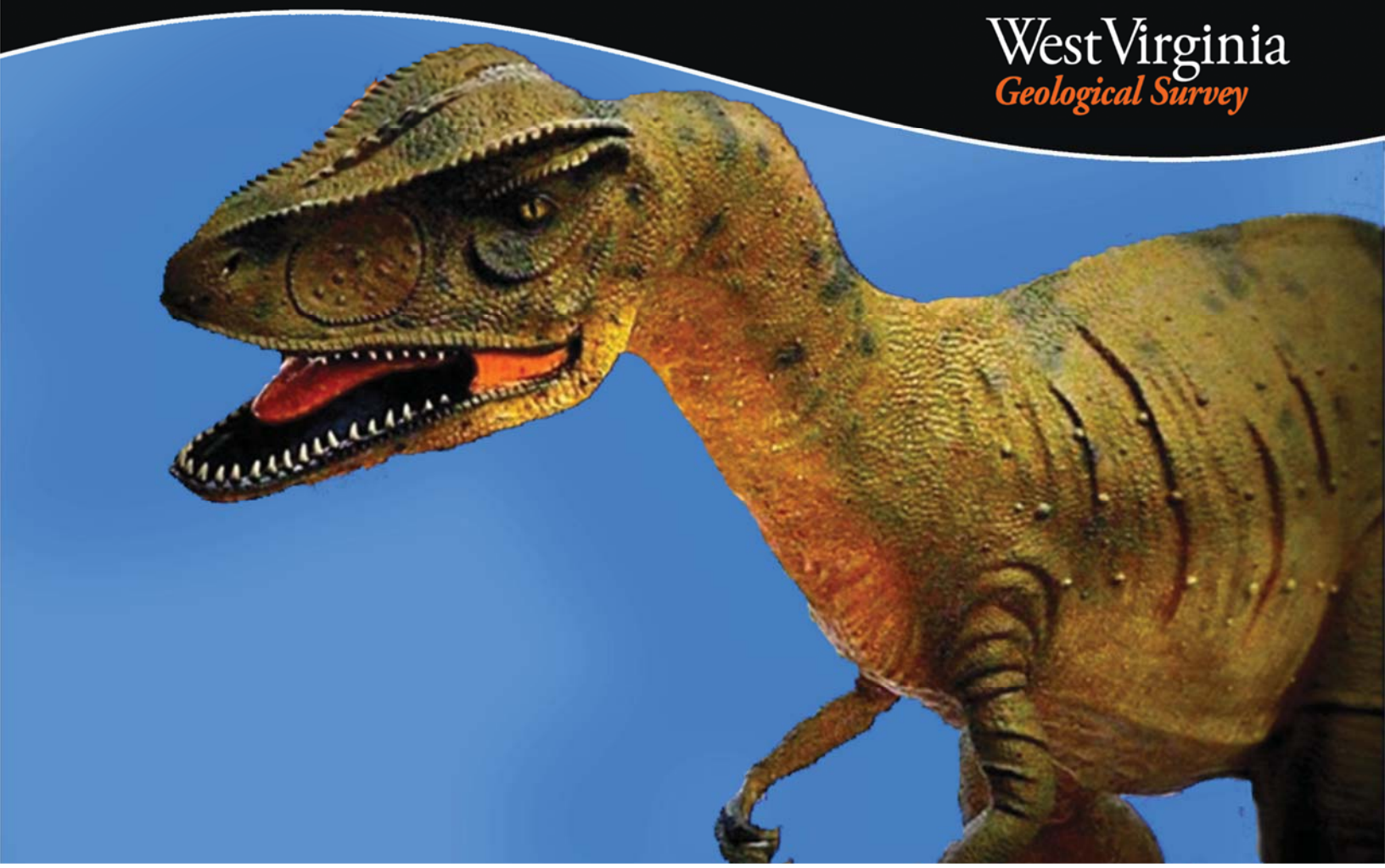
West Virginia
Geological Survey



2017 ANNUAL REPORT

West Virginia

Cover Photos

Top: Fleshed-out juvenile *Allosaurus fragilis* dinosaur model from the Morrison Formation (Jurassic Period) of central Utah, housed at the WVGES Mini-Museum in Morgantown and affectionately known as *Al*
(Photo by J.M. Bocan)

Inset: Solar eclipse as seen through telescope and filter at WVGES on August 21, 2017
(Photo by S.E. Gooding)

Technocrinus sp. a fossil crinoid in the Oriskany Formation from Berkeley Springs, West Virginia
(Photo by John M. Bocan)

West Virginia Geological and Economic Survey

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WVGES
GEOLOGY UNDERLIES IT ALL

Quarry wall in Preston County (Photo: GH McColloch)

EXECUTIVE SUMMARY

Michael E. Hohn, Ph.D., Director and State Geologist

The mission of the West Virginia Geological and Economic Survey (WVGES) is to conduct long-term analysis of the geological resources of the state, especially coal, oil, and gas, and to provide expertise and information to the citizens of West Virginia regarding geological resources and the environment through direct contact, publications, and web-based applications.

To realize this mission, WVGES conducts original geological research on current issues concerning energy, mineral resources, and the environment, and supports the development of effective, efficient state-wide geographic information systems (GIS) through the office of the GIS Coordinator.

The Year in Review

During Fiscal Year 2017, we at WVGES

- Continued working toward the long-term goal to map all significant coal seams in the state and present all results on our website in an interactive application
- Added new analyses of rare earth elements (REEs) in coal and associated rocks to our database as part of ongoing funded research
- Added new analyses of core samples to our geochemical database from a Silurian Salina Formation brine well in Marshall County
- Characterized potential options for subsurface storage of liquid ethane and other natural gas liquids along and adjacent to the Ohio and Kanawha rivers
- Monitored production of hydrocarbons from the Marcellus and Utica shale units in the state and updated maps and spreadsheets of drilling activities available for download from our website
- Continued research on potential reservoirs for carbon storage and usage, and on the effect of reservoir characteristics on wellbore integrity
- Completed geological mapping in five 7.5-minute quadrangles and prepared for mapping four new quadrangles in FY2018

The work of our partners: A significant portion of our budget supports the WV Geographic Information Systems Technical Center at West Virginia University and the Property Tax Division of the WV Tax Department.

- The WV GIS Technical Center added new GIS layers to data services provided to the public; modernized online web applications; and continued to provide education and outreach, hazard flood risk reports, and consultation services regarding new legislation.
- The Property Tax Division mapped an additional 55,000 mineral parcels; instituted major changes in tax map availability to the public; monitored tax maps in all counties; performed digital geospatial analysis for property valuation; and upgraded software.

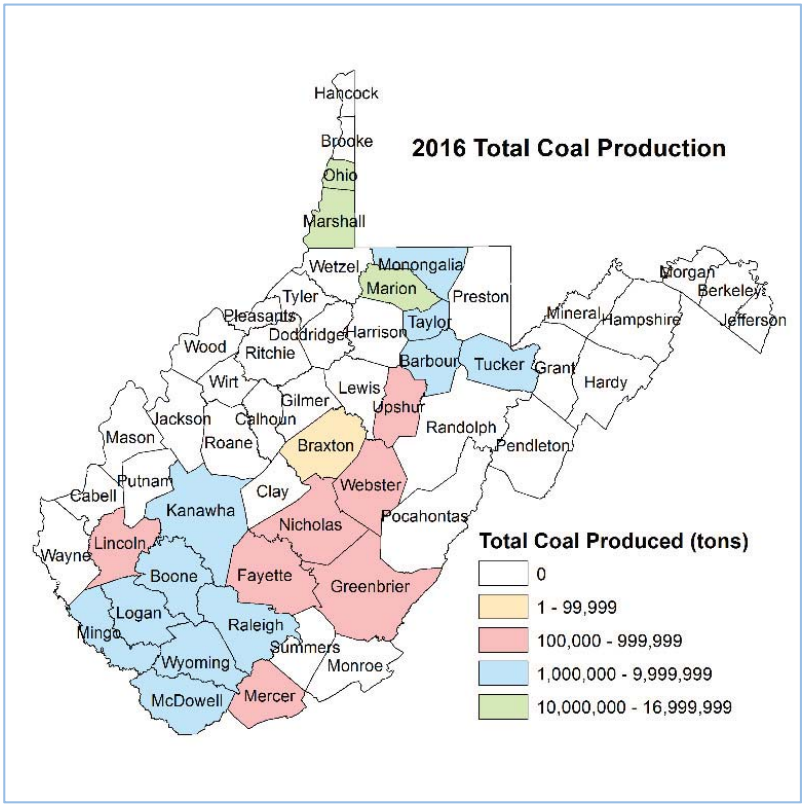
Coal outcrop known as the "Dragon's Tongue" (Photo: BM Blake)

COAL RESOURCES PROGRAM

Fiscal Year 2017 was a busy and productive year for the Coal Program with staff involved in a wide range of projects, many not necessarily in traditional coal disciplines, but all related to the Mountain State's geology.

Coal Bed Mapping

Coal Program staff have been engaged in a long-term effort to remap the Coal Measures of the state. Most of the state has been addressed, with small areas in the central and eastern portions yet to be completed. Current efforts revolve around updating mined areas, addressing newly acquired industry data, extracting coal bed site-specific data from mine maps to fine-tune coal thickness maps, and disseminating coal-chemistry data, especially rare earth elemental (REE) analyses. Maps for more than 80 individual coal beds and splits include structure contours, outcrops, general occurrence (study) area, total bed thickness, total coal thickness, total parting thickness, and mined areas by methodology.



Total tons of coal produced in 2016 by county.

- Work continued on the Coal Bed Mapping Program (CBMP), the first generation of which is nearly complete. In large parts of the Coal Measures, staff are taking a detailed look at data distribution. Thousands of new mine map control points, needed to better define coal thickness and structure, were added to the CBMP database. Staff continue to update coal bed parameter maps and serve all products out via the Survey's website: www.wvgs.wvnet.edu/www/coal/cbmp/coalims.html.

- The Coal Program has worked to acquire mine maps from various parties, annually updating mined areas provided by the West Virginia Department of Revenue-Property Tax Division (WVDR-PTD) and the West Virginia Office of Miners Health, Safety and Training (WVOMHST). In addition to documenting mined-areas-by-method, new information such as coal bed thickness and elevation data are incorporated into the various CBMP products. The Survey's coal Mine Information Database System (MIDS) is continually updated and is publicly available at www.wvgs.wvnet.edu/www/coal/MIDS_Index.htm.

