

**HB 1 Carbon Storage Research
Kentucky Consortium for Carbon Storage**

Contract PO2-855-0700011517

**Progress Report for the Quarter Ending December 31, 2008
Submitted to the Kentucky Energy and Environment Cabinet**

Kentucky Geological Survey
James C. Cobb, Director and State Geologist
University of Kentucky

David C. Harris, Principal Investigator
February 23, 2009

KYCCS.ORG



Major Accomplishments during the Quarter

- Activity continued during the quarter on all 4 of the subprojects setup to perform the research mandated by HB 1 (2007), Western and Eastern Kentucky deep CO₂ storage, CO₂ enhanced oil recovery, and CO₂ enhanced gas recovery (Devonian Shale).
- Progress continued on the Western Kentucky deep CO₂ storage test project. The project advisory group for this project met three times during the quarter in Lexington.
- An application for a Class V (experimental) underground injection control (UIC) permit was written for the Blan well in Hancock County, and submitted to the U.S. EPA Region 4 office in Atlanta on October 25. The draft permit was issued for public comment on Dec. 30, 2008. The Kentucky state oil and gas drilling permit for the KGS #1 Blan well was issued.
- Contract negotiations with WesternGeco, Houston, Tex were completed and seismic reflection data acquisition began in December. Weather and equipment delays pushed completion of the seismic work into January 2009.
- Construction of the drill site was started in November and completed in December, 2008. This involved grading, installing a gravel pad, and improvements to access roads and fences.
- Additional laboratory work was performed on Devonian shale core samples from a well in Pike County. Initial analysis of wells logs run in the Blue Flame well in Pike County was received from Schlumberger and reviewed. Final shale analysis logs were completed on 2 wells.
- Quotes for additional laboratory analysis work on cores from the Rosewood #2 Bargo well in Knox County were obtained and CO₂ injection tests requested. This work will allow better simulation of CO₂ injection into the Devonian shale, prior to a field demonstration.
- Discussions with operators and geologic characterization work continued for possible CO₂ enhanced oil recovery pilot projects.
- A research paper on the overall sequestration project was presented at the annual meeting of the Eastern Section, Am. Assoc. of Petroleum Geologists on Oct. 13 in Pittsburgh. The abstract of this paper is included in Appendix A.

Details of activity during the quarter pertaining to each of the subprojects follow. Figure 1 is a project status map indicating project activity by county.

Status of HB 1 Carbon Sequestration Projects, February 2009

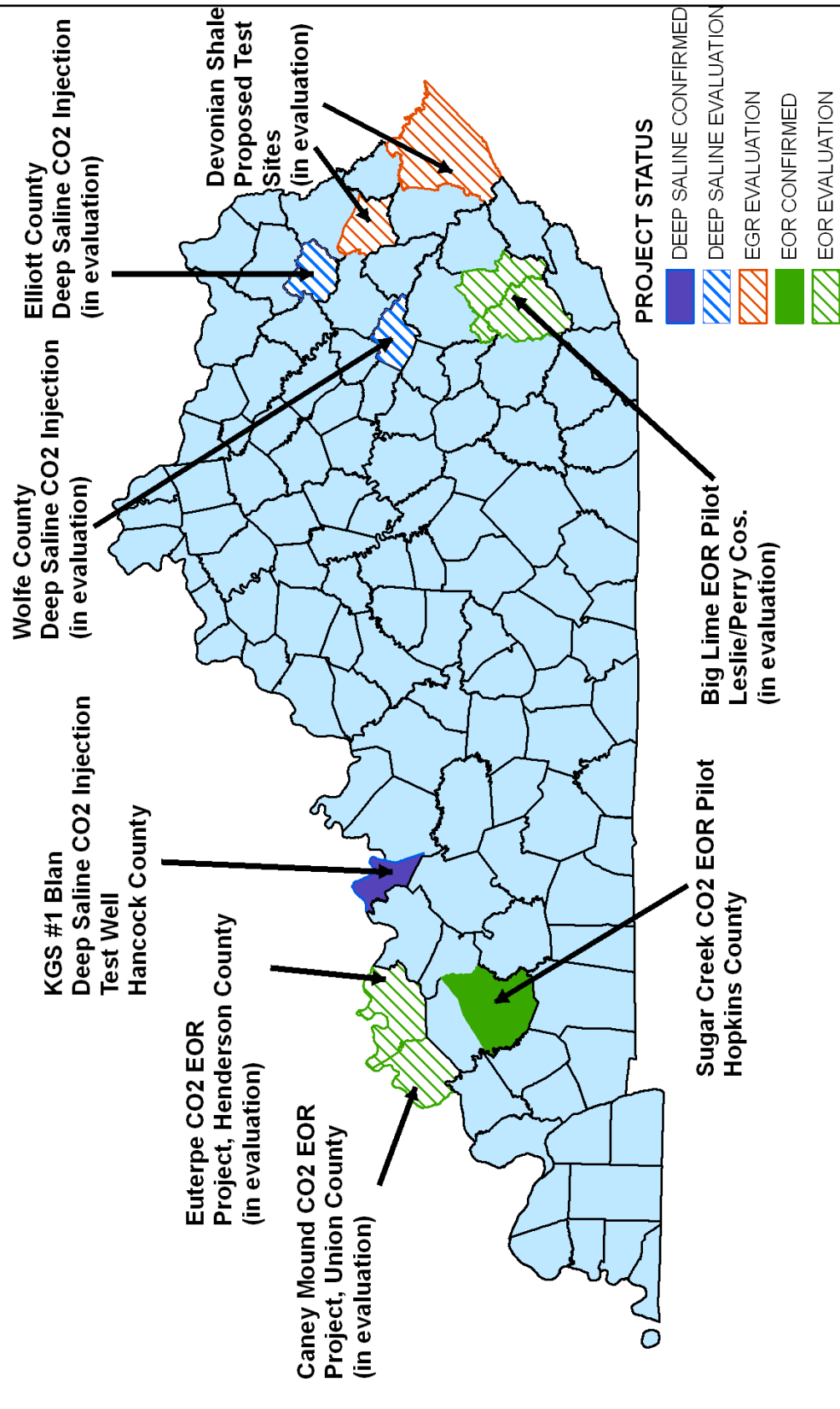


Figure 1. Map of Kentucky showing status of carbon sequestration demonstration projects in active or evaluation stages.

Western Kentucky Deep CO₂ Storage

Lead Geologists:

Rick Bowersox and Dave Williams

KYCCS-WKY – Summary of 3rd Quarter 2008 Activities

Advisory Committee Meetings Highlights:

- Three project advisory group meetings were held during the quarter in Lexington. Agendas and summaries of the meetings are included in Appendix A.
- Approval of a \$250,000 grant for the Hancock County well received from the Illinois Office of Coal Development. This funding will go into the Western Kentucky Carbon Storage Foundation account.
- An existing seismic line (line 7) was reprocessed and re-interpreted to provide additional detail on subsurface geology and structure near the well site.
- Initial soil gas samples and water samples from a domestic water well on the Blan farm were collected in October and November. These samples will provide background levels of geochemical constituents indicative of CO₂ leakage prior to injection in the Blan deep well.
- After lengthy negotiations, a contract was signed with WesternGeco in mid-October to acquire 25 miles of 2D seismic reflection data around the well site. Data acquisition using vibroseis trucks began in December and was completed in early January 2009.
- The EPA Class V injection permit application was submitted on Oct. 25. The permit application was reviewed by EPA and a draft permit was issued for a 30-day public comment on Dec. 30. The monitoring requirements included in the draft permit are a concern to the project.
- At the Dec. 11 meeting in Lexington George Ford from the EPA office in Atlanta read the draft permit to the group via telephone. Mr. Ford revealed the stringent monitoring requirements that EPA is imposing on the project. These include drilling of a monitoring well within 400 ft. of the deep well, to the top of the saline brine zone, below the deepest fresh water. In addition we would be required to sample 7 domestic wells and a spring within a 2-mile radius of the deep well. These wells would have to be sampled quarterly for a 3-year period. These requirements were news to the groups, and had not been mentioned in any previous meetings with EPA. These requirements place significant burdens on the project, including:
 - Funding to collect the samples and perform the analyses
 - Access and current condition of the domestic water wells
 - Lack of provision in our current lease with the Blan's for drilling and sampling a monitoring well on their property.

Similar monitoring requirements were placed on the MRCSP demonstration well at the Duke Energy East Bend plant in Boone County, Kentucky. The group drafted comments opposing these monitoring requirements on the draft EPA permit at East Bend and submitted to EPA at the end of the year.

- Vendor presentations and discussions were held at several meetings. These included Omni Labs (core analysis), Praxair (CO2 supply), WesternGeco (seismic data), and Core Labs (core analysis).
- Construction work to prepare the drill site and access roads was essentially completed in December. This work involved grading, building a gravel drilling pad, electric line relocation, and fencing and cattle guards. Construction work resulted in minor road damage to Sweet Road, which has been repaired.

