



## ANNUAL REPORT 2008



WEST VIRGINIA

**WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY**  
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**January 2009**

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# West Virginia Geological and Economic Survey

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The mission of the Geological and Economic Survey is to make available timely, responsive, unbiased, and credible geoscience information to promote thoughtful public policy; to help create prosperity; and to maintain a high level of environmental quality, economic opportunity, and quality of life for all West Virginians. We accomplish this mission through research, data collection, and service.

One area of research for this agency has been carbon capture and storage (CCS). Concern over global warming as a consequence of carbon dioxide emissions has led to the idea of storing this gas underground in rocks. Because carbon storage may be required for continued production and use of coal in West Virginia, the WVGES has undertaken studies of underground carbon storage in the state for over five years.

Several possibilities exist for carbon storage in West Virginia:

- 1) Storing CO<sub>2</sub> in deep saline reservoirs
- 2) Using CO<sub>2</sub> for enhancing production from existing oil fields
- 3) Storing CO<sub>2</sub> in coal seams considered unmineable or for enhanced production of coal bed methane (CBM)
- 4) Storing CO<sub>2</sub> in organic-rich Devonian shales with possible enhancement of gas production

“ . . . CO<sub>2</sub> capture and sequestration (CCS) is the critical enabling technology that would reduce CO<sub>2</sub> emissions significantly while also allowing coal to meet the world's pressing energy needs.”

Source: *The Future of Coal* Massachusetts Institute of Technology

Important geologic factors in evaluating whether a sedimentary unit is appropriate for carbon storage include depth and thickness of the potential reservoir and thickness of an impermeable, confining seal above the reservoir. The physical characteristics of CO<sub>2</sub> differ with temperature and pressure, both of which change with depth from the surface. In general, potential reservoirs must be deeper than 2,500 ft. at which point CO<sub>2</sub> acts like a liquid; CO<sub>2</sub> as a liquid requires a much smaller volume for storage than as a gas.

## Deep Saline Reservoirs

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Some of the most promising carbon storage reservoirs in the Appalachians and Midwest are relatively deep sedimentary units containing saline water. In some areas of the region, these formations are already used for disposal of waste fluids, so there is a long history of injection of material into deep saline formations. Storing CO<sub>2</sub> in these rocks involves pumping it down a well drilled for that purpose and injecting it into the reservoir, where it displaces and mixes with the saline water, filling both voids between grains and space within minerals. The depth of these rocks helps to guarantee that an adequate rock seal of low permeability overlies the reservoir, effectively containing the CO<sub>2</sub>.

Compared with adjoining states, West Virginia has limited opportunities for carbon storage because appropriate rock units are not present or are perhaps present but contain insufficient pore space and permeability. In large areas of the state we do not know if appropriate rocks are present simply because few wells penetrate the deepest formations.

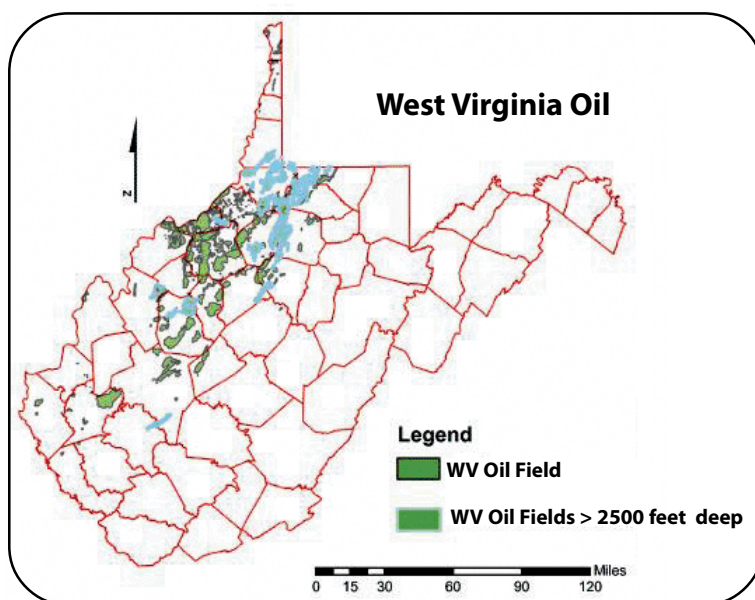


## Oil Fields

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Primary recovery from oil fields in the state is generally only a fraction of the original oil in place. Additional oil may be obtainable by flooding reservoirs with CO<sub>2</sub>. In this approach to enhanced oil recovery (EOR), CO<sub>2</sub> is injected into the reservoir through one set of wells and pushes the remaining oil toward producing wells, or mixes with the oil to make it more easily moved to the producing wells. In this value added approach, CO<sub>2</sub> becomes more than simply a waste byproduct requiring disposal.

West Virginia has a large number of old oil fields that might be used for carbon storage; as with saline reservoirs, fields that lie more than 2,500 feet underground are the best candidates for carbon storage.



## Coal

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Some coal seams may be just too deep and thin to be mined with current or foreseeable technology and may be candidates for carbon storage. CO<sub>2</sub> adsorbs onto the carbon in coal and fills void spaces in the coal bed. If the coal bed contains methane in economic quantities for production, CO<sub>2</sub> could be used to displace the methane; the methane could be removed and sold whereas the CO<sub>2</sub> remains in the coal.

## Organic-Rich Shales

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Shales with high organic carbon content are expected by researchers to behave much like coal in the ability to store CO<sub>2</sub>, both within fractures and bound to organic compounds. West Virginia has thick organic-rich shales underlying the southern part of the state from which large quantities of natural gas have been produced. The low permeability of these rocks could limit the rates at which carbon could be injected but the storage potential of organic shales is currently under study.

## The Future

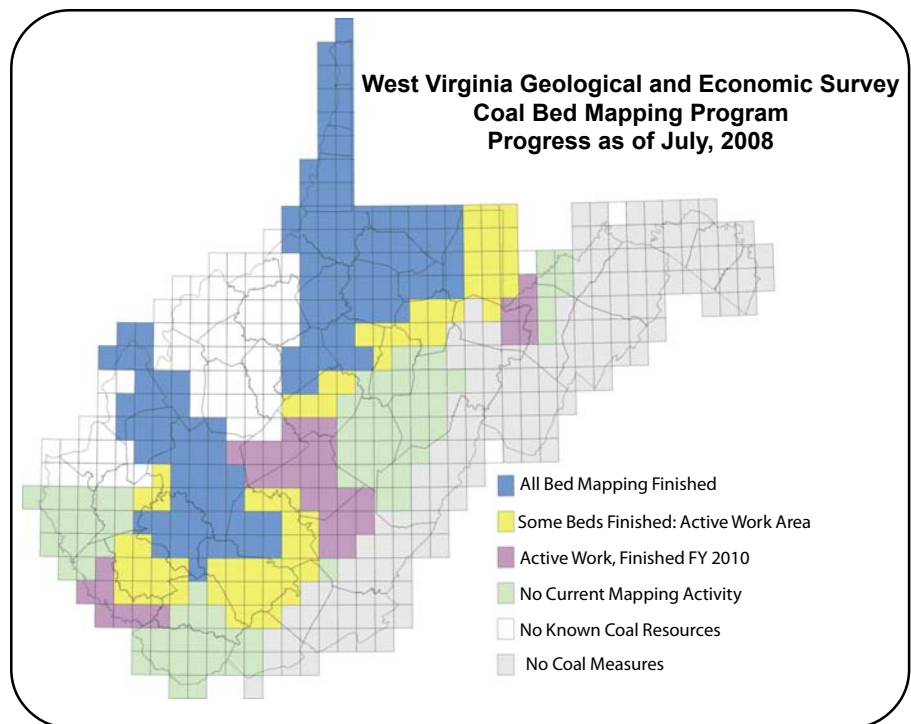
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Many questions remain and will remain in the near future regarding the practicality of carbon storage in geologic reservoirs underlying West Virginia. We have joined the research efforts of the West Virginia Division of Energy, West Virginia University, and the geologic surveys of other states to identify potential geologic reservoirs for storing CO<sub>2</sub>.

