West Virginia
Geological Survey

2011 ANNUAL REPORT

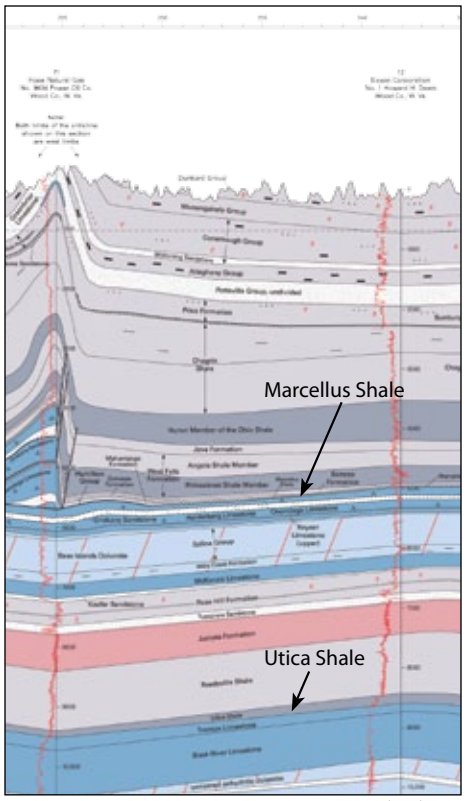
WEST VIRGINIA

MESSAGE FROM THE DIRECTOR

West Virginia's Gas Shales

The Marcellus Shale is a significant resource for West Virginia. A study by the U.S. Geological Survey conservatively estimates the recoverable volume of gas to be 18.7 billion cubic feet of gas. Most early completions in the Marcellus Shale occurred in the western counties of the state, and were usually vertical wells completed using conventional fracturing techniques. As geologists learn more about the characteristics of the Marcellus Shale, drilling activity has moved to the north-central counties in the state, where the formation is thicker and under greater pressure. In addition, companies more frequently drill horizontal wells and complete them by large-scale hydraulic fracturing.

We are beginning to see companies apply horizontal drilling and large hydraulic fracturing to reservoirs other than the Marcellus Shale. At the very least, shallower gas-bearing shale units will probably become targets for renewed drilling and application of these new technologies when economic and geological conditions are favorable. Devonian shale units such as the Marcellus have produced gas and oil for a hundred years. As the technology improves and if energy prices rise, it makes sense to apply efficient methods to older reservoirs where much gas probably remains.



U.S. Geological Survey

Geologic cross section through the Appalachian Basin at Wood County, West Virginia.

Interest is increasing in the even deeper Utica Shale in the northern part of the state. Many wells have been drilled in nearby Ohio and Pennsylvania where the Utica has produced oil and gas, as well as so-called "wet" gas. The Utica is fairly deep in our state, averaging about 4,000 feet below the Marcellus Shale in the northern panhandle, with the result that development may lag behind that in the adjacent states.

What is "wet" gas? The predominant ingredient in natural gas is methane, comprised of one carbon and four hydrogen molecules. Wet gas has more than minor quantities of hydrocarbons with two or more carbon molecules. These higher molecular-weight hydrocarbons can be separated from the methane and sent to a plant to create feedstock for industrial processes.

Our agency tracks the permitting and completion activity of all oil and gas wells in the state, and Marcellus Shale wells in particular. Our website has downloadable spreadsheets, maps and publications to inform the public, in addition to an interactive map that shows permitted wells, completed wells, thickness of the Marcellus and depth relative to sea level. As we learn more about the Utica, we will put similar information on our website.

Michael Ed. Hohn

Front cover inset photo: Devonian-age fossil crinoid *Technocrinus andrewsi* from a 10-ton chunk of Oriskany Sandstone donated by U.S. Silica, Berkely County, WV, in memory of Raymond Fox.

