, University of British Columbia, 6339 Stores Road, Vancouver, BC Canada V6T 1Z4, Phone: 604-822-2449, Fax: 604-822-6088

Interstate #4 Davis
Knott Co. 24-K-81
Permit 94086



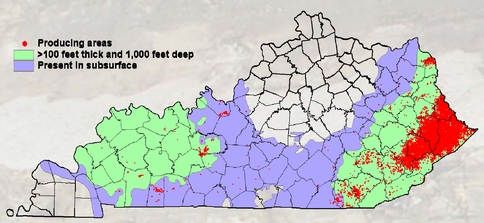
Total Depth: 3,190 ft.

Low GR High RhoB — High GR Low RhoB

ABSTRACT

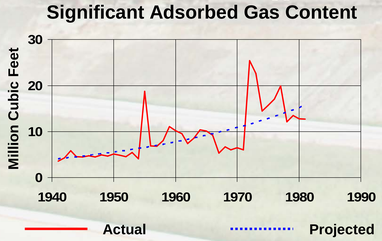
Continuous, low-permeability, fractured, organic-rich gas shales represent a possible unconventional site for geologic sequestration of CO_2. Devonian shales underlie approximately two-thirds of Kentucky. These shales are the source and trap for large quantities of natural gas. Enhanced natural gas recovery may be possible as stored CO_2 displaces methane. Drill cuttings and cores from Kentucky, West Virginia, and Indiana were sampled, and adsorption isotherms collected. Sidewall core samples were analyzed for their potential CO_2 uptake and resulting methane displacement. Average random vitrinite reflectance data range from 0.78 to 1.59, the upper oil to wet gas and condensate maturity range. Total organic carbon (TOC) ranges from 0.69 to 4.62 percent. CO_2 adsorption capacity at 400 psi ranges from 14 to 136 standard cubic feet per ton of shale. Relationships between measured TOC, gas storage capacity, the Langmuir coefficients of pressure and volume, and well-log-derived parameters (bulk density and gamma-ray) are being investigated for revising and refining sequestration capacity estimates.

Current estimates based on volumetric data indicate a sequestration capacity of 5.3 billion tons of CO_2 in the Lower Huron Member of the Ohio Shale of eastern Kentucky and as much as 28 billion tons total in the deeper and thicker parts of the Devonian shales in Kentucky. Should shales prove to be a viable geologic sink for CO_2, their extensive occurrence in Paleozoic basins across North America would make them an attractive regional target for economic CO_2 storage and enhanced natural gas production.

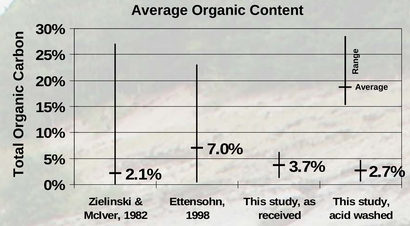


Distribution of the Devonian shale and associated gas production in Kentucky

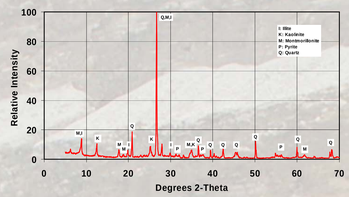
Production Incline Suggests Significant Adsorbed Gas Content



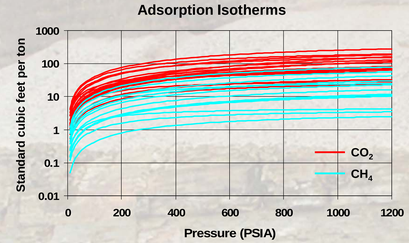
Average Organic Content



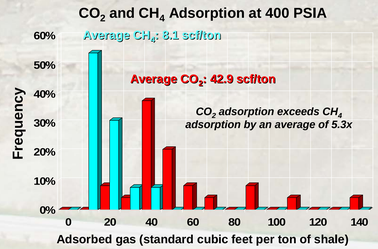
Typical X-ray Diffraction Trace



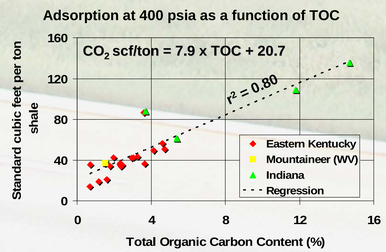
Adsorption Isotherms

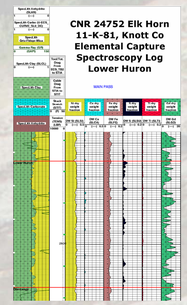


CO_2 and CH_4 Adsorption at 400 PSIA



Adsorption at 400 psia as a function of TOC

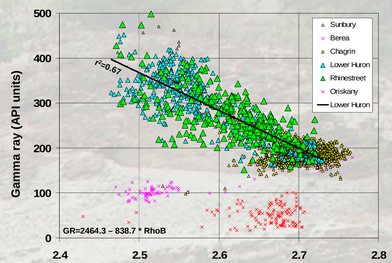




Clay content of the Lower Huron averages approximately 56 percent.