Project Administration:

1. The Kentucky state drilling permit (#104925) for the KGS #1 Blan well was issued on Nov. 6, 2008.
2. Negotiation and execution of the Grant of Subsurface Easement and Memorandum of Understanding with the oil and gas leaseholder controlling the test well site (R&B Resources) was completed on October 1st. This document secured the subsurface access for the drilling and completion of the test well. The grant of easement was submitted to the Hancock County Clerk for recording on October 23rd.
3. A funding request for project phase 4A was submitted to the Western Kentucky Carbon Storage Foundation on October 9, 2008. This request provides funds for well site construction, well casing, seismic data acquisition, and project management fees. This request was approved. The cost sharing between UK and the WKCSF for phases 3 and 4A was revised on November 19 in order to shift a larger percentage of industry funds into the 2008 budget year. This revision did not change the total amount of UK or WKCSF funding.
4. The second public information meeting for local residents was held on Oct. 27 in Hawesville. The meeting was hosted by the Hancock County Fiscal Court with Dave Williams, Jim Cobb, Jim Drahovzal, and Mike Lynch from KGS, Doug Allan of WesternGeco, Brad Stone of the Energy and Environment Cabinet, and Sara Smith of Smith Management. State Senator Boswell was also in attendance and voiced support of the project. Overall it was a good meeting with only one resident voicing strong objection to the project. Questions again arose on the purpose of the test well, earthquake safety, and relationship to the coal industry.

Presentations:

A paper describing all of the research projects being conducted under HB1 was presented by D. Harris in a carbon sequestration session at the annual meeting of the Eastern Section, Am. Association of Petroleum Geologists, on October 13 in Pittsburgh.

Agendas, meeting summaries, and other details of the western project's activity can be found in Appendix A and on the project web site (www.kyccs.org).

**Kentucky Consortium for Carbon Storage
Western Kentucky Deep Saline Project Industry Partners****Funding Partners**

ConocoPhillips
E.ON U.S. LLC
Kentucky Syngas, LLC
Kentucky Geological Survey, University of Kentucky
Kentucky Governor's Office of Energy Policy
Smith Management Group
State of Illinois Office of Coal Development (pending)
Schlumberger Carbon Services
Tennessee Valley Authority

Associate Partners

Big Rivers Electric Corp.
GEO Consultants, LLC
Henderson County Riverport Authority
ICON Construction, Inc.
Praxair Inc.
Sunshine Oil and Gas
University of Kentucky Center for Applied Energy Research
URS Corp.

Eastern Kentucky Deep CO₂ Storage

Lead Geologists:

Steve Greb and Warren Anderson

Earlier in the year the Pine Mountain Regional Development Authority offered the group a well in Bell County that could be deepened to the Knox for injection tests. That group has since decided to complete that well as a Devonian shale gas producer, and the well is no longer available for the project.

We held a conference call with Chesapeake Energy on October 21 to discuss their participation in the eastern Kentucky project. They have a drilling location in Boyd County where they would assist us in getting a deep well drilled, with an option to buy back the well if a hydrocarbon discovery is made. Funding for the well from Chesapeake would be limited to \$100,000 however. While this site is in a favorable geographic location in terms of potential future CO₂ sources, Chesapeake admits that this well would also test an oil and gas prospect, lying near an older well that had shows of gas. If we encounter hydrocarbons in the test well it could limit the available injection zones and prevent us from injecting into some targets. This project remains an option for the eastern Kentucky well. Chesapeake wanted us to visit their office in Charleston and present details to their managers. They have not gotten back to us regarding a date. E-mails sent after the first of the year were not answered, so the status of this option is uncertain.

Due to the limited industry participation and lack of matching funds, it may not be feasible to drill a new injection well in eastern Kentucky. Fortunately there are opportunities to work with oil and gas operators to inject CO₂ into a non-producing well that penetrates suitable formations. We are now working on an option to use one or two existing deep wells in eastern Kentucky. There is a possibility of using one of several depleted wells in a deep gas field in Elliott County, but this is very preliminary. Discussions and a possible meeting with the field operator are planned for February 2009.

CO₂ Enhanced Oil and Gas Recovery

Lead Geologists:

Brandon Nuttall and Marty Parris

Devonian Shale CO₂ Enhanced Natural Gas Recovery and Storage Project

Brandon Nuttall, lead geologist

Work is continuing toward selection of a pilot Devonian shale injection project. Work has been focused on the Burk Branch site in Pike County, nominated by the Pike County Fiscal Court. This site required additional data for geological characterization to determine its suitability for an injection pilot. Some very good data was obtained in July from the Blue Flame K-2605 well, drilled near the Burk Branch site. Advanced well logs and core samples were obtained from this well with contributions from the Midwest Regional Carbon Sequestration Partnership (MRCSP) and Chesapeake Energy.

The petrology report for cores from the Blue Flame K-2605 well in Pike County was received from Chesapeake's lab in Oklahoma. This report summarizes the thin section and SEM examination of samples acquired from the well. The report also includes compositional data (XRD), organic carbon characterization (Rock Eval), and tight rock analytic data (gas and water saturation, porosity, permeability, etc). I have incorporated the photomicrographs received to date from Chesapeake and a hydrocarbon richness chart prepared according to guidelines suggested by Dan Jarvie (Worldwide Geochemistry LLC) into the document. This report is included as Appendix B.

Schlumberger prepared and submitted an initial draft of the Shale Analysis log. I reviewed it and with data from the Batten & Baird and Rosewood 02 Bargo wells, a final version of the log has been distributed. The Shale Analysis log for the Rosewood #2 Bargo well was reprocessed.

We are getting cost and specification information for threshold pressure and injection zone tests for samples from the Rosewood 02 Bargo well. These tests will be performed on whole core or core plugs (not pulverized material) and will provide information on the injectivity of CO₂ into the shale. Based on recent work by a German team (Busch and others, 2008, Int. Jour. GHGC), it may be possible with these tests to perform a laboratory simulation of CO₂ flow-through and natural gas displacement during injection.

CO₂ Enhanced Oil Recovery (EOR) Project

Marty Parris, lead geologist

Discussions continued during the quarter with Bernie Miller (Miller Energy Technology) and Scott Frailey (Illinois State Geological Survey, part of the Midwest Geological Sequestration Consortium (MGSC)) regarding possible CO₂ enhanced oil recovery (EOR) projects.

Several KGS staff met with Bernie Miller and Dan Wells, a consulting geologist on Oct. 31, to discuss a different EOR technique in Euterpe oil field (Henderson County), which was previously evaluated for a EOR using a CO₂ flood. The latest plans are to try a CO₂ huff and puff project, where CO₂ is injected into a single well, allowed to react with oil in the reservoir, and then oil and other fluids are produced back from the same well. As with other CO₂-EOR techniques, the underlying strategy of the huff and puff technique is that CO₂ will cause the oil to swell and reduce its viscosity thereby allowing oil to flow more freely to the wellbore. The huff and puff technique is notable, however, because it is a lower cost EOR technology than a full CO₂ flood, and may have particular applicability to many shallow oil fields in Kentucky. Mr. Miller is working on a budget for the huff and puff project, and we should be able to make a decision on this project during the first quarter of 2009.

A good deal of effort is presently focused on the Sugar Creek field (Hopkins County), where preliminary modeling of the Mississippian sandstone oil reservoir by Scott Frailey of the ISGS indicates that CO₂ injection would have favorable results. After a conference call with Scott Frailey on December 19 to discuss the modeling results, reservoir characteristics, and condition of wells in the field, a decision was made by KGS staff to enter into a joint CO₂ EOR project with ISGS and Gallagher Drilling Incorporated (GDI). A subcontract will be written to GDI (Evansville, IN) who will operate the project and perform the CO₂ injection work. Plans include injecting up to 8,000 tons of CO₂ into the reservoir over a six-month period. KGS will be primarily responsible for CO₂ monitoring, verification and accounting (MVA) activities at the field. This involves tracking the fate of the injected CO₂ through sampling of produced gases, produced brines, and fresh water sampled from 2-3 shallow monitoring wells. Injection work is schedule to begin early in the second quarter of 2009.

A third possible EOR project involves the Caney Mound field in Union County. Marty Parris, Dave Harris and Dave Williams met with several principals of Nally Oil on September 16 in Henderson to review reservoir properties, and field and wellbore conditions. During the fourth quarter of 2008 KGS began detailed mapping and characterization of the Mississippian oil reservoir to determine suitability for a CO₂ flood. This mapping was continuing at year-end, and Nally was contacted to supply additional data for the project. Notably, the reservoir at Caney Mound is sufficiently deep that pressures might be high enough to produce at least partial miscibility between the oil and injected CO₂, which increases the amount of oil recovered.

To summarize, we have committed to a CO₂ enhanced oil recovery project in the Sugar Creek field in Hopkins County, and are considering two other CO₂ EOR projects in western Kentucky. We know of two potential EOR projects in eastern Kentucky, but efforts to contact the operators and discuss the projects have not been successful. We are continuing to solicit additional fields in eastern Kentucky to evaluate for EOR potential.