Upper Freeport Coal (Photo: BM Blake)

Coal Bed Mapping (continued)

- To enhance mine-map acquisition, the Coal Program provided letters of support and a promise of "employee match" time to WVOMHST for a grant proposal submitted to the federal Office of Surface Mining (OSM) to collect, scan, and curate mine maps currently unavailable for use.

- Last fiscal year, staff began high-resolution scanning of older mine maps, most of which are on poor quality acid paper and are deteriorating. The Survey takes great pride and responsibility in the stewardship and preservation of these priceless resources. Creating digital images of these old maps will preserve the information they provide while enhancing their legibility and enabling their use in digital computing.

- Much effort was spent integrating coal bed chemistry into the CBMP stratigraphic database this fiscal year. In addition to traditional coal chemistry data, rare earth element (REE) data were collated and analyzed as part of the increasing interest in producing REEs as a separate product stream from coal mines. The Survey provided samples for REE analysis from its large Coal Sample Library to Battelle Memorial Institute in Ohio and to the US Department of Energy's National Energy Technology Laboratory (NETL) in Morgantown. The analyses provided by Battelle and NETL were added to the Survey's coal analytical database to help WVGES understand the distribution of REEs in the state's Coal Measures. Additional research opportunities involving REEs are being developed.

Professional Activities and Appointments

- Program Head Dr. Bascombe M. Blake, Jr. peer-reviewed several articles for professional journals on aspects of Middle and Upper Pennsylvanian (Carboniferous) paleobotany and stratigraphy.

- **Paleontology services:** Professional staff are always available to identify rocks, minerals, and fossils for interested parties. The Coal Program is fortunate to have a professional paleobotanist/paleontologist on staff to aid in fossil identification. Nonetheless, most of the program geologists make routine identifications as needed. Services provided by staff in FY2017 include:
    - Fossil identification for the public.
    - Paleontological impact statements prepared for pipeline companies to meet Federal guidelines for pipeline construction.
    - Peer-review of paleobotanical articles for publication in professional journals.
    - A "Stump-the-Paleontologist" semiannual show at the Moundsville archeological site.

- Several professional staff teach evening and weekend classes for Fairmont State University, Pierpont Community and Technical College, and West Virginia University. Dr. Blake and Senior Research Geologist Bill Grady hold appointments as Adjunct Professors of Geology at West Virginia University. In addition, Dr. Blake is a Research Associate in Carboniferous Paleobotany at the Natural History Museum of the Smithsonian Institution.

Professional Activities and Appointments (continued)

- Staff members serve on various steering committees. Senior Geologist Ken Ashton is currently serving a two-year term as Chairman of the Highway Geology Symposium National Steering Committee and Dr. Blake is a long-standing member of the Mine Map Steering Committee of the US Office of Surface Mining.

- Dr. Blake is a gubernatorial appointee serving on the WV Department of Environmental Protection (WVDEP) Environmental Quality Board.

Service Activities and Outreach

- One of the Coal Program's main responsibilities is to disseminate information to all parties with interest in or questions about West Virginia's Coal Measures and other rocks. The largest number of queries are related to mining and mine subsidence, followed by tax-related coal resource questions. Other commonly asked questions include aspects of general geology, paleontology, karst, non-fuel minerals, landslides, and other subjects such as "Is this a meteorite?" or "Where can I find gold in West Virginia?" (Hint: you can't . . .).

WVGES Coal and Geoscience staff leading a field trip for the American Association of Petroleum Geologists (Photo: PJ Hunt)

- Professional staff geologists routinely speak to classes and other groups on-site at WVGES, at schools, and at other venues. Discussions include many aspects of rocks, minerals, fossils, and topics requested by the individual groups.

- Staff routinely present poster displays and talks on West Virginia geology at professional regional and national meetings, such as the American Association of Petroleum Geologists and the Geological Society of America, and at local venues such as the annual Gem and Mineral Show in Morgantown in October, Monongalia County Schools Career Day in April, and the I-68 rest area for Tourism Week in May.

- Interagency cooperation is an important aspect of much of the Coal Program's work. Program staff cooperated with WVOMHST, WVDR-PTD, WV Division of Highways, and WVDEP by providing information, data, and cogent discussions on aspects of Carboniferous stratigraphy, coal geology, and general geology.

WVGES geologists measuring a coal seam (Photo: JW Perkins)

Service Activities and Outreach (continued)

- ESIC (Earth Science Information Center) manager Paul Liston provided expertise and products on aerial photographs, topographic features, geographic place names, various "corporate" boundaries, etc. ESIC maintains a large collection of legacy aerial photographs of various vintages and makes these photographs available to the public. Many of these invaluable and irreplaceable photographs have been scanned at 1000 dpi and copies are available to all interested parties. Currently there is no plan to serve these scans online due to the very large size of the individual digital images and limited bandwidth at WVGES.

- In FY2017, the Coal Program continued its long-standing cooperative coal studies with the US Geological Survey's National Energy Resources Data System program providing data, GIS shapefiles, and expertise on an as-needed basis. This program will not be funded in FY2018.

Interference ripples in the Foreknobs Formation (Photo: RR McDowell)

GEOSCIENCE PROGRAM

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 responding to inquiries regarding geology, surface water, groundwater, geologic hazards, and bedrock chemistry.

- Geochemical analyses for 24 rock samples collected from a drill core from a Silurian Salina brine well (Marshall 674) were added to the existing stratigraphic geochemical database, bringing the number of samples up to 1,106 and covering West Virginia rock units ranging in age from Precambrian through Pennsylvanian. The database is available as a GIS layer that can be combined with or superimposed on other maps of West Virginia for use in environmental and economic assessments of the near-surface bedrock of a particular geographic location.

Deformation in the Wills Creek Formation (Photo: RR McDowell)

Geoscience and Mapping for FY2017 – By the Numbers:

- *5 new bedrock geologic maps completed*
- *4 new bedrock geologic maps in progress*
- *7 active seismic (earthquake) monitoring stations in the state*
- *1,106 total number of rock samples analyzed geochemically (24 new this fiscal year)*

Seismic Monitoring

Three small earthquakes occurred in West Virginia during Fiscal Year 2017. Summaries of these and large (≥ 6.0 magnitude) earthquakes from around the world are posted on the WVGES website: www.wvgs.wvnet.edu/www/earthquakes/seismic.html.

The six seismic stations, not counting the permanent station at WVGES, remaining at the end of the Transportable Array Project continue to operate as part of the Central and Eastern United States Network operated by the Incorporated Research Institutions for Seismology, with funding from the National Science Foundation. Funding for this network is expected to continue through 2017.

Trace fossil Pteridichnites biseriatus in the Brallier Formation (Photo: RR McDowell)

Outreach Activities

- Early in the fiscal year, Geoscience Program personnel began the planning and logistics preparation for a two-day fieldtrip to be run in conjunction with the Eastern Section – American Association of Petroleum Geologists' meeting held in Morgantown in September 2017. The trip highlighted spectacular geological features exposed by new road construction along US 48 ("Corridor H").

> ***Geoscience Education Outreach***
>
> *Geoscience Education Outreach continues to operate a completely digital program providing K-12 teachers with products designed for their classroom use. This is especially important now that West Virginia requires ninth graders to take the new ninth-grade Earth and Space Science (ESS) course. The link to this information on the WVGES website is http://www.wvgs.wvnet.edu/www/geoeduc/geoeduc.htm.*

- Geoscience personnel participated in internet webinars and attended local and regional meetings featuring topics including geological hazards, induced seismicity, and environmental issues related to oil and gas exploration and development, mine pool groundwater resources, protection of groundwater resources in karst regions, hazard mitigation, and disaster preparedness.
- In September 2016 and March 2017, Geoscience personnel conducted fossil identification workshops at the Grave Creek Mound Museum Complex in Moundsville, West Virginia.
- Geoscience personnel taught evening classes in Geological Hazards and Historical Geology at Fairmont State University.
- Geoscience staff are adjunct faculty at West Virginia University.

Tonoloway Formation on US 48 (Corridor H) with Tonoloway quarry in the distance (Photo: RR McDowell)

Tonoloway Formation in the Salina F-4 Salt core from PPG Industries Brine Well #36 (API #4705100674) in Marshall County (Photo: JP Moore)

OIL and GAS PROGRAM

Appalachian Storage Hub

During fiscal year 2017, staff in the Oil and Gas Program participated in a major research project to identify potential locations for subsurface storage of natural gas liquids (NGLs). The study, which concluded in July 2017, was funded by the Claude Worthington Benedum Foundation with matching funds provided by thirteen industry partners. Research was conducted by the Appalachian Oil and Natural Gas Research Consortium (AONGRC), a program of the West Virginia University Energy Institute's National Research Center for Coal and Energy.

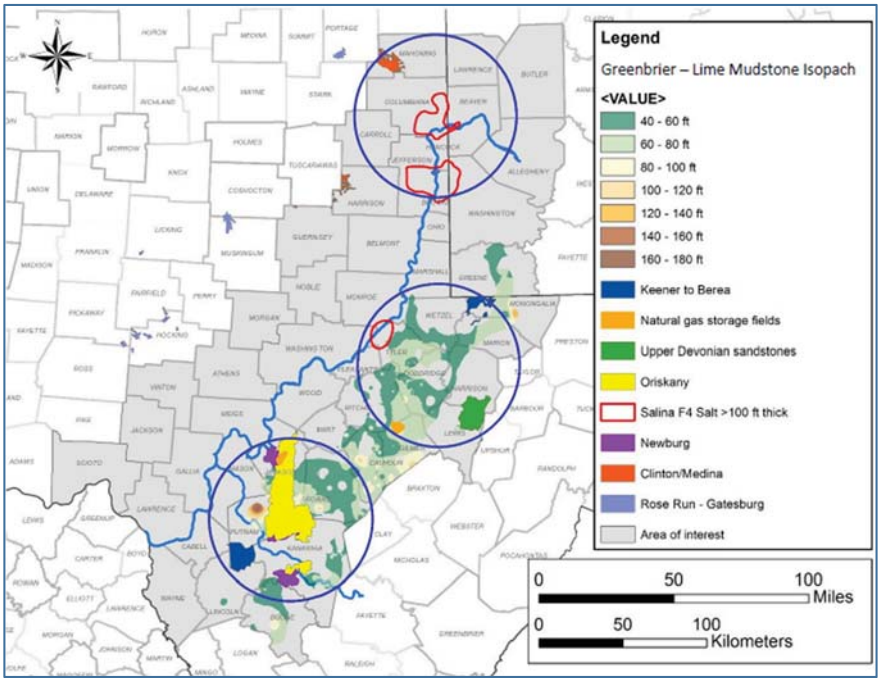


Figure 1. Location of potential targets for NGL storage determined by the ASH research partnership

Dubbed the Appalachian Storage Hub (ASH) project, the research team was comprised of researchers from the Ohio, Pennsylvania, and West Virginia geological surveys and was administered by AONGRC. The goal of the study was to characterize all potential options for subsurface storage of liquid ethane and other NGLs along and adjacent to the Ohio River from southwestern Pennsylvania to eastern Kentucky, with a similar study along the Kanawha River in West Virginia. This involved mapping and identifying areas of the Greenbrier Limestone that are at least 40 feet thick and suitable for hard-rock mining; mapping and identification of areas where the Salina F salt is at least 100 feet thick and suitable for solution mining; and mapping the thickness and extent of sandstone reservoirs in depleted gas fields that could be converted to NGL storage.

