UPDATE:
Virginia Board for Geology

Winter – 2007/2008

SEQUESTRATION OF CARBON DIOXIDE EMISSIONS IN UNMINEABLE COAL SEAMS

Considerable coverage has recently been given to global warming and proposed measures to reduce greenhouse gas (GHG) emissions in the United States and worldwide. Responding to these issues, the U.S. Department of Energy (DOE) established seven regional partnerships that include more than 350 state agencies, universities, and companies, and span forty-one states, two Indian nations, and four Canadian provinces. The partnerships were charged with evaluating the options for capturing, transporting, and permanently storing or sequestering carbon emissions from coal-fired electrical generation facilities and other large emitters of GHG. The sequestration projects include both terrestrial and geologic projects. Although reforestation and other terrestrial projects have other benefits, geologic sequestration shows much more promise in reducing the atmospheric accumulation of GHG. Consequently, the DOE projects are largely focused on geologic sequestration in depleted oil and gas fields, saline aquifers, and unmineable coal seams.

Within the Southeast Regional Carbon Sequestration Partnership (SECARB), the partnership covering eleven southeastern states, the DOE commissioned the Virginia Center for Coal and Energy Research at Virginia Tech and Marshall Miller & Associates, Inc. (MM&A) to conduct an assessment of the carbon sequestration potential of Pennsylvanian-age coalbeds in the Central Appalachian Basin. The Phase I study, initiated in April 2004, included a review of the coal geology and coalbed methane (CBM) development in a limited, but high potential, area in southwestern Virginia. Evaluated coals include those comprising the Pocahontas Formation and the overlying Lee Formation (New River Formation in West Virginia). Study results indicate that these coals appear favorable for carbon sequestration due to their thickness, depth, rank, and permeability characteristics.

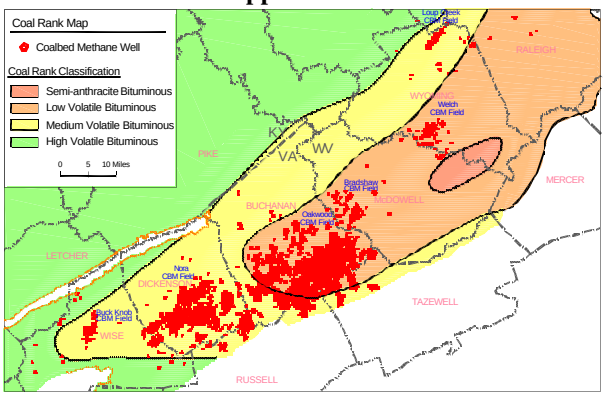
Due to the encouraging Phase I results, the DOE approved funding for a Phase II study from October 2005 to September 2009, in which the study area was expanded to include a larger area in southwestern Virginia, several counties in southern West Virginia, and a small area in eastern Kentucky. In Phase II, a pilot carbon dioxide (CO_2) injection project will be conducted at a site in Russell County, Virginia to further define the sequestration potential. The Regional Coal Rank Map delineates the areas of low volatile and medium volatile bituminous coals, which are most favorable for sequestration. It also indicates the location of the major CBM fields, which have been developed in the region.

Coal presents an attractive sequestration target, because it has a great affinity for CO_2 and is able to contain nearly twice the volume of CO_2 as it does methane gas. Both gases are adsorbed on the coal surface rather than being compressed into pore spaces as in conventional carbonate and sandstone gas reservoirs. When injected CO_2 comes into contact with the coal surface, it is adsorbed and methane gas is released. The released methane gas is then able to flow through the coal cleats to adjacent CBM producing wells, where it is recovered for sale, thereby enhancing the economic feasibility of sequestration in coal seams. The presence of major GHG emitters, the electrical generation facilities, in or near the coal fields, further enhances sequestration economics by limiting the cost to transport the CO_2 from source to sink. Also important is the fact that many existing CBM wells (more than 5,000 in the Central Appalachian Basin) could be converted to inject CO_2, thus greatly reducing the potential capital requirement to implement a sequestration project.