Appendix A

Western Deep CO₂ Storage Project

Meeting Proceedings October –December, 2008

Abstract of Eastern Section AAPG Paper, presented in Pittsburgh, Pa. on Oct. 13.

Demonstrating Carbon Storage Options in Kentucky

HARRIS, D. C., Kentucky Geological Survey, Lexington, KY
BOWERSOX, J. R., Kentucky Geological Survey, Lexington, KY
WILLIAMS, D. A., Kentucky Geological Survey, Henderson, KY
GREB, S. F., Kentucky Geological Survey, Lexington, KY
PARRIS, T.M., Kentucky Geological Survey, Lexington, KY
NUTTALL, B.C., Kentucky Geological Survey, Lexington, KY
DRAHOVZAL, J.A., Kentucky Geological Survey, Lexington, KY
TAKACS, K.G., Kentucky Geological Survey, Lexington, KY

Anticipating requirements to mitigate CO₂ emissions resulting from the use of coal, the Kentucky Legislature passed House Bill 1 in 2007. This bill authorizes funding for research by the Kentucky Geological Survey (KGS) in the areas of CO₂ enhanced oil and gas recovery, and permanent geologic storage of CO₂. To carry out these mandates, KGS partnered with energy companies and other agencies, and formed the **Kentucky Consortium for Carbon Storage** (www.kyccs.org). KYCCS projects will include deep CO₂ storage tests in eastern and western Kentucky, and CO₂ enhanced oil and gas recovery pilots.

The Cambrian Mt. Simon Sandstone is an attractive sequestration target over much of the Midwest but its depth, questionable reservoir quality, and limited extent in western Kentucky will restrict its use for CO₂ storage. Cambrian sandstones in the Rome Trough of eastern Kentucky have excellent reservoir properties, but were deposited in fault-bounded grabens, where CO₂ containment may be a concern. Knox dolostones in Kentucky have variable porosity and permeability, and contain both reservoir and seal. In early 2009 KYCCS will drill and test an 8,000 ft basement well in Hancock County, Ky., where the Knox will be the primary injection target.

KYCCS will also demonstrate the effectiveness of CO₂ in miscible and immiscible EOR projects, and test the feasibility of using CO₂ to displace methane in the organic-rich Devonian Ohio and New Albany Shales. KYCCS will partner with the Midwest Geological Sequestration Consortium to conduct an immiscible CO₂ flood in the Euterpe field in Henderson County, Ky.

**WESTERN KENTUCKY SEQUESTRATION SUB-PROJECT
MEETING**

October 2, 2008

KGS Well Sample and Core Library, Lexington, KY

These people were present for the meeting:

KGS Staff

Jim Cobb
Dave Williams
Dave Harris
Rick Bowersox
Jim Drahovzal
John Kiefer
Marty Parris
Jerry Weisenfluh
Warren Anderson
Brandon Nuttall
Mike Lynch

ConocoPhillips

Scott Rennie
Paul Heard

E.ON US

Roger Medina
Doug Schetzel
Glenn Sundheimer

Smith Management

Karen Thompson

Sandia Technologies

Phil Papadeas

TVA

Ed Stephens

ECSI

Talina Mathews

Dave Williams called the meeting to order, and participants introduced themselves.

Jim Cobb opened the meeting with remarks on several topics. He recognized Talina Mathews, formerly director of the Governor's Office of Energy Policy and now with Engineering Consulting Services, Inc.

He told the meeting that he and Rodney Andrews, director of the Center for Applied Energy Research, were to meet with Gov. Steve Beshear in the afternoon to update the governor on energy research in each agency. He said that Brandon Nuttall and he are now working part time at the state Cabinet for Energy and the Environment, providing expertise on the technical questions which come to the cabinet. He said KGS can thus influence state policy on energy issues. They report directly to Secretary Lyn Peters.

Cobb reported that he had just returned from a meeting of the Midwest Geological Sequestration Consortium, where he made a presentation about Kentucky's efforts in carbon storage and found others in the MGSC surprised at the progress made here without federal money.

He had also made a presentation on September 22 about the progress on House Bill 1 projects before the state Appropriations and Revenue Committee. He told that committee future wells will be needed to continue the progress on this research.

He had also attended an Indiana conference on sequestration as well. Cobb added that he would like to get the energy-agency heads for the states in the Illinois Basin together to start a dialogue on cross-state issues in this arena.

Karen Thompson noted that the Governor's Conference on the Environment is set for next week, with some sessions on carbon storage topics. She asked for written comments from members of this group, to be sent to Dave Harris or Sara Smith for inclusion in their remarks at the conference. They will discuss legal issues related to carbon storage. Dave Harris noted that Sara Smith is trying to get the UK law school interested in the legal ramifications of geologic carbon storage.

Brandon Nuttall said a draft new state energy policy has been sent to the governor's office for review; he added that the research being spearheaded by this group is important in the policy.

Status of Data Sharing Agreement

Rick Bowersox said R & B Resources has agreed to all the terms of the data-sharing agreement, after some minor clarifications were added. Dave Harris added that R & B has granted this group an easement to do the research until February 8, 2010. That leaves R & B six months until their agreement with the property owner expires, allowing R & B to determine what action, if any, to take at the site if economic resources are encountered in the drilling. He added R & B is enthusiastic about this project.

Phase I environmental survey

Dave Williams said the Phase I assessment gave a clean bill of health to the project site.

Title opinion, balance of owner's farm

Dave Williams also reported that the second title opinion, this one on the remainder of the property parcel, should arrive soon, and there should be no problems noted on this opinion.

Seismic Program

Rick Bowersox told the group that he and Dave Harris had met with the UK attorney over a contract impasse on a couple of issues with the proposed WesternGeco deep seismic program. The company wants to limit its liability to the value of the contract only. Dave Harris added that KGS wants a higher limit, a multiple of the contract value. While the company's proposal is an industry standard, the parties involved are not comfortable with it.

Doug Schetzel commented that, if there's property damage, the private partners are concerned about whether state or insurance funds would be available to cover such possible damage in the absence of higher liability coverage from the company.

Dave Harris added that the other possibility is that KGS would purchase an insurance policy. He will wait for an answer from WesternGeco about higher liability coverage before deciding what to do.

Scott Rennie said that it's common to limit liability as WesternGeco has, and a client's relative negotiating position has a lot to do with how this works out. In the current marketing climate, he added, a service company can dictate such terms.

The participants discussed the issue of the project schedule becoming more critical now and that the seismic work needs to get done so the project can move on.

Dave Williams said that he and a representative of WesternGeco walked and drove the route of the planned seismic lines, talking to property owners, Judge/Executives of the two counties involved, Kentucky's Transportation Cabinet and property valuation administrators about the ownership and access issues. The deep seismic shooting should take about two weeks to complete, once a contract is signed.

Shallow Seismic Program

Rick Bowersox passed out the processed data from lines 2, 3, and 4 from Ed Woolery's shallow seismic work and said there are no apparent problems in the top 800 feet of the geology. He explained that this means no faults, caves, sinkholes or similar issues are visible in the data.

Soil gas monitoring

Marty Parris of KGS used a PowerPoint presentation to explain his plans for a soil gas monitoring program around the drilling site. He said he should be able to get into the area the following week to gather data for the first of his measurements. He explained the process of determining the rate of gas movement between the atmosphere and the soil, detecting anomalies in this activity to account for human- and natural-caused seepage, and the need to sample multiple times in different settings and at different times of the year. He showed examples from

eastern Kentucky sampling programs which demonstrate the kind of data he'll be gathering for carbon dioxide and methane.

He plans to return to the deep storage test site in March to do "winter" season sampling, when plant-related activity will be much lower.

Phase IVa funding

Dave Harris said he is close to determining the cost figures for Phase IVa of the project, including contract costs for Sandia, well-design costs, etc. He expects to have the final figures in the next week or so.

Drillsite preparations and drilling contractor

Paul Heard of ConocoPhillips reported that he had found two companies with rigs capable of doing the project, but only one of them, Les Wilson, is likely to be able to do the project. The contract will be a time and labor agreement, not a fixed cost contract. The rig is new, and the plan is to have it ready for a February project-start date. But he will check on a possible conflict because the same rig is expected to be used for another deep-hole project in this region.

The question came up as to whether drilling could actually start before the EPA injection permit is acquired. Phil Papadeas noted that EPA Region IV in Atlanta wants to be present to observe the initial drilling activities.

There was a discussion of whether EPA may expect a different, higher standard of operation because its proposed Class VI regulations have been drafted for public comment.

Paul Heard said the bid on the casing came in at \$207,000 on Chinese-made casing.

Final well design and costs

Scott Rennie outlined some changes in the well design from the previous report. He will send a printed copy of the changes to project participants.

