

# West Virginia Geological and Economic Survey

# ANNUAL REPORT

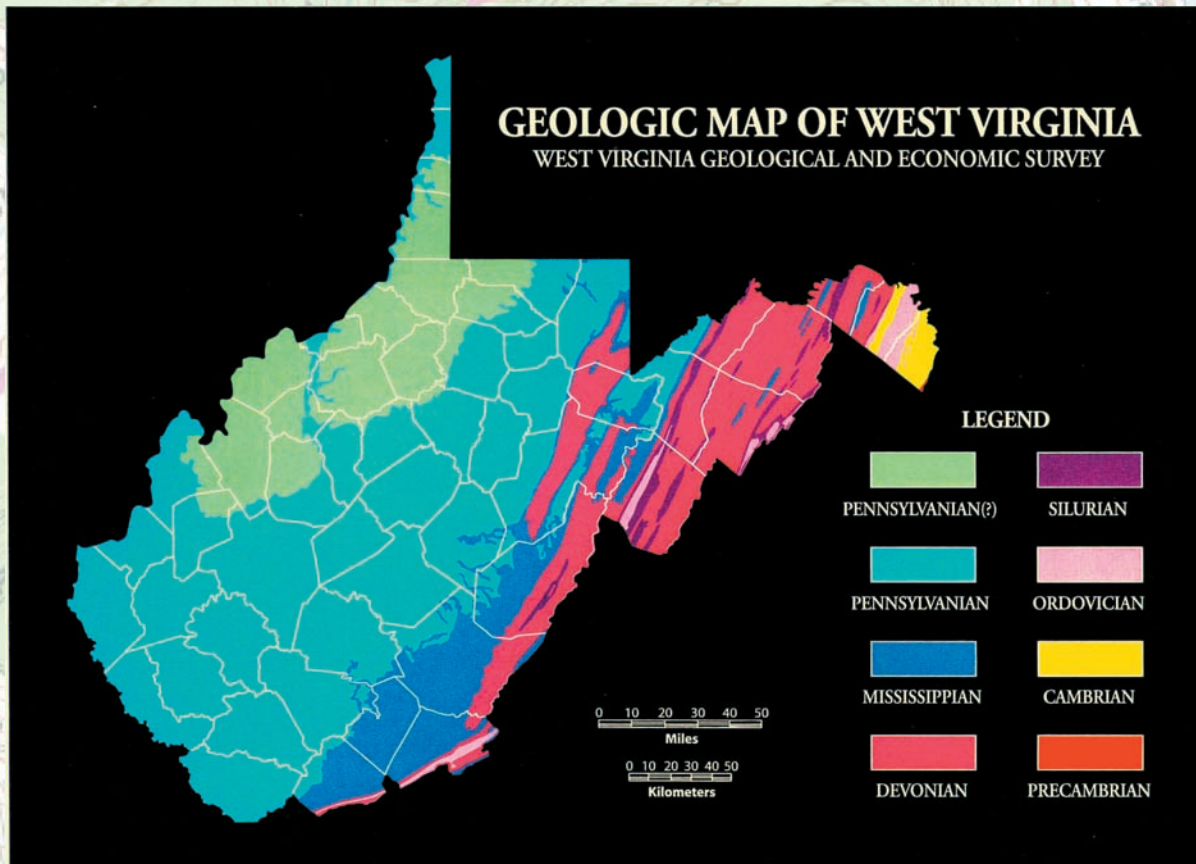
Fiscal Year 2006



STATE OF WEST VIRGINIA  
Joe Manchin III, *Governor*

BUREAU OF COMMERCE  
Kelley Goes, *Secretary*

GEOLOGICAL & ECONOMIC SURVEY  
Michael Ed. Hohn, *Director and State Geologist*



**WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY**  
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**February 2007**

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Earth Science Information Center	<i>Paul R. Liston</i>
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## THE WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY

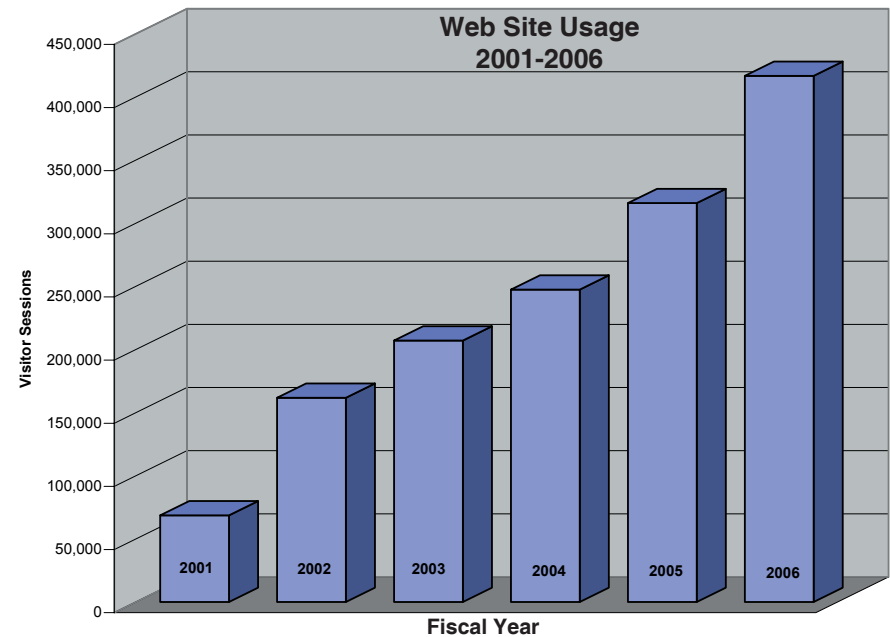
The mission of the Geological and Economic Survey is to acquire and make publicly available a detailed knowledge of the geology, mineral, energy, and water resources of West Virginia for the benefit of all citizens. We carry out this mission through three geologic programs—Applied Coal Resources Investigations, Applied Oil and Gas Resources Investigations, and General Geoscience; a service and outreach program—Public Service; and an Information Transfer program. In addition, this agency is the home for the Statewide Geographic Information Systems Coordinator.

The Applied Coal Resources Investigations Program investigates the quantity, quality, utility, location, mining, and geologic history of coal and coal-bearing rocks in West Virginia, resulting in databases, maps, reports, and consultation. The Applied Oil and Gas Resources Investigations Program compiles and distributes information on oil and gas resources in the State by maintaining a computer database, conducting research, publishing maps and reports, and consulting with the public and industry. Through field work, research, service, and outreach, the General Geoscience Program provides information and expertise on environmental geology, hydrology, geologic mapping, geochemistry, and resource assessment. Within this program, the Geoscience Education Project improves and enhances the ability of West Virginia teachers to provide their students with a meaningful and relevant understanding of West Virginia's natural resources.

The Public Service Program responds directly to citizen inquiries and distributes results of the Survey's research and provides help with, and interpretation of, those results as needed. The program provides a regional point of contact and access to a wealth of technical data about West Virginia generated by Survey employees and other sources.

The Information Transfer Program provides and maintains programming and geotechnical information support for agency staff and facilitates accumulation, documentation, and categorization of the results and interpretations.

We continue to support these programs through a combination of direct State general revenue funding, special revenue, and federal revenue through grants and contracts. We strive to carry out top-quality research and service. Recognition of our success comes in part through the outside funding we obtain through competitive proposals and requests for work from other government agencies.



Important milestones this year were completion of two projects funded indirectly by the U.S. Department of Energy: creation of a regional study of the Trenton-Black River limestones in the Appalachian geologic basin; and phase 1 of the study of carbon dioxide sequestration. Both projects are important to the future of energy production in West Virginia. The Trenton-Black River limestones comprise a deep reservoir of potentially large quantities of natural gas, and studies of this type provide information needed by the petroleum industry in using this valuable resource. Concern over global warming motivates the study of carbon sequestration in geologic reservoirs, one way in which coal remains an affordable and widely used source of energy.

This agency continues to carry out projects in cooperation with other State agencies. The largest such project for several years has been to map coal beds throughout West Virginia. In cooperation with the West Virginia Department of Tax and Revenue and the West Virginia University Department of Geology and Geography, the project has seen completion of all coal-bed mapping for 10 counties, and near-completion for three more.