At the end of FY2017 the report was on target for the July 31, 2017 completion deadline. The project delivered three main products: a regional subsurface geologic investigation of all geologic units of interest; a detailed reservoir characterization effort, including field-level studies, rating criteria used to screen candidate fields, the final ranking of storage candidates and presentation of three prospect areas (Figure 1); and a publicly-accessible website from which to serve the above items. The website, created and maintained by the WVGES Information Services Program, can be found by visiting www.wvgs.wvnet.edu/ash.

Horizontal Drilling in West Virginia: Trends and Observations

A major focus of the Oil and Gas Program is to record, archive, and interpret oil and gas well data provided by operators in fulfillment of WVDEP regulations. This is achieved through a process that involves weekly retrieval of new documents; examination of permit documents for location information; entry of well completion data into the Survey's Oil and Gas Well Database; and interpretation and dissemination of aggregate information including production and drilling trends.

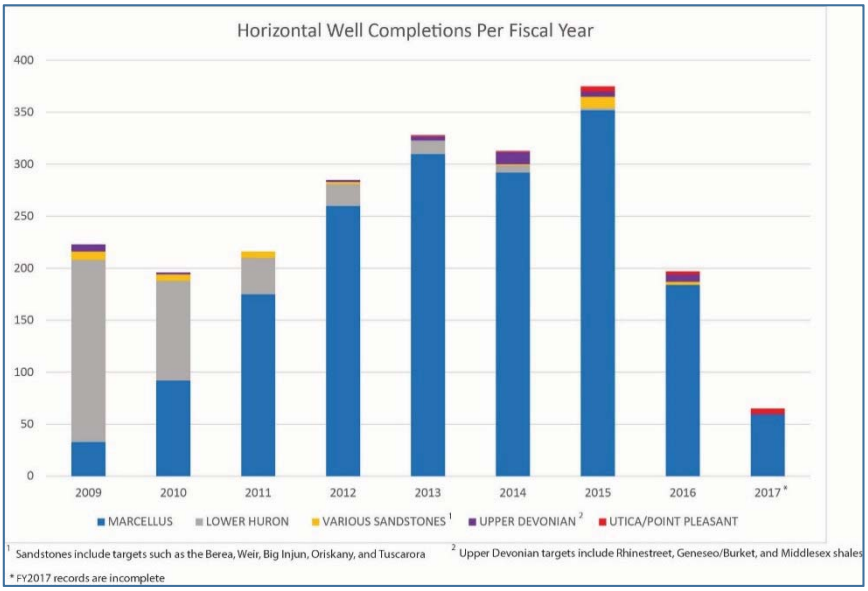


Figure 2. Number of WV horizontal well completions by fiscal year, separated by reservoir target

In the past ten years, horizontal drilling has evolved from being a relatively new technology in the Appalachian basin to being the gold standard for drilling. As operators continue to develop an improved understanding of optimal reservoir type and the best practices for drilling techniques, certain patterns emerge from the well permit and completion data. Figure 2 shows the number of wells completed, by fiscal year, to five different targets: the Lower Huron, Marcellus, "Upper Devonian" (including the Geneseo/Burket, Rhinestreet) and Utica/Point Pleasant shale units, and a collective group of "Various" sandstone or siltstone targets, which includes the Berea, Weir, and Price sandstones.

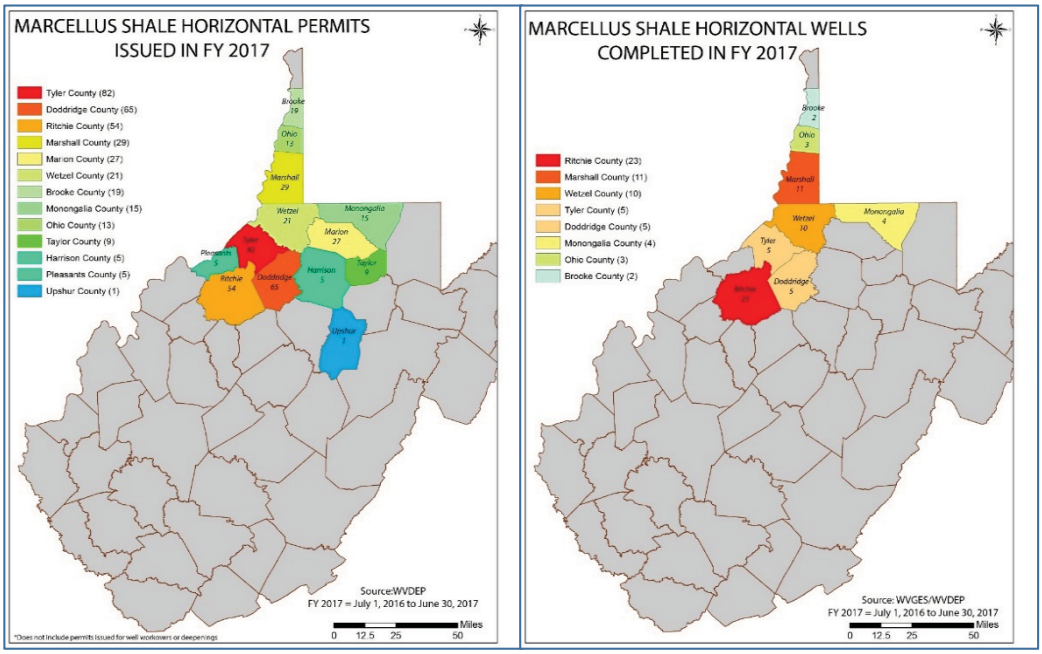


Figure 3. Left: Marcellus Shale horizontal permits issued in FY17. Right: Marcellus Shale horizontal wells completed in FY17

The data trends presented in Figure 2 show an overall decrease in the number of Lower Huron wells completed from FY2009 to FY2017.

Halite in the Salina F-4 Salt core from PPG Industries Brine Well #36 (API #4705100674) in Marshall County (Photo: JP Moore)

Horizontal Drilling in West Virginia: Trends and Observations (continued)

In FY2009, 175 horizontal wells were completed in the Lower Huron, and 33 horizontal wells were drilled to the Marcellus. By FY2011 this trend had completely reversed (175 Marcellus; 35 Lower Huron) and the Marcellus continues to be the most heavily targeted shale unit in West Virginia. Marcellus well completions reached a maximum of 352 in FY2015 and have declined steadily since then. Only 92 Marcellus wells were completed in FY2016, and WVDEP has released well completion information for just 33 wells completed in FY2017, although that number is expected to increase slightly as more completion documents become available (Figure 3).

While the number of Marcellus Shale well completions continues to decline, Utica/Point Pleasant completions increased slightly from FY2016 to FY2107 (Figure 4). Over the course of five years (FY2013-FY2017), twelve wells completed in the Utica/Point Pleasant have produced a cumulative 36 billion cubic feet (Bcf) of natural gas. By comparison, 440 horizontal wells drilled to the Lower Huron produced 78 Bcf of gas from 2007 to 2016. To phrase it differently, in fewer than three years a dozen Utica wells produced a volume of gas roughly equal to a decade of production from 200 Lower Huron wells.

The volume of gas produced from the Utica makes it an attractive, but challenging, target for operators. Vertical depths to reach the reservoir range from 10,000 to 12,000 feet, and drillers must first navigate through a thick succession of evaporites in the Silurian Salina Formation. Reservoir pressures are also very high and must be carefully monitored to prevent blowouts; pressure gradients in the Utica/Point Pleasant often approach (or exceed!) 0.9 psi/foot. Despite these challenges, the Utica/Point Pleasant presents an exciting opportunity for future development of West Virginia's shale gas resources.