EPA injection well permitting

Phil Papadeas gave a PowerPoint-assisted presentation on the progress of the permit application development. He believes it will take 3 – 5 days of additional work to complete it. He asked for guidance from the participants on who will make comments for the final version to be sent to EPA in Atlanta.

He listed the remaining items which need completion in each area of the application, and there was discussion of the total volume of injected carbon dioxide to list on the application.

Papadeas added that he believes the partnership can submit the original drilling plan, demonstrating and explaining the level of monitoring and safety to satisfy EPA, which had suggested an additional and costly well-testing packer design to be added to the plan.

He said he plans to have a draft next week of the EPA permit application and wants to get comments sent back within two days.

Dave Williams said state Department of Oil and Gas permit application is ready except for the bonding requirements. After some investigating, KGS found the correct office at UK to handle bonding requirements.

Phil Papadeas will talk to EPA about the amount of bond coverage needed, to help determine what bonding level to include in the DOG permit. He added that the EPA application can be sent in with a note that certain items like this are pending.

Dave Williams said he will find the exact location of a water well on the drilling site property; this is the well whose water will be tested during the project.

Deep gas contingency planning

Dave Harris told the meeting this item will be kept “on the radar” and discussed when there is more time to discuss how to address it, if it becomes an issue.

It was announced that TVA has become a funding member of the non-profit Foundation for the project.

There was some discussion of when to issue the next news release. It will be to announce the holding of another public meeting in Hancock County to update the fiscal court and general public on the project’s progress.

The next meeting was set for 9:00 a.m., November 6 at the same location.

ACTION ITEMS:

ALL:

All participants were asked to submit any comments they may have for a presentation to be given by Sara Smith and Dave Harris on carbon storage legal issues at the Governor’s Conference on the Environment the following week in Lexington.

Provide guidance to Phil Papadeas on who should send in comments for the final draft of the EPA permit application and who should sign the application.

KGS:

Dave Harris will investigate the possibility of having KGS / UK buy an insurance policy to cover potential property damage during the drilling because WesternGeco’s proposed liability is smaller than the partners want.

He will also provide Michelle Pittenger of ConocoPhillips with information he had earlier promised on a Knight Brothers well.

Dave will complete estimates on the Phase IVa project costs within a week or so.

Marty Parris will do his first set of soil gas measurements at the well site during the following week and his “winter” season measurements early in 2009.

Dave Williams will get the exact location of the water well near the drilling site. He will also talk to the Hancock County Judge/Executive about another public meeting on the project.

Mike Lynch will prepare a news release and ask for comments before the next public meeting.

ConocoPhillips:

Paul Heard will check into a possible schedule conflicts for the drill rig chosen for the project.

Scott Rennie will send the participants a printed copy of the last changes to the well design. He will also check with **Michelle Pittenger** on the status of the reprocessing of the “Line 7” seismic data.

Sandia Technologies:

Phil Papadeas will continue working on the final draft of the EPA permit application, add comments from partners and get the signatures needed for the final version. He will also talk to EPA / Atlanta about the expected bonding level, which will also go into the state DOG permit application.

**KYCCS - Western Kentucky Project Planning Meeting
KGS Lexington Core Library, November 6, 2008, 9 AM**

Persons present at the meeting:

EMS

Dale Honn

E.ON US

Roger Medina

Doug Schetzel

Big Rivers Electric

Mike Thompson

TVA

Ed Stephens

Suzanne Fisher

Peabody Energy

Diana Tickner

ConocoPhillips

Scott Rennie

Paul Heard

Smith Management Group

Sara Smith

Karen Thompson

Core Lab

Keith Hudson

Kentucky Geological Survey

Dave Williams
Rick Bowersox
Jim Drahovzal
Jerry Weisenfluh
Jim Cobb
Dave Harris

UK CAER

Jim Hower

Energy and Environment Cabinet

Brandon Nuttall

Sandia Technologies

Phil Papadeas

1. Welcome, Introductions, and Announcements

Dave Williams convened the meeting at 9:20 Am with introductions.

Jim Cobb discussed state budget issues with the group and noted that the Governor is very interested in sequestration in Kentucky. He stated that the Energy Committee is investigating ways to address the liability issue of CO₂ storage. Project partners discussed the possibility of additional funding from the Commonwealth additional reflection seismic surveys, an aeromagnetic survey, and additional drilling elsewhere in the state.

Dave Harris distributed the abstract to be submitted by KGS to the 2009 American Association of Petroleum Geologists annual meeting.

2. Status of Project Tasks

1. Title opinion, balance of Blan farm

The title opinion for the balance of the Blan lands is completed and title is clear.

2. Seismic program

A map of the final line locations and the existing seismic line in the area was distributed by KGS. The route has been driven by Dave Williams and Doug Allan, WesternGeco, and permits have been obtained from the state highway department and County and all but four landowners. Equipment should be on-site on November 16 with acquisition beginning on November 17. Dave Harris requested that the Foundation waive being named as an additional insured on the WesternGeco contract and Diana Tickner stated that this waiver was in progress. Modifications to the data acquisition parameters suggested by Doug Allan

were discussed and forwarded to Ron Sfara, ConocoPhillips, for review.

3. 4D seismic survey proposal

The potential of conducting a 4D seismic program over the wellsite was discussed by Rick Bowersox. Discussion was tabled pending completion of the 2D seismic program.

4. Reprocessed Line 7 interpretation

Jim Drahovzal discussed the progress of interpretation of the reprocessed Line 7 with the project committee. Reprocessing has improved imaging of this line, especially in the Rough Creek Graben. Most improvement appears in the elimination of apparent faulting due line bends and better imaging of the Mount Simon Sandstone.

5. Soil gas monitoring

Dave Harris discussed the progress of the soil gas monitoring program in-progress by Marty Parris. Three trips have been made to the wellsite. Six monitoring sites have been established and baseline soil gases collected from three of these in October. Equipment damage has delayed baseline measurements from the remaining three sites. Isotopic composition are comparable to soil gasses collected in eastern Kentucky although somewhat enriched in ¹³C. There is no evidence of coals at the wellsite that might affect measurements.

6. Budget and Funding Review

Dave Harris discussed the current budget status and upcoming funding request with the committee (see the attached summary). Expenditures to date are ~\$46,000, paid from the Kentucky Geological Survey account, and are well-under estimates except in the area of drilling services procurement. Eight invoices have been received from Sandia Technologies and are being processed for payment. Costs associated with the seismic acquisition program and wellsite construction, large-expenditure items funded by the Foundation, are likely to be invoiced before year-end. The request for approval of drilling cost funding will be submitted to the foundation by mid-December with Sandia providing the AFE (authorization for expenditure) cost estimates to KGS by the first week of December. It was noted by the Foundation representatives that any over-funding of drilling costs could be applied to testing and thus reduce the amount of that funding. KGS will provide budget reviews at each subsequent project planning meeting.

3. Drilling Project Status

5. Water well location near drillsite

Survey and sampling of the domestic water well on the Blan property will be completed by a hydrologist from the KGS Henderson office. Sampling the well will be made using a consistent protocol provided by Sandia to allow replication of the sampling at a later date.

KGS will replace the

1. Drillsite preparations and drilling contractor

Bids for drilling services were submitted to two contractors with equipment capable of the well depth. Only one bid was received, from Les Wilson Drilling, with a tentative spud date of February 1, 2009, pending the completion of drilling of the ADM well in Illinois by this rig. All costs are within the range of previous estimates and the contract with Les Wilson will be executed by November 15. Drilling will be conducted under a Kentucky Department of Oil and Gas Conservation drilling permit as a wildcat well. Wellsite construction is estimated to cost \$136,000. Pre-construction walkthrough is scheduled for November 12 with construction commencing on November 13. A purchase order for casing has been issued for evaluation.

2. Final well design and costs

Scott Rennie reported that the well design has been completed and the testing program is near-completion. Well costs will come from bids received during the next month. Logging and testing bid packages are being prepared.

D. Well permitting

EPA injection well permit: Phil Papadeas reported that the EPA permit application was submitted October 10, following a meeting at the EPA Region IV office in Atlanta on October 7 to resolve technical issues. George Ford, the EPA analyst reviewing the application has contacted Rick Bowersox by telephone and email to clarify technical points and request materials missing from the permit application package. Missing materials included the plugging report on the Langford Oil and Gas well Knight Bothers #1 and analyses of the brine and CO₂ injectates. Pending the receipt by EPA of the original UK Treasurer's certification of financials and auditor's certification, the application appears to be complete and ready to be published in the Federal Register for public comment. At that time the surrounding landowners would be notified of the pending injection permit application.

KY DOGC permit

Dave Williams reported that the well permit application was submitted for a wildcat well and is at KGS for spacing compliance review. (The permit was subsequently issued as 104925.)