This year has seen changes in our agency, including the retirement of Carl J. Smith, Director and State Geologist since 2001. Since my

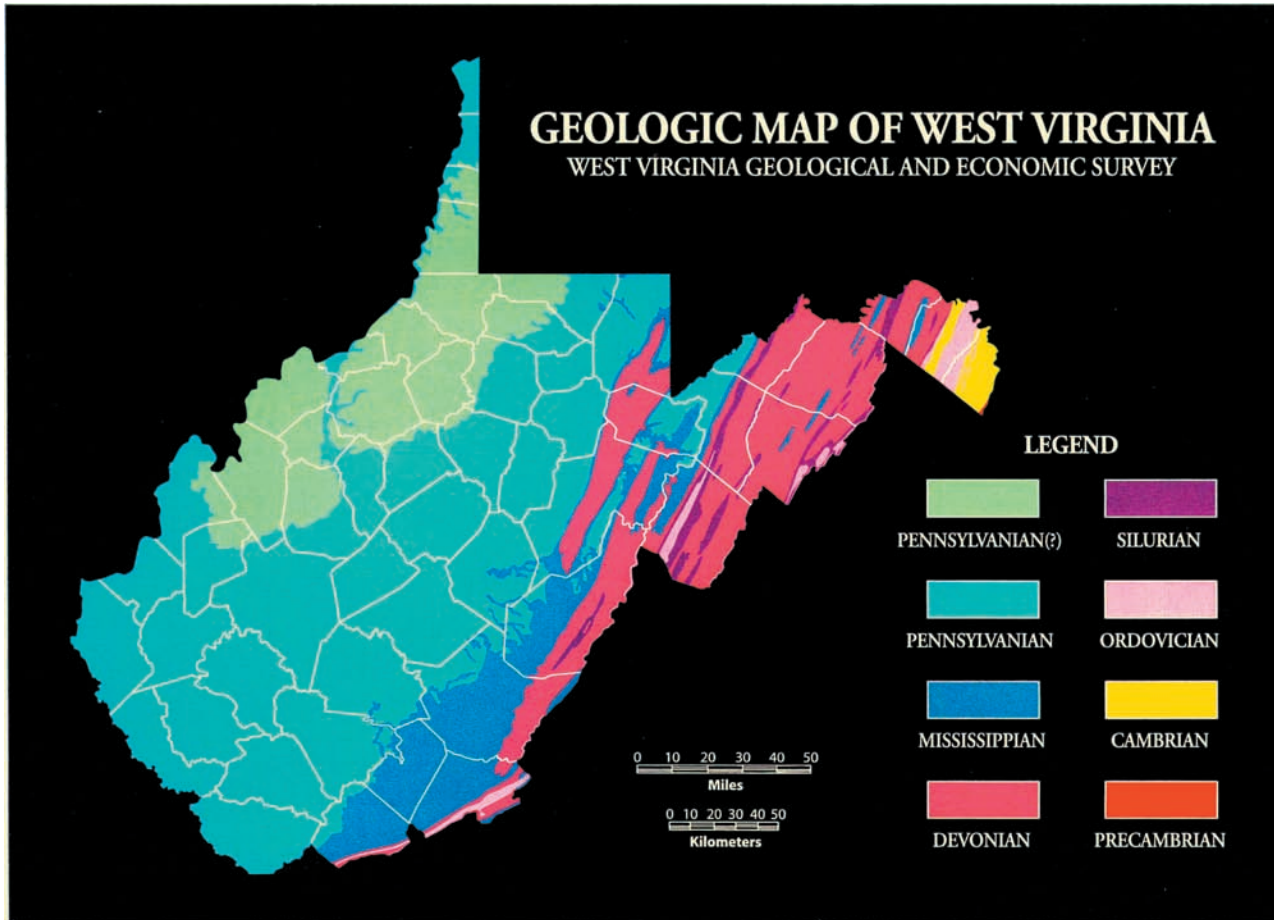


own appointment, I have tried to build on the accomplishments of my predecessors, and also to examine the scope and nature of our work, and how it is presented to the public. To this end, we carried out a customer and stakeholder review of our operations, asking representatives of the private sector, other West Virginia State agencies, educators, and other geological surveys in states adjacent to our own, what they thought we did well, what could be improved, and what we should not be doing. Above all, we want to be responsive to our base of customers and stakeholders.

Let me conclude with a few statistics. We continue to move away from traditional publications on paper and toward increased availability of

data, maps and reports on electronic media or through the World Wide Web. In fiscal year 2005-2006, we saw over 400,000 visitor sessions on our web site, up from 316,000 the previous year. We scanned 31 legacy publications as old as 1900—still in demand from our customers—for sale on electronic media. In addition, we continued to move geologic maps from open-file reports to finished, color maps available on demand.

Michael E. Hohn,  
Director and State Geologist



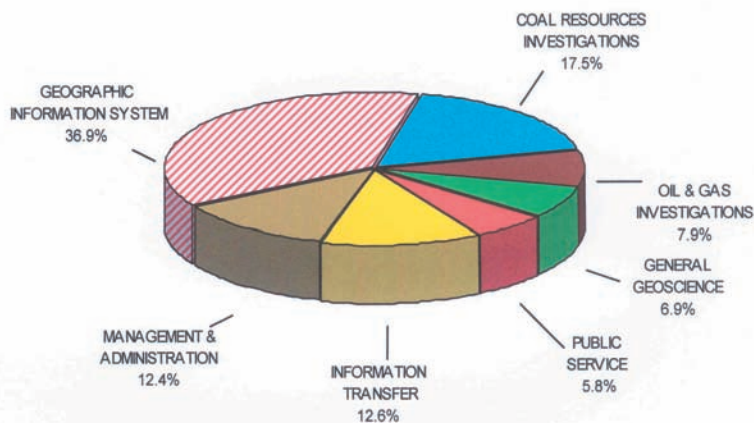
This postcard of the State's geologic map (also shown on this report's cover) is available free from the Survey's Publication Sales Office.

# FINANCIAL INFORMATION

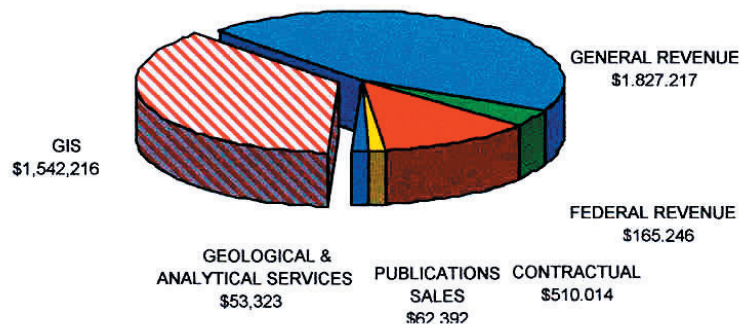
## Funding Overview

The Geological and Economic Survey encompasses seven major programs (Figure 1) that are supported through a combination of State, federal and other funding sources (Figure 2). In addition to funding for basic operations from general revenue appropriations, the agency is supported by funds dedicated to specific areas of research from supplemental general revenue, federal cooperative agreements, contracts and revenue-generating operations.

**Figure 1  
PROGRAM EXPENDITURES  
FY 2005-2006**



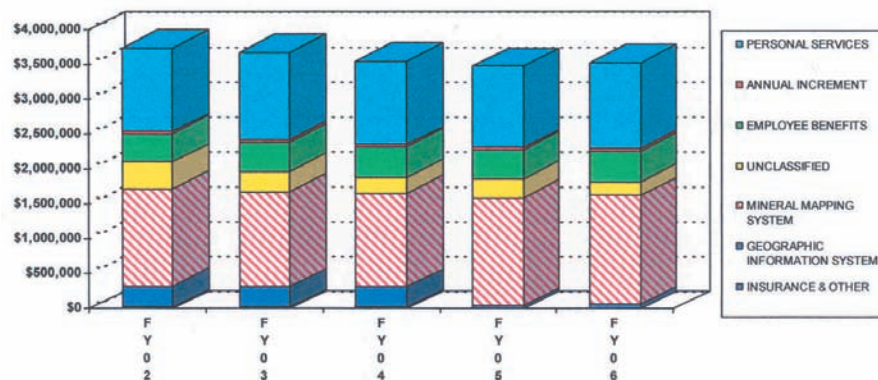
**Figure 2  
EXPENDITURES BY SOURCE OF FUNDING  
FY 2005-2006**



## General Revenue

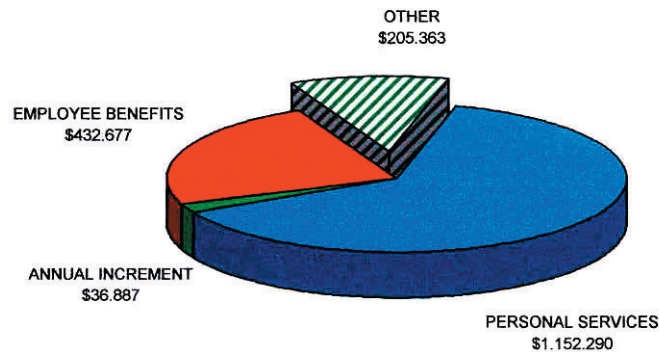
Most agency funding is provided through general revenue appropriations. In fiscal year 2005-2006, approximately 54 percent of general revenue was dedicated to support agency operations, with the balance funding the Statewide Geographic Information System (GIS). In comparison to other funding sources, general revenue has remained relatively stable, decreasing by only 5.6 percent in the past five years (Figure 3).