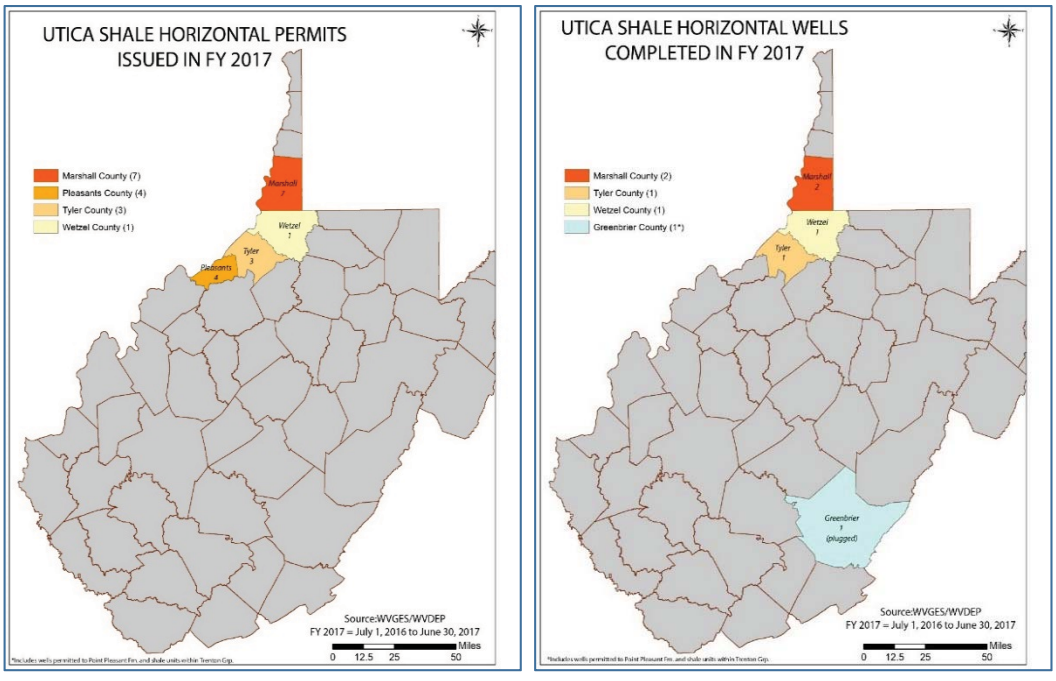
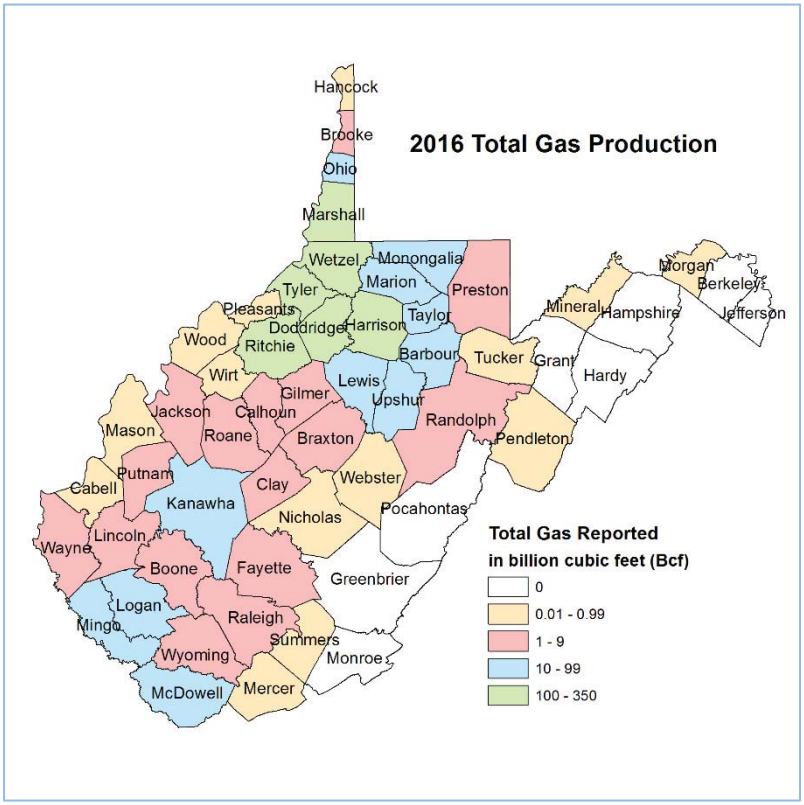


Figure 4. Left: Utica/Point Pleasant horizontal permits issued in FY17. Right: Utica/Point Pleasant wells completed in FY17

Data Preservation

Rock collections—a favorite pastime of geologists around the world—hold special significance for geological surveys. The rocks collected as drill cuttings or cores provide the ultimate ground truth for geoscientists and form an integral part of major research projects. These collections often deteriorate through time, however, and as the number of samples grows, maintaining a current inventory becomes more challenging.



Total natural gas produced in 2016 by county

In support of maintaining a robust catalog of rock samples from around the Unites States, the U.S. Geological Survey makes available funds to archive, curate, and preserve the collections. Work performed by WVGES under the FY2017 award included the purchase of new core boxes and re-boxing of several cores collected during the Rome Trough Consortium research project. These cores record the deep, and infrequently penetrated, Cambrian section. This collection of cores also contains the only publicly-held samples of the Rogersville Shale.

In addition to core boxes, new roller racks were purchased to aid in the transport and examination of cores/boxes, and shelving was purchased to store the Sandhill well, which was re-boxed in FY2016. The re-boxing effort was conducted concurrently with continued efforts to create a barcode inventory for well cuttings samples. The Oil and Gas Program greatly appreciates the support of the U.S. Geological Survey's National Geological and Geophysical Data Preservation Program and hopes to continue these efforts in the future.

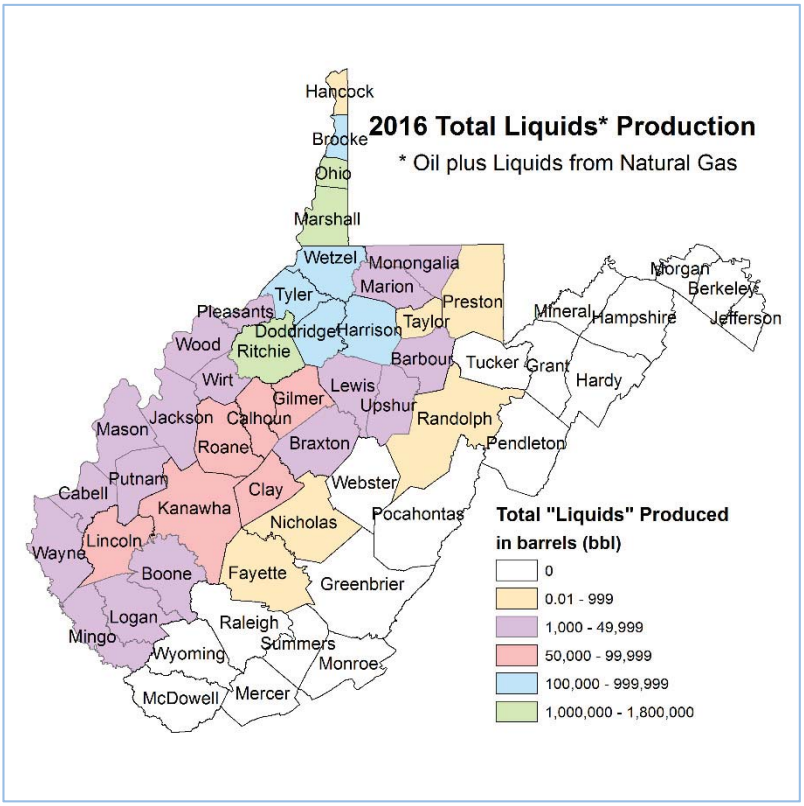
CO_2 Research

The Oil and Gas Program continues to research two different aspects of reservoir characterization related to carbon capture, utilization, and storage (CCUS) efforts. The first, in conjunction with the Midwestern Regional Carbon Sequestration Partnership, or MRCSP, is an effort to compile data related to the geologic framework of a ten-state region extending from Michigan to New Jersey. During FY2017, our geoscientists worked to finalize a database of field-level characteristics of reservoirs amenable to enhanced oil or gas recovery via CO_2 floods. This database contains more than 60,000 individual

A portion of the Salina F-4 Salt core from PPG Industries Brine Well #36 (API #4705100674) in Marshall County (Photo: JP Moore)

entries and includes information on acreage, porosity, permeability, and CO_2 storage capacity. This database serves as a complement to a set of regional cross-sections being constructed to illustrate the geologic framework of individual reservoirs. Three east-to-west cross-sections are in various stages of completion: a central section extending from Indiana to eastern West Virginia, a northern section just south of the Great Lakes region, and an onshore-to-offshore section constructed on the New Jersey coastal region.

A second research project aims to examine the conditions within a CO_2-bearing reservoir and how those conditions might affect wellbore integrity. This project focuses on a single reservoir, the Tuscarora Sandstone, which contains natural CO_2 in some locations. In support of this effort, our geoscientists identified wells penetrating the Tuscarora in southern West Virginia and used all available geophysical data to map the subsurface framework of the reservoir. At the end of FY2017 these efforts were largely complete and the resultant maps and cross-sections will be integrated with information derived from well completion reports and drilling summaries to construct a history of well work related to a CO_2-bearing reservoir.



Total oil and liquids from natural gas produced in 2016 by county

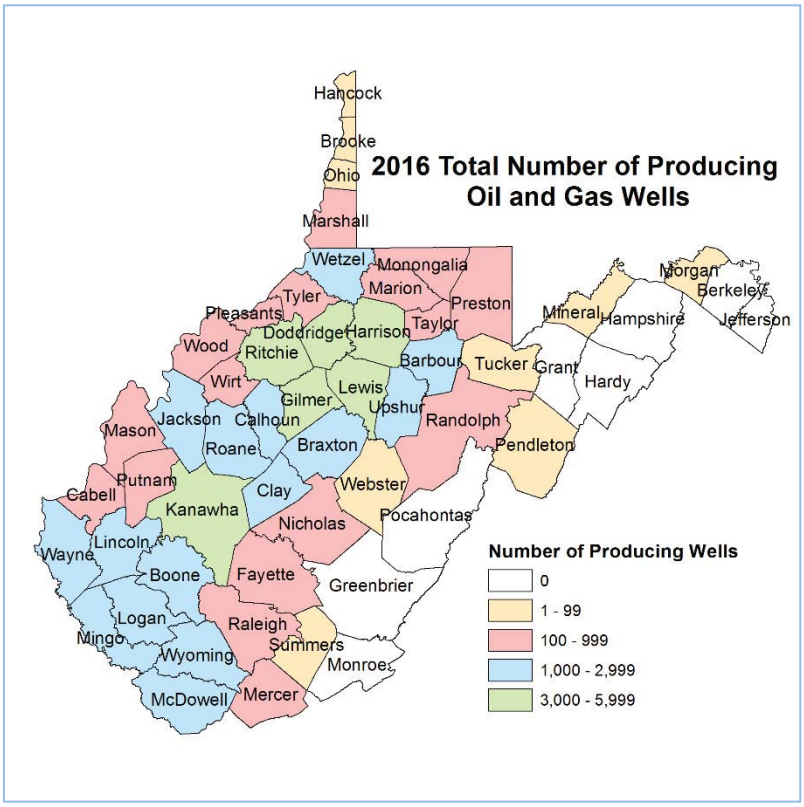
We greatly appreciate the support of Battelle Memorial Institute and the U.S. Department of Energy for their support of these research efforts.