*Michael E. Hohn,  
Director and State Geologist*

# Applied Coal Resources Investigations Program

**Coal-bed Mapping Project (CBMP)**—The geographic information system (GIS)-based Mineral Lands Mapping Program is a cooperative effort between the Survey, the West Virginia Department of Tax and Revenue, and the West Virginia University (WVU) Department of Geology and Geography. The Department of Tax and Revenue is responsible for creating GIS layers of mineral parcel ownership. WVU is charged with creating various GIS base map layers, or digital line graphs (DLGs). As part of this project, the Survey is conducting a GIS-based inventory of coal in the State. Coal-bed maps include: structural contour maps; outcrop maps; mined area maps by methodology; coal thickness maps; percent parting maps; and coal quality maps. At the end of FY2008, coal bed mapping was completed for all or parts of 25 counties and work is continuing in those and four additional counties (see map to the right). With the change in mapping accounting methodology from the previous county-based to a quadrangle-seam base at the end of FYI 2006, it is difficult to give an exact answer for the actual number of counties completed. Currently approximately half of the



State has been mapped and it is anticipated that the remaining coal areas will be finished in calendar year 2014. Work is proceeding in Clay, Grant, Greenbrier, Logan, Mineral, Mingo, Nicholas, Preston, Raleigh, and Tucker counties (see map above). Completed maps were delivered to the Department of Tax and Revenue in early June (2008) and are publicly available on the Survey's web site.

**Mineral property tax related issues.** Mineral property owners, including general public, land companies, consultants, extractive industry, oil and gas industry, and the West Virginia Division of Tax and Revenue (WVDTR) use the basic data and derived map products from the CBMP to understand property valuation issues, assist them in filing required mineral appraisal forms, resolve disputes about resource valuation, and to value mineral parcels for taxation purposes. Taxes received based on Survey products are used to fund many important parts of the State's infrastructure, notably the education system.

**Basic Data Collection and Research**—Basic geologic data is continually collected and added to various databases to increase the knowledge base of the Survey. These data include core logs,

coal analyses, measured sections of outcrops, highwalls, and road cuts, maps of underground coal mines and data extracted from the maps and a host of other important information. Most data collection throughout the year was associated with the Coal-bed Mapping Project. The Coal Section's stratigraphic data base exceeded 2 million items in FYI 2008. The presence of this amount of data allowed mapping efforts to accelerate.

An interesting part of basic data collecting is the Survey's drilling program initiated in 1995 as a tool to solve various geologic questions, including acid producing potential, problematic stratigraphic relationships, coal bed methane potential of deep coal beds, and to gather information of the stratigraphic and lithologic distribution of selenium in the Middle Pennsylvanian Kanawha Formation. To date, 17 holes have been drilled by the Survey alone or as part of cooperative research initiatives with industry or other government agencies. Although the Survey did not drill any additional holes in FY2008, Coal Section personnel were provided access to many industry holes allowing important research to continue.

**Coal-bed Methane Activities**—Coal-bed methane is an increasingly important energy resource in West Virginia. Coal Program geologists continue to work cooperatively with various coal companies and natural gas companies, describing the lithologies from coal bed methane exploration drill holes in Barbour, Braxton, Calhoun, Monongalia, Pleasants and Ritchie counties during FY 2007. These data, coupled with data from oil and gas wells, are providing insights into basin development in previously under-investigated, deeper parts of the Appalachian Basin within the State.

- **Coal Quality**—The Coal Program maintains and continually enhances a computerized database of the chemical and physical characteristics of West Virginia coals. The data base currently contains over 35,000 sample analyses and is one of the largest public databases of coal quality information in the nation. Basic coal analyses, washability data and petrography characteristics for the State's coal beds are available by request and trace element data are served through the Survey's web site. This database has proven to be very useful in helping potential customers find the specific West Virginia coal to meet their needs for power generation and to serve as chemical feedstock or as a source for coal to liquid studies. Policy makers often call on the Survey's coal quality expertise to gauge the potential effects of legislation on the State's coal industry. Unfortunately, with the Geology and Geography Department at West Virginia University moving from White Hall to newly renovated Brooks Hall, the Survey's coal analytical laboratories were forced to close due to loss of space. Although in-house analysis will cease, analytical data will continue to be added to the Survey's coal quality data base obtained from various sources when and if it becomes available. It is an important goal for FYI 2009 to incorporate the coal quality data base into the overall coal stratigraphy database.
- **National Coal Resources Data System (NCRDS)**—The Survey's Coal Program has received numerous grants from the U.S. Geological Survey's NCRDS program to contribute West Virginia coal information to the USGS' national computerized coal database. This database is used for a

variety of investigations including Coal Availability Studies, but its use is not limited to cooperative federal projects.

Data acquisition, entry into Survey computer databases, and verification by Coal Programs personnel are ongoing processes. Non-confidential data are uploaded to the NCRDS periodically. Stratigraphic database work accomplished under this effort directly benefits the Coal-bed Mapping Project. Coal samples collected by Survey geologists are forwarded to the U.S. Geological Survey for trace element analyses and the results are added to the Survey's coal quality database. Other studies funded by the USGS through the NCRDS co-op include selenium investigations, trace elements in coal, distribution of marine beds in Middle Pennsylvanian strata that are used for global correlations, and contributions to an electronic lexicon of geologic names for the United States.

**Underground Mine Mapping Project**—Recognition of the value of underground mine compilations to mine safety issues, as highlighted by the Quecreek mine accident in Pennsylvania, resulted in closer cooperation and communication between the Survey and the West Virginia Office of Miner's, Health, Safety, and Training (MHST). The two agencies formed a partnership and were successful in receiving funding from the U.S. Department of Labor, Mine Safety and Health Administration, to enhance compiling and providing public access to these important data. Funding was received in 2004 and the original project is nearing completion. MHST is focusing on collecting and archiving maps of underground mines, while the Survey digitizes the footprint of the mines areas, by seam, in a geographic information system format as new data becomes available. With the Survey's cooperation, MHST received an additional grant to collect and process old mine maps from previously identified collections. These additions should be useful in further delineation of mined areas within the State.

Mining compilation directly benefits coal bed mapping conducted under the Coal-bed Mapping Project. With the exception of clean-up work on the Douglas coal bed in McDowell County, all available mine maps from the State have been examined, inventoried and where appropriate, the mine footprint has been digitized and entered into the Survey's comprehensive coal bed GIS. All mine maps and compiled mining by bed are available for examination on the Survey's web site and individual mine map documents can be downloaded by interested parties.

## **Mine Information Database System**

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The West Virginia Geological & Economic Survey's new Mine Information Database System (MIDS) is now online and available to the public. The database went "live" in March 2008 for internal use and after testing, was opened to public access. MIDS was developed to overcome a number of limitations present in the Survey's former mine map database. While the preceding database was built in Microsoft Access, MIDS is built on an enterprise Oracle database and offers web based access with multi-user support. The new MIDS database marks a significant improvement in data interoperability. This allows our partners at MHST to update the database in real-time rather than

by quarterly imports. It also provides much improved integration with our GIS-based Coal Bed Mapping Project and our online ArcIMS interactive map server.

The MIDS system contains records of every mine map available at the WVGES and is comprised of over 43,000 documents representing over 69,000 mines. Information concerning coal seams, mine names, company names, and permit numbers can be found in the Mine Information Database System. MIDS offers a powerful set of search tools that allows users to setup advanced queries and provides quick access to downloadable digital images of mine maps.

**Mine subsidence related issues.** Potential home and land buyers require documentation as to whether a property of interest has been undermined or overlies potentially minable coals to evaluate the mine subsidence potential. Homeowners, insurance adjusters, engineering consultants, and government agencies, notably WVDTR, West Virginia Department of Environmental Protection; (WVDEP), West Virginia Department of Natural Resources (WVDNR), and the U.S. Geological Survey (USGS) contact us concerning properties experiencing suspected subsidence problems to obtain information on mining and geological conditions of coal under affected property. In addition, mining companies search our mine map data base looking for abandoned mines adjacent to proposed and active mines to forestall Quecreek type disasters. Mined area maps are available, by seam, through direct contact with Survey geologists or can be downloaded from the Survey's web site. The new MIDS system makes this service more "customer friendly."

**Comparison of Mid-Carboniferous Floras**—Geologist Mitch Blake has been participating in a National Science Foundation (NSF)-funded research project to compare mid-Carboniferous fossil plant collections available from eastern Europe and North America to address questions relevant to vegetation responses during onset of a major glacial interval. Since the Carboniferous is the last time in geologic history when there were extensive equatorial rain forests during an ice age, findings of this study are being compared with vegetative patterns of change during the Pleistocene. It is hoped these comparisons will provide insights into the impacts of climate change on vegetation distributions. Mitch presented the results of his part of the study at the annual meeting of the Geological Society of America in Lake City in October, 2005 and Philadelphia in October, 2006. A paper based on the October, 2005 presentation is scheduled for release in July, 2008,

## **General Services and Outreach**

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**Visiting Geologist Program.** This popular program, run in cooperation with WVDNR State Parks, allows Survey geologists to visit WV State Parks where they present programs on West Virginia and local geology and lead field trips for park visitors. The Survey has just completed the 16<sup>th</sup> season of this popular program.