Preliminary results of the work by MM&A and Virginia Tech indicate that Central Appalachian coals have significant CO_2 sequestration and enhanced coalbed methane (ECBM) recovery potential. The current estimate of CO_2 sequestration capacity in the unmineable Lee and Pocahontas Formation coals in southwestern Virginia and southern West Virginia is 1.34 gigatons. ECBM recovery that could potentially result from carbon dioxide injection is estimated at 2.5 trillion cubic feet, or approximately three times the total CBM production from the study area to date. Put into context, the estimated sequestration capacity represents 350 years of CO_2 emissions from American Electric Power's 713 megawatt electrical generation plant in Russell County, Virginia, located near the Phase II injection pilot site.

Negotiations of pilot-site agreements with the coal owner and CBM operator are nearing completion, and it is expected that core drilling to obtain coal-seam data will be initiated later this year followed by CO_2 injection into a converted CBM well in 2008. The testing will enable verification or revision of the estimated sequestration potential. If the pilot proves successful, a full-scale 7-10 year commercial test will follow to demonstrate the viability for development of a carbon sequestration and ECBM industry in Appalachia. MM&A and Virginia Tech believe that their project team has good potential to be selected by the DOE to design and engineer the larger coal-seam test in the Central Appalachian Basin.

Regional Coal Rank Map,
Central Appalachian Basin



Southeast Regional Carbon Sequestration Partnership *(SECARB)*
Funded by the U.S. Department of Energy - Managed by the Southern States Energy Board
Activities under:
Phase I - Central Appalachian Coal Group
Phase II - Coal Seam Group

The SECARB (Southeast Regional Carbon Sequestration Partnership) is one of seven partnerships created by the U.S. Department of Energy (DOE) to determine the optimum approaches for capturing and storing carbon dioxide (CO_2). Under the overall leadership of the Southern States Energy Board (SSEB), SECARB has addressed in Phase I point source CO_2 emissions in the southeastern United States by geographically linking sources with potential sequestration sinks. Options for carbon dioxide storage include depleted oil and natural gas reservoirs, deep saline aquifers, terrestrial ecosystems, and deep, unmineable coal seams.

Under Phase I, the Central Appalachian coal seam research team led by the Virginia Center for Coal and Energy Research (Virginia Tech) and Marshall Miller & Associates, conducted regional characterization of the coalbeds, located favorable areas to sequester CO_2, and quantified the CO_2 storage capacity and associated enhanced coalbed methane (ECBM) recovery potential within southwestern Virginia.

CO_2 sequestration capacity values (Figure 1) for coal seams have been calculated by processing and assimilating net coal thickness, coal rank, coal isotherm, and other related coal reservoir data. Factors such as historical deep mining and currently permitted mine areas for the Pocahontas No. 3 seam have been taken into account in the calculations, as carbon dioxide cannot be effectively sequestered in mined locations. Ideal areas for sequestration have been identified in mature coalbed methane (CBM) production areas within Buchanan and Dickenson Counties, Virginia.

Carbon dioxide's attraction to coal is approximately twice that of methane (natural gas). Carbon sequestration has the potential to increase methane production from coal seams (Figure 2), by displacing methane that otherwise may not be produced. Theoretically, carbon dioxide molecules will be preferentially adsorbed onto the coal, thereby releasing methane gas and boosting CBM production. The cost of implementing CO_2 sequestration technologies could be offset by enhanced CBM recovery.

The U.S. Department of Energy has provided funding for Phase II of the Carbon Sequestration Project. Under this initiative, SECARB will receive $14.3 million from the DOE, with $3.4 million dedicated to further explore and demonstrate carbon sequestration potential in unmineable coal seams in the Black Warrior and Central Appalachian Basins. An additional 20% of the total project funding will be raised through cost-sharing and industrial partners.

The primary objectives under Phase II are to further assess the sequestration potential of CBM reservoirs in the region (including southern West Virginia and eastern Kentucky) and to verify the sequestration capacity and performance of mature CBM reservoirs through pilot well injection of carbon dioxide. Subsurface monitoring programs will measure pressure falloff in the injection wells and gas quality and reservoir effects at offset well locations.

This project includes sequestration testing using both vertical and horizontal CBM wells within the Central Appalachian Basin and may develop breakthrough technologies. Comparison of the injection and sequestration potential for the two well types will help determine the optimum design of future large-scale operations.

Throughout this program, vigorous public outreach and technology transfer activities will be conducted. Activities on the Phase II research commenced October 2005.