GENERAL GEOSCIENCE PROGRAM

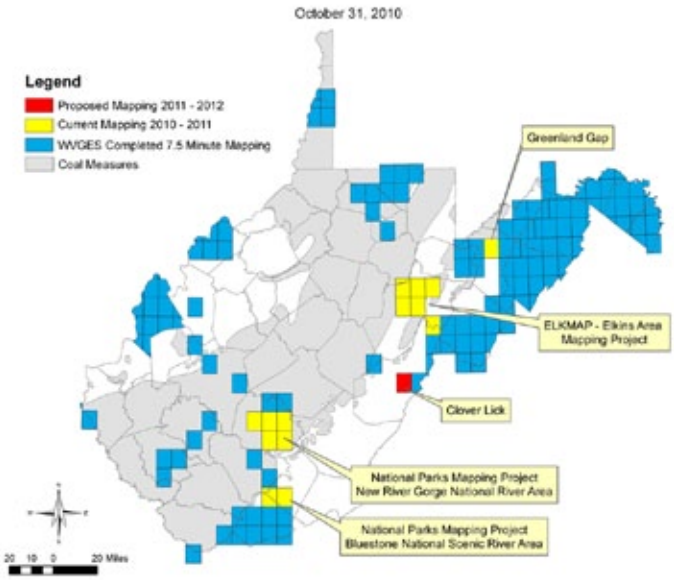
Geologic Mapping

Geologic Mapping at WVGES consists of two major components: the direct acquisition of new geological information through field reconnaissance and the digital conversion of existing geological information from hard copy (paper, mylar, etc.)

- Acquisition of new geological data is carried out under the auspices of the STATEMAP program funded jointly by the United States Geological Survey (USGS) and WVGES. In October 2010, the STATEMAP Advisory Committee, composed of individuals from industry, government and academia, met to evaluate two alternative mapping areas within West Virginia for the upcoming 2011 field season. During the summer and fall of 2010, field work was conducted on a single 7.5 minute topographic quadrangle in eastern West Virginia (Greenland Gap). Published as WVGES Open File Report, this data is currently available as a paper map; digital conversion of the map is complete and in the process of review. Field work on a new STATEMAP project (Clover Lick) began in June 2011.
- In August 2009, WVGES submitted a successful proposal to the National Park Service to map the geology of three Park units within the state of West Virginia. Over a three-year period, a consortium of geologists from WVGES, West Virginia University, and Concord University will map the bedrock and surficial geology of the Fayetteville, Thurmond, Beckwith, Winona, Danese, Prince, Meadow Creek, Hinton, Meadow Bridge, Talcott, Ansted, Summersville Dam, Flat Top and Pipestem quadrangles. These map areas cover park lands within the Gauley River National Recreation Area, the New River Gorge National River Area and the Bluestone National Scenic River Area. Final versions of the Ansted and Summersville Dam quadrangle maps were submitted to the Park Service in October 2010. Field work on the second year of this project began in the spring of 2011 with WVGES mapping teams working on the Fayetteville, Thurmond, Winona and Danese quads.
- Digital conversion of existing and future map information is a high priority at WVGES. During FY 2011, digital maps of the Ansted, Summersville Dam, Mannington, Paddy Knob and Mustoe (WV portions), Bethany, Tiltonsville, Ripley, Sissonville, Big Chimney, Louisa (WV portion), Fallsburg (WV portion), and Bramwell quads were completed.

Mine Pool Atlas Project

This two-year project, funded by the USEPA through the Division of Water and Waste Management (DWWM) of the Department of Environmental Protection (WVDEP), continues to evaluate abandoned coal mines as a source of stored ground water capable of providing large volumes of water for various private, public and industrial uses in West Virginia. To better understand the potential of this water source for development, WVGES is building a dynamic, interactive GIS to portray mine pools, the structure contour of the base of each coal seam, and an isopach of each coal seam. GIS tools are being used to estimate mine pool volumes from available WVGES Coal Bed Mapping Program (CBMP) mining and coal seam data. Available existing mine pool water quality data will be collected and linked to the GIS in the final phase of the project.



Geothermal Resources

WVGES is participating in a three-year project sponsored by the United States Department of Energy and the Association of American State Geologists to increase the publically available data on geothermal resources in all 50 states. During FY 2011, WVGES provided GIS-accessible versions of temperature logs, gravity and magnetic data. In addition, WVGES began working with engineering researchers from West Virginia University to acquire and make available direct measurements of thermal conductivity taken from drill core and cuttings currently held by WVGES.