**Figure 3  
GENERAL REVENUE APPROPRIATIONS  
FY 2002-2006**

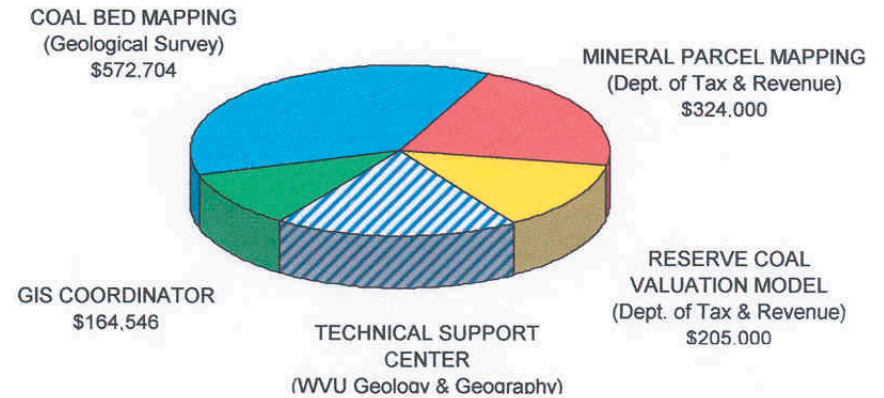


As the Survey is a human resources-intensive agency, most of its non-GIS general revenue appropriations underwrite the costs of personal services, annual increments and employee benefits. In fiscal 2005-2006, personal services-related expenditures accounted for 89 percent of all non-GIS general revenue expenditures, with the remaining funds applied to operational expenses.

**Figure 4**  
**GENERAL REVENUE EXPENDITURES**  
**(Exclusive of GIS Appropriations)**



**Figure 5**  
**ALLOCATION OF GIS APPROPRIATIONS**  
**(\$1,561,250)**



Year-end expiring appropriations (unexpended balances that are returned to the State's general fund) totaled \$103,835, an amount resulting from federal reimbursements for personal services, employee benefits, and indirect costs.

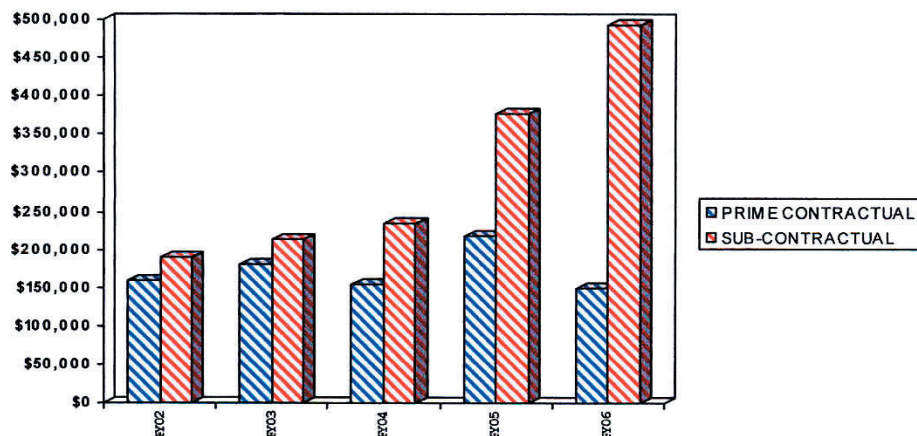
Expenditures for the Geographic Information System accounted for approximately 46 percent of total general revenue outlays in fiscal 2005-2006. The Survey serves as the lead and fiscal control agent in this joint program with the Department of Tax and Revenue and the West Virginia University Department of Geology and Geography. Approximately two-thirds of GIS appropriations are passed through to the other cooperating State agencies. The remaining one-third is allocated to the Survey's participating GIS research group, the Coal-bed Mapping Project. Fiscal 2005-2006 general revenue funding (Mineral Mapping appropriation) totaling \$1,561,250 was allocated for GIS-participating agencies as shown in Figure 5.

### Federal Programs

Direct federal funding for cooperative agreements with the U.S. Department of Interior's U.S. Geological Survey (USGS) have remained steady over the past five-year period. In contrast, sub-contractual funding for U.S. Department of Energy (USDOE) and the U.S. Department of Labor contracts has risen dramatically over the same period (Figure 6).



**Figure 6  
FEDERAL FUNDS RECEIPTS**



While it is anticipated that the USGS programs will be continued at present levels of funding, the elimination of USDOE's Fossil Fuels Program in the fiscal 2007 federal budget currently under consideration in Congress would result in a reduction of up to 75 percent of sub-contractual receipts to the Survey. As a consequence, the Survey would forgo annual reimbursements for salaries, benefits, and indirect costs of approximately \$180,000.

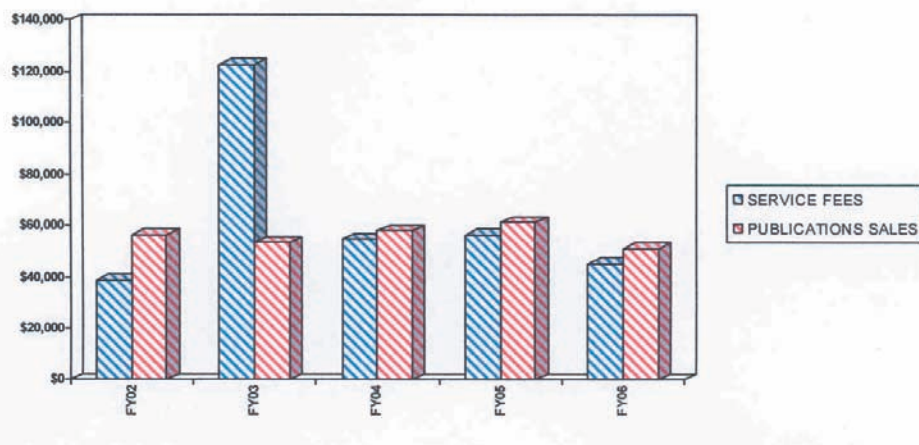
### Sales Revenues

Funds have been generated through the sales of publications and geologic services (Figure 7). Sufficient balances of sales receipts are maintained to defray agency operational costs associated with these revenue-producing activities.

Publication sales products include maps, books, reports and other agency documents reproduced on a variety of media (photo static, blackline and well-log copies, microfilm, CDs, pre-formatted diskettes, etc.). Fiscal 2005-2006 net sales receipts totaled \$51,008, a decrease of 17 percent from the prior year.

The establishment of equitable fees to be charged to users for geological services has facilitated recovery of incremental costs associated with the performance of services. Fiscal 2005-2006 service fees collected totaled \$44,912, a decrease of 20 percent from the prior year.

**Figure 7  
SALES REVENUES**



**WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY**  
**Consolidated Statement of Expenditures**  
**For the Period July 1, 2005 through June 30, 2006**

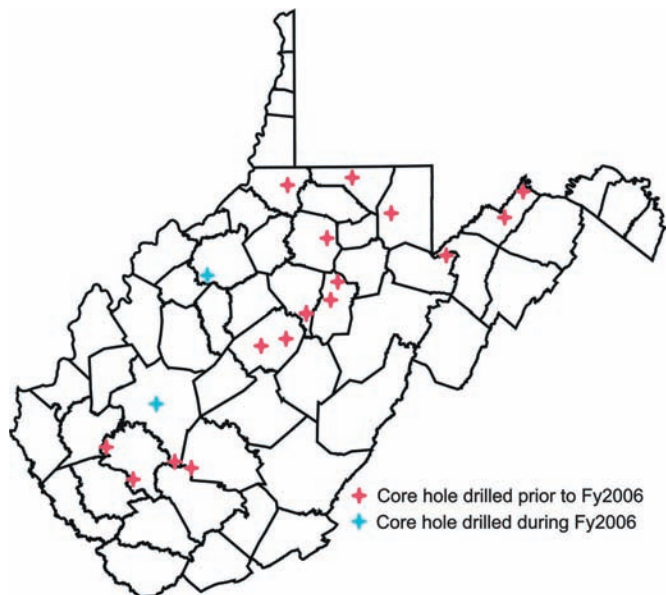
	<u>Total</u>	<u>Agency General Revenue</u>	<u>GIS General Revenue</u>	<u>Approp. Special Revenue</u>	<u>Other Special Revenue</u>	<u>Approp. Federal Revenue</u>
Personal Services	\$ 1,988,796	\$ 1,152,290	\$ 452,906	\$ 17,776	\$ 294,273	\$ 71,551
Personal Services Reimbursements	336,331		336,331			
Annual Increment	44,399	36,887	5,644	465	1,403	
Insurance & Retirement Fee	19,586	8,245	7,494	175	2,644	1,028
Matching FICA	175,201	87,549	59,077	1,007	22,153	5,415
Public Employees Insurance	353,205	185,631	117,879	1,637	41,269	6,789
Workers' Compensation	37,856	16,900	12,985	319	6,003	1,649
Retirement Benefits	243,156	122,959	82,637	1,550	30,333	5,677
PEIA Transfer	19,335	11,393	4,825	286	2,831	
Office Expense	6,390	2,134	406	185	3,539	126
Printing & Binding	729	729				
Building Rental	7,654	175	7,479			
Utilities	35,575	35,415	160			
Telecommunications	16,009	13,192	2,817			
Contractual	381,613	11,142	316,212		54,259	
Travel	84,408	27,834	30,344	4,240	4,409	17,581
Computer Services	11,150	8,880	572	190	916	592
Vehicle Rental	8,398	1,774	4,416			2,208
Machine Rental	15,347	8,664	1,423		5,260	
Association Dues	805	300	505			
Insurance Premiums	35,375	35,375				
Household Supplies	1,707	1,675				32
Advertising & Promotional	4,954	2,074	600		2,280	
Vehicle Expense	13,210	5,184	5,859			2,167
Research Expense	31,907	4,614	182		19,792	7,319
Maintenance Contracts	72,469	14,602	42,442	6,519	2,902	6,004
Merchandise For Resale	4,261				4,261	
Cellular Charges	1,017	1,017				
Hospitality	6,074	2,055	1,891		2,128	
Miscellaneous	1,648	1,205	103		241	99
Training & Development	3,847	175	597		3,075	
Postal & Freight	4,556	1,625	27		2,804	100
Computer Supplies	88,086	10,894	18,176	18,068	25,948	15,000
Miscellaneous Equipment	10,183	986	499	906	7,337	455
Bank Costs	1,264				1,264	
Office Equipment Repairs	568	568				
Household Equipment Repairs	2,899	2,234	553			112
Building Repairs & Alterations	3,151	1,315	1,836			
Vehicle Repairs	815	815				
Other Repairs & Alterations	116		116			
Office Equipment	8,711	8,711				
Computer Equipment	25,223		25,223			
Land Improvements	8,975				8,975	
Indirect Cost Reimbursement	<u>43,449</u>				<u>22,107</u>	<u>21,342</u>
<b>Total</b>	<b>\$ 4,160,408</b>	<b>\$ 1,827,217</b>	<b>\$ 1,542,216</b>	<b>\$ 53,323</b>	<b>\$ 572,406</b>	<b>\$ 165,246</b>



