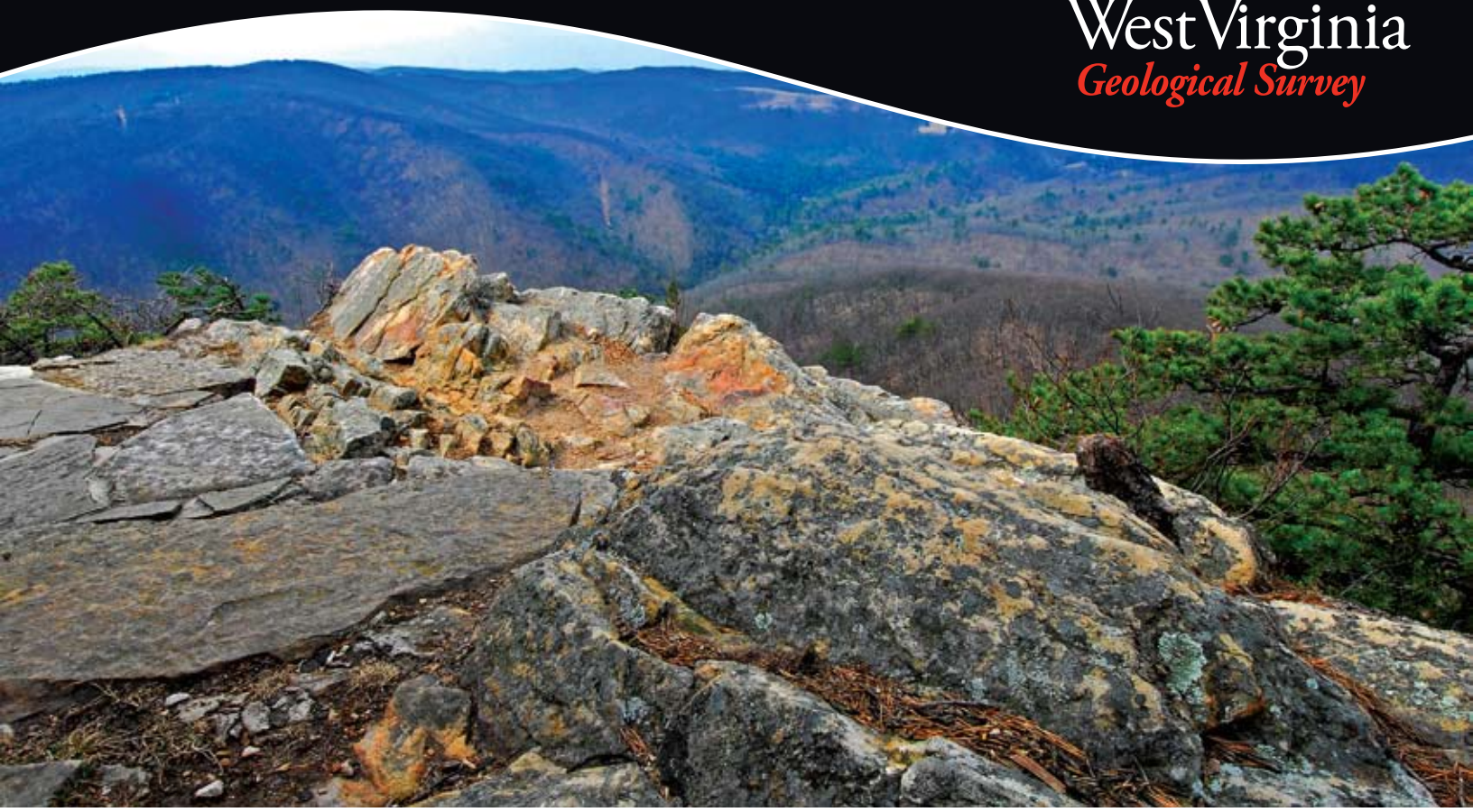
West Virginia
Geological Survey



2009 ANNUAL REPORT

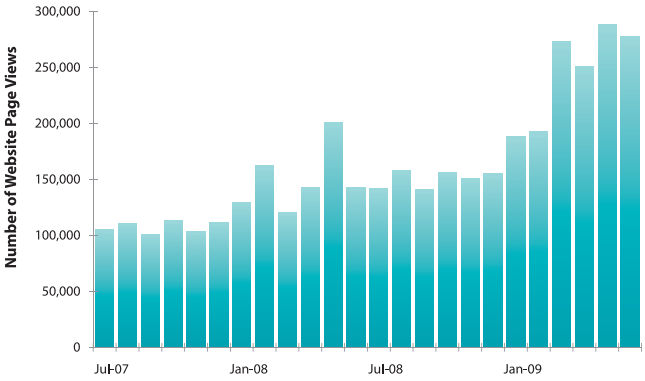
WEST VIRGINIA

MESSAGE FROM THE DIRECTOR.

Geology is in the news in West Virginia, from coal and carbon sequestration to exploration for natural gas in the Marcellus Shale. The Geological and Economic Survey provides information on these and other subjects in the area of energy resources within the state through our websites, publications, and answers to queries received by phone, e-mail, or in person. We also conduct research to back up our service to the public.

Accomplishments related to energy resources in the 2009 fiscal year include:

- Introduction of a Marcellus website that includes interactive maps and basic data.
- Introduction of an oil and gas well website that allows users to zoom in, select individual wells or groups of wells, display basic well information, and view well locations on a map.
- Continued study of carbon sequestration opportunities in the state through:
  - » Cooperative work in the Midwest Region Carbon Sequestration Partnership.
  - » Researching the Oriskany Sandstone and Helderberg Group as potential sequestration targets.
  - » Cooperative work with The Geology and Geography Department at West Virginia University for the WV Department of Commerce Division of Energy.
- Mapping significant coal beds in the state, with about 55% of the area underlain by mineable coal now complete.
- Completion of an interactive website for tight gas formations in the state, with maps, digitized well logs, photographs of cores, and access to basic well information.



A measure of the quality of our work is the amount of financial support we receive from other state and federal agencies. For instance, the U.S. Department of Energy provided significant funding for the carbon sequestration work performed through the Midwest Region Carbon Sequestration Partnership and for the new Marcellus Shale and tight gas formation web pages.