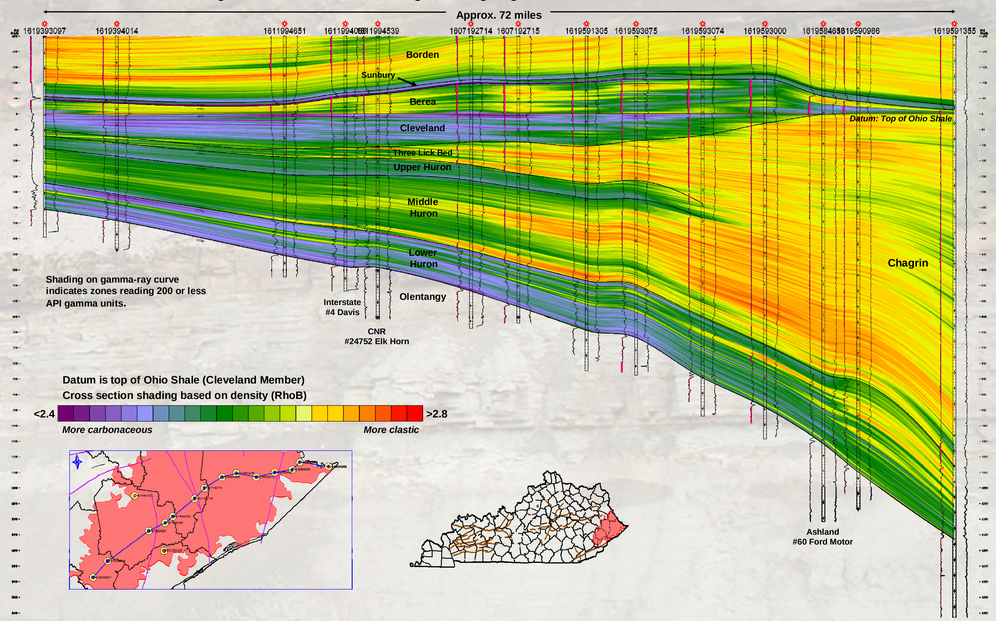
Shale can be considered a mixture of three components: clay minerals, quartz-feldspar-mica, and organic matter. Schmoker (1979) suggests the organic matter content is the main contributing factor to observed variations in shale density. Using Schmoker's method, TOC for intervals can be estimated from commonly available geophysical logs. CO_2 adsorption isotherm data exhibit a linear relationship with TOC and provide a method to estimate in-place gas storage capacity (theoretical maximum).

Log Crossplot: Ashland #60 Ford Motor, Pike County

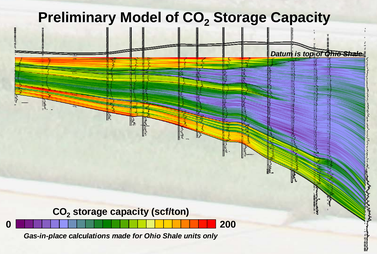


Sandstone units are shown with cross symbols.
Shale units are shown with color-shaded triangles.

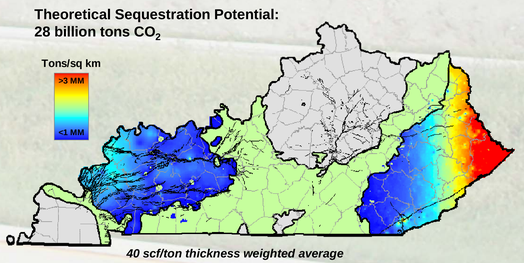
Regional Cross Section Showing Intertonguing of Carbonaceous and Clastic Shale Units



Preliminary Model of CO_2 Storage Capacity



Theoretical Sequestration Potential: 28 billion tons CO_2



40 scf/ton thickness weighted average

Project: Analyses of Devonian Black Shale in Kentucky for Potential Carbon Dioxide Sequestration and Enhanced Natural Gas Production
Survey: www.uky.edu/kgs
Project: www.uky.edu/KGS/emsweb/devsh/devshseq.html
Funded by the National Energy Technology Laboratory, U.S. Department of Energy
Grant DE-FC26-02NT41442