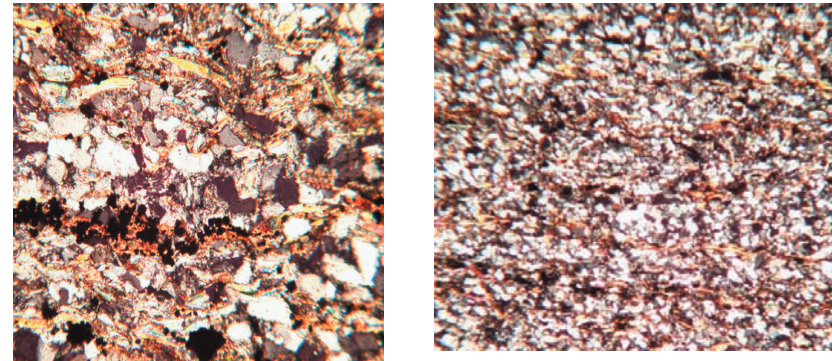
## APPLIED COAL RESOURCES INVESTIGATIONS PROGRAM

### 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 roadcuts; maps of underground coal mines; and a host of other important information. Most data collection throughout the year was associated with the Coal-bed Mapping Project. 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. The included map shows the general location of the various holes. Two test holes (blue) were drilled in fiscal year 2006. One, drilled near Big Chimney in Kanawha County, was intended to solve some perplexing stratigraphic problems, and the other test drilled with an industry partner on the State-owned Ritchie Mines Property in Ritchie County to investigate deep coal beds and their coal-bed methane potential. Following is an example of the types of research geologists at the Survey conduct to assist West Virginia businesses to be safer and more productive.



Geologist J.Q. Britton examined microscopic sedimentary features from thin sections from roof rocks of a mine to help determine possible factors in roof control problems. He determined that one factor adversely impacting roof stability was concentrations of subhorizontally aligned micaceous grains which lowered the rock's tensile strength, increasing the likelihood of roof falls.



**The colorful bands in the above photomicrographs are subhorizontally aligned concentrations of micaceous material. Increased abundances of micas in rocks can inhibit formation of secondary cement, lowering the rock's strength. The white and gray areas are quartz grains, while the black grains are secondary pyrite.**

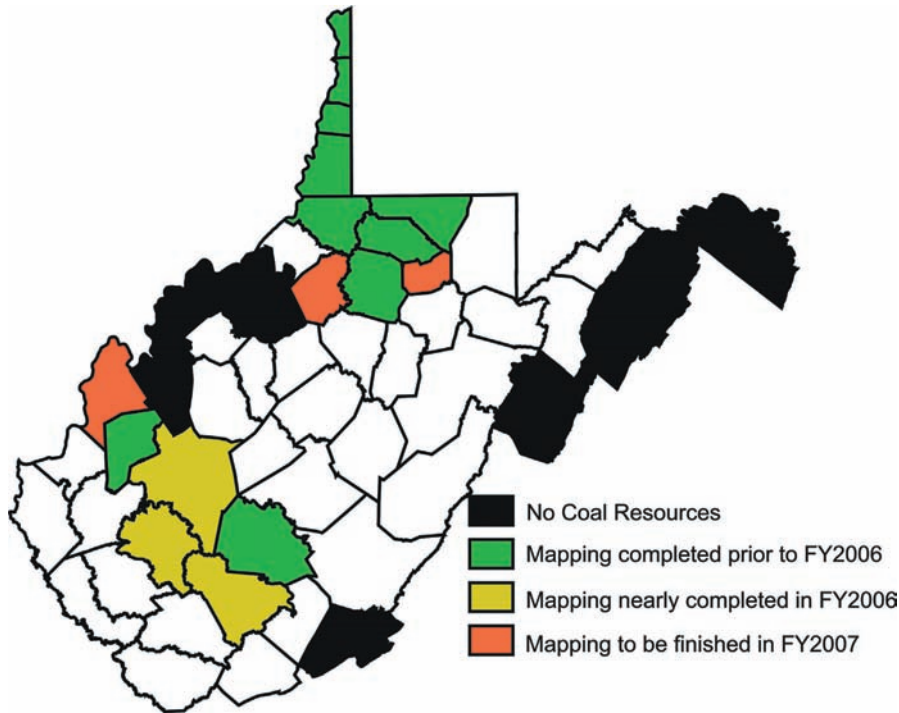
Coal Geologist and Manager B.M. Blake, Jr. assisted in the Sago Mine disaster investigation. He examined several anomalies in the mine roof near the origination point of the explosion to determine their genesis and possible connection to the explosion. Blake determined that the anomalies were fossilized tree trunks and, as such, likely played no role in the explosion.

### Encyclopedia of West Virginia Contributions

B.M. Blake, Jr. had several articles included in the newly released **Encyclopedia of West Virginia**. These articles include Coal, Marshall's Pillars (Hawk's Nest State Park), Economic (non-fuel) Minerals, Pinnacle Rock State Park, and articles on Pleistocene (Ice Age) Lakes in West Virginia.

## Coal-bed Mapping Project

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 fiscal 2006, mapping of minable coal beds were completed for 10 counties and the majority of three additional counties (see map). It is anticipated that coal seam mapping for Boone, Doddridge, Kanawha, Mason, and Taylor counties will be finished in fiscal 2007. Completed maps were delivered to the Department of Tax and Revenue in mid-June, 2006, and are publicly available on the Survey's Web site.

## Coal-bed Methane Activities

Coal-bed methane is an underutilized but growing energy resource in West Virginia. Coal Program geologists have worked cooperatively with various coal companies and natural gas companies describing the lithologies from coal-bed methane exploration drill holes in Barbour, Braxton, Nicholas, Ritchie and Upshur counties. Program monies were expended to cooperatively deepen an industry exploration hole in Upshur County to test deeper strata than the cooperator planned. As discussed above, the Survey drilled an exploration drill hole to test coal and coal-bed methane potential on a State-owned site within the Ritchie Mines Properties.



## Coal Quality

The Coal Program maintains and continually enhances a computerized database of the chemical and physical characteristics of West Virginia coals. The database currently contains over 35,000 sample analyses and is one of the largest public databases of coal quality information in the nation. 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. Policy makers often call on the Survey's coal quality expertise to gauge the potential effects of legislation on the State's coal industry.



## Comparison of Mid-Carboniferous Floras

B.M. Blake, Jr. is participating in a National Science Foundation-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. Findings will be compared with vegetative patterns of change during the Pleistocene. Blake presented preliminary results of his part of the study at a workshop in Sosnowiec, Poland in August, 2005, and at the annual meeting of the Geological Society of America in Salt Lake City in October, 2005.

Besides the benefits of increased understanding of vegetative evolution and distribution patterns during the Carboniferous, the work provides the opportunity to heighten public awareness of the severity of climatic oscillations recorded during an earlier period of Earth's geologic history and the implications for the present day. W.H. Gillespie, paleobotanist, is also a cooperating scientist on the project. Lead investigators are Dr. H.W. Pfefferkorn of the University of Pennsylvania and Dr. R. Gestaldo, Colby College.

## National Coal Resources Data System (NCRDS)

For nearly 20 years, the Survey has received grants from the U.S. Geological Survey's NCRDS program to build the West Virginia portion of a national computerized database dedicated to coal information. This database is used for a variety of investigations including the Coal Availability Study, 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.