**Informational and sales displays.** The WVGES annually exhibits at the West Virginia Hunting and Fishing show in Charleston in January and the West Virginia State Fair in August. The set-up includes an informational exhibit as well as map and publication sales, making all WV topographic maps and other assorted maps and geological publications available on-site. Another important outreach meeting is the USGS and WVGES' cooperative ESIC program that provides access to various aerial photographs and related products in West Virginia. Paul Liston, the Survey's ESIC Coordinator, provides informational displays mainly on the ESIC products annually at the Industrial Expo and West Virginia Surveyor's Convention, both in Charleston. In addition, the Survey sponsors a rock and mineral show that draws over 1,000 attendees annually.

**Informational Meetings.** The Survey routinely host various small to medium sized meetings that target a diverse clientele. These meetings are as diverse as the ESRI Northern Users Group meeting, two regional benchmarking workshops on mine maps (participants from AL, CO, IL, IN, KY, ND, NM, NY, OH, TN, VA, WV); and regional meetings for professional societies such as GSA and AAPG. Through the Petroleum Technology Transfer Council program, a joint USDOE/industry sponsored program, the Survey co-sponsored workshops, a website, and an online newsletter to provide information on new technology to oil and gas producers through out the 7 state Appalachian Region.

# General Geoscience Program

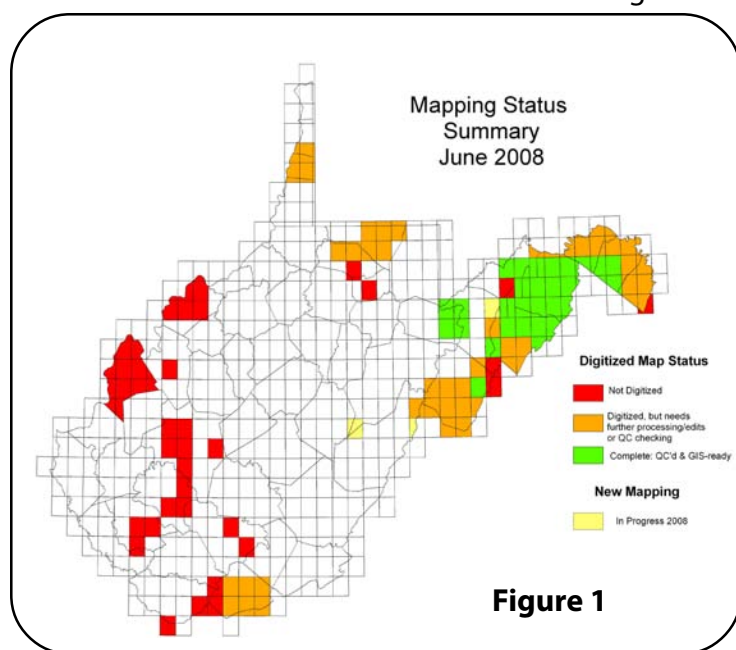
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The General Geoscience Program includes: Advanced Geoscience Research, Economic Minerals Geoscience, Environmental Geoscience, Geologic Mapping, and Geoscience Education.

## Geologic Mapping

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One of the primary activities of the General Geoscience Program is geologic mapping and the creation of new 7.5-minute geologic quadrangle maps. Status of mapping is shown in Figure 1. During FY 2007-2008, mapping efforts were carried out in the eastern and northern panhandles, and in north-central and southeastern West Virginia as part of U.S. Geological Survey's annually-



funded, competitive grant STATEMAP Program. The purpose of the STATEMAP Program is to produce high-quality, 7.5-minute quadrangle maps of West Virginia's geology. Completed mapping projects for FY 2007-2008 were submitted in June. Three mapping projects were proposed and successfully funded for 2008-2009, and work commenced on three new quadrangles.

Cooperating geologist S. L. Dean completed mapping of the Burlington (Mineral and Hampshire counties) 7.5-minute quadrangle and began mapping the Medley (Grant, Hardy, and Mineral counties) 7.5-minute quad-

rangle. Senior Research Geologist R. R. McDowell, Geologist and Program Head K. L. Avary, together with Geologists J. Q. Britton, and J. E. Lewis commenced work on the West Virginia portion of the Hightown 7.5-minute quadrangle (Pocahontas County). Geologists G. H. McColloch, Jr. and J. S. McColloch completed the open-file geologic maps of the Mannington (Monongalia and Marion counties), the Valley Grove (Ohio and Marshall counties, WV and Washington County, PA) and the Pennsylvania portion of the Bethany 7.5-minute quadrangles. Mapping of the Pennsylvania portions of the Bethany and Valley Grove quadrangles is part of a cooperative agreement with the Pennsylvania Bureau of Topographic and Geologic Survey. Geologist Paula Hunt completed the final additions and revision of the Canaan Valley four-quadrangle geologic map (OF-9902A – Bedrock Geology of Canaan Valley, West Virginia).

A request by a West Virginia State Mapping Panel member to conduct geologic mapping in the headwaters area of the Elk River led to the creation of the "Birthplace of Rivers" Initiative, to better characterize the bedrock geology and its connection to water resources in the headwaters area of the Elk, Gauley, Shavers Fork of the Cheat, Williams, Cherry, Cranberry, Greenbrier, and Tygart

Valley Rivers. To determine the feasibility of geologic mapping in this area, Geologists G. H. McColloch, J. S. McColloch, P. J. Hunt and L. Stocks began a pilot study to map the Sharp Knob (Pocahontas, Randolph, and Webster counties) 7.5-minute quadrangle.

Completed maps and accompanying text and cross section(s) are initially available as an open-file report. Maps of the bedrock geology and other relevant themes are then produced for the final publication. The open-file reports are the first step in becoming formal publications in the Survey's newly developed digital production facility. These projects also produce digital GIS data sets and maps conforming to newly adopted Association of American State Geologists guidelines.

## **Other Mapping-Related Projects**

• **Digital GIS Map Products Project**—This ongoing, long-term project produces geographic information system (GIS) data sets and digital maps of all West Virginia geologic quadrangles mapped under the federal 1:24,000-scale STATEMAP Project and other mapping projects. Other West Virginia quadrangles mapped under other projects are also slated to be digitized and converted into GIS layers to create a complete digital collection of all geologic mapping at 1:24,000-scale in West Virginia. Line work for all maps is digitized at a scale of 1:24,000. Once this work is completed, attributes are assigned to geologic contacts, faults, and bedding orientations, thus completing the process of providing detailed data for inclusion in West Virginia's growing 1:24,000-scale GIS database. This digital map conversion process results in Digital Geological Open-File Map Products that include:

1. GIS shapefiles for layers included in the data model. Layers are named according to feature type and the USGS 7.5-minute topographic quadrangles from which they are drawn.
2. Hardcopy plots of geologic maps when requested by customer.
3. ArcMap map documents (.mxd files) and layer rendering files (.lyr files) are included for the convenience of customers that also use ESRI software, when possible. Not all digitized open-file maps have reached the stage of being published in ArcMap. Some map documents contain fully published map layouts; others only contain cartographically rendered GIS layers.
4. Georeferenced scanned images of USGS topo maps used as the base maps for some quadrangles, when available.
5. Georeferenced scanned images of original geological open-file maps, cross sections, and other source material that may accompany that quadrangle.
6. Open-File Report of Investigations documents that accompanied the original paper map (in Microsoft Word or Adobe PDF format), where possible.
7. A README document containing procedures, metadata, and the GIS data model used by WVGES.

To date, 18 data sets, which include 31 quadrangles, have been completed, and digitizing continued on various legacy and new open-file map layers, such as bedding orientation points. Quality Assurance/ Quality Control (QA/QC) procedures began on another five previously digitized data

sets, which include 30 quadrangles, to check and standardize these new datasets for eventual release to the public as digital publications, and for inclusion in the 1:24,000-scale GIS database.

Work began on developing the WVGES 1:24,000-scale GIS database of geologic maps into a new State Geologic Map and internet-based interactive map application.

Two new publications in the State Park Bulletins booklet series were completed, *Canaan Valley Resort/Blackwater Falls*, and *Cacapon Resort/Lost River*, each containing two 11" by 17" geologic maps of the respective state parks, derived from the geologic maps completed under the Digital GIS Map Products Project.

A graduate student thesis project involved digitizing, revising and expanding publication OF9408, *Bedrock and Surficial Geology Maps of the Blackwater Falls Quadrangle* into 3 new digital surficial geology maps of the quadrangle: *Landform Units*, *Origin of Surficial Geology*, and *Surficial Materials*. These new maps have been made available to the public as paper and digital publications, and have also been added to the WVGES 1:24,000-scale GIS database of geologic maps.

Completed maps and publications were entered into the U.S. Geological Survey National Geologic Maps Database (NGMDB). This information is updated annually to keep our records current.