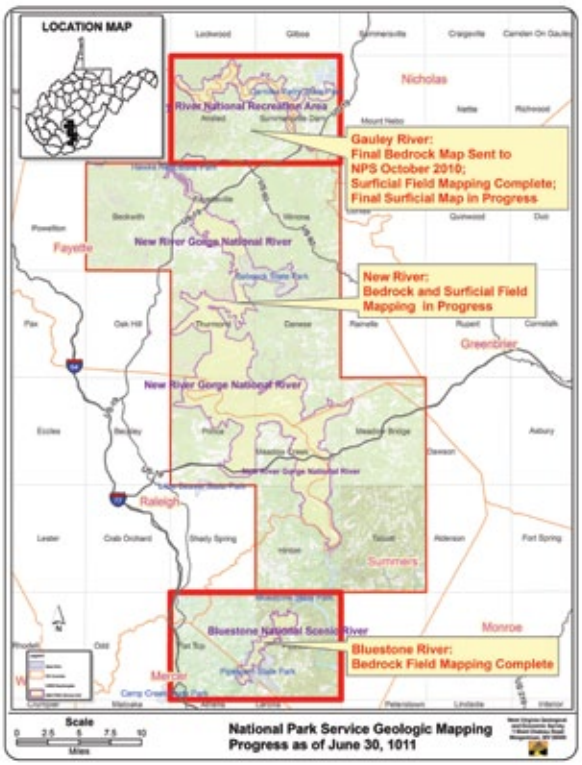
Environmental Geoscience and Geochemistry

Environmental and geochemical work at WVGES deals primarily with the evaluation of geologic site characteristics for Underground Injection Control (UIC) permits for injection of fluids into subsurface rock formations; the assembly of a database of selected metals content of the State's rock formations; and answering inquiries regarding geology, surface water, groundwater, geologic hazards and bedrock chemistry.

- Under West Virginia State Code §22-11-11, the Director of WVGES furnishes consultation to the State's Department of Environmental Protection (WVDEP) concerning UIC draft permits. During FY 2011, WVGES provided input regarding geologic conditions at injection sites for 28 Class V UIC draft permits.

Outreach Activities

- Geoscience personnel organized the WVGES Colloquium series which hosted four talks during the 2011 fiscal year. Speakers included academic and industry professionals. Topics ranged from GIS to natural gas and coal resources.
- In May 2011, Geoscience personnel authored or co-authored four posters presented at the USGS/AASG 2011 Digital Mapping Techniques Workshop held in Williamsburg, VA. Titles were: "Things You Used to Hate About Map Layout in Arc Have Changed: Attractive and Completed Maps Are Possible in ArcGIS!"; "Using the Magellan MobileMapper 6 and ArcPad 10 in the Field"; "Geology and History of a 19th and early 20th Century Industrial Complex: The Nuttall Mine and Nuttallburg, WV"; and "West Virginia Mine Pool Atlas - A Work in Progress".
- Geoscience personnel taught evening classes in Historical Geology at Fairmont State University.



OIL AND GAS PROGRAM

The Marcellus Shale

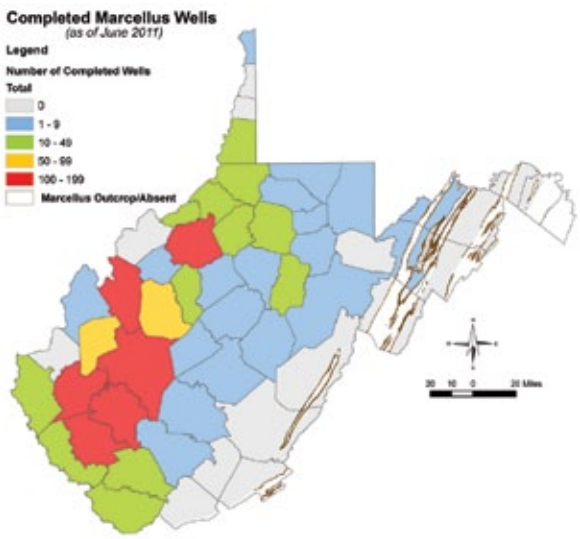
The Marcellus Shale continues to draw significant attention from oil and gas operators as a source of natural gas for large markets in the northeastern United States. Although much of the production to date has come from the southern and southwestern parts of the state, operators continue to expand the boundaries of the play, especially into the northern and northwestern parts of the state.