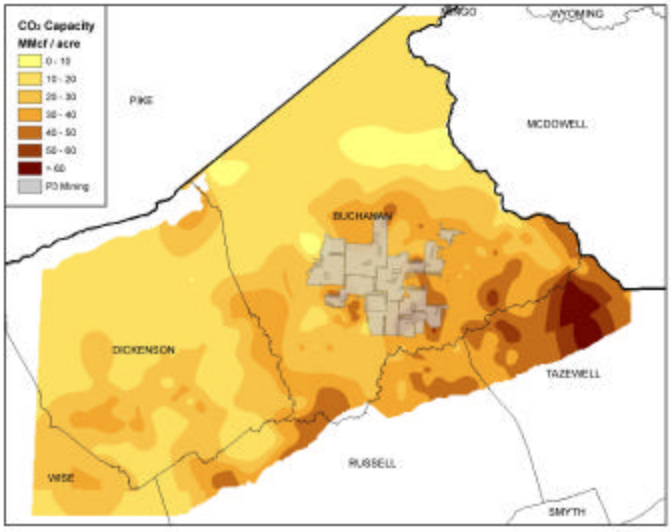


Figure 1: CO_2 Sequestration Capacity of Pocahontas and Lee Formations

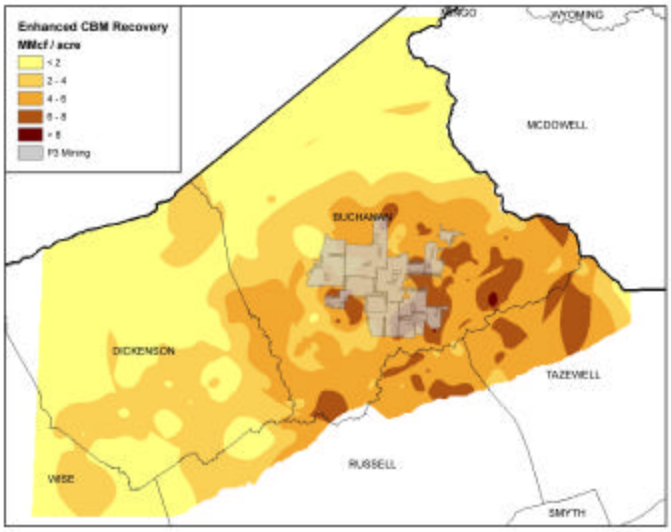


Figure 2: Enhanced Coalbed Methane Recovery Potential of Studied Coalbeds

SECARB Field Tests
Appalachian Coal Seam Project

The most favorable areas delineated for the proposed Central Appalachian sequestration field test are located within the coalbed methane (CBM) production region in Buchanan, Dickenson, Russell, Tazewell and Wise Counties, Virginia, and in Fayette, McDowell, Raleigh and Wyoming Counties, West Virginia. Economic production of coal seam gas in the Central Appalachian region began in 1988 with the development of the Nora CBM field by Equitable Production Company, located primarily in Dickenson County, Virginia. CONSOL Energy later commenced drilling CBM wells in the prolific Oakwood Field located in Buchanan County, Virginia, in 1990. Since that time, over 4,000 CBM wells have been drilled and completed through year-end 2005 in the Central Appalachian Basin. The prospective coal seams are known to be high rank (low to medium volatile bituminous), have high gas contents and occur at favorable depths for storage. CBM development in the area has provided extensive geological, engineering and production data, which will be made available for reservoir modeling. The CBM productivity of the province indicates that coal permeability should be acceptable for carbon dioxide injection.

The articles printed in this newsletter are provided by the Research Team of Marshall Miller & Associates and Virginia Tech/Center for Coal and Energy Research. For more information, please see the SECARB.org website.

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1. Phone: 804-367-8507
2. FAX: 804-527-4297
3. E-mail: geology@dpor.virginia.gov
4. Mail: Board for Geology, Perimeter Center, Suite 400 9960 Mayland Drive, Richmond, VA 23233

2008 Meetings of the Board for Geology

January 8, Board Room 1
April 23, Board Room 3
July 9, Board Room 3
October 15, Board Room 3

Meeting location:
Department of Professional and Occupational Regulation
Perimeter Center, Suite 400
9960 Mayland Drive
Richmond, Virginia 23233

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REMINDER: Change of Address - **It is a Virginia certified professional geologist's responsibility to inform the Board of a change of address. Not receiving the renewal notice does not remove the responsibility of renewal from the regulant.**