- **Full-Color Map Compilation**—This project produces full-color geologic map publications from recent STATEMAP projects. Full-color maps of 20 quadrangles are currently available. Minor revisions/corrections were made to a few published maps. A substantial revision of the *Bedrock Geology of Canaan Valley* map began this fiscal year.

- **Derivative Map Project**—Geologic data and other information to develop derivative maps are used to aid in the visualization of geologic hazards and other environmentally related aspects in the areas where digital geologic map data are available from the Digital GIS Map Products Project.

- **Digital Archiving Project**—Legacy maps are scanned for preservation and for use with other GIS datasets. Scanning of legacy 7.5-minute USGS Open-File Landslide and Related Feature maps continued, and 236 of 383 quadrangles maps have been scanned. Index maps of scanning progress were created and maintained. Scanning and processing of legacy WVGES Open-File Geologic maps, cross sections, Volumes, Bulletins, Circulars, and other documents continued, and 75% of the Open File Geologic 1:24,000-scale maps stored in the archives were georeferenced for use in GIS systems by staff and customers. File naming conventions were established and files in archives named and organized.

- **USGS Winchester 100K Map Project**—This project provided QA/QC of the digitized GIS files for 28 West Virginia 7.5-minute geologic quadrangles submitted to USGS for inclusion in the Winchester 100K Map. Quality control was completed, and final batches of data for this project were

delivered to USGS in January 2008. In May 2008, by reciprocal arrangement with USGS, WVGES received 20 maps (paper and/or digital copies) of quadrangles in WV mapped by USGS, which were not held in the WVGES map archives.

## **Geoscience Education**

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Using the premise that WVGES-web-based products would be more useful to a broader audience and more compatible with a reasonable ongoing updating policy, the rebuilding of a more user friendly website has become the primary goal of the Geoscience Education Program. Digital creation of new classroom useful materials and the digital-enhancement of existing RockCamp materials and illustrations have been undertaken.

Winter of 2007 and the spring of 2008 were spent planning and preparing for the upcoming June workshops. In June, this planning produced two teacher-enhancement workshops. These sessions were made possible by reserving a substantial portion of the annual Geoscience Education Program allocation for use during the last quarter of the fiscal year.

The first June session was a two-day field trip for 12 teachers representing 12 different counties. These teachers represent a segment of our advanced “recurrent” participants population. These



**These teachers are learning to take a strike and dip measurement of the Mississippian Mauch Chunk Group on the flank of Spruce Knob during a RockCamp workshop. (Photo by Tom Repine)**

teachers have participated in multiple RockCamp sessions and possess sufficient prior-knowledge that will allow them to comprehend post-introductory information and the scientific process associated with data accumulation and interpretation. These teachers have clearly and repeatedly stated that our K-12 success is rooted in the WVGES policy of sustained opportunities to engage in ongoing learning. In contrast to the WVGES, many institutions do not employ the “recurrent model” we use to offer past participants new and expanded learning.

This session’s primary topic was the unique igneous rocks of eastern WV. The session leader was Ron McDowell assisted by Barnes Nugent. Paula Waggy, a RockCamp graduate and now RockCamp instructor, acted as co-leader, assistant instructor, and local property access coordinator. As to be expected, Ron did a fantastic job of providing this advanced



group with both the nature of how geological science works and what his interpretations are. When asked about the rocks possible volcanic origins, he impressed the teachers by stating that we do not know much at this point, that the teachers present were seeing things not many scientists had seen, and that, at this point in time, that they were watching the scientific process in action, and that their explanations and hypothesis were worthwhile.

Accompanying us on this trip were Drs. Behling and Renton, WVU Geology Department. Dr. Deb Hemler, of Fairmont State University, was also present in her role of the Geoscience Education Program's Assistant Director. With this type of scientific representation, the teachers also had the chance to witness the scientific argument process as different opinions on specific interpretations were voiced. Our evening was filled with small groups of teachers interacting with the various scientists as they sought confirmation or explanation.



**Barnes Nugent (center) explains the structure of Germany Valley and Seneca Rocks to two teachers during this June's RockCamp session. This is at night while the teachers are working on assignments. They are in the classroom of the Mountain Institute located on top of Spruce Knob.**

*(Photo by Tom Repine)*

Our second session was conducted several days later. This 3.5-day session was conducted in partnership with The Mountain Institute and Fairmont State University. Thirteen teachers from seven different counties were selected to participate in this residency-oriented session. This was the first RockCamp session for these teachers. As such, they were "rookies." This is evident in the minor content mastery, lack of field techniques, and in the serious number and type of misconceptions they unknowingly perpetuate upon their students. For rookies, exposing misconceptions is most often the first step in getting them to advance their learning. This is why critical thinking is more important than rote content at this level. As a side note, the number of teachers who can be selected for a RockCamp session is constrained by funding and for this reason not all of the approximately thirty teachers who applied could be accommodated. Lodging and meals were provided by The Mountain Institute. Dr. Hemler, FSU, provided us with the opportunity to provide participants with graduate credit. Credit is earned by active workshop participation, submission of field note and daily journal, completion of assignments, and successful submission of post-workshop tasks designed to help them share what they learned with colleagues and students. Barnes Nugent participated in this session as an instructor and observer.

Since the completion of both workshops, focus has shifted to the participants' post-session assignments. Individuals and teams in both groups will produce a variety of on-line products that can be posted (with editing) on the WVGES website. These will be educationally focused ideas that will provide other educators with either teacher-friendly or student-friendly ideas, photos, lectures, etc that can help science teachers provide their K-12 students with a more in-depth and

more accurately taught lessons on WV geology. Late Fall 2008 completion and submission of these products is linked to participant stipend and FSU credit. Thus, these workshops are contributing to the Geoscience Education's goal of producing tangible products.

## **Data Collection**

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Activities associated with the General Geoscience Program's service and research require continuous collection and analysis of significant amounts and types of data. Databases for limestone, springs, geochemical analyses of rock samples, maps, and geographic information are maintained. Additional information and materials are available for nonfuel minerals, geologic hazards, map information, and a host of other topics that fall within the expertise of the program.

## **Service**

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The General Geoscience Program responds to service requests from industry, government, the general public, and academia. As the responsibilities of the program are to address all geologic and geographic matters not directly related to West Virginia's fossil-fuel resources, the scope of service activities is quite diverse. These areas of expertise fall into these general categories:

- Economic Minerals (limestone, dolomite, sandstone, sand and gravel, clay and shale, salt, peat, etc.).
- Environmental Geology (flood hazards, landslides, karst geology, radon, seismicity, etc.).
- Water (ground- and surface-water hydrology, water resources, water supply, water quality, water use, springs, etc.).
- Geoscience Education (teacher experiences and related topics).

## **Publications (bold names denote Survey staff)**

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- **Ashton, K.C.** and **Stocks, L.**, 2008, **The Geology of Canaan Valley Resort and Blackwater Falls State Parks**: West Virginia Geological and Economic Survey Publication SP-6A, 32 p., 2 maps on folded insert.
- **Ashton, K.C.**, 2008, **The Geology of Cacapon Resort and Lost River State Parks**: West Virginia Geological and Economic Survey Publication SP-7, 36 p., 2 maps on folded insert.
- **Dean, S.L.** and **Kulander, B.R.**, 2008, **Geology of the Burlington Quadrangle, Hampshire and Mineral Counties, West Virginia**: West Virginia Geological and Economic Survey Publication OF-0704, 1:24,000 scale.
- Fedorko, N., Kite, J.S., Cenderelli, D., Springer, G.S., Behling, R.E., Davis, E.N., and **Anderton, S.C.**, 2007, **Surficial Geology Maps of the Blackwater Falls Quadrangle, Tucker County, WV**: West Virginia Geological and Economic Survey Publication OF9408-A, 3 map sheets, scale 1:24,000.
- Matchen, D.L., Fedorko, N., III, **Blake, B.M., Jr.**, Murphy, S.J., **McDowell, R.R.**, and **Hunt, P.J.**, 2008, **Bedrock Geology of Canaan Valley, West Virginia**: West Virginia Geological and Economic Survey Publication OF9902-A, 2 sheets, scale 1:24,000.

- **McColloch, J.S., and McColloch, G.H., Jr., 2007, Creating Geologic Maps in a GIS Environment** [abs]: GSA Abstracts with Programs, v. 39, no. 6, p. 161.
- **McColloch, J.S. and McColloch, G.H., Jr., 2008, Creating Geologic Maps for the Appalachian Plateau in a GIS Environment** (poster), Agenda: Digital Mapping Techniques'08 Workshop, May 18-21, 2008.
- Ganak, M.E. and **McDowell, R.R., 2008, Mudcracks and ripped-up stromatolites: Sunshine and stormy weather in the Silurian, Tonoloway Limestone, West Virginia**: GSA Abstracts with Programs, V. 40, No. 4, p. 60-61, abstract.
- **Hunt, P.J., McDowell, R.R., and Matchen, D., 2008, The mystery corner: Finalizing the bed-rock geology map of Canaan Valley, West Virginia** [abs.]: GSA Abstracts with Programs, v. 40, no. 4, p. 12.