The particular beauty of the tight gas formation web pages is the capacity for us to display maps of well locations by play (reservoir); scanned well log images; published, open file, and working copies of maps and cross sections; photographs of cores; and to tie these resources with our online oil and gas well data system. We have created an award-winning online repository of disparate types of information. However, unlike a traditional library, where maps, oversized books, and cross sections must be located on different shelves or different rooms entirely, these research materials are linked seamlessly in a single place, accessible from home or office.

With each new or enhanced web feature introduced, the number of page downloads increases, as shown by the chart. In large measure, web resources are supplanting traditional ways of disseminating information such as publishing maps and responding directly to inquiries from business, industry, schools, government agencies, and the public. People expect to find information available online, just as they expect a serious business to have a web presence. Meanwhile, our conventional publications are still available, in many cases as scans of the original paper copies if the reader prefers.

Michael Ed. Hohn

APPLIED COAL RESOURCES

Coal-bed Mapping Project (CBMP)

Survey geologists continued to make progress on the statewide GIS (Geographic Information Service) based inventory of West Virginia's coal resources. GIS layers, by seam, include: structural contours; outcrops; mined areas; isopachs; percent partings; and coal quality. These products are regularly updated and can be viewed on the Survey's web site. These data are provided to the WV Tax Department where the information is used to generate state tax revenues. Taxes received by this information are used to fund many important parts of the State's infrastructure, most notably, the education system.

Elkins Mapping Project

Beginning in the summer of 2008, survey coal geologists have been mapping a four quadrangle area near Elkins; Junior, Elkins, Beverly West, and Beverly East. The goal of this project is to produce 1:24,000 scale geologic maps in digital format for a part of the State that has received little attention since the early 1900s. The final geologic maps will enhance on-going efforts in nearby areas to update the state's geology.