Additions to the Oil and Gas Data Repository

It is the policy of the Oil and Gas Program to allow workers from industry and academia to access and sample the cores and well cuttings held in the WVGES repository, provided that sufficient materials exist to both allow the sampling and maintain a representative archive sample. The policy also dictates that workers must submit their results to the agency within 120 days of sampling, and results are held

confidential for one year from sampling date. This policy enables the Program to acquire data that would be cost-prohibitive to collect using state funds. Additions to the data repository during FY2017 include:

- CoreLab: Utica/Point Pleasant thermal maturity and source rock analyses;
- Cabot Oil and Gas: Rogersville Shale thermal maturity and source rock analyses; and



Total number of producing oil and gas wells in 2016 by county

2016 Marcellus Shale Production Numbers

- **Production** reported from 1,862 horizontal wells and 1,425 vertical wells
- **Gas:** 1,203.5 Bcf of natural gas produced (86.9% of all gas produced in West Virginia in 2016 was from the Marcellus)
  - Top producing counties: Doddridge, Wetzel, and Marshall
  - Top producing gas wells:
    Wetzel 3036 (EQT - 3.22 Bcf);
    Wetzel 2984 (EQT - 3.15 Bcf);
    Doddridge 6533 (Antero - 3.14 Bcf)
- **Liquids**: 6,501,038 bbl of liquids produced (85% of all liquids produced in West Virginia in 2016 was from the Marcellus)
  - Top producing counties: Ohio, Marshall, and Ritchie
  - Top producing liquids wells:
    Ohio 184 (Southwestern – 80,709 bbl);
    Marshall 1776 (Southwestern – 80,357 bbl);
    Ohio 181 (Southwestern – 79,147 bbl)

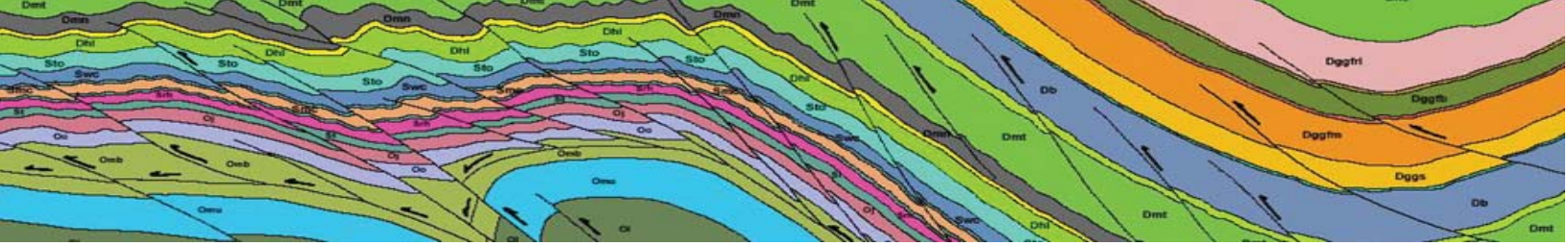
Note: Bcf = billion cubic feet, bbl = barrels, and Liquids = oil plus natural gas liquids

- Chesapeake Energy: Berea/Sunbury total petroleum system analyses.

In addition to the datasets collected by these sampling efforts, the Oil and Gas Program owes a tremendous debt of gratitude to the following industry partners:

- Cabot Oil and Gas, for their donation of specialized core boxes to aid in the re-boxing efforts of the Rome Trough (Cambrian) core set.
- Consol Energy, for their donation of thousands of paper well logs, a collection that fills fourteen industrial-sized filing cabinets and represents a comprehensive, standalone resource.

Words cannot express how much we appreciate the support of our myriad industrial and academic partnerships. These relationships have been forged through multiple generations of scientists, working together to understand the tremendous oil and gas resources of West Virginia, and have withstood the test of time. We look forward to continuing these valued partnerships for the decades ahead.

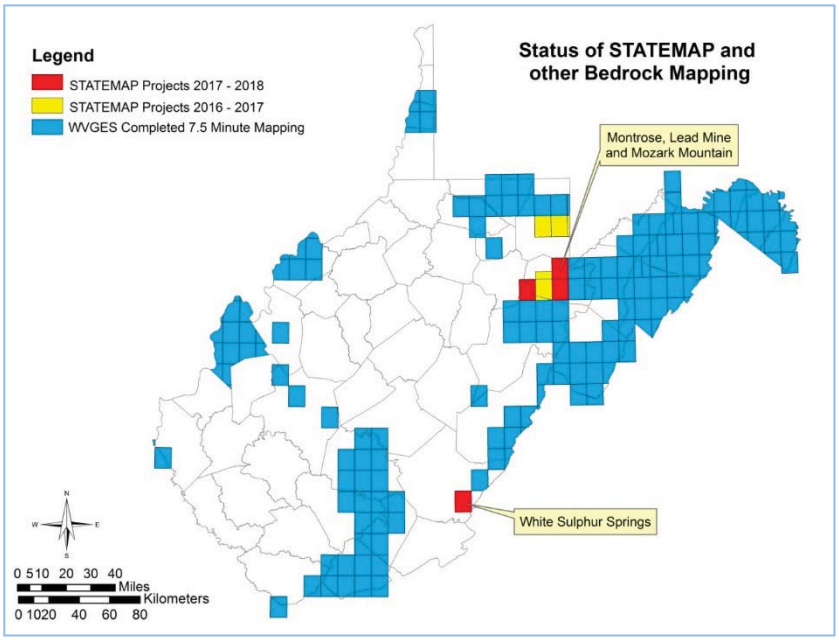


Portion of the Moorefield quadrangle's geologic cross section

GEOLOGIC MAPPING PROGRAM

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

- 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. During the summer and fall of 2016 and spring of 2017, field work was conducted on five 7.5-minute topographic quadrangles in central and eastern West Virginia: Kingwood, Terra Alta, Oakland (WV portion), St. George (southern portion), and Parsons. Published as WVGES Open-File Reports, the data are currently available as paper maps, PDF files, and geographic information system (GIS) geodatabases.

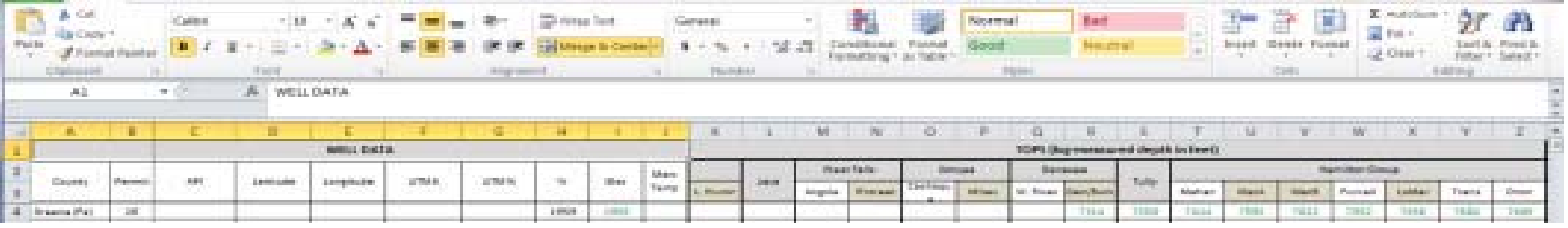


Status of STATEMAP bedrock mapping projects in West Virginia for Fiscal Year 2017

- In September 2016, the STATEMAP Advisory Committee, composed of individuals from industry, government, and academia, met to evaluate new potential map areas within West Virginia for the 2017 field season. In November 2016, a multi-project proposal was submitted to the USGS and WVGES was awarded partial funding to map the Lead Mine, Montrose, Mozark Mountain, and White Sulphur Springs 7.5-minute quadrangles. Field work on new STATEMAP projects was delayed from May until July 2017 due to the federal government's re-evaluation of certain funded projects for 2017.

WVGES and USGS geologists examine the Greenbrier Limestone in Monroe County. (Photo: JW Perkins)

- Final maps for these quadrangles will be delivered to USGS in FY2018.



Screenshot of Devonian Shales spreadsheet

INFORMATION SERVICES PROGRAM

The Information Services Program is responsible for the agency's publications, website and feedback presence, network infrastructure maintenance, server and desktop operations, developing interactive mapping applications, and programming applications in support of other programs' projects.

Public-Access Systems and Services:

- **Website**: The following were added to the Survey's website, www.wvges.org, during FY2017:
  - An updated generalized stratigraphic chart for WV (**Map-29A**)
  - 2015 oil and gas well **production data**
  - **Scientific Posters** with abstracts:
    - ***Development of Quick-Look Maps for CO_2-EOR Opportunities in the Appalachian and Michigan Basins***, Eric Lewis, Jessica P. Moore, Philip Dinterman, Michael E. Hohn, Ronald McDowell, and Susan Pool; Eastern Section of the American Association of Petroleum Geologists (ES-AAPG) Meeting, September 2016.
    - ***Developing a Karst Map for West Virginia***, Michael E. Hohn, Samantha McCreery, Jessica Pierson Moore, and Philip A. Dinterman; Southeastern Section, Geological Society of America (SE-GSA) Meeting, March 2017.
    - ***Overview of the Rogersville shale in West Virginia***, Philip Dinterman; presentation to the West Virginia Land and Mineral Owner Association's 2017 Annual Meeting, May 2017.

3-D topographic "maps" for sale at WVGES (Photo: JM Bocan)

- **Research Reports**:
  2015 Marcellus Shale Production and Utica Information, Philip Dinterman

- **Website pages** updated during the fiscal year include **Earthquakes/Seismicity**, **Karst Terrain Potential**, **STATEMAP Geologic Mapping**, **National Park Mapping**, **WV Broadband Map**, **Maps and Map Files**, **Oil/Gas Well Data DVD**, **Marcellus/Devonian Shale**, **Summary Data**, **Physiographic Provinces of West Virginia**, **Geoscience Education Resources**, **Visiting Geologists at State Parks**, **News**, **Mini-Museum**, **Price List for Services**, and **Selected Links**.

- **Web-based services** updated during the fiscal year include the oil and gas well "***pipeline***" service, "***Pipeline-Plus,***" the almost daily dynamic update of the Excel spreadsheets for **Marcellus shale wells** and for **horizontal wells**, **Scanned Well Logs**, **Coal Bed Mapping Project**, **MIDS (Mine Information Database System)**, and **Scanned Mine Maps**.

- **Web-based interactive mapping** applications updated during FY2017 include:
  - **Geology of the Marcellus Shale**, **Utica Shale Play**, and the **Coal Bed Mapping Project**.
  - Interactive mapping applications on the WVGES website include: **All (Coal) Mining Map** and **Coal Bed Mapping Project**, **WV Oil and Natural Gas Wells**, **Appalachian Basin Tight Gas Plays**, **Utica Shale Play**, **Geology of the Marcellus Shale**, **Regional Geology of the Ordovician Trenton-Black River Formations**, **WV Geothermal Map**, **Broadband Mapping Project**, and the **Topographic Map Index**.
- **Facebook page**: total posts – 32, total reach – 5,339 people, total clicks on the posts – 579, total page "Likes" – 647, total "Reactions/Comments/Shares" of the posts – 124.
- **Updates** made to the ***"pipeline"*** online oil and gas well data system reflect additions made to the well database.