## **Presentations**

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- Geologist G.H. McColloch, Jr. gave two oral presentations: "Developing Three-Dimensional Geologic Mapping in the Gently Folded Pennsylvanian Rocks in Northern West Virginia," at the 2007 GSA Annual Meeting and "Defining a Three Dimensional Geologic Map for the Appalachian Plateau" at the 2008 Digital Mapping Techniques Workshop.
- Geologist J.S. McColloch gave two poster presentations: "Creating Geologic Maps in a GIS Environment," at the 2007 GSA Annual Meeting and "Creating Geologic Maps for the Appalachian Plateau in a GIS Environment," at the 2008 Digital Mapping Techniques Workshop.

## **Awards, Elections, Appointments, Service**

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- Education Specialist and Manager T.R. Repine, Jr., who began part-time status on November 1, 2007, served on the doctoral committee for Jack Renton's PhD student. He responded to an average of 25.6 service requests per month.
- Geologist J.S. McColloch served as an Executive Committee member of the American Association of Petroleum Geologists Division of Environmental Geosciences (AAPG-DEG) and as an associate editor of the AAPG-DEG journal *Environmental Geosciences*. She serves on the Appalachian States Coalition for Geological Hazards in Transportation Committee.
- Geologist Sarah Gooding served on the thesis project committee of graduate student Susan Anderton and assisted/oversaw the development of the three new surficial geology maps of OF9408A, Blackwater Falls quadrangle.

# Oil and Gas Program

## Coalbed Methane

Coal bed methane (cbm) production and drilling has continued to increase. As of September, 2007, records for over 800 wells had been received by the WVGES (Figure 1). Production continues to increase as well, with calendar year 2007 production totaling over 22 billion cubic feet (Bcf) of gas (Figure 2). The cumulative production of CBM surpassed 100 Bcf in 2007. Most of the activity to date has been in southern and northern West Virginia; however, in the summer and fall of 2006, several wells were completed in Clay County in addition to more wells in Barbour County. Late in 2007, cbm wells were permitted in Gilmer and Harrison counties in north central West Virginia. Production includes post-mining gob gas or coal mine

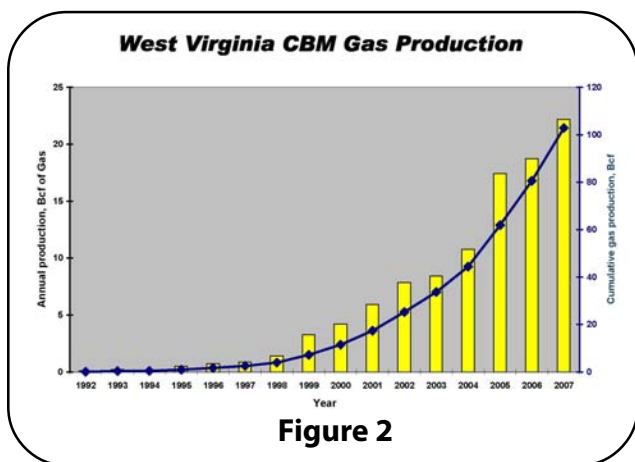


Figure 2

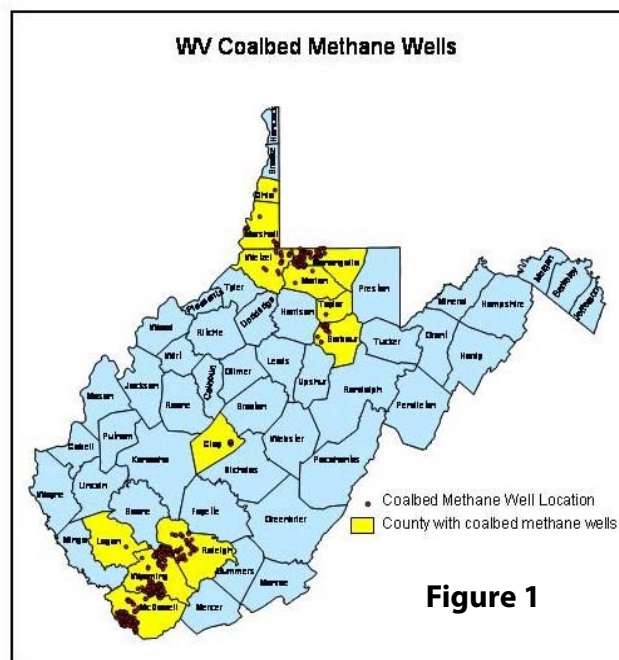


Figure 1

methane, pre-mining de-gasification of coals using a multilateral horizontal drilling system, vertical fractured wells, and simple horizontal wells. The WVGES website has available downloadable files containing data for individual CBM wells.

## Devonian Shales

Recent developments in shales in other basins have inspired renewed interest in West Virginia's Devonian shales, both the traditional Lower Huron and Rhinestreet shales in southwestern West Virginia as well as the deeper Marcellus Shale in other parts of the State. New horizontal drilling and well stimulation technologies have helped to encourage new drilling and evaluation programs in these shales. A PTTC workshop on Devonian shales was well-received. New material was added to the WVGES website to respond to a dramatic increase in requests for information about the Devonian shales, especially the Marcellus. A significant increase in leasing activity especially in counties in eastern West Virginia where historic drilling has been very limited has led to many inquiries from property owners. In many of these eastern counties in the State, the oil and gas rights are owned by the surface owner. Surface owners often have concerns about the potential impacts of drilling on their property.

A cooperative project supported by the U.S. Geological Survey to update summary Devonian shale production data contained in an earlier study performed for the Gas Research Institute (now the Gas Technology Institute) was completed. Another project to obtain samples for new geochemical analyses of Devonian shales was also completed. The data obtained from these analyses will be useful in evaluating the Devonian shales in West Virginia.

## **Technology Transfer**

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The Appalachian Region Petroleum Technology Transfer Council (PTTC) continued to provide timely workshops on a variety of topics to a broad range of attendees. Funding for this program from the U. S. Department of Energy was zeroed out in early 2007, so considerable effort was expended to transition to a new financial structure and implement a new model for the program. The American Association of Petroleum Geologists (AAPG) now manages the program and the regional lead organizations were restructured to align with AAPG's existing domestic sections. Since its inception in 1996, the Appalachian Region PTTC has hosted over 125 workshops with over 6,000 registrants, maintained a website including an interactive mapping capability for key wells, produced a newsletter, and provided technical expertise to many independent oil and gas producers throughout the Appalachian Basin. Workshop topics during this year included "Fracture in Devonian Black Shale of the Appalachian Basin", "Structural Principles and Trap Geometry in the Northern Appalachians", "Carbonate Reservoirs", "Value-added Carbon Capture and Storage: CO<sub>2</sub> Enhanced Oil Recovery and CO<sub>2</sub> Enhanced Coal Bed Methane", "Appraising and Developing Coal Bed Methane and Shale Gas Reservoirs", and "Drilling and Completion in the Shales of Appalachia".

## **Carbon Dioxide Sequestration**

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West Virginia has the potential for storage or sequestration of carbon dioxide in various zones below the surface. The WVGES is part of the geologic sequestration team for the Midwest Regional Carbon Sequestration Partnership (MRSCP). The MRSCP is one of seven regional partnerships established by the U.S. Department of Energy. Battelle Memorial Labs in Columbus, Ohio is the prime contractor for the MRSCP. The Ohio Geological Survey is the lead agency for the geologic sequestration team. As part of the Phase 1 MRSCP efforts, a large amount of basic geologic data was compiled at a regional scale in digital form. Many of these data had not previously been compiled in such a way; these data are useful for applications beyond identifying zones with potential for geologic carbon sequestration. The data can be used for oil and gas exploration and an improved understanding of subsurface geology. During the year, work continued on Phase 2, which includes more detailed characterization of selected intervals identified during Phase 1, as well as some pilot tests throughout the region. The Phase 3 large scale demonstration project award for the MRSCP was finalized. During Phase 3, in addition to the injection project which is to be located in northwest Ohio, additional regional characterization work will continue.



K.L. Avary made a presentation to the West Virginia Legislature Joint Commission on Economic Development Interim Session on Carbon Dioxide Sequestration Potential in West Virginia.