Coal Quality

The Coal Program maintains a robust computerized database of the chemical and physical characteristics of West Virginia coals. This useful database has proven to be very 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.

National Coal Resources Data System (NCRDS)

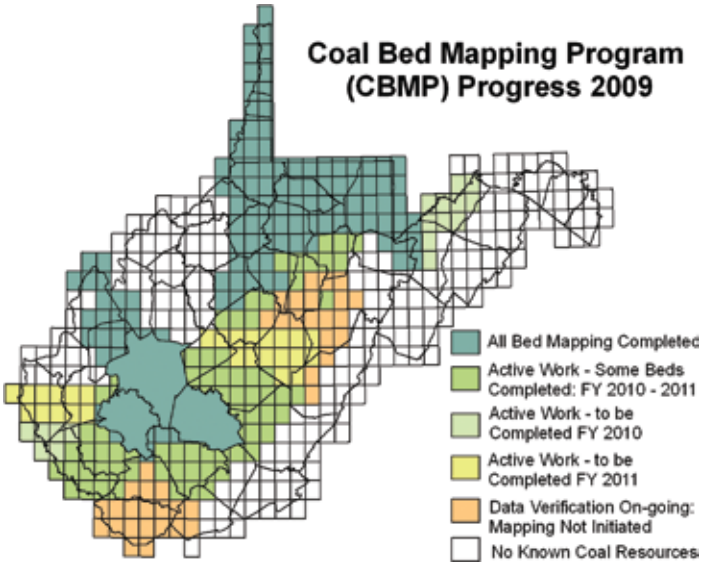
This long-running cooperative research initiative between the U.S. Geological Survey and WVGES Coal Program has enabled both partners to maintain and grow their respective coal databases. In addition to facilitating important research on the various aspects of coal, coal mining and resource analyses,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

Underground Mine Mapping Project (UMMP)

Coal Program geologists, in conjunction with West Virginia's Office of Miners, Health, Safety and Training (MHST), finished compiling underground coal mine polygons. This work involved the review of historical, recent and active underground mine map documents. Upon evaluation, the footprint of coal mines are digitized into the coal bed GIS and ancillary information is entered into WVGES' stratigraphic database for use in the comprehensive coal bed GIS. These data are constantly updated as MHST uncovers additional mining data.

Mine Information Database System

In 2008, work was completed on WVGES' new Mine Information Database System (MIDS). The MIDS database contains information on mine maps, including bed mined, mine names, company names, location information and permit numbers. MIDS contains records of every mine map available at the WVGES and comprises over 43,000 documents representing over 69,000 mines. The system is continually updated as new information becomes available.