By the Numbers

Website:

- More than 3,000 static and dynamic web pages
- 716,417 website visits
- 18,974,322 page views
  - Oil & gas well "pipeline" and oil & gas well data search – 18,000,000+ page views (96% of all page views)
  - Coal bed maps, coal data, & coal mine maps (MIDS) – 270,603 page views

Service Requests:

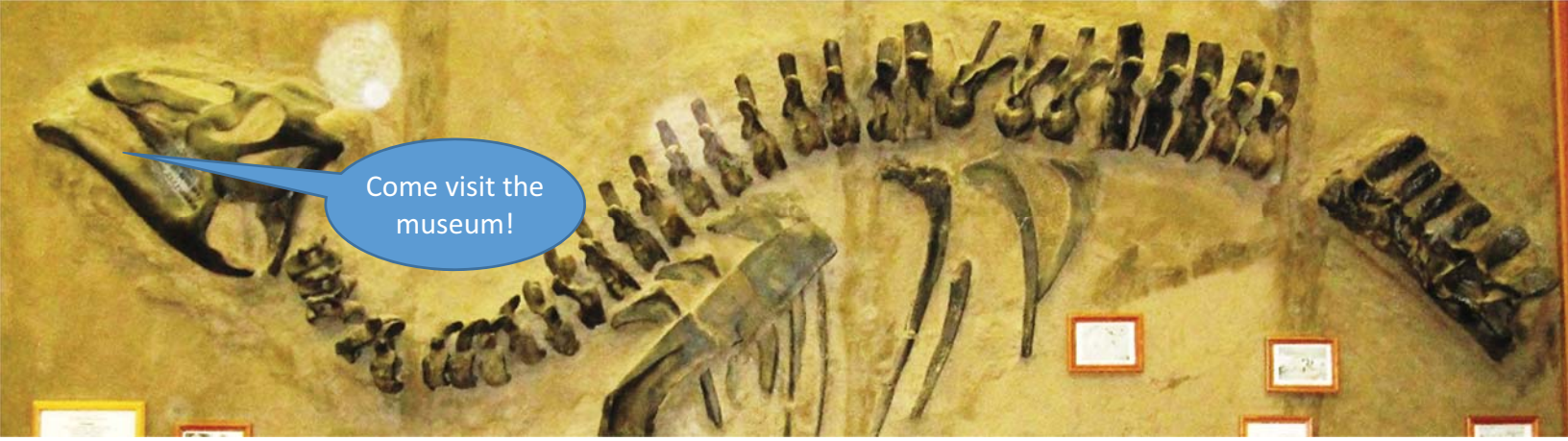
- Survey staff responded to more than 3,000 requests for information

IT Support and Professional Development:

- Program staff expanded programming to support the development and enhancement of project applications, databases, interactive mapping applications, and management of network infrastructure.

Screen shot of the Appalachian Storage Hub web page, www.wvgs.wvnet.edu/ash

- Geologist/GIS Programmer-Analyst Susan Pool is co-authoring a manuscript and associated GIS webpage on the lithostratigraphy of Upper and Middle Devonian organic shales in West Virginia, an extension of her earlier work on the Marcellus Shale in the state.
- Staff prepared customized data analysis files requested by the WV Department of Environmental Protection Division of Air Quality for their use in the preparation of reports to federal agencies.
- Program staff serve on the following committees: the State Information Technology Council (representing the Department of Commerce), the WV GIS Steering Committee, the WV Association of Geospatial Professionals Communications Committee and Conference Committee, and the USGS Community of Use – Geologic Mapping and Hazards Technical Committee. Program Head Mary Behling holds an appointment as an Adjunct Professor of Geology at West Virginia University.
- Staff designed and staffed a display booth at the annual "WV GIS Day" at the Legislature.



Come visit Hanna the Edmontosaurus at the WVGES mini-museum (Photo PJ Hunt)

WVGES Mini-Museum:

- The WVGES Mini-Museum in the Survey's office lobby and its associated web pages continue to be an important part of our outreach and educational programs. Museum displays continue to inspire and educate teachers, students, and visitors. The Mini-Museum is open to the public from 8:00 am until 5:00 pm Monday through Friday (except on State holidays). While no appointment is needed to visit the museum, organizations, groups, and classes may request a guided tour in advance of their visit. The Mini-Museum can be found on the website at www.wvgs.wvnet.edu/www/museum/museum.htm.

- The museum has 557 catalogued specimens, with 80% of them on display. The largest addition to the museum has been the loan of a fleshed-out juvenile *Allosaurus* dinosaur model (see cover page) from the Jurassic Morrison Formation of central Utah; the dinosaur is 12 feet long and 6 feet tall. The Mini-Museum section of the Survey's website features about 50 specimens with descriptions and photos.

- The skeleton of our State Fossil, *Megalonyx jeffersoni*, is undergoing a rebuild of the ribs and arms to make this 9-foot tall, 12-foot long display more stable and aesthetically pleasing.

- Museum specimens of *Dimetrodon* and *Smilodon* dinosaur skeletons continue to be a popular attraction at the I-68 Welcome Center in Preston County.

New Publications in FY2017

AR-2016 – Annual Report: Fiscal Year 2016

OF-1601 – *Surficial Geologic Map of the Gauley River National Recreation Area, West Virginia*, by J.S. Kite

OF-1602 – *Bedrock Geologic Map of the Parsons and Southern Part of Saint George 7.5' Quadrangles, West Virginia*, by J.S. Chapman, J.W. Perkins, R.J. Johnson, J.Q. Britton, B.L. Nugent, G.W. Daft, Jr., and Digital Cartography by S.E. Gooding

OF-1603 – *Bedrock Geology of the Kingwood, Terra Alta, and Oakland (WV Portion) 7.5' Quadrangles*, West Virginia, by G.H. McColloch, J.S. McColloch, S.E. Gooding, and Digital Cartography by S.E. Gooding

OF-1701 – *SEFOP 2016: Southeastern Friends of the Pleistocene Field Trip Guidebook, Blackwater Falls State Park and Vicinity, WV, 21-23 October 2016*, by M. Shaney, J.S. Kite, M. Purtrill, M. Reed, K. Konsoer, and C. Shaney

Publications Updated in FY2017

DDS-5 – *WVGES Oil and Gas Well Data for West Virginia*, April 2017

Map-29A – *Generalized Stratigraphic Chart for West Virginia*

GEOGRAPHIC INFORMATION SYSTEM PROGRAM

The Geographic Information System Program, headed by the statewide GIS Coordinator, is responsible for planning, organizing, coordinating, and delivering high-level Geographic Information System (GIS) advice to agencies in state government.

The program continues to make headway in a number of critical areas: promoting data sharing between agencies; providing technical assistance to state, county, and local government and the public; and fostering efficient and effective use of the state's geospatial capabilities.

- The GIS Coordinator continues to provide general administrative oversight of the Mineral Lands Mapping Program in collaboration with the Survey's Coal Bed Mapping Project and the State Tax Department, Property Tax Division's Mined Minerals Mapping Project. During the year, the GIS Coordinator assisted in the development of the Property Tax Division's Statewide GIS Cadastral (digital property map) platform.

Tony Simental, State GIS Coordinator, speaks to a visitor at the WVGES display during GIS Day at the WV Legislature (Photo: JM Bocan)

- The GIS Coordinator provided technical assistance to the Broadband Enhancement Council regarding broadband coverage and mapping issues and is assisting in the design and development of a broadband interactive map.

- The Coordinator provided support to the Division of Homeland Security, Department of Environmental Protection, Water Development Authority, Infrastructure and Jobs Development Council, the West Virginia National Guard, the West Virginia Intelligence Fusion Center, Hazard Mitigation Section, and other state, regional and local agencies in their search for GIS contract services, funding, and GIS application development.

- Data exchange protocols to enhance data sharing and exchange among state and local agencies established in previous years continue to be successful. These protocols began the inclusion of state and locally produced datasets in the GIS Clearinghouse maintained by the WV GIS Technical Center.

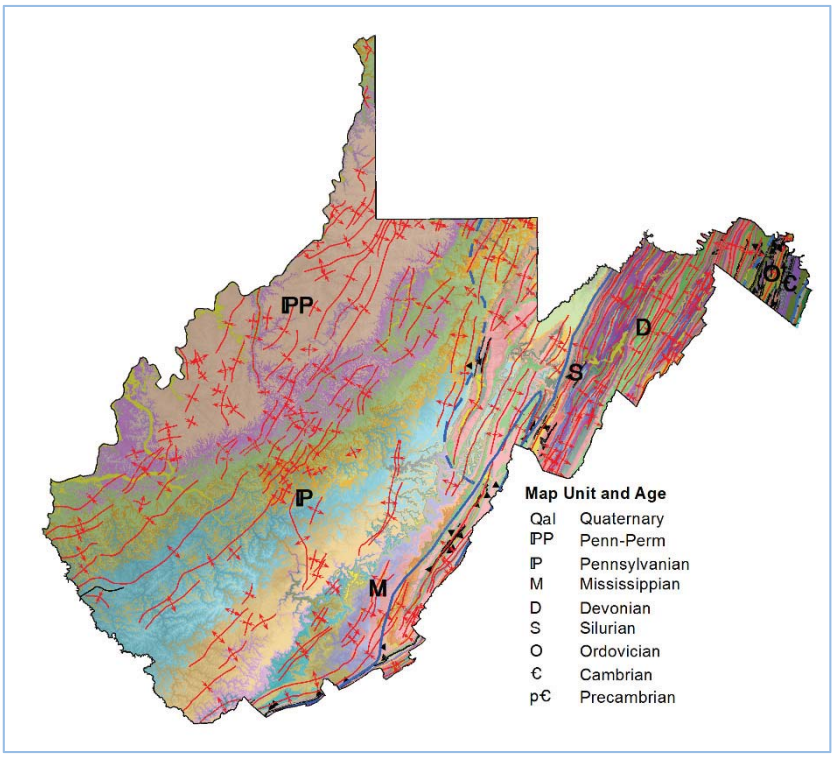
Header image from the WV GIS Coordinator's web site, www.wvgs.wvnet.edu/www/giscoord

GEOGRAPHIC INFORMATION SYSTEM PROGRAM (continued)

- The State GIS Coordinator participated in the National Emergency Number Association's GIS Data Stewardship for NextGen 911 Workgroup. The documents developed by this group will outline the development of a nationwide address spatial data infrastructure.

- The GIS Coordinator also led workshops with stakeholders to find ways to acquire statewide lidar data under the United States Geological Survey's 3D Elevation Program (3DEP).