Historically, this organic-rich shale had been regarded as an important source of gas, but it wasn't until recently that its economic potential as a production reservoir also was recognized. In that sense, it is regarded as an unconventional gas play. Today, technological approaches that were largely employed in the Gulf Coast, such as horizontal drilling and hydraulic fracturing, are common practices for exploration companies operating throughout the Appalachian Basin.

The WVGES continues to regularly update an Interactive Mapping Service (IMS), accessible via its website, for the Marcellus Shale. This service gives users the opportunity to directly search for information concerning characteristics of the Marcellus formation (e.g., presence and depth) and information for specific completed and permitted wells. The Marcellus webpage also contains downloadable files of permitted and completed wells and cancelled permits. GIS shapefiles are available for several important geologic features and units, and links to several published resources are provided.

Through the end of fiscal year 2011 (i.e., June 2011), a total of 1,408 Marcellus Shale well completions had been processed by WVGES over the past nine years; there are 1,372 active permits-to-drill into the Marcellus Shale. The most active counties with completed wells at this time include Kanawha, Logan, Ritchie, Jackson and Lincoln (see map), mostly with vertical wells. New completion practices include developing horizontal completions in the northern part of the state, in the classic Marcellus Fairway.

WVGES staff members have responded to hundreds of inquiries about the Marcellus from private citizens, government officials and industry professionals interested in a wide range of issues, including property leases, environmental impacts and geologic characteristics of the formation. In addition to routine responses, WVGES geologists have made a number of presentations to various groups interested in this subject.



Carbon Sequestration

Carbon sequestration is receiving considerable attention as a means for reducing the quantity of carbon dioxide released into the atmosphere. The process of sequestration involves injecting carbon dioxide deep into underground reservoirs where it can be stored indefinitely.

Carbon dioxide is of particular interest since it is a natural by-product from the combustion of fossil fuels, especially coal, an important economic resource for West Virginia. Carbon dioxide has been shown to be a significant greenhouse gas that contributes to the entrapment of heat from the sun within the earth's atmosphere. By capturing and sequestering carbon dioxide in deep underground reservoirs, coal can effectively be utilized as a carbon-neutral source of fuel.

In many ways, the sequestration of greenhouse gases is similar to the production of oil and natural gas. Instead of being withdrawn from subsurface reservoir rocks, sequestration involves the charging of underground reservoirs with carbon dioxide. Both processes are dependent on low-permeability rock formations, known as seals, to cap the reservoirs and contain the gas or oil within them.

WVGES is an active participant in the Midwest Regional Carbon Sequestration Partnership (MRCSP), a group of industrial and government institutions dedicated to the selection and characterization of potential large-scale sequestration sites. The MRCSP is one of seven regional partnerships established by the U.S. Department of Energy.

The focus of the MRCSP Phase I research was identification of regional sources of carbon dioxide and storage opportunities. Phase II concentrated on further characterization of potential storage formations and small-scale field testing. The WVGES contributed significantly to several Phase II final characterization reports. Phase III work involves further reservoir characterization and a large-scale geologic field test. The WVGES will build on the characterization of prospective reservoirs and seals in Phase III by further defining the structural and stratigraphic characteristics of key sequestration target formations. WVGES also contributed to a study conducted by the West Virginia Division of Energy which studied the sequestration potential of several deep saline aquifers throughout the state, including the Oriskany, Newburg and Tuscarora Sandstones.

OFFICE OF GIS COORDINATION

The office made significant headway in a number of critical areas, including data sharing between agencies and providing technical assistance to state, local agencies and the public, while fostering the efficient and effective use of the state's geospatial capabilities.

Executive Order 10-10 issued in January 2011 formally established the State Office of GIS Coordination within the West Virginia Geological and Economic Survey and better defines the coordinator's duties and responsibilities. An updated Statewide GIS Strategic Plan approved in January 2011 articulates a strategic vision for the development and use of geospatial technology within state government and sharing of information with federal, local and private entities for the benefit of West Virginians.