4. Status of Public Outreach

A. Meeting in the Hancock County Fiscal Court, October 27, 2008

The meeting was hosted by the Hancock County Fiscal Court with Dave Williams, Jim Cobb,

Jim Drahovzal, and Mike Lynch from KGS, Doug Allan of WesternGeco, Brad Stone of the Energy and Environment Cabinet, and Sara Smith of Smith Management. State Senator Boswell was also in attendance and voiced support of the project. Overall it was a good meeting with only one resident voicing strong objection to the project. Questions again arose on the purpose of the test well, earthquake safety, and relationship to the coal industry.

B. Pending news release

Tabled pending completion of drilling and testing.

5. CO₂ Legal and Regulatory Working Group

Sara Smith reported on the first meeting of the CO₂ Legal and Regulatory Working Group. Two questions were addressed by the working group: What is the direction from existing law?; and What have other states done to address sequestration? Discussion followed by government and industry representatives based on these assumptions: *i.*) some kind of CO₂ regulation is coming, *ii.*) CO₂ sequestration will be required and geologic sequestration and EOR will be used, *iii.*) sequestration is safe and will be successful, *iv.*) the topic is urgent, *v.*) sequestration is in the public good, *vi.*) there will be some future use of the sequestered CO₂, and *vii.*) that sequestration is commodity storage rather than waste disposal. Some issues were identified were *i.*) access and control of the storage site and *ii.*) who will be responsible for the stored CO₂ from transport to storage field and long-term storage, *iii.*) when is the storage phase completed and monitoring ends? Minutes of the meeting are being prepared for posting on the EEC website and a subsequent meeting is set for December 1 at the KGS Lexington Core Library.

6. Action Items

- a. **Dave Harris** will prepare a statement representing the KGS position on sequestration for the next CO₂ Legal and Regulatory Working Group meeting on December 1.
- b. **The Foundation** will provide a waiver of additional insured for the WesternGeco contract.
- c. **Dave Harris** will prepare a budget review for the next meeting.
- d. **Dave Harris** with the help of **Phil Papadeas** will prepare a budget submittal for construction and drilling by December 12.
- e. **Rick Bowersox** will prepare a log of public outreach efforts to date.
- f. **Dave Harris** will research CO₂ and water purchase contracts.

**WESTERN KENTUCKY SEQUESTRATION SUB-PROJECT
MEETING**

December 11, 2008

KGS Well Sample and Core Library, Lexington, KY

These people were present for the meeting:

KGS Staff

Jim Cobb
Dave Williams
Dave Harris
Rick Bowersox
Jim Drahovzal
John Kiefer
Jerry Weisenfluh
Warren Anderson
Brandon Nuttall
Mike Lynch

GEO Oil / Gas

Ross Miller

Icon Construction

Edward Lekson

Peabody

Dianna Tickner

U.S. EPA / Atlanta (via telephone)

George Ford
Robert Olive

PraxAir / San Diego (via telephone)

Dan Dalton
Chris Sessions

Sandia Technologies

Phil Papadeas

ConocoPhillips (via telephone)

Michelle Pittinger
Paul Heard

E.ON US

Roger Medina
Doug Schetzel
Glenn Sundheimer

Sandia Technologies (via telephone)

Phil Papadeas

TVA

Ed Stephens
Suzanne Fisher

OMNI / Weatherford Labs

Anne Terburgh
Melanie Dunn

WesternGeco

Doug Allen
Vlad Pekker (via telephone)

Dave Williams opened meeting.

EPA permit issues:

Phil Papadeas reported that the financial assurance forms were sent in with the CFO letter and auditor's letter; he had heard nothing back on them yet, but George Ford of EPA later said from Atlanta he just received a recommendation of acceptance of financial responsibility letters and related documents.

George Ford told the meeting the permit language has been completed and is going through sign-off by his supervisors. December 30 will begin the public notice period, making earliest permit issuance date Feb. 7, 2009. Public comments taken for thirty days plus one week, to insure all comment mail has been delivered and opened. People who have serious comments or objections have 30 days to go to the appeals board in Washington if they do not like the regional office's response / reaction to their comments.

He added that the comments can possibly extend the issuance time. Dave Harris asked if there have been any inquiries or comments yet. George Ford replied that one person had already expressed opposition to the project. He had told her she would receive a notice on the comment period and can comment.

Land owners, residents, water well / spring owners will receive notices. There is also "a list" of people and entities which want to receive all such public comment notices. So it's a broader audience than just "affected people."

Anyone in our region could be on "the list," and their comments could change the permit to reflect their concerns. This is an EPA Region IV policy on such public notices.

Mr. Ford explained how comments are handled: Region IV decides if there is merit to the comments and may make changes in the permit to reflect them. EPA responds to every comment, too, and the comments can be reviewed, even if the permit doesn't change. The applicant doesn't get a say on the comments and their effects, if any, on the permit unless they appeal the comments and the changed permit.

He read all of the permit language, including: type of well being permitted; construction details; casing sizes; borehole sizes; injection depths; cementing requirements; mechanical integrity, pressure testing; EPA witnessing of testing, plugging, injection operation conditions & limitations; injection pressure monitoring. He made a special point to say that EPA's requirements that their staff witness some of the initial activities is very important. Some applicants fail to do this, though it's in the permit language.

Phil Papadeas commented that this is a pretty standard permit for such wells.

But the permit also requires a monitoring well within 400 feet of main well. Analysis of water wells in the area of review. The monitoring well must be a new well

drilled to below the underground drinking water supply. The public can comment on the construction of the monitoring well, too. Phil Papadeas notes that there are no EPA comments in the permit on construction and monitoring requirements of the monitoring well. He added that the partnership plans extensive comments on the monitoring well requirement. He added the partnership believes it had already included a robust monitoring plan in its application.

Partnership members said that these monitoring wells are not required in other similar projects and wondered why this one necessary. George Ford responded: because Region IV believes you should monitor the water for impacts on the USDW. He added that the project is “on the cutting edge” and people want to know what's going on.

Robert Olive of EPA remarked that this well will be below the USDW; it will be an "early warning" well to let us know before drinking water might be impacted. Phil Papadeas responded that the integrity requirements on the main well will already do this; this is redundancy on top of that.

Project operations:

Vendor presentations:

Dan Dalton (via phone from San Diego) of PraxAir, made a presentation on his company's CO₂ / injection estimate and answered questions.

Anne Terburgh and Melanie Dunn of Omni/Weatherford Laboratories made a presentation on their companies and capabilities to do the core analysis for the project.

Doug Allen, WesternGeco (with Vlad Pekker on phone): Using a PowerPoint presentation, he summarized changes needed in “Line C” of the seismic profile program as a result of a property owner in Breckenridge county declining to allow work on property. In addition, the recent rain has made the ground soft, threatening off-road operations.

The current schedule: The survey crew should be done on Saturday (two days away); vibrators should arrive Sat. 13th. He hopes to do testing on Monday 15th and start recording that day. He hopes to get it done in less than ten days.

He recommended that Line C be changed to go up a section of U.S. 60. Ground conditions and costs make it a good change. There will be 2.5 to 3 fewer line miles this way.

Michelle Pittenger reported that she will be able to send the old reprocessed Line 7 data to WesternGeco for their use.

Dave Williams reported the analyses should be returned soon on the sampling of the well site property owner's water well.

Paul Heard reported the drill site preparation is basically complete; a few more items left to do; probably about \$2000 for road damage; we should still be able to get the first drill rig available when we need it.

Discussion that the schedule is somewhat dependant on how far the partners want to push an appeal on the monitoring well requirement, but it was agreed that an appeal to Washington can take too long for our project, and appeals rarely succeed.

The cost of the monitoring well was discussed: At 400 - 600 feet deep, Phil Papadeas' rough first estimate: \$100,000 to \$250,000 for drilling and three year logging, sampling, monitoring. Casing required; any anomaly encountered could result in more-frequently required sampling.

Dianna and Phil will discuss this later for strategy.

Paul Heard said he is awaiting final bids for well design and construction. Currently, we're an estimated 3.1% (\$5400) over budget, including contingencies, on construction cost.

Rick Bowersox made a PowerPoint presentation of the site, photos/drawings, construction, road improvements, and some road damages on Sweet Rd.

Dave Williams reported that he talked to magistrates and the County Judge/Executive, assuring them the partners will foot the bill for the road damages. Judge McCaslin is asking for a letter stating that we will put the road back to the condition just before our work started. To re-surface it with 2 inches of asphalt (.6 - .7 miles) would be under \$20,000. Some temporary fixes (i.e., culverts, potholes) during the project work will also need to be done.

Jim Cobb said he will to send Judge McCaslin the letter.

There was further discussion on the types of repairs needed and how to go about paying for them.

Project administration:

Dave Harris handed out budget summary documents showing the spending so far on Phases III and IVa. Phase III is mostly done. He said he expects to come within the seismic program budget now as a result of the changes (above). This may allow contingency money to be spent elsewhere.

The Foundation private partners will now pay all of the seismic acquisition costs, to accelerate their 2008 costs.

Dave Harris handed out the project management costs for Sandia Technologies to date.

Phil: I spoke to Texas Bureau of Economic Geology on the core analysis portion. He'll send info to Rick.