- GIS workshops developed and presented in collaboration with the WV Association of Geospatial Professionals, WV GIS Technical Center, Property Tax Division, County Assessors, and 911 directors continue to be popular among GIS professionals. 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 educate those officials that have not embraced GIS technology in their own organizations. The workshops emphasize inter-agency collaboration and are held at different locations throughout the state.



West Virginia Generalized Bedrock Geology

- The GIS Coordinator attended sessions and made presentations at the National Association of Regulating Utility Commissions in Alexandria, VA, and the West Virginia Association of Geospatial Professionals 2017 GIS meeting held at the Stonewall Resort. The Coordinator participated in sessions of the Geographical Information Systems Certification Institute Board of Directors, National States Geographic Information Council Leadership Group (NSGIC), WV Information Technology Council, WV Broadband Deployment Council, E911 Council, WV Association of Professional Surveyors, and NSGIC's NextGen 911 and Broadband workgroups.

WV GIS TECHNICAL CENTER

The West Virginia GIS Technical Center, located in the Department of Geology and Geography at West Virginia University, provides focus, direction, statewide coordination, and leadership to users of geographic information systems (GIS), digital mapping, and remote sensing within the State of West Virginia. The Center was established by Executive Order 4-93 to provide coordination and technical support in the development and operation of geographic information systems (GIS) for the State.

Web Portals

The Center maintains two major web portals to distribute spatial data and information in the State. The **WV GIS Clearinghouse** (http://wvgis.wvu.edu) catalogs over 300 unique datasets valued at more than $56 million dollars, while **MapWV.gov** (http://mapwv.gov) provides a public gateway to online mapping resources in the Mountain State. These geospatial services are distributed through virtualized servers located at the Center with a storage capability of 120 TB. Web usage statistics reveal that over the last four quarters, the WV GIS Technical Center's site hosted an average of 586 visitors a day for a total of 213,959 visits by 79,711 unique visitors. Its companion site, MapWV.gov, hosted 223,606 unique visitors for an average of 1,258 visits per day and a grand total of 459,311 visits.

Table 1: Statewide Data Services provided by the GIS Tech Center

DATA LAYER	PURPOSE	PARTNERS
Aerial Imagery	Integrated hi-resolution aerial imagery from 29 counties into a statewide leaf-off imagery web map service	Counties
Parcels	Integrated parcel data and attributes for 95% of West Virginia into statewide parcel web layer. Published digital tax maps and GIS parcels on State Data Clearinghouse.	WV Property Tax Division & County Assessor Offices
Addresses	Integrated addressing data for 41 counties into statewide addressing layers for address matching services and online applications	WV DHSEM and County E-911 Offices
Public Lands	Updated 651 state and local public land units for the Protected Areas Database of the United States (PAD-US), the official inventory of public parks/protected open space for the nation	State (WV DNR, WV DOF) and local agencies
Hydrography	Updated stream geometries for every watershed that changed due to mining or new roads for the National Hydrography Dataset. Also corrected streams located outside the floodplain boundary.	WV DEP
Elevation	Elevation data compiled for more than 10 different lidar acquisition projects	WV View, WV DEP
Other Layers	Updated statewide recreational trails and advisory flood heights for Approximate Zone A flood hazard areas	WV DOT & WV DHSEM

Geospatial Data Layers (continued)

To reduce the duplication of costly data development efforts among organizations, the Center plays a crucial role in not only serving critical spatial data to state users but in updating and integrating local geospatial data within state and national geospatial databases. These framework data layers are utilized by almost all **state agencies, communities,** and the **general public** for emergency response, risk assessment, economic development, energy resource exploitation and management, transportation, natural resources, community planning, tax assessments, and health studies, to name a few. This past year the Center focused on the development of the geospatial data layers listed in Table 1 to enhance the State's Spatial Data Infrastructure. The continued development and publishing of GIS layers through the state clearinghouse node hosted by the Center supports the Mineral Lands Mapping Program and other vital programs in the State that depend on current and accurate base mapping layers.

GIS Map Applications

In addition to developing and updating geospatial base layers for the State, the Center also supports multiple state agencies with e-governance applications to meet their regulatory, communication, and information exchange goals (Table 2). The very successful WV Flood Tool (www.mapWV.gov/flood), for example, provides floodplain managers, insurance agents, developers, real estate agents, local planners and citizens with an effective means by which to make informed decisions about the degree of flood risk for a specific area or property. This past year the WV GIS Technical Center received a National States Geographic Information Council Leadership Group Geospatial Excellence Award and FEMA Letter of Appreciation for the outstanding support the WV Flood Tool provides for flood risk determinations and disaster assessments. During this fiscal year the Center modernized online web applications for state agencies: WV Division of Homeland Security and Emergency Management's Statewide Addressing and Mapping System, State Historic Preservation Office's Cultural Resources Map Viewer, and the Division of Natural Resources' Hunting and Fishing Tool. The Center also supported federal initiatives for the Marcellus Shale Energy and Environment Laboratory (www.mseel.org) and terrestrial biosphere carbon (www.carbonscapes.org).

Table 2: Statewide Map Applications supported by the GIS Tech Center

APPLICATION	PURPOSE	SPONSOR
WV Lidar Download Tool	Download raw lidar point cloud elevation data (www.mapwv.gov/lidar)	WV VIEW
WV Flood Tool	Make flood hazard determinations for flood insurance (www.mapwv.gov/flood)	WV DHSEM, FEMA
SHPO Map Viewer	Conduct Cultural Resource Section 106 reviews (www.mapwv.gov/SHPO)	SHPO
Statewide Addressing & Mapping System (SAMS)	Update address sites and road centerlines required for emergency response (www.mapwv.gov/address)	WV DHSEM, E-911 Address Coordinators
Hunting and Fishing	Search and identify hunting and fishing adventures (http://www.mapwv.gov/huntfish)	WV DNR

Table 2: Statewide Map Applications supported by Center (continued)

APPLICATION	PURPOSE	SPONSOR
WV Trail Inventory	View publicly accessible recreational trails in the State (http://www.mapwv.gov/trails)	WV DOT
Highway Plans Locator	View and download archival highway plans (http://www.mapwv.gov/dotplans)	WV DOT
Conservation Planning Interagency Coordination Tool	Determine conservation planning measures for endangered species in support of environmental site evaluations for West Virginia landowners (www.mapwv.gov/ICT)	WV DNR, NRCS
WV Base Map Viewer	Best available base map information for the public (http://mapwv.gov/base_viewer)	WVGES OGC

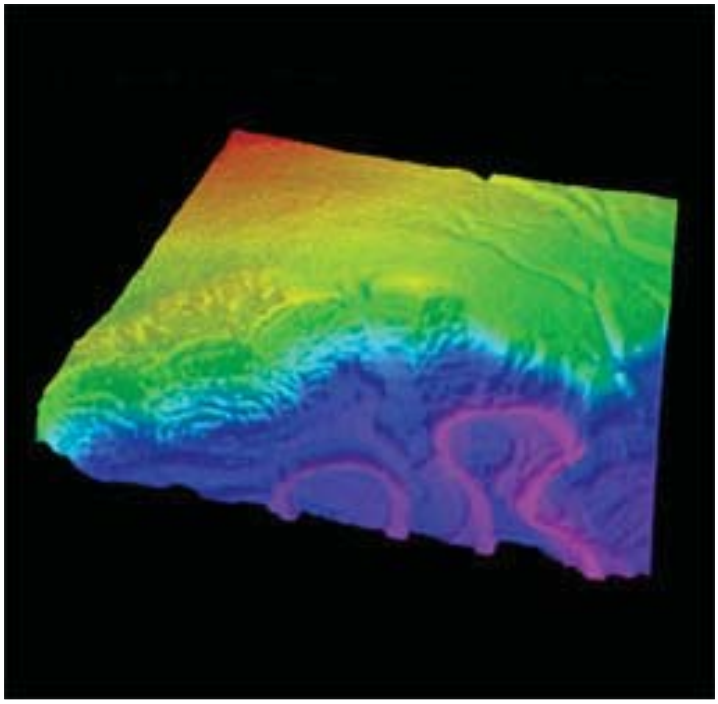
Services

This past year the WV GIS Technical Center continued to assist the WV Geospatial Community with advisory services, training programs, and the implementation of new mapping standards. These services are coordinated with the WV Office of GIS Coordination and WV Association of Geospatial Professionals.

- Educational and outreach services included organizing and hosting five instructor-led GIS training courses and presenting on the Center's geospatial initiatives and applications at the National Capitol Region HAZUS User Group Meeting, WV Floodplain Management Association Conference, Eastern Panhandle GIS Users Group Meeting, Morgantown High School GIS Day, WVDOT GIS User Day Meeting, WVDOT/MPO/ FHWA Transportation Planning Conference, and State Tax Commissioner's Annual In-Service Training for Assessors and Deputies.

- Staff completed hazard flood risk assessment reports for Berkeley and Morgan counties.

- The Center provided consultation services for approved state legislation that established new rules for tax map sales.



LIDAR representation from Jackson and Wyoming Counties

WV State Tax Department, Property Tax Division - Mined Minerals/GIS Unit

Purpose

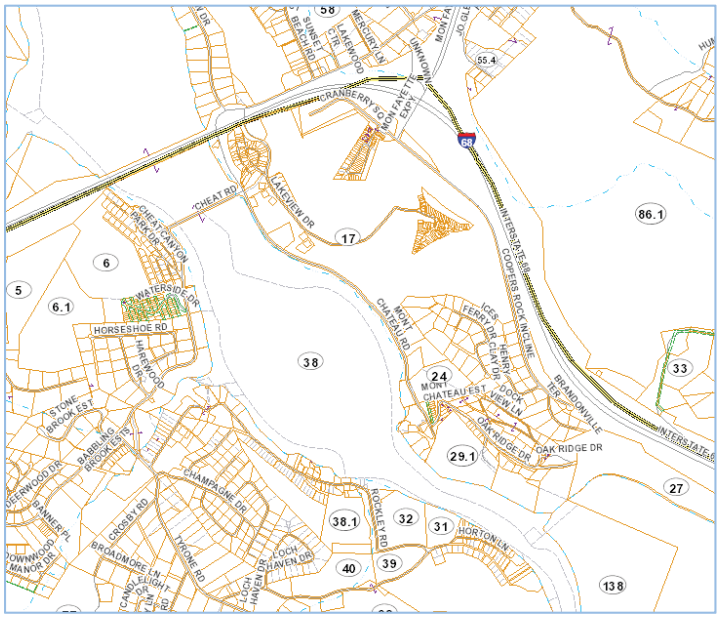
Per West Virginia Code §11-6K, the State Tax Commissioner is to value the Natural Resources Properties in the State. Coal and other mined minerals are valued, per the law, by the Mined Minerals/GIS (MMGIS) Unit of the Property Tax Division of the West Virginia State Tax Department. The unit's main goal is to accurately and equitably value the mined minerals within the State and to provide those values to the counties for taxation. The GIS section is essential because much of the valuation process is based on extensive GIS analysis. The unit aims to map and/or ensure the mapping of all properties with mineral rights in the State, to provide accurate GIS data for the tax valuation of natural resources, and to advance the availability of GIS data.