Created in collaboration with the West Virginia GIS Technical Center, Rahall Transportation Institute, West Virginia State Tax Department Property Tax Division, county assessors and 911 directors, Cadastral GIS workshops were given at locations throughout West Virginia. These workshops are designed to inform, train and advise county and local government officials that have GIS programs in the latest technology and at the same time to educate those officials that have not embraced GIS technology in their own organizations. The OGC began development of a Statewide Cadastral Layer Business Plan in cooperation with Rahall Transportation Institute.

The coordinator continues to provide general administrative oversight of the Mineral Lands Mapping Program; new procedures suggested by the coordinator produced significant results.

The office provided technical assistance and advice to the Department of Environmental Protection, the Water Development Authority (WDA), the National Guard, the West Virginia Intelligence Fusion Center, the Division of Homeland Security and Emergency Management's Hazard Mitigation section, and other state and local agencies in their search of GIS contract services and/or GIS application development.

The coordinator attended sessions and presentations at the annual and mid-year National States Geographic Information Council (NSGIC) conferences in Cleveland, Ohio, and Annapolis, Md. The coordinator participated in sessions of the WVGIS Policy Council, the West Virginia Information Technology Council, the GIS Steering Committee, E911 Council, Green Infrastructure Committee and the Statewide Addressing and Mapping Board.

Broadband Mapping Project

The Office of GIS Coordination continues to have oversight over a National Telecommunications and Information and Administration Broadband Mapping Grant totaling 4.7 million dollars. The program, funded by the American Recovery and Reinvestment Act, aims to increase broadband access and adoption through better data collection and broadband planning. Besides being displayed in NTIA's national broadband map, data gathered under this program is displayed on a state interactive mapping application. This tool informs of policymakers' planning and build-up efforts and provides West Virginia citizens with improved information on the broadband Internet services available to them. The Broadband Mapping Program has three major components:

Technical Assistance Project: In partnership with the Appalachian Transportation Institute, the West Virginia GIS Technical Center, and the 11 Regional Planning Councils, the West Virginia Geological and Economic Survey Office of GIS Coordination undertakes community-level research to assess and investigate areas with low broadband adoption rates and then develops a statewide plan to improve broadband adoption. Partnering organizations will also provide direct technical assistance to the Broadband Deployment Council, and to Regional Planning Teams created under the program presented below, as well as to individual municipalities that may, for example, require a cost modeling assessment in order to apply for a grant or loan.

Local Regional Technology Planning Teams Project: This project supports local planning groups in each of the 11 West Virginia Planning and Development regions. Each planning and development region will host a regional council that will work with stakeholders to develop regional broadband awareness and adoption plans. As part of this work, each regional council will administer and analyze a survey designed to assess the opportunities for broadband-based economic development.

Mapping Project: This project was originally funded for broadband planning activities and two years of data collection. In September of 2010, this project was amended to extend data collection activities for an additional three years and to identify and implement best practices.

West Virginia Broadband Mapping Program: www.wvbmp.org

APPLIED COAL RESOURCES

Coal-bed Mapping Project (CBMP)

Survey geologists continue to progress on the Statewide GIS-based inventory of West Virginia's coal resources. These products are regularly updated and can be viewed on the Survey's website. This data is provided to the West Virginia Department of Revenue where the information is used to generate state tax revenues for the counties. Mapping has started in areas that are extremely difficult to correlate due to the geographic limited extent of coal beds and isolation of the region from the main coal field. Although key personnel have left state government for the private sector due to an increase in high-paying mineral industries jobs, current goals still should be met during the coming fiscal year.