GENERAL GEOSCIENCE PROGRAM

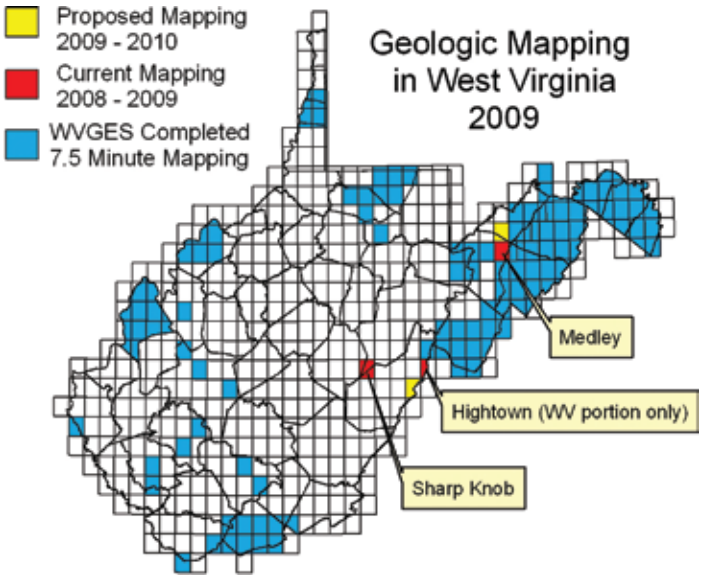
Geologic Mapping

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. 2009 field work was conducted on three 7.5 minute topographic quadrangles in eastern West Virginia (Hightown, Medley, and Sharp Knob). Published as WVGES Open File Reports, these data are available as paper maps; digital conversion of each map is either complete or in progress. Fieldwork on three new STATEMAP projects (Antioch, Paddy Knob, and Mustoe) began in May 2009.
- Digital conversion of existing and future map information is a high priority at WVGES. The final version of Bedrock Geology of Canaan Valley, a four-quadrangle map compilation, was completed in September 2008. During FY 2009, digital maps of the bedrock geology of the Burlington, Circleville, Thornwood, Cow Knob, Hightown, Medley, and Milam 7.5-minute quadrangles and the surficial geology of the Romney 7.5-minute quadrangle were completed. Digitizing and further processing of six Mercer County 7.5-minute geologic quadrangle maps (Athens, Bluefield, Lerona, Matoaka, Oakvale, and Princeton), which began in May 2008, is ongoing and scheduled for completion in FY 2010.

WVGES organized the 13th Annual Digital Mapping Techniques Workshop (DMT09), held May 10-13, 2009, in Morgantown, WV. The annual workshop is sponsored by the U.S. Geological Survey (USGS) and the Association of American State Geologists (AASG) to facilitate communication and transfer of training primarily between government agencies that produce digital geologic maps. This year's workshop featured 17 oral and 23 poster presentations and 3 discussion sessions that detailed many aspects of digital mapping. Ninety scientists, cartographers, and GIS specialists from 29 states, Washington, D. C., four Canadian provinces, and the United Kingdom participated in the workshop. For more information, visit: http://ngmdb.usgs.gov/Info/dmt/DMT09presentations.html.

Two posters about digital mapping were presented at the annual meeting of the American Association of Petroleum Geologists (AAPG), June 7-10, 2009, in Denver, CO.



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.

Environmental Geoscience and Geochemistry continued…

- 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 2009, WVGES provided input regarding geologic conditions at injection sites for 44 Class V UIC draft permits.
- Analyses of 25 geochemical samples collected during field reconnaissance were added to the existing geochemical database bringing the total number of analyses to just over 900. The database currently contains geochemical information on approximately 90% of the state's bedrock formations, exclusive of the coal bearing strata. A poster describing the creation and maintenance of the geochemical database was presented at the 24th International Applied Geochemistry Symposium, June 1-4, 2009, in Fredricton, New Brunswick, Canada.

Outreach Activities

- Geoscience personnel organized the WVGES Colloquium series which hosted eight talks during the 2008 fiscal year. Speakers included academics, industry professionals, and WVGES staff members. Topics ranged from the Marcellus Shale to travels to Nepal and Iceland.
- Geoscience personnel taught evening classes in Environmental and Historical Geology at Fairmont State University and gave several lectures on volcano-logical researches in Hawai'i, Peru, and Vanuatu to home-schooling students.
- Two K-12 teachers from Pocahontas County, WV were hired as geological field assistants for the 2008 and 2009 mapping seasons. In addition, two undergraduate geology students, one from West Virginia University and one from Concord University, were employed as geological interns for the 2008 field season.

OIL AND GAS PROGRAM

The Marcellus Shale

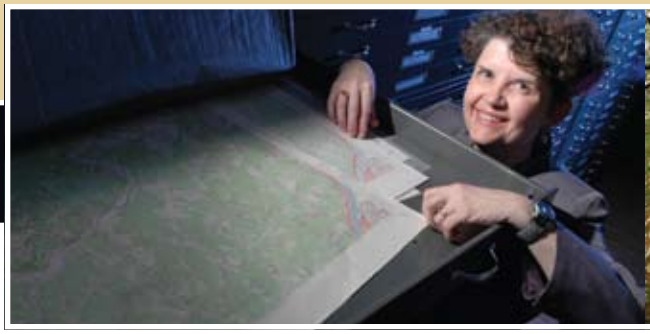
The Marcellus Shale has attracted a great deal of attention in the last few years as oil and gas operators explore for new sources of natural gas in locations close to the large markets in the northeastern United States.