Geology

MMGIS unit's geologists perform a wide scope of geological work such as the correlation and evaluation in the areas of mining, quarrying, and environmental preservation or impact. They perform quality control on geological work from outside sources and the in-house geological mapping by computer. Annually, the unit supplies WVGES with core hole and drill hole data gathered from the Annual Appraisal for the Production of Coal reports. This information is vital to the WVGES Coal Bed Mapping Project by providing new data control points. As the Coal Bed Mapping Project is critical to property valuation, the unit closely reviews the information WVGES provides, adding an extra layer of quality control for the Geological Survey. This year, the Property Tax Division was able to fill a vacant geologist position. The unit coordinated and helped facilitate a field research visit to a coal mine to participate in the WVGES study of rare earth elements associated with coal seams.

Mapping Responsibilities

The MMGIS unit operates on an ESRI software platform and has an inventory of surface maps for all 55 West Virginia counties. Estimates show that the master data sets have 1.334 million parcels (both surface and mineral) mapped of 1.808 million possible parcels. While much of the surface is mapped, there are still mineral parcels that need to be located and mapped using field mappers. The unit is responsible for using analysis to locate deficiencies in the areas that need to be mapped. In the last year, nearly 55,000 parcels have been mapped.

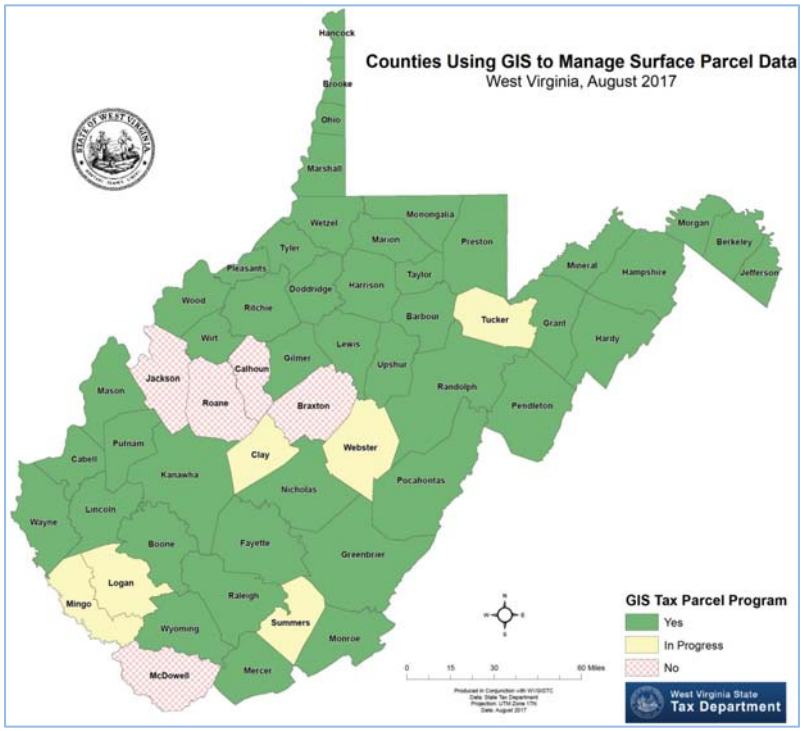


Screen capture of Monongalia County's GIS parcel map

Map Distribution

Major changes were made this past year regarding the availability and distribution of county tax maps. Due to a change in the law, the MMGIS unit transformed the way it provides access to tax maps and shapefiles. The MMGIS unit distributes the counties' surface tax maps to the public and other government agencies. Anyone can view and print a map in our office using a digital kiosk that inventories the maps and allows customers to view the maps they want. One can also download the statewide property lines in a geodatabase format through this link: http://public.wvtax.gov/Business/PropertyTax/WVSurfaceMaps/2017_Master_Surface.gdb.zip

Through a cooperative effort with the West Virginia GIS Technical Center, the county surface tax maps and shapefiles can be downloaded at: http://wvgis.wvu.edu/data/dataset.php?ID=371.



Counties Using GIS to Manage Surface Parcel Data, Fiscal Year 2017

Mapping Maintenance

The MMGIS unit works closely with the county tax assessors and their mapping personnel to ensure the compliance of their tax maps to the regulations set forth by the Property Valuation Training and Procedures Commission. The unit receives maps and GIS shapefiles (if available) from all West Virginia counties every year. To further ensure compliance with the mapping regulations, the unit monitors all 55 counties' tax maps and their map changes using a 3-year cycle. The unit also oversees manual mapping updates completed for the counties by mapping contractors and maintains mylar and linen maps for the manual counties, if needed. This year, 21 counties were monitored for map design and content, maintenance, submission, and digital parcel submission, where applicable.

Mapping and the Valuation Process

GIS is an essential part of the valuation process by providing access to contours, layers, and other natural resource features. The unit updates and maintains the geological, economic, infrastructure, and environmental mapping. It is also an invaluable asset in the location of properties for valuation as well as the mapping of Managed Timberland throughout the state. Annually, the unit performs digital geospatial analysis for Managed Timberland, the Coal Bed Mapping Project, Coal Quality, and Economic and Environmental Impact of the Mining and Severance of Natural Resources. Mineral mapping is currently being updated using sources such as taxpayer submitted maps, county parcel shapefiles, etc. The unit is also in the process of adding fee parcels to the MLMP/MPD in non-coal bearing counties such as Calhoun, Roane, and Jackson.

STATE OF WEST VIRGINIA
Department of Revenue State Tax Department

Jim Justice, Governor — Dale W. Steager, State Tax Commissioner

Tax Year 2018
TO ALL COAL PERMIT HOLDERS:

Enclosed, please find a copy of the Annual Appraisal Report for Production of Coal for Tax Year 2018, which is due **May 1st, 2017**. Instructions, which describe the procedures for completion of the report, have been updated and included. All natural resource reports, legislative rules, and procedures associated with Mined Minerals GIS Section are available on WV Property Tax Division's web site:
http://tax.wv.gov/Business/PropertyTax/Pages/PropertyTaxFormsAndPublications.aspx

All approved mining permits, regardless of the mine status, must be reported to this office. **We will accept the form *Letter of No Change on Coal Producing Properties* only if a return has been filed in previous years.** All reports filed must be completed and accompanied by a map showing the involved parcels, permit/subsidence control plan limit, etc. If you have any doubt as to what to send us map-wise, send a copy of the map submitted for permitting purposes. If it is a new operation that is being reported for the first time, the Property Tax Division will assign the NRA account number when processing the report. **Incorrect filings will be rejected and the taxpayer will be notified by the fax and/or email that must be included in the return. If we do not receive a correctly filed amended return, the property will be valued using the best available information.**

To assure that we have your most current parcel mapping we are requesting the following location information: Select a point or points representing the general location of your parcel in a known coordinate system. Our preferred Coordinate System for digital or paper format drawings and map submission is Universal Transverse Mercator (UTM), North American Datum 1983 (NAD 83) Zone 17 or 18. (UTM NAD 83 Zone 17 or 18). The recommended unit measure is the US survey meter. **We will no longer be accepting files using NAD 27 WV-S, NAD 27 WV-N or Lat/Lon.** The coordinate system must be clearly marked on the paper copy or the media label if submitting geo-referenced (preferred) electronic/digital maps. Paper maps should clearly indicate scale and parcel boundaries. Electronic/digital files must be submitted in one of the following formats, MapInfo (.tab), ESRI Shape file (.shp), Universal CAD format (.dxf), Microstation (.dgn), or AutoCAD drawing (.dwg) format. While you or your firm may use a different CAD platform, all project CAD files shall be submitted in clean and usable MapInfo (.tab), ESRI Shape file (.shp), Universal CAD format (.dxf), Microstation (.dgn), or AutoCAD drawing (.dwg) format, and should be an authentic representation of parcels included in a Producing (active) &/or a Reserve return. Also, we are requesting that the production mine map for deep mines display a geo-referenced latitude/longitude for the mine portal(s).
As you review this report and the accompanying instructions, you should note the following:

1. REQUIRED FILING

(a) Reports should be filed by all PRODUCERS or ORIGINAL PERMIT HOLDERS that have a permit on file with the West Virginia Department of Energy/Office of Miner's Health, Safety and Training. If you are a contractor with no lease rights, please forward this report to the company for whom you are contracting and notify us by mail of your status.

The Mined Minerals/GIS Unit provides information to the Department of Revenue to value properties for taxation.

Recent Achievements and Future Goals

- Recent achievements include upgrading to an ESRI enterprise level server and expanding GIS software and data availability to the entire Property Tax Division. The MMGIS met with other State government agencies using GIS for a data sharing initiative. The unit is currently developing an external web tool to enhance the statewide infrastructure for site research by counties and eventually the public. The unit has been working with a group of counties and other agencies on the relevant layers to be included in that project.

- The State Property Tax Division is currently exploring the outsourcing of our mineral field mapping which should be more efficient in product output and cost. The unit will continue to make progress in the mapping of both mineral and surface parcels, launch a project management system, and to continue to develop and introduce the external web tool.

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Principal Staff Directory and Points of Contact
June 2017

Director and State Geologist	*Michael E. Hohn, Ph.D.*
GIS Program and Statewide GIS Coordinator	*Tony Simental*
Coal Resources and Geologic Mapping	*Bascombe M. Blake, Jr., Ph.D.*
Geoscience	*Ronald R. McDowell, Ph.D.*
Oil and Gas Resources	*Jessica Pierson Moore*
Water Issues and Geologic Hazards	*Jane S. McColloch*
Information Services and Publications	*Mary C. Behling*
Earth Science Information Center	*Paul R. Liston*
Public Service	*Kenneth C. Ashton*

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304.594.2331 • fax: 304.594.2575
www.wvges.org • info@geosrv.wvnet.edu
39°39'30" N, 79°50'57" W

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

Bedrock Geology of Canaan Valley, West Virginia