KGS will contact Alliance, LLP for potential participation.

Discussion of other potential sources of funding (companies, groups, associations, etc.)

Phil Papadeas suggested that there may be some DOE or NETL funding available to offset CO₂ costs and some interest from the national laboratories. With other projects behind schedule, they may be willing to help the project, which has actually moved more quickly than those. Dianna Tickner and Jim Cobb agreed to make some contacts on this.

Paul Heard reminded the partners not to overlook the 2.5% discount if charges are paid within 10 days to Sandia.

Paul Heard promised a first pass at the costs of Phase IVb by mid of the following week.

It's believed that, considering the public comment schedule, Feb. 7 is earliest possible permit issuance date (30 day comment period plus 7 "mailed comments" days). EPA wants to be there for the casing. And the monitoring well needs to go in first to draw the first samples before the main-well drilling.

Dianna Tickner agreed to ask for the comments on the Duke well via FOIA to get an idea of the kinds of comments other similar projects have received.

There was discussion on where to drill the monitoring well close to the main-well site and agreement that the monitoring well will most likely have to happen.

Phil Papadeas said he and Bill Armstrong will work on details, specifications, and costs on a monitoring well.

There was discussion of the need to get permission from owners to sample their water wells per the EPA expectations, which could be problematic. It was agreed that the owners of the affected wells should be contacted soon for their reactions and that information should be put into our permit comments. Dave Williams will contact the well owners.

It was noted that most, maybe all, of the wells are abandoned, in poor shape, or even gone.

Public Outreach:

Rick Bowersox drew the members' attention to a list attached to the agenda of all news items found in newspapers or on the web relating to the project.

Mike Lynch reported that the UK Center for Visualization and Virtual Environments had contacted him about including this project in a documentary on "clean coal" which the Center is working on. The documentary would be sent to the Documentary Channel for national distribution and possibly sent to KET. He recommended that we pursue this, to get good documenting of the value of this project. Partners agreed the fairest coverage would be received this way.

Review of KGS Knox Dolomite research:

Warren Anderson made a presentation on the extent of the Knox formation in Kentucky and its sequestration potential. He noted that southern Kentucky was investigated for minerals in the Knox, so much data on the Knox has been gathered from there.

Michelle Pittenger (et. al.) will contact WesternGeco to work out seismic acquisition parameters.

She will send Line 7 Data to WesternGeco processing group

Next meeting: January 8th at the same location: KGS Core Library.

ACTION ITEMS:

WesternGeco:

Begin testing as soon as Monday, Dec. 15th, when the equipment arrives and possibly start recording that day. Program may be finished in less than ten days.

ConocoPhillips:

Michelle Pittenger reported that she will be able to send the reprocessed Line 7 data to WesternGeco for their use.

She will contact WesternGeco to work out seismic acquisition parameters.

Paul Heard will produce a first pass at the costs of Phase IVb by middle of the following week.

Peabody:

Dianna Tickner will contact Phil Papadeas to discuss the strategy for convincing EPA the monitoring well is not needed.

She will also make some contacts with DOE, NETL and national laboratories about participating financially in the project.

KGS:

Jim Cobb said he will to send Judge McCaslin the letter of assurance that the partnership will pay for repairs and restoration of Sweet Road.

Dave Harris and Jim Cobb will contact Alliance, LLP for potential participation in the project.

Jim Cobb will make some contacts with DOE, NETL and national laboratories about participating financially in the project.

Dave Williams will contact water well owners whose wells must be tested by EPA requirements to determine if they will give permission.

Sandia Technologies:

Phil Papadeas will send information to Rick Bowersox about an expression of interest in assisting the project from the Texas Bureau of Economic Geology.

He and Bill Armstrong will work on details, specifications, and costs on a monitoring well.

Foundation and KGS:

Will submit payments to Sandia Technologies to get the 2.5% / ten day payment discount.

Appendix B.

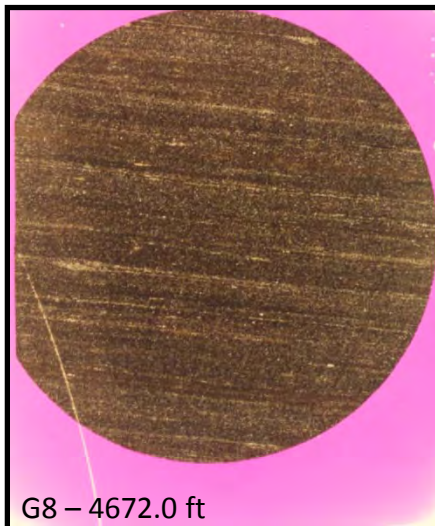
Devonian Shale Petrology Report

Blue Flame K-2605

Petrologic Analysis of Rotary Sidewall Core Samples

Huron Formation

Pike County, Kentucky



Nineteen rotary sidewall core samples were received and divided into ten groups. Six of these groups were chosen for Tight Rock Analysis and the remaining four were prepared for thin section analysis. X-Ray diffraction, total organic carbon analysis, and source rock analysis were performed on all ten groups. Table 1 lists the ten groups and their gas-filled porosity (GFP), permeability, lithotype, and brief description if available. Lithotype for Groups 1, 4, 8, and 10 was determined by thin section analysis. SEM analysis was performed on Groups 3, 5, and 7 to determine lithotype.

Table 1. Test matrix for the rotary sidewall samples of the Blue Flame K-2605 well

Sample ID	Depth ft	GFP % of BV	Permeability, md	LITHOTYPE	DESCRIPTION
G1	4015	n/a	n/a	mudstone	laminated; matrix = clay; 45% silt (15% mica); common pyrite, organic particles, phosphate nodules; minor dolomite nodules
G2	4181.9	2.02	.000076		no thin section
G3	4319.9	1.57	.000056	mudstone	SEM
G4	4348	n/a	n/a	mudstone	laminated; matrix = clay; 45% silt (15% mica); common pyrite; pyrite-rich lamination
G5	4373.9	2.74	.000106	mudstone	SEM
G6	4473.9	1.59	.000063		no thin section
G7	4612.9	2.02	.000071	mudstone	SEM
G8	4672	n/a	n/a	mudstone	laminated; matrix = clay; 40% silt (10% mica); common silt-filled burrows, clay-rich pods, pyrite; minor cherty nodules; silty laminations
G9	4696.9	2.08	.000065		no thin section
G10	4796	n/a	n/a	mudstone	laminated; matrix = clay; 40% silt (10% mica); common silt-filled burrows, clay-rich pods; microfault, dolomite- and Fe-dolomite-filled fractures

All samples examined in thin section and SEM are classified as mudstones. Total clay content ranges from 53-68%, but up to 15 % of that is silt-sized mica. The ratio of silt-sized to clay-sized particles is roughly 50/50. The clay component is predominately illite (Figure 1), but mixed-layer illite-smectite (I/S) with 12-21% expandability also occurs (see XRD results in Table 2). Total expandable I/S layers is less than 1% in all samples. Minor silica cement was observed in Sample G5, but overall silica cement is scarce in the matrix of these mudstones.

Samples G1, G8, and G10 are distinctly laminated and faint laminations were observed in Sample G4. Laminations reflect variations in silt versus clay content (Figures 2 and 3). Silt-filled lenses in Sample G8 are interpreted as burrows. The silt-sized fraction comprises quartz, muscovite, and minor feldspars and chlorite (Figure 4).