D.G. Patchen served on a task force to examine issues associated with regulations and permitting for potential CO<sub>2</sub> sequestration activities. This task force organized by the Interstate Oil and Gas Compact Commission, is supported by the U.S. DOE. The IOGCC formally approved the report during their May 2007 meeting and distributed it to the appropriate state regulatory agencies. Patchen provided feedback about the draft report to the committee throughout the year.

### **Improving the Availability and Delivery of Critical Information for Tight Gas Resource Development in the Appalachian Basin**

This three-year USDOE-sponsored project, begun in fall 2005 in cooperation with the Pennsylvania Geological Survey, will provide ready public access to well-specific and region-wide data and interpretations of those regional data that will allow gas producers to advance their understanding of the nature of six significant regional tight gas accumulations in the central Appalachian Basin. The improved understanding of these reservoirs will enable expanded resource recoverability through more cost-effective exploration of new areas, and more efficient infill drilling and recompletion programs in existing fields.

The project will provide easier access to scanned wireline logs, digitized wireline logs, production data, core analysis reports, digital photographs of cores, scanned maps and cross-sections, and related data on tight gas plays through an interactive website. Wireline logs are being scanned and database entries are being updated for use in system queries.

Two main objectives to this project are:

1. *Collect a broad range of data* and information in public records and published sources and convert it to digital format. The work concentrates on the Lower Mississippian/Upper Devonian Berea/Murrysville play and the Upper Devonian Venango, Bradford, and Elk plays in Pennsylvania and West Virginia; the Lower Silurian "Clinton"/Medina play in Pennsylvania; and the Lower Silurian Tuscarora Sandstone play in West Virginia. Scanning of wireline logs, digitizing of logs, database updates, data quality assessment, digital core photography, and digital conversion of relevant maps are on-going.

2. *Design and implement an on-line, interactive digital and geospatial Web site* that consolidates a broad range of existing information about tight gas reservoirs, and has the potential to be extended to any tight gas reservoir in the future. This Web site will include scanned images of logs, photomicrographs of thin-sections, digital photographs of core slabs, selected basic well data, and digital regional maps and cross-sections. Development of this Web site is underway.

## **Zero Emissions Research and Technology (ZERT)**

Researchers at Montana State University created a DOE-funded ZERT Center to develop a comprehensive approach to the measurement, monitoring, migration and risk assessment of geological sequestration of carbon dioxide. This approach includes fundamental studies of geophysical and geochemical investigations of CO<sub>2</sub> with formation waters and reservoir lithologies, and development of new monitoring methods, as well as strategic use of suites of methods, parameterization of potential leakage/seepage mechanisms and assessment of reservoirs relevant to these mechanisms.

Montana State assembled a research team consisting of scientists from Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and West Virginia University, among others. The WVU team includes members from the National Energy Technology Laboratory, the West Virginia Geological Survey, and the Departments of Petroleum & Natural Gas Engineering, Civil & Environmental Engineering, and Geology & Geography. The task assigned to the WVU Research team is to determine the feasibility of sequestering carbon dioxide in Appalachian coal beds.

The WVU-NETL-WVGS researchers organized their effort into four subtasks: computational modeling and visualization; determination of key physical data; a structural integrity investigation; risk assessment; and a cost effectiveness investigation. Drs. Thomas Wilson and Douglas Patchen are cooperating on the first part of the structural integrity subtask, which is to conduct geophysical monitoring and subsurface characterization of storage and seal intervals. Part two of this subtask, structural integrity modeling, is being conducted by Dr. Hema Siriwardane.

Consol Energy has drilled multiple horizontal laterals in the Pittsburgh and Upper Freeport coals in Marshall County. Some of the laterals will become production wells, whereas others will serve as CO<sub>2</sub> injection wells. Consol plans to produce natural gas from both coals, and to inject CO<sub>2</sub> into the Upper Freeport coal, which will not be mined. Once ECBM from the Upper Freeport ceases, the injected CO<sub>2</sub> will remain as a long-term sequestration project.

The WVU research team, of which WVGS is a partner, will conduct characterization studies of the reservoir, develop computational models and predict the structural integrity of the CO<sub>2</sub> storage reservoir. The research team also will develop and implement field methods to monitor possible CO<sub>2</sub> emissions from the site.

The water wells have been drilled and water samples have been taken and analyzed to establish a pre-injection profile of aquifer water in the area. The same has been done for water samples collected from surface streams in the project area. Sampling to date has met the criteria in the injection permit, but will continue right up to, during, and after the injection of CO<sub>2</sub>. Obviously, the goal is to see if any CO<sub>2</sub> shows up in the shallow ground water or surface streams.

Thirty shallow wells were drilled and tiltmeters were placed in all of them. Data have been collected over an interval of several months, again to establish a pre-injection baseline. Pinnacle plans to shut down the data collection in late November, 2008 and wait until two weeks before injection begins before they begin to collect more data (this is to save us money; injection is being delayed because of the well problems). Once injection starts, the highly sensitive tiltmeters will detect any movement of the shallow rock layers caused by injection of CO<sub>2</sub> and production of methane.

Tom Wilson finally got his seismic crew on site and has collected his seismic data. The data look encouraging, although Tom said they could be better. He sees some "interesting" events in the shallow section and also sees some deeper events, well below the Oriskany. His goal is to determine the location of any structural zones that may be avenues for CO<sub>2</sub> to move up section. Right now he needs help placing formal stratigraphic names on the different intervals.

The big news of the year probably is that Consol actually got a permit to inject CO<sub>2</sub> and produce gas from the project. They have a Class II permit, so the project will not be affected by EPA's new Class VI permit, at least for this project.

## **Basic Oil and Gas Data**

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As part of the WVGES mission to archive and make available basic data on the State's mineral resources, work continued on the Oil and Gas database. Scanning of plats and well records continued during the year using the new photocopy/scanner machine. In addition, scanning of wireline logs continued, supported largely with funding from the U.S. Department of Energy.

## **Professional Service**

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- K.L. Avary completed her term as Chair of the Honors and Awards Committee of the Eastern Section AAPG. She began a term as Chair of the Eastern Section AAPG Future Meetings Committee. She also chaired the Eastern Section AAPG Imperial Barrel Award Committee and organized the section's annual Student Job Quest.
- K.L. Avary organized the Field Trips and Spouse/Guest Trips for the Centennial Meeting of the Association of American State Geologists, in Shepherdstown.
- D.G. Patchen served as President for the AAPG Energy Minerals Division.
- K.L. Avary is a member of the AAPG Student Job Fair, Professional Women in Earth Sciences (PROW-ESS), and AAPG Committee Oversight committees.
- K.L. Avary is the delegate elected to represent the Appalachian Geological Society and \*D.G. Patchen is the delegate elected to represent the Pittsburgh Association of Petroleum Geologists in the AAPG House of Delegates. K.L. Avary served as the Eastern Section representative on the House of Delegates Resolutions Committee. D. G. Patchen served as the Eastern Section representative on the House of Delegates Nominations Committee.
- D.G. Patchen represents West Virginia on the Potential Gas Committee, a group funded by the American Gas Association and company donations. He also serves as the Appalachian Basin Chairman for the Potential Gas Committee. During the year, the Potential Gas Committee released a new report which contains estimates of the nation's remaining gas resources and reserves. During the current year, the Appalachian Basin committee reviewed the data for the basin and updated the resources and reserves data for the Trenton-Black River, based on the results of the DOE-funded study.
- G.H. McColloch served as Chairman of the AAPG Energy Minerals Division Honors and Awards Committee.

- K.L. Avary serves on the West Virginia Coal Bed Methane Review Board.
- K.L. Avary became an Associate Editor for the AAPG *Bulletin* E & P notes.
- K.L. Avary received the AAPG Distinguished Service Award.
- K.L. Avary received the Cheat Lake Rotary Club's Vocational Service Award.

## **Outreach**

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- K.L. Avary and R.R. McDowell supervised two summer interns; one from Concord University and one from West Virginia University.
- K.L. Avary served as faculty advisor for the West Virginia University American Association of Petroleum Geologists Student Chapter.
- D.G. Patchen continued to participate in the Visiting Geologist Program (VGP) of the AAPG. K.L. Avary and D.G. Patchen serve as Eastern Section Coordinators for the VGP Committee.
- K.L. Avary made presentations to the Morgantown North and Cheat Lake Rotary clubs about the current oil and gas leasing and drilling activity in West Virginia.
- K.L. Avary made a presentation at a Girl Scout Day Camp Program at Camp Roy Weller in Bruceton Mills, WV on geology and working as a geologist.
- K.L. Avary made a presentation to a WVU Faculty Enrichment Group, "What's Under My Land".

## **Presentations**

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- G.H. McColloch and J.S. McColloch made presentations at the Digital Mapping Techniques'08 Workshop.
- J.E. Lewis made a poster presentation at the Eastern Section AAPG meeting.
- K.L. Avary was a co-author on a poster presentation at the Eastern Section AAPG meeting.