The organic-rich Marcellus has long been viewed as a source of much of the natural gas produced to date in the Appalachian Basin. Until recently, the Marcellus had not been thought of as a reservoir as well as a source rock. New technological advances developed in other shale basins such as the Barnett in the Fort Worth Basin, Texas, have been adapted for use in the Marcellus. The new technologies include horizontal drilling and massive hydraulic fracturing. Interest in the Marcellus in West Virginia, Pennsylvania and New York has drawn companies from other parts of the US and the world to lease land, acquire companies with acreage positions often held by shallower production, and begin to drill both vertical and horizontal wells to evaluate the gas potential of the Marcellus.

The WVGES created an Interactive Mapping Service, accessible on via the website, specifically for the Marcellus, to give users an idea of where the Marcellus is present, about how deep it is and about how thick it is. Also, a layer on the interactive map shows wells targeting the Marcellus. In addition, downloadable files of the individual well data are available on the website. Support for these efforts has been provided in part by the US Department of Energy.

More than 2700 wells have been identified as targeting the Marcellus. Records for about 1300 of these wells have been received. More than 1000 of these wells have a reported pay interval in the Marcellus. Over 26 Bcf of gas production is reported from these wells for 2005-2008. About 160 of the permitted wells have been cancelled.

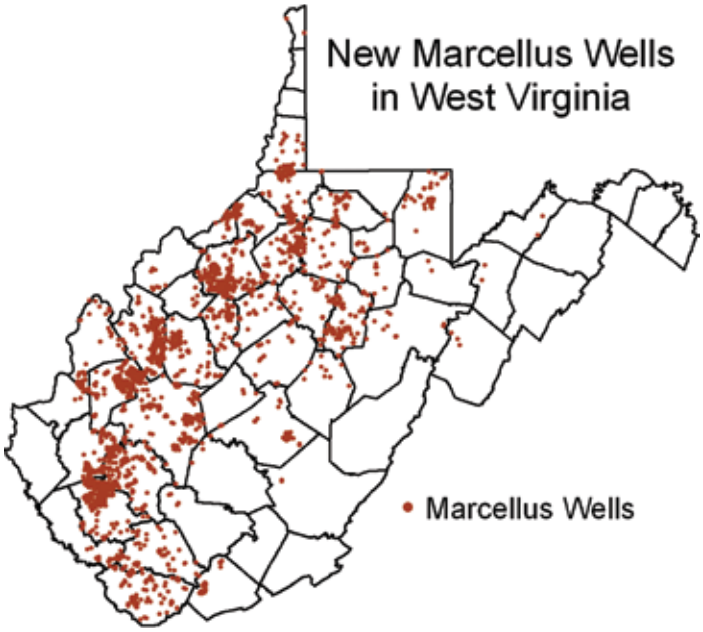
The WVGES has responded to hundreds of inquiries about the Marcellus from a broad spectrum of customers, ranging



OIL AND GAS PROGRAM CONTINUED...

The Marcellus Shale continued...

from citizens who have been approached about leasing their property to oil and gas company employees looking for geologic data in their quest to evaluate the Marcellus. In addition to responding to individual visits, phone calls and e-mails, WVGES geologists have also made a number of presentations to various groups about the geology of the Marcellus. These groups have included the Eastern Section of the American Association of Petroleum Geologists/Eastern Region of the Society of Petroleum Engineers, the West Virginia Highlands Conservancy, the West Virginia Chapter of the Society of American Foresters, the Pittsburgh Association of Petroleum Geologists, and the Developing Unconventional Gas Conference.



WVGES INTERACTIVE MAPPING SERVICES

The Geological Survey has created publicly-available, web-based interactive mapping services for coal, oil and gas, and a topographic map applications. These services are products resulting from the agency's ongoing work on these resources.

Among the coal services are:

- **All Mining Map,** with general information pertaining to all of the types of mining within the State;
- **Coal Bed Mapping Project Maps,** with more than 60 coal beds arranged in stratigraphic order and including mining activity, net coal thickness, and other features; and
- **Pocahontas Formation Combined Maps,** a prototype service for all of the coal beds within a specific formation.