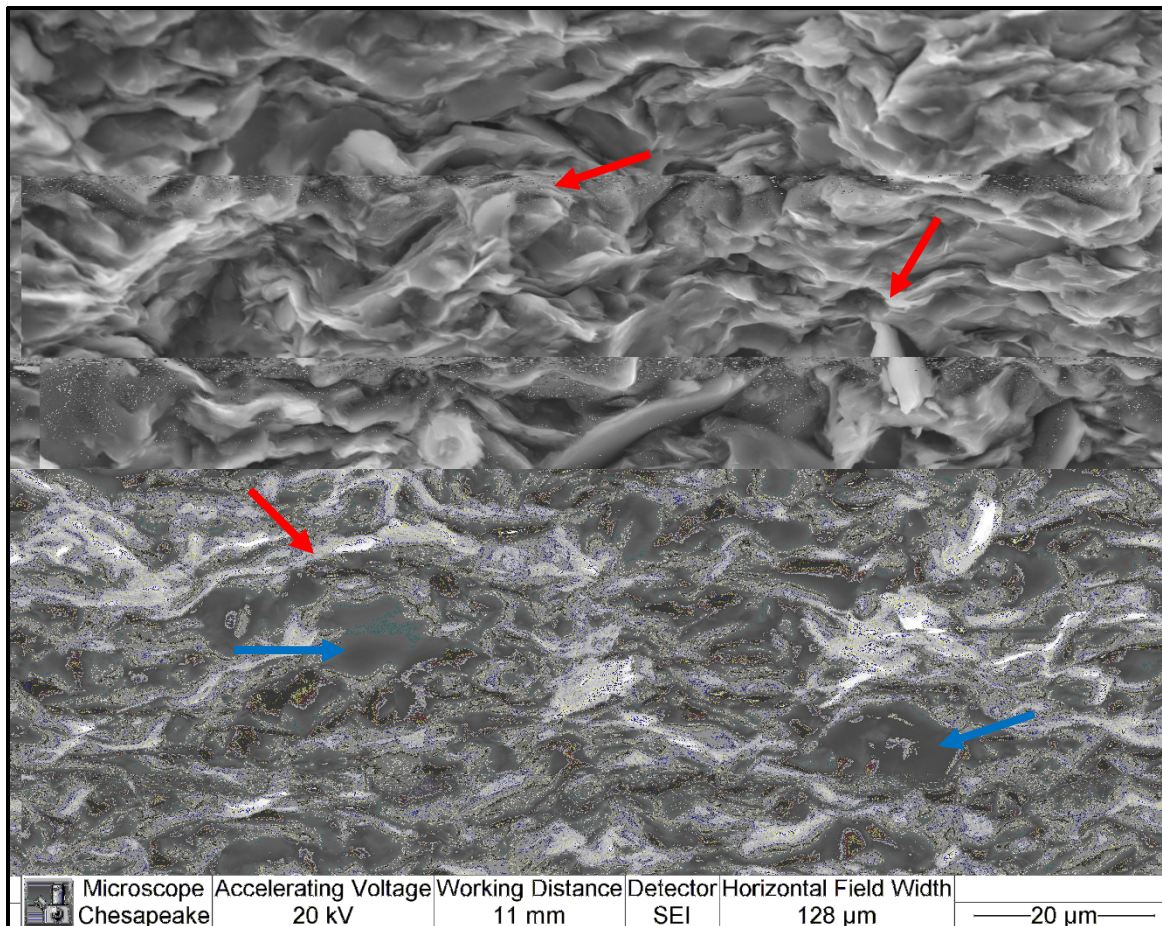


Figure 1. SEM image of the clay-rich matrix of Sample G3. Illite (red arrows) is the dominant clay mineral in mudstones from the Blue Flame well. Clays in the matrix appear moderately aligned at best. Compaction around silt grains (blue arrows) most likely prevented better foliation.



Figure 2. Photograph of Sample G1 thin section. Light and dark bands represent silty (light) versus more clay-rich (dark) laminations.

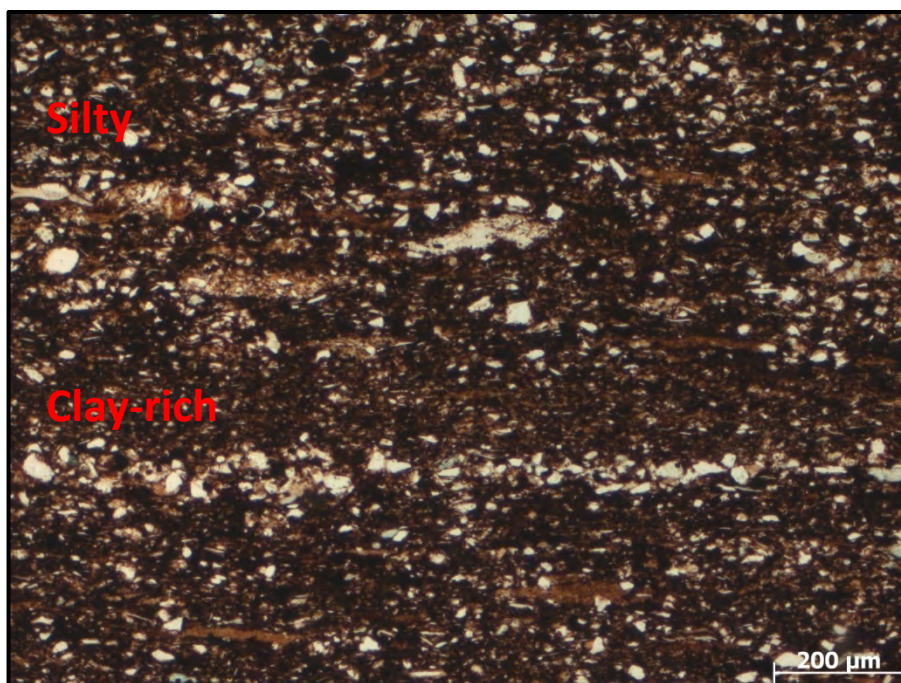


Figure 3. Photomicrograph of Sample G8 illustrating silty versus more clay-rich laminations.

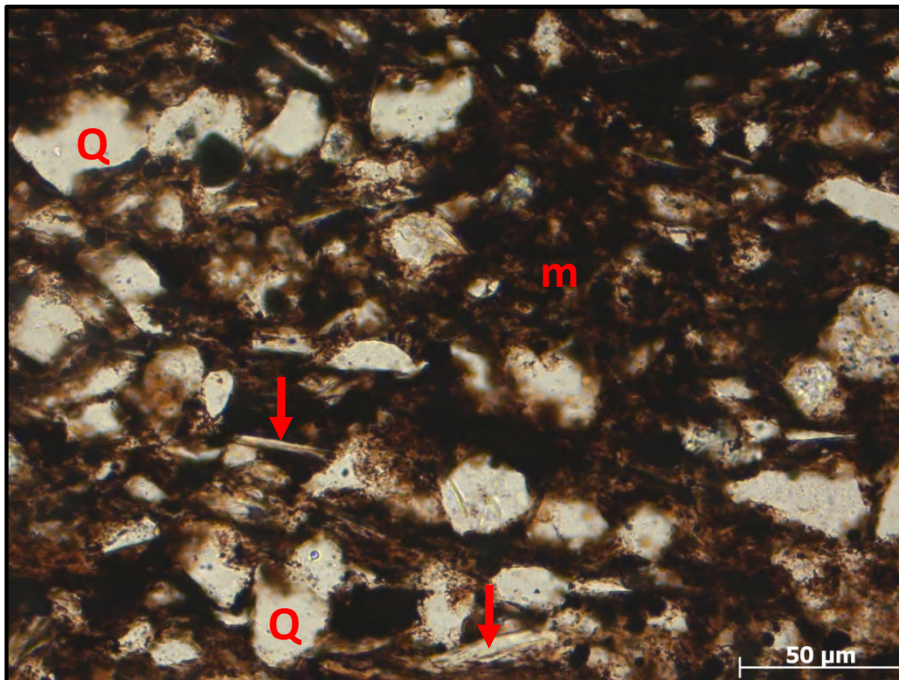


Figure 4. Photomicrograph of Sample G8. The silt component of mudstones in the Blue Flame well is dominated by quartz (Q) and muscovite (red arrows). Chlorite and feldspars are a minor constituent. The matrix (m) comprises illite and disseminated kerogen.

Secondary cements are a minor component of mudstones in the Blue Flame well. Pyrite (+marcasite) is common in most samples, particularly Samples G5 and G10. G3 is unique in that it only has a trace of pyrite. Carbonate cement occurs in trace amounts. Samples G3 and G7 contain approximately 4% dolomite plus siderite. Phosphate nodules were observed in Sample G1, but overall apatite is scarce.

Biotic grains are scarce; conodonts were observed only in Sample G8. Organic matter is fairly prominent in Samples G1 and G10, but is scarce to minor in the other samples. Organic matter occurs both as discrete particles and disseminated kerogen in the matrix. Source rock analysis of these rocks (see SRA results in Table 3) indicates that the kerogen is at or just past peak oil generation ($0.9 < R_o < 1.15$). Two R_o values of 1.7 are considered inaccurate because the S_2 values (.28 and .13 mg/g) are very low.

Overall, the reservoir quality of the Huron Formation in the Blue Flame K-2605 well is poor. Average porosity is 4.4% (maximum of 5.6% in Sample G5) and average TOC is only 2.0% (maximum of 5.1% in Sample G1). Maximum permeability is only 106 nd in Sample G5 (see TRA results in Table 4). Slightly elevated reservoir quality in Sample G5 may reflect the presence of minor silica cement. Generally, mudstones with low TOC and high silt contents have low porosity and permeability. This holds true in the Blue Flame K-2605 well.