## **Publications (bold names denote Survey staff)**

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**Lewis, J. E., McDowell, R.R., and Avary, K.L.**, Use of Digital Log Analysis to Evaluate the Helderberg Group as a Confining Layer for CO<sub>2</sub> Sequestration: Eastern Section American Association of Petroleum Geologists Annual Meeting Program and Abstracts, p. 43.

**McColloch, G.H. and McColloch, J.S.**, Bedrock Geology of the Valley Grove Quadrangle, Ohio and Marshall Counties, West Virginia: West Virginia Geological and Economic Survey, Open-File Report OF-0801, scale 1:24,000.

**McColloch, G.H. and McColloch, J.S.**, Bedrock Geology of the Mannington Quadrangle, Marion and Monongalia Counties, West Virginia: West Virginia Geological and Economic Survey, Open-File Report OF-0802, scale 1:24,000.

**McColloch, G.H., Jr. and McColloch, J.S.,** Bedrock Geology of the Bethany Quadrangle, Ohio and Brooke Counties, West Virginia: West Virginia Geological and Economic Survey, Open-File Report OF-0703, scale 1:24,000.

**McColloch, G.H., Jr. and McColloch, J.S.,** 2008, Defining a Three Dimensional Geologic Map for the Appalachian Plateau (talk), Agenda: Digital Mapping Techniques'08 Workshop, May 18-21, 2008.

**McColloch, G.H., Jr. and McColloch, J.S.,** 2007, Developing three dimensional geologic mapping in the gently folded Pennsylvanian Rocks in Northern West Virginia {abs}: GSA Abstracts with Programs. v. 39, no. 6, p. 120.

**McColloch, J.S. and McColloch, G.H., Jr.,** 2007 Creating Geologic Maps in a GIS Environment {abs}: GSA Abstracts with Programs, v. 39, no. 6, p. 161.

Riley, Ronald A., Nuttall, Brandon, Harper, John A. and **Avary, K.L.,** Assessing the Potential for CO<sub>2</sub>-Enhanced Oil Recovery in the MRCSP Region: Eastern Section American Association of Petroleum Geologists Annual Meeting Program and Abstracts, p. 50.





## **WV GIS Technical Center**

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Located in the Department of Geology and Geography at West Virginia University, the West Virginia GIS Technical Center (WVGISTC) is separate from the Geological and Economic Survey. However, the Center receives significant funding through our agency and works with the West Virginia Geographic Information System Coordinator's office, a program within our agency.

### **Mission and Objectives**

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The WV GIS Technical Center provides focus, direction and leadership to users of geographic information systems (GIS), digital mapping and remote sensing within the State of West Virginia. The WVGISTC was established under Executive Order No. 4-93 in November 1993, which specified that the Technical Center should provide technical support services to development and operation of GIS in West Virginia.

The primary objectives of the Center are to reduce the duplication of GIS data development among organizations; disseminate GIS spatial data, Web map services, mapping applications, and other geographic information free-of-charge through the Internet; coordinate acquisition of new data additions to the West Virginia Spatial Data Infrastructure; assist with strategic planning, development and implementation of GIS and mapping guidelines statewide; provide advisory services and training programs in GIS; and conduct research and provide education towards improvement of geographic information technologies in West Virginia.

### **Personnel**

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The staff consists of two geography professors who serve as co-directors, five full-time employees, and student and temporary employees hired periodically to accomplish project tasks.

- Dr. Gregory Elmes, Co-director
- Dr. Trevor Harris, Co-director
- Kurt Donaldson, Manager
- Frank LaFone, Senior Internet Programmer
- Evan Fedorko, GIS Analyst
- Eric Hopkins, GIS Analyst
- Kevin Kuhn, GIS Analyst

### **Funding**

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Primary FY 2007-08 funding of \$295,000 was received from the state-appropriated Mineral Lands Mapping Program (Fund 0253, Activity 207) approved under House Bill 2222 in February 1995. Fiscal management of this program was delegated to the WV Geological & Economic Survey, with programmatic oversight by the GIS Policy Council. Additional external funding was obtained from several grants and service contracts.

## **Projects and Activities FY 2008**

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### **Build and Disseminate State's Spatial Data Infrastructure**

The WVGISTC supports digital data conversion, data development, and coordination with federal geospatial data initiatives, statewide mapping programs, and local (county, municipal) data producers. The Center collaborates with the Statewide Addressing and Mapping Board (SAMB), U.S. Geological Survey, and other partners to create a value-added, high resolution 1:4800-scale digital base map for West Virginia. Elevation, transportation, streams and administrative map layers benefit the entire state community; government, private sector and non-profits.

**National Hydrology Dataset (NHD):** In cooperation with the U.S. Geological Survey and WVU Natural Resource Analysis Center, continued development of an attributed, linear referenced, 1:4800-scale local resolution hydrography data set for two 8-digit watersheds: Upper Guyandotte (05070101) and Gauley (05050005). Business plan and stewardship agreements for NHD are also being developed.

**Transportation and Structures:** In spring 2008 WVGISTC received a grant from the Federal Geographic Data Committee to build stewardship for integrating statewide structure and transportation data into national, standardized databases.

**Orthophotos:** This past year WVGISTC quality checked and published statewide one-meter resolution natural color and color infrared orthophotos funded by the State and USDA's National Agricultural Imagery Program (NAIP). In certain regions of West Virginia the NAIP imagery has been added to commercial products like Google Maps.

**Geology:** In partnership with the West Virginia Geological and Economic Survey, WVGISTC digitized and geo-referenced six statewide geophysical and structural maps as well as 36 landslide maps.

**Economic Development:** In partnership with the Development Office, WVGISTC created poverty rate and population maps of West Virginia.

**Historical Geospatial Data:** In the summer of 2007, WVGISTC coordinated with the WV Geological Survey, WVU Library, and State Archives to inventory historical geospatial resources in West Virginia. A report was published for Sanborn Fire Insurance Maps (1866-1982), Topographic Maps (1883-present), and Aerial Photographs (1936-present).

## **Mapping Projects and Applications**

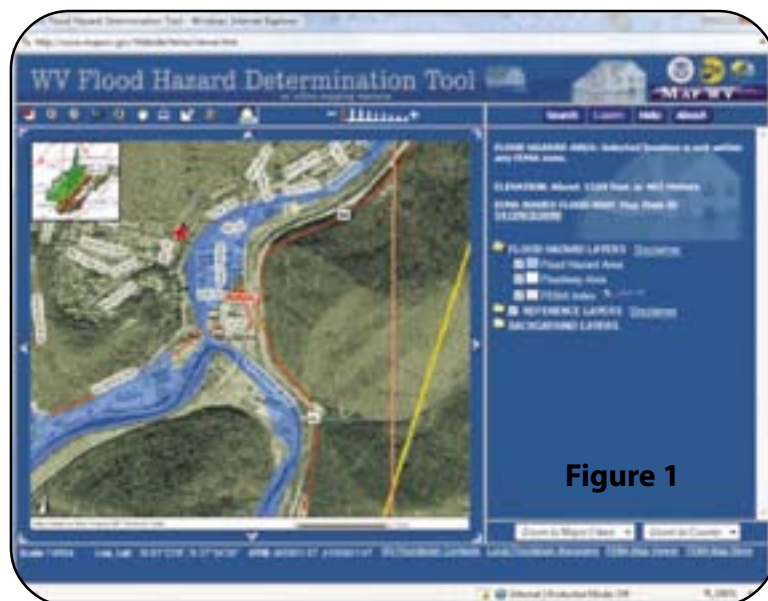
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During fiscal year 2008, WVGISTC participated in a number of projects which generated geospatial data and products. Select projects are highlighted below:

**Flood Hazard Mapping and Hazard Determination Tool:** In cooperation with FEMA and flood map modernization contractors, WVGISTC created digital flood insurance rate maps (FIRM) for select counties in the Eastern Panhandle to assist in the implementation of a statewide digital flood-mapping program. In partnership with the State Floodplain Manager, WVGISTC created an

online Flood Hazard Determination System (Figure 1). This interactive mapping tool, which utilizes the best available digital flood hazard data, elevation data, and aerial photography for West Virginia, allows home and business owners, insurance and real estate agents, developers, and flood plain managers to make informed decisions about the degree of flood risk faced and what precautions, if any, should be taken. The flood mapping application has garnered acclaim from FEMA as well as from the state floodplain management office and local floodplain managers and is part of the MapWV.gov initiative to make online mapping resources in the Mountain State available to the public.