**Pictures of *Sphenopteris elegans* (left) and *Mariopteris laciniata* (right) from uppermost Upper Mississippian beds in Mercer County. These plants also occur in similar-aged rocks in Poland and Belgium and are useful in determining relative ages of rocks across the Earth.**

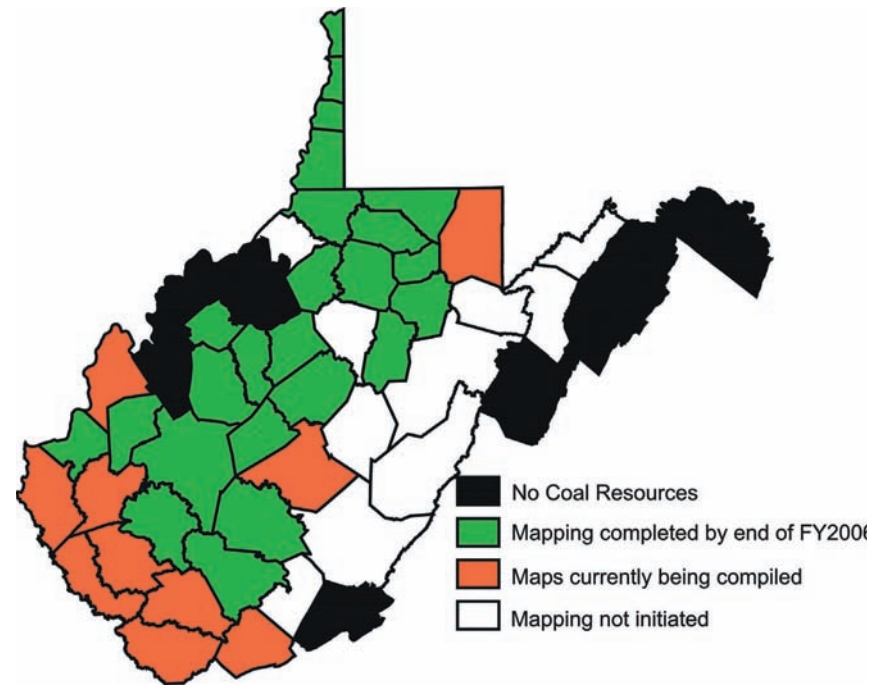




## Underground Mine Mapping Project

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 Miners' 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 mapping efforts. Funding was awarded in 2003 and received in 2004. MHST is focusing on collecting and archiving maps of underground mines, while the Survey is accelerating compilation of mined areas in a geographic information system format. Mining compilation directly benefits mapping conducted under the Coal-bed Mapping Project.

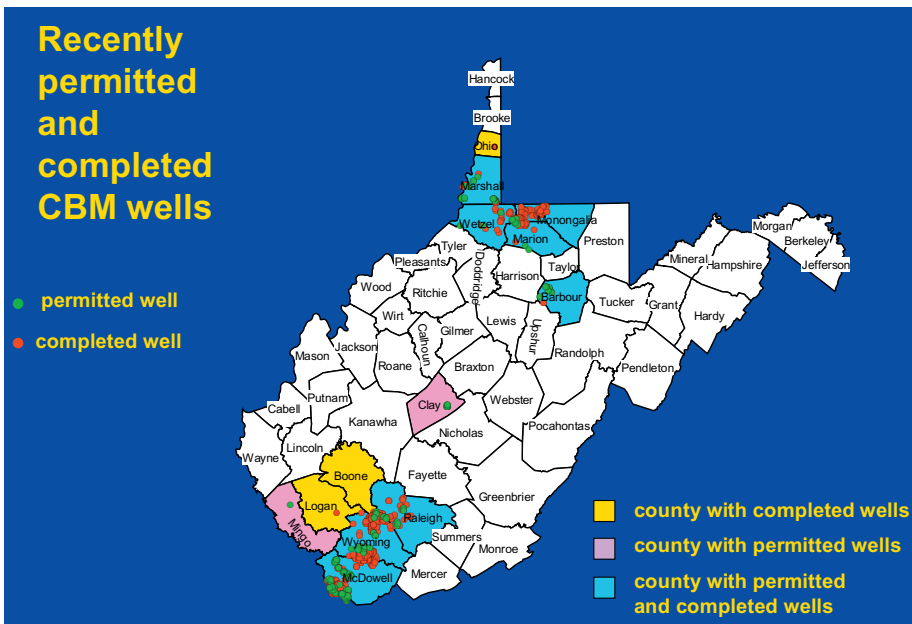
As of the end of fiscal 2006, all available mine maps from 24 counties have been examined, inventoried and where appropriate, the mine footprint has been digitized and entered into the Survey's comprehensive coal geographic information system (see map). Compilation of mining in additional areas continues and finished areas are updated as new data become available.



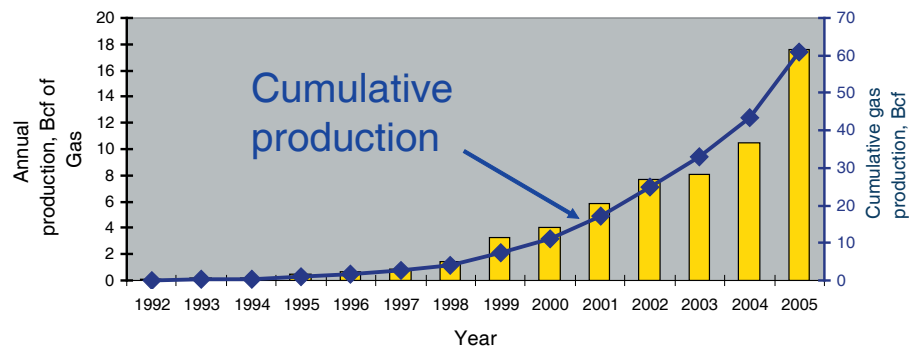
**Coal-bed Methane**

Coal-bed methane production and drilling has continued to increase. As of June 30, 2006, records for almost 700 wells had been received by the Survey (Figure 1). Production continues to increase as well, with calendar year 2005 production totaling more than 17.6 billion cubic feet (Bcf) of gas (Figure 2). Most of the activity to date has been in southern and northern West Virginia; however in the spring of 2006, several wells were permitted in Clay County. Production includes post-mining gob gas or coal-mine methane, pre-mining de-gasification of coals using a multilateral horizontal drilling system, vertical fractured wells, and simple horizontal wells. The Survey Web site has available downloadable files containing data for individual coal-bed methane wells.

**Figure 1**



**West Virginia CBM Gas Production**



**Figure 2. Annual and Cumulative CBM production for WV; total 62 Bcf of gas; 2005 production >17.6 Bcf.**

**Trenton-Black River**

The Survey completed work on a two year contract with the U.S. Department of Energy (USDOE) to create a regional play book for the Trenton-Black River limestones in the Appalachian Basin. Although nearly 300 wells were permitted to these zones in West Virginia from 1999 through 2004, only about 10 percent of the permitted wells were drilled. Cumulative production from the West Virginia wells is about 10.1 Bcf through 2005. Even with this additional deep drilling, there are still large parts of West Virginia that are not well-explored at depths below a few thousand feet.

**Technology Transfer**

The Appalachian Region Petroleum Technology Transfer Council (PTTC) continued to provide timely workshops on a variety to topics to a broad range of attendees. Funding for this program from the USDOE will be zeroed out in early 2007, so efforts are underway to identify other sources of funding for this program. Since its inception in 1996, the Appalachian Region PTTC has hosted over 100 workshops with over 5,000 registrants;

maintained a Web site 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 well-log interpretation and analysis; rocks to models for reservoirs; well testing; well safety; geochemical exploration techniques' well control; and drilling and completion technology.

### **Carbon Dioxide Sequestration**

The Survey 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 USDOE. 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 began on Phase 2, which will include more detailed characterization of selected intervals identified during Phase 1, as well as some pilot tests throughout the region.

Chief Geologist D.G. Patchen is serving on a task force to examine issues associated with regulations and permitting for potential CO<sub>2</sub> sequestration activities.

### **FutureGen**

The Survey teamed with the West Virginia Development Office to prepare the State's application for a FutureGen power plant site. The proposed FutureGen plant will be a zero-emission, integrated combined cycle plant, administered by the FutureGen Alliance, with funding from the USDOE. The proposed West Virginia site was not selected in the first round, but an appreciation for this process was gained. Prior to the application preparation, Petroleum Geologist and Manager K.L. Avary and Coal Geologist and Manager N. Fedorko had evaluated eight sites for the Development Office as to their potential for serving as a FutureGen site.

### **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, 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, database updates, and digital conversion of relevant maps is currently 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 USDOE-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 (WVU), among others. The WVU team includes members from the National Energy Technology Laboratory (NETL), the West Virginia Geological and Economic Survey, and the departments of Petroleum and Natural Gas Engineering, Civil and Environmental Engineering, and Geology and 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-Survey researchers organized their effort into five subtasks: computational modeling and visualization; determination of key physical data; a structural integrity investigation; risk assessment; and a cost-effectiveness investigation. Dr. T. Wilson of WVU and D.G. 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. H. Siriwardane of WVU.

Initially, geophysical studies, subsurface characterization and structural integrity modeling were focused on the coal-bearing interval overlying the

Granny Creek oil field in Clay County. However, during 2006 the potential of collaborative efforts with a gas company and a large coal company that produces natural gas from coal beds were explored. Although the gas company declined an offer, discussions are continuing with the coal company.

The activities of each subtask being investigated by the WVU ZERT team require certain data to accurately perform flow and geomechanical simulation and geophysical monitoring and reservoir assessment. Therefore, one of the goals in support of the team's efforts is to obtain a variety of core, log, and geophysical data for input into team's models. To achieve this goal, actively being pursued is a cooperative field venture in an area of coal-bed natural gas production and perhaps CO<sub>2</sub> injection, if possible.