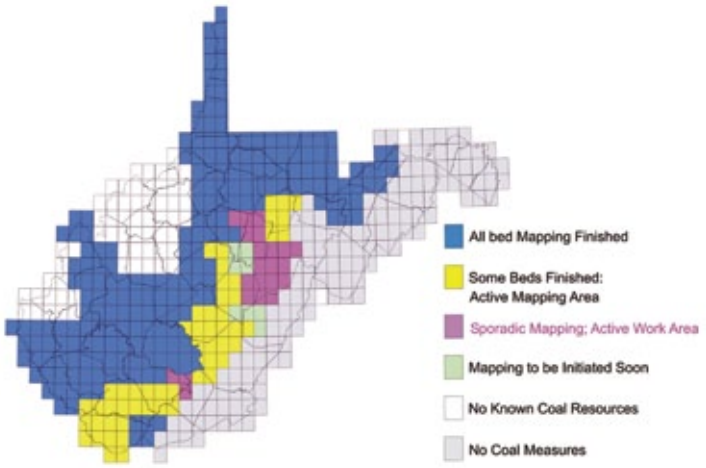
All stratigraphic data has been migrated into a new Oracle database on a provisional basis. Beta testing will begin this fall. We continue to add new data to our stratigraphic database through cooperation with industry contacts and other governmental agencies. These additions allow continual refinement of the various map products. All available data files have been scanned into a PDF format. We are exploring options of serving permissible data through the Survey's website.

Elkins Mapping Project

Survey coal geologists continue mapping five 7.5' quadrangles near Elkins: Junior, Elkins, Beverly West, Beverly East and the Sinks of Gandy. More than 1,600 geologic data points have been collected, geologic contacts have been drawn and the maps are being reviewed by Survey geologists. This project is producing 1:24,000 scale geologic maps in digital format for a part of the state that has received little attention since the early 1900s. Completed geologic maps will enhance ongoing efforts in nearby areas to update the state's geology. This project expanded into the Bowden quadrangle in May 2011.

Coal Quality

The Coal Program maintains a robust and growing computerized database of the chemical and physical characteristics of West Virginia coals. This database has been effective in aiding potential customers to identify specific West Virginia coals that meet their needs for power generation and to serve as chemical feedstock or as a source of coal-to-liquid applications. During the year we initiated a cooperative agreement with the Kentucky Geological Survey to analyze coal samples, enabling the Survey to continue collecting new coal samples from areas of the state that are currently poorly represented in the databases.



National Coal Resources Data System (NCRDS)

This long-running cooperative research initiative between the U.S. Geological Survey and WVGES Coal Program has enabled both partners to maintain and grow their respective coal databases. In addition to facilitating important research on various aspects of coal, coal mining and resource analyses, the cooperative has resulted in the collection of valuable data on the occurrence, distribution and quantities of various trace elements found in West Virginia's coal measures. This program has been continued for an additional year.

Underground Mine Mapping Project

Coal Program geologists, in conjunction with West Virginia's Office of Miners Health, Safety and Training (OMHST) continue to expand the large collection of coal mine maps by obtaining previously unavailable historic maps from various repositories. The footprints of newly obtained maps are digitized and added to the Survey's coal bed GIS. Ancillary information is entered into WVGES' stratigraphic database for use in the statewide coal bed GIS. Footprints of active mine areas are updated annually. Additional mine maps received from other state agencies and industries are added to the database.

Mine Information Database System

The Mine Information Database System (MIDS) is updated as new mine maps become available. MIDS contains records of every mine map available at the WVGES and is comprised of more than 44,000 documents depicting more than 71,000 mines. Submissions and comments from online users are requested to make the system more complete and user-friendly.

WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY

Principal Staff Directory and Points of Contact
January 2012

Director and State Geologist	*Michael Ed. Hohn*
Deputy Director Finance and Administration	*John D. May*
GIS Program and Statewide GIS Coordinator	*Tony Simental*
Coal Resources	*Bascombe M. Blake, Jr.*
Geoscience Education	*Thomas E. Repine, Jr.*
Mapping	*Ronald R. McDowell*
Oil and Gas Resources	*Mary C. Behling*
Water Issues and Geologic Hazards	*Jane S. McColloch*
Computing Services and Publications	*Mary C. Behling*
Earth Science Information Center	*Paul R. Liston*
Public Service	*Kenneth C. Ashton*
Publication Sales	*Michael A. Kirk*

West Virginia Geological and Economic Survey
Mont Chateau Research Center

1 Mont Chateau Road • Morgantown, W.Va. 26508-8079
304.594.2331 • fax: 304.594.2575
www.wvgs.wvnet.edu • info@geosrv.wvnet.edu

Charleston GIS Coordinator: 304.558.4218 • fax: 304.558.4963 • www.gis.wv.gov

Hours: 8:00 a.m. to 5:00 p.m. Monday through Friday *(closed holidays)*