Link: <http://www.mapwv.gov/flood>



**Figure 1**

### **Mass Evacuation Mapping and**

**Modeling:** In support of emergency planning by the WV Department of Military Affairs and Public Safety, the WVGISTC at West Virginia University is developing geospatial data of critical facilities and infrastructure and building models to estimate resource capacities and potential impacts on the State of a mass evacuation from one of the surrounding metropolitan areas. Initial modeling efforts have focused on estimating the resource capacities of the food, fuel, and shelters in West Virginia under a series of disaster evacuation scenarios. In December 2007, WVGISTC published a GIS data assessment report of resource capacity maps and preliminary simulation models.

**Carbon Sequestration Mapping and Modeling:** In cooperation with federal and state energy partners, WVGISTC created an interactive carbon sequestration explorer to locate potential sequestration sites in oil, gas, and coal fields suitable for hosting a Coal-To-Liquids facility. Based on infrastructure and geological variables, 762 sites were rated for their suitability for hosting Coal-To-Liquids facilities. <http://www.wvcarb.org>

**Internet Mapping Applications:** WVGISTC assisted in the development of a Trout Stream Stocking application for the WV Division of Natural Resources (<http://www.mapwv.gov/website/dnr/viewer.htm>), a source water application for the Department of Health and Human Resources, and a National Register application for the State Historic Preservation Office.

**Next Generation Topographic Maps:** WVGISTC is working with state partners and the U.S. Geological Survey to create the next-generation topographic maps in West Virginia. In fall 2007, a

workshop was held at WVGISTC in which federal and state representatives of mapping organizations presented new ideas and concepts relevant to creating a new nationwide graphic product.

## **Geographic Information Network Services**



**Figure 2**

WVGISTC provides a suite of Internet services to disseminate geographic data and information, including the MapWV.gov portal, State GIS Data Clearinghouse, and State GIS Directory.

*MapWV.gov:* MapWV.gov is a public gateway to online mapping resources in the Mountain State, providing a wealth of high-quality maps and geographic data via the Internet. The site provides access to static and dynamic maps as well as Web map services. The target audience of MapWV.gov is the general public or casual user who is seeking geospatial information. MapWV.gov has been visited by nearly 120,000

unique visitors since its inception in early, a 17% increase from the previous year. In spring 2008 the website was re-designed and new content was added (Figure 2). To support the growth of this public service, a new enterprise hardware system was installed which expanded storage capacities from 16 to 52 Terabytes.

<http://www.mapwv.gov/>

**Data Clearinghouse:** The State Data Clearinghouse has over 270 GIS data sets valued at more than \$50 million dollars. Since 2004, the website has serviced 1.8 million visitors. This includes nine Terabytes of data downloaded from the clearinghouse over the past 5 years. Mapping professionals in the state and nation are the target audience for this online service. Data is accessed by FTP download, Web map services, or links to data stewards who routinely post geospatial data on their websites. Data clearinghouse at <http://wvgis.wvu.edu/data/data.php>

## **Strategic Planning Services**

This past year WVGISTC and other state partners completed a Fifty States Initiative grant from the Federal Geographic Data Committee to re-organize the GIS governance in West Virginia. Other

strategic planning efforts include cooperating with the Office of State GIS Coordinator, WV GIS Steering Committee, and other state partners to update the 1993 GIS Development plan. The Fifty States Initiative Strategic Planning Process Guide is being used as a template to create an effective strategic plan.

## **Technical Support, Educational and Training Services**

WVGISTC provides outreach, educational and training support, and advisory services to the citizens, government agencies, non-profit organizations, and businesses of West Virginia in the area of GIS and related spatial data handling technologies.

**2008 WV GIS Conference:** WVGISTC was the lead organizer of the biennial WV GIS Conference in June 2008. The theme of the WV GIS Conference was “Mapping the Mountain State...Today and Tomorrow.” The largest program to date, the 2008 WV GIS Conference includes a plenary session, 28 concurrent paper presentations, a poster viewing and competition, and 17 seminars/workshops.

**Instructor-Led Training:** Staff presented workshops and training throughout the year, including five “Introduction to GIS” courses by an ESRI-certified instructor.

**WV Association of Geospatial Professionals:** WVGISTC provided Web site development and other start-up task in support of the new GIS user and advisory group in West Virginia.

**WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY**  
**Consolidated Statement of Expenditures**  
**For the Period July 1, 2007 through June 30, 2008**

	<u>Total</u>	<u>Agency General Revenue</u>	<u>GIS General Revenue</u>	<u>Approp. Special Revenue</u>	<u>Other Special Revenue</u>	<u>Approp. Federal Revenue</u>
Personal Services	\$ 1,886,640	\$ 1,237,223	\$ 363,308	\$ 27,157	\$ 232,765	\$ 26,187
Personal Services Reimbursements	260,927		260,927			
Annual Increment	38,634	33,122	3,270	565	1,677	
Insurance & Retirement Fee	19,141	9,973	6,616	144	1,682	726
Matching FICA	160,399	92,448	46,179	2,041	17,729	2,002
Public Employees Insurance	333,411	183,822	112,851	3,232	31,763	1,743
Workers' Compensation	5,219	2,557	1,119	101	1,153	289
Retirement Benefits	222,959	130,673	65,022	2,911	23,008	1,345
PEIA Transfer	17,876	11,832	4,409	274	1,361	
Office Expense	8,692	6,453	1,793	118	328	
Printing & Binding	10,822	321			10,501	
Building Rental	11,162		11,162			
Utilities	32,142	31,248	243	206	445	
Telecommunications	18,455	17,402	1,053			
Contractual	257,153	25,400	215,642		10,211	5,900
Travel	79,828	24,038	47,652	1,133	3,230	3,775
Computer Services	12,332	10,715	1,252		365	
Vehicle Rental	14,670	10,436	2,392			1,842
Machine Rental	19,241	17,660	165		1,416	
Association Dues	300	300				
Insurance Premiums	29,180	29,180				
Household Supplies	842	842				
Advertising & Promotional	4,307	1,952	1,727		628	
Vehicle Expense	16,738	10,751	3,773		185	2,029
Research Expense	113,514	6,077	104,146		1,932	1,359
Maintenance Contracts	83,352	23,854	50,808	65	8,625	
Merchandise For Resale	5,104				5,104	
Cellular Charges	1,209	1,209				
Hospitality	506	249	257			
Miscellaneous	108	106	2			
Training & Development	15,153	4,594	2,571	350	7,440	198
Postal & Freight	5,145	3,684			1,416	45
Computer Supplies	59,989	20,151	21,989	605	6,894	10,350
Miscellaneous Equipment	7,754	4,485		35		3,234
Bank Costs	886			36	850	
Office Equipment Repairs	15	15				
Household Equipment Repairs	2,559	2,559				
Building Repairs & Alterations	73	73				
Vehicle Repairs	4,903	902	3,125			876
Ground Improvements	480	480				
Other Repairs & Alterations	21		21			
Computer Equipment	11,220		8,220		3,000	
Indirect Cost Reimbursement	<u>40,499</u>				<u>23,442</u>	<u>17,057</u>
<b>Total</b>	<b>\$ 3,813,560</b>	<b>\$ 1,956,786</b>	<b>\$ 1,341,694</b>	<b>\$ 38,973</b>	<b>\$ 397,150</b>	<b>\$ 78,957</b>



# West Virginia Geological and Economic Survey Staff

## 2008

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Katherine E. Kapo, B.A. Statewide Coordinator  
Douglas G. Patchen, Ph.D. Chief Geologist

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Linda C. Carlier Administrative Assistant  
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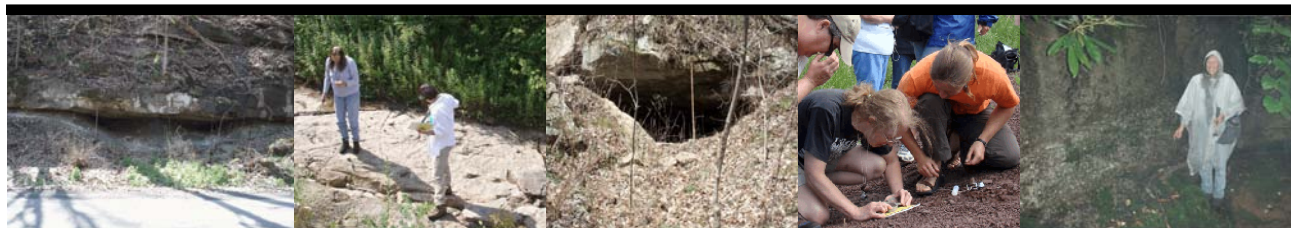
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\*Transferred within program during year

\*\*Left during year





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### STATEWIDE GEOGRAPHIC INFORMATION SYSTEMS COOPERATING AGENCIES

#### West Virginia GIS Technical Center West Virginia University Department of Geology and Geography

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