### **Basic Oil and Gas Data**

As part of the Survey's mission to archive and make available basic data on the State's mineral resources, work continued on the Oil and Gas Database. In addition, a new photocopy/scanner machine was acquired late in the fiscal year. The new scanning capability will make it possible to scan plats and well records and provide these to customers. In addition, scanning of wireline logs continued, supported largely with funding from the USDOE. Also late in the fiscal year, a major clean up of the core and sample warehouse was undertaken in preparation for a large donation of cores from the old U.S. Bureau of Mines Reservoir Evaluation Program.

## GENERAL GEOSCIENCE PROGRAM

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

### Geologic Mapping

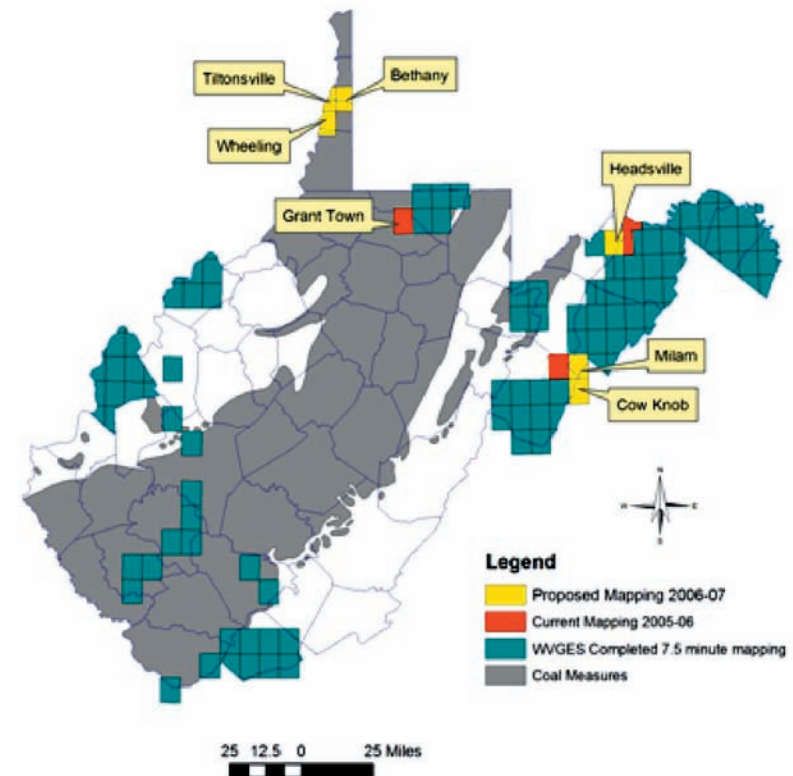
One of the primary activities of the General Geoscience Program is geologic mapping and the creation of new 7.5-minute geologic quadrangle maps. Status of this mapping is shown below. During fiscal year 2006, mapping efforts were carried out in the eastern panhandle, the northern panhandle, and in north-central 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 were submitted in May. Proposals for two mapping projects were successfully funded for 2006-2007, and work commenced on six new quadrangles.

Senior Research Geologist R.R. McDowell, Geologist. Program Head K.L. Avary, and Geologist J.Q. Britton completed the open-file geologic map of the Mozer (Pendleton, Grant, and Hardy counties) 7.5-minute quadrangle and began mapping both the Milam and Cow Knob (both Pendleton County) 7.5 minute-quadrangles. Cooperating geologists S.L. Dean and B.R. Kulander completed mapping of the Springfield and Patterson Creek (Mineral and Hampshire counties) 7.5-minute quadrangles, and began mapping the Headsville (Mineral and Hampshire counties) 7.5-minute quadrangle. Geologist G.H. McColloch, Jr. and Geologist/Hydrogeologist J.S. McColloch completed the open-file geologic map of the Grant Town (Marion County) 7.5-minute quadrangle, and began mapping the West Virginia parts of the Wheeling (Ohio and Marshall counties), Tiltonsville, and Bethany (Ohio and Brooke counties) 7.5-minute quadrangles.

These completed digital maps and accompanying text and cross sections 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. This project will also result in digital GIS data sets and maps conforming to newly adopted American Association of State Geologists guidelines.

### West Virginia Geological and Economic Survey Status of 1:24,000 Geologic Mapping

October 15, 2005



Status of 1:24,000 geologic mapping by the West Virginia Geological and Economic Survey as of October 15, 2005.

## Other Mapping-Related Projects

**Derivative Map Project**—This is a pilot study using geologic data and other information to develop derivative maps to aid in the visualization of geologic hazards and other environmentally-related aspects in the areas of Jefferson and Berkeley counties east of 78-degrees west longitude, in West Virginia’s eastern panhandle. Further work is planned as more digital geologic map data becomes available from the Digital Map Compilation Project.

**Digital Map Compilation Project**—This project will produce geographic information system (GIS) data sets and digital maps of legacy geologic information. Currently, source material is limited to recent 1:24,000-scale published and open-file report maps deemed acceptable for inclusion in the data set. Line work for all maps is initially digitized at a scale of 1:24,000 and then generalized to a scale of 1:100,000 for inclusion in the National Geologic Map Database. 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.

To date, 1:100,000-scale digital data are available for 48 7.5-minute quadrangles located in the eastern panhandle. The more detailed 1:24,000-scale work is in progress, supported by matching funds provided by the U.S. Geological Survey’s STATEMAP Program. Other work planned in this project includes digital compilation of any remaining acceptable 1:24,000-scale published or open-file report maps, a “maps-on-demand” printing and plotting system, compilation of the 1:250,000-scale West Virginia State Geologic Map, preservation of the 1:62,500-scale county report series geologic maps, and other early agency-published maps.



**Rugged topography is characteristic of the Washington Formation of the Dunkard Group, west of Hagens on the Grant Town 7.5-minute quadrangle.**





Survey geologists look for microscopic fossils in an outcrop to help determine if the rock here is the Devonian Needmore Shale or one of the other fine-grained units exposed in the Cave Mountain area, Grant County, West Virginia.



A Survey geologist examines an outcrop of the Ames Limestone and marine shale and the overlying Grafton Sandstone in a roadcut along State Route 67 near McKinleyville, Brooke County. The Grafton Sandstone was deposited in a system of stream channels in this area during the Late Pennsylvanian. The Ames has been partially eroded by a channel in this roadcut. Approximately 3,000 feet to the north of this location, the Ames has been completely eroded by a channel, and the Grafton Sandstone is in contact with the underlying Harlem coal.

## Geoscience Education

Geoscience education is another major component of the General Geoscience Program, and it is nearly half-way through its second decade of providing professional development “teacher experiences” to West Virginia’s kindergarten through 12th-grade (K-12) science teachers. The cumulative number of provided “teacher experiences” since 1992 now stands at 7,992. (One professional development “teacher experience” represents outreach and assistance in the form of a time-intensive workshop, field trip, professional presentation and/or publication opportunity to a single teacher.) These contacts have resulted in the indirect transfer of Survey and geological knowledge awareness to more than 159,000 classroom students in all 55 counties.

Using teachers as a vehicle to reach young citizens, the program’s goal is to increase awareness of earth science in general, the Geological and Economic Survey in particular, and the reasons for understanding the role geology plays in our state’s past, present, and future.

To accomplish these goals, educators are trained and provided experiences that can be translated into classroom-useful activities and lessons. The Geoscience Education Program cooperated with Fairmont State University and the Educator Resource Center at the NASA IV and V Facility to provide 38 teachers with a series of Project GLOBE workshops funded by the West Virginia Higher Education Policy Commission. This project was a direct result of Geoscience Education Program general revenue funding which provided matching funds available to secure the grant.



**Introducing and teaching use of global positioning satellite (GPS) units to teachers in Harrison County.**

### Data Collection

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, 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.

### Outreach

One hundred CD copies of the **Mountain State Coal** publication were provided for use in workshops and classes conducted by the faculty of Fairmont State University and West Virginia University.

### Service

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).



**Droop Mountain Battlefield State Park, as shown in this 2003 West Virginia Statewide Addressing and Mapping Board aerial photo and superimposed park map, is located on a ridge top along U.S. Route 219 north of Droop in southern Pocahontas County. West Virginia Division of Natural Resources, Parks, and Recreation, requested the Survey's assistance in locating a new public supply water well.**



## Geographic Information System (GIS) Program

### Mineral Lands Mapping Program

The Mineral Lands Mapping Program (MLMP) continued into its 10th year. The MLMP is a cooperative program between the Survey, West Virginia Department of Tax and Revenue, and the West Virginia GIS Technical Center at West Virginia University (WVU) to remap the economic coal units of West Virginia for tax valuation purposes. The Survey portion of the program, the Coal-bed Mapping Program (CBMP) is explained elsewhere in this report.