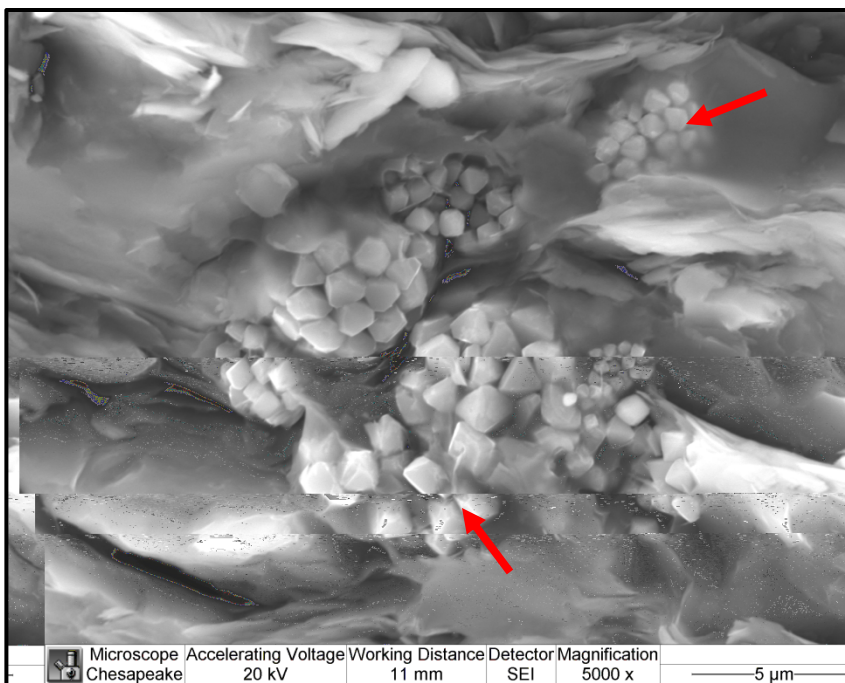


Figure 5. SEM image of Sample G3. Pyrite (arrows) is the most common secondary mineral in these mudstones and generally occurs as framboids disseminated throughout the matrix.

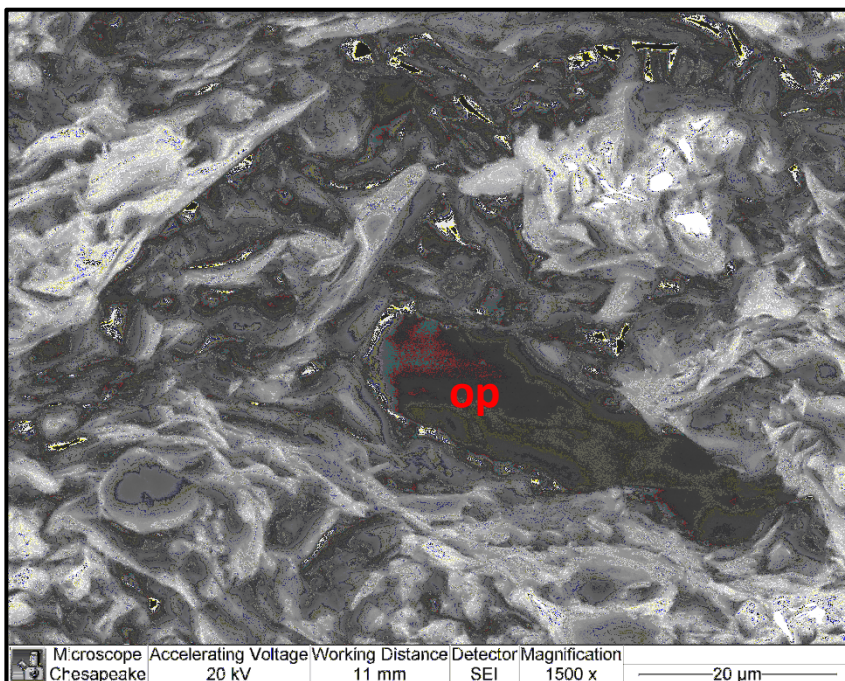


Figure 6. SEM image of Sample G3. Organic particles (op) were observed in this sample, but overall organic matter is scarce. The surrounding matrix is poorly foliated illite.

Table 2. Data from X-ray diffraction analysis.

WELL NAME	Blue Flame K-2605										Weight %
SAMPLE ID	1	2	3	4	5	6	7	8	9	10	
SAMPLE DEPTH	4014.7-4015	4181.7	4290-4305	4348	4335-4380	4440-4570	4635-4665	4665-4695	4695-4710	4755-4800	
NON-CLAY FRACTION											
Quartz	28.9	36.8	30.9	28.6	36.8	25.6	24.9	32.8	28.0	32.7	
K-Feldspar	0.0	0.1	0.1	0.5	0.0	0.0	0.2	0.1	0.1	0.1	
Plagioclase	1.5	2.9	1.4	1.1	2.5	0.6	0.7	1.7	1.6	1.2	
Apatite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	
Pyrite	2.8	3.0	0.1	1.4	4.7	2.8	4.2	4.5	4.2	4.4	
Marcasite	0.7	0.0	0.0	0.0	1.5	0.6	0.6	0.7	0.6	1.7	
Dolomite	0.0	0.2	1.5	0.0	1.1	0.0	0.6	1.3	0.0	0.3	
Siderite	0.0	0.0	2.3	0.0	0.0	2.5	3.9	0.5	0.6	0.1	
Halite	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL	33.9	43.0	36.8	31.6	46.6	32.1	35.0	41.6	35.4	40.6	
CLAY FRACTION											
Mixed-Layer ILLITE/SMECTITE (Includes R3)	4.7	5.0	4.9	3.9	4.1	5.1	6.0	3.6	3.6	1.6	
Illite + Mica	60.0	50.4	54.1	60.8	47.7	59.7	56.6	52.8	59.0	56.7	
Chlorite	1.4	1.7	4.2	3.7	1.6	3.1	2.4	2.0	2.0	1.1	
TOTAL	66.1	57.0	63.2	68.4	53.4	67.9	65.0	58.4	64.6	59.4	
GRAND TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
% Expandable Layers in I/S	21.2	16.4	12.1	12.5	19.3	15.5	15.0	15.3	16.4	19.7	
% I/S to Illite in <1.0um Fraction	9.4	12.1	13.7	9.4	12.3	11.3	13.9	9.1	8.8	3.9	
% Expandable I/S Layers in sample	0.99	0.82	0.59	0.48	0.80	0.79	0.90	0.55	0.59	0.31	

Table 3. Data from source rock analysis and total organic carbon analysis.

Depth	SAMPLE ID	vTPH (S1)	pTPH (S2)	S1+S2	cTemp	tTemp	Calc. %Ro †	TOC	TS	HI	PI
4014.7-4015	G 1	1.82	6.37	8.19	454.4	493.4	1.02	5.06	1.21	126.01	0.222
4171.70	G 2	1.13	3.03	4.16	450.2	489.2	0.94	2.94	1.13	103.10	0.272
4290-4305	G 3	0.09	0.28	0.37	496.1	535.1	1.77	0.38	0.07	73.76	0.243
4348.00	G 4	0.09	0.13	0.22	494.7	533.7	1.74	0.34	0.54	38.38	0.409
4335-4380	G 5	1.05	2.37	3.42	460.3	499.3	1.13	2.80	2.15	84.67	0.307
4440-4570	G 6	0.21	0.31	0.52	455.7	494.7	1.04	0.68	1.28	45.59	0.404
4635-4665	G 7	0.45	0.52	0.97	456.8	495.8	1.06	1.12	1.93	46.59	0.464
4665-4695	G 8	0.63	0.94	1.57	459.8	498.8	1.12	1.45	2.20	64.78	0.401
4695-4710	G 9	0.58	0.84	1.42	458.5	497.5	1.09	1.50	2.10	56.11	0.408
4755-4800	G 10	1.74	3.23	4.97	461.6	500.6	1.15	4.06	2.49	79.65	0.350

vTPH (S1) = Volatile Total Petroleum Hydrocarbons (mg/g)

pTPH (S2) = Kerogen yield

cTemp = calculated temperature (Rock Eval)

tTemp = true temperature (Rock Eval temp + 39)

TOC = Total Organic Carbon

HI = Hydrogen Index

PI = Production Index

Table 4. Data from tight rock analysis.

Sample ID	Depth, feet	A-R Bulk Density, gms/cc	A-R Grain Density, gms/cc	Dry Grain Density, gms/cc	Porosity, % of BV	Water Saturation, % of PV	Gas Saturation, % of PV	Mobile Oil Saturation, % of PV	Gas Filled Porosity, % of BV	Expandable Clay Water, % of BV	Bound Hydrocarbon Saturation, % of BV	Bound Clay Water, % of BV	Pressure-Decay Permeability, md
2	4181.9	2.598	2.651	2.694	4.32	36.67	46.63	16.70	2.02	1.80	0.80	3.96	0.000076
3	4319.9	2.732	2.776	2.826	4.21	55.00	37.30	7.70	1.57	1.31	0.39	7.78	0.000056
5	4473.9	2.573	2.646	2.699	5.56	29.80	49.33	20.86	2.74	1.66	1.16	5.32	0.000106
6	4373.9	2.713	2.757	2.808	4.30	55.60	36.92	7.48	1.59	1.31	0.55	6.25	0.000063
7	4612.9	2.672	2.727	2.772	4.37	39.37	46.12	14.51	2.02	1.78	0.65	6.43	0.000071
9	4696.9	2.707	2.765	2.795	3.69	34.80	56.49	8.70	2.08	0.77	0.54	6.24	0.000065