The oil and gas services include:

- **West Virginia Oil and Gas (WVOG),** with locations and specific data for 145,000 wells, linking to our comprehensive well database;
- **Appalachian Basin Tight Gas Plays,** featuring six tight gas clastic plays in West Virginia and Pennsylvania and including play-based map layers, wells penetrating the plays, cross-sections, play documents, references, logs, core photos, etc.;
- **Geology of the Marcellus Shale,** a reservoir of current exploratory and development interest for gas resources in the state;
- **Regional Geology of the Ordovician Trenton-Black River Formations,** a resource-assessment model for these carbonate formations in five Appalachian basin states;
- **Selected Appalachian Region Oil and Gas Wells,** displaying selected historic and recent unconventional wells in eight states in the Appalachian basin.

The **Topographic Map Index** enables users to view and identify specific 7.5' quadrangles from a tiled topographic map of the state.

These services and further information may be accessed at http://ims.wvgs.wvnet.edu/index.html.

WVGES developed two geology of the state park guides ($5.95 each) to help visitors identify the visible rock units.

Please visit WVGES's publications page (www.wvgs.wvnet.edu/www/services/servpubc.htm) for a complete list of maps and other publications available to the public. Or call us at (304) 594-2331 to order your copies.

OFFICE OF THE GEOGRAPHIC INFORMATION SYSTEM COORDINATOR

The office fostered efficient and effective use of the State's geospatial capabilities and 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.

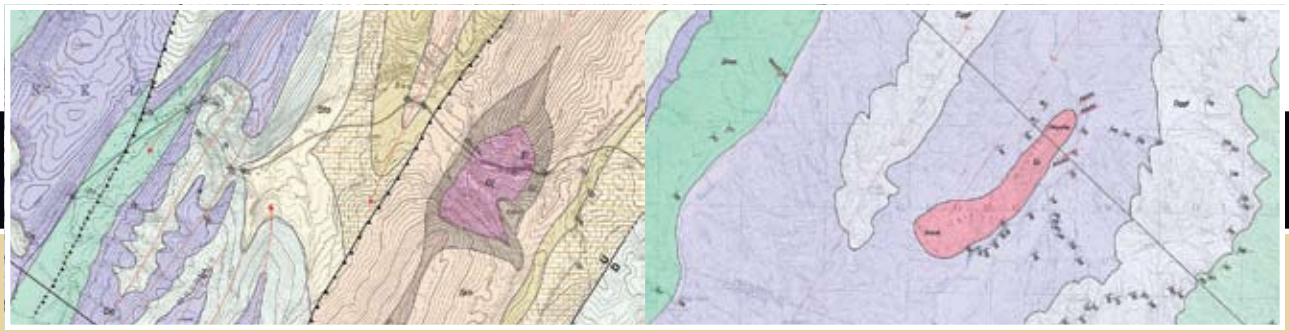
The office was instrumental in jumpstarting the GIS State Strategic Plan updating efforts by the GIS Steering Committee. The updated Plan, a critical component of the GIS Program, will articulate a strategic vision for the development and use of geospatial technology within state government and sharing of information with federal, local and private entities for the benefit of West Virginians.

The GIS Coordinator provided general administrative oversight of the Mineral Lands Mapping Program (MLMP). In collaboration with the Coal Bed Mapping Project and the Property Tax Division, the coordinator reviewed the MLMP mapping process and suggested new procedures designed to speed up the program.

The office provided technical assistance and advice to the Water Development Authority (WDA), the Division of Homeland Security and EM's Hazard Mitigation section, and other state and local agencies in their search for GIS contract services by participating in every step of the contractor/ vendor selection process.

The GIS Coordinator began a series of Cadastral GIS workshops in collaboration with the WV GIS Technical Center, Nick J. Rahall II, Appalachian Transportation Institute, Property Tax Division, County Assessors and 911 directors. 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 workshops emphasize inter-agency collaboration and are given at locations throughout WV.

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



WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY

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January 2010

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