### West Virginia Statewide Addressing and Mapping Project

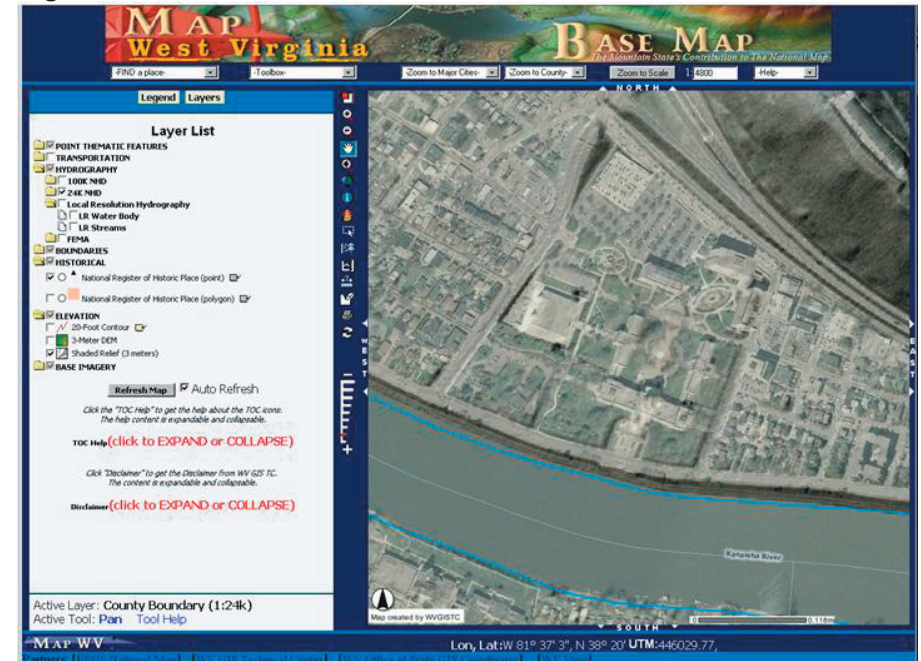
The State GIS Coordinator continued to serve as the Chair of the Statewide Addressing and Mapping Board (SAMB). L.A. Cielensky served as SAMB Executive Secretary. During 2006, the SAMB focused on the addressing portion of the project, including deployment of a centralized addressing database management system, and development of the addressing database at the county level. As chair, the GIS Coordinator worked in close association with the project management team, the addressing contractor, other board members, and county 9-1-1 officials.

### Cooperative Mapping Programs

The State GIS Coordinator cooperated with the West Virginia GIS Technical Center at WVU to receive a \$50,000 Cooperative Agreement Program grant from the Federal Geographic Data Committee (FGDC). The grant will be used to fund the development of a new statewide GIS strategic plan as well as the organization efforts of the newly created West Virginia Association of Geospatial Professionals (WVAGP).

In December 2005, the [www.mapwv.gov](http://www.mapwv.gov) portal (Figure 1) debuted as part of the GIS data clearinghouse services offered by the GIS Technical Center at WVU. The project was made possible by a previous FGDC CAP grant award supported in part by the State GIS Coordinator's office.

Figure 1



Data from the SAMB project continues to be developed for the benefit of the State. In 2005, the GIS Technical Center at WVU, in cooperation with the State GIS Coordinator and the U.S. Geological Survey (USGS), completed development of one-ninth arcsecond, or 3-meter ground resolution, digital elevation data for the State. The new data replace the 25-year old 30-meter digital elevation data derived from the 1:24,000-scale USGS topographic quadrangles (Figure 2). *West Virginia is the first state in the nation to have this resolution of high-quality publicly available elevation data.* The data also is part of the National Elevation Dataset (NED), hosted by the USGS.



SAMB stream centerline data also serves as the foundation for the development of the Locally Enhanced National Hydrological Dataset (L-NHD).

The GIS Coordinator has been involved in discussions for cooperative

data development for use of the SAMB data for Federal Emergency Management Agency flood map modernization efforts and with the U.S. Census Bureau regarding preparations for the 2010 census. The copy of the SAMB statewide planimetric data was delivered to the Census Bureau to align and correct omissions in the TIGER data set for use in preparations for the 2010 census.

**Figure 2**



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- Blake, B.M., Jr., N. Fedorko, and G.H. McColloch, Jr., 2006, State Summaries: West Virginia: **Mining Engineering 2005 Annual Review**, p. 122-125.
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- Matchen, D.L. and R.R. McDowell, 2005, Significance of Marine Ichnofossils in the Mississippian Black Hand Sandstone of Central Ohio: **Geological Society of America Abstracts with Programs**, vol.37, no. 7, p. 143.
- McColloch, G.H., Jr. and J.S. McColloch, 2006, **Bedrock Geology of the Grant Town Quadrangle, Monongalia and Marion Counties, West Virginia**: West Virginia Geological and Economic Survey, publication OF-0106, 1:24,000 scale.
- McDowell, R.R., K.L. Avary, B.M. Blake, Jr., T.D. Grote, and D.L. Matchen, 2005, Late Devonian Marine-Nonmarine Transition in the Catskill Clastic Wedge: Curiouser and Curiouser: **Geological Society of America Abstracts with Programs**, vol. 37, no. 1, p. 71.
- McDowell, R.R., K.L. Avary, J.Q. Britton, D.L. Matchen, P.J. Waggy, L.C. Walkup, and M.S. Burns, 2005, **Preliminary Bedrock Geologic Map of the Mozer Quadrangle**: West Virginia Geological and Economic Survey, publication OF-0505, 1:24,000 scale.
- Wickstrom, L.H., J.A. Harper, D.A. Barnes, K.L. Avary, and B.C. Nuttall, 2006, CO<sub>2</sub>-Sequestration and Enhanced Oil Recovery Potential in the Michigan and Appalachian Basins: **AAPG Annual Meeting Abstracts**, Houston, TX.

## PRESENTATIONS

- Petroleum Geologist and manager K.L. Avary made a presentation on West Virginia Coal-bed Methane drilling and production activity at a workshop sponsored by the Interstate Oil and Gas Compact Committee. The workshop was designed to educate K-12 teachers in southern West Virginia about coal-bed methane. She made a presentation to the West Virginia Public Energy Authority on West Virginia's oil and gas resources and reserves, and prepared a report and made a presentation to the West Virginia Department of Corrections on the oil and gas potential on State prison properties.
- Geologist G.H. McColloch, Jr. gave a talk, "Thirty Years of Coal Production in West Virginia: 'Energy Crisis' to Present," at the 2005 American Association of Petroleum Geologists Eastern Section Meeting.
- Statewide GIS Coordinator C.A. Neidig made a presentation at the West Virginia Telecommunicators Association Annual Meeting, Charleston.
- Education Specialist and Manager T.E. Repine, Jr. and Dr. D. Hemler of Fairmont State University presented "Assessing and Addressing Preservice Teachers' Misconceptions about Earth Systems" at the ASTE Annual International Conference, Portland, OR.



## AWARDS, ELECTIONS, APPOINTMENTS, SERVICE

- Petroleum Geologist and Manager K.L. Avary served on the Honors and Awards Committee of the Eastern Section, American Association of Petroleum Geologists (AAPG) and became Chair of the Committee in September, 2005. She is a member of the AAPG Student Job Quest, Professional Women in Earth Sciences (PROWESS), and AAPG Committee Oversight Committees. Avary is the Eastern Section AAPG Advisory Council Representative and is the delegate elected to represent the Appalachian Geological Society in the AAPG House of Delegates. She served as the Eastern Section AAPG representative on the House of Delegates Resolutions Committee, serves on the West Virginia Coal Bed Methane Review Board, served as a mentor for the Shlemon Mentoring Program in Applied Geology at the Southeastern Section Meeting of the Geological Society of America, and served as faculty advisor for the West Virginia University AAPG Student Chapter. With Senior Research Geologist R.R. McDowell, Avary worked with a K-12 teacher while doing STATEMAP field work. The teacher, a veteran of the RockCamp and Geoteach programs, was an integral part of the STATEMAP mapping team. Avary and McDowell also conducted a field trip in eastern West Virginia for a geology class from Concord University and a geology club from Keene State University, New Hampshire, and one for State Secretary of Commerce Tom Bulla. Avary was the General Chair for the 2005 meeting of the Eastern Section AAPG, held in Morgantown September 18-20, 2005. Also serving on the organizing committee for the meeting were Associate State Geologist M.E. Hohn, technical program chair; Senior Research Geologist R.R. McDowell, field trip chair, Data Analyst S.C. Kite, registration chair, Geologist/Hydrogeologist J.S. McColloch, judging chair; Geologist G.H. McColloch, Jr., assistant judging chair; and Chief Geologist D.G. Patchen, workshop chair and hotel liaison. The Survey co-hosted the meeting with the Appalachian Geological Society; over 300 people attended.
- GIS Executive Secretary L.A. Cielensky received a certificate of appreciation for her work with the West Virginia Enhanced 9-1-1 Council, and a certificate of completion for attending the annual State Purchasing Card Workshop sponsored by the State Auditor's Office.
- Geologist G.H. McColloch, Jr. served as Chair of the American Association of Petroleum Geologists (AAPG) Energy Minerals Division Honors and Awards Committee and served on the North American Geologic Map Data Model (NADM) Steering Committee. The NADM Steering Committee sponsors and facilitates cooperative development of digital infrastructure for geologic map databases and works on behalf of the sponsoring agencies to develop products and ideas that can be adapted as agency standards for geologic map databases. McColloch also served as a member of the joint U.S. Geological Survey/American Association of State Geologists Data Capture Working Group. This committee is charged with helping to promote more efficient and useful methods for digital mapping and GIS analysis.
- Statewide GIS Coordinator C.A. Neidig is Chair of the West Virginia Statewide Addressing and Mapping Board; is Communications Committee Chair for the National States Geographic Information Council (NSGIC); and served on the Evaluation Review Committee for the 2005 STATEMAP Program, and on the committee developing the organizational structure and bylaws for the West Virginia Association of Geospatial Professionals. Neidig served as a judge at the 2006 West Virginia Geography Bee, sponsored by the West Virginia Department of Education and the National Geographic Society, and made numerous visits to county commission meetings and other county offices in conjunction with statewide addressing and project. The office answered dozens of calls from the general public regarding the statewide addressing project. In addition, Neidig completed a professional grant proposal writing workshop sponsored by West Virginia State University.
- Chief Geologist D.G. Patchen is the Eastern Section Councilor for the American Association of Petroleum Geologists (AAPG) Energy Minerals Division; is chair of the AAPG Domestic Sections Committee and the Eastern Section AAPG Technical Meetings Committee; and is the delegate elected to represent the Pittsburgh Association of Petroleum Geologists in the AAPG House of Delegates. Patchen served as the Eastern Section AAPG representative on the House of Delegates Nominations Committee and 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. Patchen also continued to participate in the Visiting Geologist Program of the AAPG.

**WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY STAFF — Fiscal Year 2006**

Carl J. Smith, A.M., C.P.G.\*\* ..... Director and State Geologist  
 Michael Ed. Hohn, Ph.D. .... Director and State Geologist  
 John D. May, M.B.A. .... Deputy Director Finance and Administration

**ADMINISTRATIVE AND FACILITIES MAINTENANCE**

Gloria J. Rowan, B.S. .... Administrative Service Manager  
 Linda C. Carlier ..... Administrative Clerk  
 Judith A. Sparks ..... Receptionist/Director’s Secretary  
 Gary C. Rowan\*\* ..... Maintenance Man  
 David M. Vukmanic\*\* ..... Maintenance Man  
 Louis W. Curkendall ..... Maintenance Worker

**APPLIED COAL RESOURCES INVESTIGATIONS**

Nick Fedorko III, M.S. .... Coal Geologist and Manager  
 Bascombe M. Blake, Jr., M.S. .... Senior Geologist Assistant Manager  
 David E. Anderson, B.S. .... Geologist I  
 Tayrn A. Bell, B.A. .... GIS Technician  
 James Q. Britton, M.S. .... Geologist III  
 Michael T. Clifford, M.S. .... GIS Technician  
 William C. Grady, M.S. .... Microscopist  
 Ronald D. Lane, M.S. .... GIS Technician  
 Edward I. Loud, B.S. .... Coal Geologist  
 Darren McConnell, B.S. .... Geologist I  
 Barnes L. Nugent, M.S. .... Geologist III  
 Charles D. Renton, B.A.\*\* ..... Lab Assistant II  
 Ledrew Stocks, Jr., M.S. .... GIS Technician  
 Jennifer L. Stump, B.S. .... Geologist I

**GENERAL GEOSCIENCE**

Jane S. McColloch, M.S., R.P.G. .... Hydrogeologist

**GEOSCIENCE EDUCATION**

Thomas E. Repine, Jr., Ed.D., R.P.G. .... Education Specialist and Manager

**COMPUTING SERVICES AND COMPUTER UPGRADES**

Mary C. Behling, M.S. .... Geologist and Manager  
 Steven A. Munro, M.S. .... Network Administrator  
 Susan C. Kite, B.S. .... Data Analyst  
 John T. Saucer, B.S. .... Database Administrator  
 Susan E. Pool, B.S. .... Programmer/Analyst II  
 Susan C. Anderton, B.S. .... GIS Technician  
 Tara R. Miller, B.A. .... Data Analyst I

**GIS PROGRAM**

Craig A. Neidig, M.S. .... Statewide Coordinator  
 Nick Fedorko III, M.S. .... Coal Geologist and Coal-Bed Mapping Project Manager  
 Richard D. Binns, Jr., M.S. .... GIS Database Administrator II  
 John M. Bocan, B.S.\* ..... Programmer/Analyst I  
 Todd Bowman, B.S. .... Information Systems Coordinator I  
 Misty L. Cawthorn, B.S. .... Geologist I  
 Leigh A. Cielensky ..... Executive Secretary  
 Gary W. Daft, Jr., B.S. .... Geologist I  
 Sarah E. Gooding, B.S.\* ..... Geologist I  
 Kendra L. Hatcher, B.S.\*\* ..... Geologist I  
 Nathan T. Heilmann, B.S. .... Geologist I  
 Robert J. Johnson, B.S. .... Geologist III  
 David A. Jones, B.S. .... Geologist II  
 J. Eric Lewis, B.S.\* ..... Geologist I  
 John T. Snider, B.S. .... Programmer/Analyst II  
 Jeanne M. Sutton, B.S. .... Geologist II  
 Brian J. Walker, M.A. .... Assistant Editor

**APPLIED OIL AND GAS RESOURCES INVESTIGATIONS**

Katherine L. Avary, M.S. .... Petroleum Geologist and Manager  
 Patricia J. Johns ..... Records Manager  
 J. Eric Lewis, B.S. .... Geologist III  
 Gayle H. McColloch, Jr., M.S., R.P.G. .... Geologist IV  
 Annie J. Morris, M.S.\*\* ..... Geologist III  
 John M. Bocan, B.A., B.S.\* ..... Information Systems Coordinator II

\*Transferred within program during year

\*\*Left during year

## PUBLICATIONS AND GRAPHICS

Charles H. Gover, Jr., B.S. .... Editor  
J. Daniel Barker, A.A.\*\* ..... GIS Cartographer  
Sarah E. Gooding, B.S.\* ..... Geologist I  
Betty L. Schleger ..... Editorial Assistant  
Charles P. Bowman ..... Production Assistant

## ADVANCED GEOSCIENCE RESEARCH

Douglas G. Patchen, Ph.D. .... Chief Geologist  
Ronald R. McDowell, Ph.D. .... Senior Research Geologist

## PUBLIC SERVICE

Steven W. McClelland, M.S. .... Coal Geologist and Manager  
Kenneth C. Ashton, B.S. .... Coal Geologist  
Michael A. Kirk, B.S. .... Publication Sales Manager  
Paul R. Liston, A.A. .... Engineering Technician/Surveyor

## COOPERATING PERSONNEL

Robert E. Behling, Ph.D. .... Geologist  
E. Ray Garton ..... Geologist/Curator  
William H. Gillespie, M.S. .... Geologist  
Thomas W. Kammer, Ph.D. .... Paleontologist  
J. Steven Kite, Ph.D. .... Geologist  
Philip A. Martin, M.S. .... Geologist  
Ronald L. Martino, Ph.D. .... Geologist

## PART-TIME EMPLOYEES

Edwin K. Berry, M.S. .... Geoscience Education  
Alison L. Behling ..... Applied Oil and Gas Resources Investigations  
John D. Beuthin, Ph.D. .... Applied Coal Resources Investigations  
Jeffrey P. Brusoe ..... Computing Services  
Mary Sue Burns, B.S. .... Geoscience Education  
Gary W. Daft, Jr., B.S.\* ..... Applied Coal Resources Investigations

Stuart L. Dean, Ph.D. .... Applied Geoscience Research  
Richard J. Diecchio, Ph.D. .... Applied Oil and Gas Resources Investigations  
Joshua K. Hull ..... Applied Coal Resources  
Byron R. Kulander, Ph.D. .... Applied Geoscience Research  
Charity L. Liston\*\* ..... Public Service Program  
Marie A. Patchen ..... Applied Coal Resources Investigations  
John J. Renton, Ph.D. .... Applied Coal Resources Investigations  
Adam Simms ..... Applied Geoscience Research  
Paula J. Waggy, M.S. .... Geoscience Education

## DIGITAL LINE GRAPH DEVELOPMENT PROJECT

### West Virginia University Department of Geology and Geography

Dr. Trevor Harris ..... Co-director  
Dr. Gregory Elmes ..... Co-director  
Kurt Donaldson ..... Senior Research Coordinator  
Eric Hopkins ..... GIS Analyst  
Kevin R. Kuhn ..... GIS Analyst  
Frank LaFone ..... Senior Internet Coordinator  
Evan Fedorko ..... GIS Analyst

## MINERAL PARCEL MAPPING PROJECT

### West Virginia Property Tax Division, GIS Development Unit

Yi-Ning Chen ..... GIS Manager  
Robert Barker ..... Tax Map Technician—Office  
Diane Leadmon ..... GIS Unit Office Assistant  
Randy Butler ..... Tax Map Technician—Field  
Leo Muncy ..... Tax Map Technician—Field  
Norbert Netzel ..... Tax Map Technician—Field  
John Wright ..... Tax Map Technician—Field  
Ron Oxley ..... Tax Map Technician—Field  
Craig Wanless ..... Tax Map Technician—Field  
Vacant ..... GIs Programmer/Analyst

\*Transferred within program during year

\*\*Left during year





(Left) A Survey geologist explains the local geology to park visitors participating in a geology walk at Watoga State Park as part of the WVGES Visiting Geologist Program.



(Right) A Survey geologist discussing geology to students from Marshall County on a science field trip to the Sinks of Gandy area.



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